Solutions Manual

PREFACE

Here will be found a complete set of solutions to the exercises that appear at the end of sections and chapters in the Fourteenth Edition of *Introduction to Logic*. This (very sizable!) packet differs from the solutions manuals for earlier editions in the following important way: It is complete in the sense that it includes (as earlier manuals did not) the solutions that are also provided at the back of the book itself, in "Solutions to Selected Exercises."

The formal proofs of validity of deductive arguments provided here are (for many exercises) neither the only ones nor the shortest ones possible. For some proofs of invalidity not all truth value assignments that could serve the same purpose are included.

Many exercises cannot be said to have a single definitive solution. Where there are complications introduced by the possibility, or even the likelihood, of differing interpretations, we have given what seem to us to be the best answers. But our judgment will be disputable in some cases, and alternative analyses will often be plausible, sometimes perhaps superior. Ingenious students often surprise one with a variety of alternative answers for which some justifications can be supplied; it is surely proper to give credit for analyses and solutions that can be plausibly defended.

The responses to some exercises in Chapters 12 and 13, in addition to being subject to alternative interpretations, can be very lengthy, for which reason several models only are provided, in place of an extensive discursive response to each exercise.

It is nearly impossible, in work of this kind, to eliminate every flaw. We acknowledge with sincere thanks—and continue to welcome—improvements our readers may suggest. Especially valuable are corrections of errors, for which we are grateful. Readers are invited to send corrections and suggestions of every sort to: *ccohen@umich.edu*

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Chapter 1

Section 1.2 Identify premises and conclusions

Exercises on pages 9–11

1. Premise: A well-regulated militia is necessary for the security of a free state.

   Conclusion: The right of the people to keep and bear arms shall not be infringed.

2. Premises:

   (1) It's easier (than photocopying) to buy your friend a paperback copy of a book.

   (2) A paperback copy of the book is inexpensive.

   Conclusion: What stops many people from photocopying a book and giving it to a pal is not integrity but logistics.

3. Premise: Human intelligence is a gift from God.

   Conclusion: To apply human intelligence to understand the world is not an affront to God, but is pleasing to him.

4. Premise: Sir Edmund Hilary dedicated his life to helping build schools and hospitals for the Sherpas who helped him to climb Mount Everest.

   Conclusion: He is, for that reason, a hero.

5. Premises:

   (1) Standardized tests have a disparate racial impact, as illustrated by the difference in the average scores of different ethnic groups.

   (2) Ethnic differences arise on all kinds of tests, at all levels.

   Conclusion: If a racial gap is evidence of discrimination, then all tests discriminate.

6. Premise: Everybody thinks himself so abundantly provided with good sense that even those most difficult to please in all other matters do not commonly desire more of it than they already possess.

   Conclusion: Good sense is, of all things in the world, the most equally distributed.

7. Premise: Any words new to the United States are either stupid or foreign.

   Conclusion: There is no such thing as the American language; there's just bad English.

8. Premise: In New York State alone taxpayers spent more than $200 million in a failed death penalty experiment, with no one executed.

   Conclusion: The death penalty is too costly.

   Premise: [There has been] an epidemic of exonerations of death row inmates upon post-conviction investigation, including ten New York inmates freed in the last 18 months from long sentences being served for murders or rapes they did not commit.

   Conclusion: Capital punishment is unfair in its application, in addition to being too costly.

9. Premise: Houses are built to live in, not to look on.

   Conclusion: Use is to be preferred before [i.e., above] uniformity.

10. Premises:

    (1) A boycott, although not violent, can cause economic harm to many.

    (2) The greater the impact of a boycott, the more impressive is the statement it makes.

    (3) The economic consequences of a boycott are likely to be felt by innocent bystanders, who suffer loss of income because of it.

    Conclusion: The boycott weapon ought to be used sparingly.

11. Premises:

    (1) In the early part of the 20th century forced population shifts were not uncommon.

    (2) In that period multicultural empires crumbled and nationalism drove the formation of new, ethnically homogenous countries.

    Conclusion: Ethnic cleansing was viewed not so long ago as a legitimate tool of foreign policy.

12. Premises:

    (1) If a jury is sufficiently unhappy with the government's case or the government's conduct, it can simply refuse to convict.

    (2) This possibility puts powerful pressure on the state to behave properly.

    Conclusion: A jury is one of the most important protections of a democracy.

13. Premises:

    (1) Orangutans spend more than 95 percent of their time in the trees, which, along with vines and termites, provide more than 99 percent of their food.

    (2) Their only habitat is formed by the tropical rain forests of Borneo and Sumatra.

    Conclusion: Without forests, orangutans cannot survive.

14. Premise: If God is omniscient, he must already know how he is going to intervene to change the course of history using his omnipotence.

    Conclusion: God cannot change his mind about his intervention.

    Premise: God cannot change his mind about his intervention.

    Conclusion: If God is omniscient he is not omnipotent.

    Premise: If God is omniscient he is not omnipotent.

    Conclusion: Omniscient and omnipotence are mutually incompatible.

15. Premises:

    (1) Reason never comes to the aid of spiritual things.

    (2) More frequently than not, reason struggles against the divine Word, treating all that comes from God with contempt.

    Conclusion: Reason is the greatest enemy that faith has.

Section 1.4 Arguments and Explanations
Exercises on pages 20–24

1. This is essentially an explanation. *What* is being explained is the fact that humans have varying skin colors. The explanation is that different skin colors evolved as humans came to live at different distances from the Equator and hence needed different degrees of protection from the rays of the sun. One might interpret the passage as an argument whose conclusion is that skin color is not a permanent trait of all humans. Under this interpretation, all the propositions preceding the final sentence of the passage serve as premises.

2. This is an argument, whose conclusion is that the victories of American labor through the passage of ostensibly neutral laws regulating labor, were seriously adverse to the interests of blacks, and resulted in the now longstanding gap between black and white unemployment rates. One might interpret the passage simply as an explanation, in

which what is being explained is that gap, but this interpretation leaves aside the many ramifications of the argument.

3. This is an explanation. *What* is being explained is why sex feels good. The explanation is that those animals in which it does feel good have more offspring, and therefore more evolutionary success, than those animals in which sex does not so effectively motivate. If we did not know that sex feels good, this might be considered an argument to show that it does; but since the pleasure of sex is a fact not in serious question here, the passage is best viewed as an explanation of that reality.

4. This is an argument. Its premises are that (1) changes are real and (2) changes are only possible in time. The conclusion is that time must be something real.

5. This may be interpreted either as an explanation or as an argument. Viewed as an explanation, *what* is being explained is the fact, not doubted here, that the nursing shortage has turned into a crisis. The explanation of that fact is a combination of observations, including the fact that fewer young people are going into nursing, that many older nurses are on the verge of retirement, that nurses often report high rates of job dissatisfaction and plan to leave the profession, and that hospitals routinely cancel or delay surgical cases because of a lack of nursing staff. Viewed as an argument, all these factors are premises supporting the conclusion that the shortage of nurses has indeed turned into a crisis.

6. This is an argument. Dewey is calling attention to the fact that to show what caused an event is not sufficient to justify it or to condemn it, because justification or condemnation comes (in his view) only through the consequences of the event, not its origin.

7. This passage is mainly an argument, whose conclusion is that a king cannot be subject to his own laws. Its premises are: (1) it is impossible to bind oneself in any matter which is the subject of one's own free exercise of will, and (2) the laws are no more than the product of the king's free will. The passage also serves as an explanation of the words commonly used in completing edicts and ordinances of a king: "for such is our good pleasure." This reinforces the argument above, since the king plainly cannot be bound by that which is determined only by his own good pleasure.

8. This is a bit of Oscar Wilde's humor that can be interpreted in various ways—as a sardonic argument attacking Wagner's music, perhaps, or as a lighthearted explanation of Wilde's hidden pleasure in that music. Or perhaps there is nothing seriously intended in the passage at all!

9. Although this could be viewed as an argument, it was very probably intended by the author as an explanation of the increased likelihood of cheating, that explanation consisting of the enumeration of several aspects of contemporary American society.

10. This is an explanation. *What* is explained is the fact that Cupid has been traditionally painted as blind. The explanation is that love, which Cupid represents, does not look with the eyes and therefore does not see.

11. This may be viewed either as an explanation or as an argument. If one takes the reported suggestion (that it is greater sexual selection pressure on women that accounts for their quantity of body hair) as true or known to be highly probable, then this passage is a more detailed explanation of how this came to pass. If, on the other hand, one takes the conclusion (that the lesser amount of body hair on women is due to sexual selection pressure) as in genuine doubt, then this passage may be interpreted as an argument in support of that conclusion. Of the two interpretations, the former seems the more plausible.

12. This is an argument whose conclusion is that the threat of nuclear war is useless against Iranian president Mahmoud Ahmadinejad. The premises are: (1) Iran's leaders do not care about killing their people in great numbers. (2) Ahmadinejad is a religious fanatic. (3) To such a fanatic, dying while fighting the enemy is a quick pass to heaven. (4) The mutually assured destruction that worked so well as a deterrent during the Cold War would instead be an inducement to war.

13. This is an argument whose conclusion is that interesting life can exist only in three dimensions. The premises are that (1) blood flow and large numbers of neural connections cannot exist in fewer than three dimensions; and (2) stable planetary orbits are not possible in more than three dimensions. [The argument makes the unstated assumption that the conditions described are necessary conditions for interesting life.]

14. This is an argument; but the first sentence in the passage is background material and not strictly a premise, although it is needed by the reader to understand the argument that follows immediately. After the conclusion ("we need them") appears the traditional Q.E.D.—which is the abbreviation for "quod erat demonstradum," meaning "what was to be demonstrated."

15. This is an argument. Its conclusion is that the Treasury Department has violated Section 504 of the Rehabilitation Act. Its premises are: (1) The Department has failed to design and issue paper currency that is readily distinguishable to blind and visually impaired individuals; and (2) [implied] this failure subjects blind and visually impaired persons to discrimination under an activity by an Executive agency.

16. This is an argument, whose conclusion is that acting in ways that fulfill one's duty never guarantees the moral goodness of the actor. The premise is that the act may be done from a motive that is indifferent or bad, and that the act may therefore be morally indifferent or bad.

17. This is an argument. Its conclusion is that belief in God is not beyond reason. Its premises are: (1) Only the supreme mind of God could create immutable and eternal laws. (2) Human reason can grasp some immutable and eternal laws, such as the circle or the square or the laws of physics. (3) In having that capacity, human reason must possess an innate particle of the mind of God.

18. This is an explanation. What is explained is the author's unhesitating celebration of religious holidays, although he is an atheist. The explanation is that many such rituals did not originate with Christian practices or beliefs, and that they really celebrate universal human goods and relationships.

19. This is an argument. Its conclusion is that ethnic movements are "two-edged swords"—that is, they can serve good and evil ends. The premises are (1) the fact that such movements are often necessary to repair injured collective psyches, and (2) the fact that such movements often end in tragedy, especially when they turn political, as in Germany.

20. This is an argument. Its conclusion is that it is false to say that all who are happy are equally happy. Its premises are: (1) happiness consists in the multiplicity of agreeable consciousness, and (2) a peasant does not have the capacity for happiness that a philosopher does (presumably because a philosopher will have a greater multiplicity of agreeable consciousness), and so cannot be equally *happy*, although the peasant can be equally *satisfied*.

Chapter 2

Section 2.1
Exercises on pages 36–38

1. Premise: The Detroit Pistons are an all-around better team than the San Antonio Spurs.

   Conclusion: The Pistons did not lose [the NBA finals, in 2005] because of lack of ability.

   Premise: The Pistons will beat the Spurs two out of every three times; and the Spurs will win one out of every three times.

   Premise: The Pistons had won the 5th and 6th games of the series—two in a row—so if they had won the final game they would have won three out of three.

   Conclusion: The Pistons lost because of the law of averages.

2. Premise: Universities have commonly been offering strange literary theories and assorted oddities, in place of the writing courses that ought to have been offered. Students have been shortchanged.

   Conclusion: Vast numbers of students cannot express themselves well in writing.

3. Premise: People divided on ethnic lines tend not to adopt programs that will give mutual support.

   Conclusion (and premise of the following argument): Therefore nations that are racially diverse tend to have lower levels of social support than nations that are racially homogenous.

   Conclusion: A welfare state with a racially diverse population is in tension, and the more racially diverse a community is, the more difficult it is to maintain comprehensive welfare programs.

4. Premise: If freedom were a natural part of the human condition we could expect to find free societies spread throughout human history.

   Premise: We do not find that, but instead find every sort of tyrannical government, from time immemorial.

   Conclusion: It is simply false to say (as Orlando Patterson does) that freedom is a natural part of the human condition.

5. Premise: If future scientists find a way to signal back in time, their signals would already have reached us.

Premise: No such signals have ever reached us.

Conclusion: Future scientists never will find a way to signal back in time.

6. Premise: Japanese and European whale-hunting countries have no need to eat whales; they can choose their diets.

   Premise: Eskimos live in an environment so harsh that their survival obliges them to eat whales; they have no choice in dietary matters.

   Conclusion: Permitting primitive Eskimos to kill some whales for survival, while at the same time demanding that modern societies cease to hunt whales, is fair and reasonable, not hypocritical.

7. Premise: The number of atoms in all of space is so huge that we can never count them or count the forces that drive them in all places.

   Conclusion: There must be other worlds, in other places, with different kinds of men and animals.

8. Premise: Where marriages are prearranged, divorce rates are often very low.

   Premise: Where marriages are formed on the basis of romantic love, divorce rates are very high.

   Premise: You can come to love a person you married without love.

   Premise: You can fall out of love with a person you married for love (or the marriage can fail).

   Conclusion (unstated): We ought not suppose that romantic love is a necessary precondition of successful marriage.

9. Premise (unstated): Our tax system depends upon the willingness of persons to pay the taxes they owe.

   Premise: That willingness depends, in turn, upon the widespread belief that almost everyone, including competitors and neighbors, are also paying the taxes they owe.

   Conclusion: If the Internal Revenue Service (the IRS) cannot assure us that this fairness is reasonable for us to suppose, the entire system of voluntary tax payments is seriously (and perhaps irremediably) threatened.

10. Premise: People and government are obsessed with racism and talk about it endlessly.

    Premise: But we don't listen and we don't see, and therefore we remain in a state of denial, thinking ourselves absolved of all complicity in racism.

    Conclusion: Invariably we conclude that it is the other guy who is in the wrong.

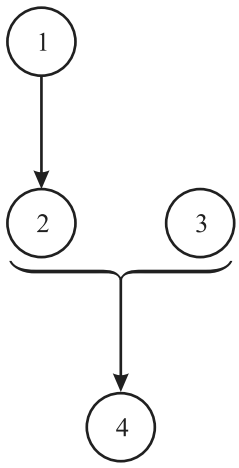
Section 2.2 – A
Exercises on pages 43–45

1. In a recent attack upon the evils of suburban sprawl, the authors argue as follows:

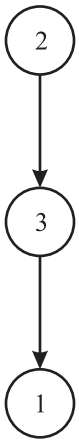
> The dominant characteristic of sprawl is that each component of a community—housing, shopping centers, office parks, and civic institutions—is segregated, physically separated from the others, causing the residents of suburbia to spend an inordinate amount of time and money moving from one place to the next. And since nearly everyone drives alone, even a sparsely populated area can generate the traffic of a much larger traditional town.

Solution

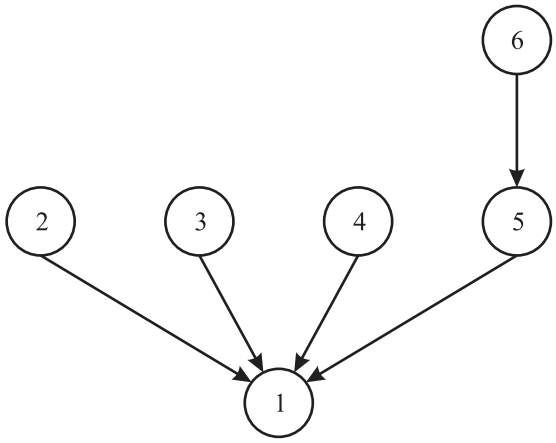
① The dominant characteristic of sprawl is that each component of a community—housing, shopping centers, office parks, and civic institutions—is segregated, physically separated from the others, causing ② the residents of suburbia to spend an ordinate amount of time and money moving from one place to the next. And since ③ nearly everyone drives alone, ④ even a sparsely populated area can generate the traffic of a much larger traditional town.



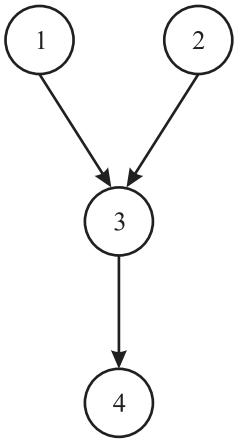
2. ① At any cost we must have filters on our Ypsilanti Township library computers. ② Pornography is a scourge on society at every level. ③ Our public library must not be used to channel this filth to the people of the area.



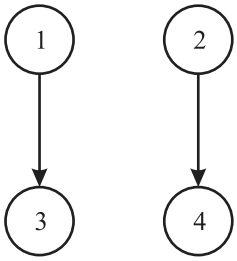
3. ① At his best, Lyndon Johnson was one of the greatest of all American presidents. ② He did more for racial justice than any president since Abraham Lincoln. ③ He built more social protections than anyone since Franklin Roosevelt. ④ He was probably the greatest legislative politician in American history. ⑤ He was also one of the most ambitious idealists. ⑥ Johnson sought power to use it to accomplish great things.



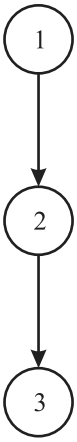
4. ① Married people are healthier and more economically stable than single people, and ② children of married people do better on a variety of indicators. ③ Marriage is thus a socially responsible act. ④ There ought to be some way of spreading the principle of support for marriage throughout the tax code.



5. ① Vacuum cleaners to ensure clean houses are praiseworthy and essential in our standard of living. ② Street cleaners to ensure clean streets are an unfortunate expense. Partly as a result ③ our houses are generally clean and ④ our streets generally filthy.

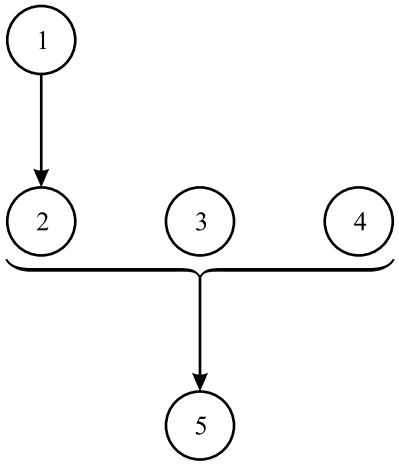


6. ① We are part of Europe. ② It affects us directly and deeply. Therefore ③ we should exercise leadership in order to change Europe in the direction we want.

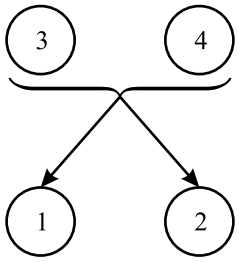


7. ① California's "three strikes and you're out" law was enacted 10 years ago this month (March 2004). ② Between 1994 and 2002, California's prison population grew by 34,724, ③ while that of New York, a state without a "three strikes" law, grew by 315. ④ Yet during

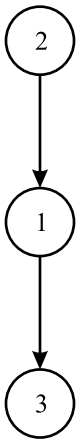
that time period New York's violent crime rate dropped 20 percent more than California's. ⑤ No better example exists of how the drop in crime cannot be attributed to draconian laws with catchy names.



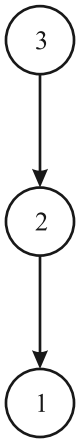
8. ① No one means all he says, and yet ② very few say all they mean, for ③ words are slippery and ④ thought is viscous.



9. ① The first impression becomes a self-fulfilling prophesy: ② we hear what we expect to hear. ③ The interview is hopelessly biased in favor of the nice.



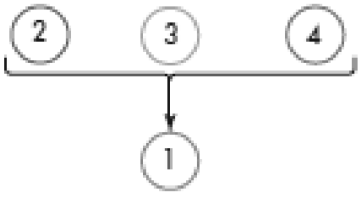
10. ① No government can ever guarantee that the small investor has an equal chance of winning. ② It is beyond dishonest to pretend that rules can be written to prevent future financial scandals. ③ No set of regulations can ensure fairness and transparency in the [securities] markets.



Section 2.2 – B
Exercises on pages 45–48

Solution

1. ① An outstanding advantage of nuclear over fossil fuel energy is how easy it is to deal with the waste it produces. ② Burning fossil fuels produces 27,000 million tons of carbon dioxide yearly, enough to make, if solidified, a mountain nearly one mile high with a base twelve miles in circumference. ③ The same quantity of energy produced from nuclear fission reactions would generate two million times less waste, and it would occupy a sixteen-meter cube. ④ All of the high-level waste produced in a year from a nuclear power station would occupy a space about a cubic meter in size and would fit safely in a concrete pit.



2. Premise: Economic inequality is correlated with political instability.

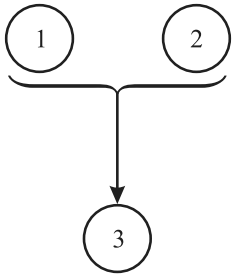
   Premise: Economic inequality is correlated with violent crime.

   Premise: Economic inequality is correlated with reduced life expectancy.

   Premise: Simple justice is offended when chief executives are paid hundreds of times more than is paid to ordinary employees.

   Conclusion: We should be gravely concerned about economic inequality—the wealth gap.

3. ① Genes and proteins are discovered, not invented. ② Inventions are patentable, discoveries are not. Thus, ③ protein patents are intrinsically flawed.



4. Premise: A growing number of Japanese don't want to eat whale meat.

   Conclusion: More and more Japanese consumers won't buy whale meat.

   Premise: If the Japanese won't buy whale meat, the Japanese whaling industry is in serious trouble and is probably doomed.

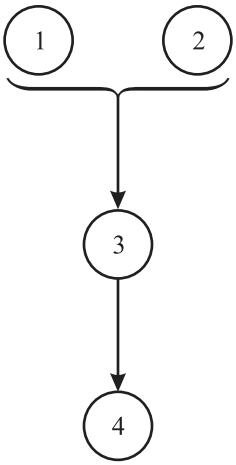
   Conclusion: The Japanese whaling industry is in serious trouble, and is probably doomed.

5. Premise: Without the memory of past horrors, there can be no justice for us. [*Sin memoria, no hay justicia*].

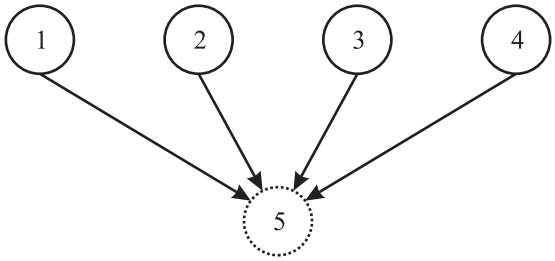
   Premise: Without justice , there will be no future for us. [*Sin justicia, no hay futuro*].

   Conclusion (unstated): If we do not remember the horrors of the past we will have no future. [*Sin memoria, no hay futuro*].

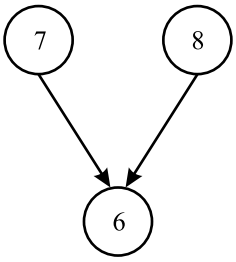
6. Since ① Grover Cleveland has a terrific public record, but a blemished private life, and since ② his opponent, James G. Blaine, has a storybook private life but a checkered public record, ③ it would be well to put both where they perform best. ④ Let's return Blaine to private life, and keep Cleveland in public life.



7. ① World War II solved problems called Nazi Germany and militaristic Japan, and created alliances with the nations we crushed. ② The Revolutionary War solved the problem of taxation without representation, and created the United States of America. ③ The Persian Gulf War solved the problem of the Iraqi invasion of Kuwait. ④ The Civil War solved the problem of slavery. ⑤ It is false to say that wars create problems but do not solve them.



⑥ These wars created a better world. ⑦ War is the only way to defeat evil enemies with whom there is no reasoning; it's either us or them. ⑧ What creates true peace is victory.



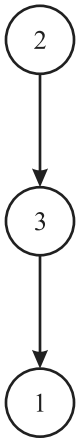
8. Premise: He who disobeys the laws is in effect disobeying his parents.

   Premise: He who disobeys the laws defies the authors of his education, to whom so very much is owed.

   Premise: He who disobeys the laws violates the agreement that he made, explicitly or tacitly, that he would obey the laws' commands.

   Conclusion: He who deliberately disobeys the laws is thrice wrong.

9. ① The reality is that money talks. ② Court officers, judges, and juries treat private lawyers and their clients differently from those who cannot pay for representation. ③ Just as better-dressed diners get prime tables at a restaurant, human nature dictates better results for those who appear to have money.



10. Premise: When Morton Grove, Illinois, passed a law *banning* guns, Kennesaw, Georgia, passed a law making gun ownership *mandatory*.

    Premise: Criminals would rather break into a house where they are not at risk of being shot.

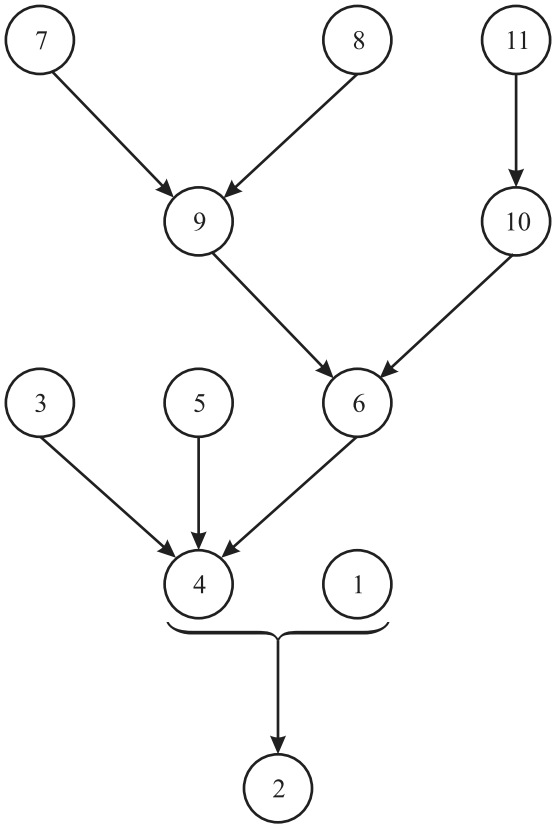
    Premise: Kennesaw's crime rate dropped sharply, but Morton Grove's did not.

    Conclusion:

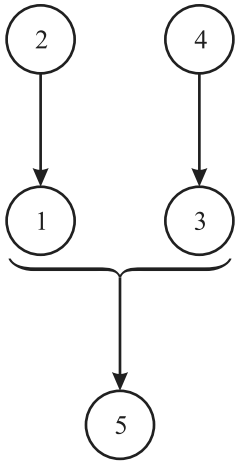
    A) Criminals will naturally believe that towns like Kennesaw, with such laws on their books, are very unsympathetic to them, and that if they plan to engage in crime they will be better off elsewhere. B) We are likely to see other communities adopting similar mandatory gun-ownership laws for self-protection.

Section 2.3
Exercises on pages 52–53

1. A question arises: whether it is better [for a prince] to be loved than feared or feared than loved? One should wish to be both, but, because ① it is difficult to unite them [being loved and being feared] in one person, ② it is much safer to be feared than loved, when, of the two, one must be dispensed with. Because ③ this is to be asserted in general of men, that they are ungrateful, fickle, false, cowards, covetous.... and ④ that prince who, relying entirely on their promises, has neglected other precautions, is ruined, because ⑤ friendships that are obtained by payments may indeed be earned but they are not secured, and in time of need cannot be relied upon. ⑥ Men have less scruple in offending one who is beloved than one who is feared, for ⑦ love is preserved by the link of obligation which, ⑧ owing to the baseness of men, ⑨ is broken at every opportunity for their advantage; ⑩ but fear preserves you by ⑪ a dread of punishment which never fails.



2. ① Democratic laws generally tend to promote the welfare of the greatest possible number; for ② they emanate from the majority of the citizens, who are subject to error, but who cannot have an interest opposed to their own advantage. ③ The laws of an aristocracy tend, on the contrary, to concentrate wealth and power in the hands of the minority; because ④ an aristocracy, by its very nature, constitutes a minority. It may therefore be asserted, as a general proposition, that ⑤ the purpose of a democracy in its legislation is more useful to humanity than that of an aristocracy.

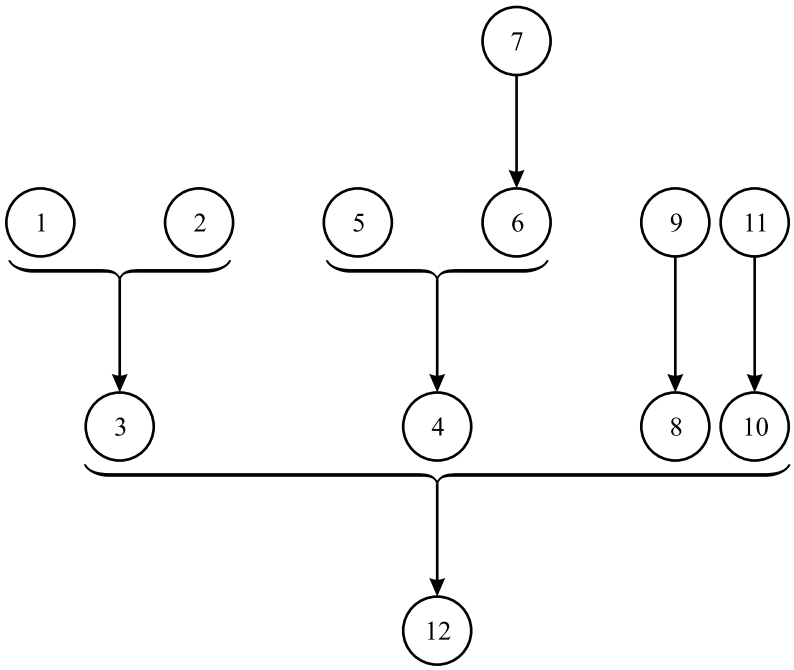


3. "…You appeared to be surprised when I told you, on our first meeting, that you had come from Afghanistan."

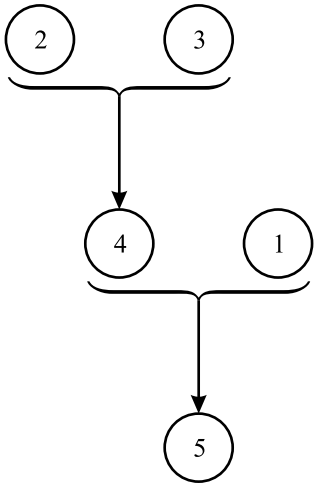
"You were told, no doubt."

"Nothing of the sort. I *knew* you came from Afghanistan. From long habit the train of thoughts ran so swiftly through my mind that I arrived at the conclusion without being conscious of intermediate steps. There were such steps, however. The train of reasoning ran, ① 'Here is a gentleman of medical type, but ② with the air of a military man. Clearly ③ an army doctor, then. ④ He has just come from the tropics, for ⑤ his face is dark, and ⑥ that is not the natural tint of his skin, for ⑦ his wrists are fair. ⑧ He has undergone hardship and sickness, as ⑨ his haggard face says clearly. ⑩ His left arm has been injured. ⑪ He holds it in a stiff and unnatural manner. ⑫ Where in the tropics could an English army doctor have seen much hardship and got his arm wounded? Clearly in Afghanistan.' The whole train of thought did not occupy a second. I then remarked that you came from Afghanistan, and you were astonished."

"It is simple enough as you explain it," I said, smiling.



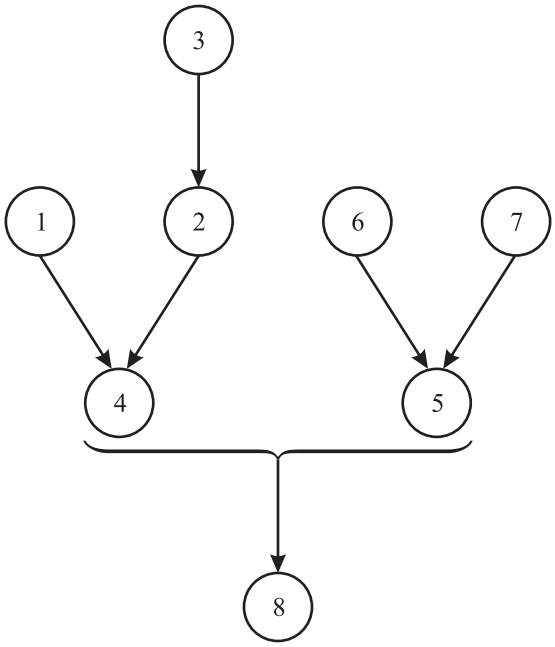
4. ① Nothing is demonstrable unless the contrary implies a contradiction. ② Nothing that is distinctly conceivable implies a contradiction. ③ Whatever we conceive as existent, we can also conceive as nonexistent. ④ There is no being whose nonexistence, therefore, implies a contradiction. Consequently ⑤ there is no being whose existence is demonstrable.



Challenge to the Reader: Prop 29, Book I, *Ethics Geometrically Demonstrated*, B. Spinoza

① Whatever is, is in God. ② But God cannot be called a contingent thing, for ③ He exists necessarily and not contingently. Moreover, ④ the modes of the divine nature [the creations which depend on, or have been created by, God immediately] have followed from it necessarily and

not contingently.…But ⑤ God is the cause of these modes not only in so far as they simply exist, but also in so far as they are considered as determined to any action. ⑥ If they are not determined by God it is an impossibility and not a contingency that they should determine themselves; and, on the other hand, ⑦ if they are determined by God it is an impossibility and not a contingency that they should render themselves indeterminate. ⑧ Wherefore all things are determined from a necessity of the divine nature, not only to exist, but to exist and act in a certain manner, and there is nothing contingent.



Section 2.4
Exercises on pages 59–62

1. Only one.

   If the first native is a politician, then he lies and denies being a politician. If the first native is not a politician, then he tells the truth and denies being a politician. In either case, the first native denies being a politician. Since the second native reports that the first native denies being a politician, he tells the truth, and is, therefore, a nonpolitician. The third native asserts that the first native is a politician. If the first native is a politician, then the third native speaks the truth and is, therefore, a nonpolitician. If the first native is a non-politician, then the third native lies and is, therefore, a politician. Hence only one of the first and third natives is a politician, and since the second is a nonpolitician, there is only one politician among the three natives.

2. The blind prisoner must have had on a white hat, for if he had had on a red hat, one of the other prisoners would have known the color of the hat on his own head, and would have announced it. Call the prisoners A, B, and C. If A had seen a red hat on both B and C, he would have known and announced immediately that his hat must be white. But he did not announce and therefore did not know this; hence there must be a white hat on either B or C. B knew this, because he reasons well. Then, if B, having his opportunity to name the color of his hat, had seen a red hat on C, he would have concluded (from the fact that there is a white hat on either C or himself) that he himself must be wearing a white hat. He would have announced that, but he did not. Therefore B did not see a red hat on C. C realizes this because, although he is blind, he can reason well, and from the fact that B did not see a red hat on C, C concludes that his own hat must be white.

3. Mr. Jones is not the brakeman's next-door neighbor, for if he were then (by *e*) his earnings would be divisible by 3, but (by *c*) he earns exactly $40,000 a year, and that sum is not divisible by 3. Mr. Robinson is not the brakeman's next-door neighbor, for if he were then (by *b*) he would live halfway between Detroit and Chicago, but (by *a*) he lives in Detroit. Hence, Mr. Smith must be the brakeman's next-door neighbor.

   Neither Mr. Robinson (by *a*) nor Mr. Smith (by the preceding argument) lives in Chicago. Hence, Mr. Jones lives in Chicago and so (by *f*) Jones must be the brakeman.

   Smith (by *d*) is not the fireman, and Jones (by the preceding argument) is not the fireman either. Hence, Robinson is the fireman. Since (as has been shown) the brakeman is Jones, and the fireman is Robinson, the engineer's name must be Smith.

4. The manager has a grandson and is therefore neither Mr. Black, the bachelor, nor the twenty-two-year-old Mr. White, nor either Miss Ambrose or Miss Earnshaw who are unmarried, nor Mr. Kelly who is the manager's neighbor. Therefore the manager is Mrs. Coffee.

   The stenographer has a married child and is therefore neither Mr. Black nor Miss Ambrose nor Miss Earnshaw (who are unmarried), nor twenty-two-year-old Mr. White, nor Mrs. Coffee the manager. Therefore, Mr. Kelly is the stenographer.

   The cashier is a married man since he is a son-in-law, and is therefore neither Mr. Black, the bachelor, nor any of the females (Mrs. Coffee, Miss Ambrose, or Miss Earnshaw), nor is he Mr. Kelly, the stenographer. Therefore, Mr. White is the cashier.

   The assistant manager is a grandson, and therefore is none of the females, nor by the preceding arguments is he Mr. Kelly or Mr. White. Therefore, Mr. Black is the assistant manager.

   The teller is not her own stepsister and so is not Miss Ambrose. Nor is she any of the persons already identified: Mrs. Coffee, Mr. Kelly, Mr. White, or Mr. Black. Therefore, the teller is Miss Earnshaw. And so, by elimination, Miss Ambrose must be the clerk.

5. Since Lefty said that Spike did it, Spike's first and third statements are equivalent in meaning and therefore either both true or both false. Since only one statement is false, they are both true.

   Dopey's third statement is, therefore, false, and so his first two are true. Therefore Butch's third statement is false and so his first two are true, of which the second reveals that Red is the guilty man.

   (An alternative method of solving this problem is suggested by Peter M. Longley of the University of Alaska: All but Red both assert their innocence and accuse someone else. If their professions of innocence are false, so are their accusations of other persons. But no one makes two false statements, so their statements that they are innocent must be true. Hence Red is the guilty one. This solution, however, presupposes that only one of the men is guilty.)

   (Still another method of solving this problem comes from James I. Campbell of Eisenhower College and Walter Charen of Rutgers College: If Dopey's second statement and Butch's third statement were false, Dopey's third statement would be true and Spike would be guilty. However, if Spike were guilty, his first and third statements would both be false, so he cannot be guilty and hence Dopey's second statement cannot be false. Therefore, Butch's third statement must be false, whence his second statement is true and Red is the guilty man.)

6. The following statements are known to be true:

   (1) The best player's twin and the worst player are of opposite sex.

   (2) The best player and the worst player are the same age.

   The problem: Determine, by reasoning, who is the best player of the foursome.

   We begin by focusing on the ages of the players. The best player and the worst player are the same age, by (2). The best player and the best player's twin must be the same age, from the meaning of the word "twin." The best player's twin and the worst player cannot be the same person, because, from (1), they are of opposite sex. Therefore, there are three players of the same age: the best player, the best player's twin, and the worst player.

   The remaining player must be Mr. Short, since he must be older than his son and daughter.

   So the three players of the same age must be Mr. Short's son, daughter, and sister. Therefore, the twins mentioned in (1) must be Mr. Short's son and daughter, and one of these two must be the best player.

   But the best player cannot be Mr. Short's son, because if that were true, then none of the four could be the worst player! We can show this by assuming that the best player

is Mr. Short's son. Then, by (1), his twin would be of the opposite sex from the worst player. Since his twin is Mr. Short's daughter, the worst player must be a male. Therefore, neither Mr. Short's sister nor Mr. Short's daughter can be the worst player. Nor can the worst player be Mr. Short's son, for we have assumed that he is the best player. This leaves Mr. Short himself. But Mr. Short cannot be the worst player, because by (2), the best player and the worst player are the same age, and a man cannot be the same age as his son.

Therefore, the best player must be Mr. Short's daughter.

7. Curly's four statements are the key to this problem.

Otto accused the Kid. The Kid's first and fourth statements are equivalent and therefore either both true or both false. Since only one of his statements can be false, they must be both true. Therefore, Otto's third statement is false and the rest are true. The truth of his fourth statement entails that Mickey's third statement is false, and so Mickey's other statements are true. The truth of Mickey's fourth statement entails that Curly's fourth statement is true.

The truth of Mickey's second statement entails that the Kid's second statement is true, and since the Kid's first and fourth statements have already been shown to be true, his third statement must be false, from which it follows that Curly's third statement is true.

The truth of Otto's first statement entails that Slim's third statement is true. The statement of the problem shows that Slim's second and fourth statements are true also, so Slim's first statement must be false, from which it follows that Curly's second statement is true.

Since Curly's fourth and third statements have already been shown to be true above, his first statement must be the false one. Hence we may know that Curly "dunnit."

8. First weighing: (R1 + G1) // (R2 + B1)

There are three possible outcomes on this first weighing: (A) the two sides balance; (B) the left side goes down; and (C) the left side goes up. We will examine each outcome and show how all the balls can be identified in each case.

(A) The two sides balance on the first weighing.

We know that, of the pair R1 and R2, one ball is heavy and the other light. Since the two red balls are on opposite sides of the scale, we know that if the two sides balance there must be a heavy ball and a light ball on *each* side (because two heavies on one side would have to go down, and two lights on one side would have to go up). Therefore we know that either G1 is heavy and B1 is light, or G1 is light and B1 is heavy.

Having determined, on the first weighing, that G1 and B1 have different weights, we know that a second weighing of G1 // B1 cannot be balanced. Only two outcomes are possible:

(1) G1 goes down on the second weighing. In this case,

- G1 must be heavy (and therefore G2 must be light);
- B1 must be light (and therefore B2 must be heavy);
- R1 must be light (and therefore R2 must be heavy).

(2) G1 goes up on the second weighing. In this case,

- G1 must be light (and G2 must be heavy);
- B1 must be heavy (and B2 must be light);
- R1 must be heavy (and R2 must be light).

In each case, all the balls are identified. This exhausts all the possibilities for (A).

(B) The left side goes down on the first weighing.

We know that, in this case, R1 (the red ball on the side that goes down) must be heavy, because if R1 had been light, then R2 would have had to be heavy, and if R2 had been heavy, then (R1 + G1) could not have gone down. Knowing this, we can eliminate the possibility that G1 is light and B1 heavy, because in that case, (R1 + G1) could not have gone down. Therefore, one of the following three combinations must be the case:

(a) G1 is heavy and B1 is light.

(b) G1 is light and B1 is light.

(c) G1 is heavy and B1 is heavy.

We can now identify all the balls by choosing (R1 + R2) // (G1 + B1) for the second weighing. On this weighing, we know that the left side, (R1 + R2), has a heavy ball and a light ball, and therefore it may go down, go up, or balance the right side, (G1 + B1). We now show how all the balls can be identified in each case:

(1) The two sides balance on the second weighing.
In this case, G1 and B1 must be heavy and light, respectively. The combination must be pattern (a) above, and all the balls are identified (R1, G1, and B2 are heavy; R2, G2, and B1 are light).

(2) The left side goes down on the second weighing.
In this case, G1 and B1 must both be light, because a heavy and a light can outweigh only two lights. The combination must be pattern (b) above, and all the balls are identified (R1, G2, and B2 are heavy; R2, G1, and B1 are light).

(c) The left side goes up on the second weighing.
In this case, G1 and B1 must both be heavy, because a heavy and a light can be outweighed only by two heavies. The combination must be pattern (c) above, and all the balls are identified (R1, G1, and B1 are heavy; R2, G2, and B2 are light).

In each case, all the balls are identified. This exhausts all the possibilities for (B).

(C) The left side goes up on the first weighing.

In this case, the solution mirrors the steps described in (B), with the weights simply reversed.

9. Yes, the third native is a politician. This can be shown as follows:

Call the natives A, B, and C. The first native, A, must be a politician because if he were a nonpolitician he would say that he is a nonpolitician, but instead he says that all three, including himself, are politicians. Therefore A is not telling the truth—it is not the case that all three are politicians. In other words, of the three natives, either two are politicians, or only one is a politician.

However, it cannot be the case that only one of the three natives is a politician. If that were the case, then by the reasoning above the politician must be A. But in that case, B would have to be a nonpolitician and would tell the truth, which (under our assumption) is that there is only one politician. Instead, B says that there are two politicians, which would be false. Therefore, it is impossible that there is only one politician.

Since there cannot be one politician only, there must be two politicians, of whom A must be one. B states that there are two politicians, which is true, and therefore B is a nonpolitician. And since we now know that there are two politicians among the three natives, the third native, C, must be a politician. (This is consistent with the fact that C accuses B of lying, and we know that B told the truth.)

10. It is not possible to distribute the strings so that no one triangle has all three sides (strings) of the same color; at least one triangle must have three sides of the same color.

Consider any one nail; say the one on a wall we call A. From it stretch five strings, and among these five there must be a group of at least three strings of the same color, since only two colors (red and blue) are available.

Suppose that three of the strings from the nail in wall A are red, and that they go to the other three walls, B, C, and D. Now consider the triangle formed by the nails on these three other walls, B, C, and D. Its sides must not all be of the same color, so they cannot all be blue, so at least one of them must be red. But if any one of the strings connecting B, C, and D is red, it must complete a triangle of three red strings! (Suppose the string connecting B and D is the red one. Then there will be a triangle of three red strings connecting A, B, and D. The same problem arises if we try to connect B and C, or C and D.) No matter which nail we begin with, there is no way to avoid at least one triangle all of whose sides are strings of the same color.

Challenge to the Reader

NOTE: There are different solutions to this problem, and each solution has a mirror image. The second weighings may differ from those suggested below, but every correct solution must begin with four balls weighed against four. Every correct solution must also provide a proof that justifies the identification of the odd ball and shows why it is heavier or lighter than the others.

In the following discussion, we assume that the balls are uniquely numbered (1 through 12):

First weighing: (1 + 2 + 3 + 4) // (5 + 6 + 7 + 8)

There are three possible outcomes on this first weighing: (A) the two sides balance; (B) the left side goes down; and (C) the left side goes up. We will examine each outcome and show how all the balls can be identified in each case.

(A) The two sides balance on the first weighing.

In this case, we know that

- Balls 1–8 are all regular;
- The odd ball must be 9, 10, 11, or 12.

For a second weighing, we choose (9 + 10 + 1) // (11 + 2 + 3).
Three outcomes are possible:

(1) The two sides balance on the second weighing.
In this case, the odd ball must be 12. For the third weighing, we choose 12 // 1. The two balls cannot balance, because 1 is regular. Therefore, if 12 goes up, it is odd and light, and if 12 goes down, it is odd and heavy.

(2) The left side goes down on the second weighing.
In this case, the odd ball is either 9 or 10 (and heavy), or it is 11 (and light). For the third weighing, we choose 9 // 10. If one of those two balls goes down, it is odd and heavy. If the two balls balance, then the odd ball is 11, and it must be light.

(3) The left side goes up on the second weighing.
In this case, the odd ball is either 9 or 10 (and light), or it is 11 (and heavy). For the third weighing, we choose 9 // 10. If one of those balls goes up, it is odd and light. If they balance, the odd ball is 11, and it must be heavy.

In each case, the odd ball is identified. This exhausts all the possibilities for (A).

(B) The left side goes down on the first weighing.

In this case, either the odd ball is on the left side and it is heavy, or it is on the right side and it is light. Balls 9–12 are therefore known to be regular.

For the second weighing, we choose (1 + 2 + 5 + 9) // (3 + 4 + 6 + 10).
Three outcomes are possible, and in each case we can identify the odd ball, as follows:

(1) The two sides balance on the second weighing.
In this case, balls 1–6 must be regular, and since balls 9–12 were shown to be regular on the first weighing, the odd ball must be either 7 or 8, and it must be light. For the third weighing, we choose 7 // 8. The ball that goes up must be the odd ball, and it must be light.

(2) The left side goes down on the second weighing.
In this case, either 1 or 2 is odd (and heavy), or 6 is odd (and light). For the third weighing we choose 1 // 2. If either ball goes down, it must be the odd ball, and it is heavy. If the two balls balance, the odd ball must be 6, and it is light.

(3) The left side goes up on the second weighing.
In this case, either 3 or 4 is odd (and heavy), or 5 is odd (and light). For the third weighing we choose 3 // 4. If either ball goes down, it must be the odd ball, and it is heavy. If the two balls balance, the odd ball must be 5, and it is light.

In each case, the odd ball is identified. This exhausts all the possibilities for (B).

(C) The left side goes up on the first weighing.

In this case, as in (B), the odd ball can be identified. The pattern of second and third weighings will mirror the pattern described above for (B), with the weights reversed.