A CONCISE INTRODUCTION TO LOGIC

Thirteenth Edition

PATRICK J. HURLEY
LORI WATSON

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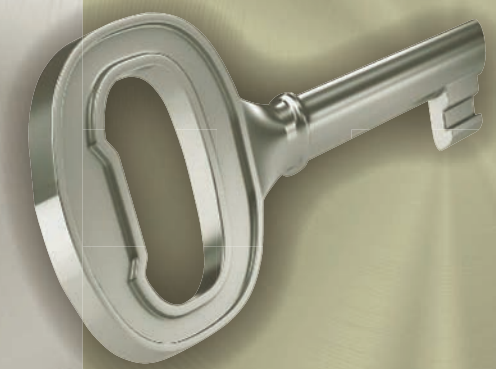

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***A Concise Introduction to Logic*, 13th Edition**
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Compositor: MPS Limited
Text and Cover Designer: Deborah Dutton
Cover Images: iStockphoto.com/pavlen; Route55/Shutterstock.com

Library of Congress Control Number: 2016941673

Student Edition:
ISBN: 978-1-305-95809-8

Loose-leaf Edition:
ISBN: 978-1-305-95976-7

Cengage Learning
20 Channel Center Street
Boston, MA 02210
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Printed in the United States of America
Print Number: 01 Print Year: 2016

To Linda

It is wrong always, everywhere, and for anyone, to believe anything upon insufficient evidence.

—W. K. Clifford

Nothing can be more important than the art of formal reasoning according to true logic.

—Gottfried Wilhelm Leibniz

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Preface

Logic: The key to all learning

The most immediate benefit derived from the study of logic is the skill needed to construct sound arguments of one's own and to evaluate the arguments of others. In accomplishing this goal, logic instills a sensitivity for the formal component in language, a thorough command of which is indispensable to clear, effective, and meaningful communication. On a broader scale, by focusing attention on the requirement for reasons or evidence to support our views, logic provides a fundamental defense against the prejudiced and uncivilized attitudes that threaten the foundations of our democratic society. Finally, through its attention to inconsistency as a fatal flaw in any theory or point of view, logic proves a useful device in disclosing ill-conceived policies in the political sphere and, ultimately, in distinguishing the rational from the irrational, the sane from the insane. This book is written with the aim of securing these benefits.

About *A Concise Introduction to Logic*

The new edition of *A Concise Introduction to Logic* maintains the text's tradition of careful sequencing, precision, elegance, and clarity, by retaining a number of signature features:

- Chapters are organized so that earlier sections provide the foundation for later ones. Later sections can be skipped by instructors opting to do so.
- The main points are always presented up front so students cannot possibly miss them.
- Relevant and up-to-date examples are used extensively.
- Key terms are introduced in boldface type and defined in the Glossary/Index.
- Central concepts are illustrated in graphic boxes.
- Numerous exercises, many drawn from real-life sources such as newspapers, textbooks, and magazines, are included to perfect student skills—the current edition includes over 2,700 exercises.
- Biographical vignettes of prominent logicians are included to give logic a human face.

- Dialogue exercises illustrate the application of logical principles to real-life situations.
- Venn diagrams for syllogisms are presented in a novel and more effective way, using color to identify the relevant areas.
- End-of-chapter summaries facilitate student review.
- The solution to every third exercise is provided in the Answer section, so students can easily check their work.
- Important rules and tables are printed on the inside covers for ready access, and they are also presented on a tear-out card.

New to This Edition

New to MindTap

MindTap™ Important to this revision is the introduction of several new features in MindTap. MindTap is a personalized, fully online digital learning platform that offers an interactive eBook, a tutorial program, and homework all in one place. We have enhanced the resources in MindTap and added to them.

Revised Learning Path In response to user and reviewer feedback, we have modified the MindTap learning path. The *Concise Introduction to Logic* MindTap for this edition still includes the prized tools that contribute to this product's popularity, including

- The interactive version of some of the textbook's exercise sets
- Aplia™
- *Learning Logic* tutorials
- Video lectures

In addition, the revised learning path incorporates improvements and new resources to help guide students and instructors.

- Each chapter opens with stated Learning Objectives.
- The section folders now include the reading, with video lectures when available, along with the interactive version of most of the text's exercise sets, and an online writing exercise—see the more detailed description of this new addition that follows.
- The *Learning Logic* tutorials and Aplia are now found at the chapter level, with all their respective sections in a folder.
- The new Living Logic activity, the Chapter Review (the textbook's Chapter Summary), and the Chapter Test (now available as an online gradable activity) round out the new learning path's offerings.

How Logical Are You? These short, real-life scenarios, which replace the Previews of the prior edition, engage students creatively with the themes of the chapter. The questions posed in these scenarios are answered online in MindTap.

Annotated Answers We have added explanations to the exercise answers, detailing why the answer is correct, for most sections of Chapter 1 (Sections 1.1–1.4) and Chapter 3 (Sections 3.1–3.4).

Writing Exercises Any set of exercises that did not already include a writing activity now does. These new writing activities require students to create a short example of a concept presented in the section, such as an explanation, a deductive argument, or a dispute. In performing this activity, students are further engaged and retention is reinforced.

Living Logic This integrative digital activity helps students apply their logic skills to a current real-world problem: climate change. It offers exercises targeted to the content of Chapters 1 through 7, bringing to life the practical and relevant nature of this content.

Chapter Tests These multiple-choice questions, offered as PDFs in the prior edition of MindTap, are now available, at the end of each chapter, as gradable interactive quizzes.

Visualizing Inferences This new technique, introduced in Chapter 7 (Natural Deduction in Propositional Logic) uses geometrical shapes in the place of "p" and "q" to help students visually understand the rules of inference. The technique is introduced in the textbook and expanded in MindTap. We have also added exercises that offer practice in creating instances of the rules of inference.

Well-Formed Formulas A more detailed account of this subject supplements the account found in Chapter 6 of the textbook.

New Text Features

- A feature entitled "How Logical Are You?" replaces the prior edition "Preview" and occurs at the beginning of every section of the textbook (except for Chapters 9–14, where it occurs at the beginning of every chapter). These prompts are intended to get the students thinking about the content of the pertinent section before they actually start reading that material. The questions presented in these selections are answered in MindTap.
- Every exercise set now includes a writing component—an activity to engage the student's creativity. These usually involve creating arguments of various kinds, definitions, fallacies, and symbolized expressions.
- "Why Study Logic?" has been added to the front material. This section aims to motivate the study of logic by emphasizing its importance across a variety of activities. Among other things, it compares studying logic to going to the gym for your brain.

New Chapter Content

As you proceed through the textbook, you will encounter numerous improvements. For example, many exercises have been rewritten and updated. A more detailed list of the substantive changes follows:

Chapter 3

- Slippery slope has been expanded by noting that the fallacy is usually committed to defend the status quo and by pointing to the importance of identifying the precise causal link where the reasoning fails.

Chapter 4

- New exercises have been added to Sections 4.1 and 4.2.
- A subsection entitled "Boole, Venn, and Existential Import" has been written to address student questions about the Boolean standpoint, which makes no assumption as to whether the things referred to actually exist. Students often ask about the utility of a logic that deals with nonexisting things. This subsection also sketches the history of the Boolean standpoint in the nineteenth century.
- The concept of vacuous falsity is introduced in Section 4.3.
- A note, added to Section 4.5, addresses the truth value of statements such as "All unicorns are two-horned animals," and "Some unicorns are one-horned animals."

Chapter 6

- Truth tables are now introduced using the technique of writing the truth values of the simple propositions to the left of the truth table and using those truth values to generate the truth values of the compound propositions. The presentation of this technique is followed by the abbreviated technique whereby truth values are entered initially beneath the simple components of the compound propositions.
- New exercises for using truth tables to test arguments for validity have been added to Section 6.4.
- Section 6.6 has been reorganized so that the valid argument forms are introduced in the same order as the inference forms in Section 7.1. Also, the invalid forms (affirming the consequent and denying the antecedent) are assigned to a separate subsection to help prevent their being confused with the valid forms.

Chapter 7

- A new way of visualizing *modus ponens* and disjunctive syllogism, using squares and circles, is introduced to aid students who learn best through visual imagery. This technique is expanded in MindTap.
- In Section 7.3 a dialogue entitled "New Cradle" replaces "With This Ring."

Chapter 10

- A simpler characterization of the joint method of agreement and difference is given to ease students through the more complicated definition of this method.

Chapter 11

- A brief account is given of recent applications of Bayes's theorem. These include the attempt to use Bayes's theorem to locate Malaysia Airlines Flight 370.

Chapter 12

- A paragraph has been added to show how samples become biased in clinical trials intended to disclose drug side effects.
- A brief explanation is given as to how pharmaceutical companies use tricks with percentages to mislead customers.

Chapter 14

- An account is given explaining how large corporations undermine the integrity of science by enlisting the services of university scientists to sway public opinion regarding the safety of their products.

Note to the Student

Imagine that you are interviewing for a job. The person across the desk asks about your strengths, and you reply that you are energetic, enthusiastic, and willing to work long hours. Also, you are creative and innovative, and you have good leadership skills. Then the interviewer asks about your weaknesses. You hadn't anticipated this question, but after a moment's thought you reply that your reasoning skills have never been very good.

> The interviewer quickly responds that this weakness could create big problems.
>
> "Why is that?" you ask.
>
> "Because reasoning skills are essential to good judgment. And without good judgment your creativity will lead to projects that make no sense. Your leadership skills will direct our other employees in circles. Your enthusiasm will undermine everything we have accomplished up until now. And your working long hours will make things even worse."
>
> "But don't you think there is some position in your company that is right for me?" you ask.
>
> The interviewer thinks for a moment and then replies, "We have a competitor on the other side of town. I hear they are hiring right now. Why don't you apply with them?"

The point of this brief dialogue is that good reasoning skills are essential to doing anything right. The business person uses reasoning skills in writing a report or preparing a presentation; the scientist uses them in designing an experiment or clinical trial, the department manager uses them in maximizing worker efficiency, the lawyer uses them in composing an argument to a judge or jury. And that's where logic comes in. The chief purpose of logic is to develop good reasoning skills. In fact, logic is so important that when the liberal arts program of studies was formulated fifteen hundred years ago, logic was selected as one of the original seven liberal arts. Logic remains to this day a central component of a college or university education.

From a more pragmatic angle, logic is important to earning a good score on any of the several tests required for admission to graduate professional schools—the LSAT, GMAT, MCAT, GRE, and so on. Obviously, the designers of these tests recognize that the ability to reason logically is a prerequisite to success in these fields. Also, logic is a useful tool in relieving what has come to be called math anxiety. For whatever reason, countless students today are terrified of any form of reasoning that involves abstract symbols. If you happen to be one of these students, you should find it relatively easy to master the use of logical symbols, and your newly found comfort with these symbols will carry over into the other, more difficult fields.

In addition to the existing and new features described in the "New to This Edition" section of this preface, MindTap also includes the following supplements. *Critical*

Thinking and Writing offers practice in writing arguments about real-life topics; *Truth Trees* presents a standard introduction to the method of truth trees, which can be used as a supplement or alternative to the truth-table method; and *Logic and Graduate-Level Admission Tests* shows how the principles learned in studying logic can be used to answer questions on the LSAT, GMAT, MCAT, and GRE. Finally, *Existential Import* traces the history of existential import through the logic of Aristotle and George Boole.

Among the MindTap offerings that I would especially urge you to investigate is *Learning Logic*. This interactive tutorial program teaches the basics of the entire course in a very user-friendly way. It tracks the textbook chapter by chapter, but your computer must be equipped with speakers or headphones, because the audio component is essential.

Note to the Instructor

The image on the front cover is intended to convey the message that logic is the key to all learning. Keys open doors. Logic is the key that opens the door to reasoned discourse and dialogue, unlocking an important opportunity for learning. Through logic, students learn to support their views with reasons and to open their minds to the reasons of others. Logic creates a common foundation upon which individuals who hold opposing points of view can learn from each other. What might otherwise devolve into a shouting match of conflicting opinions becomes a venue for the rational exchange of ideas.

To promote the achievement of this goal, this new edition features selections entitled "How Logical Are You?" at the beginning of chapter sections, that are designed to get students thinking, activate prior learning, and induce the students to read the section that follows. The instructor can also use these selections as springboards for in-class lectures. While the inclusion of these selections is probably the most visible change in the new edition, as you proceed through the book you will encounter numerous less-visible improvements. Many of them are listed previously in "New Chapter Content," and a complete list is given in the Instructor's Manual.

The online resource, MindTap, continues to be a central component of this new edition. One of the more noteworthy offerings on MindTap is *Learning Logic*. This tutorial program teaches the fundamentals of the whole course, and it is especially helpful for students who have difficulty mastering logical principles directly from the textbook or from classroom lectures alone. The program is multimedia, which means that students learn not only by seeing but also by hearing. In addition, it incorporates easy-to-use forward and reverse buttons, so students who have failed to understand something the first time can easily go back to hear the lesson repeated. *Learning Logic* contains over two thousand practice problems not contained in the textbook, and students get immediate feedback for correct and incorrect answers.

Another great product available on MindTap is Aplia, an online homework program that improves student comprehension by increasing effort and engagement. Students get immediate feedback on their work—not only what they got right or wrong—but *why*; and they can choose to see another set of related problems if they want further

practice. Aplia's simple-to-use course management interface allows instructors to post announcements, host student discussions, e-mail students, and manage the grade book. Personalized help is available from a knowledgeable and friendly support team. To learn more, ask your Cengage Learning sales representative for a demonstration, or view a specific demonstration for this book at www.aplia.com.

Also note that the Instructor's Companion Website contains the Instructor's Manual and the Test Bank. The Instructor's Manual includes answers to all the book's exercises and a complete list of the improvements introduced in this edition. The 600-page author-generated Test Bank includes numerous tests for each chapter in the book, and most of them are in easily gradable multiple-choice format.

This thirteenth edition marks a break with its predecessors in that it has a coauthor, Lori Watson. One of Professor Watson's contributions has been to ensure that the new edition engages the interests of today's students. When we began our collaboration we split up the work so that Professor Watson would focus mainly on the online material, while Professor Hurley would revise the hard-copy book. But as work progressed, it turned out that each of us contributed to both areas. For example, Watson wrote the piece on the value of studying logic following this preface, and she contributed to many of the new exercises and the "How Logical Are You?" selections, while Hurley contributed to some of the online annotated answers to the exercises and the Living Logic activity.

Type of Course

	Traditional logic course	**Informal logic course, critical-reasoning course**	**Course emphasizing modern formal logic**
Recommended material	Chapter 1 Chapter 3 Chapter 4 Chapter 5 Chapter 6 Sections 7.1–7.4	Chapter 1 Chapter 2 Chapter 3 Chapter 4 Sections 5.1–5.3 Sections 5.5–5.6 Sections 6.1–6.4 Section 6.6 Chapter 9 Chapter 12 Chapter 13 Chapter 14 *Critical Thinking and Writing* supplement	Chapter 1 Sections 4.1–4.3 Section 4.7 Sections 6.1–6.5 Chapter 7 Chapter 8 *Truth Trees* supplement
Optional material	Chapter 2 Sections 7.5–7.7 Chapters 9–14	Section 5.4 Section 5.7 Section 6.5 Chapter 10 Chapter 11	Chapter 3 Sections 4.4–4.6 Sections 5.1–5.2 Section 5.7 Section 6.6

Let us now turn to alternate ways of approaching the textbook. In general, the material in each chapter is arranged so that certain later sections can be skipped without affecting subsequent chapters. For example, those wishing a brief treatment of natural deduction in both propositional and predicate logic may want to skip the last three sections of Chapter 7 and the last four (or even five) sections of Chapter 8. Chapter 2 can be skipped altogether, although some may want to cover the first section of that chapter as an introduction to Chapter 3. Finally, Chapters 9 through 14 depend only slightly on earlier chapters, so these can be treated in any order one chooses. However, Chapter 14 does depend in part on Chapter 13.

Digital Options

A Concise Introduction to Logic is available in multiple formats, including as a printed textbook that can be bought alone [ISBN: 9781305958098], and it can be combined with digital solutions in a variety of ways, including the following:

1. **MindTap (alone) [ISBN: 9781305959644].** Available with the interactive eBook (MindTap Reader), this option includes *Learning Logic* (the tutorial), Aplia quizzing assignments, videos (covering difficult-to-master topics), chapter learning path activities, quizzing, and appendices. Available only at www.cengagebrain.com, this option can be a cost-saving choice for students.

2. **Aplia (alone) [ISBN: 9781305959712].** Available with the interactive eBook (MindTap Reader), this option includes everything in Option 2 except the printed textbook. Available only at www.cengagebrain.com, this option can be a cost-saving choice for students.

Contact your personal Learning Consultant, http://www.cengage.com/repfinder/, for more information about all available options, pricing, and assistance in selecting the best solutions for your students and your course.

Acknowledgments

For their reviews and suggestions leading to this thirteenth edition I want to thank the following:

Karl Aho, Baylor University; Benjamin Arah, Bowie State University; Peter Barry, Saginaw Valley State University; Jeff Broome, Arapahoe Community College; Louis Colombo, Bethune-Cookman University; Rosibel Cruz, Harold Washington College; Benjamin Easton, Azusa Pacific University; Samantha Emswiler, John Tyler Community College; William Ferraiolo, San Joaquin Delta College; Albert Filice, Mesa Community College; Paul Gass, Coppin State University; Dimitria Gatzia, University of Akron Wayne College; Douglas Hill, Saddleback College and Golden West College; Ron Jackson, Clayton State University; Stephen Leach, University of Texas–Pan American; Chris Lorkowski, Kent State University–Trumbull Campus; Leemon McHenry, California State University Northridge; Daniel Metz, Metropolitan State College of Denver (Program chair at CCCOnline); Mike Monge, Orange Coast College; Tim O'Neill, Rochester Community and Technical College; Christopher Pallotti, Los Angeles Valley College/CSUN; Sean Stidd, Wayne State University; Corine Sutherland, Cerritos College; Catherine S. Sutton, Virginia Commonwealth University; Michael Thune, Joliet Junior College; Dennis Weiss, York College of Pennsylvania; Elaine Yoshikawa, Arizona State University; Xiaoyu Zhu, Antelope Valley College.

Of course any errors or omissions that may remain are the result of my own oversight.

Those who have contributed reviews and suggestions leading to the twelve previous editions, and to whom I express my continued thanks, are the following:

James T. Anderson, University of San Diego; Carol Anthony, Villanova University; Joseph Asike, Howard University; Harriet E. Baber, University of San Diego; Kent Baldner, Western Michigan University; James Baley, Mary Washington College; Jerome Balmuth, Colgate University; Victor Balowitz, State University of New York, College at Buffalo; Ida Baltikauskas, Century College; Gary Baran, Los Angeles City College; Robert Barnard, University of Mississippi; Peter Barry, Saginaw Valley State University; Gregory Bassham, Kings College; Thora Bayer, Xavier University of Louisiana; David Behan, Agnes Scott College; John Bender, Ohio University, Athens; James O. Bennett, University of Tennessee, Knoxville; Victoria Berdon, IUPU Columbus; Robert Berman, Xavier University of Louisana; Kevin Berry, Ohio University; Joseph Bessie, Normandale Community College; John R. Bosworth, Oklahoma State University; Andrew Botterell, University of Toronto; Jeff Broome, Arapahoe Community College; Tom Browder, University of Nevada, Las Vegas; Harold Brown, Northern Illinois University; Kevin Browne, Indiana University Southeast; Ken Buckman, University of Texas, Pan American; Robert Burch, Texas A&M University; Keith Burgess-Jackson, University of Texas, Arlington; Michael Byron, Kent State University; Scott Calef, Ohio Wesleyan University; Gabriel Camacho, El Paso Community College; James Campbell, University of Toledo; Joseph Keim Campbell, Washington State University; Loren Cannon, Humboldt State University; Charles Carr, Arkansas State University; William Carroll, Coppin State University; Jennifer Caseldine-Bracht, IUPU Fort Wayne; John Casey, Northern Illinois University; Robert Greg Cavin, Cypress College; Ping-Tung Chang, University of Alaska; Prakash Chenjeri, Southern Oregon University; Drew Christie, University of New Hampshire; Timothy Christion, University of North Texas; Ralph W. Clarke, West Virginia University; David Clowney, Rowan University; Darryl Cohen, Mesa Community College; Michael Cole, College of William and Mary; Michael Coledu, Reedley College; Louis Colombo, Bethune-Cookman University; Michael J. Colson, Merced College; William F. Cooper, Baylor University; William Cornwell, Salem State College; Victor Cosculluela, Polk Community College; Mike Coste, Front Range Community College; Ronald R. Cox, San Antonio College; Houston A. Craighead, Winthrop University; Donald Cress, Northern Illinois University, DeKalb; Jack Crumley, University of San Diego; Drew Dalton, Florida Southern College; Linda Damico, Kennesaw State University; Ray Darr, Southern Illinois University; William J. DeAngelis, Northeastern University; Joseph DeMarco, Cleveland State University; Paul DeVries, Wheaton College; Jill Dieterle, Eastern Michigan University; Mary Domski, University of New Mexico; Beverly R. Doss and Richard W. Doss, Orange Coast College; Paul Draper, Purdue University; William A. Drumin, King's College, Pennsylvania; Clinton Dunagan, Saint Philips College; Jeffrey Easlick, Saginaw Valley State University; Paul Eckstein, Bergen Community College; Anne M. Edwards, Austin Peay State University; Michael Epperson, California State University, Sacramento; Lenore Erickson, Cuesta College; Cassandra Evans, San Diego City College; Frank Fair, Sam Houston State University; Evan Fales, University of Iowa; Thompson Faller, University of Portland; William Ferraiolo, San Joaquin Delta College; Albert Filice, Mesa Community College; Lewis S. Ford, Old Dominion University; Gary Foulk, Indiana State University, Terre Haute; Timothy C. Fout, University of Louisville; LeAnn Fowler, Slippery Rock University; Craig Fox, California University of Pennsylvania; Thomas H. Franks, Eastern Michigan University; Bernard D. Freydberg, Slippery Rock University; Thomas J. Frost, Biola University/Long Beach City College; Dick Gaffney, Siena College; George Gale, University of Missouri–Kansas City; Pieranna Garavaso, University of Minnesota at Morris; Paul Gass, Coppin State University; Dimitria Gatzia, The University of Akron Wayne College; Joseph Georges, El Camino College; Kevin Gibson, University of Colorado;

James Granitto, Santiago Canyon College; Victor Grassian, Los Angeles Harbor College; Catherine Green, Rockhurst University; James Greene, Northern Michigan University; Harold Greenstein, SUNY Brockport; J. Randall Groves, Ferris State University; Shahrokh Haghighi, California State University; Alexander W. Hall, Clayton State University; Dean Hamden, Montclair State University; Courtney Hammond, Cuyamaca College; Ken Hanly, Brandon University; Anthony Hanson, West Valley College; Merle Harton, Edward Waters College; Larry Hauser, Alma College; Deborah Heikes, University of Alabama in Huntsville; Ryan Hickerson, Western Oregon University; Ronald Hill, University of San Diego; Lawrence Hinman, University of San Diego; Lynn Holt, Mississippi State University; Jeremy Hovda, Minneapolis Community & Technical College; John B. Howell, III, Southwestern Baptist Theological Seminary; R. I. G. Hughes, University of South Carolina, Columbia; Peter Hutcheson, Texas State University; Debby Hutchins, Gonzaga University; William H. Hyde, Golden West College; Ron Jackson, Clayton State University; William Jamison, University of Alaska Anchorage; Sandra Johanson, Green River Community College; Gary Jones, University of San Diego; Richard A. Jones, Howard University; Russel Jones, University of Oklahoma; Glenn C. Joy, Texas State University, San Marcos; Olin Joynton, North Harris County College; Grant Julin, St. Francis University; Patrick Kenny, Onondaga Community College; Glen Kessler, University of Virginia; Charles F. Kielkopf, Ohio State University; Moya Kinchla, Bakersfield College; Kristin Klamm-Doneen, Anoka Ramsey Community College; Bernard W. Kobes, Arizona State University; Keith W. Krasemann, College of DuPage; Richard La Croix, State University College at Buffalo; Sandra LaFave, West Valley College, Saratoga, California; William Lawhead, University of Mississippi; Stephen Leach, UTPA; Richard Lee, University of Arkansas; Lory Lemke, University of Minnesota, Morris; Robert Levis, Pasadena City College; Chenyang Li, Monmouth College, Monmouth, Illinois; Chris M. Lorkowski, Kent State University; Keane Lundt, Massachusetts College of Liberal Arts; Ardon Lyon, City University of London; Scott MacDonald, University of Iowa; Ian MacKinnon, The University of Akron; Krishna Mallick, Salem State College; Thomas Manig, University of Missouri–Columbia; James Manns, University of Kentucky; Dalman Mayer, Bellevue Community College; Larry D. Mayhew, Western Kentucky University; Leemon McHenry, California State University Northridge; Robert McKay, Norwich University; Rick McKita, Colorado State University; Phillip McReynolds, Pennsylvania State University; Erik Meade, Southern Illinois University–Edwardsville; Noel Merino, Humboldt State University; Kenneth R. Merrill, University of Oklahoma; Daniel Metz, Metropolitan State College of Denver; Thomas Michaud, Wheeling Jesuit College; Alexander Miller, Piedmont Technical College; Dolores Miller, University of Missouri–Kansas City; George D. Miller, DePaul University; Richard Miller, East Carolina University; Frederick Mills, Bowie State University; Jeff Mitchell, Arkansas Tech University; John Mize, Long Beach City College; Allyson Mount, Keene State College; Seyed Mousavian, University of Alberta; Dwayne Mulder, California State University, Fresno; John D. Mullen, Dowling College; Madeline Muntersbjorn, University of Toledo; Henry Nardone, Kings College; Nathaniel Nicol, Washington State University; Theresa Norman, South Texas Community College; David O'Connor, Seton Hall University; Len Olsen, Georgia Southern University; Tim O'Neill, Rochester Community and Technical College; Elane O'Rourke, Moorpark College; Brendan O'Sullivan, Rhodes College; Stephen Pacheco, University of San Diego; Joseph Pak, Los Angeles City College; Christopher Pallotti, Los Angeles Valley College/CSUN; Christopher Pearson, Southern Illinois University Edwardsville; Rodney Peffer, University of San Diego; Linda Peterson, University of San Diego; Robert G. Pielke, El Camino College; Cassandra Pinnick, Western Kentucky University; Nelson Pole, Cleveland State University; Norman Prigge, Bakersfield State University; Gray Prince, West Los Angeles College; R. Puligandla, University of Toledo; T. R. Quigley, Oakland University; Nani Rankin, Indiana University at Kokomo; Robert Redmon, Virginia Commonwealth University; Bruce Reichenbach, Augsburg College; Herminia Reyes, San Diego State University; Fernando Rincon-Tellez,

Piedmont Technical College; David Ring, Southern Methodist University; Tony Roark, Boise State University; Matthew Roberts, Patrick Henry College; Michael Rooney, Pasadena City College; Phyllis Rooney, Oakland University; Beth Rosdatter, University of Kentucky; Michelle M. Rotert, Rock Valley College; Paul A. Roth, University of Missouri–Saint Louis; Daniel Rothbart, George Mason University; Robert Rupert, University of Colorado, Boulder; Sam Russo, El Camino College; Frank Ryan, Kent State University; Eric Saidel, George Washington University; Kelly Salsbery, Stephen F. Austin State University; Paul Santelli, Siena College; Stephen Satris, Clemson University; Philip Schneider, George Mason University; James D. Schumaker, University of North Carolina at Charlotte; Stephanie Semler, Radford University; Pat Sewell, University of North Texas; Elizabeth Shadish, El Camino College; Joseph G. Shay, Boston College; Candice Shelby, University of Colorado Denver; Janet Simpson, Suffolk County Community College; Robert Skipper, St. Mary's University; Aeon Skoble, Bridgewater State College; Matthew Slater, Bucknell University; Kent Slinker, Pima Community College; Dennis L. Slivinski, California State University, Channel Islands; Arnold Smith, Youngstown State University; John-Christian Smith, Youngstown State University; Joshua Smith, Central Michigan University; Paula Smithka, University of Southern Mississippi; Eric W. Snider, University of Toledo; Bob Snyder, Humboldt University; Joseph Snyder, Anne Arundel Community College; Lynne Spellman, University of Arkansas; David Stern, University of Iowa; James Stuart, Bowling Green State University; Paul Studtmann, Davidson College; Krys Sulewski, Edmonds Community College; John Sullins, Sonoma State University; Weimin Sun, California State University, Northridge; Corine Sutherland, Cerritos College; Robert Sutton, Cape Fear Community College; John Sweigart, James Madison University; Clarendon Swift, Moorpark College; Wayne Swindall, California Baptist College; Mojgan Taheri, California State University, Northridge; Brian Tapia, Foothill College; Bangs Tapscott, University of Utah; J. Ramon Tello, Shasta College; Mark Thames, El Centro College; Jan Thomas, University of Arkansas at Little Rock; Phil Thompson, Eastern Illinois University; Michael Thune, Joliet Junior College; Richard Tieszen, San Jose State University; Larry Udell, West Chester University; Ted Ulrich, Purdue University; Robert Urekew, University of Louisville; William Uzgalis, Oregon State University; William Vanderburgh, Wichita State University; Michael Ventimiglia, Sacred Heart University; Susan Vineberg, Wayne State University; Mark Vopat, Youngstown State University; Thomas H. Warren, Solano College; Andrew J. Waskey, Dalton State University; Roy Weatherford, University of South Florida; Chris Weigand, Our Lady of the Lake University; David Weinburger, Stockton State College; Paul Weirich, University of Missouri–Columbia; David Weise, Gonzaga University; Dennis Weiss, York College of Pennsylvania; Robert Wengert, University of Illinois at Urbana–Champaign; Shannon Grace Werre, Edmonds Community College; Gerald Joseph Williams, Seton Hall University; Derrick Willis, Temple College; Frank Wilson, Bucknell University; W. Kent Wilson, University of Illinois, Chicago; Katherine D. Witzig, Southwestern Illinois College; Sandra Woien, Mesa Community College; Stephen Wykstra, Calvin College; Julie Yoo, California State University, Northridge; Marie Zaccaria, Georgia Perimeter College; Jeffrey Zents, University of Texas; Xiaoyu Zhu, Antelope Valley College.

Finally, it has been a pleasure working with philosophy editor Debra Matteson, product director Paul Banks, content developer Florence Kilgo, production supervisor Greg Hubit, copy editor Marne Evans, and proofreader Debra Nichols. Most of all, I want to thank my wife, Linda Peterson, for her countless suggestions and support.

Why Study Logic?

Logic can be a challenging subject for beginners. Much like learning a new language, it takes patience and hard work to master the skills necessary to truly excel at logic. Given that challenging work can sometimes prove frustrating, students often wonder why logic is a required course for their major, or what the real value of learning logic truly is. This latter concern is often expressed as: How does logic help me in the "real" world? Given that students raise this question over and over, it's worthwhile to provide an answer right at the beginning of this textbook.

On the first day of any logic class, we ask our students if they regularly go to the gym. The majority say that they do. We then ask them what they do at the gym; many reply that they walk or run on a treadmill and that they lift weights. We ask them "why do you do this?" After all, they are not likely to encounter a treadmill in "real" life or to bench press weights in any other than a gym setting. As the dialogue continues, students eventually reveal that the reason they do these specific activities in the gym is because by doing so they build or maintain the muscles they need for other activities they enjoy doing, such as, surfing, hiking, biking, skateboarding, or just going for a walk on the beach.

We tell them that doing logic is, in many ways, like going to the gym for your brain. While you may never be called upon to do a formal logic proof in the context of your everyday activities, learning how to construct such a proof hones the skills needed for those routine activities. If asked what distinguishes human beings from the rest of the animal kingdom, one common answer is that humans have the ability to reason in a particular way. Learning the various techniques of logic improves and perfects that very reasoning ability that is so essential to our being human.

Moreover, recognizing that logic is primarily concerned with distinguishing good reasoning from bad reasoning may lessen some of the anxiety you have with learning this new material. It should soon become clear that you already engage in the kind of reasoning that you will learn in this textbook all the time. Studying logic will just make explicit the rules of inference (reasoning) that are already a part of your everyday life.

For example, consider the kinds of inferences you made today just to arrive at class on time: Last night, you may have set your alarm clock to wake you up in the morning. You may have reasoned, "If I want to arrive at class on time, I need to get up by 8:00 a.m. I do want to arrive at class on time, so I will set my alarm for 8:00 a.m." That is a basic form

of reasoning that logicians call *modus ponens*. We will study this particular rule of inference and many others in later chapters of the book. While calling it *modus ponens* and representing it symbolically may seem intimidating at first, remember that you already know and understand how to make this inference and you do it all the time.

To the point, if you didn't understand this rule already or couldn't draw the correct conclusion, you would likely not be alive. That is, you would have walked off a cliff or strolled in front of a speeding car or succumbed to some other tragedy. But, you stop walking when you get to the edge of a cliff, you pause at a red light and look both ways before crossing the street, and you do many other such things because you realize the importance of making inferences that are necessary to preserve your life. You are "doing logic"!

Whatever your college major or career plans, a strong foundation in making good inferences (doing logic) will improve your performance. If you are interested in science—designing an experiment, testing hypotheses, drawing warranted conclusions from the evidence, all of these involve making basic logical inferences. If you are interested in business, economics, or finance, making sound financial decisions requires knowing how to make correct inferences. If you are interested in marketing, you will do well to understand the kinds of tactics that convince people to purchase the products you are trying to promote. Sometimes this will involve asking *them* to make good inferences; for example, if you are marketing products or medications that claim to improve their lives.

However, sometimes marketing involves appealing to the emotions of consumers or to their vanity, or convincing the potential buyer that your product is necessary in some way. While such appeals are not grounded in logic, they reflect common mistakes of reasoning we call "fallacies." Chapter 3 of the textbook will introduce many of these common mistakes of reasoning. If you are a marketer you may want to draw on such appeals, for they often work! If you are a consumer, you may hope to arm yourself against such appeals so you aren't taken in by advertising claims that lead you to buy products you don't need. Either way, you are using logic.

If you are interested in computer science, you will quickly realize how necessary logic is to computer programing. In fact, the first person to invent a computer was a logician and mathematician! All the technology we have come to rely on as a part of our daily lives—our mobile phones, our iPads, our computers, and so on—are made possible by logic.

If you are interested in the humanities, philosophy, literature, the arts, or history, you too rely on logic as a fundamental part of your engagement with these subjects. There is a reason that logic is taught in philosophy departments, and that is because philosophers make and evaluate arguments across a wide range of subjects, including what gives value and meaning to life, whether it is rational to believe in a God, and what counts as having knowledge as opposed to mere belief or opinion on these and other topics. If you study literature, engaging with a text critically means evaluating its coherence, its development of characters and their motivations, and many other things, almost all of which involve

logic. In short, logic teaches and improves the kinds of knowledge and basic skills that are relevant to almost everything you do or want to study.

Finally, it's worth saying that logic can also be fun! Undertaking any new form of study can, of course, prove frustrating and challenging at times, but with patience and hard work the material gets easier and clearer. We think you will find that mastering some of these skills is rewarding in itself, and once you become good at it, you will see just how much fun it can be to identify a fallacy, point out someone else's poor argument, and even construct a proof.

1 Basic Concepts

1.1 Arguments, Premises, and Conclusions
1.2 Recognizing Arguments
1.3 Deduction and Induction
1.4 Validity, Truth, Soundness, Strength, Cogency
1.5 Argument Forms: Proving Invalidity
1.6 Extended Arguments

1.1 Arguments, Premises, and Conclusions

HOW LOGICAL ARE YOU? After a momentary absence, you return to your table in the library only to find your smartphone is missing. It was there just minutes earlier. You suspect the student sitting next to you took it. After all, she has a guilty look. Also, there is a bulge in her backpack about the size of your phone, and one of the pouches has a loose strap. Then you hear a "ring" come from the backpack—and it's the same ringtone that you use on your phone. Which of these pieces of evidence best supports your suspicion?

Find the answer on MindTap.

Logic may be defined as the organized body of knowledge, or science, that evaluates arguments. All of us encounter arguments in our day-to-day experience. We read them in books and newspapers, hear them on television, and formulate them when communicating with friends and associates. The aim of logic is to develop a system of methods and principles that we may use as criteria for evaluating the arguments of others and as guides in constructing arguments of our own. Among the benefits to be expected from the study of logic is an increase in confidence that we are making sense when we criticize the arguments of others and when we advance arguments of our own.

An **argument**, in its simplest form, is a group of statements, one or more of which (the premises) are claimed to provide support for, or reasons to believe, one of the others (the conclusion). Every argument may be placed in either of two basic groups: those in which the premises really do support the conclusion and those in which they do not, even though they are claimed to. The former are said to be good arguments (at least to that extent), the latter bad arguments. The purpose of logic, as the science that evaluates arguments, is thus to develop methods and techniques that allow us to distinguish good arguments from bad.

As is apparent from the given definition, the term *argument* has a very specific meaning in logic. It does not mean, for example, a mere verbal fight, as one might have with one's parent, spouse, or friend. Let us examine the features of this definition in greater detail. First of all, an argument is a group of statements. A **statement** is a sentence that is either true or false—in other words, typically a declarative sentence or a sentence component that could stand as a declarative sentence. The following sentences are statements:

Chocolate truffles are loaded with calories.
Melatonin helps relieve jet lag.
Political candidates always tell the complete truth.
No wives ever cheat on their husbands.
Tiger Woods plays golf and Maria Sharapova plays tennis.

The first two statements are true, the second two false. The last one expresses two statements, both of which are true. Truth and falsity are called the two possible **truth values** of a statement. Thus, the truth value of the first two statements is true, the truth value of the second two is false, and the truth value of the last statement, as well as that of its components, is true.

Unlike statements, many sentences cannot be said to be either true or false. Questions, proposals, suggestions, commands, and exclamations usually cannot, and so are not usually classified as statements. The following sentences are not statements:

Where is Khartoum?	(question)
Let's go to a movie tonight.	(proposal)
I suggest you get contact lenses.	(suggestion)
Turn off the TV right now.	(command)
Fantastic!	(exclamation)

The statements that make up an argument are divided into one or more premises and exactly one conclusion. The **premises** are the statements that set forth the reasons or evidence, and the **conclusion** is the statement that the evidence is claimed to support or imply. In other words, the conclusion is the statement that is claimed to follow from the premises. Here is an example of an argument:

All film stars are celebrities.
Halle Berry is a film star.
Therefore, Halle Berry is a celebrity.

The first two statements are the premises; the third is the conclusion. (The claim that the premises support or imply the conclusion is indicated by the word "therefore.") In this

argument the premises really do support the conclusion, and so the argument is a good one. But consider this argument:

> Some film stars are men.
> Cameron Diaz is a film star.
> Therefore, Cameron Diaz is a man.

In this argument the premises do not support the conclusion, even though they are claimed to, and so the argument is not a good one.

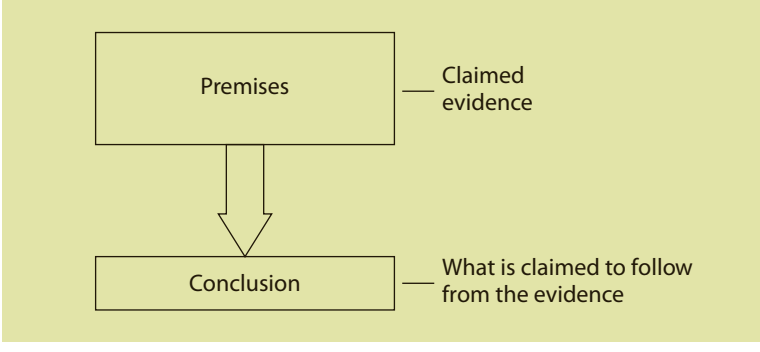
One of the most important tasks in the analysis of arguments is being able to distinguish premises from conclusions. If what is thought to be a conclusion is really a premise, and vice versa, the subsequent analysis cannot possibly be correct. Many arguments contain indicator words that provide clues in identifying premises and conclusion. Some typical **conclusion indicators** are

therefore	accordingly	entails that
wherefore	we may conclude	hence
thus	it must be that	it follows that
consequently	for this reason	implies that
we may infer	so	as a result

Whenever a statement follows one of these indicators, it can usually be identified as the conclusion. By process of elimination the other statements in the argument are the premises. Example:

> Tortured prisoners will say anything just to relieve the pain. Consequently, torture is not a reliable method of interrogation.

The conclusion of this argument is "Torture is not a reliable method of interrogation," and the premise is "Tortured prisoners will say anything just to relieve the pain."



If an argument does not contain a conclusion indicator, it may contain a premise indicator. Some typical **premise indicators** are

since	in that	seeing that
as indicated by	may be inferred from	for the reason that
because	as	inasmuch as
for	given that	owing to

Any statement following one of these indicators can usually be identified as a premise. Example:

> Expectant mothers should never use recreational drugs, since the use of these drugs can jeopardize the development of the fetus.

The premise of this argument is "The use of these drugs can jeopardize the development of the fetus," and the conclusion is "Expectant mothers should never use recreational drugs."

In reviewing the list of indicators, note that "for this reason" is a conclusion indicator, whereas "for the reason that" is a premise indicator. "For this reason" (except when followed by a colon) means for the reason (premise) that was just given, so what follows is the conclusion. On the other hand, "for the reason that" announces that a premise is about to be stated.

Sometimes a single indicator can be used to identify more than one premise. Consider the following argument:

> It is vitally important that wilderness areas be preserved, for wilderness provides essential habitat for wildlife, including endangered species, and it is a natural retreat from the stress of daily life.

The premise indicator "for" goes with both "Wilderness provides essential habitat for wildlife, including endangered species," and "It is a natural retreat from the stress of daily life." These are the premises. By method of elimination, "It is vitally important that wilderness areas be preserved" is the conclusion.

Some arguments contain no indicators. With these, the reader/listener must ask such questions as: What single statement is claimed (implicitly) to follow from the others? What is the arguer trying to prove? What is the main point in the passage? The answers to these questions should point to the conclusion. Example:

> We must get serious about modernizing our nation's crumbling infrastructure. Many of our bridges are practically falling down, and our transit system is in dire need of repair. Furthermore, making these improvements would create jobs for millions of workers.

The conclusion of this argument is the first statement, and all of the other statements are premises. The argument illustrates the pattern found in most arguments that lack indicator words: The intended conclusion is stated first, and the remaining statements are then offered in support of this first statement. When the argument is restructured according to logical principles, however, the conclusion is always listed *after* the premises:

P_1: Many of our bridges are practically falling down.
P_2: Our transit system is in dire need of repair.
P_3: Making these improvements would create jobs for millions of workers.
C: We must get serious about modernizing our nation's crumbling infrastructure.

When restructuring arguments such as this, one should remain as close as possible to the original version, while at the same time attending to the requirement that premises and conclusion be complete sentences that are meaningful in the order in which they are listed.

Note that the first two premises are included within the scope of a single sentence in the original argument. For the purposes of this chapter, compound arrangements of

statements in which the various components are all claimed to be true will be considered as separate statements.

Passages that contain arguments sometimes contain statements that are neither premises nor conclusions. Only statements that are actually intended to support the conclusion should be included in the list of premises. If, for example, a statement serves merely to introduce the general topic, or merely makes a passing comment, it should not be taken as part of the argument. Examples:

> The claim is often made that malpractice lawsuits drive up the cost of health care. But if such suits were outlawed or severely restricted, then patients would have no means of recovery for injuries caused by negligent doctors. Hence, the availability of malpractice litigation should be maintained intact.

> Massive federal deficits push up interest rates for everyone. Servicing the debt gobbles up a huge portion of the federal budget, which lowers our standard of living. And big deficits also weaken the value of the dollar. For these reasons, Congress must make a determined effort to cut overall spending and raise taxes. Politicians who ignore this reality imperil the future of the nation.

In the first argument, the opening statement serves merely to introduce the topic, so it is not part of the argument. The premise is the second statement, and the conclusion is the last statement. In the second argument, the final statement merely makes a passing comment, so it is not part of the argument. The premises are the first three statements, and the statement following "for these reasons" is the conclusion.

Closely related to the concepts of argument and statement are those of inference and proposition. An **inference**, in the narrow sense of the term, is the reasoning process expressed by an argument. In the broad sense of the term, "inference" is used interchangeably with "argument." Analogously, a **proposition**, in the narrow sense, is the meaning or information content of a statement. For the purposes of this book, however, "proposition" and "statement" are used interchangeably.

Note on the History of Logic

The person who is generally credited as the father of logic is the ancient Greek philosopher Aristotle (384–322 B.C.E.). Aristotle's predecessors had been interested in the art of constructing persuasive arguments and in techniques for refuting the arguments of others, but it was Aristotle who first devised systematic criteria for analyzing and evaluating arguments.

Aristotle's chief accomplishment is called **syllogistic logic**, a kind of logic in which the fundamental elements are *terms,* and arguments are evaluated as good or bad depending on how the terms are arranged in the argument. Chapters 4 and 5 of this textbook are devoted mainly to syllogistic logic. But Aristotle also deserves credit for originating **modal logic**, a kind of logic that involves such concepts as possibility, necessity, belief, and doubt. In addition, Aristotle catalogued several informal fallacies, a topic treated in Chapter 3 of this book.

After Aristotle's death, another Greek philosopher, Chrysippus (280–206 B.C.E.), one of the founders of the Stoic school, developed a logic in which the fundamental elements were

whole propositions. Chrysippus treated every proposition as either true or false and developed rules for determining the truth or falsity of compound propositions from the truth or falsity of their components. In the course of doing so, he laid the foundation for the truth-functional interpretation of the logical connectives presented in Chapter 6 of this book and introduced the notion of natural deduction, treated in Chapter 7.

For thirteen hundred years after the death of Chrysippus, relatively little creative work was done in logic. The physician Galen (C.E. 129–ca. 199) developed the theory of the compound categorical syllogism, but for the most part philosophers confined themselves to writing commentaries on the works of Aristotle and Chrysippus. Boethius (ca. 480–524) is a noteworthy example.

The first major logician of the Middle Ages was Peter Abelard (1079–1142). Abelard reconstructed and refined the logic of Aristotle and Chrysippus as communicated by Boethius, and he originated a theory of universals that traced the universal character of general terms to concepts in the mind rather than to "natures" existing outside the mind, as Aristotle had held. In addition, Abelard distinguished arguments that are valid because of their form from those that are valid because of their content, but he held that only formal validity is the "perfect" or conclusive variety. This textbook follows Abelard on this point.

After Abelard, the study of logic during the Middle Ages flourished through the work of numerous philosophers. A logical treatise by William of Sherwood (ca. 1200–1271) contains the first expression of the "Barbara, Celarent . . ." poem quoted in Section 5.1 of this book, and the *Summulae Logicales* of Peter of Spain (ca. 1205–1277) became the standard textbook in logic for three hundred years. However, the most original contributions from this period were made by William of Ockham (ca. 1285–1347). Ockham extended the theory of modal logic, conducted an exhaustive study of the forms of valid and invalid syllogisms, and further developed the idea of a metalanguage, a higher-level language used to discuss linguistic entities such as words, terms, and propositions.

Toward the middle of the fifteenth century, a reaction set in against the logic of the Middle Ages. Rhetoric largely displaced logic as the primary focus of attention; the logic of Chrysippus, which had already begun to lose its unique identity in the Middle Ages, was ignored altogether, and the logic of Aristotle was studied only in highly simplistic presentations. A reawakening did not occur until two hundred years later through the work of Gottfried Wilhelm Leibniz (1646–1716).

Leibniz, a genius in numerous fields, attempted to develop a symbolic language or "calculus" that could be used to settle all forms of disputes, whether in theology, philosophy, or international relations. As a result of this work, Leibniz is sometimes credited with being the father of symbolic logic. Leibniz's efforts to symbolize logic were carried into the nineteenth century by Bernard Bolzano (1781–1848).

In the middle of the nineteenth century, logic commenced an extremely rapid period of development that has continued to this day. Work in symbolic logic was done by many philosophers and mathematicians, including Augustus De Morgan (1806–1871), George Boole (1815–1864), William Stanley Jevons (1835–1882), and John Venn (1834–1923). The rule bearing De Morgan's name is used in Chapter 7 of this book. Boole's interpretation of categorical propositions and Venn's method for diagramming them are covered in Chapters 4 and 5. At the same time a revival in inductive logic was initiated by the British

philosopher John Stuart Mill (1806–1873), whose methods of induction are presented in Chapter 10.

Across the Atlantic, the American philosopher Charles Sanders Peirce (1839–1914) developed a logic of relations, invented symbolic quantifiers, and suggested the truth-table method for formulas in propositional logic. These topics are covered in Chapters 6 and 8 of this book. The truth-table method was completed independently by Emil Post (1897–1954) and Ludwig Wittgenstein (1889–1951).

Toward the end of the nineteenth century, the foundations of modern mathematical logic were laid by Gottlob Frege (1848–1925). His *Begriffsschrift* sets forth the theory of quantification presented in Chapter 8 of this text. Frege's work was continued into the twentieth century by Alfred North Whitehead (1861–1947) and Bertrand Russell (1872–1970), whose monumental *Principia Mathematica* attempted to reduce the whole of pure mathematics to logic. The *Principia* is the source of much of the symbolism that appears in Chapters 6, 7, and 8 of this text.

During the twentieth century, much of the work in logic focused on the formalization of logical systems and on questions dealing with the completeness and consistency of such systems. A now-famous theorem proved by Kurt Gödel (1906–1978) states that in any formal system adequate for number theory there exists an undecidable formula—that is, a formula such that neither it nor its negation is derivable from the axioms of the system. Other developments included multivalued logics and the formalization of modal logic. Most recently, logic has made a major contribution to technology by providing the conceptual foundation for the electronic circuitry of digital computers.

EXERCISE **I.1**

I. Each of the following passages contains a single argument. Using the letters "P" and "C," identify the premises and conclusion of each argument, writing premises first and conclusion last. List the premises in the order in which they make the most sense (usually the order in which they occur), and write both premises and conclusion in the form of separate declarative sentences. Indicator words may be eliminated once premises and conclusion have been appropriately labeled. The exercises marked with a star are answered in the back of the book.

★**1.** Carbon monoxide molecules happen to be just the right size and shape, and happen to have just the right chemical properties, to fit neatly into cavities within hemoglobin molecules in blood that are normally reserved for oxygen molecules. Consequently, carbon monoxide diminishes the oxygen-carrying capacity of blood.

(Nivaldo J. Tro, *Chemistry: A Molecular Approach,* 2nd ed.)

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2. Since the good, according to Plato, is that which furthers a person's real interests, it follows that in any given case when the good is known, men will seek it.

(Avrum Stroll and Richard Popkin, *Philosophy and the Human Spirit*)

3. As the denial or perversion of justice by the sentences of courts, as well as in any other manner, is with reason classed among the just causes of war, it will follow that the federal judiciary ought to have cognizance of all causes in which the citizens of other countries are concerned.

(Alexander Hamilton, *Federalist Papers*, No. 80)

★4. When individuals voluntarily abandon property, they forfeit any expectation of privacy in it that they might have had. Therefore, a warrantless search or seizure of abandoned property is not unreasonable under the Fourth Amendment.

(Judge Stephanie Kulp Seymour, *United States v. Jones*)

5. Artists and poets look at the world and seek relationships and order. But they translate their ideas to canvas, or to marble, or into poetic images. Scientists try to find relationships between different objects and events. To express the order they find, they create hypotheses and theories. Thus the great scientific theories are easily compared to great art and great literature.

(Douglas C. Giancoli, *The Ideas of Physics*, 3rd ed.)

6. The fact that there was never a land bridge between Australia and mainland Asia is evidenced by the fact that the animal species in the two areas are very different. Asian placental mammals and Australian marsupial mammals have not been in contact in the last several million years.

(T. Douglas Price and Gary M. Feinman, *Images of the Past*)

★7. It really does matter if you get enough sleep. We need sleep to think clearly, react quickly, and create memories. Studies show that people who are taught mentally challenging tasks do better after a good night's sleep. Other research suggests that sleep is needed for creative problem solving.

(U.S. National Institutes of Health, "Your Guide to Healthy Sleep")

8. The classroom teacher is crucial to the development and academic success of the average student, and administrators simply are ancillary to this effort. For this reason, classroom teachers ought to be paid at least the equivalent of administrators at all levels, including the superintendent.

(Peter F. Falstrup, letter to the editor)

9. An agreement cannot bind unless both parties to the agreement know what they are doing and freely choose to do it. This implies that the seller who intends to enter a contract with a customer has a duty to disclose exactly what the customer is buying and what the terms of the sale are.

(Manuel G. Velasquez, "The Ethics of Consumer Production")

★10. Punishment, when speedy and specific, may suppress undesirable behavior, but it cannot teach or encourage desirable alternatives. Therefore, it is crucial to use positive techniques to model and reinforce appropriate behavior

that the person can use in place of the unacceptable response that has to be suppressed.

(Walter Mischel and Harriet Mischel, *Essentials of Psychology*)

11. Profit serves a very crucial function in a free-enterprise economy, such as our own. High profits are the signal that consumers want more of the output of the industry. High profits provide the incentive for firms to expand output and for more firms to enter the industry in the long run. For a firm of above-average efficiency, profits represent the reward for greater efficiency.

(Dominic Salvatore, *Managerial Economics*, 3rd ed.)

12. Cats can think circles around dogs! My cat regularly used to close and lock the door to my neighbor's doghouse, trapping their sleeping Doberman inside. Try telling a cat what to do, or putting a leash on him—he'll glare at you and say, "I don't think so. You should have gotten a dog."

(Kevin Purkiser, letter to the editor)

★**13.** Since private property helps people define themselves, since it frees people from mundane cares of daily subsistence, and since it is finite, no individual should accumulate so much property that others are prevented from accumulating the necessities of life.

(Leon P. Baradat, *Political Ideologies, Their Origins and Impact*)

14. To every existing thing God wills some good. Hence, since to love any thing is nothing else than to will good to that thing, it is manifest that God loves everything that exists.

(Thomas Aquinas, *Summa Theologica*)

15. Women of the working class, especially wage workers, should not have more than two children at most. The average working man can support no more and the average working woman can take care of no more in decent fashion.

(Margaret Sanger, *Family Limitations*)

★**16.** Radioactive fallout isn't the only concern in the aftermath of nuclear explosions. The nations of planet Earth have acquired nuclear weapons with an explosive power equal to more than a million Hiroshima bombs. Studies suggest that explosion of only half these weapons would produce enough soot, smoke, and dust to blanket the earth, block out the sun, and bring on a nuclear winter that would threaten the survival of the human race.

(John W. Hill and Doris K. Kolb, *Chemistry for Changing Times*, 7th ed.)

17. An ant releases a chemical when it dies, and its fellows then carry it away to the compost heap. Apparently the communication is highly effective; a healthy ant painted with the death chemical will be dragged to the funeral heap again and again.

(Carol R. Ember and Melvin Ember, *Cultural Anthropology*, 7th ed.)

18. Every art and every inquiry, and similarly every action and pursuit, is thought to aim at some good; and for this reason the good has rightly been declared to be that at which all things aim.

(Aristotle, *Nicomachean Ethics*)