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With generous support from the Bill and Melinda Gates Foundation, the State of Washington Board for Community and Technical Colleges selected eighty-one community college faculty members and gave them the task of creating an online library of complete online courses in nearly every introductory subject in the community college curriculum. The online classes in the Open Course Library are freely available to any teacher or student who wants to use them. The Open Course Library logic class, which Mark and I created, currently entitled â€œPhilosophy 106,â€ may thus be used as an additional resource to help you master the concepts covered in Introduction to Logic. (The online course that we created may also be used to supplement any logic course taught with a standard logic text.) Your teacher has the relevant information. The Many Worlds of Logic Website In addition to the Open Course Library logic course described above, you will find further self-tests, a general overview of logic, philosophical arguments that you can analyze and debate, and various materials for advanced study in logical theory at the following website: www.manyworldsoflogic.com. Once here, click on â€œPractice Quizzes with Answersâ€ (at the top) for practice problems that can help build understanding. This website can serve as a general supplement to any logic course. The requested URL was not found on this server. Additionally, a 404 Not Found error was encountered while trying to use an ErrorDocument to handle the request. Apache/2.4.41 (Ubuntu) Server at m.central.edu Port 443 This is a comprehensive introduction to the fundamentals of logic (both formal logic and critical reasoning), with exceptionally clear yet conversational explanations and a multitude of engaging examples and exercises. Herrick's examples are on-point and fun, often bringing in real-life situations and popular culture. And more so than other logic textbooks, Introduction to Logic brings in the history of philosophy and logic through interesting boxes/sidebars and discussions, showing logic's relation to philosophy. The book is especially suited for use in the "Open Course Library," a comprehensive online logic course that is open and free. Jointly funded by the state of Washington and the Bill & Melinda Gates Foundation, the Logic Course is one of 80 hybrid courses available online at no charge to the more than 400,000 students in the Washington system. The course is also available for logic courses throughout the US and the world. The Logic Course is available online now. Herrick was chosen to develop the Logic Course for the online Open Course Library. Here is a link for information on the Open Library Course Logic Course: The most affordable logic text available, Introduction to Logic is offered in both paperback and eBook formats and is ideal for any introduction to logic course. Ancillaries: An Instructor's Manual features a brief summary of each chapter of the text, answers to all the questions in the text, additional questions and exercises for instructors to use on quizzes and exams, and a PowerPoint presentation that covers the entire book. The Instructor's Manual is available on CD or online at www.oup.com/us/herrick. Also online at www.oup.com/us/herrick, students will find self-quizzes with a limited number of questions taken from the test bank. As part of the Open Course Library, instructors and students can access the entire online logic course, which features 115 video demonstrations that follow the book chapter-by-chapter, over 20 detailed PowerPoint presentations covering the most technical parts of the course, and over 40 online lectures featuring a self-test with answers for each chapter. Additionally, Herrick's website, www.manyworldsoflogic.com, exists as a general online resource for teachers and students of logic and features extra credit assignments and further study materials. Message: Untangling the complexities of logical theory using clear explanations and many examples drawn right out of everyday life Introduction to Logic By Paul Herrick (Oxford University Press, 2012) Student Workbook This document is divided into two parts. Part One contains supplementary materials created by Paul Herrick and Mark Storey, under a grant from the Bill and Melinda Gates Foundation administered by the Washington State Board for Community and Technical Colleges. These materials accompany the standard Symbolic Logic class and comprise the Open Course Library Symbolic Logic Course, Philosophy 120. Included here are online lectures covering Chapters 1 - 35 of the textbook, Introduction to Logic (Oxford University Press, 2012), and URLs for online videos on the same material. Part Two contains the Student Manual materials for the text, posted at the Student Support Page at the Oxford University Press Website. All materials from the Student Manual at the Oxford University Press Website are copyright Oxford University Press and may not be reproduced without permission. Included in this section is a summation of nearly all the definitions and rules (truth-table rules, inference rules, replacement rules, etc.) used in the text. This section ends with a list of errata for the text as of June 2013. Table of Contents Part One Lectures and Supplements.....2 URLs for the Videos.....233 Part Two Student Manual.....244 List of Definitions and Rules.....366 Errata.....391 1 Part One. Open Course Library Lectures on Logic Unit One Online Lecture 1 Overview Remarks On Unit One in General Welcome to logic class! You are about to study a subject that college students have been studying since the days of ancient Greece. Logic is one of the oldest of all academic subjects. When you begin a journey sometimes it helps to have a roadmap of where you are going and why you are on the road. Unit One, which comprises Chapters 1-6 in the textbook, presents and carefully defines all the fundamental ideas of logical theory, from the definition of logic itself, to the notion of an argument, to the definition of logical contingency at the end of Chapter 6. In these opening chapters, the basic ideas of logic are all defined in plain English, without the use of special symbols or mathematical formulas. This is a very important part of the textbook because it lays the foundation for the rest of the course. A clear understanding of the basic ideas of logic in the beginning, in English, without symbols and formulas, will prepare you for everything to follow. In short, Unit One is the launching pad for the rest of the course. After Unit One, each succeeding unit systematically deepens and sharpens one or more of the fundamental concepts taught in Unit One and applies it to a particular type of reasoning. The first unit is the conceptual foundation for the course; the material gets more technical after Unit One. This is why it is important that you study this opening unit carefully. When you start the textbook, we recommend that you read the “To the Student” greeting before you start reading Chapter 1. That page in the textbook contains important information as you start the text. Also, it is important that you read the overview of Unit One as well, on the page before the start of Chapter 1. All of this will help you get properly oriented at the start of the course. Things to Watch For as You Study Unit One The chapters in the text build on each other. Make sure that you understand Chapter 2 before you study Chapter 3, and Chapter 3 before you understand Chapter 4, and so on. 2 The concepts introduced in Chapters 1 and 2 are very elementary; things do not start to build until Chapter 3, with the distinction between deduction and induction. For a thorough understanding of this very crucial distinction—the difference between deductive and inductive arguments--study the definitions and examples carefully. The most difficult concept to master, in all of Unit One, is surely the concept of deductive validity, introduced in Chapter 4. We recommend that you pay special attention when learning this basic logical idea. The textbook explains the concept very, very carefully, with many examples. Sometimes when learning a difficult concept, it helps to hear it explained in several different ways. This is why the text explains the concept of validity in several different ways. One way of explaining the basic idea may make better sense to one person, another way of explaining it may make better sense to someone else, and so on. The explanations may be a little “wordy” at times, but they are very exact. Explanations in technical subjects often tend to be a little complicated and wordy. In addition to paying close attention to the explanations of validity, study the applications and examples carefully to really nail down the concept. The text also warns you away from certain common mistakes students often make when first learning the definition of validity and when first learning to distinguish valid from invalid arguments. These warnings are marked with a bold “Caution!” heading. Be sure to notice them! So, read the section on validity with extra care, concentrating on the definitions and the examples. Make sure you really understand this crucial idea, one of the central ideas in all of logical theory. A Word of Caution Some students take the first quiz or the first test, over the fundamental ideas of logical theory, and they ace it and are very happy. But many students take the very first test or quiz, earn a low score, and are both surprised and discouraged. They studied, and they thought they understood the material. And they are disappointed. When this happens, they sometimes express their disappointment, telling us that they studied and really thought they knew the material. In most cases, what happened was probably this: They thought they understood the material, but in reality they did not understand it very well at all. They overestimated how well they understood the material. Sometimes we fool ourselves and think we understand something when we in reality we don’t. Sometimes we only discover that we do not understand something when we test our knowledge against a more objective measure. This is true in life as well as in the classroom, isn’t it? This is why the self-tests—the “Practice Problems With Answers”—provided in the individual lectures on each chapter in the text, are so important. If used properly the online lectures (in Course Materials, Online Lectures to Accompany the Text) can give you valuable feedback. However, it is also true that the fundamental ideas of logic are not as easy to grasp as the ideas taught in Water Boiling 101. (“Place pan of water on stove, turn burner to high…”) 3 We believe that one reason the fundamental ideas of logic are more difficult (quite a bit more difficult) is that (a) they are extremely abstract and conceptual, and (b) for most of us, the authors of this course included, extra mental effort is required when we learn extremely abstract ideas. Whether the subject is calculus, physics, or chemistry, abstract subjects all require a lot of mental concentration, the power of abstraction, sustained mental attention and effort, good study habits, and effective note-taking skills. Logic is no exception. After Unit One Here is what happens after Unit One. Each unit after the first unit will analyze and sharpen certain of the fundamental ideas of logic, forming them into a system of precise thought with very exact rules for the evaluation of important kinds of reasoning. Once we enter modern logic, reasoning will be translated into a symbolic logical language much like the symbolic languages used in mathematics and computer programming. Combined with exact rules, these languages will allow us to solve problems with the precision of mathematics. Here is one way to picture modern logic: We translate reasoning from English into logical symbolism, somewhat the way mathematicians translate a “story problem” into mathematical formulas. After this, exact rules and procedures are applied and answers are found with extreme precision. Main Objectives of Unit One The student who successfully completes all six chapters of Unit One will be expected to meet all of the following objectives. 1. Demonstrate your understanding of logic by accurately defining it in your own words. 2. Demonstrate your understanding of reasoning by correctly defining it in your own words. 3. Demonstrate your understanding of how logic (as an academic subject) began by explaining its historical origin in your own words and by correctly answering relevant questions, including true-false, multiple-choice, and other types of short answer questions and essay questions. 4. Demonstrate your understanding of the basic concepts of logic explained in Unit One by correctly distinguishing arguments from nonarguments, by accurately identifying the parts of arguments, by distinguishing deductive from inductive arguments, valid from invalid arguments, and strong from weak arguments, by identifying the logical properties of sentences (necessary truth and falsity and 4 contingent truth and falsity) and by correctly identifying the presence of logical relations among groups of sentences (consistency, inconsistency, implication, and equivalence). 5. Demonstrate your understanding of the basic concepts of logical theory explained in Unit One by correctly explaining them in your own words, by accurately applying them to examples given, and by correctly answering relevant questions, including true-false, multiple-choice, and other types of short answer questions and essay questions. The basic concepts of logic covered in Unit One include but are not limited to those indicated by, or corresponding to, the following questions, problems, and operations: 1. What is logic? 2. What is reasoning? 3. How does logic differ from psychology? 4. What is an argument? 5. How does an argument differ from a nonargument? 6. What are the parts of an argument? 7. What is a declarative sentence? 8. List four different types of sentences. 9. How do declarative sentences differ from other types of sentences? 10. What is a premise indicator? 11. What is a conclusion indicator? 12. List three premise indicators. 13. List three conclusion indicators. 14. What is an inductive argument? 15. What is a deductive argument? 16. What are some common patterns of deductive reasoning? 17. What are some common patterns of inductive reasoning? 18. What is a deductive argument indicator? 19. What is an inductive argument indicator? 20. List three deductive indicators. 21. List three inductive indicators. 22. What is a valid argument? 23. How can we tell whether an argument is valid or invalid? 24. What is a logical possibility? 25. How does the logical concept of possibility differ from the everyday sense of possibility? 26. What is a counterexample to an argument? 27. How do we use a counterexample to show that an argument is invalid? 28. What is a self-contradiction? 29. What is a strong argument? 30. How can we tell whether an argument is strong or weak? 31. What is a sound argument? 32. What is a cogent argument? 5 33. How does induction differ from deduction? 34. What is an argument diagram? 35. What is the procedure for properly diagramming an argument? 36. What are the two ways that an argument can go wrong? 37. What are the two ways to effectively criticize an argument? 38. What is an enthymeme? 39. Define the logical properties of sentences (necessary truth, necessary falsity, and contingency). 40. Identify sample sentences as necessarily true, necessarily false, or contingent. 41. Define the logical relations (consistency, inconsistency, implication, and equivalence). 42. Identify the logical relations existing between sentences in groups of sample sentences. 43. What is an ideal of reasoning? State an example. 44. Solve a brain teaser and then explain your reasoning in your own words. The Core Concepts The following is a list of the most fundamental or core concepts presented and defined in Unit One. These are the basic concepts taught in virtually every standard, universitylevel logic course around the world. The concepts identified here form the conceptual foundation, the launching pad, for the rest of the course. The definition of logic (as an academic subject) Reasoning Argument Deductive argument Inductive argument Valid, invalid, sound arguments Strong, weak, cogent arguments These are the concepts emphasized in Chapters 1 through 5 of the textbook. The following very basic logical ideas are also presented in Unit One, Chapters 1 through 5. In most logic courses, the ideas on this list are covered along with the core concepts listed above. 6 The parts of an argument (premises, conclusions, indicator words) The different types of sentences (declarative, interrogative, imperative, etc.) Differences between deductive and inductive reasoning Two ways to effectively criticize or object to an argument Enthymemes Diagramming arguments The following basic concepts of logic are also covered in Unit One, in Chapter 6. In some logic courses these concepts—the ideas of Chapter 6--will be taught at the beginning of the course, in other courses they will be covered later in the course, in subsequent units as the class advances through specialized branches of logic. Thus, some teachers will skip Chapter 6, others will cover it: Consistency and inconsistency Implication Equivalence Necessary truth and necessary falsehood Contingent truth and contingent falsehood That’s our overview of Unit One. Thank you for taking this course. We sincerely hope that it will be a positive experience for you and that you will learn a great deal about logical theory. Study hard. Good luck to you! Paul Herrick, Shoreline Community College Mark Storey, Bellevue College September 4, 2011 Unit One Online Lecture 2 On Chapter 1 Every academic subject begins by defining itself and logic is no exception. Consequently, Chapter 1 (in your textbook) begins with a definition of logic. Since the definition of logic (“the systematic study of the standards of correct reasoning”) presupposes an understanding of what reasoning is, the chapter also defines reasoning. Make sure you understand these important definitions; they are pre-requisite for all that follows in this course. Chapter 1 also explains how logic began and discusses the historic role it has played in higher education since the days of ancient Greece. We always understand something better when we can place it in a larger context, and what larger context can there be, for an academic subject, than the context of world history? The historical background 7 provided in this chapter, and provided in more detail in the Appendix to Chapter One, is the background context for the rest of the course. Some teachers will choose to cover this historical background in full, and they will assign the Appendix to Chapter One. Other teachers will not require you to study the historical background included in the Appendix, and they won’t assign it. It’s all good either way. For more on the history of logic, read Appendix One at the back of the textbook, on ancient Indian logic. Written by professor Mark Storey (Bellevue College, Bellevue, Washington), this essay will give you an international, multicultural perspective on the early history of our subject. People sometimes confuse logic with psychology. As you begin your study of logical theory, make sure you understand the difference between logic and psychology. As the text points out, psychology studies human thinking as it actually is, with all of its errors and imperfections. Logic, on the other hand, is the study of the standards of correct reasoning—the standards our reasoning ideally ought to follow if it is to be good reasoning. Logic is thus more abstract than psychology. It would not be too far off to say that psychology is concerned with what is, while logic is concerned with what ideally ought to be. Chapter 1 Outcomes An understanding of all of Chapter 1 and its appendix would encompass the following learning outcomes. Individual teachers may, of course, assign some but not all of these objectives. 1. Demonstrate an understanding of the definition of logic by accurately explaining the definition in your own words. 2. Demonstrate an understanding of the definition of reasoning by correctly explaining the definition in your own words and by giving examples of reasoning. 3. Demonstrate an understanding of the distinction between deductive and inductive logic by correctly explaining the difference in your own words and by answering relevant questions, including true-false, multiple choice, and short answer questions and essay questions. 4. Demonstrate your understanding of the distinction between formal and informal logic by correctly explaining the difference in your own words and by answering relevant questions, including true-false, multiple choice, and short answer questions and essay questions. 5. Demonstrate your understanding of how logic as an academic subject began by explaining the historical origin of logic in your own words and by correctly answering relevant questions about its historical origin, including true-false, multiple choice, and short answer questions and essay questions. 8 6. Demonstrate an understanding of the difference between myth and philosophy by accurately explaining the difference in your own words and by correctly answering relevant questions about the matter, including true-false, multiple choice, and short answer questions and essay questions. 7. Demonstrate an understanding of the concepts in this chapter by correctly answering relevant true-false, multiple-choice, and other types of short answer and essay questions. 8. If something taught in the text was inadvertently not included in this list of objectives, be prepared to correctly demonstrate an understanding of that item too! We placed the last clause (8) in the list just in case a legalistic (and possibly litigious) student says something like this to his or her teacher after a quiz or test: “But I didn’t study that because it wasn’t specifically on the list of outcomes and so you can’t put it on the test!” Thanks to this little “catch-all” clause, our hypothetical future law student won’t be able to use that excuse in this class! Our clause 8 is sort of the converse of the 10th amendment to the United States Constitution, that basically says to the Federal Government: We’ve listed the things you cannot do, and if we left anything off the list, you can’t do that either! Some Advice as You Start the Course We recommend that you read the textbook very carefully, the way you would read a math text. This means that you should concentrate on what you are reading and pay close attention to definitions and technical details. In some cases, missing one word makes all the difference in the world. Why? Logic is a lot like mathematics. Both are very precise subjects. Both are technical disciplines. In both fields, if you do not understand the terminology and the technical details, you will not be able to apply the principles correctly and solve the problems. Successful logic students find that they must concentrate on details and master the terminology before they can correctly answer the questions and solve the problems correctly. This should not be seen as a defect in the subject—it is simply the way it is in any technical discipline. Students must concentrate on details and technical definitions in math, medicine, computer science, nursing, engineering, physics, biology, chemistry, cosmetology, accounting, and auto mechanics as well, right? If a nurse misreads one word and gives the patient the wrong medicine, the patient may die. In some fields, small details matter. Logic is such a field. Take Notes We also recommend that you take notes and summarize the key points in your own words as you go. We always understand something better after we have put it into our own words. Some experts in education maintain that we do not really understand something until we can explain it in our own words. 9 Taking good notes is a learned skill. It requires distinguishing between things that are important and matters that are less important, ideas that are central and ideas that are tangential, and so on. It is assumed that a student has acquired note-taking skills by the time he or she enters a college class. One way to identify key ideas is to look at the glossary provided at the end of each chapter. Each glossary presents definitions of the most important ideas introduced in the chapter. Test Your Understanding We also strongly recommend that you test your knowledge as you go. To do this, solve the answered problems (in the text and in the online class) and then check your answers against the corresponding answer key. Many years of experience have shown that students who do not continually self-test their knowledge are quite likely to do poorly on real quizzes and tests. The reason has to do with human psychology: It often happens that a student studies the text and confidently thinks he understands the concepts, only to discover after taking a quiz or test that he really didn’t understand them at all. Again: sometimes we fool ourselves. Sometimes we are absolutely sure we know something or can do something--until we test our alleged knowledge against a more objective standard (than our own self-image) and find out we were totally deluded with regard to our own abilities! Practice In addition, we recommend practicing logic by solving the practice problems provided in the text and in the online course. The ability to solve logic problems is a skill that improves with practice. Experience has shown that students who do not practice logic by working the problems in the text and in the online course are likely to do poorly on tests and quizzes. Just as most of us would not become good piano players without practice, most people will not become good at solving logic problems without practice. Even Vladimir Horowitz had to practice before he became a great pianist. Online Video Demos It is extremely important that you watch the video lectures and demonstrations. These are available for free, online, from within the course (Course Materials, Videos to Accompany the Text). Most students who complete this course say that they could not have learned the material without watching the online, filmed demos, in addition to reading the text and the other online supplements. The online video lectures provide visual demonstrations of most of the key concepts and techniques. For most of us, a visual presentation, in addition to the written text, makes all the difference in the world. However, the online videos (there are about 115 of them) should not take the place of reading the text. They are short (usually 5-10 minutes) and they merely provide visuals for the key ideas and activities. In other words, the videos are not a complete course unto themselves. Anyone who tries to learn the material through the online video lectures alone will very probably be disappointed when they take the tests and quizzes. 10 Again: the filmed demonstrations, available online from within the course, supplement the text, they do not take its place. Class Discussions Contributing to the assigned online class discussions is also a very important part of the course. You will almost certainly develop a better grasp of logical theory if you talk about the ideas with others in the class and if you help others solve logic problems in class. In the class discussion boards, you will learn to articulate the concepts of logic in your own words and you will also apply them to real problems. Don’t we usually understand something better after we have put it into our own words? Don’t we usually understand an idea better after we have discussed it with others? Don’t we usually understand an idea better after we have applied it to something? PowerPoints Finally, it is recommended that at the relevant places you click through the corresponding PowerPoints for step-by-step instructions. These short, step-by- step demonstrations are not provided for every concept in the course (that would require thousands of PowerPoints); but they are provided in places where a detailed, step-bystep slide show may be a helpful supplement. What You Won’t Find in These Online Lectures You will not find summaries of all the key ideas and procedures that are taught in the textbook. To provide summaries of all the key ideas and techniques presented in the text would be to do your work for you. It is your responsibility to take notes and summarize the material as you go. This is a good thing to do, for as previously noted, we always understand something better after we have summarized it in our own words. Furthermore, experience has shown that when summaries of all key ideas are provided online, some students simply read the summaries and do not study the text. Not only do they miss a great deal of the information provided in the text, students who only read the summaries and not the text generally do poorly on quizzes and tests as well. Sometimes they blame the summary for not covering every detail in the text, rather than their own lack of effort—as if a summary could be more than a summary. You will also not find in the online lectures all the ideas and material in the text reexplained and rehashed all over again. The online lectures are not supposed to take the place of the text. They are not supposed to present all the material that is in the text. Presenting the course material is the job of the text, not of the online lectures. Besides, if the online lectures presented and re-hashed all material presented in the text, then there would be no need for a text. But presenting the course content is not the job of the online lectures, it is the job of the textbook. The online lectures serve as a guide and mentor, not as an online replacement for a textbook. You will not be told the quiz and test questions in advance. To provide questions in advance would defeat the purpose of the tests and quizzes, which is to test you to see if 11 you really understand the material. You also may not be told in advance the exact number of questions or the types of questions on tests and quizzes. That is not the responsibility of the instructor—it is your responsibility as a student to be prepared to answer any relevant questions that may be asked. Which you will surely do with flying colors if you study the textbook and the online materials effectively! Unit One Lecture 3 On Chapter 2 When we put our reasoning into words, the result is called an “argument.” This may not be the meaning of the word “argument” in all contexts, but this is the standard meaning in academic contexts. Since reasoning cannot be studied systematically until it has been placed into words, logical theory begins with the concept of an argument. The central idea, but by no means the only idea, of Chapter 2 is the definition of the word “argument” as that word is used in logic and in academic subjects generally. This little word is one of the most fundamental technical terms in all of logical theory. It is important to understand it thoroughly. Read the text carefully here and study the examples! We always understand something better after we have contrasted it with other things. Consequently, Chapter 2 distinguishes arguments from “nonarguments.” An important logical skill is the ability to recognize an argument when one is presented to you. Study the examples in the text carefully and notice the difference between arguments and things that are not arguments. In this chapter you also learn to identify the parts of arguments. Make sure you understand how to spot premises and conclusions and premise indicators and conclusion indicators. Once you understand the parts of an argument, and how the parts fit together, and how they work together, you will have a better understanding of what an argument is and how arguments are constructed. Just as auto mechanics use their knowledge of the parts of an engine when they diagnose and repair broken ones, you will learn in this course to use your knowledge of the parts of an argument when you need to diagnose and repair broken (illogical) arguments. Arguments, like machines, have many moving parts. Keep in mind that many of the main ideas of the chapter can be identified by reading the glossary at the end of the chapter. Chapter Objectives The student who has successfully studied Chapter 2 will be expected to meet all of the following objectives: 12 1. Demonstrate an understanding of the textbook’s definition of an argument by correctly explaining the idea in your own words. 2. Demonstrate an understanding of the structure of an argument by accurately identifying the parts of an argument, including premises, conclusions, and premise and conclusion indicator words. 3. Demonstrate an understanding of how the word “argument” as defined in academic contexts differs from the meaning of “argument” as the word is defined and used in nonacademic contexts by correctly explaining the difference in your own words. 4. Demonstrate that you know how to recognize an argument and can distinguish arguments from nonarguments by correctly distinguishing passages containing arguments from passages that do not contain arguments. 5. Demonstrate that you understand the idea of a premise indicator and the idea of a conclusion indicator by correctly identifying premise and conclusion indicators in sample arguments. 6. Demonstrate an understanding of the difference between a premise and a conclusion by correctly identifying the premises and conclusions of arguments. 7. Demonstrate an understanding of the definitions of the various types of sentences (declarative, imperative, interrogative, exclamatory, and performative) by accurately explaining the definitions in your own words. 8. Given sentences of English, correctly classify them as declarative, imperative, interrogative, exclamatory, or performative. 9. Demonstrate an understanding of the definition of an enthymeme by correctly explaining it in your own words. 10. Demonstrate an understanding of the principle of charity by correctly explaining it in your own words. 11. Given an enthymematic argument, fill in the missing step or steps in accord with the principle of charity. 12. Demonstrate that you know how to diagram an argument by accurately diagramming sample arguments. 13. Demonstrate an understanding of the concepts in this chapter by correctly answering relevant true-false, multiple-choice, and other types of short answer questions and essay questions. 13 14. If something taught in the text was not included in this list of objectives, be prepared to demonstrate an understanding of that item too! Test Your Understanding! Practice Problems with Answers Indicator Words For each argument, (a) state any premise or conclusion indicators and (b) state the conclusion. 1. Since Tuan is a student, it follows that he studies regularly. 2. Sarah is a mother, because she has given birth to a child. 3. All dogs are mammals, and all mammals are animals; thus all dogs are animals. 4. Given that Kim is the country’s president, that Kim is a politician may be inferred from the fact that all presidents of countries are politicians. 5. The ground is wet during a heavy rain. Consequently, due to the fact that it’s raining now, the ground now is wet. 6. Provided that two is greater than one, and three is greater than two, it follows that three is greater than one. 7. Tran is happy. Hence Tran is happy. 8. Simón Bolívar was born in Venezuela. Bolívar was a military hero in South America. This implies that a military hero was born in Venezuela. 9. According to Socrates, people will do what they believe is in their best interests. Thus, since the good is in people’s best interest, it behooves philosophers to explain the good to people. 10. Given that all dogs are mammals, and because no mammals are birds, it must be concluded that no dogs are fish. Answers: 1. (a) Since; it follows that; (b) he studies regularly 2. (a) because; (b) Sarah is a mother 3. (a) thus; (b) all dogs are animals 4. (a) Given that; may be inferred from; (b) Kim is a politician 5. (a) Consequently; due to the fact that; (b) the ground is now wet 6. (a) Provided that; it follows that; (b) three is greater than one. 7. (a) Hence; (b) Tran is happy (the second instance of the claim) 8. (a) This implies that; (b) a military hero was born in Venezuela 9. (a) Thus; since; (b) it behooves philosophers to explain the good to people 10. (a) Given that; because; it must be concluded that; (b) no dogs are fish Which Type of Sentence? 14 1.I love renaissance art. 2.Boo. 3.If today is Monday then tomorrow is Tuesday. 4.Renaisance art, wow!!! 5.Do your homework. 6.Do you like peanut butter? 7.Hydrogen is the most common element in the universe. 8.Logic is my favorite class. 9.Dang it!!! 10.Do you know the way to San Jose? 11.I’ve been away so long. 12.Fidel Castro executed thousands of political opponents without trial. Answers 1.Declarative 2.Exclamatory 3. Declarative 4. Exclamatory 5.Imperative 6.Interrogative 7.Declarative 8. Declarative 9. Exclamatory 10.Interrogative 11.Declarative 12.Declarative Arguments and Non-arguments In each case, does the passage present an argument? Or does it not contain an argument? 1. Elizabeth and Marty went together to school on Tuesday, got in a minor automobile accident, and were late for their biology class. Their teacher was giving a test that day, and the two students were not there to take it. 2. Elizabeth and Marty left their house to go to school on Tuesday, but on the way decided to spend the day at the movie theater instead. Their biology teacher was giving a test that day, and the two students were not there to take it. That is why they received a poor grade for their coursework that week. 15 3. Elizabeth and Marty, you two are crazy! You should not have gone to the movies Tuesday, especially when you had a test in your biology class. You should go to school each day classes are in session. 4. Elizabeth and Marty went together to school every day this week and studied the material covered in class. Students who attend class regularly and study regularly usually do well in class. Thus Elizabeth and Marty probably did well in class this week. 5. Some students do not attend class regularly. For instance, Elizabeth and Marty went together to school on Tuesday, but decided to return home to play Grand Theft Auto all day. Such behavior is indicative of poor study habits. 6. Maria studies every night for her chemistry class, and works very precisely in her chemistry lab work. She also attends class each day and takes complete notes. We can conclude that Maria will likely do well in her chemistry class. 7. Both Mahatmas Gandhi and Sri Aurobindo were philosophically minded, both were male, both were from India, and both wrote commentaries on the Bhagavad Gita. Gandhi fought against British occupation of India. Thus Aurobindo did, too. 8. Rene Descartes was unable to see the relations between things, focused on breaking “problems” into smaller parts, and missed viewing systems holistically. Thus he has been deemed a “mechanistic” philosopher. 9. Fatima likes pizza. Julio likes football. Takashi likes reading The Tale of Genji. 10. Sunzi wrote The Art of War, and The Art of War was written by a Chinese philosopher. Sunzi must then be a Chinese philosopher. Answers: 1. Non-argument. It’s merely a report of the day’s events with no inference. 2. Non-argument. It’s a causal explanation of the students’ poor grades with no inference. 3. Non-argument. It’s a combination of opinion and advice, but with no inference. 4. Argument. There are a series of claims serving as premises leading to a conclusion (note the indicator word “thus”). 5. Non-argument. It’s merely an illustration of the opening claim with no inference. 6. Argument. Note the use of the conclusion indicator, “We can conclude that.” 7. Argument. This is an argument from analogy. 8. Non-argument. We find the word “thus” (which is often a conclusion indicator), but here it is pointing to the effect of a causal relation. That is, the final statement is explained by the previous ones, but there is no inference intended here. 9. Non-argument. It’s just an unconnected string of claims. 10. Argument. The first two claims give good reason to believe the third claim. Diagramming Arguments 16 Number each premise and conclusion in the following arguments, and diagram the arguments using arrows to indicate the inference from one or more premises to a conclusion. 1. Amanda wrote Tim a love letter. Amanda gave Tim a birthday present. Amanda told Tim she really likes him. It follows that Amanda probably likes Tim a lot. 2. All dogs are animals, and all dogs are mammals. Fido is a dog. Thus Fido is an animal and a mammal. 3. Every crow I’ve ever seen has been black. Also, ravens are similar to crows, and ravens are black. Thus the next crow I see will probably be black. 4. Either Smith is a politician, or she is a logic teacher and a tennis player. But Smith is not a politician. Thus Smith is a logic teacher. 5. If Garcia is a philosopher, then he is logical. If Garcia is logical, then Garcia is at least in part rational. Thus if Garcia is a philosopher, then he is at least in part rational. And if that conditional statement is true, then Garcia is a thinking being. Thus Garcia is a thinking being. Answers: 1. (1) Amanda wrote Tim a love letter. (2) Amanda gave Tim a birthday present. (3) Amanda told Tim she really likes him. It follows that (4) Amanda probably likes Tim a lot. (1) (2) (3) Three separate arrows to (4) (4) 2. (1) All dogs are animals, and (2) all dogs are mammals. (3) Fido is a dog. Thus (4) Fido is an animal and a mammal. (1)+(2)+(3) One arrow from the premise group to (4) (4) 3. (1) Every crow I’ve ever seen has been black. Also, (2) ravens are similar to crows, and (3) ravens are black. Thus (4) the next crow I see will probably be black. (1) (2)+(3) Two separate arrows from (1) and from (2)+(3) to (4) (4) 4. (1) Either Smith is a politician, or she is a logic teacher and a tennis player. But (2) Smith is not a politician. Thus (3) Smith is a logic teacher. (1)+(2) One arrow from premise group to (3) (3) 5. (1) If Garcia is a philosopher, then he is logical. (2) If Garcia is logical, then Garcia is at least in part rational. Thus (3) if Garcia is a philosopher, then he is at least in part 17 rational. And (4) if that conditional is true, it follows necessarily that Garcia is a thinking being. Thus (5) Garcia is a thinking being. (1)+(2) One arrow from premise group to (3) (3)+(4) One arrow from second premise group to (5) (5) Unit One Supplement to Chapter 2 Monty Python’s famous skit “The Argument Clinic” Chapter 2 introduces the precise academic meaning of the word “argument” and explains how the meaning of the word “argument” in academic and intellectual contexts differs from its meaning in other contexts. As you learn the difference between the academic and the nonacademic meanings of the word, enjoy this hilarious and wonderful spoof performed by the Monty Python cast. Watch this classic skit on YouTube by copying and pasting the following into your browser: The Script Scene: The reception desk at the Argument Clinic. Receptionist: Yes, sir? Man: I'd like to have an argument please. Receptionist: Certainly, sir, have you been here before...? Man: No, this is my first time. Receptionist: I see. Do you want to have the full argument, or were you thinking of taking a course? 18 Man: Well, what would be the cost? Receptionist: Yes, it's one pound for a five-minute argument, but only eight pounds for a course of ten. Man: Well, I think it's probably best of I start with the one and see how it goes from there. OK? Receptionist: Fine. I'll see who's free at the moment... Mr. Du-Bakey's free, but he's a little bit conciliatory... Yes, try...Room 12. Man: Thank you. [...] The man knocks on the door of room 12. Professional arguer: Come in. The man enters the room. The arguer is sitting at a desk. Man: Is this the right room for an argument? Arguer: I've told you once. Man: No you haven't. Arguer: Yes I have. Man: When? Arguer: Just now! Man: No you didn't. Arguer: Yes I did! Man: You didn't. Arguer: Did. Man: Didn't. Arguer: I'm telling you I did! Man: You did not! Arguer: I'm sorry, is this a five-minute argument, or the full half-hour? 19 Man: Oh, just a five minute one. Arguer: Fine....Thank you. Anyway I did. Man: You most certainly did not. Arguer: Now, let's get one thing quite clear... I most definitely told you! Man: You did not. Arguer: Yes I did. Man: You did not. Arguer: Yes I did.... Man: Look this isn't an argument. Arguer: Yes it is. Man: No it isn't, it's just contradiction. Arguer: No it isn't. Man: Yes it is. Arguer: It is not ... Man: Oh, look this is futile. Arguer: No it isn't. Man: I came here for a good argument. Arguer: No you didn't... Man: Well, an argument's not the same as contradiction. Arguer: It can be. Man: No it can't. An argument is a connected series of statements intended to establish a definite proposition. Arguer: No it isn't. Man: Yes it is. It isn't just contradiction.... 20 Arguer: Yes it is. Man: No it isn't, an argument is an intellectual process... contradiction is just the automatic gainsaying of anything the other person says. Arguer: No it isn't. Man: Yes it is. Arguer: Not at all. Man: Now look! Arguer:(pressing the bell on his desk) Thank you, good morning. Man: What? Arguer: That's it.... Man: But I was just getting interested. Arguer: Sorry the five minutes is up. Man: That was never five minutes just now! Arguer: I'm afraid it was. Man: No it wasn't. Arguer: I'm sorry, I'm not allowed to argue any more. Man: What!? Arguer: If you want me to go on arguing, you'll have to pay for another five minutes. Man: But that was never five minutes just now... oh come on! ... Arguer: I'm very sorry, but I told you I'm not allowed to argue unless you've paid. Man: Oh. All right. (The man pays.) There you are. Arguer: Thank you. Man: Well? Arguer: Well what? 21 Man: That was never five minutes just now. Arguer: I told you I'm not allowed to argue unless you've paid. Man: But I've just paid. Arguer: No you didn't. Man: I did! I did! I did! Arguer: No you didn't. Man: Look I don't want to argue about that. Arguer: Well I'm very sorry but you didn't pay. Man: Aha! Well if I didn't pay, why are you arguing... got you! Arguer: No you haven't. Man: Yes I have... if you're arguing I must have paid. Arguer: Not necessarily. I could be arguing in my spare time. Man: I've had enough of this. Arguer: No you haven't. End.... [From "Monty Python's Flying Circus: Just the Words, Volume 2", episode 29. Methuen, ISBN 0-413-62550-8 (hardback).] Question Which of the characters in this skit has the better understanding of the word “argument” as it is used in logic? The professional arguer? Or the man trying to buy an argument? Explain. Unit One Online Lecture 5 22 On Chapter 3 The distinction between deductive and inductive arguments is the central point of this chapter. It is also one of the most fundamental distinctions in all of logical theory. The ability to distinguish deductive from inductive reasoning is a very important logical skill. Pay very close attention to the definitions and examples. They are very precise. Don’t forget to test your understanding by trying the “Practice Problems with Answers.” The online videos are also important. That was just a reminder. Chapter Objectives 1. Demonstrate an understanding of the definition of an inductive argument by correctly explaining it in your own words. 2. Demonstrate an understanding of a deductive argument by correctly explaining it in your own words. 3. Demonstrate an understanding of the difference between deduction and induction by correctly classifying sample arguments as deductive or inductive. 4. Demonstrate an understanding of deductive and inductive indicator words by correctly classifying indicator words as deductive or inductive. 5. Demonstrate an understanding of the definition of an argument form by correctly explaining it in your own words. 6. Demonstrate an understanding of the differences between deductive and inductive arguments by explaining the differences in your own words. 7. Demonstrate an understanding of the concepts in this chapter by correctly answering relevant true-false, multiple-choice, and other types of short answer questions and essay questions. 8. If something taught in the text was not included in this list of objectives, be prepared to demonstrate an understanding of that item too! Test Your Understanding Practice Problems With Answers Is the indicator word deductive or inductive? 23 1.Necessarily 2.Probably 3.Certainly 4.Perhaps 5.For sure 6.Must be so 7.It’s likely that 8.It’s guaranteed that 9.It may very well be that 10.It’s a good bet that Answers 1. D (De

Consistent 2. Inconsistent 3. Consistent 4. Inconsistent 5. Consistent 6. Consistent 7. Inconsistent 8. Inconsistent 9. Consistent 10.Consistent Implication Consider the following pairs of statements. In each case, determine whether the first member of the pair implies the second member. 1. Plato lived before Aristotle. Aristotle lived after Plato. 2. The tabletop is wet. The tabletop is not dry. 3. Soren Kierkegaard admired Immanuel Kant. Immanuel Kant admired Soren Kierkegaard. 4. Two plus two equals five. Elephants fly to the Moon. 5. Alfred North Whitehead liked math. Two plus two equals four. 6. Plato was a teacher of Socrates. Socrates was a student of Plato. 7. The students in Smith's logic class study daily. The students in Smith's logic class will all get As. 8. Garcia received an A in Smith's logic class. Garcia studied logic every day. 9. Francisco Vitoria was a philosopher from Spain. Francisco Vitoria was from the Iberian Peninsula. 10. Bartolome de Las Casas defended indigenous Americans against the Spanish in the 36 1500s. Bartolome de Las Casa was Spanish. Answers: 1. Implication 2. Implication 3. No implication 4. Implication 5. Implication 6. Implication 7. No implication 8. No implication 9. Implication 10. No implication Equivalence Consider the following pairs of statements. In each case, are the sentences logically equivalent? 1. Plato wrote more books than Socrates. Socrates wrote fewer books than Plato. 2. No ancient Jain philosophers are 21st century logicians. No 21st century logicians are ancient Jain philosophers. 3. Xunzi was a male Chinese philosopher. Xunzi was a Chinese philosopher. 4. Some dogs are not black animals. Some black animals are not dogs. 5. All dogs are organic beings. No dogs are inorganic beings. 6. The Indian tradition of Samkhya is metaphysically dualist. The Indian tradition of Samkhya affirms the existence of two distinct kinds of substance. 7. Carvaka philosophers tended to be atheists. Carvaka philosophers tended to not believe in the existence of God. 8. Martha Nussbaum is a female and she's a philosopher. Martha Nussbaum is a female philosopher. 9. Melody is holding a total of three coins in her right hand. Melody is holding an odd number of coins in her right hand. 10. Some Chileans are philosophers. Some philosophers are Chileans. Answers: 1. Equivalent 2. Equivalent 3. Not equivalent 4. Not equivalent 5. Equivalent 37 6. Equivalent 7. Equivalent 8. Equivalent 9. Not equivalent 10. Equivalent Necessary and Contingent Statements Consider the following statements. In each case, is the statement necessarily true, necessarily false, contingently true, or contingently false? 1. Squares have four sides. 2. Elephants can fly. 3. Squares have four sides or elephants can fly. 4. It is false that elephants can fly. 5. Squares have five sides. 6. Unicorns are commonly seen in New York City. 7. French women are commonly seen in Paris. 8. There are no rivers in India. 9. Either apples are fruit or it is false that apples are fruit. 10. Apples are fruit and it is false that apples are fruit. 11. Tokyo has a human population of over 10,000. 12. Two plus two equals four. 13. All bachelors are married men. 14. Columbia has beautiful beaches that attract tourists. 15. A Maya dialect is the official language of Nigeria. Answers: 1. Necessarily true 2. Contingently false 3. Necessarily true 4. Contingently true 5. Necessarily false 6. Contingently false 7. Contingently true 8. Contingently false 9. Necessarily true 10. Necessarily false 11. Contingently true 12. Necessarily true 13. Necessarily false 38 14. Contingently true 15. Contingently false Unit Two Online Lecture 1 About Unit Two Unit Two takes you into categorical logic, the study of categorical reasoning, the first branch of logic systematized by Aristotle, the founder of logic. Study this unit and learn to recognize categorical arguments and to evaluate them using principles and techniques as precise as any in mathematics. This unit builds on the ideas covered in Unit One. A solid understanding of Unit One is thus a pre-requisite for a solid understanding of the ideas in this unit. The Online Videos We also strongly recommend that you watch the corresponding online video lectures as you learn this material. Few students can adequately learn this material without watching these visual, step-by-step demonstrations. General Objectives of Unit Two The student who successfully studies Unit Two will be expected to meet all of the following objectives. 1. Demonstrate an understanding of the definition of categorical logic by defining it correctly in your own words. 2. Demonstrate an understanding of how categorical logic began by correctly explaining its origin in your own words. 39 3. Demonstrate an understanding of categorical sentences by correctly identifying the parts of categorical sentences. 4. Demonstrate an understanding of the four categorical sentence forms by correctly identifying them and by classifying sample categorical sentences in terms of their forms. 5. Demonstrate an understanding of categorical arguments by correctly identifying the parts of categorical arguments. 6. Distinguish the three different types of categorical arguments: immediate inferences, mediate inferences, and sorites. 7. Demonstrate an understanding of the traditional square of opposition by using it to determine relations between opposing sentences and to test single-premise arguments for validity and be prepared to demonstrate your understanding by correctly doing so. 8. Demonstrate an understanding of the traditional square of opposition by using it to test single-premise arguments for validity. 9. Demonstrate an understanding of the laws of conversion, obversion, and contraposition by correctly identifying relevant inferences as valid or invalid and by correctly judging whether sample pairs of sentences are equivalent or not equivalent. 10. Demonstrate an understanding of the rules of validity for categorical arguments by correctly applying them to each of the different types of categorical argument. 11. Demonstrate an understanding of the definition of logical form for categorical arguments by correctly determining logical form when presented with a categorical argument. 12. Demonstrate an understanding of the valid forms of categorical syllogisms by correctly classifying arguments under the headings of the valid forms. 13. Show that an argument is formally invalid using the method of logical analogy. 14. Demonstrate an understanding of the 19th century developments in categorical logic by correctly answering true-false, multiple-choice, and other relevant short answer questions and essay questions. 15. Demonstrate an understanding of the difference between traditional (prenineteenth century) and modern categorical logic by correctly comparing and contrasting the two methods. 40 16. Demonstrate an understanding of an axiom system, proof by contradiction, and proof by reduction by correctly explaining these ideas in your own words. 17. Demonstrate an understanding of the basic ideas in this unit by correctly answering relevant true-false, multiple-choice, and other types of short answer questions and essay questions. 18. If something taught in the text was not included in this list of objectives, be prepared to demonstrate an understanding of that item too. Unit Two Online Lecture 2 On Chapter 7 Chapter 7 covers introductory categorical logic. For the most part this is logic as it would have been taught in ancient times, in Aristotle's Lyceum. After the categorical sentence is defined and its parts are identified, the four standard logical forms of categorical sentences are presented and explained. After this, the concept of an immediate (single premise) inference is defined, the square of opposition is introduced, and strict rules are stated for the evaluation of immediate inferences. The laws of conversion, obversion, and contraposition supplement the square of opposition and complete a very comprehensive system of logic for one-premise categorical arguments. The definitions are very precise. Study them carefully! The Online Videos We also strongly recommend that you watch the corresponding online video lectures as you learn this material. The visual, step-by-step demonstrations can be very helpful when learning this material. Chapter 7 Objectives 1. Demonstrate your understanding of the definition of categorical logic by defining it in your own words. 2. Demonstrate your understanding of how categorical logic began by explaining its origin in your own words. 41 3. Demonstrate your understanding of the definition of a categorical sentence by correctly defining the notion in your own words. 4. Demonstrate your understanding of quality and quantity for categorical sentences by correctly assigning the proper quality and quantity to sample categorical sentences. 5. Demonstrate your understanding of the four logical forms of categorical sentences by accurately classifying sample categorical sentences under the four forms. 6. Demonstrate your understanding of the notion of standard form for a categorical sentence by accurately translating improperly formed English sentences into standard form categoricals. 7. Demonstrate your understanding of categorical arguments by correctly distinguishing the different types of categorical arguments: immediate inferences, mediate inferences, and sorites. 8. Demonstrate your understanding of the definition of an immediate inference by correctly explaining the definition in your own words. 9. Demonstrate your understanding of the traditional square of opposition by correctly answering questions about it, including true-false, multiple-choice, and short answer questions and essay questions. 10. Demonstrate that you know how to identify logical relations among opposing categorical sentences by correctly evaluating immediate inferences using the square of opposition and by correctly answering relevant questions. 11. Demonstrate your understanding of contrariety, subcontrariety, contradiction, alternation, subalternation, and related ideas by correctly defining these terms in your own words. 12. Demonstrate your understanding of contrariety, subcontrariety, contradiction, alternation, subalternation, and related ideas by correctly identifying the appropriate relationship (contrariety, contradiction, etc.) given pairs of sentences. 13. Demonstrate your understanding of how logic inspired the birth of the computer by accurately explaining the story in your own words. 14. Demonstrate your understanding of conversion, obversion, and contraposition by correctly converting, obverting, and contraposing sample sentences. 42 15. Demonstrate your understanding of the laws of conversion, obversion, and contraposition by correctly determining whether or not sample sentences are equivalent and whether or not sample inferences are valid--on the basis of the laws of conversion, obversion, and contraposition. 16. Demonstrate your understanding of the ideas in this chapter by correctly answering relevant true-false, multiple-choice, and other short answer questions and essay questions. 17. If something taught in the text was not included in this list of objectives, be prepared to correctly demonstrate an understanding of that item too. Test Your Understanding Practice Problems with Answers Parts of Categorical Statements For each of the following categorical statements, state its (a) quantifier, (b) subject term, (c) copula, and (d) predicate term. 1. Some dogs are poodles. 2. No peacocks are bright fish. 3. All white bears are polar bears. 4. Some reptiles are not lizards. 5. No dogs that do no bark are animals that purr. 6. Some animals that are fast are not cats that are not purple. 7. All green parrots are birds that are not white. Answers: 1. (a) Some, (b) dogs, (c) are, (d) poodles 2. (a) No, (b) peacocks, (c) are, (d) bright fish 3. (a) All, (b) white bears, (c) are, (d) polar bears 4. (a) Some, (b) reptiles, (c) are not, (d) lizards 5. (a) No, (b) dogs that do no bark, (c) are, (d) animals that purr 6. (a) Some, (b) animals that are fast, (c) are not, (d) cats that are not purple 7. (a) All, (b) green parrots, (c) are, (d) birds that are not white Truth Value of Categorical Statements What is the truth value of the following statements? (I.e., are they true or false?) 1. No dogs are pets. 2. At least one dog is a pet. 3. At least one pet is a dog. 4. All pets are dogs. 5. Some pets are dogs. 6. Some cats are pets. 43 7. Some pets are cats. 8. Some cats are dogs. 9. A few cats are animals. 10. Some cats are not pets. Answers: 1. False 2. True 3. True 4. False 5. True 6. True 7. True 8. False 9. True 10. True Characteristics of Categorical Statements I. For each of the categorical statements below, determine its label (or kind, i.e., A, E, I, or O), quantity, and quality. 1. No salmon are eels. 2. Some antelope are not prairie denizens. 3. All mountain goats are acrobatic animals. 4. Some parakeets that live in cages are birds that do not sing. Answers: 1. E, universal, negative 2. O, particular, negative 3. A, universal, affirmative 4. I, particular, affirmative II. Given a statement with the one characteristic provided below, what can be said about that statement's other two characteristics? 1. An E statement. 2. A negative statement. 3. An I statement. 4. An affirmative statement. 5. A universal statement. 6. A particular statement. 7. An A statement. 8. An O statement. Answers: 1. The statement would be universal and negative. 2. The statement would be E and universal, or O and particular. 44 3. The statement would be particular and affirmative. 4. The statement would be A and universal, or I and particular. 5. The statement would be A and affirmative, or E and negative. 6. The statement would be I and affirmative, or O and negative. 7. The statement would be universal and affirmative. 8. The statement would be particular and negative. Square of Opposition Relations I. Change the original statement using the relation and assuming the truth value indicated, and then state whether the new statement is true (T), false (F), or undetermined (U). Example: All D are G (T, contradiction) Answer: Some D are not G (F) 1. Some A are B (F, contradiction) 2. No H are C (T, contrariety) 3. Some J are not U (T, subcontrariety) 4. All P are Y (F, subimplication) 5. All K are J (T, subimplication) 6. Some R are E (F, superimplication) 7. No L are F (T, subimplication) 8. Some N are no M (T, superimplication) 9. All M are D (F, contrariety) 10. Some Z are V (F, subcontrariety) 11. All N are G (T, contradiction) 12. Some L are not M (F, contradiction) 13. No A are B (F, contrariety) 14. Some J are E (T, subcontrariety) 15. Some Y are W (T, superimplication) 16. Some R are not U (T, contradiction) 17. All O are I (T, contrariety) 18. Some C are not W (F, subcontrariety) 19. All M are N (F, subimplication) 20. No Z are W (F, subimplication) Answers: 1. No A are B (T) 2. All H are C (F) 3. Some J are U (U) 4. Some P are Y (U) 5. Some K are J (T) 6. All R are E (F) 7. Some L are not F (T) 8. No N are M (U) 9. No M are D (U) 45 10. Some Z are not V (T) 11. Some N are not G (F) 12. All L are N (T) 13. All A are B (U) 14. Some J are not E (U) 15. All Y are W (U) 16. All R are U (F) 17. No O are I (F) 18. Some C are W (T) 19. Some M are N (U) 20. Some Z are not W (U) Testing Immediate Inferences for Validity with the Square of Opposition Consider each of the immediate inferences below. State which square of opposition relation is used, and whether the inference is valid or invalid. "F:" will be used to abbreviate "It is false that." 1. All A are B. Thus F: some A are not B. 2. No W are S. Thus some W are not S. 3. All J are E. Thus F: some J are E. 4. Some K are T. Thus some K are not T. 5. F: some P are not I. Thus some P are I. 6. F: some H are F. Thus no H are F. 7. F: some N are M. Thus F: all N are M. 8. Some S are not U. Thus no S are U. 9. All A are T. Thus F: no A are T. 10. No C are Y. Thus all C are Y. 11. F: no J are A. Thus F: some J are A. 12. F: no H are Q. Thus F: some H are not Q. 13. Some X are N. Thus F: all X are N. 14. No Y are S. Thus F: all Y are S. 15. F: some A are R. Thus some A are not R. Answers: 1. Contradiction, valid 2. Subimplication, valid 3. Subimplication, invalid 4. Subcontrariety, invalid 5. Subcontrariety, valid 6. Contradiction, valid 7. Superimplication, valid 8. Superimplication, invalid 46 9. Contrariety, valid 10. Contrariety, invalid 11. Contradiction, invalid 12. Subimplication, invalid 13. Superimplication, invalid 14. Contrariety, valid 15. Subcontrariety, valid Conversion, Obversion, and Contraposition Change the original statement using the relation and assuming the truth value indicated, and then state whether the new statement is true (T), false (F), or undetermined (U). Example: Some A are B (F, obversion) Answer: Some A are not non-B (F) 1. All G are E (T, conversion) 2. No J are M (T, conversion) 3. Some K are not L (T, contraposition) 4. Some H are W (F, obversion) 5. All N are S (T, obversion) 6. No L are T (T, contraposition) 7. No I are B (F, obversion) 8. Some non-A are not non-Y (F, contraposition) 9. Some non-A are Q (T, conversion) 10. All X are non-K (T, conversion) 11. All non-K are E (T, obversion) 12. All J are non-O (F, contraposition) 13. Some G are non-P (F, conversion) 14. No F are Q (T, contraposition) 15. Some non-R are not N (T, obversion) Answers: 1. All E are G (U) 2. No M are J (T) 3. Some non-L are not non-K (T) 4. Some H are not non-W (F) 5. No N are non-S (T) 6. No non-T are non-L (U) 7. All I are non-B (F) 8. Some Y are A (F) 9. Some Q are non-A (T) 10. All non-K are X (U) 11. No non-K are non-E (T) 12. All O are non-J (F) 13. Some non-P are G (F) 47 14. No non-Q are non-F (U) 15. Some non-R are non-T (T) More Testing of Inferences For each of the following immediate inferences, determine which of the eight categorical relations (i.e., contradiction, subimplication, superimplication, contrariety, subcontrariety, conversion, obversion, or contraposition) is used, and whether the inference is valid or invalid. "F:" will be used to abbreviate "It is false that." 1. All A are G. Thus no A are non-G. 2. F: Some U are I. Thus F: some I are U. 3. No J are Y. Thus some J are not Y. 4. F: some L are H. Thus no L are H. 5. Some G are E. Thus F: some G are not E. 6. All M are N. Thus F: no M are N. 7. Some W are O. Thus some non-O are non-W. 8. Some K are not non-I. Thus some I are not non-K. 9. All non-P are T. Thus all T are non-P. 10. No H are non-I. Thus all H are I. 11. All B are A. Thus F: no B are non-A. 12. No H are W. Thus some H are W. 13. No H are W. Thus F: some H are W. 14. Some E are I. Thus F: some I are E. 15. Some E are I. Thus some I are E. Answers: 1. Obversion, valid 2. Conversion, valid 3. Subimplication, valid 4. Contradiction, valid 5. Subcontrariety, invalid 6. Contrariety, valid 7. Contraposition, invalid 8. Contraposition, valid 9. Conversion, invalid 10. Obversion, valid 11. Obversion, invalid 12. Contradiction, invalid 13. Contradiction, valid 14. Conversion, invalid 15. Conversion, valid 48 Unit Two Online Lecture 3 On Chapter 8 This chapter completes the presentation of the traditional system of categorical logic first developed by Aristotle and taught with few significant changes into the 19th century. Chapters 7 and 8 together complete introductory categorical logic. In this chapter, after the categorical syllogism is introduced and defined, exact rules are stated for the evaluation of categorical syllogisms. The concept of argument form for categorical syllogisms is developed and the standard forms of valid syllogism are presented along with the names assigned during the medieval period. The system is rounded out with explanations of Aristotle's axiom system, his methods of proof by reduction and by contradiction, refutation by logical analogy, translating syllogisms into standard form, reduction of the number of terms, and the evaluation of sorites. If you study only this and the previous chapter (Chapter 7) in this unit, you will have a solid grounding in the traditional logic taught in nearly all universities and colleges, from the time of Aristotle until the 19th century. Chapter 8 Objectives 1. Demonstrate your understanding of the definition of a categorical syllogism by correctly defining the notion in your own words. 2. Demonstrate your understanding of the structure and parts of a categorical syllogism (minor, major and middle terms, and minor and major premises) by correctly identifying the parts when presented with a syllogism. 3. Demonstrate your understanding of logical form for categorical arguments by providing an accurate definition in your own words. 4. Demonstrate your understanding of logical form for categorical arguments by correctly classifying categorical syllogisms in terms of their logical form. 49 5. Demonstrate your understanding of standard form for categorical arguments by correctly placing improperly formed categorical syllogisms into standard form. 6. Demonstrate your understanding of the valid forms of categorical syllogism identified by Aristotle and his successors by correctly classifying sample arguments under the headings of those valid forms. 7. Demonstrate your understanding of the notion of distribution by correctly determining whether a term is distributed or not distributed when presented with a categorical sentence. 8. Demonstrate your understanding of the traditional rules of validity for categorical syllogisms by correctly using them to classify sample arguments as valid or invalid. 9. Demonstrate that you know how to reduce the number of terms in a categorical syllogism by correctly reducing the number of terms in a categorical syllogism in need of reduction. 10. Demonstrate that you understand the definition of a sorites by correctly defining the notion in your own words. 11. Demonstrate your understanding of the concept of standard form for sorites by correctly placing improperly formed sorites into standard form. 12. Demonstrate that you know how to apply the rules of validity for sorites by using them to correctly determine whether sample sorites are valid or invalid. 13. Demonstrate your understanding of the nature of an axiom system, proof by contradiction, and proof by reduction, by correctly explaining these ideas in your own words and by correctly answering relevant questions including true-false, multiple-choice, and other short answer questions and essay questions. 14. Demonstrate that you know how to use the method of logical analogy to show that an argument is formally invalid by correctly doing so. 15. Demonstrate your understanding of the ideas in this chapter by correctly answering relevant true-false, multiple-choice, and other short answer questions and essay questions. 16. If something taught in the text was not included in this list of objectives, be prepared to demonstrate an understanding of that item too! Test Your Understanding Practice Problems with Answers 50 Standard Form Abbreviate each of the following categorical syllogisms in standard form (i.e., with the major premise listed first, and the conclusion last); then (using the single capital letters from your abbreviation) state the argument's major term, minor term, and middle term. 1. All dogs are animals. Some dogs are poodles. Thus some poodles are animals. 2. Some cats are lions, because some lions are animals, and some animals are cats. 3. No tigers are elephants. Thus some elephants are mammals, since all tigers are mammals. 4. All mice are rodents, and all rodents are animals. Thus all mice are animals. 5. Some rats are not mice. No rats are cats. Thus no cats are mice. 6. All birds are animals. Some parrots are birds. Thus some animals are not parrots. 7. No trout are birds. Thus, since some birds are eagles, no trout are eagles. 8. Because all falcons are birds, and some falcons are raptors, some birds are not raptors. 9. No gerbils are rabbits, and no rabbits are hares. Thus no gerbils are hares. 10. Some agouti are mammals, and some deer are mammals. Thus some agouti are not deer. 11. All horses are animals, and some horses are stallions. Thus some animals are stallions. 12. No cows are fish, and no fish are birds. Thus some cows are not birds. 13. All wolves are mammals. Thus some wolves are animals, because all mammals are animals. 14. Some owls are birds, and no birds are fish, thus some owls are not fish. 15. All sheep are mammals. No mammals are pelicans. Thus no pelicans are sheep. Answers: 1. All D are A Some D are P Some P are A APD 2. Some L are A Some A are C Some C are L LCA 3. All T are M No T are E Some E are M MET 4. All R are A All M are R All M are A AMR 5. Some R are not M No R are C No C are M 51 MCR 6. Some P are B All B are A Some A are not P PAB 7. Some B are E No T are B No T are E ETB 8. Some F are R All F are B Some B are not R RBF 9. No R are H No G are R No G are H HGR 10. Some D are M Some A are M Some A are not D DAM 11. Some H are S All H are A Some A are S SAH 12. No F are B No C are F Some C are not B BCF 13. All M are A All W are M Some W are A AWM 14. No B are F Some O are B Some O are not F FOB 15. All S are M No M are P No P are S SPM Translating Into Standard Categorical Form Rewrite the following English claims into the standard categorical form of an A, E, I, or O sentence. 52 1. Every cat is an animal. 2. All birds are not fish. 3. A few mice are rodents. 4. Most ducks are birds. 5. All horses are fast. 6. Some rich realtors are Republicans. 7. Parrots are birds. 8. Only mammals are pigs. 9. None but animals are llamas. 10. Julio is a logic teacher. 11. Tokyo is in Japan. 12. Most fish swim. 13. I do not love Molly. 14. Some animals live in caves. 15. Bob always wears a hat. 16. Whoever studies will do well on the test. 17. A dog is not a cat. 18. If something is a goose, then it's a bird. 19. Apples are tasty unless they are rotten. 20. The only people who voted for Tran are women. Answers: 1. All cats are animals. All C are A. 2. No birds are fish. No B are F. 3. Some mice are rodents. Some M are R. 4. Some ducks are birds. Some D are B. 5. All horses are fast things. All H are F. 6. Some wealthy realtors are Republicans. Some W are R. 7. All parrots are birds. All P are B. 8. All pigs are mammals. All P are M. 9. All llamas are animals. All L are A 10. All people identical to Julio are logic teachers. All J are L. 11. All things identical to Tokyo are things in Japan. All T are J. 12. Some fish are swimmers. Some F are S. 13. No people identical to me are people who love Molly. No M are L. 14. Some animals are things that live in caves. Some A are L. 15. All people identical to Bob are people who wear a hat. All B are W. 16. All people who study are people who will do well on the test. All S are W. 17. No dogs are cats. No D are C. 18. All geese are birds. All G are B. 53 19. All unrotten apples are tasty things. All U are T. 20. All people who voted for Tran are women. All P are W. Standard Form and Validity Consider the arguments in the previous set of practice problems, and name each argument's logical form (e.g., EAO-3), and determine whether the argument is valid or invalid. Answers: 1. AII-3, valid 2. III-4, invalid 3. AEI-3, invalid 4. AAA-1, valid 5. OEE-3, invalid 6. IAO-4, invalid 7. IEE-1, invalid 8. IAO-3, invalid 9. EEE-1, invalid 10. IIO-2, invalid 11. IAI-3, valid 12. EEO-1, invalid 13. AAI-1, valid 14. EIO-1, invalid 15. AEE-4, valid Constructing Categorical Syllogisms Create categorical syllogisms with guidance from the instructions below. Students' choice of terms will vary, but each argument's structure must conform to the requested form. 1. Construct a syllogism with the form AIO-2. 2. Construct a syllogism with the form EOE-1. 3. Construct a syllogism with the form AII-1. 4. Construct a syllogism with the form AEE-3. 5. Construct a syllogism with the form IAI-4. Answers: 1. All dogs are animals. Some cats are animals. Some cats are not dogs. 2. No dogs are cats. Some birds are not dogs. No birds are cats. 3. All dogs are animals. 54 Some poodles are dogs. Some poodles are animals. 4. All birds are animals. No birds are rocks. No rocks are animals. 5. Some poodles are dogs. All dogs are animals. Some animals are poodles. Unit Two Online Lecture 4 On Chapter 9 This chapter takes categorical logic into the modern era by presenting the two major 19th century developments that revolutionized the field: (1) The Boolean interpretation of universal sentences; and (2) the method of Venn diagrams. In this chapter, learn to interpret universal sentences from both the Aristotelian and Boolean standpoints and the logical implications of doing so. Learn how the modern square of opposition differs from the traditional square. Next, learn how to evaluate immediate inferences, categorical syllogisms, and sorites using Venn diagrams--from both the Aristotelian and Boolean standpoints. If you have a philosophical bent, you might ponder the logical and philosophical differences between the traditional Aristotelian logic (Chapters 7 and 8) and the modern update developed by Boole and Venn, and why someone might, or might not, favor the modern update. This chapter completes the presentation of categorical logic. The Videos and PowerPoints We also strongly recommend that you watch the corresponding online video lectures and the PowerPoints as you learn to construct Venn diagrams. Few students can adequately learn to build correct Venn diagrams without watching these visual, step-bystep demonstrations. Chapter 9 Objectives 55 1. Demonstrate that you understand the 19th century developments in categorical logic, including the distinction between the Aristotelian and hypothetical viewpoints and the method of Venn diagrams, by accurately explaining these ideas in your own words. 2. Demonstrate that you understand the difference between traditional (prenineteenth century) and modern categorical logic by correctly comparing and contrasting the two. 3. Demonstrate that you understand the difference between the hypothetical and the Aristotelian viewpoints by correctly evaluating given sentences on the basis of both standpoints. 4. Demonstrate that you understand the method of Venn diagrams for one premise arguments by correctly testing one premise arguments for validity using Venn diagrams from both the Aristotelian and Boolean standpoints. 5. Demonstrate your understanding of the method of Venn diagrams for categorical syllogisms by correctly testing categorical syllogisms for validity using Venn diagrams from both the Aristotelian and Boolean standpoints. 6. Demonstrate that you understand the method of Venn diagrams for sorites by correctly testing sorites for validity using Venn diagrams from both the Aristotelian and Boolean standpoints. 7. Demonstrate your understanding of the ideas in this chapter by correctly answering relevant true-false, multiple-choice, and other short answer questions and essay questions. 8. If something taught in the text was not included in this list of objectives, be prepared to demonstrate an understanding of that item too. Test Your Understanding Practice Problems with Answers Drawing Venn Diagrams Abbreviate the following categorical statements, and make a complete two-circle Venn diagram for each. Use the existential or hypothetical viewpoint as warranted. 1. All dogs are animals. 2. No cats are fish. 3. Some birds are not ravens. 4. Some crows are black animals. 5. All unicorns are animals. 56 6. No vampires are vegetarians. 7. Some three-sided rectangles are geometric figures. 8. Some geometric figures are horses. 9. Some dogs that are not blue are animals that are not pink. 10. All raptors are carnivores. Answers: [Descriptions of which quadrants shading or an X is to be found are provided here.] 1. All D are A; shading in 1; X in 2. 2. No C are F; shading in 2; X in 1. 3. Some B are not R; no shading; X in 1. 4. Some C are B; no shading; X in 2. 5. All U are A; shading in 1; no X. 6. No V are E; shading n 2; no X. 7. Some T are G; no shading; X in 1. 8. Some G are H; no shading; X in 2. 9. Some D are A; no shading; X in 2. 10. All R are C; shading in 1; X in 2. Testing Immediate Inference with Venn Diagrams Use a Venn diagram to determine if the following arguments are valid or invalid. Begin by abbreviating the argument. Use the existential or hypothetical viewpoint as warranted. 1. Some pigs are mammals. Thus some mammals are pigs. 2. All canines are animals. Thus some animals are not canines. 3. No purple leprechauns are dissatisfied logicians. Hence some purple leprechauns are not dissatisfied logicians. 4. All living people who are over 1000 years old are folks with bad knees. Therefore some folks with bad knees are living people over 1000 years old. 5. It is false that some sea creatures are bison. Thus some bison are not sea creatures. 6. It is not the case that all logicians are party animals. Thus no logicians are party animals. 7. Some Yetis are white, hairy creatures. Consequently, some white, hairy creatures are Yetis. 8. All oxen are plow animals. Thus it is false that no plow animals are oxen. 9. It is false that some birds are fish. Thus it is false that some fish are birds. 10. No vampires are environmentalists. Thus it is false that some environmentalists are vampires. 11. Some trucks are not Fords. Thus no Fords are trucks. 12. All werewolves are people in need of a barber. Hence some werewolves are people in need of a barber. 13. Some wealthy poor people are not cola drinkers. Thus it is false that all wealthy poor people are cola drinkers. 14. No buffalo are shufflers. Thus some buffalo are not shufflers. 57 15. Some insects are not ants. Therefore some ants are insects. Answers: [Descriptions of which quadrants shading or an X is to be found are provided here.] 1. Some P are M Some M are P No shading; X in 2; valid 2. All C are A Some A are not C Shading in 1; X in 2; invalid 3. No P are D Some P are not D Shading in 2; no X; invalid 4. All L are F Some F are L Shading in 1; no X; invalid 5. F: some S are B Some B are not S Shading in 2; X in 1; invalid 6. F: all L are P No L are P No shading; X in 1; invalid 7. Some Y are W Some W are Y No shading; X in 2; valid 8. All O are P F: no P are O Shading in 1; X in 2; valid 9. F: some B are F F: some F are B Shading in 2; no X; valid 10. No V are E F: some E are V Shading in 2; no X; valid 11. Some T are not F No F are T No shading; X in 1; invalid 12. All W are P Some W are P Shading in 1; no X; invalid 13. Some W are not C F: all W are C No shading; X in 1; valid 14. No B are S Some B are not S Shading in 2; X in 1; valid 15. Some I are not A 58 Some A are I No shading; X in 1; invalid Testing Categorical Syllogisms with Venn Diagrams Use a Venn diagram to determine if the following arguments are valid or invalid. Use the existential or hypothetical viewpoint as warranted. 1. Some people are logicians. All logicians are amicable individuals. So, some amicable individuals are people. 2. All traffic cops are rugged individuals. Some hockey players are rugged individuals. Therefore, some hockey players are traffic cops. 3. All teachers are happy persons. No logic loathers are happy persons. Thus, no logic loathers are teachers. 4. All mermaids are fishy-smelling creatures. All fishy-smelling creatures are swimmers. Thus all mermaids are swimmers. 5. All puppies are cute animals. All small mammals are cute animals. So, all small mammals are puppies. 6. Some pianists are not skiers. All pianists are aesthetically gifted persons. Therefore, some aesthetically gifted persons are not skiers. 7. No chefs are garlic haters. Some vampires are garlic haters. Thus some chefs are not vampires. 8. No poets are doctors. No doctors are baseball fans. So, no poets are baseball fans. 9. No scuba divers are musicians. All musicians are artistic persons. Consequently, no artistic persons are scuba divers. 10. No presently living brontosauruses are marsh dwellers. No marsh dwellers are leaping lizards. Thus no presently living brontosauruses are leaping lizards. 11. Some nudists are conservatives. No conservatives are prudes. So, some prudes are not nudists. 12. No taxi drivers are musicians. Some taxi drivers are bald people. Therefore, some bald people are not musicians. 13. Some apes are primates. Some deer are not apes. So, some deer are not primates. 14. Some pixies are tiny females. Some elves are tiny females. Thus some pixies are elves. 15. Some people who can swim across the Pacific Ocean in five minutes are superior athletes. All superior athletes are teenagers in good shape. Hence, some teenagers in good shape are people who can swim across the Pacific Ocean in five minutes. [For the remainder of the problems in this section, assume that each term refers to existing things.] 16. No R are B. All C are R. Thus, no C are B. 17. All P are B. All P are C. Hence, some C are B. 18. Some H are B. All C are B. Therefore, some C are H. 59 19. All J are B. No B are C. Consequently, some C are J. 20. All W are B. All W are C. It follows that, all C are B. 21. All D are B, since all D are C, and all B are C. 22. No S are B, thus some C are B, because no S are C. 23. Some G are B. Some G are C. Accordingly, some B are C. 24. Some K are not B, provided that some K are not C, and all C are B. 25. No L are B, so some C are not L, since all B are C. 26. All N are P. No S are N. Thus, no S are P. 27. All O are M. Some S are M. Therefore, some S are O. 28. All I are M. All S are M. We conclude that all S are I. 29. Some U are not P. Some S are U. Thus, some S are not P. 30. No X are P. All X are S. Therefore, some S are not P. 31. No V are B. No C are B. Consequently, no C are V. 32. No J are G. All F are G. Thus, Some F are not J. 33. No Z are G. Some F are G. Thus, some F are not Z. 34. Some T are not H. No F are T. Thus, some F are not H. 35. Some Q are G. Some F are G. So, some F are Q. Answers: [Descriptions of which quadrants shading or an X is to be found are provided here.] 1. Shading in quadrants 1, 4; X in quadrant 3; valid 2. Shading in 6, 7; X on line separating 2 and 3; invalid 3. Shading in 2, 3, 6, 7; X in 4 and 5; valid 4. Shading in 1, 2, 5, 6; no X; valid 5. Shading in 5, 6, 7; no X; invalid 6. Shading in 1, 4; X in 2; valid 7. Shading in 2, 3; X in 4; invalid 8. Shading in 2, 3, 4; X in 1; invalid 9. Shading in 1, 3, and 4; X in 2; invalid 10. Shading in 2, 3, 4; no X; invalid 11. Shading in 2, 3; X in 4; invalid 12. Shading in 3, 4; X in 2; valid 13. No shading; X on line separating 3 and 4, and separating 5 and 6; invalid 14. No shading; X on line separating 2 and 3, and separating 3 and 4; invalid 15. Shading in 1, 4; X in 3; valid 16. Shading in 3, 4, 5, 6; X in 2; valid 17. Shading in 1, 2, 4; X in 3; valid 18. Shading in 5, 6; X on line separating 3 and 4; invalid 19. Shading in 2, 3, 6, 7; X in 1; invalid 20. Shading in 1, 2, 4; X in 3; invalid 21. Shading in 5, 6, 7; no X; invalid 60 22. Shading in 2, 3, 4; X in 1; invalid 23. No shading; X on line separating 2 and 3, and separating 3 and 4; invalid 24. Shading in 1, 2; X on line separating 5 and 6; invalid 25. Shading in 1, 3, 4; X in 2; valid 26. Shading in 1, 2, 3; X in 4; invalid 27. Shading in 6, 7; X on line separating 2 and 3; invalid 28. Shading in 5, 6, 7; no X; invalid 29. No shading; X on line separating 1 and 2, and separating 2 and 3; invalid 30. Shading in 1, 3, 4; X in 2; valid 31. Shading in 2, 3, 4; no X; invalid 32. Shading in 3, 4, 5, 6; X in 2, 6; valid 33. Shading in 2, 3; X in 2; valid 34. Shading in 2, 3; X in 1; invalid 35. No shading; X on line separating 2 and 3, and separating 3 and 4; invalid Sorites and Venn Diagrams Rewrite each sorites below in standard form. Use a Venn diagram to determine any needed intermediate conclusions, and using Venn diagrams determine if each sorites is valid or invalid. Assume the Aristotelian standpoint. 1. Some CEOs are business people. All business people are tactful individuals. All CEOs are people in public life. So, some people in public life are tactful individuals. 2. Baseball players are athletic. No philosophers are maudlin. Athletic people are maudlin. Therefore, no baseball players are philosophers. 3. No chess players are athletes. Some doctors are chess players. No athletes are lethargic people. Therefore, some doctors are not lethargic people. 4. All Q are L. Some C are Q. All C are D. So, some D are L. 5. Some P are not D. All D are H. All P are G. Therefore, some G are H. 6. No M are K. All C are M. All C are D. So, some D are K. 7. All S are M. No C are S. All C are D. So, some D are M. 8. All I are J. No C are J. All D are C. So, no D are I. 9. All F are B. Some P are not D. No B are D. So, no F are P. 10. All N are B. All P are D. No D are B. So, no P are N. Answers: 1. All B are T Some C are B < Thus some C are T All C are P Thus some P are T Valid 2. No P are M All A are M < Thus no A are P All B are A 61 Thus no B are P Valid 3. No A are L No C are A < No conclusion can be drawn Some D are C Thus some D are not L Invalid 4. All Q are L Some C are Q < Thus some C are L All C are D Thus some D are L Valid 5. All D are H Some P are not D < No conclusion can be drawn All P are G Thus some G are H Invalid 6. No M are K All C are M < Thus some C are not K All C are D Thus some D are K Invalid 7. All S are M No C are S < Thus some M are not C All C are D Thus some D are M Invalid 8. All I are J No C are J < No conclusion can be drawn All D are C Thus no D are I Invalid 9. All F are B No B are D < Thus no D are F Some P are not D Thus no F are P Invalid 10. All N are B No D are B < Thus no D are N 62 All P are D Thus no P are N Valid Enthymemes For each of the following enthymemes, supply the missing premise or conclusion. In each case, try to add missing elements so as to produce a valid argument. 1. All bears are mammals. Thus Yogi is a mammal. 2. If Boo-Boo is Yogi's friend, then Boo-Boo is loyal. And Boo-Boo is indeed Yogi's friend. 3. Either Scooby Doo is a dog or a cat. But he's not a cat. 4. Sponge Bob Square Pants lives underwater. Hence he must be wet. 5. If Tom & Jerry are friends, then Tom & Jerry are pals; and if Tom & Jerry are pals, then Tom & Jerry are buddies. 6. No married people are single, and Wilma Flintstone is married. 7. Speed Racer is a male. Thus Speed Racer is

Videos and PowerPoints We also strongly recommend that you watch the corresponding online video lectures and the PowerPoints as you learn to build truth tables. Few students can adequately learn to build proper truth tables without watching these visual, step-by-step demonstrations. They are there for a good reason. Chapter Objectives 1. Demonstrate that you understand how to use truth tables to test a sentence for logical status (tautology, contradiction, contingency) by correctly testing sentences for logical status on truth-tables. 2. Demonstrate your understanding of the definitions of the logical properties of tautology, contradiction, and contingent by correctly answering relevant questions, including possibly true / false and multiple choice, and essay questions about these notions. 3. If something taught in the text was not included in this list of objectives, be prepared to demonstrate an understanding of that item too. Test Your Understanding! Practice Problems with Answers Truth Tables and the Logical Status of a Single Statement 83 Create two- or four-row truth tables and determine for each of the following statements whether it is a tautology, contradiction, or contingency. 1. (K & ~K) v K 2. ~J & (~J v ~J) 3. (G ↔ G) 4. (~A v ~B) ↔ (B & A) 5. (~D v U) & ~(D U) 6. E v (R & ~E) 7. (S L) → (L ↔S)8. [A & (A M)] M 9. ~(J & G) → (G v ~J) 10. (N & ~B) (B & ~N) 11. (A & B) v (B ~A) 12. (K & J) v ~(J & ~K) 13. (~A v ~B) (A B) 14. (B ~C) ~(C & B) 15. (H & P) & (H ~H) Answers: 1. Contingency (K & ~ K) T F F T F F T F v T F K T F 2. Contradiction ...

Unit Three Online Lecture 8 On Chapter 16 In this chapter we use truth-tables to test arguments for validity. Arguments are made up of sentences. This chapter “automates” one of the ideas of Unit One, namely, the concept of validity. The method of truth tables automates the concept of validity in the sense that it provides a mechanical test for validity. Read this chapter carefully: it is all very mechanical. It works every time if you simply follow the rules! It can’t hurt to repeat the advice from the last lecture: As you work through this chapter, keep in mind the old adage: “When in doubt, read the instructions.” The Videos and PowerPoints We also strongly recommend that you watch the corresponding online video lectures and the PowerPoints as you learn to build truth tables. Few students can adequately learn to build proper truth tables without watching these visual, step-by-step demonstrations. Chapter Objectives 1. Demonstrate that you understand how to use truth tables to test arguments for validity by correctly testing arguments for validity on truth tables. 2. Demonstrate that you understand the meaning of validity by correctly answering questions, including possibly true / false and multiple choice, about it. 3. Demonstrate that you understand how to establish validity or invalidity using a partial truth table and using a short cut tables by actually doing so. 4. Demonstrate that you understand the formal semantics for truth-functional logic by explaining it in your own words and by answering relevant questions. 5. Demonstrate your understanding of the ideas in this chapter by correctly answering relevant true/false, multiple-choice, and other short answer questions and essay questions. 87 6. If something taught in the text was not included in this list of objectives, be prepared to demonstrate an understanding of that item too. Test Your Understanding! Practice Problems with Answers Truth Tables and Testing Arguments for Validity Use truth tables to determine whether the following arguments are valid or invalid. ... Unit Three Online Lecture 9 On Chapter 17 In this chapter we use truth-tables to test pairs of sentences for the presence of the logical relations (consistency, inconsistency, implication, equivalence). No arguments appear in this chapter, just pairs of individual sentences. The logical relations between sentences were introduced and carefully defined in Chapter 6; thus, the present chapter can be seen as “automating” some of the logical ideas taught in Unit One, Chapter 6. It automates them in the sense that it provides mechanical tests for the relations. The tests are explained in detail; read the instructions carefully. If you follow the instructions exactly, they work perfectly every time. It can’t hurt to repeat the advice from the last lecture one more time: As you work through this chapter, it may pay to keep in mind the old adage: “When in doubt, read the instructions.” Chapter Objectives 1. Demonstrate that you understand how to use truth tables to test pairs of sentences for the logical relations of consistency, inconsistency, implication, and equivalence by correctly testing pairs of sentences for those relations using truthtables. 90 2. Demonstrate your understanding of the meanings of consistency, inconsistency, implication, and equivalence by correctly answering questions, including possibly true / false and multiple choice and short answer questions about them. 3. If something taught in the text was not included in this list of objectives, be prepared to demonstrate an understanding of that item too. Test Your Understanding! Practice Problems with Answers Truth Tables and Testing Pairs of Sentences for Equivalence Use a truth table to determine whether the following pairs of statements are equivalent or not. 1. K & ~L / L K 2. J G / J v ~G 3. (A & U) v (~A & ~U) / U A 4. ~F v ~D / ~(D & F) 5. (M & W) v ~M / W 6. ~I O / (~I O) & (O ~I) Answers: 1. Not equivalent K & ...

Unit Three Online Lecture 10 Optional Lecture: Extra Prep for Natural Deduction This is an optional lecture. It does not correspond directly to a chapter in the text. It is extra prep and background to help you when you start natural deduction in the next chapter. Natural deduction is the method presented in the next five chapters, Chapters 18-22. The ability to recognize argument forms and their instances is a crucial prerequisite for learning natural deduction. Generally, students who practice recognizing argument forms and their instances can only help you as you prepare to learn natural deduction in the following chapters. This lecture is not required reading—we have already learned the definition of an argument form and a sentence form. This lecture is just more depth on the matter, with more examples, and it is offered only as “extra prep” for the five chapters to follow, Chapters 18-22. Without further adieu, here is some extra background material to help you learn Chapters 18-22. The Concept of Logical Form An in-Depth Analysis I. Sentence Forms Recall the difference between a variable and a constant. A variable stands for anything from a specified set of things, whereas a constant is a symbol that stands for one specified thing. Consider the following three sentences: a. It will rain or it will snow. b. Jan is from Michigan or Jan is from Arkansas. c. It is not Wednesday or this is not Belgium. Symbolized within our formal language TL, these become a. R v S b. M v A c. ~W v ~B What do these three sentences of TL have in common? Each consists of a left disjunct joined by a disjunction operator to a right disjunct. In logic, this general pattern is expressed by P v Q where P and Q are variables ranging over sentences of TL. This expression, P v Q, represents a general pattern exhibited by the three TL sentences above. The expression P v Q is the form of the three TL sentences, and those three sentences are instances of, or substitution instances of the form P v Q. A TL sentence will qualify as a substitution instance of a form if and only if that TL sentence can be generated from the form by replacing only the variables in the form with TL sentences and, in addition, 93 making any necessary parenthetical adjustments. This will become clearer after working through several examples. Consider again the form P v Q. Suppose we abbreviate the English sentence "Jean attended the Monterey Pop Festival in 1967" with the letter J and "Chris attended the Monterey Pop Festival in 1967" with the letter C. If we begin with the form P v Q and replace P with the constant J and Q with the constant C, we generate the substitution instance J v C. To record the replacements, we write J/P, C/Q (read: J replaces P and C replaces Q). Notice that the form P v Q is the form of any sentence where the variable P was replaced by the constant C. If we return to the form P v Q and replace P with the TL formula A, and we replace Q with the TL formula B, we generate a new substitution instance: A v B. To record the replacements, we write P/A Q/B Substitution instances can grow quite large. For instance, remaining with the same form, if we replace P with (A & B) and we replace Q with (C v D), we generate the substitution instance (A & B) v (C v D) To record the replacements, we write P/A&B Q/CvD. Notice that the parentheses were retained. Suppose we replace P with ~(A & B) and Q with (C v D), we now generate ~(A & B) v (C v D) Consider now a different form, the form ~(P v Q). If we replace the variable P with (A & B) and Q with (C v D), after we make the appropriate parenthetical adjustments, we derive the substitution instance ~ [(A & B) v (C v D)] Notice that the tilde on the left side of the form carried down from the form to the instance unchanged. Ditto for the wedge in the form: the wedge was carried down from the form to the instance unchanged. When we go from the form to the instance, the connectives in the form carry down unchanged. The only change that takes place concerns the variables. We "swap out" the variables. That is, each variable is replaced with a specific wff. The connectives in the form retain their position and scope—they do not change. It is very important that you understand this point. If instead we replace the variable P with ~(A v B) and the variable Q with ~(A v E) we have a different substitution instance: ~[~(A v B) v ~(A v E)] Notice again that the tilde on the left side of the form carried down from the form to the instance unchanged. Ditto for the wedge in the form. However, since the variable P was replaced by ~(A v B), the instance has a tilde that was not in the form. Since the variable Q was replaced in this instance by ~(A v E), the instance has another tilde that was not in the form. This illustrates the fact that the instance can have more tildes than the form (or any connective) but it can never have fewer connectives than the form. For example, consider the following substitution instance: ~[(A v B) v (A v E)] ... The principle at work here is the following. Any instance of a form must have at least as many connectives as the form; the instance can have more connectives than the form. However, for reasons given above, the instance can never have fewer instances than the form (for every connective in the form carries down into the instance). Other TL substitution instances of the form ~(P v Q) include the following: INSTANCES: REPLACEMENTS MADE: ... One way to get a sense of an argument form is to abstract a set of TL sentences from their content, leaving only the logical structure intact. Just as we used the operators' positive and scope-indicating devices to capture the form of a sentence, so may we capture the form of an argument. The operators and their associated scope-indicating devices give the form its character, its identity. It is this character, the arrangement of operators, that the form shares with all instances of it. Thus, the form is, in a sense, a "blueprint" for the arrangement of its instances. A form is therefore constituted by a set of symbolic template, and substitution instances of a form are sentences that fit that template. Notice that in the arrangement of the form's operators carries over into the instance. The relationship between a form and its instances is similar in some ways to the relationship between a cookie cutter and the cookies it produces. The cookie cutter 95 imposes a common form on each cookie in the batch. However, within the constraints of that form, the individual cookies may vary. For instance, within the common form some might have cherries, and so on. Similarly, all the instances of a form share an arrangement of operators, but within that structure each instance of the form may have different TL sentences. 2. Argument Forms An argument form may be defined as a set of two or more sentence forms with one of these designated as the conclusion and the other (or others) designated as a premise (or premises). An argument form can be transformed into a symbolized argument by replacing the variables in the form with TL sentences, and an argument formed in this way from an argument form is a substitution instance (or instantiation) of the argument form. The relationship between an argument form and a symbolized argument is similar to the relationship between a sentence form and a symbolized sentence. The distinction should become clear as we identify and examine some very common forms of deductive reasoning. THE DISJUNCTIVE SYLLOGISM FORM Consider the argument: 1. We'll either eat or drink. 2. We won't eat. 3. So, we'll drink. In TL this is: 1. E v D 96 2. ~E // D These two arguments look similar, don't they? As you can see by simple inspection, these arguments display the same abstract logical structure or logical form. We can see that form when we replace the constant with variables. In each case, if we replace constants with variables, making no other changes, the result is the same: 1. P v Q 2. ~P // Q I call this common form the disjunctive syllogism form because it is a syllogism, i.e., a deductive argument, and it begins with a disjunction. THE MODUS PONENS FORM Consider the following short argument: 1. If it is raining over the roof, then the roof is wet. 2. It is raining over the roof. 3. So, the roof is wet. In TL this is symbolized as follows: 1. R ⊃ W 2. R // W Again, the premises are numbered and the conclusion follows the slanted lines. This argument is a substitution instance of the argument form 97 1. P ⊃ Q 2. P // Q Logicians named this form of reasoning Modus Ponens, Latin for "method of affirmation," reflecting the fact that the second premise affirms the antecedent of the first premise. Additional instances of the Modus Ponens form follow: 1. (A v B) ⊃ (E v F) 2. (A v B) // E v F Here, the variable P was replaced with (A v B) and Q was replaced with (E v F). 1. (A & B) ⊃ ~(G & H) 2. A & B // ~(G & H) Here P was replaced with A and Q was replaced with (H & G). Notice that an argument form constitutes a general form or pattern of reasoning that many individual arguments may instantiate. THE MODUS TOLLENS FORM Consider the following argument: 1. If it's raining, then the roof is wet. 2. The roof is not wet. 3. So, it is not raining. In TL, with obvious abbreviations, this is: 1. R ⊃ W 2. ~W // ~R This argument is an instance of the argument form named Modus Tollens: 1. P ⊃ Q 2. ~Q // ~P The name Modus Tollens is Latin for "method of denial" and derives from the fact that the second premise is a denial of the consequent of the first premise. THE HYPOTHETICAL SYLLOGISM FORM In everyday reasoning we often link several things together in a chain of "if-then" connections. For instance: 1. If it rains, then the roof gets wet. 2. If the roof gets wet, then the ceiling leaks. 3. So, if it rains, then the ceiling leaks. In TL, with obvious abbreviations, this becomes: 1. R ⊃ W 2. W ⊃ C / R ⊃ C This argument instantiates the Hypothetical Syllogism argument form: 1. P ⊃ Q 2. Q ⊃ R / P ⊃ R Here is another instance of this form: 1. If Moe slaps Curley, then Curley will jab Larry. 98 2. If Curley jabs Larry, then Larry will hit Moe. 3. So, if Moe slaps Curley, then Larry will hit Moe. In TL, with the usual abbreviations, this is: 1. M ⊃ C 2. C ⊃ L / M ⊃ L Valid Argument Form Defined Each of the four argument forms identified above has a special property: No matter how the form is instantiated, the result is a valid argument. A form has this property if and only if there is no form all of whose instances are valid arguments. Accordingly, we may define a valid argument form as follows: An argument form is valid if and only if it has no substitution instance with all true premises and a false conclusion. Equivalently, an argument form is valid if and only if its truth-table has no row showing all true premises and a false conclusion. This suggests a way to test an argument form for validity: construct a truth-table for the form, write the form across the top of the table, and fill in the truth-values for each cell of the table. Look for a row showing the possibility of all true premises and false conclusion. If you find one or more such rows, the form is an invalid argument form. The Modus Ponens form and the Modus Tollens forms can both be seen to be valid on the basis of the following tables: Disjunctive Syllogism Modus Ponens 99 P∨Q ~P Q P⊃Q P Q T T F T T T T F T F F F T T T F T F T T F F F T F F T F Modus Tollens P⊃Q ~Q ~P T T F F F F T T F T F T T F T T F T T F F ... Notice that neither table contains a row showing all true premises and false conclusion, which proves that each is a valid argument form. Invalid Argument Forms An invalid argument form is an argument form that can be instantiated in such a way that true premises lead to a false conclusion. Here are two examples of invalid argument forms. The first is the fallacy of affirming the consequent. This suggests that the form is valid. In English instantiates a valid argument form, the argument itself must be valid. Proof: Suppose a substitution instance of a valid argument form is given. The arrangement of operators in the form carries over into every substitution instance of the form. Thus, the final columns on the truth-table will be in the same arrangement of truth-values as the final columns on the form's truth-table. One consequence of this is that every instantiation of a valid argument form is itself a valid argument. Consequently, an argument that instantiates a valid form must be valid. If an argument instantiates an invalid form, however, it does not follow that it is invalid. Some invalid forms are interesting and noteworthy because although they are invalid, they may look valid at first. Their appearance is thus deceptive. Two Noteworthy Argument Forms Invalid argument forms can be deceptively similar to Modus Ponens: 1. P ⊃ Q 2. Q / P Here is an instance of this form of reasoning: 1. If Freddie is a member of the Mafia, then Freddie is Italian. 2. Freddie is Italian. Therefore, Freddie is a member of the Mafia. Symbolized in TL, this argument is 1. F ⊃ I 2. I // F 100 You can easily verify the invalidity of this argument form by performing a simple truthtable test. Of course, some instances of this form will be valid (since validity is determined by the form, but not all) sufficient substitution instances of this form are valid. A fallacy is an error in reasoning that may nevertheless appear correct to some even though it is incorrect. The invalid argument form just described is thus a "logical fallacy." It is called the fallacy of affirming the consequent because the second premise "affirms" the consequent of the first premise. Be careful not to confuse Modus Tollens with the "fallacy of denying the antecedent." On the surface, they look somewhat alike. For another example, the fallacy of denying the antecedent, looks deceptively similar to Modus Tollens: 1. P ⊃ Q 2. ~P // ~Q For instance: 1. If Chris swims, then Dave will swim. 2. But Chris won't swim. 3. So, Dave won't swim. Symbolized in TL, this is an instance of the fallacy of denying the antecedent: 1. C ⊃ D 2. ~C // ~D Once again, you may easily prove the invalidity of this form with a simple truth-table. Be careful not to confuse this form with the Modus Tollens form—they look similar on the surface. These two fallacies, the fallacy of affirming the consequent, and the fallacy of denying the antecedent, are formal fallacies because the logical error has to do with the general form or structure of the argument rather than the specific content of the argument. In other words, the fallacy is in the form, not in the content. Logic also studies "informal fallacies"—we will examine several of these when we turn to the informal branch of logical theory, in Chapter 24. When arguing within a natural language, one must constantly be on the lookout for invalid or fallacious patterns of reasoning, because patterns that appear at first glance to be an instance of a valid argument form sometimes turns out to be an invalid pattern of reasoning. Don't let an invalid form fool you! Test Your Understanding! Practice Problems with Answers 101 Matching Sentence Forms and Instances Match the numbered statement instance from the first (upper) section to the lettered statement form in the second (lower) section. 1. P2 - ~P3. P & Q4. ~(P & Q) 5. P v (Q & ~P) 7. P Q8. ~(P Q) 9. P Q 10. ~P ... Answers: 1. None 2. c 3. f 4. g 5. e 6. None 7. h 8. i 9. a 10. j Matching Argument Forms and Instances Determine the name of argument form of which each of the following arguments: Choices include modus ponens, modus tollens, disjunctive syllogism, hypothetical 102 syllogism, affirming the consequent, and denying the antecedent. Then determine if each argument is valid or invalid. ... Answers: 1. disjunctive syllogism, valid 2. modus tollens, valid 3. affirming the consequent, invalid 4. hypothetical syllogism, valid 5. modus tollens, valid 6. disjunctive syllogism, valid 7. modus ponens, valid 8. hypothetical syllogism, valid 9. denying the antecedent, invalid 10. modus tollens, valid 11. disjunctive syllogism, valid 12. affirming the consequent, invalid 13. affirming the antecedent, invalid 14. hypothetical syllogism, valid 15. modus ponens, valid Unit Three Online Lecture 11 On Chapter 18 This and the next four chapters of the text cover natural deduction. The following chapters, Chapters 18-22 teach the method of natural deduction. Do you remember doing “proofs” in geometry class? Natural deduction is very similar. In the same way that geometric proofs use a small number of basic axioms and rules, natural deduction is a method of proof that begins with a set of true (or assumed true) premises. The method of natural deduction was first invented and introduced by the Stoic logicians during the 3rd century B.C. The Stoics was thus the inventors of natural deduction. In the 20th century, the method was refined and it has become the main method of establishing logical truths in the academic world, all over the world. It all unfolds in stages in the text. This chapter introduces a specific system of natural deduction, the system TD, and explains in detail the first four rules of the system. As a first step, read this chapter slowly and carefully—one step at a time. Gradually, you will find that natural deduction becomes easier and easier. It is like learning a new game. Like any game, it will take time at first. But with sufficient practice, you will use them as easily as you use a knife and fork at the dinner table. Each succeeding chapter adds another layer. As in a math text, each chapter builds on the previous one. Don't move to Chapter 19 until you have mastered Chapter 18; don't move on to Chapter 20 until you understand Chapter 19, and so on. This chapter develops "natural deduction" and explains in detail exactly what counts as a system of natural deduction. The system TD is defined in detail. Don't miss these explanations. Why does this chapter teacher only the first four rules of the system? Why not all 20 rules in one big 100 page chapter? When learning something like this, it is best to proceed in small steps. If you have seen the movie, "What About Bob?", baby steps. You will have to wait until the next chapter for the next four rules. This is important. There is a proper form for constructing and stating a proof. You cannot simply write a proof any way you want to. You have to follow the proper form. Similarly, when working with a computer program, commands must be written in a proper form; the computer will not execute the command if it is not written in a proper form. The form for stating a natural deduction proof is precise and it is taught in the text. Many examples in the text show you what the proper form looks like. Your proofs must be constructed in the proper form and this means they need to look like the examples of proofs presented in the text (and in this lecture below.) The text explains the matter and its theories. It is important that you understand the format: (a) each line of the proof must be numbered, (b) each premise of the argument being proven is the very first step of the proof and (d) each step of the proof correctly follows from previous lines in the proof via one of the rules of inference, the rule has been applied and used correctly, and the rule is correctly cited in the justification of the line. The text demonstrates this in detail. The PowerPoints and the online video demo on natural deduction are explained in detail to help you learn natural deduction in detail. Note that students must learn how to construct a formal proof. 104 One bit of advice. We strongly recommend that you practice proofs the way we practice problems in math class. Practice at least some proofs every day. Practice proofs at least three consecutive days. Chapter Objectives 1. Demonstrate that you understand the nature of a proof in the system TD by correctly constructing proofs (and do well on tests) with proofs. No one studies proofs well, or proofs without gaining familiarity at the beginning. Reminder: Practice is crucial! Videos and PowerPoints We also strongly recommend that you watch the corresponding online video lectures and the PowerPoints as you learn to construct proofs. Few students can adequately learn natural deduction without watching these visual, step-by-step demonstrations. You will find many, many video lectures and natural deduction. We hope they are helpful. Objectives 1. Demonstrate that you understand the nature of a natural deduction system by correctly defining the terms "natural deduction" and "natural deduction system" in your own words. 2. Demonstrate that you understand that the nature and ... 3. Demonstrate that you understand how to symbolize an argument in TL and prove it valid using natural deduction by correctly doing so. 4. Demonstrate that you understand the meaning of the four rules of inference introduced in this chapter by using them to correctly prove arguments valid. 5. Demonstrate your understanding of the ideas in this chapter by correctly answering relevant true-false, multiple-choice, and other short answer questions and essay questions. 6. If something taught in the text was not included in this list of objectives, be prepared to demonstrate an understanding of that item too. Test Your Understanding! Practice Problems with Answers Proofs Using the First Four Inference Rules 105 Construct natural deduction proofs using any of the first four rules—MP, MT, DS, and HS—for the following valid arguments. ... Answers: Note: In most cases more than one proof is possible. Each proof below is thus one way to prove the corresponding argument valid. In many cases, alternative proofs are possible as well. ... Unit Three Online Lecture 12 On Chapter 19 This chapter introduces the second set of four rules of inference: Simp, Conj, Add, and CD. ... Reminder: Practice is crucial! Videos and PowerPoints We also strongly recommend that you watch the corresponding online video lectures and the PowerPoints as you learn to construct proofs. 1. Demonstrate that you understand how to correctly apply each of the eight inference rules by using them to correctly prove arguments valid. ... Remember that in most cases more than one proof is possible for any particular valid argument, as the text explains. If we include every possible proof of every argument in the practice sets, our lectures would become thousands and thousands of pages long. ... Whenever you apply Modus Ponens, one whole line must be the antecedent of the conditional, and the other line must be the whole conditional itself. ... 115 Modus Ponens A common mistake is to apply an inference rule to a line when only part of the line instantiates or fits the relevant part of the inference rule. The book warns you against making this error, as do the videos, but a little emphasis on the point can't hurt ... The Trial and Error Strategy Suppose you begin a proof and are unsure where to start or where to go. ... THE DECOMPOSITION STRATEGY Another proof strategy may be described as follows: Break larger sentences down into smaller sentences by deriving parts of the larger sentences. ... WORKING BACKWARD FROM THE CONCLUSION Let's suppose we are trying to prove the following symbolized argument valid. ... Unit Three Online Lecture 13 On Chapter 20 This chapter introduces the next five rules of our system, ten “replacement rules.” ... DeMorgan's Rule ... Unit Three Online Lecture 14 On Chapter 21 This chapter introduces the remaining replacement rules ... Unit Three Online Lecture 15 On Chapter 22 ... 1. Demonstrate that you understand the nature of conditional proof by correctly using conditional proof to construct premise-free proofs of theorems. ... Unit Four Lecture 1 General Comment On Unit Four Unit Four introduces our third branch of logic, predicate logic, also called "quantificational" logic or "quantifier" logic. The first two chapters of this unit introduce the formal language of predicate logic, the formal language PL. The language PL is "resident within" PL. The rest of the unit teaches five new deduction rules and defines a system of natural deduction for predicate logic. ... Note the way in which the language PL includes the language TL. As your text explains, TL is "resident within" PL. ... Chapter Objectives 1. Demonstrate that you understand the nature of the language PL by correctly translating English sentences into PL and by explaining the nature of PL in your own words. ... 9. Demonstrate that you understand how to use natural deduction to prove quantified arguments valid by correctly doing so. 10. If something taught in the text was not included in this list of objectives, be prepared to demonstrate an understanding of that item too. Unit

Four Online Lecture 2 On Chapter 23 This and the next chapter introduce you to the formal language PL and teach you how to translate sentences of English into PL. In this chapter you translate only singular sentences and sentences that contain quantifiers and monadic predicates; the next chapter adds more complicated translations involving relational predicates and overlapping quantifiers. What are these? You'll see in the next chapter! [illegible]

translations requiring the identity operator by correctly translating sentences of English whose translation requires the identity operator (in addition to quantifiers, predicates, etc.). 2. Demonstrate that you understand express specific quantities of things using the identity operator by correctly making the relevant translations. 3. Demonstrate that you understand the ideas in this chapter by correctly answering relevant true-false, multiple-choice, and other short answer questions and essay questions. 4. If something taught in the text was not included in this list of objectives, be prepared to demonstrate an understanding of that item too. Test Your Understanding! Practice Problems with Answers Translating Identity Statements Translate the following English statements into the language of predicate logic making use of the identity sign as appropriate. Use the capital letters provided for your predicate constants. E.g., "Only Mark has a watch (W)" translates as "Wm & (x)[Wx (x = m)]." 1. Samuel Clemens is Mark Twain. 2. If Cicero is Tully, then at least one Roman was an orator. (RO) 3. George W. Bush is not Bob Marley. 4. Mark is Diane's firstborn son. 160 5. It is false that the room with the evidence is the place where the murder took place. 6. There is no best flavor of ice cream. (BF) 7. There is only one building. (B) 8. The barber shaves everybody except himself. (S) 9. Only Kant could critique pure reason. (C) 10. The only book written by Isabel Allende is The House of the Sprits. (BW) 11. No author except Herman Melville wrote Moby Dick. (AW) 12. The only musicians who won a prize were Rueben Blades and Jose Alfredo Jimenez. (MW) 13. The tallest basketball player is Stretch. (TB) 14. There is at most one choice. (C) 15. There are at least two Libertarians in the room. (LR) Answers: 1. c = t 2. (c = t) (x)(Rx & Ox) 3. ~(b = m) 4. m = f 5. ~(e = m) 6. ~(x){Fx & (y)[(Fy & ~(x = y)] Bxy}} 7. (x)(y){Bx & [By (x = y)]} 8. (x){[(Px & ~(x = t)] Stx)} 9. Ck & (x)[Cx (x = k)] 10. (Bh & Wh) & (x)[(Bx & Wx) (x = h)] 11. (Am & Wm) & (x)[(Ax & Wx) (x = m)] 12. [(Mb & Wb) & (Pj & Wj)] & (x){(Mx & Wx) [(x = b) v (x = j)]} 13. Bs & (x){[Bx & ~(x = s)] Tsx} 14. (x)(y)[(Cx & Cy) (x = y)] 15. (x)(y){[(Lx & Rx) & (Ly & Ry)] & ~(x = y)} Unit Four Online Lecture 5 On Chapter 26 This exciting chapter introduces the second system of natural deduction, the system we call here QD (for "quantificational deduction"), the deduction system for predicate arguments (also called "quantified" arguments). Five rules are presented, with many examples. Four of these rules are inference rules, which (you will recall) means they are applied only to whole lines of a proof. One is a replacement rule, which means it can be 161 applied to a whole line or to a part of a line. Make sure you keep in mind the difference between the two types of rules. This was first explained in Unit Three of course. We also recommend that you study the examples carefully. We also recommend that you practice proving arguments valid in this new system. The more proofs you complete, the better at creating proofs you will be. Constructing proofs is a skill that improves with practice. In this chapter, you are only asked to prove monadic predicate arguments valid—those containing only monadic predicates. Arguments with relational predicates are more complex and they are considered separately, in the next chapter. Keep in mind the difference between the two types of predicates. Monadic predicates attach to one thing at a time. A relational predicate represents a relation between two or more things. Notice that QD incorporates all the rules from TD. The system TD is "resident within" the system QD. The text explains this in detail, of course. This is very important. Remember that there is a proper form for constructing and stating a proof. You cannot simply write a proof any way you feel like at the moment. You have to follow the proper format. (Similarly, when writing instructions or commands in a computer programming language, the commands must be written in a proper form; the computer will not execute a command if it is not written in a proper form.) The form for stating a natural deduction proof is as precise and it is taught in the text. Many examples in the text show you what the proper form looks like. Your proofs must be constructed in the proper form and this means they need to look like the examples of proofs presented in the text (and in this lecture below.) The text explains the matter and demonstrates it in detail, of course! This is important: As the text explains and demonstrates, your proof is correct as long as (a) the conclusion of the argument being proven is the very last step of the proof, and (b) each step in the proof after the premises correctly follows from one or more previous lines via one of the rules of inference, the rule has been applied and used correctly, and the rule is correctly cited in the justification of the line. The text demonstrates this in detail. The PowerPoints and the online video demos also demonstrate in detail how to construct a proper proof. One bit of advice. We strongly recommend that you practice proofs the way you would practice problems in a math class. Practice at least some proofs every day. Experience shows that most students only become good at constructing proofs (and do well on tests) with practice; rarely does anyone become good at proofs without a fair amount of practice. Remember: Practice makes perfect! The Videos and PowerPoints 162 We recommend that you watch the corresponding online video lectures and the PowerPoints as you learn to construct proofs in predicate logic. Few students can adequately learn this material without watching visual, step-by-step demonstrations. Chapter 26 Objectives 1. Demonstrate that you understand how to correctly use the five rules of the natural deduction system QD by correctly proving monadic predicate arguments valid. 2. Demonstrate that you understand the ideas in this chapter by correctly answering relevant true-false, multiple-choice, and other short answer questions and essay questions. 3. If something taught in the text was not included in this list of objectives, be prepared to demonstrate an understanding of that item too. Test Your Understanding! Practice Problems with Answers Proofs in Predicate Logic Use natural deduction to show that the following arguments are valid. Available to you are the truth-functional rules, and the four quantifier rules. Do not use CP or IP. 1. 1. (x)(Ax Gx) 2. (x)Ax / Ab & Gb 2. 1. (x)(Dx v Mx) 2. (y)~Dy / (z)Mz 3. 1. Js & ~Pj 2. [(x)Mx v Js] Lm / Lm & ~Pj 4. 1. He v He 2. ~He v Jd / Jd 5. 1. (x)[Ax v (Mx & Nx)] 2. ~Mb / (x)Ax 6. 1. (x)(Rx Tx) 163 2. (x)Rx / (y)Ty 7. 1. (x)(Dx v Mx) 2. (x)(Dx Ax) 3. (x)(~Ax & Px) / (z)Mz 8. 1. (x)(~Hx v Zx) 2. (x)Hx / (x)Zx 9. 1. (x)Ax 2. (z)Az (x)Bx / (y)By 10. 1. ~Pg 2. (y)[(Py v Py) v Gy] / Gg v (x)~Px 11. 1. Ab (x)Kx 2. (y)Ay / (y)Ky 12. 1. ~Jc v Lg 2. Jc 3. (y)Ly (x)(Dx & Hx) / He 13. 1. ~Df 2. (x)(Jx Dx) 3. (x)(Jx v Mx) / Mf 14. 1. Ac 2. (x)Bx 3. (Ac & Bc) (x)Rx / (x)Rx 15. 1. (x)(Ax Bx) 2. ~Bk / (z)(~Az v Bz) 16. 1. (z)(Mz Nz) 2. (y)(Ny Oy) 3. (x)(Ox Px) / (x)(~Mx v Px) 17. 1. (x)(Gx Fx) 2. (y)Gy / (y)Fx & (x)Gx 3. (x)Gx 164 18. 1. (x)[(Ax v Bx) Ox] 2. (y)(Ay & Dy) / (y)Oy 19. 1. (x)(Gx Hx) 2. (x)(Ix & ~Hx) 3. (x)(~Fx v Gx) / (x)(Ix & ~Fx) 20. 1. (x)Gx ~Ox 2. (x)Wx (x)(Fx Ox) 3. (x)(Wx & Gx) / (x)~Fx Answers: Remember: As the text explained in Unit Three, in most cases more than one proof can be given for any particular valid argument. Each proof below is thus one way to prove the corresponding argument valid. In many cases, alternative proofs are possible as well. If we included every possible proof, for every argument in these practice sets, our online lectures would become thousands of pages long. Way too many pages to be useful. We simply do not have the space to include every possible proof for every argument. 1. 2. 3. 165 1. (x)(Ax Gx) 2. (x)Ax / Ab & Gb 3. Ab Gb 4. Ab 5. Gb 6. Ab & Gb UI 1 UI 1 MP 3, 4 Conj 4, 5 1. (x)(Dx v Mx) 2. (y)~Dy / (z)Mz 3. ~Da 4. Da v Ma 5. Ma 6. (z)Mz EI 2 UI 1 DS 3, 4 EG 5 1. Js & ~Pj 2. [(x)Mx v Js] Lm / Lm & ~Pj 3. Js 4. Js v (x)Mx Simp 1 Add 3 4. 5. 6. 7. 8. 166 5. (x)Mx v Js Comm 4 6. Lm 7. ~Pj 8. Lm & ~Pj Comm 4 MP 2, 5 Simp 1 Conj 6, 7 1. He v He 2. ~He v Jd / Jd 3. He 4. ~~He 5. Jd Taut 1 DNeg 3 DS 2, 4 1. (x)[Ax v (Mx & Nx)] 2. ~Mb / (x)Ax 3. Ab v (Mb & Nb) 4. (Ab v Mb) & (Ab v Nb) 5. Ab v Mb 6. Mb v Ab 7. Ab 8. (x)Ax UI 1 Dist 3 Simp 4 Comm 5 DS 2, 6 EG 7 1. (x)(Rx Tx) 2. (x)Rx / (y)Ty 3. Ru 4. Ru Tu 5. Tu 6. (y)Ty EI 2 UI 1 MP 3, 4 EG 5 1. (x)(Dx v Mx) 2. (x)(Dx Ax) 3. (x)(~Ax & Px) / (z)Mz 4. ~Ab & Pb 5. Db v Mb 6. Db Ab 7. ~Ab 8. ~Db 9. Mb 10. (z)Mz EI 3 UI 1 UI 2 Simp 4 MT 6, 7 DS 5, 8 EG 9 1. (x)(~Hx v Zx) 2. (x)Hx / (x)Zx 9. 10. 11. 12. 13. 167 3. ~Hx v Zx 4. Hx 5. ~~Hx 6. Zx 7. (x)Zx UI 1 UI 2 DNeg 4 DS 3, 5 UG 6 1. (x)Ax 2. (z)Az (x)Bx / (y)By 3. Ax 4. (z)Az 5. (x)Bx 6. Ba 7. (y)By UI 1 UG 3 MP 2, 4 EI 5 EG 6 1. ~Pg 2. (y)[(Py v Py) v Gy] / Gg v (x)~Px 3. (Pg v Pg) v Gg 4. Pg v Gg 5. Gg 6. Gg v (x)~Px U 2I Taut 3 DS 1, 4 Add 5 1. Ab (x)Kx 2. (y)Ay / (y)Ky 3. Ab 4. (x)Kx 5. Kb 6. (y)Ky UI 2 MP 1, 3 UI 4 EG 5 1. ~Jc v Lg 2. Jc 3. (y)Ly (x)(Dx & Hx) / He 4. ~~Jc 5. Lg 6. (y)Ly 7. (x)(Dx & Hx) 8. De & He 9. He DNeg 2 DS 1, 4 EG 5 MP 3, 6 UI 7 Simp 8 1. ~Df 14. 15. 16. 17. 168 2. (x)(Jx Dx) 3. (x)(Jx v Mx) / Mf 4. Jf Df 5. ~Jf 6. Jf v Mf 7. Mf UI 2 MT 1, 4 UI 3 DS 5, 6 1. Ac 2. (x)Bx 3. (Ac & Bc) (x)Rx / (x)Rx 4. Bc 5. Ac & Bc 6. (x)Rx 7. Ra 8. (x)Rx UI 2 Conj 1, 4 MP 3, 5 UI 6 EG 7 1. (x)(Ax Bx) 2. ~Bk / (z)(~Az v Bz) 3. Ak Bk 4. ~Ak 5. ~Ak v Bk 6. (z)(~Az v Bz) UI 1 MT 2, 3 Add 4 EG 5 1. (z)(Mz Nz) 2. (y)(Ny Oy) 3. (x)(Ox Px) / (x)(~Mx v Px) 4. Mx Nx 5. Nx Ox 6. Ox Px 7. Mx Ox 8. Mx Px 9. ~Mx v Px 10. (x)(~Mx v Px) UI 1 UI 2 UI 3 HS 4, 5 HS 6, 7 Imp 8 UG 9 1. (x)(Gx Fx) 2. (y)Gy / (y)Fx & (x)Gx 3. Gu 4. Gu Fu 5. Fu EI 2 UI 1 MP 4, 5 18. 19. 20. 169 6. (x)Fx 7. (x)Gx 8. (x)Fx & (x)Gx EG 5 EG 3 Conj 6, 7 1. (x)[(Ax v Bx) Ox] 2. (y)(Ay & Dy) / (y)Oy 3. Au & Du 4. (Au v Bu) Ou 5. Au 6. Au v Bu 7. Ou 8. (y)Oy EI 3 UI 1 Simp 3 Add 5 MP 4, 6 EG 7 1. (x)(Gx Hx) 2. (x)(Ix & ~Hx) 3. (x)(~Fx v Gx) / (x)(Ix & ~Fx) 4. Iu & ~Hu 5. Gu Hu 6. ~Hu 7. ~Gu 8. ~Fu v Gu 9. Gu v ~Fu 10. ~Fu 11. Iu 12. Iu & ~Fu 13. (x)(Ix & ~Fx) 1. (x)Gx ~Ox 2. (x)Wx (x)(Fx Ox) 3. (x)(Wx & Gx) / (x)~Fx 4. Wu & Gu 5. Wu 6. Gu 7. (x)Wx 8. (x)Gx 9. (x)(Fx Ox) 10. (x)~Ox 11. ~Ov 12. Fv Ov EI 2 UI 1 Simp 4 MT 5, 6 UI 3 Com 8 DS 7, 9 Simp 4 Conj 10, 11 EG 12 EI 3 Simp 4 Simp 4 EG 5 EG 6 MP 2, 7 MP 1, 8 EI 10 UI 9 13. ~Fv 14. (x)~Fx MT 11, 12 EG 13 5. Proofs Using QE Use natural deduction to show that the following arguments are valid. Available to you are the truth-functional rules, UI, UG, EI, EG, and QE. Do not use CP or IP. 1. 1. ~(x)Mx 2. (x)~Mx ~(y)Dy / (y)~Dy 2. 1. (x)~Ax ~(y)By 2. (y)~By (z)~Dz / ~(x)Ax ~(z)Dz 3. 1. ~(x)Nx 2. ~(y)My / ~(x)~(Nx v Mx) 4. 1. (x)Bx (x)Tx 2. ~(x)Tx / ~(x)~Bx 5. 1. (x)Ax 2. (y)Ay (x)Sx / ~(x)~Sx 6. 1. (x)Px ≡ (x)Kx 2. ~(x)~Px 3. Ka Gc / (y)Gy & Pb 7. 1. (x)Ax 2. (x)Bx / ~(x)~Ax ≡ ~(x)~Bx 8. 1. ~(x)~Sx 2. (x)Sx ≡ (x)Mx 3. Ma ~Gb / ~(y)Gy 9. 1. ~(y)Dy 2. (y)~Dy ~(x)~Mx / ~(x)Mx 10. 1. ~(y)Hy 2. ~(y)Jy 170 3. ~(x)~(Hx v Jx) [(y)Jy v (x)Mx] / ~(x)~Mx 11. 1. (x)[(Ax v Bx) Px] 2. ~(y)(Py v Dy) / ~(x)Ax 12. 1. ~[(x)Fx v (x)Gx] 2. (x)~Fx (y)Hy 3. ~(x)~Gx (z)Jz / (x)(Hx & Jx) 13. 1. (x)~Ax (x)(Bx Ox) 2. ~(x)(Ax v Ox) / ~(x)Bx 14. 1. (x)[(Fx & Qx) Sx] 2. ~(x)(Fx Sx) / ~(x)Qx 15. 1. (x)Cx (x)Ax 2. (x)Dx (x)Bx 3. ~(x)(Ax v Bx) / ~(x)(Cx v Dx) Answers: 1. 1. ~(x)Mx 2. (x)~Mx ~(y)Dy / (y)~Dy 3. ~(x)Mx QE 1 4. ~(y)Dy MP 2, 3 5. (y)~Dy QE 4 2. 1. (x)~Ax ~(y)By 2. (y)~By (z)~Dz / ~(x)Ax ~(z)Dz 3. ~(x)Ax ~(y)By QE 1 4. ~(x)Ax (z)~Dz HS 2, 3 5. ~(x)Ax ~(z)Dz QE 4 3. 1. ~(x)Nx 2. ~(y)My / ~(x)~(Nx v Mx) 3. ~(x)Nx 4. (y)~My 5. ~Na 171 QE 1 QE 2 UI 3 6. ~Ma 7. ~Na & ~Ma 8. ~(Na v Ma) 9. (x)~(Nx v Mx) 4. 5. 6. UI 4 Conj 5, 6 DM 7 EG 8 1. (x)Bx (x)Tx 2. ~(x)Tx / ~(x)~Bx 3. ~(x)Bx 4. ~Bx MT 1, 2 QE 3 1. (x)Ax 2. (y)Ay (x)Sx / ~(x)~Sx 3. Aa 4. (y)Ay 5. (x)Sx 6. ~(x)~Sx EI 1 EG 3 MP 2, 4 QE 5 1. (x)Px ≡ (x)Kx 2. ~(x)~Px 3. Ka Gc / (y)Gy & Pb 4. (x)Px 5. [(x)Px (x)Kx] & [(x)Kx (x)Px] 6. (x)Px (x)Kx 7. (x)Kx 8. Ka 9. Gc 10. (y)Gy 11. Pb 12. (y)Gy & Pb QE 2 Equiv 1 Simp 5 MP 4, 6 UI 7 MP 3, 8 EG 9 UI 4 Conj 10, 11 7. 1. (x)Ax 2. (x)Bx / ~(x)~Ax ≡ ~(x)~Bx 3. ~(x)~Ax QE 1 4. ~(x)~Bx QE 2 5. ~(x)~Ax & ~(x)~Bx Conj 3, 4 6. [~(x)~Ax & ~(x)~Bx] v [~~(x)~Ax & ~~(x)~Bx] Add 5 7. ~(x)~Ax ≡ ~(x)~Bx Equiv 6 8. 1. ~(x)~Sx 172 9. 2. (x)Sx ≡ (x)Mx 3. Ma ~Gb / ~(y)Gy 4. (x)Sx 5. [(x)Sx (x)Mx] & [(x)Mx (x)Sx] 6. (x)Sx (x)Mx 7. (x)Mx 8. Ma 9. ~Gb 10. (y)~Gy 11. ~(y)Gy QE 1 Equiv 2 Simp 5 MP 4, 6 UI 7 MP 3, 8 EG 9 QE 10 1. ~(y)Dy 2. (y)~Dy ~(x)~Mx / ~(x)Mx 3. (y)~Dy 4. ~(x)~Mx 5. ~(x)Mx QE 1 MP 2, 3 QE 4 10. 1. ~(y)Hy 2. ~(y)Jy 3. ~(x)~(Hx v Jx) [(y)Jy v (x)Mx] / ~(x4)~Mx 4. (y)~Hy QE 1 5. (y)~Jy QE 2 6. ~Hx UI 4 7. ~Jx UI 5 8. ~Hx & ~Jx Conj 6, 7 9. ~(Hx v Jx) DM 8 10. (x)~(Hx v Jx) UG 9 11. (y)Jy v (x)Mx MP 3, 10 12. (y)~Jy UG 7 13. ~(y)Jy QE 12 14. (x)Mx DS 11, 13 15. ~(x)~Mx QE 14 11. 1. (x)[(Ax v Bx) Px] 2. ~(y)(Py v Dy) / ~(x)Ax 3. (y)~(Py v Dy) 4. (Ax v Bx) Px 5. ~(Px v Dx) 6. ~Px & ~Dx 7. ~Px 173 QE 2 UI 1 UI 3 DM 5 Simp 6 12. 13. 14. 174 8. ~(Ax v Bx) 9. ~Ax & ~Bx 10. ~Ax 11. (x)~Ax 12. ~(x)Ax MT 4, 7 DM 8 Simp 9 UG 10 QE 11 1. ~[(x)Fx v (x)Gx] 2. (x)~Fx (y)Hy 3. ~(x)~Gx (z)Jz / (x)(Hx & Jx) 4. ~(x)Fx & ~(x)Gx 5. ~(x)Fx 6. (x)~Fx 7. (y)Hy 8. ~(x)Gx 9. (x)~Gx 10. (z)Jz 11. Hz 12. Jz 13. Hz & Jz 14. (x)(Hx & Jx) DM 1 Simp 4 QE 5 MP 2, 6 Simp 4 QE 8 MP 3, 9 UI 7 UI 10 Conj 11, 12 UG 13 1. (x)~Ax (x)(Bx Ox) 2. ~(x)(Ax v Ox) / ~(x)Bx 3. (x)~(Ax v Ox) 4. ~(Au v Ou) 5. ~Au & ~Ou 6. ~Au 7. (x)~Ax 8. (x)(Bx Ox) 9. ~Ou 10. Bu Ou 11. ~Bu 12. (x)~Bx 13. ~(x)Bx 1. (x)[(Fx & Qx) Sx] 2. ~(x)(Fx Sx) / ~(x)Qx 3. (x)~(Fx Sx) 4. ~(Fu Su) 5. (Fu & Qu) Su QE 2 EI 3 DM 4 Simp 5 EG 6 MP 1, 7 Simp 5 UI 8 MT 9, 10 EG 11 QE 12 QE 2 EI 3 UI 1 15. 175 6. ~(Fu v Su) 7. ~~Fu & ~Su 8. ~Su 9. ~(Fu & Qu) 10. ~Fu v ~Qu 11. ~~Fu 12. ~Qu 13. (x)~Qx 14. ~(x)Qx Imp 4 DM 6 Simp 7 MT 5, 8 DM 9 Simp 7 DS 10, 11 EG 12 QE 13 1. (x)Cx (x)Ax 2. (x)Dx (x)Bx 3. ~(x)(Ax v Bx) / ~(x)(Cx v Dx) 4. (x)~(Ax v Bx) 5. ~(Ax v Bx) 6. ~Ax & ~Bx 7. ~Ax 8. ~Bx 9. (x)~Ax 10. (x)~Bx 11. ~(x)Ax 12. ~(x)Bx 13. ~(x)Cx 14. ~(x)Dx 15. ~(x)Cx 16. ~(x)Dx 17. ~Cy 18. ~Dy 19. ~Cy & ~Dy 20. ~(Cy v Dy) 21. (x)~(Cx v Dx) 22. ~(x)(Cx v Dx) QE 3 UI 4 DM 5 Simp 6 Simp 6 UG 7 UG 8 QE 9 QE 10 MT 1, 11 MT 2, 12 QE 13 QE 14 UI 15 UI 16 Conj 17, 18 DM 19 UG 20 QE 21 Unit Four Online Lecture 6 On Chapter 27 No proofs will be found in this chapter. This chapter gives you a break from doing proofs. The central idea in this chapter is the notion of an interpretation for a quantified sentence. In this chapter you learn the formal semantics for predicate logic and a semantical method for demonstrating validity and invalidity—all using the notion of an interpretation. Some logic teachers will consider this an optional chapter and will skip it. Others will use this chapter to teach some important and interesting aspects of predicate logic. Logic teachers are human; they do not agree on everything! Either way is good. As you study this chapter, keep in mind the difference between syntax and semantics. The method of natural deduction is purely syntactic in nature: The rules of deduction are applied to items based on their shape or syntax, that is, to the way the symbols look, without reference to what the symbols or shapes mean or stand for. However, when we specify an interpretation for a sentence of PL, we are saying what the symbols stand for, we are attaching meanings to the symbols. An interpretation is thus semantic in nature, while proofs are purely syntactic in nature. When we specify an interpretation for a predicate sentence or an argument, we leave pure syntax behind and we enter the realm of semantics—the assignment of meanings to the symbols of a language. The text explains this in detail. We mention it here because it is an important point. Once defined, the notion of an interpretation is used to state a formal semantics for PL and it also is used to show arguments valid and invalid in a semantical rather than a purely syntactical way. Note the comparison, drawn in the text, between truth tables (in truth-functional logic, Unit Three) and interpretations (in predicate logic). Interpretations are the analogue, in predicate logic, of truth tables in truth-functional logic. If you understand that, you will really understand this chapter in depth. The notion of an interpretation is thus in a sense a bridge connecting truth-functional and predicate logic. 176 The notion of truth-functional expansions, taught in this chapter, also forms a bridge connection between truth-functional and quantificational (predicate) logic. Note the connection when you study the idea, which is explained in detail in the text. Note also that the method of truth-functional expansions only works with monadic predicate arguments—with arguments containing nothing more than monadic predicates. In metalogic—the logic of logical systems--it has been proven that the method does not work for arguments containing relational predicates. Chapter 27 Objectives 1. Demonstrate that you understand the formal semantics for predicate logic by correctly explaining it in your own words. 2. Demonstrate that you understand the nature of an interpretation by correctly constructing interpretations for sentences and arguments. 3. Demonstrate that you know how to use interpretations to show that an argument in predicate logic is invalid by correctly showing sample arguments invalid using appropriate interpretations. 4. Demonstrate that you understand how to use truth-functional expansions to test monadic predicate arguments for validity and to show that a monadic predicate argument is valid or invalid by correctly doing so using truth-functional expansions. 5. Demonstrate your understanding of the ideas in this chapter by correctly answering relevant true-false, multiple-choice, and other short answer questions and essay questions. 6. If something taught in the text was not included in this list of objectives, be prepared to demonstrate an understanding of that item too! Test Your Understanding! Practice Problems with Answers Establishing Invalidity in Predicate Logic Specify an interpretation showing that each argument below is invalid. 1. (x)Ax / (x)Ax 177 2. (x)(Ax & ~Bx) / (x)(Ax & Bx) 3. (x)(~Ax v ~Bx) / (x)~(Ax v Bx) 4. (x)(Ax & Bx) (x)(Ax & Cx) / (x)[Ax & (Bx & Cx)] 5. (x)(Ax Bx) (x)(Ax Cx) / (x)(Bx Cx) 6. (x)(Ax ~Bx) (x)(Bx Cx) / (x)(Cx & Ax) Answers: 1. Domain: universal; Ax: is an aardvark Something is an aardvark. Thus all things are aardvarks. 2. Domain: universal; Ax: is a dog; Bx: is a cat Some dogs are not cats. Thus some dogs are cats. 3. Domain: whole numbers; Ax: is odd; Bx: is even There is a whole number that is odd or even. Thus there is a whole number that is neither odd nor even. 4. Domain: universal; Ax: is a female; Bx: is a human; Cx: is an eagle Some females are humans. Some females are eagles. Thus some females are both humans and eagles. 5. Domain: universal; Ax: is a mouse; Bx: is an animal; Cx: is a mammal All mice are animals. All mice are mammals. Thus all animals are mammals. 6. Domain: universal: Ax: is a car; Bx: is a dog; Cx: is an animal No cars are dogs. All dogs are animals. Thus something is both an animal and a car. Unit Four Online Lecture 7 On Chapter 28 Now we are back to proofs! No new rules are added in this chapter; however, in this chapter we learn to apply the existing rules to arguments containing overlapping quantifiers and relational predicates. You will notice that the proofs in this chapter take on an added level of complexity. All the more reason to watch the online videos. In addition, we again recommend that you practice these proofs every day. We say: Good exercise for the brain! Chapter 28 Objectives 178 1. Demonstrate that you can correctly use the five rules of the natural deduction system QD to prove arguments valid containing relational predicates and overlapping quantifiers valid by correctly proving such arguments valid. 2. Demonstrate your understanding of the ideas in this chapter by correctly answering relevant true-false, multiple-choice, and other short answer questions and essay questions. 3. If something taught in the text was not included in this list of objectives, be prepared to demonstrate an understanding of that item too. Test Your Understanding! Practice Problems with Answers Proofs with Dyadic Predicates and Overlapping Quantifiers Use natural deduction to derive the conclusions of the following valid arguments. 1. 1. (x)(y)Pxy / (y)(z)Pyz 2. 1. (x)Cxx 2. (y)(z)(Cyz Azy) / Abb 3. 1. (x)Rxa (y)(x)Mxy 2. Rba / Mbc 4. 1. ~Ukg ~(x)Ix / (x)Ix (y)Uyg 5. 1. Dq 2. (x)[Fx (y)(Dy Oxy)] & Fp / Opq 6. 1. Tp 2. (y)[Ty (z)Dyz] / (x)Dpx & (y)Ty 7. 1. (x)(z)Mxz 2. (x)(zMxz (y)Ny / ~(y)~Ny 8. 1. ~Fb v (Ab v Gbq) 2. (z)(x)~Gxz / (y)(x)~Fxy (Fb Ab) 179 9. 1. (x)(y)(z)(Rxy ~Rxz) / (y)(x)~Rxy 10. 1. ~(x)(y)(Ax v By) / (x)~Ax & (y)~By 11. 1. (x)Gx (y)(My & Jx) / (x)[Gx (y)Jy] 12. 1. (x)[(y)Axy (z)Nz] / (x)(y)Axy (z)Nz 13. 1. ~(x)~Axa (z)~Aza 2. (y)(x)Axy / ~(x)Mx 14. 1. ~(x)[Px & (y)(Py Lxy)] / (x)[Px ~(y)(Py Lxy)] 15. 1. Aq / (z)[(Gzq & Fz) (y)(Ay & Gzy)] 16. 1. (x)(Px v Gx) 2. (x)(y)[(~Lx v Mx) Nyx] / (x)[~(y)(Gy v Lx) (z)(Pz & Nzx)] 17. 1. Qe & Fb 2. (x){Fx (y)[Qy (z)(Rz & Axyz)]} / (z)(Abez & Rz) 18. 1. (x)(y)(Axy v Bxy) (z)Pz 2. (x)(y)(Px ~Py) / (x)(y)~Axy 19. 1. (x)Hx (y)Ky 2. (x)[Hx & (y)(Ky Lxy)] / (x)(y)Lxy 20. 1. (y)(x)(Ax & Hxy) ~Mb 2. (x)[Ax & (y)(My Hxy)] / (x)~Mx Answers: 1. 180 1. (x)(y)Pxy / (y)(z)Pyz 2. (y)Pxy 3. Pxa 4. (z)Pxz 5. (y)(z)Pyz UI 1 EI 2 EG 3 UG 4 2. 3. 4. 1. (x)Cxx 2. (y)(z)(Cyz Azy) / Abb 3. Cbb 4. (z)(Cbz Azb) 5. Cbb Abb 6. Abb UI 1 UI 2 UI 4 MP 3, 5 1. (x)Rxa (y)(x)Mxy 2. Rba / Mbc 3. (x)Rxa 4. (y)(x)Mxy 5. (x)Mxc 6. Mbc EG 2 MP 1, 3 UI 4 UI 5 1. ~Ukg ~(x)Ix / (x)Ix (y)Uyg 2. (x)Ix 3. ~~(x)Ix 4. ~~Ukg 5. Ukg 6. (y)Uyg 7. (x)Ix (y)Uyg AP DNeg 2 MT 1, 3 DNeg 4 EG 5 CP 2-6 5. 1. Dq 2. (x)[Fx (y)(Dy Oxy)] & Fp / Opq 3. (x)[Fx (y)(Dy Opy)] Simp 2 4. Fp Simp 2 5. Fp (y)(Dy Opy) UI 3 6. (y)(Dy Opy) MP 4, 5 7. Dq Opq UI 6 8. Opq MP 1, 7 6. 1. Tp 2. (y)[Ty (z)Dyz] / (x)Dpx & (y)Ty 3. Tp (z)Dpz 4. (z)Dpz 5. Dpx 6. (x)Dpx 7. (y)Ty 8. (x)Dpx & (y)Ty 181 UI 2 MP 1, 3 UI 4 UG 5 EG 1 Conj 6, 7 7. 8. 1. (x)(z)Mxz 2. (x)(zMxz (y)Ny / ~(y)~Ny 3. (z)Maz 4. Mab 5. (z)Maz 6. (x)(z)Mxz 7. (y)Ny 8. ~(y)~Ny 1. ~Fb v (Ab v Gbq) 2. (z)(x)~Gxz / (y)(x)~Fxy (Fb Ab) 3. (y)(x)~Fxy 4. (x)~Gxq 4. ~Gbq 5. (~Fb v Ab) v Gbq 6. Gbq v (~Fb v Ab) 7. ~Fb v Ab 8. Fb Ab 9. (y)(x)~Fxy (Fb Ab) UI 1 UI 3 EG 4 EG 5 MP 2, 6 QE 7 AP UI 2 UI 3 Assoc 1 Comm 5 DS 4, 6 Imp 7 CP 3-8 9. 1. (x)(y)(z)(Rxy ~Rxz) / (y)(x)~Rxy 2. (y)(z)(Ray ~Raz) UI 1 3. (z)(Rau ~Raz) EI 2 4. Rau ~Rau UI 3 5. ~Rau v ~Rau Imp 4 6. ~Rau Taut 5 7. (x)~Rxu EG 6 8. (y)(x)~Rxy EG 7 10. 1. ~(x)(y)(Ax v By) / (x)~Ax & (y)~By 2. (x)~(y)(Ax v By) QE 1 3. (y)~(Ax v By) UI 3 5. ~(Ax v Bb) EI 4 6. ~Ax & ~Bb DM 5 7. ~Ax Simp 6 8. ~Bb Simp 6 9. (x)~Ax UG 7 10. (y)~By EG 8 11. (x)~Ax & (y)~By Conj 9, 10 182 11. 1. (x)Gx (y)(My & Jx) / (x)[Gx (y)Jy] 2. Gx AP 3. (x)Gx EG 2 4. (y)(My & Jx) MP 1, 3 5. Mv & Jv UI 4 6. Jv Simp 5 7. (y)Jy EG 6 8. Gx (y)Jy CP 2-7 9. (x)[Gx (y)Jy] UG 8 12. 1. (x)[(y)Axy (z)Nz] / (x)(y)Axy (z)Nz 2. (x)(y)Axy AP 3. (y)Auy (z)Nz UI 1 4. (y)Auy UI 2 5. (z)Nz MP 3, 4 6. (x)(y)Axy (z)Nz CP 2-5 13. 1. ~(x)~Axa (z)~Aza 2. (y)(x)Axy / ~(x)Mx 3. ~~(x)Mx 4. (x)Mx 5. (x)Axa 6. ~(x)~Axa 7. (z)~Aza 8. ~Axa 9. (x)~Axa 10. (x)~Axa & ~(x)~Axa 11. ~(x)Mx AP DNeg 3 UI 2 QE 5 MP 1, 6 UI 8 UG 7 Conj 6, 9 IP 3-10 14. 1. ~(x)[Px & (y)(Py Lxy)] / (x)[Px ~(y)(Py Lxy)] 2. (x)~[Px & (y)(Py Lxy)] QE 1 3. (x)[~Px v ~(y)(Py Lxy)] DM 2 4. (x)[Px ~(y)(Py Lxy)] Imp 3 15. 1. Aq / (z)[(Gzq & Fz) (y)(Ay & Gzy)] 2. Gzq & Fz AP 3. ~(y)(Ay & Gzy) AP 4. (y)~(Ay & Gzy) QE 3 5. ~(Aq & Gzq) UI 4 183 6. ~Aq v ~Gzq 7. ~~Aq 8. ~Gzq 9. Gzq 10. Gzq & ~Gzq 11. (y)(Ay & Gzy) 12. (Gzq & Fu) (y)(Ay & Gzy) 13. (z)[(Gzq & Fz) (y)(Ay & Gzy)] DM 5 DNeg 1 DS 6, 7 Simp 2 Conj 8, 9 IP 3-10 CP 2-11 UG 12 16. 1. (x)(Px v Gx) 2. (x)(y)[(~Lx v Mx) Nyx] / (x)[~(y)(Gy v Lx) (z)(Pz & Nzx)] 3. ~(y)(Gy v Lx) AP 4. (y)~(Gy v Lx) QE3 5. ~(Gv v Lx) UI 4 6. ~Gv & ~Lx DM 5 7. ~Gv Simp 6 8. ~Lx Simp 6 9. Pv v Gv UI 1 10. Gv v Pv Comm 9 11. Pv DS 7, 10 12. (y)[(~Lx v Mx) Nyx] UI 2 13. (~Lx v Mx) Nvx UI 12 14. ~Lx v Mx Add 8 15. Nvx MP 13, 14 16. Pv & Nvx Conj 11, 15 17. (z)(Pz & Nzx) EG 16 18. ~(y)(Gy v Lx) (z)(Pz & Nzx) CP 3-17 19. (x)[~(y)(Gy v Lx) (z)(Pz & Nzx)] UG 18 17. 1. Qe & Fb 2. (x){Fx (y)[Qy (z)(Rz & Axyz)]} / (z)(Abez & Rz) 3. Qe Simp 1 4. Fb Simp 1 5. Fb (y)[Qy (z)(Rz & Abyz)] UI 2 6. (y)[Qy (z)(Rz & Abyz)] MP 4, 5 7. Qe (z)(Rz & Abez) UI 6 8. (z)(Rz & Abez) MP 3, 7 9. Rv & Abev EI 8 10. Abev & Rv Comm 9 11. (z)(Abez & Rz) EG 10 184 18. 1. (x)(y)(Axy v Bxy) (z)Pz 2. (x)(y)(Px ~Py) / (x)(y)~Axy 3. ~(x)(y)~Axy 4. ~(x)(y)~Axy 5. (x)(y)Axy 6. (y)Auy 7. Auv 8. Auv v Buv 9. (y)(Auy v Buy) 10. (x)(y)(Axy v Bxy) 11. (z)Pz 12. Pw 13. (y)(Pw ~Py) 14. Pw ~Pw 15. ~Pw v ~Pw 16. ~Pw 17. Pw & ~Pw 18. (x)(y)~Axy AP QE 3 QE 4 EI 5 EI 6 Add 7 EG 8 EG 9 MP 1, 10 EI 11 UI 2 UI 13 Imp 14 Taut 15 Conj 12, 16 IP 3-17 19. 1. (x)Hx (y)Ky 2. (x)[Hx & (y)(Ky Lxy)] / (x)(y)Lxy 3. Hu & (y)(Ky Luy)] EI 2 4. Hu Simp 3 5. (y)(Ky Luy) Simp 3 6. (x)Hx EG 4 7. (y)Ky MP 1, 6 8. Kv EI 7 9. Kv Luv UI 5 10. Luv MP 8, 9 11. (y)Luy EG 10 12. (x)(y)Lxy EG 11 20. 1. (y)(x)(Ax & Hxy) ~Mb 2. (x)[Ax & (y)(My Hxy)] / (x)~Mx 3. ~(x)~Mx AP 4. (x)Mx QE 3 5. Mb UI 4 6. ~~Mb DNeg 5 185 7. ~(y)(x)(Ax & Hxy) 8. (y)~(x)(Ax & Hxy) 9. (x)~(Ax & Hxb) 10. Av & (y)(My Hvy) 11. Av 12. (y)(My Hvy) 13. Mb Hvb 14. Hvb 15. ~(Ax & Hxb) 16. ~(Av & Hvb) 17. Av & Hvb 18. (Av & Hvb) & ~(Av & Hvb) 19. (x)~Mx MT 1, 6 QE 7 QE 8 EI 2 Simp 10 Simp 10 UI 12 MP 5, 13 UI 9 UI 15 Conj 11, 14 Conj 16, 17 IP 3-18(x)~Mx Unit Four Online Lecture 8 On Chapter 29 In this chapter, we combine indirect and conditional proof with the other rules of predicate logic. You will recall that indirect proof and conditional proof were introduced and explained in Unit Three. Those explanations are presupposed in this unit. In this chapter we also use the IP and CP rules to construct premise-free proofs of theorems in predicate logic. Premise-free proofs were introduced and explained in the last unit as well, and that explanation is of course presupposed here too. Our system is almost complete! The Videos and PowerPoints Have we said this lately? We recommend that you watch the corresponding online video lectures as you learn to construct these proofs. Few students can adequately learn natural deduction without watching visual, step-by-step demonstrations. Chapter 29 Objectives 186 1. Demonstrate that you know how to use the natural deduction system QD and the methods of indirect proof and conditional proof to prove arguments valid by correctly proving arguments valid using indirect and conditional proof. 2. Demonstrate that you understand how to correctly use the natural deduction system of QD to construct premise-free proofs and establish theorems in the system by doing so. 3. Demonstrate your understanding of the ideas in this chapter by correctly answering relevant true-false, multiple-choice, and other short answer questions and essay questions. 4. If something taught in the text was not included in this list of objectives, be prepared to demonstrate an understanding of that item too. Test Your Understanding! Practice Problems with Answers Conditional and Indirect Proof with Quantifiers Use conditional proof, indirect proof, or both to derive the conclusions of the following valid arguments. 1. 1. (x)(Ax Bx) 2. Bb Gb / Ab Gb 2. 1. (x)Fx (x)Rx / (x)(Fx Rx) 3. 1. (x)(Ix Mx) 2. (x)(Ix v Rx) / (x)(~Mx Rx) 4. 1. (x)Hx ~(x)Bx 2. (y)(By Hy) / ~Ba 5. 1. Pa Da 2. (x)Px v (x)Mx 3. ~Mg & Ng / Da 6. 1. (x)(Lx v Bx) (x)~Lx / ~(x)Lx 187 7. 1. (x)Ax (x)~Bx / ~(x)(Ax & Bx) 8. 1. ~(x)~(Mx Ax) / (x)(Ax Rx) (x)(Mx Rx) 9. 1. (x)Fx (x)(Gx & Hx) 2. (x)Hx (x)Jx / (x)(Fx Jx) 10. 1. (y)~By v ~(x)~Ax 2. (Ab v Bc) (x)Bx / (x)Ax ≡ (x)Bx 11. 1. (x)Ax (x)(Bx & Px) 2. (x)(Px v Dx) (x)Hx / (x)(Ax Hx) 12. 1. (x)Rx (x)Sx 2. (x)(Tx Rx) / (x)(Tx Sx) 13. 1. (x)[(Qx v Sx) Ix] 2. (x)(~Qx v Dx) (x)Fx / (x)Ix v (x)Fx 14. 1. (x)[Rx (Hx & Px)] 2. (x)[Bx (Ax & Ox)] / (x)(Ox Rx) (x)(Bx Px) 15. 1. (x)[Px (Qx v Rx)] 2. (x)[(Sx & Px) ~Qx] / (x)(Sx Px) (x)(Sx Rx) Answers: Remember: As we have explained, in most cases more than one proof can be given for any particular valid argument. Each proof below is thus one way to prove the corresponding argument valid. In many cases, alternative proofs are possible as well. If we included every possible proof, for every argument in these practice sets, our online lectures would become thousands of pages long. Again, we simply do not have the space to include every possible proof for every argument. 1. 188 1. (x)(Ax Bx) 2. Bb Gb / Ab Gb 3. Ab 4. Ab Bb ACP UI 1 2. 3. 4. 5. 189 5. Ab Gb 6. Gb 7. Ab Gb HS 2, 4 MP 3, 5 CP 3-6 1. (x)Fx (x)Rx / (x)(Fx Rx) 2. Fx 3. (x)Fx 4. (x)Rx 5. Rx 6. Fx Rx 7. (x)(Fx Rx) ACP EG 2 MP 1, 3 UI 4 CP 2-5 UG 6 1. (x)(Ix Mx) 2. (x)(Ix v Rx) / (x)(~Mx Rx) 3. ~Mx 4. Ix Mx 5. Ix v Rx 6. ~Ix 7. Rx 8. ~Mx Rx 9. (x)(~Mx Rx) ACP UI 1 UI 2 MT 3, 4 DS 5, 6 CP 3-7 UG 8 1. (x)Hx ~(x)Bx 2. (y)(By Hy) / ~Ba 3. ~~Ba 4. Ba 5. Ba Ha 6. Ha 7. (x)Hx 8. ~(x)Bx 9. (x)~Bx 10. ~Ba 11. Ba & ~Ba 12. ~Ba AIP DNeg 3 UI 2 MP 4, 5 EG 6 MP 1, 7 QE 8 UI 9 Conj 4, 10 IP 3-11 1. Pa Da 2. (x)Px v (x)Mx 3. ~Mg & Ng / Da 4. ~Da 5. ~Pa AIP MT 1, 4 6. (x)~Px 7. ~(x)Px 8. (x)Mx 9. Mg 10. ~Mg 11. Mg & ~Mg 12. Da 6. 7. 8. 190 EG 5 QE 6 DS 2, 7 UI 8 Simp 3 Conj 9, 10 IP 4-11 1. (x)(Lx v Bx) (x)~Lx / ~(x)Lx 2. ~~(x)Lx 3. (x)Lx 4. Lu 5. Lu v Bu 6. (x)(Lx v Bx) 7. ~Lx 8. ~Lu 9. Lu & ~Lu 10. ~(x)Lx AIP DNeg 2 EI 3 Add 4 EG 5 MP 1, 6 UI 7 Conj 4, 8 IP 2-9 1. (x)Ax (x)~Bx / ~(x)(Ax & Bx) 2. ~~(x)(Ax & Bx) 3. (x)(Ax & Bx) 4. Ax & Bx 5. Ax 6. Bx 7. (x)Ax 8. (x)~Bx 9. ~Bx 10. Bx & ~Bx 11. ~(x)(Ax & Bx) AIP DNeg 2 UI 4 Simp 4 Simp 4 UG 5 MP 1, 7 UI 8 Conj 6, 9 IP 2-10 1. ~(x)~(Mx Ax) / (x)(Ax Rx) (x)(Mx Rx) 2. (x)(Ax Rx) ACP 3. Mx ACP 4. Ax Rx UI 2 5. (x)(Mx Ax) QE 1 6. Mx Ax UI 5 7. Ax MP 3, 6 8. Rx MP 4, 7 9. Mx Rx CP 3-8 9. 10. 11. 191 10. (x)(Mx Rx) 11. (x)(Ax Rx) (x)(Mx Rx) UG 9 CP 2-10 1. (x)Fx (x)(Gx & Hx) 2. (x)Hx (x)Jx / (x)(Fx Jx) 3. Fx 4. (x)Fx 5. (x)(Gx & Hx) 6. Gv & Hv 7. Hv 8. (x)Hx 9. (x)Jx 10. Jx 11. Fx Jx 12. (x)(Fx Jx) ACP EG 3 MP 1, 4 EI 5 Simp 6 EG 7 MP 2, 8 UI 9 CP 3-10 UG 11 1. (y)~By v ~(x)~Ax 2. (Ab v Bc) (x)Bx / (x)Ax ≡ (x)Bx 3. (x)Ax 4. Ab 5. Ab v Bc 6. (x)Bx 7. (x)Ax (x)Bx 8. (x)Bx 9. Bb 10. (y)By 11. ~(y)~By 12. ~(x)~Ax 13. (x)Ax 14. (x)Bx (x)Ax 15. [(x)Ax (x)Bx] & [(x)Bx (x)Ax] 16. (x)Ax ≡ (x)Bx ACP UI 3 Add 4 MP 2, 5 CP 3-6 AP UI 8 UG 9 QE 10 DS 1, 11 QE 12 CP 8-13 Conj 7, 14 Equiv 15 1. (x)Ax (x)(Bx & Px) 2. (x)(Px v Dx) (x)Hx / (x)(Ax Hx) 3. Ax ACP 4. (x)Ax EG 3 5. (x)(Bx & Px) MP 1, 4 6. Bu & Pu EI 5 12. 7. Pu 8. Pu v Du 9. Du v Pu 10. (x)(Px v Dx) 11. (x)Hx 12. Hx 13. Ax Hx 14. (x)(Ax Hx) Simp 6 Add 7 Comm 8 EG 9 MP 2, 10 UI 11 CP 3-12 UG 13 1. (x)Rx (x)Sx 2. (x)(Tx Rx) / (x)(Tx Sx) 3. (x)Tx 4. Tu 5. Tu Ru 6. Ru 7. (x)Rx 8. (x)Sx 9. (x)Tx (x)Sx ACP EI 3 UI 2 MP 4, 5 EG 6 MP 1, 7 CP 3-8 13. 1. (x)[(Qx v Sx) Ix] 2. (x)(~Qx v Dx) (x)Fx / (x)Ix v (x)Fx 3. ~[(x)Ix v (x)Fx] AIP 4. ~(x)Ix & ~(x)Fx DM 3 5. ~(x)Ix Simp 4 6. ~(x)Fx Simp 4 7. ~Ix QE 5 8. ~Iu EI 7 9. (Qu v Su) Iu UI 1 10. ~(Qu v Su) MT 8, 9 11. ~Qu & ~Su DM 10 12. ~Qu Simp 11 13. ~Qu v Du Add 12 14. (x)(~Qx v Dx) EG 13 15. (x)Fx MP 2, 14 16. (x)Fx & ~(x)Fx Conj 6, 15 17. (x)Ix v (x)Fx IP 3-16 14. 1. (x)[Rx (Hx & Px)] 2. (x)[Bx (Ax & Ox)] / (x)(Ox Rx) (x)(Bx Px) 3. (x)(Ox Rx) ACP 192 4. Bx 5. Bx (Ax & Ox) 6. Ax & Ox 7. Ox Rx 8. Ox 9. Rx 10. Rx (Hx & Px) 11. Hx & Px 12. Px 13. Bx Px 14. (x)(Bx Px) 15. (x)(Ox Rx) (x)(Bx Px) 15. AP UI 2 MP 4, 5 UI 3 Simp 6 MP 7, 8 UI 1 MP 9, 10 Simp 11 CP 4-12 UG 13 CP 3-14 1. (x)[Px (Qx v Rx)] 2. (x)[(Sx & Px) ~Qx] / (x)(Sx Px) (x)(Sx Rx) 3. (x)(Sx Px) ACP 4. Sx ACP 5. Sx Px UI 3 6. Px MP 4, 5 7. Px (Qx v Rx) UI 1 8. Qx v Rx MP 6, 7 9. ~Rx AIP 10. Rx v Qx Com 8 11. Qx DS 9, 10 12. (Sx & Px) ~Qx UI 2 13. Sx & Px Conj 4, 6 14. ~Qx MP 12, 13 15. Qx & ~Qx Conj 11, 14 16. Rx IP 9-15 17. Sx Rx CP 4-16 18. (x)(Sx Rx) UG 17 19. (x)(Sx Px) (x)(Sx Rx) CP 3-18 Unit Four Online Lecture 9 193 On Chapter 30 Congratulations! You have reached the last chapter of the toughest unit in the course. (For most people, predicate logic is the most difficult branch of introductory logic to master.) This chapter adds one last group of rules to our natural deduction system: rules for handling the identity operator. As usual, read the instructions carefully and follow them exactly as they are written. Study the examples carefully. And remember: practice makes perfect. Even Bono had to practice before he became a great musician. The online videos are of course strongly recommended. With this chapter, our system of predicate logic is as complete as it is going to get. Chapter 30 Objectives 1. Demonstrate that you know how to use the natural deduction system QD, augmented with the rules for the identity operator, to prove valid arguments that contain the identity operator, by correctly proving such arguments valid. 2. Demonstrate your understanding of the ideas in this chapter by correctly answering relevant true-false, multiple-choice, and other short answer questions and essay questions. 3. If something taught in the text was not included in this list of objectives, be prepared to demonstrate an understanding of that item too. Test Your Understanding! Practice Problems with Answers Proofs with Identity Statements Use natural deduction to derive the conclusions of the following valid arguments. These proofs require the rules for the identity operator. 1. 1. Hs 2. s = m 3. Ts / Hm & Tm 2. 1. (a = a) (x)Hx / ~(x)~Hx 3. 1. a = c 2. c = f 194 3. (a = f) (f = p) 4. Ja / Jp 4. 1. (x)[Kxg & (x = b)] / (z)Kzb 5. 1. (x)(x = a) / (x)(y)(x = y) 6. 1. (x)(y)[Syx (z)~Dz] 2. (x)[Hx & (n = x)] 3. (x)[Ax & (y)(Ay Sxy)] / ~Dn 7. 1. a = s 2. Ha 3. (x)(Hx ≡ Tx) / Ts 8. 1. Pd & (x)[(Px (x = d)] 2. Po / o = d 9. 1. (x)(Fx ~Pxn) 2. Fa & Ofn 3. a = g / ~Pgn 10. 1. Ba & ~Bn 2. a = f / ~(n = f) 11. 1. [(e = g) & Qme] Qma 2. ~(x)Qmx / (x)[~(x = a) v ~Qmx] 12. 1. Sg 2. (x)[(Px & Dbx) (g = m)] / (x)[(Px & Dbx) Sm] 13. 1. (x){Lxp & (y)[Lyp (y = x)]} & Lxf} 2. (x)(Nx Lxp) / (x)(Nx Lxf) 14. 1. We & (x)[Wx ~(x = e)] / n = e 15. 1. ~Pm & (x){[Px & ~(x = m)] Fmx} 2. Pb / Fmb 16. 1. (x)(y)[(Px & Py) (y = x)] 195 2. (x)(Px & ~Ax) 3. Ae / ~Pe 17. 1. Gr & (x){[Gx v ~(x = r)] Grx} 2. ~(x)Grx / ~(x)Gxx v Ga 18. 1. (x)~(y)~[Om (x = y)] 2. Om / ~(z)~Oz & (b = a) 19. 1. (x)~(Ax v Bx) 2. (x)(y)(Myx & Rx) 3. (Ra & ~Ba) g = a / a = g 20. 1. (x){Fx & (y)[Fy (x = y)]} / (x)(y)[(Fx & Fy) (x = y)] & (x)Fx Answers: 1. 1. Hs 2. s = m 3. Ts / Hm & Tm 4. Hm 5. Tm 6. Hm & Tm LL 1, 2 LL 2, 3 Conj 4, 5 2. 1. (a = a) (x)Hx / ~(x)~Hx 2. (x)(x = x) Self-Identity 3. a = a UI 2 4. (x)Hx MP 1, 3 5. ~(x)~Hx QE 4 3. 1. a = c 2. c = f 3. (a = f) (f = p) 4. Ja / Jp 5. a = f 6. f = p 7. a = p 8. Jp 4. 196 LL 1, 2 MP 3, 5 LL 5, 6 LL 4, 7 1. (x)[Kxg & (g = b)] 2. Kgg & (g = b) 3. Kgg 4. g = b 5. ~(z)Kzb 6. (z)~Kzb 7. ~Kgb 8. ~Kgg 9. Kgg & ~Kgg 10. (z)Kzb UI 1 Simp 2 Simp 2 AP QE 7 UI 8 LL 4, 7 Conj 3, 8 IP 5-9 5. 1. (x)(x = a) / (x)(y)(x = y) 2. x = a UI 1 3. y = a UI 1 4. x = y LL 2, 3 5. (y)(x = y) UG 4 6. (x)(y)(x = y) UG 5 6. 1. (x)(y)[Syx (z)~Dz] 2. (x)[Hx & (n = x)] 3. (x)[Ax & (y)(Ay Sxy)] / ~Dn 4. ~~Dn AP 5. Dn DNeg 4 6. Aa & (y)(Ay Say) EI 3 7. Aa Simp 6 8. (y)(Ay Say) Simp 6 9. (y)[Syn (z)~Dz] UI 1 10. San (z)~Dz UI 9 11. Ha & (n = a) UI 2 12. n=a Simp 11 13. Aa Saa UI 8 14. Saa MP 7, 13 15. San LL 12, 14 16. (z)~Dz MP 10, 15 17. ~Dn UI 16 18. Dn & ~Dn Conj 5, 17 19. ~Dn IP 4-18 7. 1. a = s 2. Ha 3. (x)(Hx ≡ Tx) / Ts 197 8. 9. 10. 11. 198 4. Ha ≡ Ta 5. (Ha Ta) & (Ta Ha) 6. Ha Ta 7. Ta 8. Ts UI 3 Equiv 4 Simp 5 MP 2, 6 LL 1, 7 1. Pd & (x)[(Px (x = d)] 2. Po / o = d 3. (x)[(Px (x = d)] 4. Po (o = d) 5. o = d Simp 1 UI 3 MP 2, 4 1. (x)(Fx ~Pxn) 2. Fa & Ofn 3. a = g / ~Pgn 4. Fg ~Pgn 5. Fa 6. Fg 7. ~Pgn UI 1 Simp 2 LL 3, 5 MP 4, 6 1. Ba & ~Bn 2. a = f / ~(n = f) 3. ~~(n = f) 4. n=f 5. Bf & ~Bn 6. Bf & ~Bf 7. ~(n = f) AP DNeg 3 LL 1, 2 LL 4, 5 IP 3-6 1. [(e = g) & Qme] Qma 2. ~(x)Qmx / (x)[~(x = a) v ~Qmx] 3. (x)~Qmx QE 2 4. ~(x)[~(x = a) v ~Qmx] AP 5. (x)~[~(x = a) v ~Qmx] QE 4 6. ~[~(e = a) v ~Qme] UI 5 7. ~~(e = a) & ~~Qme DM 6 8. ~~Qme Simp 7 9. Qme DNeg 8 10. ~Qme UI 3 11. Qme & ~Qme Conj 9, 10 14. (x)[~(x = a) v ~Qmx] IP 4-11 12. 1. Sg 2. (x)[(Px & Dbx) (g = m)] / (x)[(Px & Dbx) Sm] 3. Px & Dbx AP 4. (Px & Dbx) (g = m) UI 2 5. g=m MP 3, 4 6. Sm LL 1, 5 7. (Px & Dbx) Sm CP 3-6 8. (x)[(Px & Dbx) Sm] UG 7 13. 1. (x){{Lxp & (y)[Lyp (y = x)]} & Lxf} 2. (x)(Nx Lxp) / (x)(Nx Lxf) 3. {Lap & (y)[Lyp (y = a)]} & Laf 4. Lap & (y)[Lyp (y = a)] 5. Laf 6. (y)[Lyp (y = a)] 7. Nx 8. Nx Lxp 9. Lxp 10. Lxp (x = a) 11. a=x 12. Lxf 13. Nx Lxf 14. (x)(Nx Lxf) EI 1 Simp 3 Simp 3 Simp 4 AP UI 2 MP 7, 8 UI 6 MP 9, 10 LL 5, 11 CP 7-12 UG 13 14. 1. We & (x)[Wx ~(x = e)] / n = e 2. We Simp 1 3. (x)[Wx ~(x = e)] Simp 3 4. ~(n = e) AP 5. We ~(e = e) UI 3 6. ~(e = e) MP 2, 5 7. (x)(x = x) Self-Identity 8. e=e UI 7 9. (e = e) & ~(e = e) Conj 6, 8 10. n = e IP 4-9 15. 1. ~Pm & (x){[Px & ~(x = m)] Fmx} 2. Pb / Fmb 3. ~Pm Simp 1 4. (x){[Px & ~(x = m)] Fmx} Simp 1 199 16. 17. 200 5. [Pb & ~(b = m)] Fmb 6. ~(b = m) Fmb 7. ~Fmb 8. ~~(b = m) 9. b=m 10. Pm 11. Pm & ~Pm 12. Fmb UI 4 Simp 5 AP MT 6, 7 DNeg 8 LL 2, 9 Conj 3, 10 IP 7-11 1. (x)(y)[(Px & Py) (y = x)] 2. (x)(Px & ~Ax) 3. Ae / ~Pe 4. Pe 5. Pb & ~Ab 6. (y)[(Pe & Py) (y = e)] 7. (Pe & Pb) (b = e) 8. Pb 9. Pe & Pb 10. b=e 11. Ab 12. ~Ab 13. Ab & ~Ab 14. ~Pe AP EI 2 UI 1 UI 6 Simp 5 4Conj 4, 8 MP 7, 9 LL 3, 10 Simp 5 Conj 11, 12 IP 4-13 1. Gr & (x){[Gx v ~(x = r)] Grx} 2. ~(x)Grx / ~(x)Gxx v Ga 3. ~(x)Grx 4. ~Grb 5. (x){[Gx v ~(x = r)] Grx} 6. [Gb v ~(b = r)] Grb 7. ~[Gb v ~(b = r)] 8. ~Gb & ~~(b = r) 9. ~Gb 10. Gr 11. ~~(b = r) 12. b = r 13. (x)Gxx v Ga 14. Gb 15. Gb & ~Gb 16. ~(x)Gxx v Ga QE 2 EI 3 Simp 1 UI5 MT 4, 6 DM 7 Simp 8 Simp 1 Simp 8 DNeg 11 AP LL 10, 12 Conj 9, 14 IP 13-15 18. 19. 20. 201 1. (x)~(y)~[Om (x = y)] 2. Om / ~(z)~Oz & (b = a) 3. ~(y)~[Om (b = y)] 4. (y)[Om (b = y)] 5. Om (b = a) 6. b = a 7. (z)Oz 8. ~(z)~Oz 9. ~(z)~Oz & (b = a) UI 1 QE 3 UI 4 MP 2, 5 EG 2 QE 7 Conj 6, 8 1. (x)~(Ax v Bx) 2. (x)(y)(Myx & Rx) 3. (Ra & ~Ba) (g = a) / a = g 4. ~(Aa v Ba) 5. (y)(Mya & Ra) 6. Mba & Ra 7. Ra 8. ~Aa & ~Ba 9. ~Ba 10. Ra & ~Ba 11. g = a 12. a = g 13. ~(g = a) 14. (g = a) & ~(g = a) 15. a = g UI 1 UI 2 EI 5 Simp 6 DM 4 Simp 8 7Conj 7, 9 MP 3, 10 AP LL 11, 12 Conj 11, 13 IP 12-14 1. (x){Fx & (y)[Fy (x = y)]} / (x)(y)[(Fx & Fy) (x = y)] & (x)Fx 2. Fa & (y)[Fy (x = y)] EI 1 3. Fa Simp 2 4. (y)[Fy (x = y)] Simp 2 5. (x)Fx EG 3 6. Fx & Fy AP 7. Fx (a = x) UI 4 8. Fx Simp 6 9. a=x MP 7, 8 10. Fy (a = y) UI 4 11. Fy Simp 6 12. a=y MP 10, 11 13. x=y LL 9, 12 14. (Fx & Fy) (x = y) CP 6-13 15. (y)[(Fx & Fy) (x = y)] UG 14 16. (x)(y)[(Fx & Fy) (x = y)] UG 15 Unit Five Online Lecture 1 On Chapter 31 If you are getting a little tired of symbols and formulas and formal principles, this unit will give you a "breather." This is the first of four chapters on the nonformal branches of logical theory—those branches that do not focus on the abstract forms of reasoning but instead for the most part study nonformal aspects of the reasoning process. This chapter presents some of the basic principles pertaining to the art of defining words. Your text explains why defining words is an important part of the reasoning process, and hence why it is a special concern of logical theory. Don't forget the online videos. They may help you put it all together. Chapter 31 Objectives 1. Demonstrate that you understand the nature of a definition by correctly explaining the idea in your own words. 2. Demonstrate that you understand why definitions are needed by correctly explaining the point in your own words. 3. Demonstrate that you understand the purposes definitions serve by correctly explaining these purposes in your own words and by correctly answering questions about them. 4. Demonstrate that you understand the purposes that definitions serve by correctly identifying the purposes served by sample definitions. 5. Demonstrate that you understand the main types of definitions by accurately classifying definitions in terms of these main types . 6. Demonstrate that you understand the common methods for constructing definitions by correctly identifying the method employed by sample definitions. 202 7. Demonstrate that you understand the rules for constructing good definitions by correctly evaluating definitions on the basis of these rules. 8. Demonstrate your understanding of the ideas in this chapter by correctly answering relevant true-false, multiple-choice, and other short answer questions and essay questions. 9. If something taught in the text was not included in this list of objectives, be prepared to demonstrate an understanding of that item too. Test Your Understanding! Practice Problems with Answers Definitions Answer the following multiple-choice questions. 1. What kind of definition is the following? "A physician is a doctor." (A) analytic, (B) persuasive, (C) demonstrative, (D) synonymous, (E) enumerative. 2. What kind of definition is the following? "A physician is a leach-using quack who only wants the money of the helpless and the wretched." (A) analytic, (B) persuasive, (C) demonstrative, (D) synonymous, (E) enumerative. 3. What kind of definition is the following? "A physician is a professional who heals people." (A) analytic, (B) persuasive, (C) demonstrative, (D) synonymous, (E) enumerative. 4. What kind of definition is the following? "A physician is someone like Dr. Jones, Dr. Smith, or Dr. Perez." (A) intensional, (b) extensional. 5. 'Extension' means roughly the same things as (A) corporality, (B) sense, (C) connotation, (D) denotation, (E) conventional connotation. 6. Which of the following are all denoted by the term 'corporation'? (A) Gillette, Oracle, Pfizer, Boeing, (B) directors, officers, shareholders, employees, (C) Razors, software, drugs, airplanes, (D) bankers, brewers, camera makers, real estate developers, (E) large, impersonal, powerful, wealthy. 7. Which of the following are all connoted by the term 'baseball player'? (A) Yankee, Cub, Giant, Oriole, (B) Babe Ruth, Frank Robinson, Ty Cobb, Stan Musial, (C) pitcher, catcher, first baseman, shortstop, (D) New York, Chicago, San Francisco, Baltimore, (E) athletic, cap-wearing, skillful, speedy. 8. Which of the following pairs of terms have the same extension? (A) actor, actress, (B) elf, genie, (C) football player, linebacker, (D) professor, instructor, (E) Kansas, Nebraska. 203 9. Which of the following is always an intensional definition? (A) a persuasive definition (B) a demonstrative definition, (C) an ostensive definition, (D) a synonymous definition, (E) stipulative definition. 10. The difference between a claim being vague and its being ambiguous is that the meaning of an ambiguous claim (A) is not at all clear, (B) uses emotive language, (C) is not intended to convey cognitive meaning, (D) has two or more clear meanings, but it's not clear which one is intended, (E) has no intended meaning. 11. The definition, "'Filly' means a young female horse," is most clearly (A) stipulative, (B) theoretical, (C) lexical, (D) precising, (E) persuasive. 12. The definition, "'Balzorite' is the term for the first life form we find in space," is most clearly (A) stipulative, (B) theoretical, (C) lexical, (D) precising, (E) persuasive. 13. The definition, "'Euthanasia' refers to the senseless, self-centered murder of the innocent and helpless," is most clearly (A) stipulative, (B) theoretical, (C) lexical, (D) precising, (E) persuasive. 14. The definition, "An act is 'morally obligatory' if and only if it maximizes happiness in terms of increased pleasure and decreased pain for all sentient beings involved," is most clearly (A) stipulative, (B) theoretical, (C) lexical, (D) precising, (E) persuasive. 15. The definition, "'Hot', in the context of spas and hot tubs, means 105-110 degrees Fahrenheit," is most clearly (A) stipulative, (B) theoretical, (C) lexical, (D) precising, (E) persuasive. Answers: 1. D 2. B 3. A 4. B 5. D 6. A 7. E 8. B 9. D 10. D 11. C 12. A 13. E 14. B 15. D 204 Unit Five Online Lecture 2 On Chapter 32 This chapter explains what a logical fallacy is, distinguishes formal from informal fallacies, and surveys the common forms of informal fallacies. Make sure you understand what a fallacy is and how informal fallacies differ from formal fallacies. We examined several formal fallacies in Unit Three. You may want to return to that discussion (the fallacies of "affirming the consequent" and "denying the antecedent") and compare the formal truth-functional fallacies identified there with the informal fallacies of this chapter. The online videos may be helpful as you study this chapter. This offhand comment may be a little controversial, but if you want to see informal fallacies being used to good effect, we recommend you look at the world of politics and political debate. Not all politicians use informal fallacies to get their way or to win the debate, and not all political arguments are fallacious; but the field of politics seems to have more than its fair share of fallacious "arguments." At least that is our opinion. This is an important chapter. Chapter 32 Objectives 1. Demonstrate that you understand the nature of a logical fallacy by correctly defining the idea in your own words. 2. Demonstrate that you understand the distinction between a formal and an informal fallacy by correctly defining the point in your own words. 3. Demonstrate that you understand the important informal fallacies identified in the chapter by correctly explaining them in your own words. 4. Demonstrate that you can recognize the informal fallacies by accurately identifying the presence of informal fallacies in sample passages and examples. 5. Demonstrate that you understand the fallacies by criticizing sample fallacious arguments using what you know of the informal fallacies. 6. Demonstrate your understanding of the ideas in this chapter by correctly answering relevant true-false, multiple-choice, and other short answer questions and essay questions. 205 7. If something taught in the text was not included in this list of objectives, be prepared to demonstrate an understanding of that item too. Test Your Understanding! Practice Problems with Answers Informal Fallacies Determine which of the following informal fallacies each argument below most clearly illustrates. Fallacies may be used more than once or not at all. A Special Pleading B Appeal to the People C Abusive Ad Hominem D Circumstantial Ad Hominem E Tu Quoque Ad Hominem F Appeal to Questionable Authority G Hasty Generalization H False Cause I Slippery Slope J False Dilemma K Genetic Fallacy L Straw Man M Suppressed Evidence N Red Herring O Irrelevant Conclusion P Composition Q Division R Begging the Question 1. Clearly the moral standards of our youth have decayed. Three brain surgeons at Central Hospital appeared recently on a talk show, and all three were convinced that the youth of today have no morals at all. 2. Smith, Adams, and Harris all outlived their wives, and their wives were younger than they were. It must be the case that men outlive women these days. 3. Twenty percent of the women at State University are tall. Since Sue is a student there, it follows that twenty percent of her is tall. 4. Driver to traffic court judge: "I was paying full attention when I ran into that other car. Thus I should be given the minimum traffic fine." 5. We acquire our moral beliefs due to environmental conditioning. Therefore there is nothing objectively true about our moral beliefs. 6. Either you send Hallmark cards or you do not care enough to send the very best. Surely you do care to send the very best. Thus you will want to send Hallmark cards. 7. There has been a rise in petty crime in our neighborhood recently. Therefore we should execute all people caught committing petty crimes. 8. Abortion is murder. Therefore abortion is morally wrong. 9. Most elderly people who are hospitalized with cancer eventually die from the disease. Thus, if an elderly person wants to recover from cancer, he or she must, at all costs, refuse hospitalization. 206 10. You have heard Representative Smith's arguments in favor of gun control. But surely you won't take them seriously. Smith is known to have sexually harassed three women ten years ago and wants to legalize marijuana. 11. Every student in this school is under 40 years old. Thus this school is under 40 years old. 12. Little Billy came to believe that a man walked on Mars by reading of such an event in a science fiction comic book. Thus Billy's belief is false. 13. Either dogs are fish or birds. But they are not birds. Thus they are fish. 14. Each word in Lincoln's "Gettysburg Address" is very ordinary. Therefore the "Gettysburg Address" must be a very ordinary speech. 15. More people in America drink Budweiser than any other beer. Clearly, if you drink beer, you should drink Bud. 16. You should read The Color Purple. Everyone at our school is. 17. Professor Jones, surely you will give me an A for the class. I need to get into a good graduate school and my parents are really hoping to see me succeed. I'll be a nervous wreck if I don't get that A. 18. Senator Garcia argues that we should support wheat subsidies in Washington State. But his constituents are wheat farmers and he knows that they want these subsidies. Thus we can discount Garcia's arguments for such subsidies. 19. If we in the USA allow the state to ban automatic rifles, they'll next ban all rifles; then they'll ban all hand guns; and then Canada will take it as a window of opportunity to attack the USA. For the love of our country, we thus must not allow the state to ban automatic rifles. 20. Jack Sherman argues that modern technology does not hold the key to human happiness. Apparently Sherman would have us throw out our computers, TVs, and appliances and return to the Stone Age. I bet he also says we should turn in our clothing for animal skins and live in caves. What utter foolishness! 21. You argue that I should cut down on my drinking. But you drink much more heavily than I. You haven't been sober in a year. 22. Premarital sex is sinful because any sexual relation outside of marriage is morally wrong. 23. Every time I take a shower the phone rings. Therefore since I am dying to talk to someone right now, I should jump in the shower. 24. Professor Thomson polled her three best math students out of her class of 200, and asked them if they liked math. All three said, "yes." She concluded that close to 100% of her students liked math. 25. So your stockbroker has tried to persuade you to buy 1000 shares of Macro Data stock. Well, I wouldn't trust his arguments. He just wants to earn that fat commission on the sale. Answers: 207 1. F 2. G 3. Q 4. M 5. K 6. J 7. O 8. R 9. H 10. C 11. P 12. K 13. J 14. P 15. B 16. B 17. A 18. D 19. I 20. L 21. E 22. R 23. H 24. G 25. D Unit Five Online Lecture 3 On Chapter 33 Recall that inductive reasoning was first defined in Chapter One. The concept was defined again, more precisely, in Chapter 3, and several common forms of inductive reasoning were presented. This chapter is an in-depth and systematic survey of the most important forms of inductive reasoning used in science, in the courtroom, in many academic fields, and in everyday life as well, and the standards by which they are evaluated. As usual, the online videos are recommended as you study this material. Once you understand the common forms of inductive reasoning analyzed in this chapter, you will notice that these arguments are used all the time in everyday life. Chapter 33 Objectives 1. Demonstrate that you understand the nature of an inductive argument by correctly defining the idea in your own words. 2. Demonstrate that you understand the distinction between inductive and deductive arguments by correctly defining the distinction in your own words. 3. Demonstrate that you understand the common patterns of inductive reasoning, including analogical induction, enumerative induction, inference to the best explanation, the confirmation and disconfirmation of hypotheses, and Mills methods, by accurately classifying various inductive arguments in terms of these common patterns. 4. Demonstrate that you understand the principles used to evaluate inductive arguments by correctly evaluating various inductive arguments in terms of those principles. 208 5. Demonstrate that you understand how to make inductive arguments stronger or weaker by suggesting changes to sample arguments that make the arguments stronger or weaker as the case may be. 6. Demonstrate your understanding of the ideas in this chapter by correctly answering relevant true-false, multiple-choice, and other short answer questions and essay questions. 7. If something taught in the text was not included in this list of objectives, be prepared to demonstrate an understanding of that item too. Test Your Understanding! Practice Problems with Answers Analogical Reasoning Consider the argument from analogy below. For each change afterward, first determine if that change would (S) strengthen the argument, (W) weaken the argument, or leave its strength/weakness (U) unchanged. Then state which single principle the change relates to the most: (A) Number of common characteristics, (B) Relevancy of common characteristics (C) Number of primary analogates, (D) Diversity of primary analogates, (E) Number or relevance of dissimilarities, or (F) Specificity of conclusion. Mary is thinking of buying a car from Hal's Used Cars. Her friend Tom bought a car from Hal's, and it ran well for over two years. Mary concludes that if she buys a car from Hal's Used Cars, that her car will also run well for at least two years. 1. Mary has three other friends who purchased cars from Hal's Used Cars, and their cars have run well for over two years. 2. One of the friends bought a sedan; one bought a station wagon; the third bought an SUV; while Tom bought a hatchback. 3. Mary's four friends are avid amateur car mechanics, while Mary knows little about cars. 4. Mary adjusts her conclusion to say merely that her new car will likely not break down within a month of purchase. 5. Mary changes her conclusion again to say that her car will last her lifetime and will run better than any of her friends' cars. 6. Mary notices that her four friends bought their cars from Hal's on sunny days, and she plans on buying hers from Hal's on a sunny day, also. 7. Mary notices that all the cars bought from Hal's Used Cars by her four friends had been worked on by Mike, the experienced chief mechanic at Hal's. Mary's car will be worked on by Mike, too. 209 8. Mary finds out that her four friends regularly use the best high-octane gasoline, and she is determined to do so, too. 9. Mary's four friends live in Los Angeles, California, whereas she lives in Hollywood, California. 10. Unlike her friends, Mary plans to use her car in extensive off-road travel touring Baja California, Mexico. Answers: 1. S, C 2. S, D 3. W, E 4. S, F 5. W, F 6. U, B 7. S, A 8. S, A 9. U, E 10. W, E Enumerative Induction I. Consider the observations in each problem below. What reasonable conclusion (if any) can be drawn using enumerative induction? 1. On the mornings of Monday, Tuesday, Wednesday, and Thursday this week I saw my new neighbor drive off to work at 6:00 am. 2. I've been watching the squirrels in my back yard, and the last ten I saw appeared nervous. 3. At 8:00 in the morning I saw a bird in my front yard. At 9:00 I saw another bird in my front yard. At 10:00 I saw yet another bird in my front yard. For the following six hours I saw different birds in my front yard. 4. I went to the grocery store this morning, and someone had spilled some jelly all over the floor. Answers: 1. Thus probably my new neighbor needs to leave for work at 6:00 am each morning. Or, probably my new neighbor will continue to leave for work at 6:00 am. Related conclusions are possible. 2. Thus it is likely that squirrels are generally or usually nervous. 3. Thus it is probably that birds like or are attracted to my front yard. Or, thus it's probably that I'll see birds in my front yard in the future. Related conclusions are possible. 4. No conclusion using enumerative induction can be made here, as there is no pattern or set of examples from which to draw such a conclusion. 210 II. Consider the argument below and the changes that follow. For each change, determine whether it strengthens or weakens the argument, or leaves its strength unaltered. I have enrolled in literature classes here at State University for the last three semesters. In each class, I've been assigned a term paper. Thus in my next literature class here at State University, I'll probably be assigned a term paper. 1. I've enrolled in one literature class each of the previous five semesters, and each instructor assigned a term paper. 2. I also enrolled in a Chemistry class last semester, and the instructor did not assign a term paper. 3. All of my friends who enrolled in literature classes at State University were assigned term papers for those classes. 4. I've enrolled in only two literature classes at State University, and the instructor of each assigned a term paper. 5. I've been enrolled full-time at State University for three years, and I've never been assigned a term paper. Answers: 1. Strengthen. There is a larger array of examples, or a more established pattern, from which to draw the conclusion. 2. Unchanged. A chemistry instructor not assigning a term paper says little or nothing about what literature instructors might do. 3. Strengthen. More examples help establish a more reliable pattern supporting the conclusion. 4. Weaken. The argument is still fairly good, but two examples provide less support than five (or three). 5. Weaken. Now the argument is straightforwardly weak. There are no examples to point to in establishing a pattern leading to the conclusion. It may remain likely that at State University the literature instructors will always assign term papers, but there is now nothing in the premises to support the conclusion, thus making this argument weak. Explanations and Hypotheses Part I. Imagine two theories purporting to explain why Mars appears to exhibit backand-forth retrograde motion in its observed motion through the night sky. (I.e., over the course of many nights, Mars sometimes looks like it's moving back and forth across the night sky.) 211 Theory 1: Given the elliptical orbits of Mars and the Earth around the Sun, and given what we know about gravity, it only appears from our earthly vantage point that Mars radically changes its direction of motion. Theory 2: Little five-year-old boys are floating in space pushing Mars back and forth. With consideration of the four criteria for a best explanation, why is Theory 1 a better explanation than Theory 2? Answer: Although both theories are internally consistent, Theory 1 is more consistent with what we know (or take as knowledge) about eth world: little boys don't float out in space, and they are not strong enough to push a planet around. Theory 1 also has more explanatory power, as it is more testable and explains why other planets move about as they do. Finally, Theory 1 can be said to be more simple, as it does not appeal to the added entities of nearly overly powerful, space-dwelling boys. Part II. Provide the single best answer to the following multiple choice problems. 1. If a hypothesis goes against what we normally take to be obviously true about the world, then we'd say that the hypothesis is not (A) internally consistent, (B) externally consistent, (C) fruitful, (D) testable, (E) simple. 2. If one hypothesis appeals to fewer entities than a second hypothesis, the first is said to be more (A) internally consistent, (B) externally consistent, (C) fruitful, (D) testable, (E) simple. 3. If a prediction of a hypothesis is found to be true, then (A) the hypothesis is not proven true, but the reason for believing it might be strengthened, (B) there is no need for further tests, (C) the hypothesis is proven true, at least in part, (D) the hypothesis is proven false, (E) the hypothesis is rendered useless. 4. To the extent that a hypothesis suggests new ideas for future analysis and confirmation, a hypothesis is said to be (A) experimental, (B) fruitful, (C) externally consistent, (D) internally consistent, (E) have explanatory power. 5. To the extent that a hypothesis fits the facts it is intended to explain, the hypothesis is said to be (A) externally consistent, (B) having explanatory power, (C) fruitful, (D) experimental, (E) internally consistent. 6. Hypothetical reasoning is useful (A) as a substitute for deductive reasoning, (B) when the scientific method fails, (C) in science but not in philosophy, (D) in philosophy but not in science, (E) when the evidence, by itself, does not suggest the answer to a problem. 7. In hypothetical reasoning, the prediction from the hypothesis must (A) be directly testable, (B) follow from the hypothesis, (C) both A and B, (D) be indirectly testable, (E) none of the above. 212 8. If a prediction in hypothetical reasoning is found to be false, then (A) the hypothesis is proven to be true, (B) the hypothesis is merely confirmed, (C) the test is disconfirmed, (D) the hypothesis is proven false, (E) the test is proven false. 9. To the extent that a hypothesis is not self-contradictory, the hypothesis is said to be (A) internally consistent, (B) fruitful, (C) testable, (D) externally consistent, (E) simple. 10. If a hypothesis lends itself to experimentation and to confirmation, it is said to be (A) internally consistent, (B) fruitful, (C) testable, (D) externally consistent, (E) simple. Causal Arguments: Mill's Methods 1. What kind of causal condition is best understood as intended in the claims below: a necessary condition, sufficient condition, both, or neither? a. Oxygen causes wood to burn. b. Throwing a brick through a window causes the window to break. c. Getting straight As on one's tests in Introduction to Logic will get a student an A for the class. d. Being greater than two and less than four causes one—as a whole number—to be three. e. Air is needed for humans to live. f. Eating leafy greens causes good health. g. Being an enclosed geometric figure with four equal sides and four internal 90-degree angles makes something a square. 2. Consider the following situation. Bob and Sue go out for dinner. They each enter the Chunk-O-Cheese Pizzeria in basically the same state of health. Bob is sick later in the evening from something he eats there. Bob and Sue both drank two glasses of root beer; both ate the triple-cheese pizza; and both ate from the same plate of "Cheese-Goo Nachos." Bob ate cheesecake for dessert, Sue—being, as she says, "on a diet"—decided not to. a. What is the cause of Bob's illness? b. Which of Mill's methods is used to determine this? c. What sense of causality is involved in your conclusion? 3. Consider the following situation. A birthday party was held at the Chunk-O-Cheese Pizzeria. Al had pizza, pasta, and a cola. Barbara had pizza, a house salad, beer, and cheesecake. Charley just ordered the house salad and beer. Debbie had a house salad, pizza, pasta, and the house red wine. Ellen ate pizza, but drank too much beer and started dancing naked on the table. Frank was not amused at Ellen's eccentricities, and drowned his concerns in cola, pasta, and cheesecake, and then split a pizza with Charley. Later, after the restaurant owner threw the party out, they all got sick from something they ate or drank. a. What is the cause of the illness? b. Which of Mill's methods is used to determine this? 213 c. What sense of causality is involved in your conclusion? 4. Consider the following situation. The owner of the Chunk-O-Cheese Pizzeria notes that the number of his customers has declined as the number of people claiming that his food made them sick has increased. After giving it some thought, he determines that he probably should take steps to avoid the health inspector. a. Which of Mill's methods is used? Answers: 1. a. Oxygen is a necessary condition. b. Throwing a brick through a window is a sufficient condition. c. Getting straight As on one's tests in Introduction to Logic is a sufficient condition. d. Being greater than two and less than four causes one—as a whole number—is both. e. Air is a necessary

proposition is possibly true, it is possibly true in all possible worlds, in other words, it is necessarily true that it is possibly true. 229 Its status as a "possible" is a matter of necessity. In short, in the system S5, necessity, possibility, and contingency are all understood to be matters of logical necessity. It follows from this, that if we remove one iterated modal operator from a formula that is prefixed with 2 iterated modal operators, the reduced formula is equivalent to the original formula, that is, it expresses a proposition that is equivalent to that expressed by the original formula. Here is another way to argue for the same conclusion, presupposing the modal principles of S5. Where P is any proposition: 1. If P is necessarily true, then in every possible circumstance it is true that P is necessarily true. That is, □P □□ P. Furthermore, if in every possible circumstance it is true that P is necessarily true, then P is necessarily true. That is, □□ P □ P. One sentence is equivalent to another just in case the two imply each other. Because □ P and □□ P imply each other, it follows that □□P is equivalent to □ P. 2. If there is at least one possible circumstance in which P is true, then there is a circumstance in which it is true that there is a circumstance in which P is true. That is, ◊ P ◊◊ P. Furthermore, if there is a possible circumstance in which it is true that there is a possible circumstance in which P is true, then there is a circumstance in which P is true. That is, ◊ ◊ P◊ P. Because ◊◊P and ◊ P imply each other, it follows that ◊◊ P is equivalent to ◊ P. 3. Parallel arguments can be given for all the other combinations of modal operators, thus showing that: ◊□P is equivalent to □P □◊P is equivalent to ◊P And so on. Therefore, the S5 reduction rule is valid. A sentence of ML that contains no iterated operators is called a "fully reduced" modal sentence. Thus, the following formulas are all fully reduced: ◊B □ (A & □B) And these formulas are not fully reduced: □□□ A □◊◊ A ◊◊□B Using the S5 reduction rule, then, any sequence of iterated monadic modal operators in a formula, no matter how long, can be reduced to the last member on the right, and the resulting 230 formula will express a proposition equivalent to the proposition expressed before the reduction. For example: □□ A reduces to □A ◊ ◊□ A reduces to □ A ◊◊◊□□◊A reduces to ◊ A □□(◊◊ A & □◊ B) reduces to □(◊A & ◊B) The following two proofs employ the Reduction rule: □◊◊□ J ◊ B ~◊~J/◊B □J □J◊B ◊B (1) 1. 2. 3. 4. 5. (2) 1. □□◊ J 2. ◊J ~ □ B 3. □ R □ B 4. ◊ ~ R ◊~ S 5. ◊ ~ G □ S / G 6. ◊ J 7. ~□ B 8. ~ □ R 9. ◊~ R 10. ◊~ S 11. ~ □S 12. ~ ◊~ G 13. □ G 14. G DE 2 S5 Red 1 MP 3, 4 S5 Red 1 MMP 2, 6 MMT 3, 7 DE 8 MMP 4, 9 DE 10 MT 5, 11 DE 12 BR 13 EXERCISE Use the reduction rule plus any of the other rules of our system to prove the following: (1) 1. ◊□A / □ A (2) 1. □□◊ A / ◊A (3) 1. ◊◊ A / ◊ A (4) 1. □□□ Q ◊◊ S 2. ◊S □ P 3. (□ Q □ P) ◊ R 4. ~ ◊ R v □ A / A 231 (5) 1. □ ◊ □ P 2. ◊ ~ P v □ Q 3. Q S / S (6) 1. ◊ □ ◊ P v □ Q 2. ◊ ~ Q 3. ◊ P □ P / P (7) 1. □ ◊ ◊ □ P 2. Q ~ P 3. ~ □ Q □ S / S (8) 1. □□ P ◊ Q 2. ◊ □ P 3. ~ ◊ Q v □ R 4. R □ S / S (9) 1. ◊◊◊□ P 2. P Q 3. Q R / R (10) 1. □◊◊ P 2. □S □ ~ P 3. ◊ ~ S □ G / G 232 Open Course Library Videos on Logic Created By Paul Herrick and Mark Storey for the Open Course Library Course Philosophy 120, Symbolic Logic To watch a particular video, simply paste the URL into your browser. The links below may also be placed into any online logic class or web-supplemented face-to-face class by logic teachers as well. Thanks to the Bill and Melinda Gates foundation, and to the Washington State Board for Technical and Community Colleges, for the grant that supported our work creating these videos. Thanks also to Shoreline Community College videographer Dwight Edwards for filming and editing our videos. The video demonstrations are labeled by topics covered and by chapter number. The chapter numbers refer to the corresponding chapters in the course textbook, Introduction to Logic by Paul Herrick (Oxford University Press, 2012). UNIT ONE. FUNDAMENTAL CONCEPTS OF LOGIC 1. Welcome to Logic Class and Introduction to the Series (October 12, 2010) 2. What is Logic? (Chapter 1) 3. What is an Argument? (Chapter 2) 4. The Argument Clinic (Famous Monty Python Skit as Supplement to Chapter 2.) 5. Arguments vs NonArguments (Chapter 2) 233 6. What is a Deductive Argument? (Chapter 3) 7. What is an Inductive Argument? (Chapter 3) 8. What is a Valid Argument? (Chapter 4) 9. What is a Deductively Sound Argument? (Chapter 4) 10. What is a Strong Argument? (Chapter 5) 11. Inductively Sound or Cogent Arguments (Chapter 5) 12. The Fundamental Concepts of Logic—Consistency, Inconsistency, Implication, Equivalence, Necessity, Contingency (Chapter 6) 13. Overview of the Fundamental Concepts of Logic—Argument, Deduction, Induction, Validity, Strength, Consistency, Inconsistency, Implication, Equivalence, Necessity, and so forth. (Chapters 1-6.) UNIT TWO Categorical Logic 14. Translating Categorical Sentences into Standard Form--1 (Chapter 7) 4L9z2i 15. Translating Categorical Sentences into Standard Form--2 (Chapter 7) 16. Constructing the Converse, Obverse, and Contrapositive of a Cat Sentence (Chapter 7) 234 17. Logical Form of a Categorical Syllogism--1(Chapter 8) L9z2i 18. Logical Form of a Categorical Syllogism--2 (Chapter 8) 19. Constructing Venn Diagrams--1 (Chapter 9) 20. Constructing Venn Diagrams--2: (Chapter 9) 21. Aristotelian vs Boolean Standpoints (Chapter 9) 4L9z2i 22. Constructing Venn Diagrams--3 (Chapter 9) 23 -More Venn Diagrams (and our videographer Dwight's cameo) (Chapter 9) 24. Constructing Venn Diagrams--4 (Chapter 9) 25. Constructing Venn Diagrams Yet Again (Chapter 9) 26. Venn Diagraming Unicorns (Chapter 9) UNIT THREE TRUTH-FUNCTIONAL LOGIC 27. What is a "Truth-functional" Compound Sentence? (Chapter 10) 235 28. Argument Forms and Substitution Instances (Chapter 11) 29. Symbolizing Truth-functional Sentences -1 (Chapter 12) 30. Alternative Truth-functional English Operators (however, but, although, etc.) (Chapter 12) [Someone deleted this video by mistake; we are having in the process of getting it back online.] 31. Alternative Truth-functional Symbols Used in Various Logic Texts (dot, arrow, etc.) (Chapter 12) GYhEVCrffn 32. Symbolizing Truth functional Sentences--2 (Chapters 12-13): 33. Symbolizing Truth-functional Sentences--3 (Chapters 12-13): 34. Symbolizing Truth-functional Sentences --4 (Chapter 13) 35. Symbolizing Truth-functional Sentences--5 (Chapter 13) 36. Symbolizing Truth-functional Sentences--6 (Chapter 13) 37. Truth table for "and" (Chapter 14) 38. Truth table for "or" (With "Thing") (Chapter 14) 39. Truth table for "if then" (Chapter 14) 236 40. Calculating Truth-values Using the Replacement Method (Chapter 14) 41. Identifying the Main Connective (Chapter 14) 42. Truth table Analysis 1: Testing a Single Sentence for Logical Status (Chapter 15) 43. Truth table Analysis 2: Testing a Single Sentence for Logical Status (Chapter 15) 44. Truth table Analysis 3: Constructing 8-row Tables (Chapter 15) 45. Truth table Analysis 4: Testing an Argument for Validity (Chapter 16) 46. Truth table Analysis 5:Testing a Pair of Sentences for Equivalence: (Chapter 17) 47. Argument Forms and Substitution Instances (This is repeated as a good prep for Chapter 18) 48. Introducing the Inference Rules Modus Ponens (MP) and Modus Tollens (MT) (Chapter 18) 49.Proofs Using the First Four Inference Rules--MP, MT, DS, HS (Chapter 18) 50: Introducing the Second Four Inference Rules—Simp, Conj, Add, CD (Chapter 19) 51. The Constructive Dilemma Rule (CD): (Chapter 19) 52.Proofs Using the Second Four Inference Rules-1. (Chapter 19) 237 53. Proofs Using the Second Four Inference Rules-2 (Chapter 19) 54. Proofs Using the Second Four Inference Rules-3 (Chapter 19) 55. Proofs Using the Second Four Inference Rules-4 (Chapter 19) 56. Proofs Using the Second Four Inference Rules-5 (Chapter 19) 57. Common Errors Made in Truth-functional Proofs-1 (Chapters 18, 19 on) 58. Common Errors Made in Truth-functional Proofs-2 (Chapters 18, 19 on) 59. Replacement Rules 1—Comm, Assoc (Chapter 20) 60. Replacement Rules 2—Double Negation (Chapter 20) 61. Replacement Rules 3--DeMorgan (Chapter 20) 62. Replacement Rules--Distribution (Chapter 20) 63. Replacement Rules--Implication (Chapter 20) 64. Replacement rules--Taut (Chapter 20) 238 65. Extra Replacement Rule Proofs--1 (Chapter 20) 65. Extra Replacement Rule Proofs--2 (Chapter 20) 67. Indirect Proof Explanation--1 (Chapter 21) 68. Indirect Proof Explanation--2 (Chapter 21) 69. Indirect Proof Demo (Chapter 21) 70. Indirect Proof Explanation--3 (Chapter 21) 71 Indirect Proof in Math (Chapter 21) 72. Introducing Conditional Proof (Chapter 21) 73. Conditional Proof Once More (Chapter 21) 74. Intro to Nested Proofs (Chapter 21 Appendix) 75. Nested Conditional Proof (Chapter 21, Appendix) 76. More Nested Proofs (Chapter 21, Appendix) 239 77. Premise–free Proofs--1 (Chapter 22) 78. Premise-free Proofs-2 (Chapter 22) UNIT FOUR PREDICATE LOGIC 79. Predicate Logic Intro to Translations --1(Chapter 23) 80. Predicate Logic Translations Introduction-- 2 (Chapter 23) 81. Translating Existentials (Chapter 23) 82. Translating Exceptives--1 (Chapter 23) 83. Translating Exceptives--2 (Chapter 23) 84. Translating Dyadic Predicates and Overlapping Quantifiers (Chapter 24) 85.Main Connectives in Predicate Logic (Chapters 23-24) 86. Two Meanings of Identity(Chapter 25) 87. Predicate Proofs--1--UI and EG: (Chapter 26) 88. Predicate Proofs--2 (Chapter 26) 240 89. Predicate Proofs--3 (Chapter 26) 90. Predicate Proofs--4 (Chapter 26) 91. Predicate Logic Interpretations (Chapter 27) 92. Predicate Proofs with Overlapping Quantifiers (Chapter 28) 93.Premise-free Predicate Proofs (Chapter 29) 94. Predicate Proofs with Identity--1 (Chapter 30) 95. Predicate Proofs with Identity--2 (Chapter 30) 96. Common errors in Predicate Logic Proofs (Chapters 26 -28) UNIT FIVE INFORMAL AND INDUCTIVE LOGIC 97. Definitions--1 (Chapter 31) 98. Definitions--2 (Chapter 31) 99. Definitions--3 (Chapter 31) 241 100. Informal Fallacies--1 (Chapter 32) 101. Informal Fallacies--2 (Chapter 32) 102. Analogical Arguments (Chapter 33) 103. Enumerative Induction (Chapter 33) 104. More on Analogical induction and Enumerative Induction (Chapter 33) 105. Logic of Science (Chapter 33) 106. Hypothetical Reasoning (Chapter 33) 107. "Inference to the Best Explanation" (Chapter 33) 108. Inference to the Best Explanation Again (Chapter 33) 109. Very Elementary Probability Theory (Chapter 34) UNIT SIX MODAL LOGIC 110. Very Elementary Modal Logic (Chapter 35) 242 GOODBYE VIDEO 111. Our Goodbye Video (July 12, 2011) 243 Part Two. Student Manual Introduction to Logic Student Manual Practice Problems with Answers By Paul Herrick Preface Most of the questions and answers in this student manual are drawn from the test bank that accompanies Introduction to Logic and that is available (as part of the Instructor's Manual) only to teachers using the textbook. The questions below are thus samples of the questions that teachers have in the test bank that accompanies the textbook—questions they may use to create tests and quizzes for class. Other questions below are leftover questions I created during the writing of the textbook that never made it into the textbook or into the instructor's test bank. A number of the questions and answers in Unit 1 below were created for this manual by my friend and colleague, Mitchell Erickson, professor of philosophy, Everett Community College. Thank you, Mitch, for creating some great problems (and answers) on the fundamental concepts of logic. The textbook, Introduction to Logic, that accompanies this manual, contains approximately two thousand logic problems for you to solve, organized in approximately 175 exercise sets. None of the problems contained in this student manual is drawn from the textbook. For maximum effect, practice solving logic problems by solving the problems in the textbook as well as the problems in this student manual. The questions in this little manual are meant to serve only as a modest supplement to the practice problems available in the textbook. In other words, the problems in this manual are not intended to serve as a complete set of practice problems for a course in logic—the more numerous problems in the textbook, Introduction to Logic, serve that purpose. Additional Resources The Open Course Library Logic Class 244 Many, many more logic problems with answers, covering every chapter in the textbook, are available in the free online logic course that my colleague, Mark Storey (Bellevue College), and I created for the Open Course Library. What is this? With generous support from the Bill and Melinda Gates Foundation, the State of Washington Board for Community and Technical Colleges selected eighty-one community college faculty members and gave them the task of creating an online library of complete online courses in nearly every introductory subject in the community college curriculum. The online classes in the Open Course Library are freely available to any teacher or student who wants to use them. The Open Course Library logic class, which Mark and I created, currently entitled "Philosophy 106," may thus be used as an additional resource to help you master the concepts covered in Introduction to Logic. (The online course that we created may also be used to supplement any logic course taught with a standard logic text.) Your teacher has the relevant information. The Many Worlds of Logic Website In addition to the Open Course Library logic course described above, you will find further selftests, a general overview of logic, philosophical arguments that you can analyze and debate, and various materials for advanced study in logical theory at the following website: www.manyworldsoflogic.com Once here, click on "Practice Quizzes with Answers" (at the top) for practice problems that can help build understanding. This website can serve as a general supplement to any logic course. In conclusion, I sincerely hope that the questions and answers in this little manual will help you test your understanding and will give you valuable feedback as you use the accompanying textbook, Introduction to Logic. Good luck to you as you study one the oldest of all academic subjects! Paul Herrick Shoreline Community College Unit 1: The Fundamental Concepts of Logical Theory Chapter 1 What Is Logic? Questions 245 True or False? 1. Logic is the study of how people actually think—flaws, warts, and all. 2. According to the text, philosophy and myth have this in common: Both offer explanations of the world. 3. According to the text, logic was taught in ancient times and then was not taught again until the twentieth century. 4. According to the text, philosophy differs from myth in this way: Philosophy seeks rational explanations, whereas myth does not. 5. Thales was an Egyptian philosopher who carried philosophy to the Greeks. 6. Logic is defined in the text as the study of the standards of correct or good reasoning. 7. Inductive reasoning seeks to show that the conclusion is probably true but not certain. 8. Aristotle studied under Plato. 9. According to the text, Plato is the founder of logic as an academic subject. 10. According to the text, logic was founded in ancient India and then copied by the ancient Greeks. 11. According to the text, Socrates is the founder of logic. 12. Chapter 1 offers reasoning in support of the claim that not all acts of reasoning are equally reasonable or logical. 13. Aristotle wrote the first logic textbook in history. Multiple Choice 1. The Academy was located in: a. Atlantis b. Sparta c. Athens d. America e. Thebes f. None of the above 246 2. According to the text, logic is: a. One of the most difficult of all academic subjects b. One of the oldest of all academic subjects c. The academic subject with the shortest history d. A branch of psychology Answers 1. Logic is the study of how people actually think—flaws, warts, and all. F 2. According to the text, philosophy and myth have this in common: Both offer explanations of the world. T 3. According to the text, logic was taught in ancient times and then was not taught again until the twentieth century. F 4. According to the text, philosophy differs from myth in this way: Philosophy seeks rational explanations, whereas myth does not. T 5. Thales was an Egyptian philosopher who carried philosophy to the Greeks. F 6. Logic is defined in the text as the study of the standards of correct or good reasoning. T 7. Inductive reasoning seeks to show that the conclusion is probably true but not certain. T 8. Aristotle studied under Plato. T 9. According to the text, Plato is the founder of logic as an academic subject. F 10. According to the text, logic was founded in ancient India and then copied by the ancient Greeks. F 11. According to the text, Socrates is the founder of logic. F 12. Chapter 1 offers reasoning in support of the claim that not all acts of reasoning are equally reasonable or logical. T 13. Aristotle wrote the first logic textbook in history. T 247 Multiple Choice 1. c 2. b Chapter 2 Let's Have an Argument! True or False? 1. As "argument" is defined in the text, every argument has exactly one conclusion. 2. As "argument" is defined in the text, some arguments may have no premises at all. 3. According to the text, Aristotle defined truth as the correspondence of a statement or proposition with reality. 4. A conclusion indicator word is used to flag the presence of a conclusion. 5. If no premise or conclusion indicator word is present, then no argument is present. 6. An enthymeme is an argument that is missing a premise or a conclusion or both. 7. An argument that is missing a premise or a conclusion or both is called an "enthymeme." 8. Some exclamatory sentences are true. 9. The principle of charity is a principle that urges us to contribute 10% of our surplus to registered charitable organizations. 10. In logic, the term "argument" refers to a heated, nasty verbal fight. Answers 1. As "argument" is defined in the text, every argument has exactly one conclusion. T 2. As "argument" is defined in the text, some arguments may have no premises at all. F 248 3. According to the text, Aristotle defined truth as the correspondence of a statement or proposition with reality. T 4. A conclusion indicator word is used to flag the presence of a conclusion. T 5. If no premise or conclusion indicator word is present, then no argument is present. F 6. An enthymeme is an argument that is missing a premise or a conclusion or both. T 7. An argument that is missing a premise or a conclusion or both is called an "enthymeme." T 8. Some exclamatory sentences are true. F 9. The principle of charity is a principle that urges us to contribute 10% of our surplus to registered charitable organizations. F 10. In logic, the term "argument" refers to a heated, nasty verbal fight. F Argument or Not an Argument? 1. The Beatles were the greatest rock band of all times. 2. If the French had not helped, the Americans probably would not have won the Revolutionary War. 3. It is impossible that something pop into being from nothing. But the universe was not created. Therefore, the universe must have simply existed from all eternity. 4. It is impossible that something existed before time began. But time began when the universe began. Therefore, it is impossible that something created the universe. 5. Part of the road from Lexington, Massachusetts, to Concord, Massachusetts, is named "Battle Road" in honor of the historic battle fought on the very spot the morning of April 19, 1775. 6. If rocking-horse people eat marshmallow pies, then Lucy will take a newspaper taxi to the sky. There she will find cellophane flowers of yellow and green, towering over her head as people walk by slowly. The flowers there grow so incredibly high! Answers 249 1. Not 2. Not 3. Argument 4. Argument 5. Not 6. Not Multiple Choice 1. In an argument, ideally the premises: a. Are supported by the conclusion b. Support the conclusion c. Counterbalance the conclusion d. Are there only as "window dressing" 2. An argument must have at least ___ premises. a. One b. Two c. Three d. Four e. Five 3. According to the text, critical thinking is: a. Constantly criticizing your own views and the views of others b. Oppositional thinking c. Evaluating beliefs and values on the basis of rational, reality-based standards d. A kind of thinking that takes place unconsciously 4. He invented the Socratic method: a. Socrates b. Plato c. Pluto d. Aristotle e. Moses 5. Critical thinking is identified in the text as: a. A type of level 1 thinking b. A type of level 2 thinking 250 c. A type of thinking suited mainly for intellectuals d. A primarily negative form of thinking Answers 1. b 2. a 3. c 4. a 5. b In each case, is the passage an argument or a non-argument? 1. The Marx Brothers did vaudeville before they got into the movies. So did the Three Stooges. They were sure funny, weren't they? 2. In the last election, our opponent unleashed a smear campaign against our candidate, but it happened on the last day of the campaign, so we didn't have time to respond. As a result, we lost the election. 3. The light from that star displays a peculiar wobble. The only possible explanation of the wobble is that the star has an unseen planet. So, it is reasonable to conclude that the star has a planet. 4. First we stopped and got hamburgers. About an hour later we stopped for some tacos. Then we stopped for a corndog about two hours later. At dinner we got fish and chips and onion rings and a couple hotdogs. After that, we got sick. Answers 1. Non-argument 2. Non-argument 3. Argument 4. Non-argument Indicator words. For each argument below, (a) state any premise or conclusion indicators and (b) state the conclusion. 251 1. Given that all finches are birds, and because no birds are mammals, it must be concluded that no finches are fish. 2. Ulysses S. Grant was born in the United States. Grant was a military hero in the United States. This implies that a military hero was born in United States. 3. The pavement is dry during a drought. Consequently, due to the fact that there is a drought, the pavement is dry. 4. Since George is a student, it follows that he attends classes daily. 5. All carp are fish, and all fish are animals; thus, all carp are animals. 6. According to my friend, people are selfish. Thus, since being good is also selfish, people should be good. 7. Sara is sad. Hence, Sara is sad. 8. Provided that four is greater than three, and five is greater than four, it follows that five is greater than three. 9. Jan is a mother, because she has given birth to a baby. 10. Given that Sam is a senator, that Sam is a politician may be inferred from the fact that all senators are politicians. Answers 1. (a) Given that; because; it must be concluded that; (b) no finches are fish. 2. (a) This implies that; (b) a military hero was born in the United States. 3. (a) Consequently; due to the fact that; (b) the pavement is dry. 4. (a) Since; it follows that; (b) he attends classes daily. 5. (a) thus; (b) all dogs are animals. 6. (a) Thus; since; (b) people should be good. 7. (a) Hence; (b) Sara is sad (the second occurrence of the sentence). 8. (a) Provided that; it follows that; (b) five is greater than three. 9. (a) because; (b) Jan is a mother. 10. (a) Given that; may be inferred from; (b) that Sam is a politician. Are the following sentences interrogative, declarative, exclamatory, or imperative? 1. If today is Tuesday, then tomorrow is Wednesday. 252 2. I love ice cream. 3. Darn! 4. Do you know where Seattle is? 5. Go to sleep. 6. Philosophy is my favorite class. 7. I've been gone for a while. 8. Surprise. 9. Stalin executed his political opponents. 10. Do you like ice cream? 11. An artist, wow! 12. Matter is the only thing in the universe. Answers 1. Declarative 2. Declarative 3. Exclamatory 4. Interrogative 5. Imperative 6. Declarative 7. Declarative 8. Exclamatory 9. Declarative 10. Interrogative 11. Exclamatory 12. Declarative Are the following passages arguments or not? 1. Joan studies every day for her philosophy class and writes very carefully for her papers. She also takes complete notes. We can conclude that Joan will likely do well in her class. 2. Jenny likes ice cream. John likes football. Jenny likes reading. 253 3. Both Plato and Aristotle were philosophers, both were male, both were from Greece, and both wrote political works. 4. Plato wrote The Republic, and The Republic was written by an ancient Greek philosopher. Plato must then be an ancient Greek philosopher. 5. Mary and Ian went together to work on Wednesday, got into an automobile accident, and were late. Their boss was having a meeting that day, and they missed it. 6. Mary and Ian left for work on Wednesday but decided to go to the movies instead. Their boss was having a meeting that day, and they missed it. That is why they did not hear about the layoffs. 7. Mary and Ian, you are irresponsible. You should not have gone to the movies, especially when you had an important meeting. You should always go to meetings. 8. Mary and Ian drove together to work every day this year and worked. People who go to work every day and work hard usually do get raises. Thus, Mary and Ian probably will get a raise. 9. Some people do not go to work regularly. For example, Mary and Ian started to go to work on Wednesday but decided to return home to practice their tennis. This shows poor work habits. 10. Plato believed the Forms were more real than matter. So, Plato has been called an "Idealist." Answers 1. Argument 2. Non-argument 3. Non-argument 4. Argument 5. Non-argument 6. Non-argument. This is an explanation. 7. Non-argument 8. Argument 9. Non-argument 10. Non-argument. This is an explanation. 254 Diagramming arguments. Number each premise and conclusion in the following arguments and diagram the arguments using arrows to indicate the inference from one or more premises to a conclusion. 1. If Fred is a chemist, then he is detail oriented. If Fred is detail oriented, then he careful. Thus, if Garcia is a chemist, then he is careful. And if the last statement is true, then Fred will be successful. Thus, Fred will be successful. 2. Either Sally is a senator, or she is a philosopher and a bridge player. But Sally is not a senator. Thus, Sally is a philosopher. 3. Every crow ever seen has been black. Ravens are related to crows, and ravens are black. Thus, the next crow seen will probably be black. 4. All whales are animals, and all whales are mammals. Moby Dick is a whale. Thus, Moby Dick is an animal and a mammal. 5. Ann gave John a valentine. Then she gave him a present. Then she told him she likes him. It follows that Ann probably likes John a lot. Answers 1. (1) If Fred is a chemist, then he is detail oriented. (2) If Fred is detail oriented, then he is careful. Thus, (3) if Garcia is a chemist, then he is careful. And (4) if the last statement is true, then Fred will be successful. Thus, (5) Fred will be successful. (1)+(2) One arrow from premise group to (3) (3)+(4) One arrow from second premise group to (5) (5) 2. (1) Either Sally is a senator, or she is a philosopher and a bridge player. But (2) Sally is not a senator. Thus, (3) Sally is a philosopher. 255 (1)+(2) One arrow from premise group to (3) (3) 3. (1) Every crow ever seen has been black. (2) Ravens are related to crows, and (3) ravens are black. Thus, (4) the next crow seen will probably be black. (1) (2)+(3) Two separate arrows from (1) and from (2)+(3) to (4) (4) 4. (1) All whales are animals, and (2) all whales are mammals. (3) Moby Dick is a whale. Thus, (4) Moby Dick is an animal and a mammal. (1)+(2)+(3) One arrow from the premise group to (4) (4) 5. (1) Ann gave John a valentine. Then (2) she gave him a present. Then (3) she told him she likes him. It follows that (4) Ann probably likes John a lot. (1) (2) (3) Three separate arrows to (4) (4) Chapter 3 The Two Basic Types of Argument True or False? 1. Deductive arguments aim to show that the conclusion must be true. 256 2. Inductive arguments aim to show not that the conclusion must be true but rather that it is likely true. 3. Every deductive argument has at least two premises. 4. No inductive argument aims to prove its conclusion with certainty. 5. Mathematical arguments are a type of deductive argument. 6. Cause-and-effect reasoning is a type of deductive argument. 7. Categorical arguments are a common type of deductive argument. Answers 1. Deductive arguments aim to show that the conclusion must be true. T 2. Inductive arguments aim to show not that the conclusion must be true but rather that it is likely true. T 3. Every deductive argument has at least two premises. F 4. No inductive argument aims to prove its conclusion with certainty. T 5. Mathematical arguments are a type of deductive argument. T 6. Cause-and-effect reasoning is a type of deductive argument. F 7. Categorical arguments are a common type of deductive argument. T Deductive or inductive? Decide by considering the form of reasoning displayed in the argument. 1. All cats are mammals. All mammals are hairy. Therefore, all cats are hairy. 2. The cheese has turned moldy. Mold is usually caused by organisms in the air. So, the cheese was left exposed to the air. 3. This car gets 20 mpg. It has ten gallons in its tank. Therefore, it will go two hundred miles before needing gas. 257 4. We have always collected a lot of candy on Halloween. Therefore, tomorrow night, Halloween night, we will collect a lot of candy. 5. Every time in the past that Jan has spoken, she has gone over her time limit. Therefore, she will speak too long tomorrow night at the awards banquet. 6. If we move to Colorado, then we will ski often. If we ski often, then we will become better skiers. So, if we move to Colorado, then we will become better skiers. 7. My doctor says this drug is safe. She is an expert in this area. So, the drug is safe. Answers 1. All cats are mammals. All mammals are hairy. Therefore, all cats are hairy. D 2. The cheese has turned moldy. Mold is usually caused by organisms in the air. So, the cheese was left exposed to the air. I 3. This car gets 20 mpg. It has ten gallons in its tank. Therefore, it will go two hundred miles before needing gas. D 4. We have always collected a lot of candy on Halloween. Therefore, tomorrow night, Halloween night, we will collect a lot of candy. I 5. Every time in the past that Jan has spoken, she has gone over her time limit. Therefore, she will speak too long tomorrow night at the awards banquet. I 6. If we move to Colorado, then we will ski often. If we ski often, then we will become better skiers. So, if we move to Colorado, then we will become better skiers. D 7. My doctor says this drug is safe. She is an expert in this area. So, the drug is safe. I Are the indicator words below inductive argument indicator words or deductive argument indicator words? 1. There's a good chance that 258 2. Necessarily 3. Must 4. It's likely that 5. Certainly 6. Probably 7. The chances are high that 8. For sure 9. It may well be that 10. It's guaranteed that Answers 1. Inductive 2. Deductive 3. Deductive 4. Inductive 5. Deductive 6. Inductive 7. Inductive 8. Deductive 9. Inductive 10. Deductive For each argument below, decide whether it is inductive or deductive. 1. I am ten feet tall. Therefore, I must be ten feet tall. 2. Either George is an sculptor, or he is a painter. But he is not a sculptor. So, he definitely is a painter. 259 3. No fish have ever been found in the Dead Sea. So, it is likely that no fish will be caught by us in the Dead Sea. 4. Some cats are mammals. Some mammals are vertebrates. Consequently, some cats are vertebrates. 5. The sign at the Mt. Rainier National Park says that it the park was established in 1300. Most official signs are accurate. Thus, the park was likely established in 1300. 6. No person has ever moved faster than the speed of light. So, the next space flight with people will probably not go faster than the speed of light. 7. No whales are sharks. No sharks are dolphins. So, it is certain that some sharks are not dolphins. 8. Every doctor says that we should eat a balanced breakfast. So, we certainly should eat a balanced breakfast. 9. Almost everyone agrees that pi is an irrational number. So, we probably can conclude that pi is an irrational number. 10. If Susan is a child, then Susan is a minor. But Susan is not a minor. Thus, Susan is not a child. 11. Some things in the universe are not made by people. Thus, it is certain that some things in the universe occur naturally. 12. John lives to the north of Marsha. Fred lives north of John. So, it is certain that Fred lives north of Marsha. 13. If Stalin was a leader of the Soviet Union, then he was a dictator. Stalin was a dictator. Thus, Stalin was certainly a leader of the Soviet Union. 14. The traffic at rush hour always moves at about thirty miles an hour. At rush hour I have to drive to work, which is about thirty miles away. So, it will probably take me about thirty minutes to drive to work. 15. There is a handwritten note here that says the park is closed. Therefore, the park must be closed. Answers 1. Deductive 2. Deductive 260 3. Inductive 4. Deductive 5. Inductive 6. Inductive. 7. Deductive 8. Deductive 9. Inductive 10. Deductive 11. Deductive 12. Deductive 13. Deductive 14. Inductive. 15. Deductive Chapter 4 How to Evaluate a Deductive Argument True or False? 1. All valid arguments have all true premises and true conclusions. 2. All sound arguments are valid arguments. 3. If an argument is valid, then it must have at least one true premise. 4. Every valid argument is a sound argument. 5. The following is a valid deductive argument: If it snows, then we will go sledding, just like when we were kids. It is snowing. So, certainly we will go sledding, just like when we were kids. 6. The following is clearly a valid deductive argument: All rock fish are orange and red. So, if we catch a rock fish, then it will surely be red and orange. 7. The following is an invalid argument: Jim is at least sixty. Jan is at least as old as Jim. So, Jan is at least sixty. 261 8. The following is an invalid argument: Jim is between fifty and sixty years old. Jan is older than Jim. So, Jan is older than sixty. 9. The following is a valid argument: Britney is a good musician. Christa is a good musician. Therefore, they will make a good musical duo. 10. The following is a valid argument: Senator Clarke associates with known horologists. Therefore, the argument he just gave must be an invalid argument. 11. The following is a valid argument: No splogs are crogs. All crogs are blonks. So, no splogs are blonks. 12. If a deductive argument is invalid, then it must also be unsound. 13. If an argument is invalid, then it must have at least one false premise. 14. If an argument has a conclusion that is certainly false, then the argument must be invalid. Answers 1. All valid arguments have all true premises and true conclusions. F 2. All sound arguments are valid arguments. T 3. If an argument is valid, then it must have at least one true premise. F 4. Every valid argument is a sound argument. F 5. The following is a valid deductive argument: If it snows, then we will go sledding, just like when we were kids. It is snowing. So, certainly we will go sledding, just like when we were kids. T 6. The following is clearly a valid deductive argument: All rock fish are orange and red. So, if we catch a rock fish, then it will surely be red and orange. T 7. The following is an invalid argument: Jim is at least sixty. Jan is at least as old as Jim. So, Jan is at least sixty. F 262 8. The following is an invalid argument: Jim is between fifty and sixty years old. Jan is older than Jim. So, Jan is older than sixty. T 9. The following is a valid argument: Britney is a good musician. Christa is a good musician. Therefore, they will make a good musical duo. F 10. The following is a valid argument: Senator Clarke associates with known horologists. Therefore, the argument he just gave must be an invalid argument. F 11. The following is a valid argument: No splogs are crogs. All crogs are blonks. So, no splogs are blonks. F 12. If a deductive argument is invalid, then it must also be unsound. T 13. If an argument is invalid, then it must have at least one false premise. F 14. If an argument has a conclusion that is certainly false, then the argument must be invalid. F More True-False Questions 1. If the premises and conclusion are all false, the argument must be invalid. 2. Some invalid arguments have true premises and a true conclusion. Answers 1. False 2. True Multiple Choice 1. The following is one of the two ways to effectively criticize an argument: a. Hit the arguer over the head with a broom 263 b. c. d. Make fun of the arguer's appearance State an argument against one of the argument's premises Present an argument against the conclusion of the target argument 2. The combination that you will not find in a valid argument is: a. b. c. d. e. True premises and a false conclusion True premises and a true conclusion False premises and a false conclusion False premises and a true conclusion None of the above 3. The combination that you will not find in a sound argument is: a. True premises and a true conclusion b. True premises and valid reasoning c. False premises or invalid reasoning d. All of the above Answers: 1. c 2. a 3. c Assume that each of the following is a deductive argument. In each case, is the argument valid or invalid? 1. Some football coaches are poets. But no poet knows how to play football. So, some football coaches do not know how to play football. 2. Some cars are purple, and some cars are Chevrolets. So, some cars are purple Chevrolets. 3. If Smith wins, Jones will be happy. However, Smith won't win. So, Jones won't be happy. 4. Only birds are blue. My pet is blue. So, my pet is a bird. 5. Ann and Bob both won't be home. So, Ann won't be home. 6. No aardvarks are reptiles. No reptiles are blue. So, no aardvarks are blue. 7. If Sue wins, then Ed will be happy. If Ed is happy, then George will be happy. So, if Sue wins, then George will be happy. Answers 1. Valid 264 2. Invalid 3. Invalid 4. Valid 5. Valid 6. Invalid 7. Valid For each of the deductive arguments below, determine whether it is valid or invalid. 1. All dogs are wolves. No wolves are insects. So, no dogs are insects. 2. The United States comprises fifty states. Thus, the United States has an even number of states. 3. If John is a bachelor, then John is unmarried. However, John is not a bachelor. Therefore, John is unmarried. 4. Tigers live underwater. Tigers are mammals. So, some mammals live underwater. 5. Some felines are lions. Therefore, some felines are not lions. 6. Either Susan is not an actress, or she is not a director. However, she is a director. Consequently, she is not an actress. 7. Bill Gates is now the richest man in the world. So, Bill Gates is now the richest man in the world. 8. Five is greater than two, and two is greater than three. So, five is greater than two. 9. This drawing is a pentagon. Thus, this drawing has six sides. 10. Some cats are animals. Some cats are Siamese. Therefore, some animals are Siamese. 11. If George plays soccer, then he must be in good physical shape. George is not in good physical shape. Hence, George must not play soccer. 12. George W. Bush is a Quello. So, George W. Bush must be a Quello. 13. Either Sarah isn't a good actress, or she is a good singer. If Sarah has ever taken acting lessons, then she's a good actress. Sarah has taken action lessons. So, Sarah is a good singer. 14. Ten is greater than six. Six is greater than twelve. Consequently, ten is greater than twelve. 265 Answers 1. Valid 2. Valid 3. Invalid 4. Valid 5. Invalid 6. Valid 7. Valid 8. Valid 9. Invalid 10. Invalid 11. Valid 12. Valid 13. Valid 14. Valid Each of the following arguments is an enthymeme. For each of them do the following: (1) State whether a conclusion or a premise is missing and (2) provide the missing premise or conclusion. Assume that all of the arguments are valid. So, the premise or conclusion you provide must keep the argument valid. 1. Because all whales are mammals, orcas are mammals. 2. Mammals have backbones, and insects do not. So, whales have backbones. 3. Anyone who is a Republican is a conservative. Jane is a conservative. 4. Some mammals have fur because bears have fur. 5. All governments enact laws. So, the United States enacts laws. 6. A person can survive only if he or she has eaten enough food. You have survived. 7. Many people have a disease because overconsumption is a disease. 8. Jane is either an actress or a singer. So, Jane is an actress. 9. If Jane is an actress, then she does not perform at The Met, and Jane performs at The Met. 10. Some cows are milked. So, some animals are milked. 266 11. Only people are rational. Consequently, Fido is not rational. 12. No one who exercises is weak. So, people who run every day are not weak. 13. If you like to overeat, then you get overweight. So, you will be unhealthy if you overeat. 14. Amha must be well-educated, because he studies every day. 15. All cows are mammals. So, all cows have lungs. 16. If it hasn't rained, then the corn is parched. The corn is parched. Answers 1. Premise: All orcas are whales. 2. Premise: Whales are mammals. 3. Premise: Jane is a Republican. 4. Premise: Bears are mammals. 5. Premise: The United States is a government. 6. Conclusion: You have eaten enough food. 7. Premise: Many people overconsume. 8. Premise: Jane is not a singer. 9. Conclusion: Jane is not an actress. 10. Premise: Some cows are animals. 11. Premise: Fido is not a person. 12. Premise: People who run every day exercise. 13. Premise: If you get overweight, then you will be unhealthy. 14. Premise: Anyone who studies every day must be well-educated. 15. Premise: All mammals have lungs. 16. Premise: It hasn't rained. Again, each of the following is an enthymeme. In each case, fill in the missing element (i.e., add a premise or conclusion) so as to turn the enthymeme into a valid deductive argument. 1. All frogs are orange. No orange things are cute. So, ... 2. If it rains, then we'll go swimming. It will rain. So, ... 3. We will eat either hotdogs or hamburgers. So, we will eat hamburgers. 267 4. All illy pies are hairy. So, all illy pies are warm-blooded. Answers 1. No frogs are cute. 2. We will go swimming. 3. We won't eat hotdogs. 4. All hairy things are warm-blooded. Chapter 5 How to Evaluate an Inductive Argument True or False? 1. The following is a strong argument: It has been snowing for thirty days straight, and the prediction is for the snow to continue tomorrow. Thus, tomorrow it will probably snow. 2. The following is a weak argument: It has been snowing for sixty days straight, and the prediction is for the snow to continue tomorrow. Thus, tomorrow it will probably be a sunny day. 3. The following is a weak argument: Joe has eaten lunch at the taco stand every day for two days straight. Thus, tomorrow he will probably eat there again. 4. The following is a strong argument: Sodium burns yellow. This metal burns yellow. So, this metal is very probably sodium. 5. If an argument is inductively strong, then it must also have all true premises. 6. If an argument is cogent, then it must also be valid. Answers 1. True 2. True 268 3. True 4. False 5. False 6. False Suppose that the following arguments are inductive. In each case, is the argument strong or weak? 1. Almost every time that Pete has gone to Gorditos restaurant, he has ordered a large taco. He has eaten there many times. He just left for Gorditos. He will probably order a large taco. 2. Over the past month, Fred has eaten eight burritos at Gorditos. All eight were good. For his next dinner, he plans to buy another Gordito burrito. His next burrito will likely be good. 3. Professor Smith wore a bright red tie twice last week. He rarely wears a tie. So, he will probably wear a bright red tie next week. Answers 1. S 2. S 3. W Determine whether the following inductive arguments are strong or weak. 1. Yesterday someone told me that driving a diesel truck causes cancer. So, driving a diesel truck probably causes cancer. 2. Most physicists agree that nothing can travel faster than the speed of light. Thus, it is likely that nothing can travel faster than the speed of light. 3. We sampled the box of a thousand nails by picking ten of them, and none of them was bent. So, it is likely that none of the nails in the box is bent. 4. It has snowed on Christmas in our town every year for the past forty years, so it will probably snow on Christmas this year. 269 5. The tide washed up some garbage onto my beach yesterday, so I conclude that the tide will wash up some garbage onto my beach tomorrow. 6. I went out to lunch with Yolanda yesterday at the hamburger drive-in, and she ordered a diet cola. We loved that drive-in's food, so we are going there tomorrow again. Yolanda will probably order a diet cola again. 7. Numerous studies have shown that people who go to movies once a week do not buy snacks at the concession stand. Jackie goes to movies once a week, so she probably doesn't buy snacks at the concession stand. 8. My biology teacher told me that automobiles are designed to break down after 100,000 miles. So, it's probably true that automobiles are designed to break down after 100,000 miles. 9. Two people from out of town were fined for littering in our town. Consequently, I conclude that most of the litter in our town is caused by people from out of town. 10. Shawn and Liz went to a romantic comedy last night. Liz liked it, but Shawn didn't. Therefore, it is likely that Shawn doesn't like romantic comedies, but Liz does. 11. Every Friday night for the past five years Yusif has taken Sherry to an action movie, and Yusif has noticed that Sherry didn't like the movie. So, it is likely that Sherry won't like the next action movie that they go to. 12. When we went to the restaurant last night, we saw that the employees were clearing tables, mopping the floors, and putting chairs onto the table. Therefore, it is likely that the restaurant was closing. 13. The sign on the restaurant says that it is closed, so it's likely that the restaurant is closed. 14. Whenever people go to a wedding, they dress up. Whenever they go to a funeral, they dress up. Whenever they go to the opera, they dress up. Consequently, when they go to a party, they should dress up. 15. Paul's boss tells him every day that he needs to be more aggressive in his sales pitch to customers. Paul's coworkers tell him that he should let customers lead the conversation and not be aggressive. Some of Paul's customers respond well to aggressive sales pitches, but some do not. Paul is probably feeling confused. Answers 1. Weak 2. Strong 3. Weak 270 4. Strong 5. Weak 6. Weak 7. Strong 8. Weak 9. Weak 10. Weak 11. Strong 12. Strong 13. Strong 14. Weak 15. Strong Chapter 6 The Logical Relations and Concluding Matters True or False? 1. If two sentences are equivalent, then they imply each other. 2. If two sentences are consistent, then both sentences must be true. 271 3. If P implies Q and Q implies P, then P and Q are equivalent. 4. If P is contingent, then it is possible P is false. 5. If P is necessarily false, then P is contingent. 6. If P implies Q, then Q implies P. 7. Socrates asked a lot of questions. Answers 1. T 2. F 3. T 4. T 5. F 6. F 7. T Consistent or inconsistent (C or I)? (Assume the ordinary meanings of the words and assume that the author is not playing tricks with words. For example, if Jan is referred to twice, assume it is the same Jan both times and so on.) 1. Someone in room 1410 is twenty. Someone in room 1410 is thirty. 2. Maria is under thirty. Maria is over thirty. 3. Maria is over forty. Maria is thirty. 4. Maria is a Democrat. Maria is Hindu. In each case, does the first sentence imply the second? Yes (Y) or No (N) 272 1. Someone is over twenty. Someone is over thirty. 2. Maria is over forty. Maria is over thirty. 3. Maria is a Democrat. Maria is Hindu. 4. Jan is younger than thirty. Jan is younger than sixty. In each case, does the second imply the first? Yes (Y) or No (N) 1. Someone in room 1410 is over twenty. Someone in room 1410 is over sixteen. 2. Maria is under forty. Maria is under thirty. 3. Maria is over twenty. Maria is under fifteen. 4. Joe is rich. Joe is a socialist. In each case, are the two sentences equivalent? Yes (Y) or No (N) 1. Someone is over twenty-one. Someone is over twenty. 2. Joe knows Pete. Pete knows Joe. 3. Today is Monday. Today is not Tuesday. 4. Carbon is one of the elements. One of the elements is carbon. 5. No cats are reptiles. No reptiles are cats. 6. No mechanics exist. Nothing in existence is a mechanic. Answers C or I? 1. C 2. I 3. I 4. C Yes or No? 1. N 273 2. Y 3. N 4. Y Yes or No? 1. N 2. Y 3. N 4. N Yes or No? 1. N 2. N 3. N 4. Y 5. Y 6. Y Insert: Rules and Reminders, by Unit The rules and reminders collected in this insert cover the next four units of the text. As you study one or more of the remaining units, you may want to create note cards containing the relevant rules and reminders gathered here. Categorical Logic Reminders Sentence Forms A: E: I: O: Universal Affirmative Universal Negative Particular Affirmative Particular Negative. All S are P No S are P Some S are P Some S are not P Conversion, Obversion, Contraposition To Produce the Converse of a Categorical Statement: Switch the subject and predicate terms. To Produce the Obverse: 274 1. Change the quality (without changing the quantity) from affirmative to negative or negative to affirmative. 2. Replace the predicate term with its term complement. To Produce the Contrapositive: 1. Switch the subject and predicate. 2. Replace each term with its term complement. Rules of Validity for Categorical Syllogisms A categorical syllogism is valid if, and only if, all the following conditions are met: 1. 2. 3. 4. The middle term is distributed in at least one premise. If either term is distributed in the conclusion, it is also distributed in a premise. The syllogism does not contain two negative premises. If one premise is negative, then the conclusion is negative; if the conclusion is negative, then one premise is negative. Truth-functional Logic Reminders Rules for Truth-Functions 275 A conjunction (P & Q) is true only when both conjuncts are true; it is false in all other cases. A disjunction (P v Q) is false only when both disjuncts are false; it is true in all other cases. A negation (~P) is false when the sentence negated is true and it is true when the sentence negated is false. A conditional (P Q) is false only when the antecedent is true and the consequent is false; it is true in all other cases. A biconditional (P ≡ Q) is false only when the left and the right sides have differing truthvalues; it is true when both sides have the same truth-value. Truth-Table Tests A formula is a truth-functional tautology if and only if the final column of its truth-table is all T's. A formula is a truth-functional contradiction if and only if the final column of its truth-table is all F's. A formula is truth-functionally contingent if and only if the final column of its truth-table contains at least one T and at least one F. An argument is truth-functionally valid if and only if its truth-table contains no row with all true premises and a false conclusion. An argument is truth-functionally invalid if and only if its truth-table contains at least one row with all true premises and a false conclusion. Two formulas are truth-functionally consistent if and only if the corresponding truth-table contains at least one row on which both are true. A formula P truth-functionally implies a formula Q if and only if there is no row on the respective truth table showing P true and Q false. Two formulas are truth-functionally equivalent if and only if the final columns on their respective truth-tables match. Truth-functional Inference Rules (Chapters 18-19) Disjunctive Syllogism (DS) PvQ ~P Q or Modus Ponens (MP) PQ P 276 P vQ ~Q P Q Modus Tollens (MT) P Q ~Q ~P Hypothetical Syllogism (HS) PQ QR PR or QR P Q P R Simplification (Simp) P & Q P or P & Q Q Conjunction (Conj) P Q P&Q Addition (Add) P PvQ Constructive Dilemma (CD) PQ RS PvR QvS Indirect Proof (IP) To prove P : Indent, assume ~ P, derive a contradiction, end the indentation, assert P. Conditional Proof (CP) 277 To prove a sentence of the form P Q: Indent, assume P, derive Q, end the indentation, and assert P Q. Truth-functional Replacement Rules (Chapter 20) Commutation (Comm) A formula P v Q may replace, or be replaced by, the corresponding formula Q v P. A formula P & Q may replace, or be replaced by, the corresponding formula Q & P. Association (Assoc) A formula (P v Q) v R may replace, or be replaced with, the corresponding formula P v (Q v R) . A formula (P & Q) & R may replace, or be replaced with, the corresponding formula P & (Q & R). Double Negation (DN) A formula ~ ~ P may replace, or be replaced with, the corresponding formula P. De Morgan's rule (DM) Anywhere in a proof, a formula ~ (P & Q) may replace, or be replaced with, the corresponding formula ~P v ~ Q. Anywhere in a proof, a formula ~(P v Q) may replace, or be replaced with, the corresponding formula ~ P & ~Q. Distribution (Dist) A formula P v (Q & R) may replace, or be replaced with, the corresponding formula (P v Q) & (P v R). A formula P & (Q v R) may replace, or be replaced with, the corresponding formula (P & Q) v (P & R). Transposition (Trans) 278 A formula P Q may replace, or be replaced with, the corresponding formula ~ Q ~ P. Implication (Imp) A formula P Q may replace, or be replaced with, the corresponding formula ~ P v Q. Exportation (Exp) A formula (P & Q) R may replace, or be replaced with, the corresponding formula P (Q R). Tautology (Taut) A formula P may replace, or be replaced with, the corresponding formula P v P. Equivalence (Equiv) A formula P Q may replace, or be replaced with, the corresponding formula (P Q) & (Q P). A formula P Q may replace, or be replaced with, the corresponding formula (P & Q) v (~ P & ~ Q). Predicate Logic Reminders Inference Rules (Chapter 26) Universal Instantiation (UI) From a universal quantification, you can infer any instantiation, provided that the instantiation was produced by uniformly replacing each occurrence of the variable that was bound by the quantifier with a constant. Existential Generalization (EG) From a sentence containing an individual constant, you may infer any corresponding existential generalization, provided that (a) the variable used in

the generalization does not already occur in the sentence generalized upon, and (b) the generalization results by replacing at least one 279 occurrence of the constant with the variable used in the generalization, with no other changes being made. Existential Instantiation (EI) From an existential quantification, you may instantiate using any constant, provided that (a) each occurrence of the variable bound by the quantifier in the existential quantification is uniformly replaced with a constant and no other changes are made, and (b) the constant used in place of the variable is completely new to the proof, meaning it does not appear anywhere else in the argument. Thus, the constant used does not appear in a premise, in a previous line, in the present line, or in the conclusion. Special Restriction for Relational Sentences. When applying EI to an existential quantification containing one or more relational predicates, do not use a constant if the constant already appears in the existential quantification. Universal Generalization (UG) From a sentence containing a constant, one may infer the corresponding universal generalization, provided that (a) the constant is uniformly replaced by a variable and no other changes are made, (b) the constant generalized upon does not appear in any premise of the argument, (c) the constant was not introduced into the proof by EI, (c) the variable you use in the generalization does not already appear in the sentence from which you are generalizing; and (d) the constant used in the generalization does not already appear in any premise of the argument. Special Restriction for Relational Sentences. Do not apply UG to a constant when that constant appears in a relational sentence along with a constant that was introduced into the proof by EI. The Quantifier Exchange Rule (QE) If P is a wff of PL containing either a universal or an existential quantifier, ~P may be replaced by, or may replace, a sentence that is exactly like P except that the quantifier in the first of the following steps: 1. Negate each side of the quantifier. 2. Switch the quantifier. 3. Cancel out any double negatives that result. Universal Instantiation (UI) Alternative System Rules 280 Alternative Universal Instantiation Rule ("UI-A") From a universal quantification, you may infer any instantiation, provided that the instantiation was produced by uniformly replacing each occurrence of the variable that was bound by the quantifier with a constant. Alternative Existential Generalization Rule ("EG-A") From a sentence containing one or more constants or variables, you may infer any corresponding existential generalization, provided that (a) the variable used in the generalization does not already occur in the sentence generalized upon and (b) the generalization results by replacing at least one occurrence of the constant or variable with the variable used in the generalization, with no other changes being made. Alternative Universal Generalization Rule ("UG-A") From a sentence containing no constants and no quantifiers, you may infer the corresponding universal generalization. The Self-Identity Rule (SI) At any step in a proof, you may assert (x)(x = x). The Indiscernibility of Identity Rule (Leibniz's Law or LL) If c and d are two constants in a proof and a line of the proof asserts that the individual designated by c is identical with the individual designated by d, you may copy down and rewrite any available line of the proof replacing any or all occurrences of c with d or any occurrences of d with c. A line of a proof is "available" unless it is within the scope of a discharged assumption. 281 Symmetry of Identity Rule (Sym) Given a formula c = d, you may infer d = c. End Insert Unit 2: Categorical Logic Chapter 7 Logic Takes Form Categorical Logic True or False? 1. Categorical logic is the first specialized branch of logic to be systematized and presented in textbook form. 2. The A sentence is universal and affirmative. 3. The O sentence is universal and affirmative. 4. The I sentence is universal and negative. 5. The E sentence is particular and affirmative. 6. The O sentence is particular and negative. Answers 1. T 2. T 3. F 4. F 5. F 282 6. T Multiple Choice 1. The E sentence is: a. Universal and affirmative b. Universal and negative c. Particular and affirmative d. Particular and negative Answer: b Translate the following into standard form (A, E, I, or O sentences). 1. Many heavy metal rockers love long hair. Answer: Some heavy metal rockers are persons with long hair. 2. Whales can grow to be pretty big. Answer: Some whales are big creatures. 3. No lily pads belong to the class of mammals. Answer: No lily pads are mammals. 4. Prunes are groovy. Answer: All prunes are groovy things. 5. Quite a few hippies attended the concert. Answer: Some hippies are persons who attended the concert. For each sentence below, write (a) the converse, (b) the obverse, (c) the contrapositive. 283 1. All dolphins are mammals. Answer: Converse: All mammals are dolphins. Obverse: No dolphins are non-mammals. Contrapositive: All non-mammals are non-dolphins. 2. No oysters are tree climbers. Answer: Converse: No tree climbers are oysters. Obverse: All oysters are non-tree climbers. Contrapositive: No non-tree climbers are non-oysters. Chapter 8 The Square of Opposition True or False? 1. Contradictories cannot both be true. 2. Contraries can both be true. 3. Subcontraries cannot both be false. Answers 1. T 2. F 3. T Assuming the traditional square of opposition, determine the truth values of the following (true, false, or undetermined). 1. All ostriches are pets. Answer: True. So: No ostriches are pets is false; Some ostriches are pets is true; Some ostriches are not pets is false. Chapter 9 Categorical Syllogisms True or False? 1. A categorical syllogism is a deductive argument consisting of three categorical statements. 2. The middle term appears in both premises. 3. The major term is the predicate of the conclusion. 4. The minor term is the subject of the conclusion. 5. In a valid syllogism, the middle term must be distributed at least once. Answers 1. T 2. T 3. T 4. T 5. T Test the following syllogisms using the five rules of validity. (1) 1. All blogs are glogs. 2. All glogs are wogs. 3. So, all wogs are blogs. Answer: Invalid 2. Invalid Chapter 9 Categorical Syllogisms 2 Boole, Venn, and the Nineteenth-Century Revolution in Categorical Logic True or False? 1. John Venn is the inventor of the method of Venn diagrams. 2. The X in a Venn diagram marks the spot where the treasure is buried. 3. George Boole was a friend of Aristotle. 4. Aristotle and Venn fought a duel; Aristotle lost. 5. At the end of the eighteenth century, the German philosopher Kant believed that logic was basically a completed subject. Answers 1. T 2. F 3. F 4. F 5. T Multiple Choice 1. A Venn diagram for a categorical syllogism contains regions. a. Three b. Seven c. Eight Answer: b Use Venn diagrams to test the following arguments for validity. Assume the Aristotelian standpoint. 1. All truckers are happy persons. No prisoners are happy persons. Thus, no prisoners are truckers. 2. No snowboarders are MTV fans. So, no snowboarders are truckers. Answers: 288 1. Valid 2. Invalid 3. Invalid 4. Invalid. Unit 3: Truth-Functional Logic Chapter 10 Truth-Functional Logic Truth-Functional Logic True or False? 1. A function is a rule relating one set of values to another set of values. 2. Truth-functional logic is the branch of logic that studies the truth values of its component or components. 5. The Stoics founded their school on a porch. 6. The Stoics were ancient Egyptian philosophers. 7. The Stoic school of philosophy was founded in Concord, Massachusetts, in 1860. 8. In the case of a truth-functional compound sentence, if we know the truth values of the component(s), then we can compute the truth value of the compound. 9. No interrogative sentence is ever true or false. 10. The conjunction operator is dyadic. 11. The disjunction operator is monadic. 12. If a conjunction is true, then each of its disjuncts must be true. 13. If a conditional is true and its antecedent is true, then its consequent must also be true. 14. If a conditional is true and its consequent is false, then its antecedent must be false. 15. It is possible that a conditional is true at the same time its antecedent is true and its consequent is false. 16. A truth-functional compound is one whose truth value is determined by the time of day in addition to the truth values of the components. 18. Some compound sentences are not truth functional. Answers 1. T 2. T 3. T 4. T 5. T 6. F 7. F 8. T 9. T 10. T 11. F 293 12. F 13. T 14. T 15. F 16. F 17. F 18. T For each of the following, use the truth-table rules to determine the truth values of the sentences. For these questions, assume that Ann is tall, Bob is not tall, and Carl is tall. 1. Ann is tall and Bob is tall. 2. Ann is tall or Bob is tall. 3. If Ann is tall, then Bob is tall. Answers 1. F 2. T 3. F Chapter 11 Truth-Functional Logic Arguments and Argument Forms True or False? 1. An argument form is a pattern of reasoning that many different arguments share. 2. Some argument forms are valid; others are invalid. 3. All argument forms are valid. 4. A valid argument form is one in which every instance is a valid argument. 5. Every instance of a valid argument form is a valid argument. 6. Every instance of an invalid argument form is an invalid argument. 7. An argument might fit, or instantiate, more than one form. 8. An argument form is all content and no form. 9. An argument form is built up out of sentence letters and logical operators. Answers 1. T 2. T 3. F 4. T 5. T 6. F 7. T 8. F 9. T Identify the form of each of the following arguments. Answers: 1. Modus ponens 2. Modus tollens 3. Disjunctive syllogism 4. Hypothetical syllogism 5. Constructive dilemma Chapter 12 Truth-Functional Logic Symbolizing Sentences True or False? 1. The tilde symbolizes negation. 2. The wedge symbolizes disjunction. 3. The horseshoe symbolizes the conditional. 4. The triple bar symbolizes the biconditional. Answers 1. T 2. T 3. T 4. T Symbolize the following sentences. 1. If Ann and Bob go, then Carl goes. Answer: (A & B) ⊃ C 2. Either Ann goes or Bob does not go. Answer: A v ~B 3. Ann will go only if Bob goes. Answer: A ⊃ B 4. Ann will go if Bob goes. Answer: B ⊃ A 5. Neither Ann nor Bob will go. Answer: ~(A v B) or ~A & ~B 6. Not both Ann and Bob will go. Answer: ~(A & B) Chapter 13 Truth-Functional Logic Symbolizing Arguments Assuming obvious abbreviations, which of the following is an accurate translation of "If Ann goes and Bob goes, then Carl goes"? Answer: (A & B) ⊃ C Assuming obvious abbreviations, which of the following is an accurate translation of "Either Ann or Bob goes, but not both"? Answer: (A v B) & ~(A & B) Chapter 14 Truth-Tables True or False? 1. A truth-table displays the truth value of a formula under every possible assignment of truth values to its sentence letters. 2. A formula with two sentence letters has four rows in its truth-table. 3. A formula with three sentence letters has eight rows in its truth-table. Answers 1. T 2. T 3. T Chapter 15 Truth-Table Analysis 1 Testing Sentences for Logical Status True or False? 1. A tautology is true on every row of its truth-table. 2. A contradiction is false on every row of its truth-table. 3. A contingent formula has at least one T and at least one F in its final column. Answers 1. T 2. T 3. T Results 1. Tautology 2. Contradiction 3. Contingent Chapter 16 Truth-Table Analysis 2 Testing Pairs of Sentences Results 1. Equivalent 2. Not equivalent 3. Consistent 4. Inconsistent Chapter 17 Truth-Table Analysis 3 Testing Arguments for Validity Results 1. Valid. No row of the table shows all true premises and a false conclusion. 2. Invalid. At least one row of the table shows all true premises and a false conclusion. 3. Valid 4. Invalid 308 5. Valid Chapter 17 Truth-Table Analysis 4 Indirect Truth-Tables Use the indirect method to determine whether the following arguments are valid or invalid. Answers 1. Valid 2. Invalid 3. Valid 4. Valid Chapter 18 Truth-Functional Deduction Part 1 First Four Rules True or False? 1. Using HS one may validly derive A ⊃ B from A ⊃ E and E ⊃ B. 2. Using HS one may validly derive A ⊃ (B ⊃ C) from A ⊃ B and B ⊃ C. 3. Using MP one may validly derive B from A ⊃ B and A. Answers 1. T 2. F 3. T Chapter 19 Truth-Functional Deduction Part 2 Four More Inference Rules Using the first eight rules, construct proofs for the following arguments. Answers 1. T 2. T 3. T 4. F 5. T For each of the following, identify the rule of

inference underlying the reasoning. 1. Ann is a bank president. Ed is a lawyer. So, Ann is a bank president, and Ed is a lawyer. 318 2. If it is necessary that all uncles are males, then it is possible that all uncles are males. It is necessary that all uncles are males. So, it is possible that all uncles are males. Answers 1. Conjunction 2. Modus ponens More Proofs 1. (A J) & X 2. F v (J F) 3. ~F / ~A v Z Answer: 4. J F DS 2, 3 5. A J Simp 1 6. A F HS 4, 5 7. ~A MT 3, 6 8. ~A v Z Add 7 1. (J I) & (R S) 2. J v R 3. (I R) & (S A) 4. (R v A) E / E Answer: 5. J I Simp 1 6. R S Simp 1 7. I v S CD 2, 5, 6 319 8. I R Simp 3 9. S A Simp 3 10. R v A CD 7, 8, 9 11. E MP 4, 10 1. (J I) & (~ J S) 2. I B 3. [(J I) & (I B)] [(J & B) v (~ J & ~ B)] 4. (J & B) A 5. (~ J & ~ B) H / A v H Answer: 6. J I Simp 1 7. (J I) & (I B) Conj 2, 6 8. (J & B) v (~J & ~B) MP 3, 7 9. Av H CD 4, 5, 8 1. A B 2. ~ B & I 3. ~ S v ~ G 4. (~ A & ~ B) [(~ S A) & (~ G X)] / X Answer: 5. ~B Simp 2 6. ~A MT 1, 5 7. ~A & ~B Conj 5, 6 8. (~S ⊃ A) & (~G ⊃ X) MP 4, 7 320 9. ~S ⊃ A Simp 8 10. ~G ⊃ X Simp 8 11. A v X CD 3, 9, 10 12. X DS 6, 11 1. I v J 2. ~ I 3. (~ I v F) (J M) 4. (M v H) (S I) / ~ S Answer: 5. J DS 1, 2 6. ~I v F Add 2 7. J ⊃ M MP 3, 6 8. M MP 5, 7 9. M v H Add 8 10. S ⊃ I MP 4, 9 11. ~S MT 10, 2 1. (A v B) [(E G) & (J I)] 2. (A v E) (E v J) 3. A & B / G v I Answer: 4. A Simp 3 5. A v B Add 4 6. (E ⊃ G) & (J ⊃ I) 321 MP 1, 5 7. A v E Add 4 8. E v J MP 2, 7 9. E ⊃ G Simp 6 10. J ⊃ I Simp 6 11. G v I CD 9, 10, 8 1. ~ A & B 2. ~ A & (~ J v I) ⊃ (J S) & (~ I ~ H) 4. (S A) & (~ H ~ Z) / ~ Z Answer: 5. ~A Simp 1 6. J v ~I Simp 1 7. J S Simp 3 8. ~I ~H Simp 3 9. S v ~H CD 6, 7, 8 10. S A Simp 4 11. H ⊃ ~Z Simp 4 12. A v ~Z CD 9, 10, 11 13. ~Z DS 2, 12 322 Chapter 20 Truth-Functional Deduction Part 3 Replacement Rules Use the inference rules and the first five replacement rules to prove the following arguments valid. (1) 1. Y & (A v G) 2. (Y & A) S 3. (Y & G) K / S v K Answer: 4. (Y & A) v (Y & G) Dist 1 5. S v K CD 2, 3, 4 Use any of the replacement and inference rules to prove the following. (1) 1. 2. 3. W v ~S ~W v G (S G) Z / Z Answer: 4. ~W ~S 5. W G 6. ~G ~W 7. ~G ~S 8. S G 9. Z (2) Imp 1 Imp 2 Trans 5 HS 4, 6 Trans 7 MP 3, 8 1. A I 2. (~ I ~ A) W 3. M ~ W / ~ M Answer: 4. ~I ~A 5. W 6. ~~W 323 Trans 1 MP 2, 4 DN 5 7. ~M MT 3, 6 Prove this valid: 1. (A v B) ~ (H v E) 2. A v (B & H) 3. (A & ~ E) (P & Q) / Q v X Answer: 4. (A v B) & (A v H) Dist 2 5. A v B Simp 4 6. ~(H v E) MP 1, 5 7. ~H & ~E DM 6 8. A v H Simp 4 9. ~H Simp 7 10. A DS 8, 9 11. ~E Simp 7 12. A & ~E Conj 10, 11 13. P & Q MP 3, 12 14. Q Simp 13 15. Q v X Add 14 Translate and prove valid: Annette will make the scene at the beach if and only if Frankie hangs ten in the big surfing competition. Therefore, either Annette will not make the scene, or Frankie will hang ten. Answer 1. A F / ~A v F 2. (A F) & (F A) 324 Equiv 1 3. A F 4. ~A v F Simp 2 Imp 3 Translate and prove valid: If Euathlus wins his case in court, then he does not have to pay Protagoras. If Euathlus does not win his case in court, then he does not have to pay Protagoras. Therefore, he does not have to pay Protagoras. Answer 1. E ~P 2. ~E ~P / ~P 3. P ~E Trans 1 4. P ~P HS 2, 3 5. ~P v ~P Imp 4 6. ~P Taut 5 Prove valid using replacement rules plus inference rules. 1. R v S 2. ~ (A & R) 3. ~ (A & S) / ~ A Answer: 4. ~A v ~R DM 2 5. ~A v ~S DM 3 6. (~A v ~R) & (~A v ~S) Conj 4, 5 7. ~A v (~R & ~S) Dist 6 8. ~(~R & ~S) DM 1 9. ~A DS 7, 8 1. (A v B) ~ E 325 2. (H & A) v (B & E) / A Answer: 3. [(H & A) v B] & [(H & A) v E] Dist 2 4. (H & A) v B Simp 3 5. B v (H & A) Comm 4 6. (B v H) & (B v A) Dist 5 7. B v A Simp 6 8. A v B Comm 7 9. ~E MP 1, 8 10. (H & A) v E Simp 3 11. H & A DS 9, 10 12. A Simp 11 1. ~ (A v B) 2. (~ B v C) (E & G) 3. S ~ G / ~ S v X Answer: 4. ~A & ~B DM 1 5. ~B Simp 4 6. ~B v C Add 5 7. E & G MP 2, 6 8. G Simp 7 9. ~S MT 3, 8 10. ~S v X Add 9 326 1. A (B v C) 2. ~ A (B & E) 3. ~ (C v ~ E) / ~ A Answer: 4. ~C & ~~E DM 2 5. ~C & E DM 3 6. ~C Simp 5 7. E Simp 5 8. ~B DS 4, 7 9. ~B & ~C Conj 6, 8 10. ~(B v C) DM 9 11.~A MT 1, 10 1. Q v R 2. [(P v Q) v R] ~ S 3. H S / ~ H Answer: 4. (Q v R) v P Add 1 5. P v (Q v R) Comm 4 6. (P v Q) v R Assoc 5 7. ~S MP 2, 6 8. ~H MT 3, 7 1. ~(A & B) 2. S B 3. S v ~J 327 4. J /~A Answer: 5. ~A v ~B 6. ~J v S 7. ~ ~J 8. S 9. B 10. ~B v ~A 11. ~ ~B 12. ~ A DM 1 Comm 3 DN4 DS 3, 7 MP 2, 8 Comm 5 DN 9 DS 10, 11 1. ~(A v B) 2. B v ~E 3. J E / ~J Answer: 4. ~A & ~B 5. ~B 6. ~E 7. ~J DM 1 Simp 4 DS 2, 5 MT 3, 6 1. A v (B v D) 2. ~D (v C) 3. ~(A v B) v S /S Answer: 4. ~D & ~C 5. (A v B) V D 6. D v (A v B) 7. ~D 8. A v B 9. ~ ~(A v B) 10. S 1. J v (B & D) 328 DM 2 Assoc 1 Comm 5 Simp 4 DS 6, 7 DN 8 DS 3, 9 2. (A v D) ~ C 3. J V C / J Answer: 4. (J v B) & (J v D) 5. A v D 6. ~C 7. C v J 8. J Dist 1 Simp 4 MP 2, 5 Comm 3 DS 6, 7 1. A & (B V S) 2. J ~(A & S) 3. ~J ~K 4. K V G 5. ~ (A & B) / G Answer: 6. (A & B) V (A & S) 7. A & S 8. ~ ~(A & S) 9. ~J 10. ~K 11. G DS 4, 10 DIST 1 DS 6, 5 DN 7 MT 2, 8 MP 3, 9 1. A v ~ I 2. ~ A v G / I G Answer: 3. ~I v A Comm 1 4. I ⊃ A Imp 3 5. A ⊃ G Imp 2 6. I ⊃ G HS 4, 5 329 1. ~ A ⊃ S 2. ~ E ⊃ S 3. ~ (A & E) / S v H Answer: 4. ~A v ~E DM 3 5. S v S CD 1, 2, 4 6. S Taut 5 7. S v H Add 6 1. J v (I & S) 2. J ⊃ S / S Answer: 3. (J v I) & (J v S) Dist 1 4. J v S Simp 3 5. ~J ⊃ S Imp 4 6. ~S ⊃ J Trans 5 7. ~S ⊃ S HS 2, 6 8. S v S Imp 7 9. S Taut 8 1. A ⊃ B / A ⊃)B v E) Answer: 2. ~A v B Imp 1 3. (~A v B) v E Add 2 330 4. ~A v (B v E) Assoc 3 5. A ⊃)B v E) Imp 4 1. A ⊃ ~)B ⊃ G) 2. A v G / A ~ G Answer: 3. ~A v ~(B ⊃ G) Imp 1 4. ~A v ~(~B v G) Imp 3 5. ~A v (B & ~G) DM 4 6. (~A v B) & (~A v ~G) Dist 5 7. ~A v ~G Simp 6 8. A ⊃ ~G Imp 7 9. G A Comm 2 10. ~G ⊃ A Imp 9 11. (A ⊃ ~G) & (~G ⊃ A) Conj 8, 10 12. A ~G Equiv 11 1. (A v B) G 2. (I G) S 3. B / S Answer: 4. B v A Add 3 5. A v B Comm 4 6. G MP 1, 5 7. G v ~I Add 6 331 8. ~I v G Comm 7 9. I ⊃ G Imp 8 10. S MP 2, 9 1. A B 2. A v B 3. A ⊃)B ⊃ E) / E Answer: 4. (A ⊃ B) & (B ⊃ A) Equiv 1 5. ~A ⊃ B Imp 2 6. B ⊃ A Simp 4 7. ~A ⊃ A HS 5, 6 8. A v A Imp 7 9. A Taut 8 10. B ⊃ E MP 9, 3 11. ~B ⊃ A Trans 5 12. A ⊃ B Simp 4 13. ~B ⊃ B HS 11, 12 14. B v B Imp 13 15. B Taut 14 16. E MP 10, 15 1. ~A ~B 2. (~B v A) S 332 /S Answer: 3. B A 4. ~B v A 5. S Trans 1 Imp 3 MP 2, 4 1. (A & B) E 2. A / B E Answer: 3. A (B E) 4. B E Exp 1 MP 2, 3 1. A E 2. E. B / ~B ~A Answer: 3. (A E) & (E A) 4. (E B) & (B E) 5. A E 6. E B 7. A B 8. ~ B ~A Equiv 1 Equiv 2 Simp 3 Simp 4 HS 5, 6 Trans 7 1. ~A v J 2. J E / ~E ~A Answer: 3. A J 4. A E 5. ~E ~A 333 Imp 1 HS 2, 3 Trans 4 Chapter 21 Truth-Functional Deduction Part 4 Indirect and Conditional Proof Prove using conditional proof: (1) 1. A (B C) 2. B & E 3. (C & E) X / A X Answer: 4. 5. 6. 7. 8. 9. 10. 11. A X (2) 1. A BC B C E C&E X CP 4-10 ACP MP 1, 4 Simp 2 MP 5, 6 Simp 2 Conj 7, 8 MP 3, 9 1. H v B 2. H ~E 3. K E 4. ~K A / ~H A Answer: 5. 6. 7. 8. 9. 10. ~H A 334 ~H B ~E ~K A ACP DS 1, 5 MP 2, 6 MT 3, 7 MP 4, 8 CP 5-9 (3) 1. (B v I) D 2. A B /A (D v T) Answer: 3. 4. 5. 6. 7. 8. A (D v T) A B BvI D DvT CP 3-7 ACP MP 2, 3 Add 4 MP 1, 5 Add 6 (4) 1. ~ D v ~ ~ C 2. X ~ C 3. A (W & ~ ~ D) 4. ~ X M / A M Answer: 5. 6. 7. 8. 9. 10. 11. A M A W & ~~D ~~D ~~C ~X M CP 5-10 ACP MP 3, 5 Simp 6 DS 1, 7 MT 2, 8 MP 4, 9 (5) 1. H B 2. (H & B) C / H C Answer: 3. 4. 5. 6. 7. H C H B H&B C CP 3-6 Prove using indirect proof: (1) 335 1. G v H ACP MP 1, 3 Conj 3, 4 MP 2, 5 2. K R 3. H ~R 4. S v ~G 5. ~K G / S Answer: 6. 7. 8. 9. 10. 11. 12. 13. 14. S ~S ~G ~~K K R H ~R R & ~R IP 6-13 AIP DS 4, 6 MT 5, 7 DN 8 MP 2, 9 DS 1, 7 MP 3, 11 Conj 10, 12 ~ ~A ~A ~A & ~ ~A IP 3-5 AIP MT 1, 2 Conj 3, 4 (2) 1. A B 2. ~B / ~ A Answer: 3. 4. 5. 6. ~A (3) 1. A v ~ (B & C) 2. (B & C) v W 3. ~ (A v W) (~ A & ~ W) / A v W Answer: 4. 5. 6. 7. 336 ~(A v W) ~A & ~W ~A ~(B & C) AIP MP 3, 4 Simp 5 DS 1, 6 8. 9. 10. 11. A v W W ~W W & ~W IP 4-10 DS 2, 7 Simp 5 Conj 9, 8 ~A ~ ~B A A & ~A AIP DS 1, 3 DS 2, 4 Conj 3, 5 IP 3-6 (4) 1. A v ~B 2. ~B v A / A Answer: 3. 4. 5. 6. 7. A Construct a nested proof for the following argument: (1) 1. A (J M) 2. (M v H) K / A (J K) Answer: 3. A ACP 4. 5. 6. 7. 8. 9. J ⊃ K 10. A ⊃)J ⊃ K) J J⊃M M MvH K ACP MP 1, 3 MP 4, 5 Add 6 MP 2, 7 CP 4-8 CP 3-9 Chapter 22 Premise-Free Proofs Prove the following theorems: 337 To prove: (A B) [A (A & B)] Answer: 1. AB AP 2. A 3. B 4. A&B 5. A (A & B) 6. (A B) [A (A & B)] AP MP 1, 2 Conj 2, 3 CP 2-4 CP 1-5 To prove: [(A B) & (B C)] (A C) Answer: 1. (A B) & (B C) 2. AB 3. BC 4. AC 5. [(A B) & (B C)] (A C) AP Simp 1 Simp 1 HS 2, 3 CP 1-4 Unit 4: Predicate Logic Chapter 23 338 Predicate Logic Version 1.1 Frege Unites Categorical and Stoic Logic True or False? 1. The following sentence is singular: A dog is man's best friend. 2. The following sentence is singular: One man can be an army. 3. The following symbol belongs to the vocabulary of PL: . 4. The following symbol belongs to the vocabulary of PL: (x). 5. The following symbol belongs to PL: %. 6. The following is a well-formed formula of PL: A. 7. The subject clause of a sentence states what the sentence is about. 8. An open sentence can be symbolized with a variable and a predicate constant. Answers 1. F 2. F 3. T 4. T 5. F 6. T 7. T 8. T 339 True or False? 1. The letter a is a sentence constant in PL. 2. The syntax of a language includes the semantics of the language. 3. The language PL is resident within TL. 4. The expression Fa is an open sentence. Answers 1. F 2. F 3. F 4. F Multiple Choice 1. Which of the following would be an accurate PL translation of "Jumpin' Jack is happy"? a. (x) Jx b. JH c. Hj d. HJ e. JJIS 2. Which of the following would be an accurate translation of "Some people are exploited" (assuming a universal domain)? a. b. c. d. e. (∃x) Ex Px & Ex (∃x) (Px & Ex) Sx & Ex Some people are exploited. 3. Frege: a. Wrote a logic book with a really long and imposing title 340 b. Swam the English Channel c. Waged a one-man war against France d. Got into a wrestling match with Bertrand Russell (and won) Answers 1. c 2. c 3. a Provide PL translations for the following English sentences. Use the letters provided. 1. Fred is a chemist. (C) 2. Weasels and possums are disgusting pests. (W, P, D) 3. Only the athletic are strong. (A, S) 4. Any student who is tardy will be reprimanded. 5. If everything is temporary and perishable, then life is contingent. Answers 1. Fred is a chemist. (C) Answer: Cf 2. Weasels and possums are disgusting pests. (W, P, D) Answer: (x)[(Wx v Px) Dx] 3. Only the athletic are strong. (A, S) Answer: (x) (Sx Ax) 4. Any student who is tardy will be reprimanded. Answer: (x) [(Sx & Tx) Rx] 5. If everything is temporary and perishable, then life is contingent. Answer: (x) (Tx & Px) Cl 341 Chapter 24 Predicate Logic Version 1.2 It's All About Relationships True or False? 1. The following is a relational predicate: "knows." 2. The following is a relational predicate: "fears." 3. The following is a relational predicate: "is twenty-one years old." 4. The following is a monadic predicate: "is serene." 5. The following PL predicate constant is monadic: Hx. Answers 1. T 2. T 3. F 4. T 5. T Multiple Choice 342 1. Assuming obvious abbreviations, which of the following would be an accurate PL translation of "Jumpin' Jack is taller than Sammy": a. (x) (Jx ⊃ Sx) b. Tjs c. Jts d. Sjt e. JJTS 2. Assuming obvious abbreviations and the universal domain, which of the following would be an accurate PL translation of "Every dog is taller than any flea": a. (x) (Dx ⊃ Tx) b. (x) (y)(Dx & Fy)⊃ Txy) c. (x) (Dx ⊃ Txy) d. (x) (y) Txy e. (x) Txy 3. Assuming obvious abbreviations and the universal domain, the following would be an accurate PL translation of "Someone loves everyone": a. (∃x) (y) [(Px & Py) & Lxy] b. (∃x) (∃y)Lxy c. (∃x) (∃x) [(Px & Ex) ⊃ Lxy] d. (∃x) Lee 4. Assuming obvious abbreviations and that the domain is restricted to all people, the following would be an accurate PL translation of "Someone loves everyone": a. (∃x) (y) Lxy b. (∃x) (∃y)Lxy c. (∃x) (∃x) [(Px & Ex) ⊃ Lxy] d. (∃x) Lee Answers 1. b 2. b 3. a 4. a Provide PL translations for the following English sentences. 1. Lorraine does not consume any meat dishes. 343 2. All ostriches are larger than Elliott. 3. Arnold adores himself. (A) Answers 1. (x) (Mx ~Clx) 2. (x) (Ox Lxe) 3. Aaa Symbolize, using R. Let the domain be all persons. 1. There is someone who respects everyone. 2. Pat doesn't respect anybody. 3. Everybody respects everybody. Answers 1. (x) (y) (Rxy) 2. ~(x) (Rpx) 3. (x) (y) Rxy Chapter 25 Predicate Logic Version 1.3 344 To Be or Not to Be: The Logic of Identity True or False? 1. The following sentence belongs to PL: a=b. 2. Assuming obvious abbreviations, the following is an accurate PL translation of "Cassius Clay is not the same person as Muhammad Ali": ~(c=m). 3. The identity sign in PL represents quantitative identity. 4. "Bob Dylan is Robert Zimmerman" is an assertion of quantitative identity. 5. According to the text, there is hardly an iota of difference between the letter i and the Greek iota. Answers 1. T 2. T 3. T 4. T 5. T Chapter 26 345 Natural Deduction Proofs with Monadic Predicates For each of the following, provide a proof of validity. Use the truth-functional inference rules and the first four quantifier rules. (1) 1. 2. (x)(Gx & ~Ax) (x)(Gx Hx)/(x)(Hx & ~Ax) Answer: 3. Gv & ~Av EI 1 4. Gv Hv 5. Gv 6. Hv 7. ~Av 8. Hv & ~ Av 9. (x)(Hx & ~Ax) UI 2 Simp 3 MP 4, 5 Simp 3 Conj 6, 7 EG 8 (2) 1. 2. 3. 4. Answer: 5. Ra 6. ~~Ra 7. Pa 8. (x)(Fx) 9. Fu 10. Fu Gu 11. Gu 12. (x)(Gx) (3) Simp 2 DN 5 DS 1, 6 MP 3, 7 UI 8 UI 4 MP, 9, 10 UG 11 1. (x)[Hx (Bx v Cx)] 2. (x)(Hx & ~Cx) / (x)(Bx) Answer: 3. Hv & ~Cv 4. Hv 346 ~Ra v Pa Sa & Ra Pa (x)(Fx) (x)(Fx Gx)/(x)(Gx) EI 2 Simp 3 5. ~Cv 6. Hv (Bv v Cv) 7. Bv v Cv 8. Cv v Bv 9. Bv 10. (x)(Bx) Simp 3 UI 1 DS 5, 7 Comm 7 DS 5, 8 EG 8 For each of the following, provide a proof of validity. Use the truth-functional rules, the first four quantifier rules, and the quantifier exchange rule. 1. (x)(Wx) (x)(Dx) 2. (x)(~Dx) /(x)(~Wx) Answer: 3. ~(∃x)(Dx) QE 2 4. ~(x)(Wx) MT 1, 3 5. (∃x)(~Wx) QE 4 1. (x)(Ix) v (x)(Px Cx) 2. (x)(~Ix) /Pa Ca Answer: 3. ~(x)(Ix) 4. (x)(Px Cx) 5. Pa Ca 1. 2. ~(x)(Px) (y)(Ry Qy) ~(x)(Px v Qx)/~(x)(Rx) Answer: 3. (x) ~(Px v Qx) 4. ~(Pv v Qv) 5. ~Pv & ~Qv 6. ~Pv 7. (x) ~(Px) 8. ~(x) Px 9. (y) (Ry Qy) 10. Ra Qa 11. ~Qa 12. ~Ra 13. (x) (~Rx) 347 QE 2 DS 1, 3 UI 4 QE 2 EI 3 DM 4 Simp 5 EG 6 QE 7 MP 1, 8 UI 9 Simp 5 MT 10, 11 EG 12 14. ~(x) (Rx) QE 13 Chapter 27 A Semantical Theory for Predicate Logic Specify an interpretation showing that each QL argument below is formally invalid. 1. (x) (Ax Bx) (x) Ax / (x) Bx Answer: Domain: animals Ax: x is a cat Bx: x is a mammal Each of the following arguments is invalid. For each argument, supply a refutation by logical analogy. 1. All aardvarks are mammals. Some mammals are old. Therefore, some aardvarks are old. Answer: All cats are mammals. Some mammals are bats. So, some cats are bats. 2. All widgets are round. No widgets are green. So, no round things are green. Answer: All cats are mammals. No cats are rats. So, no mammals are rats. 3. All human beings have free will. All beings that have free will are rational beings. So, all rational beings are human beings. Answer: All dogs are mammals. All mammals have hearts. So, all beings with hearts are dogs. Construct truth-functional expansions showing that the following QL arguments are invalid. 1. (x) Hx / (x) (Hx & Gx) Answer Ha & Hb (Ha & Ga) v (Hb & Gb) Ha: T Ga: F Hb: T Gb: F 2. (x) (Ax Bx) (x) Ax / (x) Bx 348 Answer (Aa Ba) & (Ab Bb) Aa v Ab Ba & Bb Aa: T Ba: T Ab: F Bb: F 3. (x) (Ax v Bx) / (x) Ax v (x) Bx Answer (Aa v Ba) & (Ab v Bb) (Aa & Ab) v (Ba & Bb) Aa: T Ba: F Ab: F Bb: T Chapter 28 Conditional and Indirect Predicate Proofs Prove, using the conditional proof rule: (1) 1. (x)(Hx Qx) 2. (x)(Hx Rx)/(x)[Hx (Qx & Rx)] Answer: 3. Hu Qu 4. Hu Ru 5. Hu 6. Qu 7. Ru 8. Qu & Ru 9. Hu (Qu & Ru) 10. (x)[Hx (Qx & Rx)] UI 1 UI 2 AP MP 3, 5 MP 4, 5 Conj 6, 7 CP 5-8 UG 9 Prove, using the indirect proof rule: (2) 1. (x)[Kx (Bx & Sx)] / (x)(Kx Sx) 349 Answer: 2. ~(x) (Kx Sx) 3. (x) ~(Kx Sx) 4. ~(Ka Sa) 5. ~(~Ka v Sa) 6. ~~(~~Ka & ~Sa) 7. (Ka & ~Sa) 8. Ka 9. Ka (Ba & Sa) 10. Ba & Sa 11. Sa 12. ~Sa 13. Sa & ~Sa 14. (x) (Kx Sx) (3) 1. 2. Answer: 3. 4. 5. 6. 7. 8. 9. 10. 11. ~(x) ~Hx AIP QE, 2 EI 3 Imp 4 DM 5 DN 6 Simp 7 UI 1 MP 8, 9 Simp 10 Simp 7 Conj 11, 12 IP 2-12 ~(x)(~Sx) v (x)(Hx) (x)(Sx Hx)/~(x)(~Hx) (x) (~Hx) ~(x) (Hx) ~(x)(~Sx) (x) (Sx) Sv Sv Hv Hv (x) Hx AIP QE 3 DS 1, 4 QE 5 EI 6 UI 2 MP 7, 8 EG 9 IP 3-10 (4) Prove the following theorem: (x)(Hx) v (x)(~Hx) Answer: 1. ~[(x)(Hx) v (x)(~Hx)] 2. ~(x)(Hx) & ~(x)(~Hx)] 3. ~(x)(Hx) 4. ~(x)(~Hx) 5. (x)(Hx) 6. (x)(Hx) & ~(x)(Hx) 7. (x)(Hx) v (x)(~Hx) 350 AIP DM 1 Simp 2 Simp 2 QE 4 Conj 3, 5 IP 1-6 Chapter 29 Proofs with Overlapping Quantifiers Prove the following arguments valid. (1) 1. (x)(y)(Mxy) / (y)(x)(Mxy) Answer: 2. (y)(Mvy) 3. Mvu 4. (x)(Mxu) 5. (y)(x)(Mxy) EI 1 UI 2 EG 3 UG 4 (2) 1. (x) (y) (Hxy ⊃ Wxy) 2. (x) (y) (~ Wxy) / ~ (x) (y) (Hxy) Answer: 3. (y) (Hay ⊃ Way) EI 1 4. (y) (~ Way) UI 2 5. ~ Wab EI 4 6. Hab Wab UI 3 7. ~Hab MT 6, 7 8. (y)~Hay EG 7 9. (x)(∃y) ~Pxy EG 8 10. (x)~(y)Pxy QE 9 11. ~(x)(y)Pxy QE 10 Chapter 30 351 The Summit: Predicate Logic with Identity Multiple Choice 1. He is the author of Leibniz's Law: a. Leibniz b. Descartes c. Aquinas d. Aristotle Answer: a The following proofs require the identity rules (among others). (1) 1. B c Gc 2. Jd Ld 3. Bc & Jd 4. c = d / Gd & Lc Answer: 5. Bc 6. Gc 7. Gd 8. Jd 9. Ld 10. Lc 11. Gd & Lc (2) 1. a = e 2. e = s 3. s = j 4. ~Oj / ~Oa 352 Simp 3 MP 1, 5 LL 4, 6 Simp 3 MP 2, 8 LL 9, 4 Conj 7, 10 Answer: 5. ~Os LL 3, 4 6. ~Oe LL 2, 5 7. ~O a LL 1, 6 Unit 5: Informal and Inductive Logic Chapter 31 The Art of Definition True or False? 1. A definition is an explanation of the meaning of a word or words. 2. A stipulative definition is stated in order to give the commonly understood meaning of a term. 3. A stipulative definition is stated in order to give a new meaning to a term. 4. A word is vague if it has borderline cases. 5. This is an intensional definition: "Rock band" means a group like the Beatles, the Doors, the Animals, etc. 6. As it is commonly used, the following phrase is vague: "legally an adult." 7. As it is commonly used, the following word is vague: "old." Answers 1. T 2. F 353 3. T 4. T 5. F 6. F 7. T Using the rules for good intensional definitions, critique the following definitions. a. "Baseball player" means an athlete who plays a game that involves throwing a ball. Answer: too broad b. "Bird" means "warm-blooded animal with wings." (too broad, includes bats) Answer: too broad (includes bats, which are not birds) c. "Philosophy" means "the activity practiced by philosophers." Answer: circular Which type of definition? a. "Silicone" means "a polymer containing alternating silicon and oxygen atoms." Answer: theoretical b. "Theocracy" means "a system of government administered by priests or religious officials." Answer: lexical c. "Aurora" means "a radiant emission in the upper atmosphere appearing as luminous bands of light." Answer: theoretical d. "Insulin shock" means "a collapse caused by a decrease in blood sugar caused by the administration of too much insulin." 354 Answer: theoretical Chapter 32 The Informal Fallacies True or False? 1. A fallacy is an error in reasoning. 2. The appeal to the people fallacy attacks all people. 3. The fallacy of composition is committed only by artists. 4. The appeal to the people is also called the "appeal to the gallery." 5. The following is one of the fallacies identified in the text: Don't accept his conclusion; he associates with known gangsters. 6. The following is not one of the fallacies identified in the text: the fallacy of the forgotten ellipses. Answers 1. T 2. F 3. F 4. T 5. T 6. T Name the fallacy. 1. Joe: We need new laws to protect the disabled. They are being marginalized in our overly competitive society. Fred: I disagree. Everybody is disabled in one way or another. Are you going to make a set of laws protecting each person? That would be ridiculous. 355 Answer: red herring 2. Ed, you really should take Suzie to the prom; after all, she hasn't had a date in a year, and she's really lonely. Answer: appeal to pity 3. There's no sign saying "No Trespassing," so it must be OK to walk on this property. Answer: appeal to ignorance 4 Professor A is a good teacher, and professor B is a good teacher. They plan to team teach a course together next fall, so they will make a good teaching team. Answer: composition Chapter 33 The Varieties of Inductive Reasoning True or False? 1. In an analogical argument, all things equal, the more specific the conclusion, the weaker the argument. 2. In an inference to the best explanation, all things equal, the less simple the hypothesis, the stronger the argument. 3. In an analogical argument, the fewer qualities the items have in common, the stronger the argument. 4. In an enumerative induction, generally, the more cases enumerated, the stronger the argument. 5. In an enumerative induction, generally, the more heterogeneous the cases enumerated are, the stronger the argument. 6. The disconfirmation of a scientific hypothesis is inductive in nature. 7. One way to strengthen an enumerative induction is to list more cases. 356 8. A generalization from a sample is deductive in nature. Answers 1. T 2. F 3. F 4. T 5. T 6. T 7. T 8. F Read the following argument and the list of additional items following it. Would the addition of each item strengthen the argument (S), weaken the argument (W), or leave the strength of the argument unchanged (U)? Consider each addition separately from the rest. The Ace Widget Company needs a new delivery truck. The truck must be capable of hauling heavy crates of widgets, and it must be adequate for heavy city driving. The company next door, the Ajax Bakery, has a delivery truck for sale. The Ajax company's president says the truck worked extremely well for its purposes. The president of Ace concludes that the Ajax truck will make an excellent delivery truck. a. The Ajax company never hauled heavy loads. b. The Ajax company used its truck mainly on the open highway. c. The conclusion is changed to: The truck will make a good delivery truck. d. The conclusion is changed to: The truck will be OK, though not always perfect. e. The Ajax company plans to install a new widget-painting machine. f. The conclusion is changed to: The truck will make an absolutely perfect delivery truck. Answers 357 a. Weakens b. Weakens c. Strengthens d. Strengthens e. Unaffected f. Weakens One hundred college students from four colleges were surveyed, and 60% said they liked classical music. We conclude that approximately 60% of all college students like classical music. Does each of the following alterations strengthen or weaken the original argument? Does each leave the argument's strength unaffected? a. The colleges were all Catholic colleges. b. Actually, only ten students were surveyed. c. Actually, one thousand students were surveyed. d. All surveyed were Capricorns. e. All surveyed had grades of 3.8 or above. f. Ninety percent of those surveyed said they regularly read novels. g. Those surveyed were freshmen, sophomores, juniors, and seniors. h. Those surveyed were seniors only. i. Those surveyed were from large cities only. j. Those surveyed were from the South only. k. Those surveyed were from all regions of the country. l. All those surveyed said that they like Mars bars. m. We change the conclusion to: Exactly 60% like classical music. n. We change the conclusion to: At least 60% like classical music. 358 o. We change the conclusion to: The majority like classical music. p. Students were surveyed at three state universities, three private liberal arts colleges, three Ivy League colleges, and three religious colleges. q. The students were actually drawn from three music conservatories: the Ace school of music, the Ajax conservatory of piano, and the Smith school of music. Answers a. Weakens b. Weakens c. Strengthens d. Weakens e. Weakens f. Unaffected g. Strengthens h. Weakens i. Weakens j. Weakens k. Strengthens l. Unaffected m. Weakens n. Weakens o. Strengthens p. Strengthens q. Weakens 359 Chapter 34 Elementary Probability Theory True or False? 1. Pascal is one of the founders of probability theory. 2. If something is impossible, its probability is 0. 3. The probability of drawing a king from a shuffled poker deck is 4/52. 4. It is highly probable but not certain that the sun will rise tomorrow. Answers 1. T 2. T 3. T 4. T Use the rules of the probability calculus to answer these questions: Two bowls of marbles sit in front of you. The first bowl contains ten green marbles and five blue marbles. The second bowl contains six red marbles and eight orange marbles. 1. What is the probability that you reach into the first bowl and randomly pick a marble, and it is a green marble, and then, after placing it back into the bowl, you randomly pick a green marble again? 2. What is the probability that you reach into the first bowl and randomly pick a green marble, then, without placing it back into the bowl, you randomly pick a green marble again? 3. What is the probability that you randomly pick a marble from the first bowl, and it is blue, and then you randomly pick a marble from the second bowl, and it is red? Answers 1. 10/15 x 10/15 360 2. 10/15 x 9/14 3. 5/15 x 6/14 Unit 6: Modal Logic Chapter 35 Elementary Modal Logic True or False? 1. Assuming the ordinary meanings of the words, the following proposition is necessarily true: 1+1=2. 2. Assuming the ordinary meanings of the words, the following proposition is necessarily true: 1+1=12. 3. Assuming the normal meanings of the words, the following proposition is necessarily false: Someone is taller than himself. 4. Assuming the ordinary meanings of the words, the following proposition is contingent: The Earth is flat. 5. Assuming the normal meanings of the words, the following proposition is necessarily false: Someone is taller than all persons. 6. It is logically possible that two brothers are each older than the other. 7. It is logically possible that a planet exists and that no gravitational force exists on that planet. 8. It is logically possible that someone runs all the way around the world in one minute without stopping. 9. Saul Kripke is one of the giants of modern modal logic. Answers 361 1. T 2. F 3. T 4. T 5. T 6. F 7. T 8. T 9. T Symbolize the following in ML. 1. It is a contingent truth that a universe actually exists. (Let U abbreviate "A universe actually exists.") 2. Either it is necessary that the universe will expand forever, or it is necessary that the universe will not expand forever. (Let U abbreviate "The universe will expand forever.") 3. Every necessary true proposition is also possibly true. 4. Every possibly true proposition is also contingent. 5. Every necessary falsehood is non-contingent. Answers 1. U 2. U v ~U 3. □P ◊P (where P is any proposition) 4. ◊P ▼P (where P is any proposition) 362 5. □~P ~▼P (where P is any proposition) Symbolize each of the following and indicate in each case whether the sentence is true or false. 1. If A is necessarily true, then it's not possible that A is false. Answer: A ~ ~A True 2. If A is false, then A is not necessarily true. Answer: ~A ~ A True 3. If A is non-contingent, then A is either a necessary truth or a necessary falsehood. Answer: ~ A (A v ~A) True or False? Let A abbreviate "2+2=4": 1. ~ ~ A Answer: True Let B abbreviate "Dr. Frasier Crane is Seattle's most popular radio personality." True or false? 2. ~ B Answer: True 3. If a proposition is actually true, then it is necessarily true. Answer: False 4. If A is necessarily false and B is necessarily true, then A must imply B. Answer: True 5. If A and B are both necessarily true, then A and B must be equivalent. Answer: True 6. If A and B are both necessarily false, then they are inconsistent. 363 Answer: True For each proposition below, indicate its modality, i.e., whether it is contingent, necessarily true, or necessarily false. Next indicate for each pair of propositions whether the propositions are consistent or inconsistent with one another. 1. C: Pat has no siblings. D: Pat has two siblings. Answer: Contingent Contingent Inconsistent 2. K: At least one crow is black. L: Chris saw a white crow. Answer: Contingent Contingent Consistent S5 Proofs Supply proofs for the following arguments. You will need to use truth-functional inference rules plus one or more of the following modal rules: PI, MMP, MMT, PN. No replacement rules are needed. Do not use necessitation. (1) 1. B E 2. H & B / E v S Answer: 3. B 4. E 5. E v S Simp 2 MMP, 1, 3 Add 4 (2) 1. E R 2. S & (E & B) 3. RJ/J Answer: 4. E & B 5. E 364 Simp 2 Simp 4 6. E 7. R 8. J 9. J PI 5 PN 1, 6 MP 3, 7 PI 8 Construct proofs for the following arguments. You will need to use truth-functional inference and replacement rules. The necessitation rule is recommended on these problems. (1) 1. (~A J) 2. (~J v G) 3. [(A v G)S] 4. ~S v J / J Answer: 5. 6. 7. 8. 9. 10. 11. 12. 13. 14. 15. 16. S 17. ~~S 18. J (~A J) (~J v G) [(AvG) S] ~A J ~J v G (AvG) S JG ~A G ~~A v G AvG S Reit 1 Reit 2 Reit 3 BR 5 BR 6 BR 7 Imp 9 HS 8, 11 Imp 12 DN 13 MP 10, 14 Nec 5-15 DN 16 DS 4, 17 Indirect proof is recommended on this one. 1. (RS) 2. R / S Answer: 3. 4. 5. 6. 7. 8. 9. 10. 365 ~S ~S ~R AIP DE 3 ~S (RS) ~S RS ~R Nec 5-9 Reit 4 Reit 1 BR 5 BR 6 MT 7, 8 11. 12. 13. S ~ R R & ~R IP 3-12 DE 10 Conj 2, 11 Introduction to Logic Definitions and Rules Used in the Book The reminders and rules collected here cover Units One through Six. Consider creating flash cards for your favorite rules and reminders. There are free online sites that allow you to make nice flash cards, such as this one, recommended by a student: 366 Unit One Basic Concepts of Logic Chapters 1-6 Definitions Logic is the systematic study of the standards of correct reasoning. An argument is one or more statements, called premises, offered in support of the truth of a further statement, called the conclusion. A declarative sentence is one that is either true or false. A deductive argument is an argument that aims to show that the conclusion must be true. An inductive argument is an argument that aims to show that the conclusion is probably true but not certainly true. A deductive argument that succeeds in its aim is a valid argument. Thus, a valid deductive argument has this property: If its premises are all true, then its conclusion must be true. An inductive argument that succeeds in its aim is a strong argument. Thus, a strong inductive argument has this property: If its premises are all true, then its conclusion is probably true though not certain. 367 A sound deductive argument is one that is (a) valid and (b) that has all true premises. A cogent inductive argument is one that is (a) strong and (b) has all true premises. Two or more statements are consistent if it is possible they are all true. Two or more statements are inconsistent if it is not possible they are all true. One statement P implies a second statement Q if it is not possible that P is true and Q is false. Two statements are equivalent if they imply each other. In other words, two statements are equivalent if it is not possible that one is true and the other is false. A statement is contingent if there are circumstances in which it would be true and there are circumstances in which it would be false. A statement is necessarily true if it is true and it is not possible it is false. A statement is necessarily false if it is false and it is not possible it is true. Unit Two Categorical Logic Chapters 7-9 Sentence Forms A: Universal Affirmative All S are P Example: All cats are No S are P Example: No cats are Some S are P Example: Some cats are mammals. E: Universal Negative reptiles. I: pets. 368 Particular Affirmative O: Particular Negative. Some S are not P Example: Some cats are not pets. Conversion, Obversion, Contraposition To Produce the Converse of a Categorical Statement: Switch the subject and predicate terms. To Produce the Obverse: 1. Change the quality (without changing the quantity) from affirmative to negative or negative to affirmative. 2. Replace the predicate term with its term complement. To Produce the Contrapositive: 1. Switch the subject and predicate. 2. Replace each term with its term complement. Rules of Validity for Categorical Syllogisms A categorical syllogism is valid if, and only if, all the following conditions are met: 5. 6. 7. 8. The middle term is distributed in at least one premise. If either term is distributed in the conclusion, it is also distributed in a premise. The syllogism does not contain two negative premises. If one premise is negative, then the conclusion is negative; if the conclusion is negative, then one premise is negative. Venn Diagram Test for Validity 1. Abbreviate the argument, replacing (consistently) each term with a single capital letter and retaining the quantifier and copula of each statement. (Example: "Some gems are not green rubies": Some G are not R.) By convention we place the conclusion last. 369 2. Draw three overlapping circles, one for each term, to form seven distinct regions. 3. Label the circles using the three capital letters chosen (use the predicate term of the conclusion for the lower right circle, the subject term of the conclusion for the lower left circle, and the middle term for the middle circle). 4. Enter the information for both premises and stop. If the argument contains a universal premise, enter its information first. If the argument contains two universal premises or two particular premises, either premise can be entered first. This step requires a decision: Are you taking the Aristotelian standpoint, or the Boolean? It is up to you. However: a. When placing an X in an area, if one part of the area has been shaded, place the X in an unshaded part. b. When placing an X in an area, if a circle's line runs through the area, place the X directly on the line separating the area into two regions. In other words, the X must "straddle" the line, hanging over both sides equally. An X straddling a line means that, for all we know, the individual represented by the X might be on either side of the line, or on both sides; in other words, it is not known which side of the line the X is actually on. c. Look at the two circles standing for the subject terms of your premises. If these terms refer to existing things, then if there is only one region unshaded in either or both circles, place an X in that unshaded region (thereby presenting the existential viewpoint). If these terms refer to things that do not exist or that the arguer does not wish to assume exists, then you are finished (thereby presenting the hypothetical viewpoint) and can go to the next step. 5. Use the following tests to determine if the argument is valid or invalid. A categorical syllogism is valid if, when the information from only the two premises has been entered into the diagram, visual inspection of the diagram 370 reveals that the information content of the conclusion is represented as well. In other words, by diagramming only the premises, we have also diagrammed the information found in the conclusion. A categorical syllogism is invalid if, when we have diagrammed the information content of the premises, information must be added to the diagram to represent the information content of the conclusion. Unit Three Truth-functional Logic Chapters 10-22 Rules for Truth-Functions (Chapter 10) 371 A conjunction (P and Q) is true only when both conjuncts are true; it is false in all other cases. A disjunction (P or Q) is false only when both disjuncts are false; it is true in all other cases. A negation (not-P) is false when the sentence negated is true and it is true when the sentence negated is false. A conditional (if P then Q) is false only when the antecedent is true and the consequent is false; it is true in all other cases. A biconditional (P if and only if Q) is false only when the left and the right sides have differing truth-values; it is true when both sides have the same truth-value. Five Valid Forms of Truth-functional Reasoning (Chapter 11) Modus Ponens If P then Q P Therefore Q Modus Tollens If P then Q Not-Q Therefore not-P Disjunctive Syllogism P or Q Not-P Therefore Q Not-Both Not both P and Q 372 But P Therefore not-Q Two Invalid Forms (Chapter 11) Affirming the Consequent If P then Q Q Therefore P Denying the Antecedent If P then Q Not-P Therefore not-Q Symbols (Chapter 12) Negation: Tilde ~ Disjunction: Wedge v Conjunction: Ampersand & Conditional: Horseshoe ⊃ Biconditional: Triple bar ≡ Rules of Grammar (Chapter 12) Where P and Q are variables ranging over sentences of TL: 373 Rule 1. Any sentence constant standing alone is a sentence of TL. Rule 2. If P is a sentence of TL, then ~P is a sentence of TL. Rule 3. If P and Q are sentences of TL, then (P v Q), (P & Q), (P ⊃ Q), and (P ≡ Q) are sentences of TL. Truth-tables (Chapter 14) Conjunction P Q P & T T T T F F F T F F F F Q Truth-Table for Conjunction Disjunction 374 P Q P v T T T T F T F T T F F F Q Truth-Table for Inclusive Disjunction Negation P ~ T F F T P Truth-Table for Negation The Conditional ("If, Then") Operator P Q P T T T T F F F T T F F T ⊃ Q Truth-Table for the Conditional Operator The "Biconditional" Truth-Function 375 P Q P T T T T F F F T F F F T ≡ Q F F T Truth-Table for the Biconditional Operator A Summary of the Truth-Functions A conjunction (P · Q) is only true when both conjuncts are true, otherwise it is false. A disjunction (P v Q) is only false when both disjuncts are false, otherwise it is true. A negation (~P) is always opposite in truth-value to the sentence negated. A conditional (P ⊃ Q) is only false when the antecedent (P) is true and the consequent (Q) is false, otherwise it is true. A biconditional (P ≡ Q) is only true when both sides match in truth-value. Truth-Table Tests (Chapters 14-17) 376 A formula is a truth-functional tautology if and only if the final column of its truthtable is all T's. A formula is a truth-functional contradiction if and only if the final column of its truth-table is all F's. A formula is truth-functionally contingent if and only if the final column of its truthtable contains at least one T and at least one F. An argument is truth-functionally valid if and only if its truth-table contains no row with all true premises and a false conclusion. An argument is truth-functionally invalid if and only if its truth-table contains at least one row with all true premises and a false conclusion. Two formulas are truth-functionally consistent if and only if the corresponding truth-table contains at least one row on which both are true. A formula P truth-functionally implies a formula Q if and only if there is no row on the respective truth table showing P true and Q false. Two formulas are truth-functionally equivalent if and only if the final columns on their respective truth-tables match. Truth-functional Inference Rules (Chapters 18-19) Disjunctive Syllogism (DS) PvQ ~P Q or P vQ ~Q P Modus Ponens (MP) PQ P 377 Q Modus Tollens (MT) P Q ~Q ~P Hypothetical Syllogism (HS) PQ QR PR or QR P Q P R Simplification (Simp) P & Q P or P & Q Q Conjunction (Conj) P Q P&Q Addition (Add) P PvQ Constructive Dilemma (CD) PQ RS PvR QvS Indirect Proof (IP) To prove P : Indent, assume ~ P, derive a contradiction, end the indentation, assert P. Conditional Proof (CP) 378 To prove a sentence of the form P Q: Indent, assume P, derive Q, end the indentation, and assert P Q. Truth-functional Replacement Rules (Chapter 20) Commutation (Comm) A formula P v Q may replace, or be replaced by, the corresponding formula Q v P. A formula P & Q may replace, or be replaced by, the corresponding formula Q & P. Association (Assoc) A formula (P v Q) v R may replace, or be replaced with, the corresponding formula P v (Q v R) . A formula (P & Q) & R may replace, or be replaced with, the corresponding formula P & (Q & R). Double Negation (DN) A formula ~ ~ P may replace, or be replaced with, the corresponding formula P. De Morgan's rule (DM) Anywhere in a proof, a formula ~ (P & Q) may replace, or be replaced with, the corresponding formula ~P v ~ Q. Anywhere in a proof, a formula ~(P v Q) may replace, or be replaced with, the corresponding formula ~ P & ~Q. Distribution (Dist) A formula P v (Q & R) may replace, or be replaced with, the corresponding formula (P v Q) & (P v R). A formula P & (Q v R) may replace, or be replaced with, the corresponding formula (P & Q) v (P & R). Transposition (Trans) 379 A formula P Q may replace, or be replaced with, the corresponding formula ~ Q ~ P. Implication (Imp) A formula P Q may replace, or be replaced with, the corresponding formula ~ P v Q. Exportation (Exp) A formula (P & Q) R may replace, or be replaced with, the corresponding formula P (Q R). Tautology (Taut) A formula P may replace, or be replaced with, the corresponding formula P v P. Equivalence (Equiv) A formula P Q may replace, or be replaced with, the corresponding formula (P Q) & (Q P). A formula P Q may replace, or be replaced with, the corresponding formula (P & Q) v (~ P & ~ Q). Unit Four Predicate Logic Chapters 23-30 Predicate Logic Inference Rules (Chapter 26) Universal Instantiation (UI) 380 From a universal quantification, you can infer any instantiation, provided that the instantiation was produced by uniformly replacing each occurrence of the variable that was bound by the quantifier with a constant. Existential Generalization (EG) From a sentence containing an individual constant, you may infer any corresponding existential generalization, provided that (a) the variable used in the generalization does not already occur in the sentence generalized upon, and (b) the generalization results by replacing at least one occurrence of the constant with the variable used in the generalization, with no other changes being made. Existential Instantiation (EI) From an existential quantification, you may instantiate using any constant, provided that (a) each occurrence of the variable bound by the quantifier in the existential quantification is uniformly replaced with a constant and no other changes are made, and (b) the constant used in place of the variable is completely new to the proof, meaning it does not appear anywhere else in the argument. Thus, the constant used does not appear in a premise, in a previous line, in the present line, or in the conclusion. Special Restriction for Relational Sentences. When applying EI to an existential quantification containing one or more relational predicates, do not use a constant if the constant already appears in the existential quantification. Universal Generalization (UG) From a sentence containing a constant, one may infer the corresponding universal generalization, provided that (a) the constant is uniformly replaced by a variable and no other changes are made, (b) the constant generalized upon does not appear in any premise of the argument, (c) the constant was not introduced into the proof by EI, (c) the variable you use in the generalization does not already appear in the sentence from which you are generalizing; and (d) the constant

does not appear in any assumed premise that has not already been discharged. Special Restriction for relational sentences. Do not apply UG to a constant when that constant appears in a relational sentence along with a constant that was introduced into the proof by EI. Quantifier Exchange (QE) 381 If P is a wff of PL containing either a universal or an existential quantifier, P may be replaced by, or may replace, a sentence that is exactly like P except that one quantifier has been switched for the other in accord with the following steps: 4. 5. 6. Switch one quantifier for the other. Negate each side of the quantifier. Cancel out any double negatives that result. Alternative System Rules Alternative Universal Instantiation Rule (“UI-A”) From a universal quantification, you may infer any instantiation, provided that the instantiation was produced by uniformly replacing each occurrence of the variable that was bound by the quantifier with a constant or a variable. Alternative Existential Generalization Rule (“EG-A”) From a sentence containing no quantifier and one or more constants or variables, you may infer any corresponding existential generalization, provided that (a) the variable used in the generalization does not already occur in the sentence generalized upon and (b) the generalization results by replacing at least one occurrence of the constant or variable with the variable used in the generalization, with no other changes being made. Alternative Universal Generalization Rule (“UG-A”) From a sentence containing no constants and no quantifiers, you may infer the corresponding universal generalization, provided that (a) the variable is uniformly replaced by a variable bound by a universal quantifier and (b) no other changes are made. Predicate Logic Identity Rules (Chapter 30) The Self-Identity Rule (SI) At any step in a proof, you may assert (x) (x = x). 382 The Indiscernibility of Identity Rule (Leibniz’s Law or LL) If c and d are two constants in a proof and a line of the proof asserts that the individual designated by c is identical with the individual designated by d, you may carry down and rewrite any available line of the proof replacing any or all occurrences of c with d or any or all occurrences of d with c. A line of a proof is “available” unless it is within the scope of a discharged assumption. Symmetry of Identity Rule (Sym) Given a formula c = d, you may infer the corresponding formula d = c where c and d are variables ranging over constants of PL. Unit Five Informal and Inductive Logic Chapters 31-34 Types of Definitions (Chapter 31) Analytical definition A definition that explains the meaning of a word by breaking the meaning down into its constituent concepts. Extensional (or denotative) definition A definition that assigns meaning to a word or phrase by giving examples of what the word or phrase denotes. Intensional (or connotative) definition A definition that assigns meaning by indicating the qualities or attributes a word or phrase connotes, that is, by listing the properties that an entity must have if the word or phrase is to apply to it. Lexical definition A definition that reports a word’s commonly understood meaning. Precising definition A definition that provides a more precise meaning for a word that formerly had a vague but established meaning. The more precise meaning provides additional guidance as to how the word is to be applied in various borderline cases. 383 Persuasive definition A definition that aims to influence attitudes. Stipulative definition A definition that constitutes a new meaning for a word or phrase. Theoretical definition A definition that characterizes the nature of something. Such a definition provides a theoretical picture of an entity, or a way of understanding the entity. Summary of Some of the Main Fallacies (Chapter 32) Fallacies of No Evidence Argument Against the Person (argumentum ad hominem) An argument that attacks a person’s character or circumstances in order to oppose or discredit the person’s viewpoint. Appeal to Force (argumentum ad baculum, literally “argument from the stick”) A fallacy committed when an arguer appeals to force or to the threat of force to make someone accept a conclusion. (Sometimes made when rational argument has failed.) Appeal to Pity (argumentum ad misericordiam) A fallacy committed when the arguer attempts to evoke pity from the audience and tries to use that pity to make the audience accept the conclusion. Appeal to the People (argumentum ad populum) A fallacy committed when an arguer attempts to arouse and use the emotions of a group or crowd to win acceptance for a conclusion. Snob Appeal A fallacy committed when the arguer claims that if you will adopt a particular conclusion, you will be a member of a special, elite group that is better than everyone else. Irrelevant Conclusion (ignoratio elenchi, meaning “ignorance of the proof”) A fallacy in which someone puts forward premises in support of a stated conclusion, but the premises actually support a different conclusion. Begging the Question (petitio principii, meaning “postulation of the beginning”) A fallacy committed when someone employs the conclusion in some form as a premise in support of that same conclusion. 384 Appeal to Ignorance (argumentum ad ignorantium) In this fallacy, someone argues that a proposition is true simply on the grounds that it has not been proven false (or that a proposition must be false because it has not been proven true). Red Herring A fallacy committed when the arguer tries to divert attention from his opponent ‘s argument by changing the subject and then drawing a conclusion about the new subject. Genetic A fallacy committed when someone attacks a view by disparaging the view ‘s origin or the manner in which the view was acquired. The origin of the view is attacked rather than the evidence for the view, and this is offered as a reason to reject the view. Poisoning the Well The use of emotionally charged language to discredit or bash an argument or position before arguing against it. Fallacies of Little Evidence Accident A fallacy committed when a general rule is applied to a specific case, but because of unforeseen and accidental features of the case, the general rule should not be applied to the case. The argument ignores the fact that the accidental features of the case make it an exception to the general rule. Straw Man A fallacy committed when an arguer (a) summarizes his opponent ‘s argument; (b) the summary is an exaggerated, ridiculous, or oversimplified representation of the opponent ‘s argument that makes the opposing argument appear illogical or weak; (c) the arguer refutes the weakened, summarized argument; and (d) the arguer concludes that the opponent ‘s actual argument has been refuted. Appeal to Questionable Authority (argumentum ad verecundiam) When someone attempts to support a claim by appealing to an authority that is untrustworthy, or when the authority is ignorant or unqualified, or is prejudiced, or has a motive to lie, or when the issue lies outside the authority ‘s field of competence. Hasty Generalization A fallacy committed when someone draws a generalization about a group on the basis of observing an unrepresentative sample of the group, that is, a sample that is either too small to be representative or that is unrepresentative because it is exceptional or unusual in some way. False Cause A fallacy involving faulty reasoning about causality. There are two important types of this fallacy. In a Post Hoc Ergo Propter Hoc fallacy (“after this, therefore, because of this”) someone concludes that A is the cause of B simply on the grounds that A preceded B in time. In a non causa pro causa fallacy (“not the cause for the cause”) someone claims that A is the cause of B, when in fact (1) A is not the cause of B, but (2) the mistake is not based merely on one thing coming after another thing. One version of this fallacy is the fallacy of accidental 385 correlation. In this fallacy, the arguer concludes that one thing is the cause of another thing from the mere fact that the two phenomena are correlated. Slippery Slope (or “domino argument”) In this fallacy, someone objects to a position P on the grounds that P will set off a chain reaction leading to trouble; but no reason is given for supposing the chain will actually occur. Metaphorically, if we adopt a certain position, we will start sliding down a slippery slope and we won ‘t be able to stop until we slide all the way to the bottom (where some horrible result lies in wait). Weak Analogy A fallacy committed when an analogical argument is presented but the analogy is too weak to support the conclusion. False Dilemma A fallacy committed when someone assumes there are only two alternatives, eliminates one of these two, and concludes in favor of the second, when more than the two stated alternatives exist, but have not been considered. Suppressed Evidence In this fallacy, evidence that would count heavily against the conclusion is left out of the argument or is covered up. Special Pleading In this fallacy, the arguer applies a principle to someone else ‘s case but makes a special exception to the principle in his own case. Fallacies of Language Equivocation In this fallacy, a particular word or phrase is used with one meaning in one place, that word or phrase is used with another meaning in another place, and what has been established on the basis of the one meaning is regarded as established with respect to the other meaning. As a result, the conclusion depends on a word (or phrase) being used in two different senses in the argument. The premises are true on one interpretation of the word, but the conclusion follows only from a different interpretation. Amphibolу A fallacy containing a statement that is ambiguous because of its grammatical construction. One interpretation makes the statement true, the other makes it false. If the ambiguous statement is interpreted one way, the premise is true but the conclusion is false; but if the ambiguous statement is interpreted the other way, the premise is false. The meaning must shift if the argument is going to go from a true premise to a true conclusion. If the meaning is not allowed to shift during the argument, either the argument has false a premise or it is invalid. Composition A fallacy in which someone uncritically assumes that what is true of a part of a whole is also true of the whole. Division A fallacy in which someone uncritically assumes that what is true of the whole must be true of the parts. 386 Types of Inductive Arguments (Chapter 33) Analogical argument An argument in which we (a) assert an analogy between two things or kinds of things, A and B; (b) point out that A has a particular feature and that B is not known not to have the feature; and (c) conclude that B probably also has the feature. Enumerative induction Argument in which premises about observed individuals or cases are used as a basis for a generalization about unobserved individuals or cases. Inference to the best explanation A type of argument that (a) cites one or more facts that need explanation, (b) canvasses possible explanations, (c) puts one explanation forward as the best explanation, and (d) concludes that that explanation is probably the correct (or true) explanation. Mill’s Methods (for Finding Causes) Method of agreement The method for determining a probable cause that comprises the following steps. (1) Draw up a list of possible causes. (2) Look for one causal factor common to all cases of the effect. (3) Select this as the probable cause or as part of the probable cause. Method of concomitant variation The method for determining a probable cause that is based on the following general principle: If changes in one phenomenon accompany or correspond to (are concomitant with) changes in a second phenomenon, and if the magnitude of the change in the one varies along with the magnitude of the change in the second, the two phenomena are probably 387 causally related—either one of the two probably causes the other, or some third factor is probably the cause of both. Method of difference The method for determining a probable cause that comprises the following steps. (1) Examine a case where an effect E occurs and a similar case where E does not occur. (2) Choose as the probable cause the one respect in which the case where the effect E occurs differs from the case where E is absent. Method of residues This method is based on the following general principle: If we know that (a) A, B, and C are causal conditions responsible for effects X, Y, and Z; and (b) A is found to be the cause of X; and (c) C is found to be the cause of Y, we can figure that B, the residual factor, is probably the cause of Z. Unit Six Modal Logic Chapter 35 Definitions Anything short of self-contradiction counts as logically possible, no matter how improbable, unlikely, or bizarre it is. A possible circumstance is any noncontradictory state of affairs. 388 A proposition expressed by a declarative sentence is a necessarily true proposition if it is true in all possible circumstances, false in none. A proposition expressed by a declarative sentence is a necessarily false proposition if it is false in all possible circumstances, true in none. A proposition that is neither necessarily true nor necessarily false is logically contingent. A proposition is possibly true if it is true in at least one possible circumstance, and it is possibly false if there is at least one possible circumstance in which it is false. A possible world is one way the world might be or might have been. Semantics A proposition P is necessarily true if and only if it is true in all possible worlds. A proposition P is necessarily false if and only if it is false in all possible worlds. A proposition P is possibly true if and only if it is true in at least one possible world. A proposition P is possibly false if and only if it is false in at least one possible world. A proposition P is contingent if and only if it is true in some possible worlds and it is false in some possible worlds. An argument is valid if and only if there are no possible worlds in which its premises would be true and at the same time its conclusion would be false. An argument is invalid if and only if there is at least one possible world in which its premises would be true and at the same time its conclusion would be false. P implies Q if and only if there are no possible worlds in which P is true and Q is false. P and Q are equivalent if and only if there are no possible worlds in which they differ in truth-value. 389 P and Q are consistent if and only if there is at least one possible world in which they are both true. P and Q are inconsistent if and only if there is not at least one possible world in which they are both true. Modal Principles MP 1: If P is tautological, then □ P MP 2: □ P → P MP3: [□ P & (P → Q)] → □ Q MP4: □ P→ □ □ P MP 5: ◊P □ ◊ P Rules of Inference Rule 1. From □P, infer P. Box Removal Rule (BR) Rule 2. From P, infer ◊ P. Possibility Intro Rule (PI) Rule 3. From P → Q and P, infer Q. Modal Modus Ponens (MMP) Rule 4. From P → Q and ~Q, infer ~P. (MMT) 390 Modal Modus Tollens Rule 5. From P → Q and Q → R, infer P→ R. Modal Hypothetical Syllogism (MHS) Rule 6: From ▼P, infer ◊ P & ◊ ~P. Contingency (C) Rule 7: You may trade □ for ◊ or ◊ for □ if you add a tilde to each side, canceling out any double negations that might result. Diamond Exchange(DE) Errata Introduction to Logic The following are all the substantive typos identified by faculty and students using my new text, Introduction to Logic. Two or three very small typos are not listed because they are obvious and would not lead anyone astray. Many thanks especially to Professors Catharine Roth and Andrew Jeffery, who have identified errors and forwarded them to me; and to students in my logic classes who have also founds typos and sent them to me. I appreciate your help. --Paul Chapter 7: Page 117: Line 10: Add “not” to “Some Ionians are Greeks”… The line now reads: “Some Ionians are not Greeks,” is true or false. Chapter 11: 391 Page 243: Top of page, right column. The numerals “3” and “2” need to trade places. Thus, the right column reads: 2. The 2nd 3. Therefore the 1st Chapter 12: Page 252: 8 lines up from bottom: At end of line, replace (A > B) with (E > G). (Note: I am using here the greater than sign (>) for horseshoe ( ) because horseshoe doesn’t always come through in some programs.) Line then looks like this: Start with E……..and wrap: (E > G) Chapter 13: Page 280: Middle of page, 13 lines up from bottom: Replace E with O. Line now looks like this: fuel tank contains gasoline” and if O abbreviates….. 10 lines up from bottom: replace G > R with G > O. Line now looks like this: G>O 4 lines up from bottom: Replace R > G with O > G. Line now looks like this: O>G Chapter 14: Page 295: Line 12: Change each bold T to bold F. Line now looks like this: true. (Keep in mind that we assigned F to A, we did not assign F to the ~A.) Chapter 16: Page 338: Ex 16.7 Problem 8: Change conclusion of problem 8 to: A . So problem 8 now looks like this: 392 8. ~(A v B) / A. Chapter 18: – Page 369: Four lines up from bottom: Remove this odd symbol: “>/” Chapter 20: Page 403: Eight lines up from bottom: Between “apply” and “DM” insert: “DN and”. The line should then read: Because line 5 instantiates…, we next apply DN and DM to it and…” Page 403: Six lines up from bottom, so two lines below the above, Replace “DM 5 ” with “DN, DM 5” Line now looks like this: 6. (E & F) DN, DM 5 Page 406: Problem 2, line 4 of problem 2: Change conclusion, on line 4 of problem, to: ~ ~ (F v S). The line now looks like this: 4. C > S / ~ ~(F v S) On line 10 of problem, remove ~(~F & ~S) and replace with ~~(F v S). Line now looks like this: 10. ~ ~ (F v S). Page 418: Five lines up from bottom: Problem 22, line 3: Remove 2nd tilde (~) : Line then looks like this: 3. ~T / P v ~Q Page 420: Two typos: Problem 36, line 1. Main connective should be > (horseshoe) rather than ampersand (&). Bottom section of page 420, Ex 20.5: This exercise has three proofs. But proof #2 is supposed to be two proofs, not one proof. So, in problem 2, lines 1 and 2 are one proof, which should be labeled 2; and then lines 3 and 4 are the second proof, which should be 393 labeled proof #3, and thus should be numbered 1, 2. Problem #3 should be changed to #4. So, Ex 20.5 thus contains four proofs, 1, 2, 3, 4, instead of 3 proofs, and should then look like this: 1. 1. P > (P > Q) 2. P / Q 2. 1. P > P 2. ~P > P / P 3. 1. P > Q 2. P > ~Q / ~P 4. 1. P & Q) > R 2. ~R 3. P / ~Q Chapter 21: Page 435, 10 lines down: On lines 3 through 7 of the problem, move just the letters (H, H v S, ~E & B, ~E, G) over to the right side of the vertical line. Page 437: 7 lines up from bottom, line 15 of proof: Move the letter A over to right side of line and extend line one line down to the A: Selected Answers (at back of text) Page E 26, Problem 36 answer: Line 1: The missing main connective should be horseshoe . Line then looks like this: 394 Line 2: The very first horseshoe should be a triple bar (). Line then looks like this: line 7: The missing connective in middle is horseshoe. Line then looks like this: 7. J > I line 10: The connective should be triple bar not horseshoe. Line then looks like this: 10. J I Page E-28: Four lines down from top, delete the first tilde (~). Line now reads: 5. 1. I v Z Next line: Add tilde (~) to I. Line now reads: 2. Z > A / ~I >. (Z & A) Next line: Delete one tilde. Line now reads: 3. ~I ACP Line 7, last line of same problem: Delete one tilde (~). Line now reads: 7. ~I > (Z & A) 395 CP 3-6

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