An Introduction to Critical Thinking and Creativity

Think More, Think Better

Joe Y. F. Lau

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CONTENTS

PREFACE

This is a textbook on critical and creative thinking. It can be used as a course text or a self-contained study guide. Since there are many similar textbooks in the market, let me describe some special features of this book:

- Unlike most textbooks, I discuss both critical and creative thinking because they are equally important for problem solving and they are not independent of each other. We need creativity in critical thinking to come up with arguments, counterexamples, and alternative explanations. And creativity needs critical thinking in evaluating and improving new ideas. They are both part of the essential thinking toolkit.
- Good thinking requires not just knowledge of the principles of good reasoning. We discuss them of course, but personality and other psychological factors matter as well. This book emphasizes the importance of attitudes and practice for good thinking. We also discuss findings in cognitive science and psychology, such as cognitive biases in reasoning and decision making.
- Our thinking directly affects our life through the choices we make. These choices depend in part on our values and moral outlook. It is of utmost importance that we can think about these issues critically and impartially. I therefore include a chapter on decision making and another one on the foundation of moral reasoning.

- This book has a companion website: Critical Thinking Web. It is located at http://philosophy.hku.hk/think, and hosted by the Philosophy Department of the University of Hong Kong. The website includes many online tutorials that are used in schools and universities around the world. A special section is devoted to this book, which includes errata, additional notes and exercises, and further readings.
- This book is not an encyclopedia on thinking skills. It aims to be a short and readable text, providing the reader with a practical and sound foundation. I deliberately leave out a complete treatment of Venn diagrams and standard formal logic. Interested readers and teachers can consult the companion website for online tutorials on these topics.
- Useful facts and rules are often presented in bullet points to make them clearer. I also include many examples from finance and business to show how critical thinking is relevant to a variety of careers.

A note of warning: To make the text more readable and the sentences shorter, sometimes I simplify and leave out minor qualifications. I am also less strict with the use of quotations marks than I would otherwise be as an academic philosopher. Finally, many of the ideas in the book are not original. They come from other philosophers, psychologists, and experts in other areas.

Thanks to Tim van Gelder for his comments on my earlier book proposal. I also want to thank Lee Tien Ming and Jonathan Chan. I have learned a lot about critical thinking from all of them. I would also like to thank Executive Editor Stephen Quigley at John Wiley & Sons, Inc., and Assistant Editor Jacqueline Palmieri. They have been most patient even though I kept missing one deadline after another. On a more technical matter, this book was typeset with LaTeX. It has made the whole project so much more efficient and enjoyable. Thanks to Donald Knuth, Leslie Lamport, and other contributors to the system. Finally, this book is the result of over ten years of teaching in critical thinking. My heartfelt thanks to the many generations of students who endured my classes and smiled politely at my jokes.

Joe Y. F. Lau

Hong Kong
January, 2011

CHAPTER 1

INTRODUCTION

1.1 THINKING SKILLS IN THE AGE OF GLOBALIZATION

Whether we like it or not, globalization is changing the way we work and live. First of all, we are increasingly faced with complex problems that affect the whole world, whether it is global warming, pollution, financial crises, or new epidemics. We need good thinking and creative ideas to coordinate efforts to solve these problems. At the personal level, globalization brings about an ever-quickening pace of life. We have a huge amount of information available, but what we learn today might easily become obsolete tomorrow. Although fast changes also bring new opportunities, we now have to compete with talented people across the world. To be successful in this environment, we need good thinking skills that can help us make reliable decisions and acquire new knowledge quickly.

But what do we mean by good thinking skills? Basically, it comes down to two things—critical thinking and creativity. Critical thinking is thinking clearly and rationally. It involves thinking precisely and systematically, and following the rules of logic and scientific reasoning, among other things. As for creativity, it is a matter of coming up with new and useful ideas, generating alternative possibilities. This book is about these two sets of thinking skills, but at this point, you might ask,

Which is more important, critical thinking or creativity? The short answer is that they are equally important. We need creativity to come up with ideas to solve problems, but we also need critical thinking to evaluate and improve these ideas. They complement each other, and we need both to survive and to prosper.

In this book we shall discuss critical thinking first, and come back to creativity near the end. As we shall see, there is a lot more we can say systematically about critical thinking. A critical thinker is someone who is able to do the following:

- Understand the logical connections between ideas.
- Formulate ideas succinctly and precisely.
- Identify, construct, and evaluate arguments.
- Evaluate the pros and cons of a decision.
- Evaluate the evidence for and against a hypothesis.
- Detect inconsistencies and common mistakes in reasoning.
- Analyze problems systematically.
- Identify the relevance and importance of ideas.
- Justify one's beliefs and values.
- Reflect and evaluate one's thinking skills.

As we can see from the list, critical thinking skills are essential for all sorts of careers in which we have to communicate ideas, make decisions, analyze, and solve problems. This is why critical thinking is called a *domain-general* thinking skill. But critical thinking is not just for the workplace. To live a meaningful life and plan for the future, we need to think about ourselves honestly and carefully. The Greek philosopher Socrates (469–399 B.C.E.) once said, "the unexamined life is not worth living." One big difference between human beings and other animals is our capacity for self-reflection. We can examine the purpose and meaning of our life and change ourselves accordingly. Critical thinking contributes to this process of self-evaluation and transformation.

Good critical thinking is also the foundation of science and democracy. Science requires rationality in designing experiments and testing theories. A vibrant and progressive democracy requires citizens who can think objectively about social and political issues and are able to avoid biases and prejudices. So obviously the cultivation of critical thinking should be a central aim of education.

1.2 SOME MISCONCEPTIONS ABOUT CRITICAL THINKING

However, critical thinking is sometimes thought to be too confrontational. Some people think critical thinking means criticizing others all the time, which is not constructive. But this is a misunderstanding. Critical thinking is not a purely

destructive force. First, by rejecting bad ideas, we become better at finding the truth. Second, thinking critically does not mean we criticize people all the time. When other people are right, we don't have to disagree. And when other people are wrong, critical thinking helps us recognize the mistakes being made, but it does not follow we have to publicly denounce them. Sometimes mistakes do not matter. Sometimes we have to be polite, and sometimes we can help people reason better not by criticizing them but by other indirect means—for example, by giving hints and suggestions. A critical thinker can be sympathetic and constructive rather than confrontational.

Another objection to critical thinking is that it is not practically useful because people in real life do not listen to reason. They act on the basis of self-interest, emotion, or personal relationships. The first problem with this objection is that it confuses rational thinking with *talking* about reasons. It might be true that many people are irrational, and to influence them we need to appeal to authority, emotions, or anything other than reason. But we can still use critical thinking to think strategically about the best means to achieve our objectives.

The objection is also wrong in assuming that critical thinking is opposed to emotions, relationships, and so on. Consider for example love and friendship. They are certainly valuable, but critical thinking can help us cultivate them. For example, thinking carefully about what is good or bad about a relationship can help us improve it and make it more fulfilling. Besides, it is not always wise to act solely on the basis of emotions. They can be biased by ego, fear, and greed. Thinking more about our decisions can counteract this problem.

1.3 IMPROVING OUR THINKING

So how do we enhance our critical thinking if it is so useful? Obviously, we are all able to think critically to some extent, or we will not survive very long! But there is always room for improvement. Even with a skill as natural as running, training with an expert can improve our breathing and posture and help us run even better. Thinking is something we all do and take for granted, but the fact is that even normally intelligent people can sometimes be stubborn and biased. Psychology research tells us that people make lot of mistakes in their reasoning—they overestimate their abilities, interpret the world to confirm their prejudices, and look for causes and patterns in the wrong places. By studying critical thinking, we are more likely to avoid such errors. We can also help other people by studying critical thinking. Sometimes we get the feeling that an argument is wrong but we do not know exactly why. Critical thinking gives us the concepts and vocabulary to explain what is wrong. This promotes understanding and more effective discussions.

Good critical thinking is a cognitive skill. In general, developing a skill requires three conditions—learning the theory, deliberate practice, and adopting the right attitudes. By *theory* we mean the rules and facts we have to know in order to possess the skill. For example, one cannot be a good basketball player without

knowing the rules of the game—for example, kicking the basketball is not allowed. Likewise, thinking critically requires knowing a certain amount of logic. However, knowing the theory is not the same as being able to apply it. You might know in theory that you should balance the bike when you are cycling, but it does not mean you can actually do it. This is where practice comes in, because it translates your theoretical knowledge into actual ability. However, your attitudes make a big difference as to whether your practice is effective and sustainable. If you hate playing the piano, forcing you to practice is not productive in the long run.

1.3.1 Theory

Let us now look at the theoretical knowledge required for good critical thinking. It can be divided into five main areas, and in this book we shall discuss all of them:

1. **Meaning analysis**: Explain ideas clearly and systematically; use definitions and other tools to clarify meaning and make ideas more precise.
2. **Logic**: Analyze and evaluate arguments; identify logical consequences and inconsistencies.
3. **Scientific methods**: Use empirical data to test a theory; identify causes and effects; probability theory and statistics.
4. **Decision and values**: Rational decision making; critical reflection of value frameworks and moral judgments.
5. **Fallacies and biases**: Typical mistakes of reasoning and the psychological traits likely to cause such mistakes.

Naturally you will find some topics more interesting than others. But whether we are learning martial arts or the piano, there are basic techniques we have to master. They might be boring, but they form the foundation of more advanced techniques. The same is true of critical thinking. Some theories and principles seem rather dry and abstract, but I hope you will appreciate their power and relevance to everyday thinking once you understand how they can be applied.

1.3.2 Practice

Psychologists have discovered a 10-year rule when it comes to acquiring a skill. It takes about 10 years of intensive and structured practice—around 10,000 hours of practice—to reach world-class level in a certain area, even for a talented individual. This rule is supposed to apply to all kinds of expertise, whether it is sports, music, chess, writing, or scientific research. Even a genius prodigy such as Mozart spent years practicing musical instruments and writing lesser pieces, under great pressure from his father, who was himself an outstanding musician. Many of Mozart's childhood compositions were arrangements of works by other composers, or they were thought to be partly written by his father. His piano con-

certo No. 9 (K.271) is perhaps the earliest original work that is highly regarded by critics. But by then Mozart had already been composing for over 10 years.

Years of early training and dedicated parents are two typical themes in achieving world-class performance. Tiger Woods has been one of the most successful golf players of all time. His father, Earl, gave him a sawed off a golf club to play with when he was 9 months old. When Tiger was 18 months old, Earl started taking his son to the golf course, and a coach was hired when Tiger was 4 years old. Earl continued to train his son, and just over 10 years later in 1991, Tiger became the youngest ever U.S. Junior Amateur Champion.

Of course, it is probably unrealistic to expect all of us to put in the same amount of effort solely into improving our thinking. But what empirical research tells us is that good thinking does not come for free. If we are serious about improving our minds, we have to come up with a plan and be ready to spend a lot of time training. Just reading this book is not going to be enough. You also need to do the exercises and apply your knowledge to your daily life. Critical thinking should become a natural habit, a way of life, rather than something you do occasionally.

How do we turn critical thinking into a natural habit? Here is a simple and practical method for you to try out. We call it *the fourfold path to good thinking.* To follow the method, we make it a habit to ask these four basic questions about the ideas we come across:

Question	**Issues to think about**
What does it mean?	Are the keywords and the main concepts clear? Can the ideas be made more precise? How is it related to other things? Any examples to illustrate what is meant?
How many supporting reasons and objections?	List the reasons for and against the claim. Count and evaluate these reasons. Think about both sides of an issue. Any counterexamples to the claim?
Why is this important or relevant?	What are the major consequences? How does it affect people? Is it useful? Is it surprising? Have I learned something new and interesting?
Which are the other possibilities to consider?	What other information might be relevant? Any similar cases to think about?

These questions look simple, but they are actually quite powerful because they introduce a good structure to organize our analysis. As an example, suppose we are discussing whether it is wrong to eat (nonhuman) animals. Here is how we might apply the fourfold path:

1. The first question—what does it mean?—is about clarifying the key concepts so that we can understand more clearly the claim under discussion.

    - What do we mean by *animals*? Dogs and chickens are obviously animals. But what about fish, oysters, insects, bacteria? Is it also wrong to eat them? Where do we draw the line?
    - If eating animals is wrong, how wrong is it? As bad as killing people?

2. To carry out the second step of the fourfold path, we list all the reasons for and against the claim under consideration.

    - Arguments against eating meat might include: animals have rights, animal farming create a lot of suffering, and it is more efficient to use land to grow vegetables than to raise animals.
    - Arguments on the opposite side might include: farm animals exist because of us and so we can do what want with them, and humans are more intelligent than animals.
    - It is always a good idea to be able to *count* the number of arguments. For example, three arguments in support and two against.
    - Think about both sides of an issue. Even if you think eating meat is fine, you should try your best to come up with opposing arguments. You will gain a deeper understanding of your own position and be able to defend it better.
    - Evaluate the arguments on both sides. What seems to be a good argument might turn out not to be the case on further reflection—for example, why can we eat animals just because we are smarter? Does it also mean adults can eat babies and intelligent aliens can eat human beings?

3. The third step of the fourfold path is to consider whether the issue is important. Does it really matter what the correct answer is? What are the theoretical, social, personal, or political implications?

    - How would the world be different if more people give up meat?
    - How important is this question compared with other issues such as poverty and starvation?

4. The last step is to explore alternative possibilities and further issues.

    - Does the level of intelligence of the animal make a difference?
    - How about eating animals raised in a happy environment and killed in a painless manner? Is this also wrong?
    - What about eating animals that die naturally? What if we can grow meat from stem cells and eat meat without killing animals?

As you can see, although the fourfold path consists of four very simple questions, they help us examine an issue in depth from different perspectives. To improve your thinking, use this method often in your daily life, when you read magazines, surf the web, watch TV, or chat with others. You will become a more sophisticated, systematic, and creative thinker.

Critical thinking and investment

The idea that we should think critically might seem downright boring, and yet we should not underestimate the power of critical thinking. It requires having the discipline to reflect on the reasons for our actions, and this is very important if we want to improve ourselves and become more successful. Warren Buffet is one of the world's richest persons, widely admired for his investment record and philanthropy. The adherence to critical thinking is a crucial factor in Buffet's success. Here is what he says about the importance of being able to give reasons for our actions:

> You ought to be able to explain why you're taking the job you're taking, why you're making the investment you're making, or whatever it may be. And if it can't stand applying pencil to paper, you'd better think it through some more. And if you can't write an intelligent answer to those questions, don't do it.
>
> I never buy anything unless I can fill out on a piece of paper my reasons. I may be wrong, but I would know the answer to that. "I'm paying $32 billion today for the Coca-Cola Company because..." If you can't answer that question, you shouldn't buy it. If you can answer that question, and you do it a few times, you'll make a lot of money.

Making money might not be our top priority, but if we can apply the same discipline in giving reasons for our actions and think about these reasons carefully, we are more likely to achieve our goals.

1.3.3 Attitude

If you enjoy an activity and believe it is important, you will probably put in more effort and pay more attention to your performance. Similarly, there are positive attitudes that are more conducive to good thinking:

- **Independence of thought**: Good thinking is hard. Some people just want to know the answers rather than work it out themselves. Others have no patience for abstract or complicated ideas. A good thinker is able to think independently and go against conventional wisdom if need be.

- **Open-mindedness**: A good thinker looks at the evidence objectively, and is willing to suspend judgment or change her opinion depending on the evidence. This is not a sign of weakness. An open-minded thinker is not dogmatic. She is willing to admit mistakes, think about new possibilities, and will not reject new ideas without good reasons.
- **Cool-headedness and impartiality**: Good thinking does not require giving up emotions. But we should avoid letting our feelings overwhelm our reasoning. For example, it is difficult to think straight if you get angry easily when other people disagree with you. Fair and objective evaluations help us make better decisions.
- **An analytical and reflective attitude**: Do not jump to conclusions. A good thinker is one who spends time to analyze an issue systematically and carefully and to actively search for arguments and evidence on both sides. She is interested in learning more about her own strengths and weaknesses to improve her performance.

These attitudes are crucial for good thinking, but they are more a way of life than a piece of theoretical knowledge. They have to be internalized to become part of our natural habit and personality. This is easier said than done! Good thinking takes a lot of time and effort. But look at it this way: If we are willing to change ourselves when most people don't, this gives us the opportunity to excel and become better than average.

EXERCISES

Note: Suggested answers are at the end of the book, except questions that are marked with ☒.

1.1 This is a passage from the management best-seller *In Search of Excellence* (Peters and Waterman, 1982, p. 108). Can you summarize the argument against intelligence and logical thinking? Is it a good argument or not? Explain your reasons.

> If you place in a bottle half a dozen bees and the same number of flies, and lay the bottle horizontally, with its base (the closed end) to the window, you will find that the bees will persist, till they die of exhaustion or hunger, in their endeavor to discover an opening through the glass; while the flies, in less than two minutes, will all have sallied forth through the neck on the opposite side. ... It is the bees' love of flight, it is their very intelligence, that is their undoing in this experiment. They evidently imagine that the issue from every prison must be where the light shines clearest; and they act in accordance, and persist in too-logical action. To bees glass is a supernatural mystery. ... And, the greater their intelligence, the more inadmissible, more incomprehensible, will the strange obstacle appear. Whereas

> the featherbrained flies, careless of logic ... flutter wildly hither and thither, and meeting here the good fortune that often waits on the simple ... necessarily end up by discovering the friendly opening that restores their liberty to them.

1.2 Do you agree with these remarks? Explain your answers.

a) Critical thinking is too negative because we are always trying to find fault but this is not a very healthy attitude.

b) Critical thinking is not very useful because personal connections and relationships are more important for success.

c) We often have to make decisions very quickly without a lot of time to think. So critical thinking is not really that useful.

1.3 Here is another definition of critical thinking from Scriven and Paul (1987). How would you compare this definition with the one in this book?

> Critical thinking is the intellectually disciplined process of actively and skillfully conceptualizing, applying, analyzing, synthesizing, and/or evaluating information gathered from, or generated by, observation, experience, reflection, reasoning, or communication, as a guide to belief and action. In its exemplary form, it is based on universal intellectual values that transcend subject matter divisions: clarity, accuracy, precision, consistency, relevance, sound evidence, good reasons, depth, breadth, and fairness.

1.4 ☒ Apply the fourfold path to the following claims and list the issues and questions you should consider.

a) It is always better to have more choices.

b) Buying stocks is a good investment because the stock market always goes up in the long run.

c) It is not wrong for a person to commit suicide rather than to suffer through a painful terminal illness.

1.5 Here are some questions for you to reflect on your thinking attitudes. Which of them are true of you?

a) I can improve my thinking skills further.

b) The purpose of thinking is not to be right all the time.

c) I am not afraid to try out new ideas.

d) Thinking takes time and might not be easy.

e) I do not enjoy thinking about complicated ideas.

f) Thinking is boring and it is better to spend time doing other things.

g) Thinking is easy. I just use my gut feelings to make up my mind.

h) The point of giving reasons is to show people that they are wrong.

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CHAPTER 2

THINKING AND WRITING CLEARLY

Do you believe in UFOs? According to a poll in 2005, 34% of Americans do. In 2007, Japanese Cabinet Secretary Nobutaka Machimura caused quite a stir when he said on TV that UFOs "definitely" exist. But before you answer the question, pause and think about what UFO means. It is actually an abbreviation for "unidentified flying object." In other words, if there is something in the sky and nobody knows what it is, then it is an UFO. On this interpretation, there are certainly plenty of UFOs, but they could have been weather balloons, atmospheric reflections, and so on. Of course, UFO can also mean an alien spaceship. If this is what is meant, then it is not so clear that there are any.

This example shows that when the meaning of a claim is unclear, it might be impossible to say whether it is true or false. Two people might disagree about the existence of UFOs, but the disagreement is pointless if they are using the term to mean different things. Being clear helps us avoid such verbal disputes. The UFO example also illustrates a crucial habit we should cultivate if we want to become a better thinker—before accepting a claim, pause to think about what it means and whether we understand what it says. We are bombarded with sound bites and slogans every day, and we should avoid accepting them uncritically.

Consider the popular idea that the economy should be a free market without government interference. Before deciding whether we agree or disagree, we need to clarify what a free market is and what counts as interference. For example, surely companies are not free to harm people. But then what about regulating pollution or monopolies? Would investment in education and research count as interference? What about supporting arts and culture or disadvantaged minorities such as the disabled? Once we start thinking about these issues, we begin to realize that a totally free market is undesirable. The real issue is not whether, but how, the government should regulate the economy.

Although we should try to improve the clarity and precision of ideas, this is not an absolute rule. Sometimes there is no need to be clear. We do not need to understand the physics of microwave radiation to use a microwave oven. What is important is that *we can explain things clearly when we need to.* But what kind of skills do we need to be able to think and communicate ideas clearly? We are going to discuss two methods below: enhancing our sensitivity to literal meaning and making connections between ideas.

2.1 LITERAL MEANING

To begin with, we ought to be able to identify the **literal meaning** of a statement and distinguish it from its **conversational implicatures**. Literal meaning is a property of linguistic expressions. The literal meaning of a sequence of words is determined by its grammatical properties and the meanings that are conventionally assigned to the individual words. For example, the literal meaning of *bachelor* in English is "an unmarried man". The phrase *I cannot be happier* literally means it is impossible for the speaker to be more happy than he or she is right now.

On the other hand, the conversational implicature is the information that a speaker implicitly conveys in a particular context, distinct from the literal meaning of what might have been said. Someone who looks at the windows and says, "It is cold here," might be suggesting that the windows be closed. But this message is distinct from the literal meaning of the statement. Similarly, the phrase *I love books* seems to say that the speaker likes reading, but strictly speaking that is again not part of the literal meaning. The sentence is still true if the speaker does not like to read but loves to collect books as a form of investment or to show off.

Of course, good communication skills require sensitivity to conversational implicatures or related clues such as body language. But we should also be able to use literal meaning to convey ideas directly and explicitly. First, it helps us avoid misunderstanding. Second, the truth of what we say generally depends on literal meaning and not the conversational implicature. Suppose I tell you, "I shall try to come to the meeting." This reply is similar to "I will come," but with a significant difference. If I use the first sentence and I fail to show up, I can at least say I tried but could not make it in the end. But if I use the second sentence, I will have made a promise, and failing to show up implies that I have broken my promise and said something false. So if you care about truth and promises, you should care about

literal meaning. This is particularly important in law, when it comes to interpreting legislation and contracts. Take the following two clauses for a rental contract. They look similar, but they differ in literal meaning. Which version should you use for your lease if you were a prospective tenant?

1. You may terminate the lease after 12 months by giving 2 months' notice.
2. After 12 months, you may give 2 months' notice and terminate the lease.

This example illustrates an important technique in clarifying meaning. One way to explain differences in literal meaning is to identify their different logical implications. The first clause implies a lease that lasts for a minimum of 12 months (if you give notice to leave the apartment at the end of the 10th month), whereas the second one implies a minimum lease of 14 months. Obviously, if you are renting an apartment you want more flexibility and to have the option to move out as early as possible if you need to. So the first clause is preferable. As you can see, attention to literal meaning can clarify our rights and duties and help us avoid unnecessary disputes and nasty surprises later on.

Attention to literal meaning is useful in other contexts as well. For example, as consumers we are naturally concerned about the safety and quality of our food, and to make informed choices we need to paying attention to the meaning of food labels. Nowadays lots of foods are supposed to be low-fat, but *low-fat* does not imply low-sugar or low-salt. Food with "no artificial flavors" can contain preservatives, and "hormone-free" chicken might be injected with lots of antibiotics. Interesting enough, the American food company Tyson at one point was selling chickens advertised as "raised without antibiotics" when in fact the chicken eggs were injected with plenty of antibiotics before they hatched! The company insisted that they had not advertised falsely, because "raised" literally applies only to the bringing up the chicks *after* they have hatched. Whether you agree with this definition or not, it tells us that those who are concerned about food safety have to be very careful about the meanings of food labels.

2.2 CONNECTING IDEAS

Albert Einstein (1879–1955) once said, "If you can't explain it simply, you don't understand it well enough." Many people are attracted to obscure ideas that they cannot explain. They think the ideas are profound, and they might well be right. But it is often just an illusion. To avoid such self-deception, we should ensure that we can explain our ideas clearly and systematically. The way to do it is to connect our ideas to other ideas. The following sections present some typical methods.

2.2.1 Give examples

Understanding words and concepts through examples is central to learning—think about how children learn words like *red* and *vegetables*. Being able to give your

own examples is a good sign that you understand a concept well enough to apply it. Concrete examples are good for illustrating abstract concepts. The speed of light is about 300,000 kilometers per second. This number means nothing to most people. But explain that at this speed you can go round the world seven times in one second, it suddenly becomes very impressive.

Choose your examples carefully in your writing and presentations. Vivid and unexpected ones create a deeper impression. Personal stories that your audience can relate to will make your message seem more relevant. Contrasting or opposite examples are also useful, as in explaining why a rule applies in one situation but not another.

2.2.2 Definitions

Definitions can go further than examples in explaining the full meaning of a term. Why are human beings and cows examples of mammals, but fish and turtles are not? You need a definition of *mammal* to explain why. Definitions are also useful in removing ambiguity and making meaning more precise. (See Chapter 3 for further discussion.)

2.2.3 Identifying implications

To explain theories, proposals, and rules, we can point to their distinctive consequences. In other words, we explain how they make a difference if they are correct or accepted. For example, utilitarianism is the moral theory that the right thing to do in any situation is to choose the action that will maximize the greatest happiness for the greatest number of people. What does that mean? It means we should make more people happy rather than just ourselves. But it also implies that the interests of a small minority can be sacrificed if this will make the majority happier. Similarly, scientists say global warming might lead to a 5°C increase in temperature by 2100. To explain this further, we can list the dire implications, such as rising sea levels, disappearing glaciers, global water shortages, and one third of all species being threatened with extinction. Understanding the consequences of a theory allows us to see its significance and connect it to other ideas.

2.2.4 Compare and contrast

Understanding something implies knowing how it is different from other things. To explain how sentences P and Q are different in meaning, find a situation in which one is true and the other one is false, as in the rental contract example earlier. Similarly, you can explain the differences between concepts by showing that they apply in different situations. Take *speed* and *acceleration*. Acceleration is the rate of change of speed. Something moving at a very high speed can in fact have zero acceleration if the speed does not change. Similarly, an object can have a high acceleration if it changes speed very quickly, even if the final speed is very low. In law, there is a difference between *charitable* and *non-profit* organizations.

All charitable organizations are non-profit, but non-profit organizations need not be charitable. Roughly speaking, charitable ones must be for the benefit of the general public. So a club that aims to benefit only certain private members is not charitable, even if it is not for profit.

2.2.5 Breaking things down

To understand how a complex system works, we can look at its parts and how they interact with each other. A mechanic fixes a car by checking the functions of different parts and see if they fit together properly. A wine buff evaluates a wine by focusing on the different aspects of taste, color, smell, and texture and their balance.

Similarly, we can explain an idea more clearly by breaking it down. For example, in this book we explain good thinking in terms of critical and creative thinking. We then define critical thinking as clear and rational thinking, and we can explain clarity and rationality further. A general idea is broken down into smaller concepts, and the smaller concepts are broken down even further, like a tree trunk leading up to the main branches and then smaller and smaller branches. Organizing ideas like a tree has many advantages. It makes them easier to understand and remember. It also helps us adjust the level of details we want to provide in our explanations to other people. We can start with the ideas at the top level, and go down further and further depending on the audience and the time we have. Some people are incapable of explaining anything without launching into a 10-minute speech. But an intelligent person with a deep understanding is just at ease giving a 10-second explanation as a 10-minute one.

2.3 FIVE TIPS FOR EFFECTIVE WRITING AND PRESENTATION

Good communication is not just about using words with the right meaning. We also need to think about how ideas are packaged in a way that is attractive and easy to understand. It would be a pity if you put in a lot of effort but still fail to convey your important ideas. The basic rule is simple enough—*make sure that your ideas are simple, organized, and relevant to your readers.* It is easier said than done, but improving our writing and presentation can improve our critical thinking as well. Here are five general guidelines.

Tip 1: Know your audience

Focus on the points your audience will find interesting and relevant. We can communicate more effectively and leave a better impression. Ask yourself these questions:

- How much does the audience know about the topic? Are they professionals or lay people, or both? Provide the appropriate level of information.

- What do they expect from you? Is your goal to entertain, to inform, or to demonstrate your knowledge? What would the audience be most interested in? Facts, diagrams, predictions, practical advice, or personal stories?
- Should you consider any special requirements about the format? Should you provide handouts? Use a projector? Provide a summary? Is there a word or time limit?

Tip 2: What is your central message and why is it important?

It is an open secret that people who listen to a talk quickly forget most of it. The same goes for students attending lectures. When people remember things, it is because they find something interesting, useful, or funny. So think carefully about the main purpose of your presentation. Is there a take-home message? Focus on it and deliver the message clearly. If everything is important, then nothing will stand out as important. You need to make a choice about which idea to emphasize. If people are going to spend part of their lives listening to you or reading your work, which is the one thing you can point to in order to show that they have not wasted their time?

In particular, learn how to formulate a **thesis statement** for presentation and writing that is analytical in character—that is, involving analyses, arguments, or explanations. The thesis statement is a claim that summarizes the most important point you want to make. Suppose you want to write an essay explaining that people worry too much about radiation from mobile phones. Somewhere near the beginning of the essay you should write down your main point. It sets the tone of the essay and shows the reader what he or she might expect later on. For example, this can be the first sentence of your introduction:

> Many people believe that mobile phones emit dangerous radiation, but there is to date no convincing evidence that mobile phones cause cancer or other serious health problems.

Later on in the essay you can then say more about how worried people might be about this issue and what the relevant scientific studies say. Ideally, your thesis statement should be informative and attract the attention of your reader. (See the companion website for further discussion.)

Tip 3: Organize your ideas

Good writing takes time to ferment. Always begin with some research and analysis before you start typing out the real thing. Read widely and collect data, diagrams, photos, arguments, articles, and web pages and whatever else might be relevant. When you have collected enough material, think about their connections and the proper order of presentation. Develop the habit of using a point-by-point outline to organize your ideas, where each point might be a concept or a short sentence. The outline helps you distill and organize your ideas.

Recently declassified documents in the United States includes a handwritten outline by former President Richard Nixon (1913–1994). Whatever we might think of Nixon,[1] his historic visit to China in 1972 was widely regarded as a diplomatic achievement. It was the first time a U.S. president visited the People's Republic of China, and it started the normalization of relations between the two countries. But when he was preparing for his visit, Nixon used the following simple outline to condense the most fundamental issues into a list of bullet points. It might be somewhat surprising to see that complicated diplomatic issues between two countries can be written down on half a page, but the beauty of this outline is that the fundamental issues are organized so clearly:

What they want:

1. Build up their world credentials
2. Taiwan
3. Get US out of Asia

What we want:

1. Indochina (?)
2. Communists — to restrain Chinese expansion in Asia
3. In Future — Reduce threat of confrontation by Chinese Super Power

What we both want:

1. Reduce danger of confrontation + conflict
2. a more stable Asia
3. a restraint on U.S.S.R

Organization also means being clear about the function of every part of your writing. This includes:

- The whole presentation or article should have different parts. An essay typically starts with an introduction, followed by further background information, the supporting evidence and arguments, potential objections, and a conclusion.
- Each paragraph should have a clear function—for example, explaining a definition, describing some data, replying to an objection, or adding a qualification.

[1] He was involved in the coverup of a politically motivated burglary. The so-called Watergate scandal eventually led to the imprisonment of some of his aides and his own resignation, the first and only resignation of a U.S. president.

Tip 4: Be simple and direct

Leonardo da Vinci (1452–1519) is supposed to have said: "Simplicity is the ultimate sophistication." Many people think profound writing must be difficult and long. So they use complicated sentences and long words to impress people. This is a mistake. Simple writing conveys ideas more clearly. Convoluted writing gives the impression that we are bad at explaining things. In a recent study, people who used plain language were judged to be more clever than those who used long words needlessly (Oppenheimer, 2006).

Sometimes people fail to write in a simple way because they want to give as much information as possible. Paradoxically, this can have the opposite effect. People switch off their attention and forget things quickly unless they come across something really interesting. Information overload can therefore bury your main message. So be ruthless and cut out irrelevant material. Go through every word and sentence you have written and see if they can be simplified. Consider this example:

> If there are any points on which you require explanation or further particulars we shall be glad to furnish such additional details as may be required by telephone. Our telephone number is 555-5555.

This sentence is typical of many company brochures, but it is awkward and unnecessarily long. The folllowing is much simpler:

> For enquiries, please call 555-5555.

Some writers are also accustomed to long phrases when in fact simpler ones will do. Here are some common phrases that can be shortened:

Phrases	→	**Shorten to**
in order to		to
in the event that		if
whether or not		whether
is in agreement with		agree with
provide a description of		describe
come to the decision		decide

Below are some other rules for simple and direct writing. But remember that they are just guidelines with plenty of exceptions.

- Break up long sentences (for example, more than 30 words) into shorter ones. Avoid linking sentences with *and.*
- Use the active voice instead of the passive voice. "The customer filed a complaint" rather than "A complaint was filed by the customer."

- Use positive rather than negative terms. "The room was clean" rather than "The room was not dirty."

- A good test is to read a passage aloud and see if it sounds clumsy. Easy-to-read text has a higher chance of being understood.

Tip 5: Rewrite, rewrite, rewrite

Good writing does not finish with your first draft. A good author will reread every word and sentence and think about how to make the text even better. Hemingway, who won the Nobel Prize in literature in 1954, said he rewrote the ending to *A Farewell to Arms* thirty-nine times, just to "get the words right."[2] Leonardo da Vinci used a mirror to look at his own painting in reverse so it would look less familiar and he could criticize his work better. This is why it is a good idea to leave your finished writing aside for a while. Read it aloud again later with a fresh eye, and it will be easier to spot problems. Of course, you can also get someone else to read it and give some advice. But try as hard as you can to find something that can be improved, even if it is just deleting a word or changing the order of a few sentences. Good writing is often like a great performance—beautiful to behold and seeming to be without effort, but in reality it is the product of intense labor and love.

Rereading what we have written sounds obvious, but it is surprising how few people do it, even when mistakes are costly. A survey of UK recruitment firms found that more than half of the application CVs they have received contain grammatical and spelling errors, leaving a bad impression on prospective employers. Furthermore, applicants aged between 21 and 25 years made the most mistakes. Most firms also said applicants were wasting their time by including details about their hobbies and interests (BBC, 2010).

EXERCISES

2.1 For each pair of sentences below, explain whether they differ in literal meaning.

a) Do not be evil. Be good.

b) I like lobsters. I like eating lobsters.

c) We do not add preservatives to our food. Our food contains no preservatives.

d) Do not say anything if the police are here. Do not say anything in case the police are here.

e) You may kiss the bride. You must kiss the bride.

f) Everyone is not sick. Not everyone is sick.

[2] He also has this to say about his experience working at a newspaper: "On the *Star* you were forced to learn to write a simple declarative sentence. This is useful to anyone." He also told F. Scott Fitzgerald, "I write one page of masterpiece to ninety-one pages of shit. ... I try to put the shit in the wastebasket."

g) Nothing that is good is cheap. Nothing that is cheap is good.

h) There are many restaurants and the best one is The French Laundry. There is no restaurant better than The French Laundry.

2.2 ☒ How would you explain the differences in meaning of the following terms?

a) eternity, infinity

b) ideal, paradigm

2.3 Imagine that following paragraph is taken from a reference letter for a student named Harry. Read each sentence carefully, and explain why the paragraph does not literally say anything positive about Harry.

> Harry's abilities must be seen to be believed. The amount of material he knows will surprise you. It would be very hard to find someone as capable as he is. He has left a deep impression on all the teachers in the department. You would be fortunate if he works for you.

2.4 How would you rewrite these sentences to make them simpler?

a) When the teacher gave the explanation to the class, the explanation was delivered in such a way that it was rather lengthy and could not be easily understood by the students.

b) The current situation in this place, which is already tense, turned explosive earlier this month when the international administration, which was put in place after the 1995 peace accord that put an end to the war in Bosnia, gave an order to execute a raid on Herzegovacka Bank.

c) In the basement there are four baskets made of bamboo that have got absolutely nothing in them whatever and that might perhaps be given away by us to charitable organizations and societies.

d) Anaïs used money to purchase a large-type minivan produced by Toyota that is red in color.

e) Apple has designed a laptop that is quite special—the case of the laptop is made from the material aluminum and is not composed of any smaller parts.

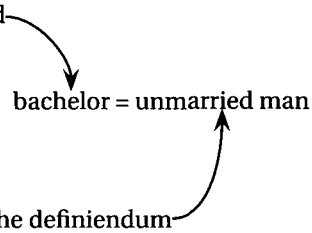
2.5 ☒ Take something you have written a few years ago, and read it again to see how it can be improved in light of the suggestions here.

CHAPTER 3

DEFINITIONS

Definitions are very useful in explaining and clarifying meaning. A typical definition has two parts:

- The **definiendum**:
  the term being defined



- The **definiens**:
  the words that define the definiendum

People often use *is* instead of the equality sign in giving definitions—for example, a bachelor *is* an unmarried man. A bit more terminology:

- A **term** is a referring expression in a language made up of one or more words, such as *The United Nations, Beethoven, mammals, purple.*

- The **referent** of a term is what the term refers to. So the terms listed in the last paragraph refer respectively to an organization, a person, a class of animals, and a particular shade of color. A term such as *Mount Everest* refers to a real physical thing in the world, but other terms such as *truth* and *13467* refer to more abstract things. The set of things a term refers to is known as the **extension** of the term. So dolphins, humans, donkeys, gorillas are all within the extension of *mammals*.
- The **concept** associated with a term is an idea that encapsulates our understanding of the term. Although a term is made up of words, a concept is not. *Agua* is a Spanish word distinct from the English word *water*. They have different spelling and pronunciation, but they have the same meaning and express the same concept.

In this book we shall take definitions to be primarily definitions of terms, although we can loosely speak of defining a concept (that is, defining the term that expresses the concept). We can divide definitions into three kinds according to their purpose: stipulative, reportive, and precising.

A definition worth US$7 billion

On September 11, 2001, terrorists destroyed the twin towers of the World Trade Center in New York City by crashing two planes into them. At the time, Larry Silverstein was holding a 99-year lease for the buildings. The buildings were covered by insurance which would pay US$3.55 billion for an "occurrence" of a terrorist attack. But Silverstein argued that he should get double the amount, because there were two occurrences of attacks, as there were two planes that hit the buildings about 15 minutes apart. Obviously, the insurers claimed this was just one occurrence of a coordinated attack. So here is a definition that is worth a few billion dollars! This is a good example about the importance of definitions in contracts and official documents. (The trial was a long and complicated affair. In the end a jury decided that there were two occurrences, even though Silverstein did not get the full amount he wanted.)

3.1 REPORTIVE DEFINITION

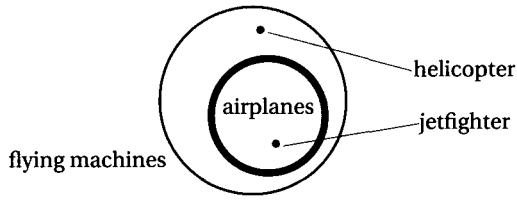
A **reportive definition** is also known as a **lexical** definition. It reports the existing meaning of a term. Here are some examples:

- Prime number = any integer greater than 1 and divisible only by 1 and itself.
- *WTO* stands for "The World Trade Organization".

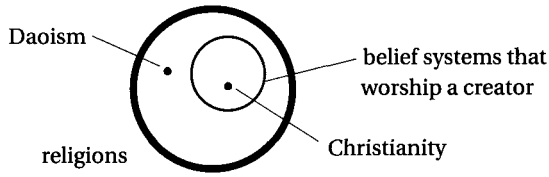
- Sushi is a kind of food made with vinegared rice with some meat or vegetable topping.

Obviously, reportive definitions are useful for learning new words in a language. The main criterion for evaluating a reportive definition is that the meaning of the definiens should match the meaning of the definiendum exactly. This means the definition should not be inconsistent with the existing usage of the term in question. Suppose someone consults a very old dictionary that defines *computer* as "a person whose job is to carry out mathematical calculations." This definition was before modern electronic computers were invented. It is inconsistent with how we actually use the word *computer* today, and so it is no longer a good reportive definition.

A correct reportive definition should not be too wide or too narrow. A definition is **too wide** if the definiens applies to things that the definiendum does not apply to. In other words, the definition *includes things that it should not.* For example, defining an airplane as a flying machine is too wide, since helicopters are also flying machines but they are not airplanes. The situation is indicated by the Venn diagram below. The thick circle represents the set of all airplanes, and the bigger circle represents all flying machines. Since all airplanes are flying machines, the thicker circle is inside the other one. But there are plenty of flying machines within the larger circle that are not airplanes, such as helicopters, rockets, and airships.

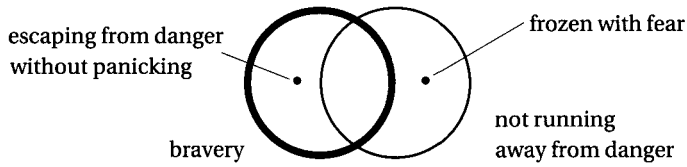


A definition is **too narrow** if the definiens fails to include things to which the definiendum applies. In other words, the definition *fails to include things that it should.* Consider the definition of religion as any belief system that includes worshiping a god who created the universe. This definition is too narrow since it excludes religions that do not postulate a creator, such as Jainism and certain versions of Buddhism and Daoism.



Notice that a definition can be too wide and too narrow at the same time. Suppose someone defines *bravery* as "not running away from danger". The definition

is too wide because even a coward might fail to run away from danger. Perhaps he is immobilized by fear, or perhaps he does not even realize that he is in danger. But the definition is also too narrow because a person can be brave even if he avoids dangerous situations. Bravery does not require stupidity. There is no reason why a fireman who escapes from a burning building cannot be brave.



3.2 STIPULATIVE DEFINITION

A **stipulative definition** is used to assign a new meaning to a term, whether or not the term has an existing meaning. If the stipulative definition is accepted, then the term is used in the new way that is prescribed. Suppose we agree to define *IBM* to mean "incredibly boring movie". Once this is accepted, we can then say things like "Cable TV is showing another IBM right now."

Stipulative definitions are not just for secret codes and acronyms. They are also used to introduce new technical terms—for example, *quark* (physics), *prion* (biology), *risk premium* (economics). Notice that a stipulative definition does not have to be faithful to the old meaning of the term being defined, if it has any. In physics, a strange quark is just one type of elementary particle, and it is not particularly strange. In a stipulative definition, the meaning of the definiendum is completely determined by the meaning of the definiens, whatever it is, so the question of whether it is too wide or too narrow simply does not apply.

One more point to bear in mind about stipulative definitions: If you define a term more than once, make sure that the definitions are equivalent. Otherwise confusion might arise due to the inconsistent definitions.

3.3 PRECISING DEFINITION

A **precising definition** is something in between reportive and stipulative definitions. The function of a precising definition is to make the meaning of a term more precise. Suppose a bus company wants to give discounts to old people. If the company simply declares, "old people pay only 50% of the full fare," this would be too vague because it is not clear when a person becomes old. Some people might say that being 60 is old, but others might disagree. To avoid disputes and uncertainty, the company might define *old person* to mean "any person of age 65 or older." This definition is in part stipulative because there is no special reason why age 65 should be chosen as the cut-off point, as opposed to say 64 or 66. But

it is not entirely arbitrary because given the purpose of the definition, it would be inappropriate to adopt a definition that classifies children as "old." As we can see, one major function of precising definitions is to make laws and regulations more precise, so there is less uncertainty regarding their application.

Precising definition are also useful in resolving **verbal disputes**. A verbal dispute is a disagreement that is due solely to the ambiguity of a term. The American philosopher William James (1842–1910) once told this story about some hunters in a forest. One of the hunters was standing on one side of a tree and there was a squirrel climbing on the other side of the tree trunk. The hunter tried to look at the squirrel by walking around the tree, but the squirrel kept moving around the tree as well and always stayed on the opposite side of the tree trunk. Now the hunter certainly circled the tree, and the squirrel was on the tree. But *did the hunter go round the squirrel or not*? The hunters entered into a heated debate about this, and it was left to James to adjudicate. He explained that it all depends on what *go round* means:

> If you mean passing from the north of him to the east, then to the south, then to the west, and then to the north of him again, obviously the man does go round him, for he occupies these successive positions. But if on the contrary you mean being first in front of him, then on the right of him, then behind him, then on his left, and finally in front again, it is quite as obvious that the man fails to go round him, for by the compensating movements the squirrel makes, he keeps his belly turned towards the man all the time, and his back turned away. Make the distinction, and there is no occasion for any farther dispute. (James, 1995, p.17)

This is a dispute that a precising definition can resolve. The ordinary meaning of *go round* is not precise, and a more fine-grained distinction accurately pinpoints the source of disagreement. Verbal disputes are contrasted with **factual disputes**, which are disagreements about facts rather than meaning. If someone thinks Sydney is the capital of Australia and others disagree, then this is a factual dispute that can be resolved by checking the facts.

Many disputes are a mixture of verbal and factual disputes, and we should separate them out to advance the discussion. Often, the first step is to use precising definitions to clarify the issue. Take the question of whether nonhuman animals have language. To answer this question, we should be more precise about what *language* means. If it refers to any system of communication, then obviously birds and other animals have languages, since they do communicate with each other. On the other hand, *language* might also be used in a different sense, requiring the use of words to form sentences according to a system of grammar or being able to communicate about arbitrary objects and situations, including those that might be far away and distant in time. Given this definition, many animal communication systems do not qualify as languages. It is of course possible that some mammals such as chimpanzees might possess language in this more

sophisticated sense. Precising definitions allow us to refine questions, so we can gain a better understanding of how to answer them.

3.4 CRITERIA FOR GOOD DEFINITIONS

We have said that a reportive definition should not be too wide or too narrow. Here are more criteria for evaluating all kinds of definitions, not just reportive ones.

3.4.1 Use intensional definitions if possible

Philosophers very often draw a distinction between the **extension** and **intension** of a term (or concept). The extension of a term is the set of things to which the term applies. So for example, the extension of *prime number* is set of numbers {2, 3, 5, 7, 11, 13, ... }. On the other hand, the intension of a term is its meaning. The intension of *prime number* would be "any integer larger than one which is completely divisible only by one and itself."

When we define a term, should we define it by extension or intension? It depends, but we should use intensional definition where possible. A term such as *human being* has a very large extension. It is impossible to define the term by listing all the human beings there are. Furthermore, even if we are able to list all the items in the extension of a term, this might not explain the criterion for including them. Defining *prime numbers* as 2, 3, 5, 7, 11, ... fails to explain how the numbers are selected and how the list should continue. An intensional definition is better. However, in some situations, an intensional definition might not be available. The *seven deadly sins*, for example, is understood as referring to pride, greed, envy, anger, lust, gluttony, and sloth. There is of course a long story about the history of the term and why it is these seven sins that appear on the list. However, this history is not relevant to the definition of the list.

3.4.2 Avoid circularity

A good definition should avoid circularity. A **circular definition** is one where the definiens cannot be understood without knowing the meaning of the definiendum. Consider the definition of *time* as "a quantity measured by clocks or watches." This definition is circular because we cannot fully explain what clocks and watches are without taking them as instruments that measure time. Similarly, sometimes people say "the meaning of life is to search for the meaning of life." This sounds profound, but taken as a definition, it is hopelessly circular and does not make much sense. If the meaning of life *is* to search for the meaning of life, then it follows that the meaning of life is to search for a search for the meaning of life, which is to search for a search for a search of the meaning of life, and so on. Of course, on a more charitable interpretation, perhaps the suggestion is that the mere process of searching for the meaning of life is itself sufficient to make one's life meaningful. But this does not seem very plausible. Imagine a selfish and bitter person who

contributes nothing to the world, who spends his entire life doing nothing except being obsessed with the question of what the meaning of life is. This does not seem like a very meaningful life at all.

3.4.3 Avoid obscurity

Definitions should avoid obscure and metaphorical language as far as possible. "Science is searching for a black cat in a dark room" might convey an amusing image of the difficulty of scientific research, but as a definition it is too obscure to tell us much about the nature of science.

However, a reportive definition should not be more precise than the term that is being defined. A ship might be defined as a vessel of considerable size for navigating on water. This definition is vague because it is unclear what *considerable size* means. But this is in itself not a good objection to the definition, because our concept of a ship is vague in exactly the same way. Defining a ship as a vessel longer than 30 meters will make the definition too precise and end up distorting the ordinary meaning of the word.

3.4.4 Avoid persuasive definitions

Finally, definitions should also avoid inappropriate emotional connotations. A **persuasive definition** is a definition that attaches a positive or negative emotional meaning to a term when there is in fact no such association. For example, if someone defines *democracy* as "dictatorship by the poor and the uneducated," obviously such a person does not think very highly of democracy. But whether democracy is a good or bad thing should depend on further arguments and not be decided solely by a definition. Similarly, consider the definition "abortion is the termination of pregnancy by murdering an unborn child." This definition assumes that abortion is wrong because it classifies abortion as murder. But it is surely possible to understand *abortion* in a more neutral way. The biased definition that is proposed distorts the ordinary meaning of the term. (Another problem with the definition is that it assumes without argument that the aborted fetus is already a child—that is, a person.) This is not to deny that a persuasive definition can be a useful rhetorical tool. They are often used in debates and political speeches, but we should avoid them in a rational and fair-minded discussion.

3.5 DEFINITION TECHNIQUES

Here are some of the different ways of formulating a definition.

3.5.1 Definition by synonym

In a **definition by synonym**, a word (or a short term) is defined by giving another term that has exactly the same meaning—for example, physicians = doctors, lawyer = attorney, ameliorate = improve, and prognosticate = predict.

3.5.2 Definition by ostension

An **ostensive definition** explains the meaning of a term by giving examples, as when we explain the meaning of *red* to children by pointing to examples of red things. Or someone might explain a *professional* as "people like doctors, lawyers, and accountants." Ostensive definitions are useful when it is difficult to explain the meaning of a term precisely. But an ostensive definition is a form of definition by extension, and intensional definitions can explain meaning better if they are available.

3.5.3 Definition by genus-differentia

The **genus-differentia** method is a very useful tool for constructing definitions. According to this approach, when we want to define a term, first we identify the broad category that the term is supposed to apply to. This category is known as **genus**. To define *mule*, we note first of all that a mule is an animal. Of course, there are many kinds of animals other than mules. So the next step is to identify the **differentia**. This is the property that separates the items in the genus into two groups—those that fall within the extension of the definiendum, and those that do not. In the case of *mule*, this would be the property of being the offspring of a male donkey and a female horse. Putting the two parts together, we arrive at the full definition:

- A mule is an animal that is the offspring of a male donkey and a female horse.

This type of definition is useful because it informs the audience about the *kind* of thing the definiendum applies to, even if the complete definition is difficult to remember and understand. Here are more examples of this kind of definition, with the genus part underlined:

- Ice = frozen water.
- Witness = a person who testifies under oath at a trial or deposition.
- Vitamin = a low molecular weight organic compound required in trace amounts for normal growth and metabolic processes.
- Bear market = a prolonged condition of the financial market in which investment prices fall and accompanied by widespread pessimism.
- Phoneme = the smallest unit of sound in a language.

3.6 THREE MISCONCEPTIONS ABOUT DEFINITIONS

Definitions are no doubt useful, and this has led some people to claim that we should define all the words we use. But this is far too extreme. First of all, we do

not have to be precise and clear all the time. Otherwise we have to throw away lots of jokes, poems, and ordinary conversations. Also, many words are difficult to define. We learn words like *green, warm* and *cold* through examples and not complete definitions. Other words like *time* and *existence* seem so basic and hard to define even though we understand them well enough in everyday life. In any case, it is surely impossible to define all the words we use without circularity, since our language contains only a finite number of words.

A second misconception about definitions is to think that dictionaries provide the most accurate and authoritative definitions. Dictionaries are of course useful in learning a language, but dictionary entries often describe only the main usage of a term, leaving out its more subtle aspects. An entry might also include extra factual information that is not part of the meaning of the term. According to *The Pocket Oxford Dictionary of Current English,* a cat is a small soft-furred four-legged domesticated animal. As a definition it is both too wide and too narrow, because a small furry dog is not a cat, and a cat that has become large as a result of hormonal injection does not thereby cease to be a cat.

Another point to remember is that a lot of terms have technical meanings, such as *inflation* in economics and *mass* in physics. A general dictionary might not give you the correct explanation. You need to consult a more specialized dictionary for that particular discipline.

Finally, the definitions of many abstract concepts can be controversial. Think of *art, justice, knowledge, rationality.* A short dictionary entry might be a good start to help us think more deeply about these concepts, but we should not expect a dictionary to give us the final word on their proper understanding.

A third misconception about definition is the belief that to know the real meaning of a term, we have to find its original definition or meaning. Many people like to explain X by beginning with the history of the word X. The **etymological fallacy** is the mistaken idea that we always need to look at the history and original usage of a term to decide what its current meaning is. For instance, the word *passion* derives from a Latin root that means "suffering." But it would be a bad argument to judge that a certain relationship is not really passionate because the parties involved are not suffering. The current meaning of a word depends on how it is actually used, and there is no reason why meaning and usage cannot change drastically over a long period of time.

EXERCISES

3.1 Classify these definitions as reportive, precising, stipulative or persuasive:

a) *Above average intelligence* means "having an IQ of more than 100."

b) A camera is an instrument for taking photos.

c) Animal rights activists are people who love animals more than human beings.

d) An atheist is a person who does not believe in the existence of God.

e) X is harder than Y = X can make a scratch on Y but not the other way round.

3.2 *Evaluate these definitions and see if they have any problems.*

a) Hatred = the wish to harm other people or to ruin something that is important to them.

b) Biology is when you study living organisms.

c) What is Yin? Not Yang. What is Yang? Not Yin.

d) Love is the master key that opens the gates of happiness. (Oliver Wendell Holmes)

e) Love is the affinity experienced between two people who are naturally able and willing to tune into one another's emotional, intellectual, and physical states—and respond to them in a nurturing and a stimulating way. (biomatch.com)

f) Furious = being angry at someone.

g) A bomb is a device designed to explode so as to hurt people.

3.3 ☒ How would you define *vegetable*?

a) What do you think of the definition of vegetable as an edible plant or part of an edible plant that is not a seed or a sweet fruit?

b) Would the following items count as vegetables under this definition: rice, avocado, mushroom, ginko nut, peanut, lemon, lotus seed, tomato juice?

3.4 What is wrong with these arguments, if anything?

a) *Philosophy* originally meant "love of wisdom" in Greek. If you are a philosopher, you must be very wise.

b) *Art* originally meant "to make." So art is created whenever someone makes something.

3.5 Insider trading is a crime in most countries. Suppose you are a legislator trying to draft regulation prohibiting insider trading. How would you define it? What about this definition:

> Insider trading is any sale or purchase of the shares or bonds of a company that relies on information about the internal operations of the company.

3.6 Consider this definition of domestic violence from a 2004 UK crime survey:

> Any violence between current or former partners in an intimate relationship, wherever and whenever the violence occurs. The violence may include physical, sexual, emotional or financial abuse.

a) Is it possible to simply it further? Which is the most important part?

b) Compare the survey definition with the following one from a women's self-help group. Identify the main differences and their respective strengths and weaknesses:

> Domestic violence is physical, psychological, sexual or financial violence that takes place within an intimate or family-type relationship and forms a pattern of coercive and controlling behavior.

3.7 Evaluate these definitions. Come up with as many objections as you can.

a) Sexual harassment is any action related to sex that makes someone distressed or unhappy.

b) Harassment means being told that a raise, promotion, or other benefit is dependent on you going on a date with your boss or some other similar activity.

3.8 A lawyer suggests defining the word *container* as "a receptacle having at least one exterior surface and a plurality of walls defining a discrete object receiving volume." What is your opinion?

3.9 ☒ Give definitions of these terms using the *genus-differentia* method: orphan, portrait, ballpoint pen, square, even number.

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CHAPTER 4

NECESSARY AND SUFFICIENT CONDITIONS

Necessary and sufficient conditions help us understand and explain the connections between concepts, and how different situations are related to each other.

4.1 NECESSARY CONDITIONS

To say that X is a **necessary condition** for Y is to say that the occurrence of X is required for the occurrence of Y (sometimes also called an **essential condition**). In other words, if there is no X, Y would not exist. Examples:

- Having four sides is necessary for being a square.
- Infection by HIV is necessary for developing AIDS.
- Having the intention to kill someone or to cause grievous bodily harm is necessary for murder.

To show that X is not a necessary condition for Y, we simply find a situation where Y is present but X is not. Examples:

- Eating meat is not necessary for living a healthy life. There are plenty of healthy vegetarians.
- Being a land animal is not necessary for being a mammal. Whales are mammals, but they live in the sea.

In daily life, we often talk about necessary conditions, maybe not explicitly. When we say combustion requires oxygen, this is equivalent to saying that the presence of oxygen is a necessary condition for combustion.

Note that a single situation can have more than one necessary condition. To be a good pianist, it is necessary to have good finger technique. But this is not enough. Another necessary condition is being good at interpreting piano pieces.

4.2 SUFFICIENT CONDITIONS

If X is a **sufficient condition** for Y, this means the occurrence of X guarantees the occurrence of Y. In other words, it is impossible to have X without Y. If X is present, then Y must also be present. Some examples:

- Being a square is sufficient for having four sides.
- Being a grandfather is sufficient for being a father.

To show that X is not sufficient for Y, we list cases where X occurs but not Y:

- Being infected by HIV is not sufficient for developing AIDS because there are many people who have the virus but have not developed AIDS.
- Loyalty is not sufficient for honesty because one might have to act in a dishonest manner to protect the person one is loyal to.

Note that a single state of affairs can have more than one sufficient condition. Being red and being green are different conditions, but they are both sufficient for something being colored.

4.3 DESCRIBING HOW TWO THINGS ARE CONNECTED

Given any two conditions X and Y, there are four ways in which they might be related to each other:

1. X is both (jointly) necessary and sufficient for Y.
2. X is necessary but not sufficient for Y.
3. X is sufficient but not necessary for Y.
4. X is neither necessary nor sufficient for Y.

Some examples:

1. Being an unmarried man is necessary and sufficient for being a bachelor.
2. Oxygen is necessary but not sufficient for our survival.
3. Having a son is sufficient but not necessary for being a parent.
4. Being rich is neither necessary nor sufficient for a happy life.

This fourfold classification is useful because it provides the starting point for analyzing how things are related. When we think about the relationship between two things X and Y, we can begin by asking whether one is necessary or sufficient for the other. For example, what is the connection between democracy and the rule of law? First, we might say that the rule of law is necessary for democracy. A democracy is impossible if people do not follow legal procedures to elect leaders or resolve disputes. But we might also add that the rule of law is not sufficient for democracy, because the legal rules that people follow might not be fair or democratic. As this example shows, the concepts of necessary and sufficient conditions can be very useful in studying and teaching. When you understand a subject more deeply, you do not just memorize individual pieces of information. You should also be able to understand the connections between the basic concepts, and this includes relationships of necessity and sufficiency.

Necessary and sufficient conditions are also related to the topic of definition. In effect, a definition of X provides conditions that are both necessary and sufficient for X. When we define a bachelor as an married man, this implies that being an unmarried man is *both* necessary *and* sufficient for being a bachelor.

4.3.1 Using necessary and sufficient conditions to resolve disputes

The concepts of necessary and sufficient conditions are quite simple, but they are very useful and fundamental concepts. Sometimes when people disagree with each other, especially about some theoretical issue, we can use these concepts to identify more clearly the differences between the parties.

For example, suppose someone claims that computers cannot think because they can never fall in love or be sad. To understand this argument better, we can ask whether this person is assuming that having emotions is necessary for thinking, and if so why? If something is capable of reasoning and deduction, then presumably it can think. But emotions seem to be a different category of mental states. We can imagine a person who is able to think and reason, but who cannot feel any emotion, perhaps due to brain injuries. If this is possible, it shows that emotions are not necessary for thinking.

4.4 THE WRITE-OFF FALLACY

Although the concepts of necessary and sufficient conditions are very important, they are also used in some bad arguments. One such fallacy, which we might call

the write-off fallacy, is to argue that something is not important, because it is not necessary or not sufficient for something else that is good or valuable.

For example, some people argue that democracy is not really that important because it is not necessary for having a good government. It is possible for a non-democratic government to work efficiently for the interests of the people, and this might be correct. Furthermore, democracy is not sufficient for good governance either, since citizens can make bad choices and end up electing a bad government. This is also possible. However, it might still be the case that a democratic political system is *more likely* to produce a good government than other alternatives.[1] In principle, a benevolent dictator can be a wise and competent ruler, but the fact is that this is extremely rare, and dictators are more likely to abuse their power. The general lesson here is that a condition C can be an important factor that makes an effect E more likely to happen, even if C is neither necessary nor sufficient for E. It is not enough to write off C as unimportant simply by pointing to isolated cases where there is C but no E, or where there is E but no C.

4.5 DIFFERENT KINDS OF POSSIBILITY

Necessary and sufficient conditions are related to the concept of possibility. To say that X is necessary for Y is to say that it is not possible for Y to occur without X. To say that X is sufficient for Y is to say that it is not possible for X to occur without Y. There are, however, different senses of *possibility*, and corresponding to these different sense there are different kinds of necessary and sufficient conditions. Let us consider these statements:

- It is impossible to draw a red square without drawing a square.
- It is impossible to dissolve gold in pure water.
- It is impossible to travel from India to France in less than one hour.
- It is impossible to vote in Australia if you are under 18.

The word *impossible* does not have the same meaning in these statements. In the first statement, what is being referred to is logical impossibility. Something is **logically impossible** if it is contradictory or against the laws of logic. Thus a round square is a logical impossibility, and it is logically impossible for there to be a red square without there being a square.

But it is not logically impossible to dissolve gold in water. Logic itself does not tell us that this cannot happen. Rather, the impossibility is due to the laws of physics and chemistry that happen to hold in our universe. If our universe had

[1] Here is a famous quote from Winston Churchill (1874–1965): "No one pretends that democracy is perfect or all-wise. Indeed it has been said that democracy is the worst form of government except all those other forms that have been tried from time to time." (Speech in the House on the Parliament Bill, November 11, 1947)

operated differently, then perhaps gold would dissolve in water. Dissolving gold in water is therefore logically possible but **empirically impossible**. Empirical possibility is sometimes also known as *causal* or *nomological* possibility.

The sense in which the third statement is true is again different. The laws of physics probably do not stop us from traveling from India to France within an hour. Perhaps such a short trip is possible with some future airplane, but it is certainly not possible at this point in time. When current technology does not permit a situation to happen, we say that it is **technologically impossible**, even though it might be both logically and empirically possible. Of course, what is currently technologically impossible might well turn out to be technologically possible in the future.

Finally, voting under the age of 18 is certainly not prohibited by logic, the laws of nature, or current technology. What is meant by *impossible* in the fourth statement is thus something else—namely **legal impossibility**. To say that X is not possible in this sense is to say that X is incompatible with the relevant legislation.

Note that what we have just said about the different senses of possibility applies to *necessary* and *must* as well. "A square must have four sides" and "it is necessary that a square has four sides" express logical necessity. Whereas "you must be 18 to vote in Australia" is obviously about legal rather than logical necessity.

4.6 EXCLUSIVE AND EXHAUSTIVE POSSIBILITIES

Apart from talking about the ways in which something is or is not possible, there are also some useful terms for talking about the connections between different possibilities.

First, we can speak of a possibility *including* another. There being rain tomorrow includes the possibility of a heavy rainstorm, and the possibility of just a light drizzle. Second, one possibility can *exclude* another. If Cinta is in Spain right now, that excludes the possibility that she is in Brazil. Finally, two possibilities can also be *independent* of each other. Whether it will rain tomorrow presumably does not depend on what you ate for breakfast this morning.

The word *exclusive* is sometimes used to talk about one possibility excluding another, and it is important not to confuse *exclusive* with *exhaustive*:

- A set of possibilities is **exhaustive** when at least one of them obtains in any logically possible situation (they do not leave out any situation).
- A set of possibilities is **exclusive** when there is no logically possible situation in which more than one of them obtains (the truth of one excludes the truth of the others).
- In other words, if a set of possibilities is both exhaustive and exclusive, then in any logically possible situation, exactly one of them obtains.

This explanation might be a bit too abstract, so here is an illustration. Suppose x is an integer:

- Two possibilities that are neither exhaustive nor exclusive: $x > 3$, $x > 4$. They are not exhaustive because the possibility that $x = 2$ is not included. They are not exclusive because both of them can be correct, as when $x > 5$.
- Exhaustive but not exclusive: $x > 4$, $x < 10$
- Exclusive but not exhaustive: $x > 4$, $x = 1$
- Exclusive and exhaustive: $x > 0$, $x = 0$, $x < 0$

EXERCISES

4.1 Suppose we have a definition $X{=}Y$. Are the following statements correct about this definition? Why or why not?

a) If the definition is too wide, then X is not necessary for Y.
b) If the definition is too wide, then Y is not necessary for X.
c) If the definition is too narrow, then X is not sufficient for Y.
d) If the definition is too narrow, then Y is not sufficient for X.
e) If X is not necessary for Y, then the definition is too wide.

4.2 Are these statements true or false?

a) If X is logically sufficient for Y, and Y is logically sufficient for Z, then X is logically sufficient for Z.
b) If X is logically necessary for Y, and Y is logically necessary for Z, then X is logically necessary for Z.
c) If X is not necessary for Y, then Y is not necessary for X.
d) Being an intelligent student in the class is necessary for being the most intelligent student in the class.
e) If something is not logically impossible, then it is logically possible.
f) If something is empirically impossible, then it does not actually happen in the world.
g) If something is empirically possible, then it actually happens in the world.
h) If something actually happens in the world, then it is empirically possible.
i) If something is logically possible, then it is empirically possible.
j) If something is empirically possible, then it is logically possible.
k) If something is empirically possible, then it is technologically possible.

4.3 A definition of X provides necessary and sufficient condition for X. See if you can fill in the blanks below correctly with *necessary condition* or *sufficient condition*:

a) If the definition is too wide, this means the definition fails to provide the correct _____ for X.
b) If the definition is too narrow, this means the definition fails to provide the correct _____ for X.

4.4 Determine whether these possibilities are exhaustive and/or exclusive.

a) Inflation goes up. Inflation comes down.

b) P and Q. Neither P nor Q.

c) Sadie and Rita are happy. Sadie and Rita are sad.

4.5 Many management and law school admission tests include questions known as "data sufficiency questions." There are also similar questions in many recruitment exams. So do try out the following questions. You will be given some information, and then you have to pick the correct answer out of the five choices listed below:

1. Statement 1 alone is sufficient to answer the question, but statement 2 alone is not sufficient.
2. Statement 2 alone is sufficient to answer the question, but statement 1 alone is not sufficient.
3. Both statements are necessary for answering the question, and neither statement alone is sufficient.
4. Either statement by itself is sufficient to answer the question.
5. Statements 1 and 2 together are not sufficient to answer the question.

a) Three stones have a combined weight of 40 kilograms. What is the weight of the heaviest stone?
Statement 1: One stone weighs 10 kilograms.
Statement 2: One stone weighs 20 kilograms.

b) Two students joined the same company at the same time. How much more money per month does trainee X now earn than trainee Y?
Statement 1: Y earns \$3000 per month more than when he first started.
Statement 2: X earns \$5000 per month more than when she first started.

c) What is the total number of cakes that Elia and Maddalena have eaten?
Statement 1: Elia ate twice as many cakes as Maddalena.
Statement 2: Maddalena ate two cakes fewer than Elia.

4.6 Describe the mistake in this argument in terms of necessary and sufficient conditions:

> Students who do not study always fail the exam. Since I have studied, it follows that I will pass the exam.

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CHAPTER 5

LINGUISTIC PITFALLS

Linguistic pitfalls are inappropriate uses of language that hinder accurate and effective communication. This can happen when we use language that is unclear, distorted, or empty in meaning. We now look at these situations one by one.

5.1 UNCLEAR MEANING

Lack of clarity can arise in many ways. The words we use might be ambiguous or imprecise or the meanings are incomplete. But it can also be due to the failure to organize ideas properly.

5.1.1 Ambiguity

An **ambiguous** expression is one with more than one meaning or reference. There are different kinds of ambiguity. **Lexical ambiguities** are cases where a single word or name has more than one meaning in a language—for example, deep ("deep insight" vs. "deep tunnel") and bank ("river bank" vs. "investment bank") and words like *light* and *over*. Consider also *Japanese teacher*, which might mean a teacher from Japan or anyone who teaches Japanese. Even place names can be

ambiguous. *Angkor Wat* is commonly used to refer to the beautiful historic site in Cambodia containing lots of temples built by the Khmer monarchs. But *Angkor Wat* is also the name of just one specific temple (the largest one) in the whole area.

Referential ambiguity arises when the context does not make it clear what a pronoun or quantifier is referring to.

- John hit Peter with *his* iPhone. Then *he* died. (John, Peter or someone else?)
- Amie and Lusina gave some cookies to Delman and Michelle because *they* liked *them.*

Syntactic ambiguity occurs when there is more than one way to interpret the grammatical structure of an expression. This can happen even when the meanings of the individual words are clear.

- Ralph saw Sharon on the roof with a telescope. (Did Ralph use a telescope or did he see Sharon carrying one on the roof?)
- The students were told to stop partying at midnight. (Were they told not to hold midnight parties or were they told at midnight not to party anymore?)
- Visiting relatives can be boring. (Are the visiting relatives boring or is it boring to visit relatives?)

To remove ambiguity, we can rewrite our sentences so that they are no longer ambiguous. Or we can list all the different interpretations. This process is called **disambiguation**. Take the famous Zen question, "If a tree falls in a forest and no one is around to hear it, does it make a sound?" We can point out that *sound* is lexically ambiguous—it might mean a physical vibration through some medium such as air, or it might mean an auditory conscious experience. When no human being or animal is around, the falling tree would make a sound in the first but not the second sense.

It is important to be able to spot ambiguity in evaluating arguments. **Equivocation** occurs when a key term changes meaning in the middle of an argument. Consider this argument against equality from Murray N. Rothbard, a libertarian author and economist:

> The diversity of mankind is a basic postulate of our knowledge of human beings. But if mankind is diverse and individuated, then how can anyone propose equality as an ideal? Every year, scholars hold Conferences on Equality and call for greater equality, and no one challenges the basic tenet. But what justification can equality find in the nature of man? If each individual is unique, how else can he be made "equal" to others than by destroying most of what is human in him and reducing human society to the mindless uniformity of the ant heap? (Rothbard, 2010)

On the face of it, the argument seems plausible. If equality is unattainable or undesirable, it would be wrong to call for more equality. But the apparent plausi-

bility rests on an equivocation between two meanings of *equality*. The argument starts by saying that equality cannot be an ideal. This is correct if *equality* means everyone being physical identical, having the same appearance, personality, and so on. This form of equality is indeed undesirable if not impossible to achieve. It is a good thing there is diversity and individuality, but nobody wants to get rid of that. When the argument goes on to talk about scholars calling for greater equality, these people are talking about a different notion of equality—people having the same basic rights and equal opportunity. Two people can be very different, but they can still enjoy the same basic rights such as the right to free speech and freedom of religion. Once we distinguish between the two senses of equality, the argument is not so plausible—the fact that equality is impossible in one sense does not imply that equality in the second sense is undesirable or unachievable. Perhaps the author believes that there is a connection between these two senses of equality. But that would require a very different and more detailed argument.

5.1.2 Vagueness

A term is **vague** if it has an imprecise boundary. A sunny room is no longer bright when the sun is gone. But as the sun sets, there is no point in time when the room suddenly changes from being bright to not bright. So *bright* is vague. *Tall* is also vague since there are borderline cases where it is impossible to say whether the person is tall or not, even when we know that person's exact height. The meaning of *tall* is just not precise enough. If you think about it, probably most words in our language are vague in some way—for example, mountain, clever, and smelly.

Strictly speaking, vagueness is different from ambiguity. A term can be vague even though it is not ambiguous, such as *the Atlantic Ocean*. An ambiguous term might have very precise meanings. For example, a billion is normally taken to be one thousand million, but some people take it to mean one million million. So *billion* is ambiguous, but the two possible meanings are very precise!

Vagueness in a statement decreases the amount of information that is being conveyed. Consider these statements in increasing order of vagueness:

1. Five men and two women suffered from minor bruises in the accident.
2. A few men and women suffered from bruises in the accident.
3. A few people were hurt in the accident.

When a statement is more precise, it contains more details and runs a higher risk of being wrong. If it turns out that only four men were hurt in the accident, the first two statements will be false but the third one is still true. So being vague can be useful if we want to be evasive or to avoid being wrong. But it also means we should be careful of vague statements that carry no useful information. Politicians are of course very good at this game, promising to do this or that when time is right but without saying what counts as the right time. Similarly, horoscope entries are full of useless and vague predictions. A typical one might say: "Be prepared for a

change of direction this week". But what counts as a change of direction? Does it include someone blocking your way so you can't walk in a straight line? Without more concrete clarification, we can easily find one event or another as "evidence" that confirms the prediction.

So it is important to avoid vagueness in situations that require concrete information. In job applications, for example, employers usually want clear evidence of your abilities and achievements. Numerical facts can get the point across quickly. In your CV, instead of vague general statements such as "responsible for writing user guides," it would be more impressive to say "wrote five program manuals for 7,000 customers within one week." The point is not to throw in as much information as possible but to highlight concrete achievements.

5.1.3 Incomplete Meaning

The following question appeared in an aptitude test for primary-school children in Hong Kong. You are supposed to pick the odd one out:

apple, banana, watermelon, orange, pear

Such questions are common in IQ tests, but they often test the ability to second-guess the examiner rather than true intelligence. This is because these questions do not have correct answers. The official answer to the question above is "banana", presumably because its shape is the least spherical. But one could equally have picked "watermelon", because it is the only vine crop on the list; or "orange", because it is the only one with an orange color! The point is that it does not make sense to judge whether two things are similar or different, unless we say how they should be compared. A raven is like a writing desk in that they are both smaller than a mountain, but they are also not like because only one is a bird.

Terms like *similar*, *same as*, *different*, *useful*, *better*, and *important* have **incomplete meanings**. They presuppose certain standards of comparison, and their meanings are unclear if the standards are not specified. Is love more important than a banana? It depends whether you are trying to cure loneliness or distract an attacking gorilla.

In some situations, the standard of comparison is clear even if it is not made explicit. If someone looks at two identical twins and says they are exactly alike, he is probably saying that they look similar. But sometimes the standard of comparison can be totally lacking. A breakfast cereal advertisement might say: "A healthier alternative for your family." But healthier compared to what? Surely not healthier than *all* other alternatives for breakfast. Without a meaningful comparison, the claim has no concrete content at all.[1]

[1]It might be suggested that the same is true of the subtitle of this book: "Think More, Think Better". More than what and better than what? But the natural interpretation in this context is that our think improves as a result of learning more about critical thinking and creativity.

5.1.4 More global defects

Ambiguity, vagueness, and incomplete meaning occur at the level of words or sentences. But lack of clarity can also happen at a more global level. If an article lacks a coherent structure or the connections between the sentences are unclear, it will be difficult to understand the article as a whole, even if the individual sentences are relatively clear. The same applies to a lecture or a presentation. To avoid this problem, it is crucial to plan ahead and organize the ideas using a good framework. (See the discussion in Section 2.3.)

5.2 DISTORTION

5.2.1 Inappropriate emotional connotation

Distortion is a matter of misconstruing the meaning of words, such as giving an incorrect reportive definition. Another typical example is the use of inappropriate emotive connotations. Many linguistic expressions are not purely descriptive but carry positive or negative connotations. Describing someone as "generous" is to portray that person in a positive light. However, sometimes people attach emotional connotations to words that do not have any. Or they try to choose words with a particular connotation to get people see things their way. Here are some examples:

- Defining *religion* as a *superstitious* belief in the existence of God.
- Insisting on calling a mistake as a valuable learning opportunity.
- Trying to be diplomatic by saying that someone is genuinely interested in other people rather than being nosy.

In everyday life, it is not easy to avoid using terms that carry connotations of one kind or another. Whether you describe a person as "independent" or "uncooperative" reflects your judgment of the person. As we can see from the last two examples, choosing words with the right emotional connotations can serve useful social purposes like saving face or maintaining politeness. But the first example is more objectionable because it injects the wrong kind of emotional connotations. Even if it is irrational to believe in a religion, this is something to be argued for independently and not by stipulation. To sum up, we should be alert to the connotations of the words that we use and be careful of attempts to use such connotations to bias our perception.

5.2.2 Weasel words

The use of **weasel words** is also an example of distortion. These are cases where the ordinary meaning of a word is changed inappropriately in the middle of a discussion, usually in response to some counterexample or an objection. Take the following exchange:

BILLY: All politicians are corrupt.
KATE: What about Nelson Mandela and Václav Havel? They are well-respected politicians with integrity.
BILLY: They are not corrupt, so they are not *real* politicians.

Billy seems to be suggesting that a person cannot be a "real" politician unless that person is corrupt. But a real politician is just the same as a politician and both Mandela and Havel have been presidents of their own countries and active in political affairs, so there is no reason why they should not be considered as politicians. The other problem is that if politicians have to be corrupt, Billy's claim that all politicians are corrupt becomes empty and uninteresting claim, since he is in effect saying that "all corrupt politicians are corrupt." But Billy's maneuver is not atypical. Many people try to distort the meaning of a term X by making similar stipulations about what a "real X" must be like.

5.2.3 Quoting out of context

Distortion includes misrepresenting what other people have said, deliberately or not. A movie critic might say sarcastically, "This is a fantastic movie, if you are brain dead." A disingenuous advertisement might then quote the critic as saying "a fantastic movie"! This way of quoting out of context is unfortunately quite common. For example, some people who object to evolution use this passage to argue that Charles Darwin (1809–1882) himself had doubts about evolution:

> To suppose that the eye with all its inimitable contrivances for adjusting the focus to different distances, for admitting different amounts of light, and for the correction of spherical and chromatic aberration, could have been formed by natural selection, seems, I freely confess, absurd in the highest degree (*On The Origin of Species*, Ch. VI).

But this is again quoting out of context, because Darwin went on to say we should not reject a scientific theory simply because it goes against commonsense, and that the complex eye in fact could have evolved slowly and gradually starting from simple light-sensitive cells. But unless you look up the origin text, you might be misled into thinking that Darwin had reservations about his own theory.

Similarly, in 2009, the British Homeopathic Association presented material to the British Government claiming that there is scientific evidence supporting the effectiveness of homeopathic therapy.[2] For example, it quoted the following conclusion from a research paper:

> There is some evidence that homeopathic treatments are more effective than placebo.

[2]Homeopathy is a form of alternative medicine that treats illnesses using solutions that are supposed to become more potent when they get more and more diluted, even to the point where the amount of active ingredient is negligible according to mainstream science.

Encouraging right? But read the full paragraph where the quote comes from:

> There is some evidence that homeopathic treatments are more effective than placebo; however, the strength of this evidence is low because of the low methodological quality of the trials. Studies of high methodological quality were more likely to be negative than the lower quality studies. Further high quality studies are needed to confirm these results (Cucherat et al., 2000).

So it turns out that the researcher's conclusion is just the opposite of the initial impression! Unfortunately this kind of selective quotation, or quote mining, is very common. We have to be very careful and if we are suspicious we should try and look up the original sources ourselves.

5.2.4 Category mistake

A **category mistake** also distorts meaning. This is to assign a property to an object when it is logically impossible for an object of that kind to have the property in question. The famous linguist Noam Chomsky gave a well-known example of a grammatical yet incoherent sentence: Colorless green ideas sleep furiously. Since an idea is not the kind of thing that can sleep or have a color, the sentence exemplifies the category mistake.

Similarly, take the slogan "Information wants to be free." The first problem with this statement is that it is ambiguous because *free* can either mean "easy to access" or "does not costing anything". More important, the sentence anthropomorphizes information as an agent that can want things to happen, which is a category mistake. Information does not and cannot want anything; people do. So it is not clear what the sentence really means. Does it mean most people want information to be free? But that is simply not true. In general we are reluctant to publicize information about sensitive financial or private matters. Perhaps a better interpretation of the statement is that once released, information tends to spread around and cannot be contained.

Sometimes category mistakes are the results of careless writing or bad grammar. A student might write in a hurry, "Procrastination is a person who keeps putting off what he should do." Interpreted literally, this sentence is logically false, because procrastination is a character trait or a habit, not a person. But the intended meaning is clear enough.

Reification is a type of category mistake. The word *reify* came from the Latin word *res*, which means "thing". Reification is treating an abstract idea or property as if it were a concrete physical object. Take "The truth wants to be told." It treats truth as if it were a person who wanted things to happen, which is impossible. But it is not hard to guess what the speaker is trying to say. Maybe she is saying it is important to tell the truth, or perhaps she thinks people will be interested to know the truth. Similarly, the Cuban leader Fidel Castro said "History will absolve me" when he was on trial at some point. But history is not a person who can forgive or

absolve anybody. Presumably he was saying that people will eventually agree with what he had done.

These two examples show that reification in itself need not be objectionable. It increases dramatic impact and is a useful literary device. But if a claim that involves reification constitutes a meaningful and informative claim, it can be usually be expressed more clearly without using reification. When it is difficult if not impossible to carry out this translation, this is a good sign that the original statement does not actually have a clear meaning. So, in general, better avoid reification unless you want dramatic impact. If you have to use it, make sure you know what you really want to say.

5.3 EMPTY MEANING

Empty meaning is a case in which words are used without serving any useful purpose or providing little information. For example, careful analysis often requires drawing subtle distinctions. Earlier in this chapter we distinguished between two senses of equality. But sometimes people try to make a distinction and fail. If so the distinction is *empty*, a distinction without a difference. Here are two examples:

- "We must follow God's will, and not what we or other people think God wants us to do." This distinction is empty because there is no way to follow God's will other than to follow what we or other people think is his will.

- *Enjo kōsai* means "compensated dating" in Japanese. The practice started in Japan (and has now spread to many countries) and involves men giving money to young girls in exchange for companionship and sometimes even sex. Many people insist it is not prostitution, but if sex is involved, the distinction is but an empty one.[3]

Questions can also be empty when they serve no useful purpose. Form I-94W is filled out by many non-U.S. citizens when they enter the United States. The form includes questions such as, "Are you now involved in espionage or sabotage or in terrorist activities?" and "Are you seeking entry to engage in criminal or immoral activities?" Surely we do not expect spies or criminals to answer truthfully, so it is not clear why such questions are needed. Someone who answers yes is probably a little bit crazy, so maybe that is the real purpose of the questions!

Apart from empty questions, there are also empty statements. These are claims that purport to provide useful information, but fail to do so in the relevant context. Sometimes this is because the statements are **analytic**. They are trivially true in virtue of their meaning, and as a result they provide no concrete information about the world. (See also Section 6.3.) Consider this weather forecast:

[3]Of course, someone in such a situation might *feel better* by believing that one is engaged in compensated dating and not prostitution. But that would be a kind of self-deception.

> Either it will rain tomorrow or it will not. If it rains tomorrow, then precipitation will occur. There might or might not be a heavy overcast tomorrow. But if there is a heavy overcast that lasts the whole morning, then it will not be a very sunny morning.

You can see that these empty statements fail to make any definite prediction about tomorrow's weather. They will be true whatever the weather is like the next day. These sentences are all analytic and in this context they convey no concrete information at all.

Or consider the slogan "survival of the fittest", often used to describe Darwin's theory of evolution.[4] Some people criticized the claim by saying that *fittest* just means "those which survive." So the whole claim becomes "those which survive, survive," which is of course empty and trivially true. Fortunately this is not an accurate description of the theory of evolution. Otherwise it would be in deep trouble!

It should be pointed out that it is not a mistake in itself to use analytic statements. They are important to logic and mathematics, and they play a useful role in language learning. "Bachelors are unmarried men" is analytic and conveys no empirical information about bachelors—for example, how many bachelors there are or whether they are happy. But obviously this statement is useful for people studying English.

Analytic statements can also convey useful conversational implicatures. Suppose Helen asks whether Francine will come to the party, and Francine replies, "If I come, I come." This empty reply does not answer the question at all, but it shows that the speaker is hesitant and does not want to commit herself. Similarly we often use analytic statements to express uncertainty or to emphasize the available options. If we don't know whether a proposal will be successful, we might say "this might or might not work" as a qualification. Or if we want to remind an indecisive person to make up his mind, we might say something like, "Either you do it or you don't." These are not cases of linguistic pitfalls since they serve to convey useful conversational implicatures.

Not all empty statements are analytic. Some empty statements are nonanalytic and do have some empirical content. But we still say they are empty because the information they provide is too trivial or obvious. For example, in many debates people want to appear to be insightful and they might say something like "*X* cannot solve all problems." Here, *X* might be democracy, technology, science, the government, money, punishment, and so on. These claims are typically empty because they are unlikely to be seriously disputed by anyone. For example, democracy cannot prevent natural disasters from happening or stop people from getting cancer, so it cannot solve all problems. But when people are debating whether a country should adopt democracy, the real issue is whether democracy is *better than* other systems of governments. The charge that democracy cannot solve all problems is an empty and irrelevant criticism.

[4] It was actually coined by the philosopher Herbert Spencer (1820–1903).

5.4 GOBBLEDYGOOK EVERYWHERE

The word *gobbledygook* was coined by Texan lawyer Maury Maverick in 1944 to describe obscure and convoluted language full of jargon.[5] It is an extreme form of linguistic pitfalls, where simple ideas are made unnecessarily complicated and cliches are dressed up as profound truths. Yet they can be found everywhere. Here are two samples from actual business writing (BBC News, 2003):

- The benefit of having dedicated subject matter experts who are able to evangelise the attributes and business imperatives of their products is starting to bear fruit.
- I admire your focused attention to screening the quantum of remaining potentiality vs. the generic strategic quantum of growth potentiality that we are now trying to seek access to.

Many people seem to think that long strings of management jargon indicate sophistication and professionalism. But in fact they hinder communication and are unnecessarily long winded. The first sentence just says that using experts to promote their products is bringing benefits. The second one is rather incomprehensible. Perhaps the writer is just saying "I admire you for making the best of what we have."

Legal documents also contain a lot of gobbledygook. Consider this piece of real traffic regulation:

> No vehicle shall be turned so as to proceed in the opposite direction within an intersection, or upon any street in a business district, or upon a freeway, expressway or controlled-access highway, or where authorized signs are erected to prohibit such movement, or at any other location unless such movement can be made with reasonable safety to other users of the street and without interfering with the safe operation of any traffic that may be affected by such movement.

The sentence is certainly verbose—"that may be affected by such movement" is redundant, and why not "U-turn" instead of "turned so as to proceed in the opposite direction"? The sentence is also way too long and creates confusion. In particular the scope of *unless* is not clear—is the sentence saying that a U-turn is not allowed anywhere unless it is safe to do so, or is it saying that a U-turn is absolutely prohibited in those places listed, and otherwise only when it is safe?

Eliminating gobbledygook and adopting plain language is not solely a matter of style and preference. There are practical benefits as well. Legal documents are supposed to provide guidance, and clear language helps citizens understand their rights and duties. For many organizations, employees make fewer errors when documents and instructions are written in plain language. Clients have fewer en-

[5]It is amusing that gobbledygook is the language of the goblins in the Harry Potter book series.

quiries and complaints, and they are more satisfied. Plain language is also important for consumer protection when they purchase products and services.

This is not to say that linguistic complexity and specialized vocabulary are always bad. Some ideas are complicated, and technical terms make it easier to communicate ideas among professionals. The problem comes when buzzwords are used to obscure, hide, or inflate ideas and actually hinder accurate and effective communication. Let us end with this list of jargon, and see if you can guess what each phrase means:

- Terminate with extreme prejudice.
- Spontaneous energetic disassembly.
- Collateral damage.
- Wooden interdental stimulator.
- Negative patient care outcome.

EXERCISES

5.1 If any statement below is ambiguous, list all its possible interpretations.

a) Here is the photo of the model everyone is talking about.
b) Park the car next to the tree in front of the house.
c) The new CEO promised to avoid layoffs during the merger.
d) For sale: 10 puppies from an Australian terrier and a Boston terrier.
e) Lack of Brains Hinders Medical Research (newspaper headline).
f) Being able to think clearly helps us learn better.
g) Students who play video games often have poor grades.
h) Bring your birth certificate or your passport and your identity card.
i) I stored my antique watch in the safe deposit box in the bank, but the river flooded the bank and the watch was ruined.

5.2 Identify the category mistakes below and rewrite the sentences properly.

a) A comedy is when lots of funny things happen.
b) Dr. Tran will talk about the experience of civil engineering in Vietnam in tomorrow's seminar.
c) The students in my class are smarter than the other classes.

5.3 Simplify these sentences as far as possible. Avoid changing their meaning.

a) Talking to Ann has induced Peter to generate the idea of building a house.
b) Our educational system at the moment is predicated on the assumption that lectures are enjoyed by students.

5.4 Discuss the linguistic pitfalls in these passages, if there are any.

a) Law graduates of the university have a higher income.
b) Rita got the flu from a kid who was ill four days ago.

c) Our cookies are tastier with 20% more butter.

d) This is the saddest day of my life since I got married.

e) Some people say that discrimination is morally wrong. But this is just hypocritical. First, we treat people differently all the time. We give higher pay to those who are more capable, and we like our friends better than strangers. Also, we actually praise people for being discriminating — in their taste for good food, wine and music, for example. So it is just plain wrong to get so worked up about discrimination.

f) A harmful truth is better than a useful lie. (Thomas Mann)

5.5 ☒ Are these statements empty? What do you think the speaker is trying to convey, if anything?

a) Art is art. Everything else is everything else. (Ad Reinhardt)

b) What will be, will be.

5.6 ☒ What do you think these statements mean?

a) The Internet treats censorship as damage, and routes around it. (Programmer and computer activist John Gilmore)

b) Nature abhors a vacuum.

5.7 ☒ Enjoy these famous quotes attributed to some famous people. What do they have to do with linguistic pitfalls?

a) Smoking kills. If you're killed, you've lost a very important part of your life. (Actress Brooke Shields)

b) You wouldn't have won if we'd beaten you. (Baseball player Yogi Berra)

c) You've got to be very careful if you don't know where you are going, because you might not get there. (Yogi Berra)

d) I do not like this word *bomb*. It is not a bomb. It is a device that is exploding. (Former French ambassador Jacques le Blanc on nuclear weapons.)

e) Traditionally, most of Australia's imports come from overseas. (Former Australian cabinet minister Keppel Enderbery)

f) I have the body of an eighteen-year-old. I keep it in the fridge. (Irish comedian Spike Milligan)

g) I don't diet. I just don't eat as much as I'd like to. (Supermodel Linda Evangelista)

h) When more and more people are thrown out of work, unemployment results. (Calvin Coolidge, the 30th President of the United States)

CHAPTER 6

TRUTH

The concept of **truth** is one of the most basic concepts in logic. There are certainly lots of controversies in philosophy about the nature of truth. However, for the purpose of critical thinking, we can adopt Aristotle's definition:

> To say of what is that it is not, or of what is not that it is, is false, while to say of what is that it is, and of what is not that it is not, is true. (*Metaphysics*, 1011b25)

The basic idea here is that truth is a matter of correspondence to reality. If you say "Paris is in France," then your statement is true since Paris is indeed in France. Whereas "Paris is in Japan" is false since it is not the case. When a statement is true, logicians like to say that it has T (truth) as its **truth-value**. When a statement is false, its truth-value is F (falsehood). If a statement is neither true nor false, then we say it lacks a truth-value.

6.1 RELATIVISM

Aristotle's simple definition does not imply we can always discover the truth. The sentence "Aristotle ate an odd number of olives during his life" is either true or

false, but we would never know. Something can be objectively true even if nobody knows it or if people disagree about it. Objectivity is also quite compatible with changes in beliefs over time. People in the past used to think that the Earth is flat. But we no longer believe that. This change in perspective does not mean that truth is a matter of perspective.

Relativism is the view that there is no objective truth, that truth is always a matter of perspective or opinion. However, this extreme position is difficult to defend. Consider the question of whether relativism itself is true in an objective way or a relative way. If the former, then there is at least one objective truth and so relativism is inconsistent. It might be said that perhaps everything is relative except relativism itself. But why should there be such an exception? Why not allow other truths to be objective as well? If relativism is objectively true, then presumably "Either relativism is true or $1 + 1 = 2$" is another objective truth. So there cannot be just one objective truth! On the other hand, if relativism is true only relative to some perspectives, then it is not clear why it should be accepted, since it is also false relative to other perspectives. In any case, we might also wonder whether anyone is sincerely a relativist about *all* truths. Suppose we ask a relativist to jump off a plane without a parachute. Unless it is objectively true that he is likely to die, it is not clear why he should refuse. If everything is relative, then the prediction that he will not die is just as true (relative to some perspective) as the prediction that he will die (relative to another perspective).

There are other restricted forms of relativism that are milder and perhaps more plausible. These theories say that only certain types of truths are relative, not that all truths are. For example, relativism about taste is not implausible. Some people think warm beer tastes better than cold beer and others disagree. Is there a correct answer or is it a matter of preference? If the latter, then this suggests that relativism about taste is true. But of course, this is quite compatible with the existence of objective truths outside the area of taste.

6.2 STATEMENTS

So far we have not said much about the *kind* of things which are supposed to be true or false. For the purpose of this book we focus on statements, which can be used to express or formulate claims, hypotheses, theories, propositions, beliefs, knowledge, and so on. We shall define a statement as a declarative sentence. In English, there are three main sentence types:

Type	Main function	Example
declarative	make assertion	Amie is here.
interrogative	ask question	Is Amie here?
imperative	issue request or command	Come here, Amie!

As you can see, a declarative sentence is a complete and grammatical sentence that makes a claim. So here are some examples of statements in English:

- Time flies.
- The sky is dark and it will rain soon.
- Everyone knows that the moon is made of green cheese.
- The data and information provided on this web page is for informational purposes only and is not intended for trading or commercial purposes, unless written prior permission is obtained by the user from the author, though the author will not be liable for any errors or delays in the content, or for any actions taken in reliance thereon.

Statements can be true or false, short or long. But they must be grammatical and complete sentences. A good test of whether something is a statement is that it should still be grammatical if you add "it is true that" to the beginning of the statement—for example, "It is true that time flies." These, however, are not statements:

- The United Nations (A proper name, but not a sentence.)
- Poker face (Not a complete sentence.)
- Is it raining? (Not a declarative sentence.)
- $¶]_©$¶]§†‡_£ (A meaningless string of symbols.)

6.3 TYPES OF TRUTH

We spend a lot of time trying to find out whether certain things are true or not. It would help if we understand better the nature of three different kinds of truths:

Type of statement	True	False
analytic	Every triangle has three sides.	All bachelors are married.
empirical	Some apples are green.	All birds can fly.
value	We should not torture babies.	We should torture babies.

An **analytic truth** is a statement that is true solely in virtue of the meaning of the words contained in the statement. Likewise, an analytic falsehood is a statement that is false solely in virtue of the meaning of the words in the statement. In both cases, what makes them true or false depend solely on the meaning of words and not other kinds of facts about the world. "Every triangle has three sides" is analytically true because of the definition of *triangle.* If you fully understand the meaning of the sentence, you will know that it is necessarily true. This is purely a

matter of linguistic convention. You do not need to look at all the different triangles one by one and count the number of sides they have.

On the other hand, the truth and falsity of an **empirical statement** depends on contingent facts about the world, facts that could have been different if the history and physical laws of the universe had been any different. Knowing the meaning of the sentence "John is a bachelor" is not sufficient for knowing whether the sentence is true. You need to actually check John's marital status, perhaps in a government registry. Generally speaking, to find out whether an empirical statement is actually true, we need empirical observations or scientific studies.

A **value statement** is one about what is be good or bad, what is morally right or wrong, or what we should or should not do. Value statements seem to be distinct from empirical statements because people can agree about all the facts and still disagree about what is good or bad. They also do not seem to be analytic because people might understand the meaning of a controversial value statement perfectly well and still disagree about its truth. (We shall talk more about value statements in Chapter 18.)

6.3.1 Analyzing questions and issues

There is actually a lot more to be said about the distinction between these three kinds of statements.[1] But for the purpose of everyday critical thinking, the distinction as presented here should be adequate. It is important not to confuse the three types of statements because they require different sorts of evidence to argue for or against them. This will help us analyze a complicated issue by breaking it down into three types of questions: questions about meaning, questions about empirical facts, and questions about values. Examples:

- *Which is the world's largest bank?* To answer this question, we need to break it down into a question about meaning and a question about empirical facts. First, we need to clarify what is meant by *largest*, because there are different ways of measuring the size of a bank—for example, assets, market value, profit. One we have defined what *largest* means, which is the largest bank becomes an empirical question. In 2010, China's ICBC was the largest bank according to market value. But if we rank in terms of total assets then the Bank of America might be the world's largest bank instead.

- *Should there be a minimum wage?* Not every country has legislation mandating a minimum wage for workers. Is this something desirable? This question combines issues about meaning, empirical facts, and values. First, what do we mean by *minimum wage*? How is the wage level determined?

[1]There are lots of philosophical controversies about the concepts mentioned. For example, it has been argued that there is no sharp distinction between analytic and empirical statements. Also, many philosophers believe there are empirical statements that are neither analytic nor contingent. It has also been argued that some analytic statements are not necessarily true, even though they are true in virtue of meaning. Many people would also argue that value statements are neither true nor false.

Does it apply to temporary or part-time workers? Then there are empirical questions about the legal, economic, and social consequences of introducing minimum wage. Does it have any effect on unemployment? Does it increase inflation or layoffs? Does it affect economic competitiveness? How does it affect those who are least well off? Finally there are questions about values. What ought to be the role of the government in the labor market? How important is the freedom of contract? Is the imposition of a minimum wage consistent with justice, equality and fairness?

As we can see from these two examples, many complicated questions can be broken down into further questions along the three dimensions of meaning, facts, and values. This provides a systematic approach to analyze complicated issues.

EXERCISES

6.1 Discuss these arguments.

a) Relativism is correct because any true sentence can be changed into a false one if you give it a different meaning, say changing "1+1=2" to mean "The Moon is made of tofu."

b) Different people have different opinions. So relativism is obviously true.

c) If relativism is false, then certain things are objectively true. But we never have direct access to objective reality. Our theories are inevitably our conceptual constructions, and they are always a product of our existing culture and perspectives.

6.2 Which of the following are statements?

a) Cats and dogs.

b) Yummy ramen noodles!

c) Is ramen yummy?

d) Ramen is yummy.

e) Go away and never come back.

f) The unexamined life is not worth living.

g) If ramen is yummy, then sushi is even more yummy.

h) Ramen is popular not just in Japan.

6.3 Classify these statements as analytic, empirical or value statements.

a) There are more rainy days in Shanghai than sunny days.

b) Violence causes more violence.

c) Many people believe that greed is good.

d) People should be required to donate their organs when they die unless they have explicitly indicated otherwise.

e) If Peter was killed yesterday, then Peter is now dead.

f) All purple things are colored.

g) Helping people makes us happier.

h) Critical thinking is something people ought to pursue.

i) If Rebecca is Shannon's mother, then Shannon is Rebecca's offspring.

6.4 ☒ What is your opinion about the following questions? List the conceptual, empirical, and value issues that should be considered.

a) Governments should subsidize industries that develop renewable energy.

b) Softdrinks should not be allowed in schools.

CHAPTER 7

BASIC LOGIC

7.1 SOME BASIC CONCEPTS

Many people associate logic with brain teasers and mathematical puzzles, which seem to have little relevance to real life. The truth is that logic is of great practical significance. If your friend is in New Zealand, you know she is not in Japan. This piece of everyday reasoning involves logic. The core of logic is about consistency and deduction, both of which are indispensable for everyday thinking, not to mention scientific research and legal reasoning. Logic also plays a special role in computer technology. Computers are good at processing information because their processors can perform a huge number of logical operations very quickly. Obviously, normal people are capable of logical reasoning to some extent, or else we would not be able to survive very long! But making the effort to study some logic can improve our understanding of what good reasoning is like so we can become even better. In this chapter we shall look at some basic concepts of logic.

An Introduction to Critical Thinking and Creativity: Think More, Think Better. By Joe Y.F. Lau

7.1.1 Consistency

A set of statements is **consistent** when and only when it is logically possible for all of them to be true in the same situation. Otherwise they are **inconsistent**. So for example, "Adrian is happy" and "Adrian is married" are consistent with each other since there is no reason why a married person cannot be happy. On the other hand, "Visanna is 30 years old" and "Visanna is 20 years old" are obviously inconsistent. Here are a few more points to remember about consistency:

- Inconsistent statements are also known as **contraries**.
- We can also speak of a single statement as consistent or inconsistent, depending on whether it is logically possible for it to be true. "There are round squares" is inconsistent and false. "Paris is in France" is consistent and true. "Nobody lives in Paris" is consistent but false.
- Whether a set of statements is consistent depends on whether it is *logically possible* for all of them to be true in the same situation. It is not necessary that they are *actually* true. "Paris is in Italy" and "Nobody lives in Paris" are consistent with each other, even though both are actually false.
- To show that a set of statements is consistent, we can either show that they are actually true or describe a logically possible situation in which they are all true. Consider the two previous statements about Paris. Imagine that Italy conquers France with chemical weapons and takes over Paris. But Paris became contaminated and everyone leaves. This imaginary situation is far-fetched but coherent, and shows that the statements are consistent.
- Statements that are actually true are consistent with each other, but false statements might or might not be consistent with each other. The two previous statements about Paris are false but consistent. "Nobody lives in Paris" and "Only 10 people live in Paris" are false and inconsistent with each other.
- If a set of statements is inconsistent, the statements will entail a contradiction of the form:

  > P and it is not the case that P.

  Take "Nobody lives in Paris" and "Only 10 people live in Paris." The second statement entails "It is not the case that nobody lives in Paris," and together with the first statement they entail the blatant contradiction:

  > Nobody lives in Paris and it is not the case that nobody lives in Paris.

Many inconsistencies are easy to detect, but not always. Suppose someone says we should be cautious in making general claims. This seems like good advice because sweeping generalizations like "Every Italian loves pizza" and "All Belgian chocolates are good" are bound to have exceptions. So we might be tempted to

conclude that all general claims have exceptions. But the claim "All general claims have exceptions" is actually inconsistent. It is itself a general claim, and if it were true, it should also have an exception. But this implies that not all general claims have exceptions. In other words, the claim cannot possibly be true and is therefore inconsistent!

If we want to speak truly, we should avoid inconsistent statements. But sometimes ordinary speakers use sentences that seem to be inconsistent, such as,"I am happy and I am not happy." Why do people say things that cannot be true? One answer is that these sentences have incomplete meaning. When we fully specify their meaning, they are no longer inconsistent. For example, perhaps the speaker is happy that she is getting married, but she is also not happy that her ex-boyfriend showed up at the wedding. She is happy about one thing and not happy about a different thing, so there is no real inconsistency.

7.1.2 Entailment

A set of statements $P_1 \ldots P_n$ **entails** (or **implies**) a statement Q if and only if Q follows logically from $P_1 \ldots P_n$. In other words, if $P_1 \ldots P_n$ are all true, then Q must also be true. For example, consider these statements:

P: A bomb exploded in London.
Q: Something exploded somewhere.

Here, P entails Q, but not the other way round. Just because there was an explosion does not mean that a bomb was involved. Perhaps it was it was an egg exploding in a microwave oven. When P entails Q, we say that Q is a **logical consequence** of P. In symbolic notation, it is $P \Rightarrow Q$. Here are two important points about entailment:

- A set of true statements *cannot* have false consequences.
- A set of false statements *can* have true consequences.

If we look at the example carefully, we can see that if P entails Q, and Q turns out to be false, then we should conclude that P must also be false. This point is worth remembering because we often decide that a hypothesis or a theory is false because it entails something false. However, if P entails Q, and P is false, it does not follow that Q is also false. A false theory can have true consequences, perhaps as a lucky accident. Suppose someone believes that the Earth is shaped like a banana. This false belief entails that the Earth is not like a pyramid, which is true. This example tells us we should avoid arguments of the following kind:

Your theory entails Q.
Your theory is wrong.
Therefore, Q must be wrong.

Entailment is related to the **logical strength** of statements. If a statement P entails another statement Q but not the other way round, then P is *stronger* than

Q, or equivalently, Q is *weaker* than P. Thus "That is a Boeing 747 airplane" is stronger than "That is an airplane." As you can see, a stronger statement provides more information, but at the same time it runs a higher risk of being false. Here are some typical ways to qualify a statement to make it weaker:

Original statement	**Weaker, qualified version**
All lawyers are talkative.	All lawyers *I know* are talkative. (restrict to personal experience)
Snakes with triangular heads are poisonous.	*Most* snakes with triangular heads are poisonous. Snakes with triangular heads are *probably* poisonous. Snakes with triangular heads are *often* poisonous. *With few exceptions*, snakes with triangular heads are poisonous. (frequency and probability qualifiers)
He won't be late.	*If* there is no traffic jam, he won't be late. (conditional qualifier)
He is tall. This cake is good.	He is *not short.* This cake is *not bad.* (weaker adjectival phrase)

Although qualifying a statement might make it more plausible, do not overdo it. "The government should increase taxes now" makes a definite and substantive claim. "The government should increase taxes when it is appropriate to do so" is so weak as to say nothing. Highly qualified writing can appear to be boring and wishy-washy. A well-argued but interesting claim is much preferable.

We should also be careful of the opposite situation in which people fail to qualify their claims for various reasons. For example, some people believe shark cartilage can cure cancer, and there is even a book called *Sharks Don't Get Cancer.* But it turns out that sharks *do* get cancer. The book does acknowledge that, but it says that a qualified claim such as "almost no sharks get cancer" would not make a good book title. Guess what, sharks can even get cancers in their cartilage!

7.1.3 Logical Equivalence

If P entails Q and Q entails P, then P and Q are **logically equivalent**—for example, "Superman is more powerful than Batman" is logically equivalent to "Batman is less powerful than Superman." When two statements are logically equivalent, they necessarily have the same truth value—it is not possible for one of them to be true and the other one to be false.

- In formal logic, $P \Leftrightarrow Q$ means that P and Q are logically equivalent.
- If $P \Leftrightarrow Q$, then $Q \Leftrightarrow P$. Every statement is logically equivalent to itself.

7.2 LOGICAL CONNECTIVES

A **logical connective** is a logical term that can be attached to statements to form more complex statements.

7.2.1 Conjunction

Given two statements P and Q, their **conjunction** is the complex statement "P and Q". P is the *left conjunct*, Q the *right conjunct*. Examples:

- Jack died, *and* Jill went to a party.
- Protons are positively charged, *and* electrons are negatively charged.

The logical behavior of a conjunction is quite simple. A conjunction "P and Q" is true when both conjuncts P, Q are true. Otherwise the conjunction is false. But be careful of possible ambiguity when *and* is used to join phrases:

- Ravel studied the philosophy of music and literature. (Literature and philosophy of music, or philosophy of music together with philosophy of literature?)
- We should hire more temporary and part-time drivers. (Temporary drivers and part-time drivers, or part-time drivers who work on a temporary basis?)
- You must use screws, nuts, and bolts of stainless steel. (Are the screws and nuts also made of stainless steel?)

7.2.2 Disjunction

Disjunction is expressed by the word *or* in English, but it is useful to bear in mind two types of disjunction. When "P or Q" is used in the **exclusive** sense, this is equivalent to "either P or Q, but not both." An example might be when a girl issues an ultimatum to her two-timing boyfriend: "Either you stay with me, or you go out with her." Presumably she is not saying that her boyfriend can do both!

On the other hand, under the **inclusive** reading, "P or Q" is consistent with the possibility where both P and Q obtains. Suppose your computer is not working, and your friend says, "The hard drive is broken or the motherboard is not working." We might not want to say that your friend is wrong if it turns out that both components are not working.

The two possible interpretations presents a potential problem in drafting and interpreting legal documents.[1] To avoid disputes and unintended consequences, it might be a good idea to be more explicit when disjunction is used, by adding

[1] Some linguists and philosophers argue that *or* has only the inclusive meaning. Any impression otherwise is due to conversational implicatures or other pragmatic effects. Whatever the case may be, there is no harm in making things clearer when we want to avoid misunderstanding.

"or both", or "but not both." Also, like *and*, the use of *or* can lead to syntactic ambiguity:

- You should use white glue or tape. (Does the tape have to be white?)
- No hunting of turtles, fish, or birds on the endangered list. (All turtles and fish, or just those on the list?)

7.2.3 Negation

The **negation** of a statement P is any statement whose truth-value is the opposite of P. Given any statement in English, we can form its negation by appending the expression "it is not the case that." So the negation of "it is raining" is "it is not the case that it is raining," or, in other words, "it is not raining." Here are some facts about negation:

- A statement and its negation are always inconsistent with each other.
- A statement and its negation form a pair of **exhaustive and exclusive alternatives**, e.g. Santa Claus exists; Santa Claus does not exist. They cannot both be true and they cannot both be false.[2]
- Negation involving modal verbs in English can be tricky. "You must leave" and "you must not leave" are inconsistent. But they are not exhaustive alternatives because it is also possible that there is nothing you must do. Perhaps it is up to you whether you stay or leave. The negation of "you must leave" is "it is not the case that you must leave," not "you must not leave." However, the negation of "you may leave" *is* "you may not leave"!
- In formal logic, the negation of P can be symbolized as $\sim P$, $\neg P$, or not-P.

7.2.4 The conditional

A **conditional statement** (or a **conditional**) is any statement of the form "If P then Q"—for example, "If you are a member, then you can get a discount." Conditionals are of special importance because they can be used to formulate rules and general laws:

- Computer programs contain lots of rules about what to do in some given situation. A rule for removing spam messages might be: "If an email contains the words *viagra* and *sex*, put it in the trash folder."
- Many universal scientific laws are conditionals in disguise. "All electrons have negative charge" is equivalent to "For any object x, if x is an electron, then x has negative charge."

[2]Recall Section 4.6 on exclusive and exhaustive possibilities.

- A lot of legal rules are conditionals describing the legal consequences of specific situations—for example, if you are in a moving vehicle equipped with seat-belts, then you are required to wear one.

Given a conditional "if P then Q", P is the **antecedent** of the conditional, and Q the **consequent**. To accept a conditional is to accept a certain logical or evidential connection between P and Q. But you don't have to accept that P and Q are both true. For example, you might agree with this statement:

> If the sun explodes tomorrow, then we shall all die a sudden death.

But you can consistently agree that the statement is true, even if you do not believe that the sun will explode tomorrow, and you also do not believe that we shall all die suddenly. Here are some additional points about the conditional:

- These claims are correct:
  - When P is true but Q is false, "If P then Q" is false. "If you drink coffee you won't be able to sleep" is false when you still manage to sleep after drinking coffee.
  - "If P then Q" is logically equivalent to "If not-Q, then not-P".
  - P. If P then Q. $\Rightarrow Q$.
  - Not-Q. If P then Q. $\Rightarrow$ not-P.
- But please note that the two claims below are *false:*
  - Not-P. If P then Q. $\Rightarrow$ not-Q.
  - Q. If P then Q. $\Rightarrow P$.
- The **converse** of "If P then Q" is "If Q then P". (In other words, the antecedent and the consequent are swapped.) Normally, a conditional does *not* entail its converse.[3]

7.2.5 The biconditional

A **biconditional** is any statement of the form "P if and only if Q". This is logically equivalent to:

> If P, then Q, and if Q, then P.

In other words, a biconditional is a conjunction of a conditional and its converse. Here are some equivalent formulations:

[3] Unless for conditionals such as "If P then P"!

- P iff Q.
- P when and only when Q.
- $P \leftrightarrow Q$ (in formal logic)

Here is a more technical point that you might skip if you want: $P \leftrightarrow Q$ is not the same as $P \Leftrightarrow Q$. If $P \Leftrightarrow Q$ is true, then $P \leftrightarrow Q$ does follow. But the converse is not correct: $P \leftrightarrow Q$ does not imply $P \Leftrightarrow Q$. For example, it might be true that in a particular course, passing the exam involves getting at least 50 marks. In this situation, a teacher would be speaking the truth when she says, "You pass the exam if and only if you get at least 50 marks." However, "you pass the exam" is not logically equivalent to "you get at least 50 marks." It just so happens that in this particular situation, one sentence is true if and only if the other one is. But this is not logically necessary, since a different pass mark is possible, and so equivalence fails.

EXERCISES

7.1 For each set of statements below, determine whether the statements are logically equivalent to each other. If not, how would you describe their logical connections?

a) Someone is loved by everyone.
Everyone loves someone.
There is someone whom everyone loves.

b) I don't know anything. I don't know everything.

c) Facebook is not building a mobile phone.
Facebook is not designing a mobile phone.
Facebook is not going to launch a mobile phone.

d) Please do not walk on the bridge.
Please stay off the bridge.

e) All robberies are cases of theft.
It is not true that all robberies are not cases of theft.
It is not the case that some robberies are not cases of theft.

f) Some cases of theft are robberies.
Some robberies are cases of theft.
Some cases that are not theft are not robberies.

g) Some robberies are not cases of theft.
Some cases of theft are not robberies.

h) Mona and Louis went to the bank.
Mona went to the bank, and Louis went to the bank.

i) Antonio and Elaine ate one apple.
Antonio ate one apple, and Elaine ate one apple.

j) Ronaldinho is a famous soccer player.
Ronaldinho is famous, and he is a soccer player.

k) Nothing is impossible.
It is not the case that everything is impossible.

7.2 Determine the consistency of each set of statements below.

a) John has a new secondhand car.

b) All puddings are nice.
This dish is a pudding.
No nice thing is wholesome.
This dish is wholesome.

c) If he is guilty, then his DNA will be on this shirt.
If he is guilty, then he was not wearing a shirt.
If he was not wearing a shirt, then his DNA won't be on this shirt.

d) We are fascinated with being wrong. It teaches us about ourselves. Not only are there things we don't know, but the things we do know can be wrong. (Hawking et al., 2003)

e) I would never get AIDS. But it somehow happened, and it was only because I was unlucky.

f) All events are caused.
Human actions are events.
Human actions are free actions.
No event that is caused is a free action.

7.3 See if these sentences are ambiguous. If so, rewrite them to make explicit the different interpretations.

a) Only Intel processors, memory chips, and motherboards will be sold.

b) I shall visit Sophie and you will visit Sandra or he will visit Sonia.

7.4 Negation can be expressed in many different ways. Rewrite these sentences into logically equivalent ones that start with "It is not the case that."

a) Hang gliding is not dangerous.

b) I am unafraid.

c) Belching is impolite.

d) You aren't Einstein.

7.5 Disjunction connects not just sentences, but often phrases as well. They can also be understood in the exclusive or inclusive sense. See which interpretation is better for the statements below:

a) Come to the party if you know the bride or the groom.

b) For your next appointment, the doctor will see you on either Tuesday or Wednesday.

7.6 ☒ Here are some famous quotes from the legendary U.S. baseball player Yogi Berra. Why are they funny?

a) Baseball is 90 percent mental and the other half is physical.

b) Nobody goes there anymore. It's too crowded.

c) You can observe a lot by watching.

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CHAPTER 8

IDENTIFYING ARGUMENTS

8.1 WHAT IS AN ARGUMENT?

In ordinary usage, an argument is often taken to be a somewhat heated dispute between people. But in logic and critical thinking, an **argument** is a list of statements, one of which is the **conclusion** and the others are the **premises** or **assumptions** of the argument. An example:

> It is raining.
> So you should bring an umbrella.

In this argument, the first statement is the premise and the second one the conclusion. The premises of an argument are offered as *reasons* for accepting the conclusion. It is therefore irrational to accept an argument as a good one and yet refuse to accept the conclusion. Giving reasons is a central part of critical thinking. It is not the same as simply expressing an opinion. If you say "that dress looks nice," you are only expressing an opinion. But if you say "that dress looks nice *because* the design is very elegant," then it would be an argument indeed. Dogmatic people tend to make assertions without giving arguments. When they cannot defend themselves, they often resort to responses such as "this is a matter

of opinion," "this is just what you think," or "I have the right to believe whatever I want."

The ability to construct, identify, and evaluate arguments is a crucial part of critical thinking. Giving good arguments helps us convince other people, and improve our presentation and debating skills. More important, using arguments to support our beliefs with reasons is likely to help us discover the truth and eliminate errors and biases.

8.2 IDENTIFYING PREMISES AND CONCLUSIONS

Here is an example of a short argument made up of three statements. We use a straight line to separate the premises at the top from the conclusion at the bottom. Call this the **standard format** for presenting an argument:

Singapore is an island.
All islands are surrounded by water.

Singapore is surrounded by water.

You can also number the premises and the conclusion to make it easier to refer to them in a discussion:

1. Amie is taller than Beth.
2. Beth is taller than Cindy.
3. Cindy is taller than Denise.
4. Denise is taller than Emily.

---

5. Amie is taller than Emily.

It is a good idea to present arguments using the standard format. It is neat and tidy, and everything is presented clearly at a glance. This makes it easier to understand and evaluate the argument, since we know exactly how many premises there are and what they say. Of course, the premises and conclusions of real arguments are rarely laid out explicitly. So how do we identify them? There are no easy mechanical rules, and it depends on the context. But remember these two points. First, in a passage that contains an argument, the conclusion is usually the most important point the author is trying to put across. The premises would be the evidence the author uses to convince the readers that the conclusion is true. In addition, see if you can find **indicator words** expressing logical connections between premises and conclusions:

- Every wizard has a wand and Harry is a wizard. Thus Harry has a wand.
- Every wizard has a wand. Harry is a wizard. It follows that Harry has a wand.
- Harry has a wand, since he is a wizard and every wizard has a wand.

The conclusions in the arguments are underlined. The first two conclusions are preceded by "thus" and "it follows that," respectively. Although the third example is a single long statement, we can still take it as an argument because it is combined from shorter statements. It is obvious that the underlined part is supported by the statements after *since.* Here are some typical indicator words or phrases:

Indicator words or phrases	**Role**
therefore, hence, thus, so, consequently, if follows that, it can be concluded that, proves that, shows that, indicates that	Often followed by the conclusion, with the premises appearing before them.
since, this is because, one reason is that	Appears before premises.

However, these are just guidelines and there are plenty of exceptions. We need to look at the actual context carefully:

- I have been here since noon.
  (Not an argument—*since* does not link to a statement.)
- You should not drink. You are going to do brain surgery afterward.
  (The first sentence is the premise and the second one its conclusion. No indicator words at all.)
- How can you believe that corruption is acceptable? It is neither fair nor legal!

In the last example, the conclusion is expressed by a rhetorical question. The real argument might be reformulated explicitly as follows:

Corruption is neither fair nor legal.

Corruption is not acceptable.

8.3 EXTRACTING AND FORMULATING ARGUMENTS

Many if not most of the arguments in real life are more difficult to analyze than the ones we have seen so far. It might be because the discussion is about complicated issues. Or the author mixes background information together with the argument itself. The structure of the argument might not be clearly indicated, and the same point might be repeated more than once. Or perhaps the author was busy or even confused and did not write as clearly as we would like. The upshot is that it takes a lot of effort to remove the superfluous information, distill the main ideas, and extract the central argument. But this is something worth doing because this makes

it easier to understand, evaluate, and remember the argument. If we do this often enough, it will also help us improve our critical thinking skills.

Take this passage taken from the website of the *Economist* magazine:

> Voltaire once wrote, "If God did not exist, it would be necessary to invent him." Leaving aside whether we actually did, can the same be said of religion? Most of the world's population professes religious feelings of some sort, and these beliefs in turn underpin many strong communities, happy individuals and tremendous acts of charity.
>
> Yet the world can be a very nasty place despite its preponderance of religious inhabitants. When faith curdles into dogmatism it often leads to arrogance, intolerance and violence. In other words, religion is a force for bad as well as good and there is no simple metric with which to measure its net effect (Economist, 2010).

The passage is very clearly written, and we can easily see that it contains an argument with the conclusion indicated by "in other words." But it can be condensed a lot further if we analyze it a little bit. Take the first paragraph. The quote in the first sentence sets the topic of discussion but does not contribute to the argument at all. The second sentence is a question and also not part of the argument. The third sentence does include a crucial premise about the positive effects of religion, but it can be simplified further. Going through the second paragraph in the same way, we can rewrite the argument in the standard format as follows:

> Religion promotes strong communities, happiness, and charity.
> Religion also leads to arrogance, intolerance, and violence.
> ---
> Religion has both good and bad consequences.

We are now able to present the central argument even more clearly and succinctly. This makes it easier to explore the argument further. First of all, the argument seems quite acceptable. The premises seem true and they support the conclusion. Of course, the premises do not exhaust all the good and bad consequences of religion. Religion can also give rise to great art and culture (such as paintings and architecture), but it can also result in superstition and ignorance.

As we can see, extracting and reformulating an argument helps us identify the central ideas so we can think more deeply and systematically. This analytical approach is particularly suitable for reading articles that aim to present arguments, evidence, and information. Here are the main steps involved:

- Identify the premises and conclusions in the target passage.
- Leave out superfluous material and focus on the main ideas. Delete anything that does not affect the central argument or the main points.
- Reformulate and simplify the central ideas in your own words to make them easier to understand.

- Identify the logical structure of the argument.

We have not said much about the last step of the process. After identifying the premises and the conclusion of an argument, we can go further to analyze the nature of the logical relation between them. This is the topic we shall focus on in the next few chapters.

EXERCISES

8.1 See if these passages contain arguments. If so, rewrite the arguments in the standard format:

a) Seriously, don't you think you should be staying at home? Didn't you hear that a thunderstorm is coming?

b) Since all Maoists are communists and all communists are Marxists, Maoists are Marxists.

c) Listen up. You should not drive. You can barely keep your eyes open.

d) He didn't call. If he wants to go out with me he would have called. Obviously he is not interested in me.

e) We shall go on to the end. We shall fight in France, we shall fight on the seas and oceans, we shall fight with growing confidence and growing strength in the air, we shall defend our island, whatever the cost may be. (Winston Churchill)

f) You should not jaywalk. It is true that many people do it. But you might get hit by a car. Or the police might fine you.

g) If the solution is acidic, the litmus paper would have turned red. But since it hasn't, the solution is not acidic.

8.2 Reformulate the following argument in the standard format. Use simple and clear language, preserving the central idea, with a maximum of 60 words (the shorter the better):

> When students who study art take a first look at art from the modern period, such as modernist abstract paintings and sculptures, their eyes are confronted by something that seems to them to contain completely meaningless and incomprehensible patterns and squiggles. It is in fact quite true that only after an extended duration and process, which consists in the study of the historical development of art, that they can begin to appreciate and grasp the meaning and significance of these pieces. This observation affords us a very important insight about the educational methodology regarding modern art. It is that it must always begin with lessons and learning of the history of art. This cannot be avoided and will only benefit students.

8.3 Read the passage from the *Economist* website again. It might be suggested that it contains a second argument. What is the conclusion of that argument?

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CHAPTER 9

VALID AND SOUND ARGUMENTS

9.1 VALIDITY AND SOUNDNESS

Validity is a most important concept in critical thinking. A valid argument is one where the conclusion follows logically from the premises. But what does it mean? Here is the official definition:

> An argument is valid if and only if there is no logically possible situation in which the premises are true and the conclusion is false.

To put it differently, whenever we have a valid argument, *if* the premises are all true, then the conclusion *must* also be true. What this implies is that if you use only valid arguments in your reasoning, as long as you start with true premises, you will never end up with a false conclusion. Here is an example of a valid argument:

Marilyn is 20 years old.

Marilyn is more than 10 years old.

This simple argument is obviously valid since it is impossible for the conclusion to be false when the premise is true. However, notice that the validity of the argument can be determined without knowing whether the premise and the conclusion are *actually* true or not. Validity is about the *logical connection* between the premises and the conclusion. We might not know how old Marilyn actually is, but it is clear the conclusion follows logically from the premise. The simple argument above will remain valid even if Marilyn is just a baby, in which case the premise and the conclusion are both false. Consider this argument also:

Every bird can fly.
Every bat is a bird.

Every bat can fly.

Again the argument is valid—if the premises are true, the conclusion must be true. But in fact both premises are false. Some birds cannot fly (the ostrich), and bats are mammals and not birds. What is interesting about this argument is that the conclusion turns out to be true. So a valid argument can have false premises but a true conclusion. There are of course also valid arguments with false premises and false conclusions. What is not possible is to have a valid argument with true premises and a false conclusion. Here are some additional points about validity:

- A valid argument is one where it is logically impossible for the premises to be true and the conclusion to be false. But *logically impossible* does *not* mean "unlikely." Consider this argument: Milton is a one-month-old human baby, and so Milton cannot walk. This seems cogent, but the argument is not valid because a one-month-old walking baby is not a logical impossibility. Imagine a scenario in which Milton is the product of a genetic experiment, and he is able to walk right after birth. Extremely implausible for sure, and maybe even biologically impossible. But the situation described is logically possible in the sense that there is no logical contradiction.[1]
- An argument that is not valid is **invalid**. This happens as long as there is at least one logically possible situation where its premises are true and the conclusion is false. Any such situation is known as an **invalidating counterexample**. It does not really matter whether the situation is realistic or whether it actually happens. What is important is that it is coherent and does not entail any contradiction. A single invalidating counterexample is sufficient to prove that an argument is invalid.
- Arguments are either valid or invalid, but we should not describe them as true or false. Because an argument is not a single statement, it is unclear what a true argument is supposed to be. Does it mean the argument has a

[1]This is not to say that the argument about Milton is a bad argument. Even though it is not valid, it is still **inductively strong**. Inductively strong arguments play a very important role in probabilistic and scientific reasoning, and we shall discuss them in more details in chapter 10.

true conclusion, or does it mean the argument is valid, or are we saying that the premises are true? It is confusing to speak of true and false arguments.

9.2 PATTERNS OF VALID ARGUMENTS

Valid arguments are useful because they guarantee true conclusions as long as the premises are true. But how do we know if an argument is valid? One indirect way is to see if we can come up with an invalidating counterexample. If we can, the argument is not valid. But of course, the weakness of this method is that when we fail to find a counterexample, this does not guarantee that the argument is valid. It is possible that we have not looked hard enough.

A more direct way of establishing validity is to demonstrate step by step how the conclusion of an argument can be derived using only logical principles. This is what formal logic is all about. But for everyday reasoning, a good understanding of some basic patterns of valid argument should also suffice.[2]

9.2.1 Modus ponens

Consider these two arguments:

If whales are mammals, then whales are warm blooded.
Whales are mammals.

Whales are warm blooded.

If you love me, you should remember my birthday.
You love me.

You should remember my birthday.

Obviously, both arguments are valid. It does not matter whether the premises and the conclusions are true or not. Furthermore, these arguments are similar to each other in the sense that they have the same logical structure, which can be represented by this pattern:

If P, then Q.
P.

Q.

Here, the letters P and Q are **sentence letters**. They are used to translate or represent statements. By replacing P and Q with appropriate sentences, we can

[2]But if you want to learn some formal logic, you can start with the online tutorials on sentential and predicate logic on our companion website. These are the two most basic systems of formal logic.

generate the original valid arguments. This shows that the arguments have a common form. It is also in virtue of this form that the arguments are valid, for we can see that any argument of the same form is a valid argument. Because this particular pattern of argument is quite common, it has been given a name. It is known as **modus ponens**. But do not confuse modus ponens with the following form of argument, known as **affirming the consequent**:

If P, then Q.
Q.

P.

Not all arguments of this form are valid. Here are two invalid ones:

If Sunarsih lives in Bali, then Sunarsih lives in Indonesia.
Sunarsih lives in Indonesia.

Sunarsih lives in Bali.

If Ching loves you, then Ching will buy you a bunch of roses.
Ching will buy you a bunch of roses.

Ching loves you.

Both arguments are invalid, and it is easy to find some invalidating counterexamples. For example, Putu might live in Jakarta and not Bali, and so the premises of the first argument are true but the conclusion is false. Similarly, it might be true that Chaak will buy you some roses if he loves you. But perhaps he will buy them even if he does not love you. Maybe he hates you so much that he decides to send you some roses that have been sprayed with a lethal virus.

9.2.2 Modus tollens

Modus tollens is also a very common pattern of valid argument:

If P, then Q.
Not-Q.

Not-P.

If Superman is a human being, then Superman has human DNA.
It is not the case that Superman has human DNA.

Superman is not a human being.

Note that "not-Q" simply means the negation of Q—for example, "it is not the case that Q." So if Q means "Superman has human DNA," then not-Q would mean "it

is not the case that Superman has human DNA," or "Superman does not have human DNA." But do distinguish modus tollens from the fallacious pattern of argument known as **denying the antecedent**:

If P then Q.
Not-P.

Not-Q.

If Einstein is a biologist, then Einstein is a scientist.
But Einstein is not a biologist.

Einstein is not a scientist.

9.2.3 Disjunctive syllogism

Both patterns are valid:

P or Q.	P or Q.
Not-P.	Not-Q.
---	---
Q.	P.

Either we should break up, or we should get married.
We should not get married.

We should break up.

9.2.4 Hypothetical syllogism

Another pattern of valid argument:

If P then Q.
If Q then R.

If P then R.

If God created the universe, then everything is perfect.
If everything is perfect, then there is no evil.

If God created the universe, then there is no evil.

9.2.5 Constructive dilemma

A pattern of valid argument with three premises:

P or Q.
If P then R.
If Q then S.

R or S.

Either the president is lying, or he is telling the truth.
If the president is lying, then he is wicked.
If the president is telling the truth, then he is mad.

Either the president is wicked, or he is mad.

When R is the same as S, this is an equally valid pattern:

P or Q.
If P then R.
If Q then R.

R.

Either our actions are random, or our actions are determined.
If our actions are random, we do not have free will.
If our actions are determined, we do not have free will.

We do not have free will.

9.2.6 Destructive dilemma

See if you can come up with your own example of this pattern of valid argument:

Not-R or not-S.
If P then R.
If Q then S.

Not-P or not-Q.

9.2.7 Reductio ad absurdum

Reductio ad absurdum is Latin for "reduced to absurdity." It is a method for showing that a certain statement S is false:

1. First assume that S is true.
2. From the assumption that S is true, show that it leads to a contradiction, or a claim that is false or absurd.
3. Conclude that S must be false.

If you can spot connections quickly you might notice that this is none other than an application of modus tollens. As an example, suppose someone claims that a human being's right to life is absolute and so we should never kill or destroy human life. But is this acceptable? If it is, then it follows that when you are being attacked, it will be wrong for you to kill your attacker if this is the only way to prevent yourself from being harmed. But surely this is not correct. Most people would agree that in some situations when your life is threatened you can respond by deadly force, and this is recognized by our legal system. Since the original assumption leads to an absurd conclusion, this entails that the right to life is not absolute.

In mathematics, reductio proofs are also known as **proofs by contradiction**, or **indirect proofs**. Many well-known proofs, such as the proof that the square root of two is an irrational number, and Euclid's proof that there are infinitely many prime numbers, employ this reductio method. They are beautiful proofs that are easy to understand. If you are interested you can look them up on the Internet quite easily.

Self-refuting claims

Many **self-refuting** claims can be shown to be false by applying the claims to themselves. Some examples:

- There are only perspectives and there is no such thing as truth.
  (But then it is a truth that perspectives exist!)
- Nothing can be known.
  (And how do we know that?)
- Nothing exists.
  (Does the sentence exist and whose idea is it?)
- All new ideas come from other people.
  (Where does the first idea come from?)

9.2.8 Combining patterns to form more complex arguments

The patterns of valid arguments we have looked at are all rather simple. But they can be combined to form more complex arguments. This valid argument involves three applications of modus tollens:

If P then Q.
If Q then R.
If R then S.
Not-S.

Not-P.

When an argument gets even more complex, it might be a good idea to break it down into parts, or use a diagram known as an **argument map** to display the argument structure more clearly. (See chapter 11 for further discussion.)

9.3 ARGUMENTS INVOLVING GENERALIZATIONS

A **generalization**, or a **general statement**, is a statement that talks about the properties of a certain class of objects. In this chapter we shall be concerned only with the following three main kinds of generalizations:

Type	Example
universal	Every F is G; all Fs are Gs (Every great idea is ridiculed in the beginning.)
existential	Some F is G; at least one F is G. (Some dinosaur is warm-blooded.)
statistical	Statements that say that a certain proportion of Fs are Gs. (Most birds can fly; 70% of the students failed.)

Note that an existential generalization of the form "some F is G" means "at least one F is G." In other words, the statement can be true even if there is just a single F that is G. The statement does not say that there are many Fs that are Gs. The reason to focus on such statements is that they are logically related to universal generalizations. The denial or negation of "every F is G" is " some F is not G." For example, to show that "all politicians are corrupt" is false, all you need to find is one single politician who is not corrupt.

Another point to note about "some F is G" is that it does not logically imply "some F is not G." Normally, if someone says "some vases are broken," we might take him to imply that some vases are *not* broken. But this is not part of the literal meaning of the statement. After all, he can consistently maintain that all he knows is that some vases are broken, but he has no idea whether all of them are since he has not seen the rest of the vases.

One important aspect about the usage of universal generalizations is that "every F is G" is often used not as literally referring to every F in the world, but to some restricted class of Fs. For example, at a meeting, you might say something like "Everyone is here so let us begin." But of course you are not really saying

that everyone in the world is at the meeting. Rather, what you mean by *everyone* is something like "Everyone who is supposed to attend the meeting." Similarly, when someone says that her apartment has been burgled and that "Everything is gone", she is probably referring to every movable object of value inside the apartment, and it would be silly and unsympathetic to reply that the bathtub is still there.

Similarly, very often people use *every* to mean something like "most." For example, it is often said that everyone loves children. But surely there are people who dislike children, perhaps thinking that they are noisy and naughty. Nevertheless, the claim is a harmless one as long as we do not take it literally. The problem comes when to avoid exceptions, general claims are qualified in such a way that they become vacuous. For example, when it is pointed out that not everyone loves children, someone might say that every *normal* person loves children. But what does *normal* mean? If *normal* just means loving children then the claim is indeed true but empty and *normal* becomes a weasel word.

9.3.1 Patterns of valid argument

Here are a few valid argument patterns involving *every*, with some examples:

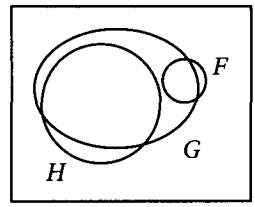
Every F is G.	Every F is G.	Every F is G.
x is F.	x is not G.	Every G is H.
x is G.	x is not F.	Every F is H.

Every dog is hairy.	Every dog is hairy.	Every terrier is a dog.
Harry is a dog.	Harry is not hairy.	Every dog is an animal.
Harry is hairy.	Harry is not a dog.	Every terrier is an animal.

But notice that all three arguments below are not valid:

Every F is G.	Every F is G.	Most Fs are Gs.
x is G.	x is not F.	Most Gs are Hs.
x is F.	x is not G.	Most Fs are Hs.

The last argument on the right is one that lots of people get wrong. We can use a Venn diagram to see why it is not valid and construct a counterexample, taking the area of a region to be proportional to the number of items in the corresponding set. So for example, the diagram on the following page shows that there are more Gs and Hs than Fs. Furthermore, most Fs are Gs, and most Gs are Hs, but there is actually no F that is H! (An example: Most birds are creatures that can fly. Most creatures that can fly are insects. So most birds are insects.)



9.4 SOUNDNESS

Given a valid argument, all we know is that if the premises are true, so is the conclusion. But validity does not tell us whether the premises or the conclusion are actually true. If an argument is valid, *and* all the premises are true, then it is called a **sound** argument. Of course, it follows from such a definition that the conclusion of a sound argument must be true. An argument that is not sound is **unsound**.

In a discussion, we should try out best to provide sound arguments to support an opinion. The conclusion of the argument will be true, and anyone who disagree would have to show that at least one premise is false, or the argument is invalid, or both. This is not to say that we can define a good argument as a sound argument. (We shall discuss this issue in chapter 12.)

EXERCISES

9.1 Is it possible to have valid arguments of the following types? If so can you provide an example?

- **a)** true premises, true conclusion
- **b)** true premises, false conclusion
- **c)** false premises, true conclusion
- **d)** false premises, false conclusion

9.2 Are these statements true or false?

- **a)** If the conclusion of this argument is true, then some or all the premises are true.
- **b)** If the premises of this argument are false, then the conclusion is also false.
- **c)** All sound arguments have true premises.
- **d)** If an argument has a false conclusion, it cannot be sound.
- **e)** If an argument is valid but unsound, its conclusion must be false.
- **f)** If all the premises and the conclusion of an argument are true, this still does not imply that the argument is valid.
- **g)** If the conclusion of a valid argument is true, the argument is sound.
- **h)** If an argument is invalid, then whenever the premises are all false, the conclusion must also be false.
- **i)** If an argument is invalid, then it is possible for the conclusion to be false when all the premises are true.

j) If P entails Q, then "P. Therefore Q." is a valid argument.

k) If "P. Therefore Q." is a valid argument, then "P and it is not the case that Q" is inconsistent.

9.3 Are these arguments valid?

a) All cocos are bobos. All lulus are bobos. So all cocos are lulus.

b) Very few insects are purple. Very few purple things are edible. So very few insects are edible.

c) Angelo is a cheap restaurant. We should eat at a cheap restaurant. So we should eat at Angelo.

d) Every F is G. Every G is not H. Therefore, no H is F.

e) No tweetle beetle is in a puddle. Nothing that is in a puddle is in a muddle. So no tweetle beetle is in a muddle.

f) Every xook is a beek. Some beek is not a kwok. So some kwok is not a xook.

g) Most cooks are men. Most men are insensitive people. So most cooks are insensitive people.

h) Very few plants are green. Very few green things are edible. So very few plants are edible.

9.4 Discuss this passage. Anything wrong?

> Dualities are bad. Suffering comes about because we make distinctions and then choose one thing over another: we want good and not bad things, we want to be happy and not sad, and we want love rather than hatred. These dualities are the root of our misery. To liberate ourselves, we should reject all distinctions and embrace non-duality.

9.5 Modus ponens is a pattern of valid arguments, while affirming the consequent is not. What is the difference between saying (a) Affirming the consequent is not a pattern of valid arguments, and (b) Affirming the consequent is a pattern of invalid arguments? This is a rather difficult theoretical question. *Hint:* Is it true that every argument of the form affirming the consequent is invalid? Use some examples to illustrate your answers.

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CHAPTER 10

INDUCTIVE REASONING

Consider these two arguments:

93% of Chinese have lactose intolerance.
Lee is Chinese.

Lee has lactose intolerance.

It has never snowed in Jakarta in the last 50 years.

It is not going to snow in Jakarta this year.

These arguments are of course not valid. Lee might be among the 7% of Chinese who can digest lactose.[1] Snow might fall in Jakarta this winter due to unusual changes in global weather. But despite the fact that the arguments are invalid, their conclusions are more likely to be true than false given the information in the premises. If the premises are indeed true, it would be rational for us to be

[1] A person with lactose intolerance lacks the enzyme lactase, which is needed for proper metabolization of lactose, a sugar present in milk and other dairy products.

highly confident of the conclusion, even if we are not completely certain of their truth. In other words, it is possible for the premises of an invalid argument to provide strong support for its conclusion. Such arguments are known as **inductively strong** arguments. We might define an inductively strong argument as one that satisfies two conditions:

1. It is an invalid argument.
2. The conclusion is highly likely to be true *given that* the premises are true.

Let us elaborate on this definition a bit more:

- Recall that a valid argument can have false premises. The same applies to an inductively strong argument. The two arguments given earlier remain inductively strong, even if Lee is not Chinese, or it turns out that it snowed in Jakarta last year.
- When we say the conclusion is highly likely to be true *given that* the premises are true, it does not mean "it is highly likely for the conclusion *and* the premises to be true." Consider this argument:

  Someone somewhere is eating bread right now.

  Someone somewhere is eating rice right now.

  It is surely plausible that at this very moment, there are people eating bread and there are people eating rice somewhere in the world. This makes it highly likely for the premise and the conclusion to be true. But the argument is not inductively strong because the fact that someone is eating bread gives us no reason to believe that someone is eating rice. There is no evidential connection between them, which is what is required when the conclusion is highly likely to be true *given that* the premise is true. What we should do is imagine a situation in which the premises are true, and then ask ourselves how likely it is that the conclusion is true in the same situation.

10.1 INDUCTIVE STRENGTH

Although inductively strong arguments are invalid, they are indispensable for science and everyday life. We often have to make predictions about the future based on past experience. Our past experience can never logically guarantee that our predictions are correct, but they can tell us what is more likely to happen. Our lives would be completely paralyzed if we did not plan our actions on the basis of probability. As Bishop Butler (1692–1752) said in a famous quote, "Probability is the very guide of life."

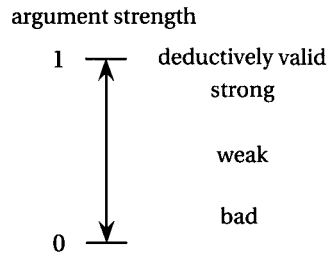
When we describe an argument as inductively strong, we are saying that although the premises of the argument do not logically entail the conclusion, the

premises nonetheless provide strong support for the conclusion. The **inductive strength** of the argument is a measure of the degree of support that is provided. Unlike validity, inductive strength is not an all-or-nothing matter. An argument is either valid or not valid, and there is no such thing as a partially valid argument. In contrast, the inductive strength of an argument is a matter of degree, as can be seen in this example:

x% of Chinese have lactose intolerance.
Lee is Chinese.

Lee has lactose intolerance.

Intuitively, whether the premise supports the conclusion depends crucially on the value of the variable x. If x is 100%, the argument is obviously deductively valid. If x is 99.999%, then the argument is invalid but inductively very strong. If x is 70%, the argument is still strong but less so. If x is 10%, then the premises are too weak to support the conclusion. We might represent inductive strength as a gradient, with deductive validity being the limiting case:



We can give a mathematical definition of inductive strength in terms of the **conditional probability** of the conclusion given the premises. Inductive strength will then vary from 0 to an upper limit of 1, which corresponds to deductive validity. Suppose we have an argument with premises $P_1, P_2 \ldots, P_n$ and conclusion C. The inductive strength of the argument is then the conditional probability of the conclusion given the conjunction of all the premises, or in mathematical notation:

$$\Pr(C \mid P_1 \text{ and } P_2 \ldots \text{and } P_n)$$

As an illustration, consider this argument:

Shannon bought just one lottery ticket.
The lottery has 1000 tickets, only one of which will be the winning ticket.
The winning ticket will be chosen randomly.

Shannon *will not* win the lottery.

Since Shannon has bought only one ticket, she will lose the lottery as long as any of the remaining 999 tickets is chosen. The conditional probability of the con-

clusion given all the facts about the lottery is therefore 0.999, which is very high, and so this is an inductively strong argument. On the other hand, if we change the conclusion of the argument to "Shannon will win the lottery," the inductive strength of the argument will be a rather low 0.001.

Of course, since it is often difficult to be precise about probability, the exact inductive strength of many arguments will be difficult if not impossible to ascertain. Suppose we offer our friend a birthday present, but when she opens it she frowns. This is a good reason to think that she does not like the present. In such typical situations, there is no need to calculate the numerical inductive strength of the inference, and it is not even clear whether it can be done. Nevertheless, our conclusion is justified because we are able to make an approximate but accurate qualitative judgment about the likelihood of the conclusion given the evidence. We are still using inductive reasoning and applying the same principles.

10.2 DEFEASIBILITY OF INDUCTIVE REASONING

Inductive strength is a matter of degree; validity is not. Another difference is that inductive strength is **defeasible**, but not validity. Adding new premises to a valid argument will not make it invalid. If all Chinese have lactose intolerance and Lee is Chinese, then it follows that Lee has lactose intolerance. Our conclusion will not change by additional information such as Lee is a chain-smoking philosopher with peculiar sleeping habits. However, new premises can increase or decrease the inductive strength of an argument. Consider this argument:

Regina fell off the roof of a 50-story building.

Regina is dead.

This argument as it stands is inductively strong, since it is rather unlikely for someone to survive such a fall. But suppose we discover some new information:

Regina fell off the roof of a 50-story building.
Regina landed on a big tent on the ground floor of the building.

Regina is dead.

Now the argument becomes weaker than before because it is less clear that Regina must die from the fall. After all, there are cases where people managed to survive after falling from tall buildings. But wait, there is more to come:

Regina fell off the roof of a 50-story building.
Regina landed on a big tent on the ground floor of the building.
The roof of the tent is fixed with sharp sticks pointing upward.

Regina is dead.

Now the situation is again different and the argument is stronger, perhaps even stronger than in the beginning when we are told only that Regina has fallen. As we can see, the inductively strength of an argument can change quite radically depending on new information. This illustrates a major difference between mathematics and the empirical sciences. Mathematics uses deductive reasoning to discover the logical consequences of definitions and axioms. Ideally, a good mathematical proof has to be a sound (and hence valid) argument. So if the proof is done correctly, new discoveries cannot change the proof into an invalid argument. However, science also relies on defeasible inductive reasoning. For example, noting that all penguins observed so far cannot sustain flight, we conclude that no penguin can fly. But this conclusion might turn out to be wrong if we discover a new species of flying penguins tomorrow. Old evidence providing strong support for a theory might fail to do so when new evidence comes in.

10.3 CASES OF INDUCTIVE REASONING

There are different types of inductive reasoning. Here are some main ones:

- **Induction based on statistics**: We rely on statistics to make generalizations about groups of things, and to make predictions about particular cases. For example, we might have seen lots of spiders, and they all produce silk, and so we conclude this is true of all spiders, including those which have not been observed. (See Chapter 17 for more about statistics.)
- **Induction based on analogy**: These are arguments where two objects A and B are very similar, and so we conclude that something that is true of A ought to be true of B as well. Supppose a chemical is discovered to be toxic to mice. By analogy we suspect it will be harmful to human beings as well, given the biological similarities between the two. This is again a form of induction since the conclusion does not logically follow. (See Chapter 21.)
- **Induction based on inference to the best explanation**: Very often we do not have enough evidence to prove that something must be true. Sometimes the evidence can also be conflicting and point to different conclusions. What we can do is to consider the alternative theories available and pick the one that on balance has the most evidence supporting it, all things considered. For example, when we leave our home we might notice that the street is wet. This might be because it has just rained, but it is also possible that somebody has just washed the street. But you notice that some cars passing by are also wet, so you conclude it is most likely that it rained.

10.4 DEDUCTIVE AND INDUCTIVE ARGUMENTS?

This paragraph is a more technical discussion about the proper use of terminology. You can skip it if you want. In this book, we treat deductive validity and induc-

tive strength as two *standards* with which to evaluate arguments. However, some critical thinking textbooks use the distinction to classify *all* arguments as either deductive arguments and inductive arguments. This approach is however problematic because it is not clear how invalid arguments are to be classified. Some authors think that if an invalid argument is intended to be valid but in fact is not then it is a (bad) deductive argument, and when an invalid argument is intended to be inductively strong but fails to be so then it is a (bad) inductive argument. The problem with this view is that very often people give arguments without thinking whether the arguments are supposed to be valid or strong. Of course, we might say that a deductive argument is simply a valid argument, and an inductive argument is an inductively strong argument. But then it is no longer the case that every argument is either deductive or inductive. (But as we shall see later on, every *good* argument is either deductively valid or inductively strong.)

EXERCISES

10.1 In the novel *A Study in Scarlet,* detective Sherlock Holmes explained how he came to the conclusion that a certain doctor came from Afghanistan:

> Here is a gentleman of the medical type, but with the air of a military man. Clearly an army doctor, then. He has just come from the tropics, for his face is dark, and that is not the natural tint of his skin, for his wrists are fair. He has undergone hardship and sickness, as his haggard face says clearly. His left arm has been injured: He holds it in a stiff and unnatural manner. Where in the tropics could an English army doctor have seen much hardship and got his arm wounded? Clearly in Afghanistan.

Do you think Holmes uses inductive or deductive reasoning here?

10.2 Are the following statements true or false?

a) If you have two sound arguments, and you take the premises of one argument and add to the second argument without changing the conclusion, would the new argument be (a) valid or (b) sound?

b) If you have two inductively strong arguments, and you take the premises of one argument and add to the second argument without changing the conclusion, would the new argument still be inductively strong?

10.3 For each argument below, determine whether it is valid. If it is not, see if you can come up with additional information that would weaken the inductive strength of the argument.

a) There is not much snow this year, and the ski resorts have never done very well whenever there was little snow, so the ski resorts will not do well this year.

b) The ski resorts must have at least 10 feet of snow before they are allowed to open, and this winter the resorts all have less than 10 feet of snow, and so they will not be allowed to open.

c) In the past, the ski resorts have not done very well whenever there is little snow, but since there is so much snow this year, the ski resorts will do very well indeed.

d) The ski resorts are doing great this year, although they were not doing very well five years ago. So it is not the case that the ski resorts have always done well.

10.4 Consider this argument:

Kevin and Britney are married.
They quarrel with each other every day.

They are going to get a divorce.

Now consider the following statements and think about how they might affect the inductive strength of the argument when added individually as a premise: (1) They still love each other deeply. (2) They sometimes have violent physical fights. (3) Britney has just made an appointment with a divorce lawyer.

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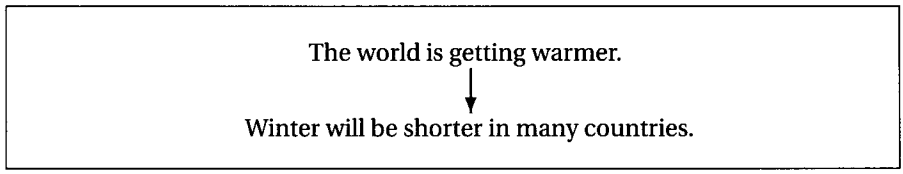
CHAPTER 11

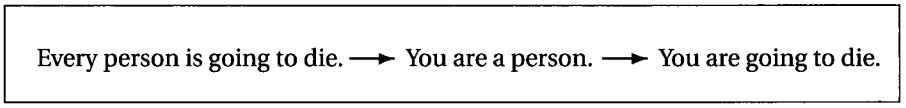
ARGUMENT MAPPING

11.1 MAPPING REASONS AND OBJECTIONS

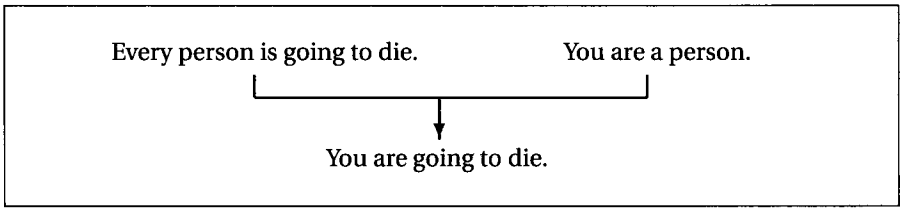
Arguments in real life are often very complicated. A discussion might involve multiple arguments. A set of premises can have multiple conclusions, or it might be unclear which are the premises and conclusions. In these situations, diagrams known as **argument maps** can display the logical structure of arguments more clearly. In an argument map, arrows link premises to their conclusions. Here is a simple one with only one premise and one conclusion:



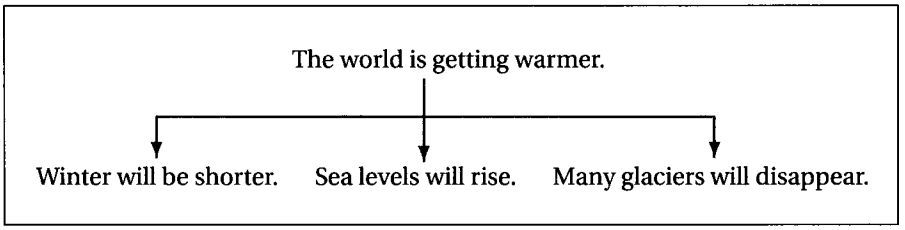
When we use an arrow to link from a sentence P to another sentence Q, this indicates that P is a *reason* for accepting Q—that is, P gives an answer to the question "Why believe Q?" So the following map is wrong:



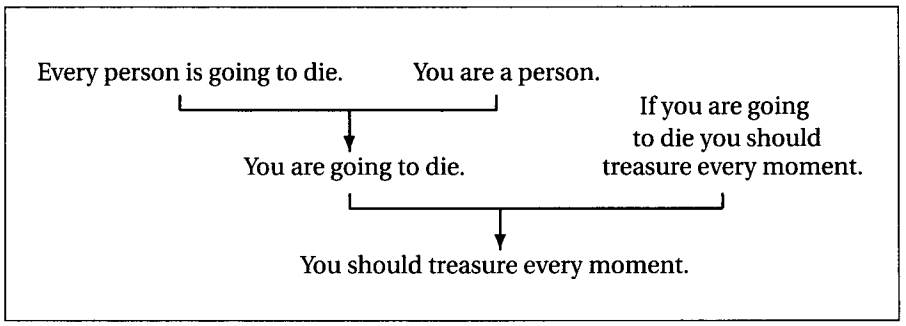
It should be like this instead—two premises leading to a single conclusion:



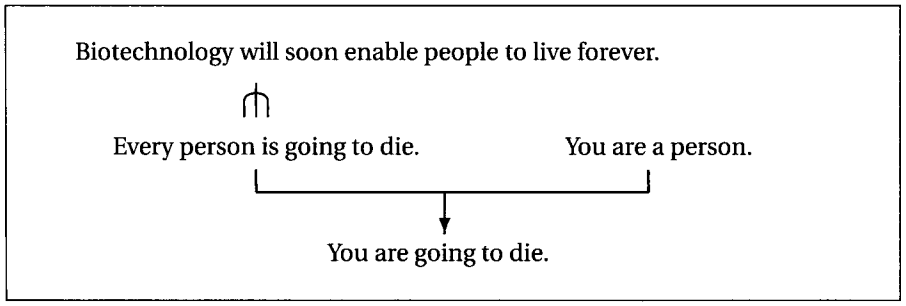
The following map has a single premise with multiple conclusions:



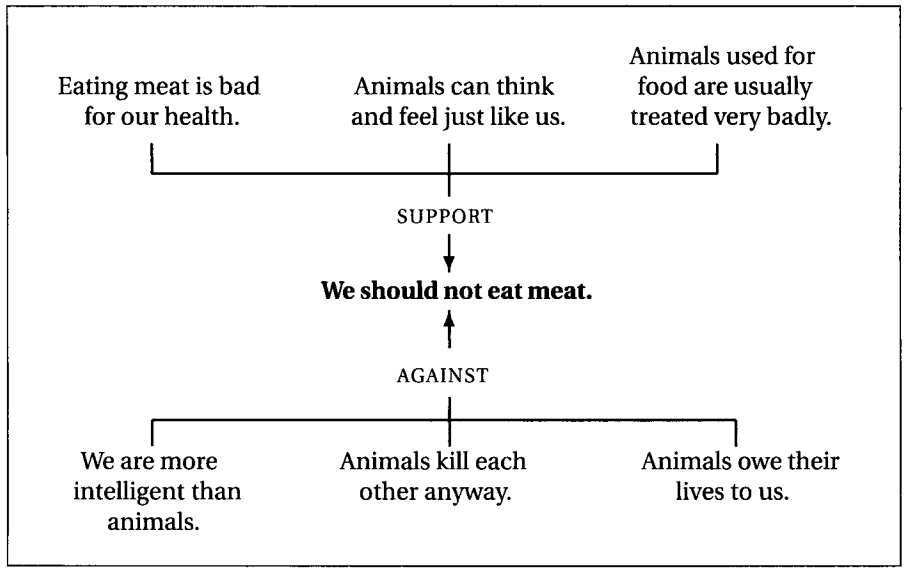
Of course, you might not need to draw diagrams for simple arguments. The power of argument maps comes in when we are dealing with more complicated ones. For example, you can combine argument maps, and use the conclusion of one argument as a premise in another one. This gives us a *multilayered* argument map:



You can also introduce *objections*, targeting particular premises and conclusions:



Here we use a pitchfork symbol to indicate an objection instead of a supporting reason. You can of course use a different notation—for example, an arrow with a different color or an ordinary arrow with "objection" written next to it. It is entirely up to you. Once we include objections into an argument map, we can represent opposing arguments from different sides, and use the diagram to explain a debate about some issue. The following diagram shows some of the arguments for and against vegetarianism:



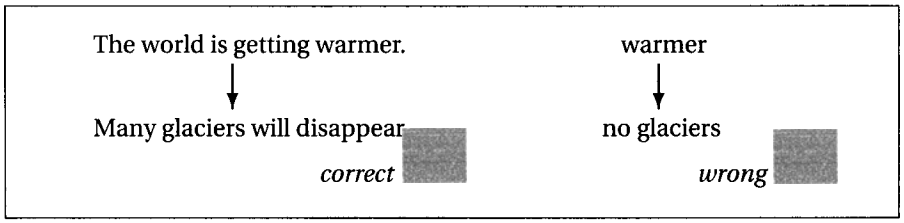
11.2 SOME NICETIES

Argument maps can display a lot of information in an intuitive and structured manner. They can be used in presentations, writing outlines and study notes, or as a basis for collaborative discussion and brainstorming. Drawing argument maps trains our critical thinking because we are forced to identify the logical structure

of arguments explicitly and systematically. The diagram format can provide a succinct overview of a topic, improving understanding and making it easier to spot sloppy reasoning. There is in fact some preliminary empirical evidence confirming the benefits of argument mapping Twardy (2004). However, as with lots of things, we can achieve better results only through extensive practice. Below we discuss some further techniques in argument mapping.

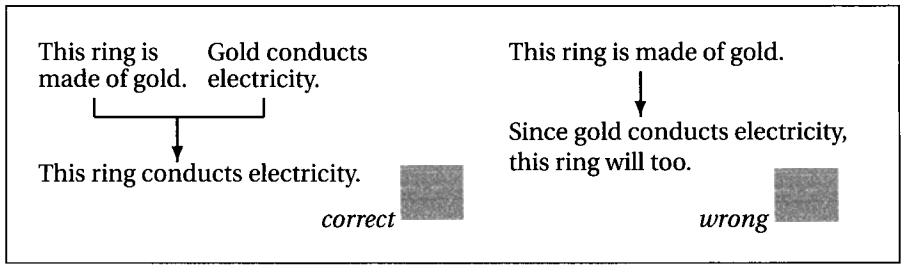
11.2.1 Use complete sentences as premises and conclusions

Use complete sentences as your premises and conclusions rather than single words and phrases. This makes it clear which are the claims to be evaluated, and other people do not have to guess what you mean.



11.2.2 Unpack reasoning using arrows

Avoid including reasoning within a premise or conclusion. The whole point of using argument maps is to use arrows to explicitly indicate logical connections. So when you have an argument or an extended piece of reasoning, break it up and link the premises and conclusions with arrows. This ensures that logical connections are analyzed and understood.



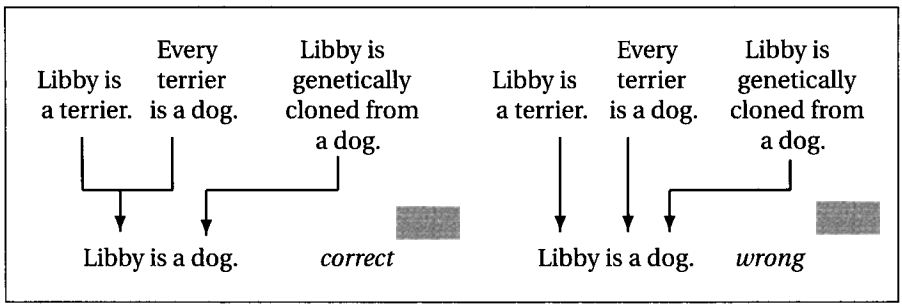
11.2.3 Actively consider counterarguments and objections

Most people are prone to consider only arguments favorable to their preexsiting opinions, and they do not think hard enough about counterexamples and reasons that might undermine their position. Psychologists call this *the myside bias* (see page 189). Argument mapping can help us overcome this problem. When we

draw an argument map, we come up with arguments on both sides of an issue, put in objections to these arguments, and list possible replies as well. By putting everything in a diagram it will be easier to see whether you have come up with a more balanced analysis of an issue or whether there is some area that you failed to explore adequately (such as no multilayered arguments).

11.2.4 Distinguish between co-premises and independent premises

In critical thinking, it is crucial to be able to determine the number of arguments in support of a conclusion. Generally, we are more confident of a position if we can find more arguments supporting it (though of course the quality of the arguments matters as well). In the context of argument mapping, this requires us to distinguish between co-premises and independent premises. Co-premises are premises that work together to form a single argument for a conclusion, whereas independent premises offer distinct reasons for accepting the conclusion. What does it mean to say that X and Y are co-premises that work together? Roughly speaking, this means if X is false, the extent to which Y supports the conclusion decreases significantly, and vice versa. Consider this argument map:

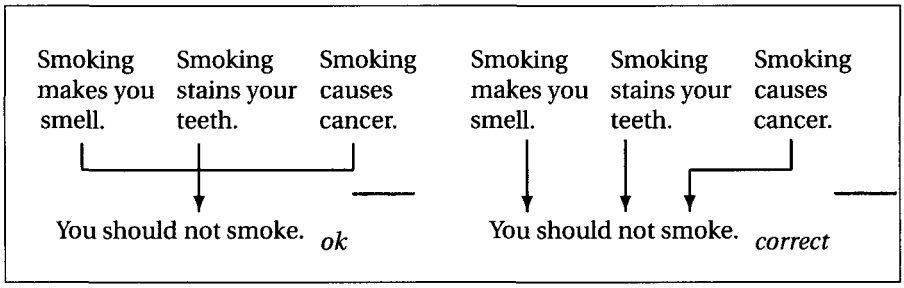


"Libby is a terrier" and "Every terrier is a dog" are co-premises, because both are necessary to support the conclusion "Libby is a dog." If Libby is not a terrier, the mere fact that every terrier is a dog offers no reason to think that Libby is a dog, since Libby could be a cat. Similarly, if for some reason not all terriers are dogs, the fact that Libby is a terrier will not support the conclusion that Libby is a dog. This is why the two premises work together to support the conclusion. On the other hand, the premise "Libby is genetically cloned from a dog" is an independent premise. Even if Libby is not a clone, this does not affect the degree to which the other two premises support the conclusion. The third premise is therefore not a co-premise with the first two.

It is a good idea in argument analysis to distinguish between co-premises and independent premises. Co-premises that work together form a single argument, whereas independent premises do not. This helps us count the number of arguments we have for a conclusion. In argument mapping, arrows leading from co-premises in a single argument are joined together before pointing to their con-

clusion. Separate arrows are used for other independent premises so that distinct arguments are not mixed together. Try to follow this convention in drawing argument maps because it represents more accurately the logical structure of arguments, especially when you have a single argument map that includes both co-premises and independent premises, as in the diagram above.

In other situations, if the argument map does not involve both co-premises and independent premises, it might not matter whether you use distinct arrows or a single arrow joining all the premises. So both versions are fine in the following maps, even though strictly speaking only the one on the right is correct.



11.2.5 Make hidden assumptions fully explicit if possible

When people give arguments sometimes certain assumptions are left implicit. Here is a popular argument against homosexuality:

> Homosexuality is morally wrong because it is unnatural.

To evaluate this argument, apply *the fourfold path* discussed in the beginning of this book and start with the question "What does it mean?". In particular, what does the word *unnatural* mean in this argument? If *unnatural* means "does not occur in the natural environment", then it is not so clear that homosexuality is unnatural, since biologists have observed homosexual behavior in over a thousand species of animals. The next question to ask is, "Is it reasonable?" and we can see that this argument is invalid. Even if homosexuality is unnatural, it does not follow that it is wrong. The conclusion might be thought to follow if it is assumed that *whatever that is unnatural is wrong.* Adding this premise will make the argument valid. But is the new premise true? Surely there are lots of "unnatural" things that are not wrong, such as video games, brain surgery, and sunglasses. If these things are not objectionable, why is homosexuality any different?

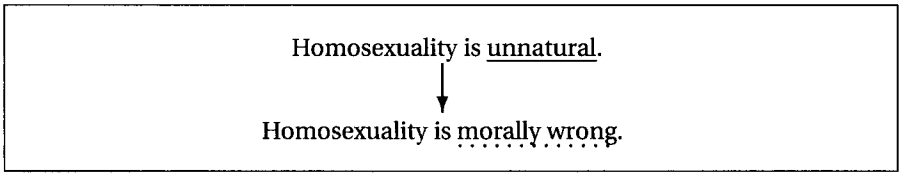
Revealing hidden assumptions is an important part of argument analysis. Many people are busy, sloppy, and sneaky, and many arguments presuppose assumptions that are not made fully explicit. One way to discover these assumptions is to check whether premises have to be added to make an argument valid. This will be easier if we are familiar with typical patterns of valid and invalid arguments.

Another method that is particularly useful in argument mapping is to follow these two guidelines:[1]

- **The holding hands rule**: Every key term appearing in a premise of an argument but not in the conclusion must also appear in some other premise.

- **The rabbit rule**: Every key term appearing in the conclusion of an argument must also appear in at least one of the premises.

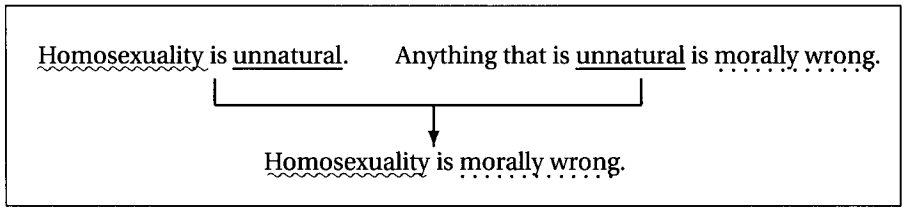
These two rules are only guidelines because they have exceptions, but they are still very useful in formulating arguments for which the reasoning from the premises to the conclusion is made explicit. They are particularly useful in drawing argument maps, and looking at an example will help us better understand how they work and their rationale. Let us return to the last argument:



The underlined phrases show that the argument violates both the rabbit rule and the holding hands rule. The rabbit rule is violated because the concept of something being *morally wrong* appears in the conclusion, but it cannot be found anywhere in the premises. The motivation for the rabbit rule is to ensure that different parts of the conclusion can be traced back to the premises. In general, if a concept is present in the conclusion, some assumption must have been made relating to the concept in question. The aim of the rabbit rule is to make these assumptions explicit and show how the premises lead to the specific conclusion. Otherwise it might not be clear how the conclusion comes about. When the conclusion suddenly introduces something that has not been mentioned before, it is like a magic trick, producing a rabbit out of a magician's hat!

On the other hand, the word *unnatural* is underlined to show that the holding hands rule has been violated. The rationale for this rule is to ensure relevance. If a concept appears in a premise but not the conclusion, we might wonder why that concept is mentioned at all. What work does it actually do in the argument? Is it really necessary? By requiring that the concept appears again in another premise, we hope to ensure that the premises are linked together ("holding hands") in a way that reveals the role of the concept in the reasoning process. Returning to our example, consider the following modified argument map:

[1]The rules came from a set of argument-mapping tutorials from the Australian company *Austhink*.



The underlined phrases in the argument now come in pairs, indicating that when the hidden assumption has been added, the argument map satisfies both the rabbit rule and the holding hands rule. When the rules are followed, the reasoning of the argument is clearer. But there are a few points to note.

The rabbit rule and the holding hands rule are only guidelines. They are not to be applied mechanically without exception. First, we should not apply them to logical words like *if... then ... , every, nothing, some,* and *any.* These words are not specifically about a particular subject matter, unlike words such as *recession, dolphins,* and *morally wrong.* So even though the word *anything* still violates the holding hands rule in the argument map above, this is perfectly fine.

Furthermore, an argument that satisfies the two rules might still be a bad argument. The rules help us improve the clarity of arguments. But a clear argument can still contain bad reasoning and false premises. So bear this in mind when you evaluate an argument.

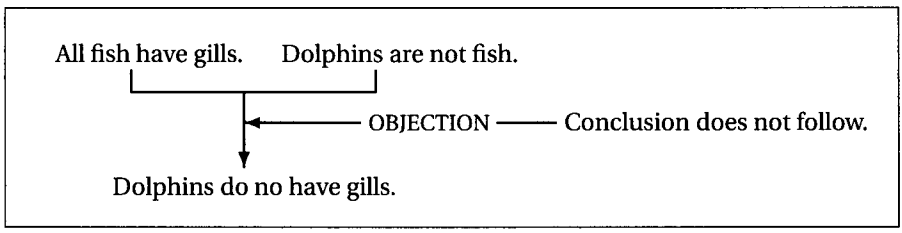
11.2.6 Dealing with objections to reasoning

It is a bit tricky to use argument maps to display objections to reasoning rather than the truth of premises. Consider this argument:

All fish have gills.
Dolphins are not fish.

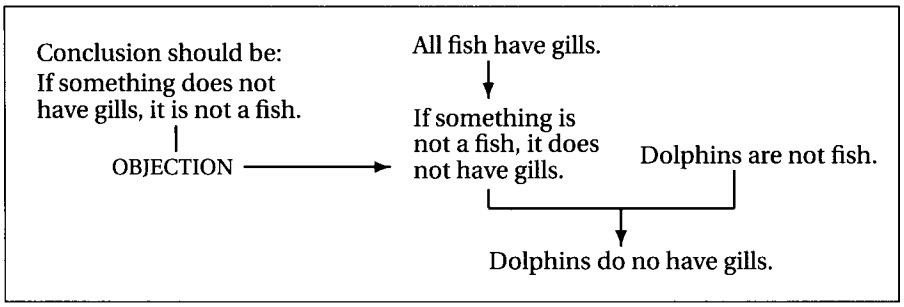
So dolphins do not have gills.

The argument satisfies both the rabbit rule and the holding hands rule, and the premises and the conclusion are true. But the reasoning is problematic. This might be indicated on an argument map as follows:



There are certainly other possibilities. Someone who offers such an argument probably mistakenly assumes that if all fish have gills, it follows that if something

is not a fish, it does not have gills. This is of course a mistake since creatures other than fish might also have gills. We can include this inference into an argument map, and object to this intermediate conclusion:



As you can see, there are different ways of representing objections to reasoning using argument maps. There is no standard notation so you can use your own as long as it is easy to understand.

EXERCISES

11.1 Simplify and rewrite these arguments in the standard format and fill in any missing premises.

a) Gold is a metal. Therefore it conducts electricity.

b) God does not exist. So life is meaningless.

c) Noam is a thinker. So he is not a doer.

d) Biden is heavier than Obama. Fatima cannot lift Obama. So there is no way she can lift Biden.

e) The whole building collapsed. So probably many people died.

f) Anyone who donates $1000 will become a member. John is a member. So he must have donated $1000.

g) I certainly had fruit today. Ketchup is made of tomatoes, and nobody can deny that tomatoes are fruits.

h) We should impose the death penalty on people who sell or possess illegal drugs because this is going to eliminate the majority of criminal activities.

11.2 Draw argument maps for these arguments. No need to fill in the hidden premises.

a) Johnny is sick. He should not go to school.

b) The road is dangerous. It is slippery because there was an oil spill. Also, there is no electricity so the lights are out.

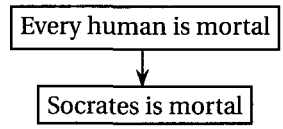
11.3 Draw argument maps for the passages below. Fill in the more important hidden premises and conclusions. Distinguish between independent premises and co-premises where feasible.

a) High school students should learn subjects that improve their critical thinking. Philosophy does just that. Philosophy is also fun.

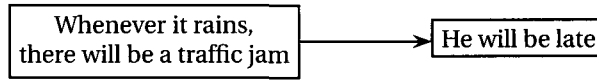
b) Tourism benefits the economy. Improving the environment will attract more tourists. Besides, a better environment improves the quality of life for everyone.

11.4 Correct these argument maps. Distinguish between independent premises and co-premises. Fill in missing premises by applying the rabbit rule and the holding hands rule. Adjust the arrows if needed. There is no need to evaluate the argument, so do not worry about false premises.

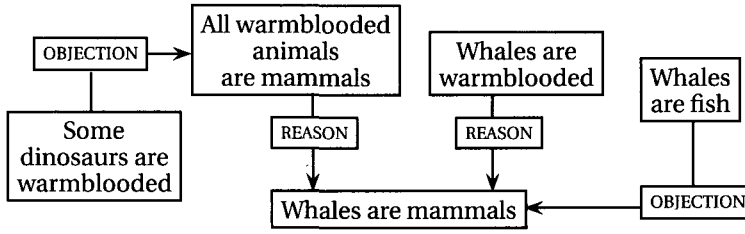
a)



b)



c)



11.5 Draw an argument map with only these sentences as premises and conclusions. The last sentence is the main conclusion.

1. Either Dumbledore and Harry are playing quidditch or Harry and Hermione are studying in the library.
2. If Dumbledore and Harry are playing quidditch, then Harry will win the game.
3. If Harry and Hermione are studying in the library, then Hermione is studying in the library.
4. If Hermione is cooking, then she is not studying.
5. If Hermione is not studying, then she is not studying in the library.
6. If Hermione is cooking, then she is not studying in the library.
7. Hermione is cooking.
8. Hermione is not studying in the library.
9. It is not true that Harry and Hermione are studying in the library.

10. Dumbledore and Harry are playing quidditch.
11. Harry will win the game.

11.6 ☒ Consider the claims below. Do some research about them and draw an argument map showing the arguments for and against each claim.

a) The world should rely more on nuclear power.

b) Torture should not be made legal.

c) The police should not use entrapment to catch criminals.

d) God exists.

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CHAPTER 12

ARGUMENT ANALYSIS

12.1 WHAT IS A GOOD ARGUMENT?

We have discussed different aspects of arguments. It is time to consider how they help us explain what a good argument is. Intuitively, a good argument is one in which the premises provide good reasons for the conclusion. This is of course quite vague. Let us try to make it more precise.

Condition 1: The premises are true or highly plausible

The premises of a good argument must be known to be true, or they have to be at least highly probable. This criterion should be rather obvious. We have no reason to accept an argument if the premises are false or are unlikely to be true.

Condition 2: The argument is deductively valid or inductively strong

Deductively valid arguments are of course valuable. Valid arguments cannot lead us from true premises to false conclusions. But we have seen that inductively strong (and hence invalid) arguments play an equally important role in reason-

ing. It will be too restrictive if we demand that all good arguments must be valid. We would have to give us most of our scientific knowledge. Note that if a good argument is either valid or inductively strong, this implies that *an inductively weak argument can never be a good argument.*

Condition 3: The premises are not question begging

The first two conditions are still not sufficient for a good argument. Consider this circular argument, where the conclusion appears as a premise:

Oatmeal is good for your health.

Oatmeal is good for your health.

This is surely a bad argument since no independent reason has been given to show why oatmeal is healthy. However, the argument is actually sound. First, the premise is indeed true, because oatmeal has lots of fibre and can lower blood cholesterol. Furthermore, the argument is valid. Since the premise is the same as the conclusion, it is impossible for the conclusion to be false when the premise is true! This example shows that not all sound arguments are good argument. To deal with this problem, we should require that the premises of a good argument cannot be **question-begging**—that is, they should not assume what the argument is trying to establish. (See also page 176 for further discussion.)

Condition 4: The premises are all relevant to the conclusion

Consider this argument:

Albert Einstein was a physicist.
All physicists studied mathematics.
Albert Einstein played the violin.

Albert Einstein studied mathematics.

This is presumably a non-question-begging, sound argument. If we accept the premises, we ought to accept the conclusion. Yet there is something wrong with the argument—namely, that the third premise is irrelevant to the conclusion, even though it is true. If we remove this particular premise, it does not affect the strength of the argument at all. The extra premise is a distraction and liable to create confusion, and it fails to provide a good reason for the conclusion. Bearing this in mind, we should require that a good argument does not contain any irrelevant premises.

Summary: Definition of a good argument

1. The premises are true or highly plausible.
2. The argument is deductively valid or inductively strong.
3. The premises are not question-begging.
4. All the premises are relevant to the conclusion.

12.2 FOUR WAYS TO ATTACK AN ARGUMENT

Now that we know what a good argument is, what should we do when we come across an argument that is *not* good? It is important not to rely on your gut feeling and just dismiss the argument. See if you can think of one or more reasons why the argument should be rejected. In general, there are four main ways to attack an argument: two direct methods and two indirect ones:

1. **Direct method 1: Attack the premises.** If you can show that an argument relies on at least one implausible premise, that is a good way of showing that the argument is not good enough. But sometimes you do not have to go all the way to show that a premise is false. You might argue that there is simply not enough evidence to show that the premise is true. This falls short of arguing that the premise is false, but it passes the burden of proof to the opponent. But remember, just because an argument has a false premise, it does not follow that the conclusion is false!
2. **Direct method 2: Attack the reasoning.** Even if the premises are all very plausible, you need to check whether the reasoning of the argument is acceptable. The argument might be invalid or inductively weak, or question begging.
3. **Indirect method 1: Attack the argument indirectly by attacking the conclusion.** If you can show that the conclusion of an argument is false, this implies that there must be something wrong with the argument. This strategy of refuting an argument is useful when it is difficult to evaluate an argument directly, perhaps because it is too long or convoluted. Of course, this strategy does not really explain what is wrong with the argument.
4. **Indirect method 2: Give an analogous argument that is obviously bad.** The idea is to compare the original argument with another argument. If the new argument is obviously bad, and it has the same structure as the original one, then the original one is likely to be a bad argument as well. This is a good strategy to use when it is difficult to see what is wrong with an argument, or your opponent refuses to admit that the argument is no good.

As an example, consider this argument:

> Capital punishment is wrong because it is always possible to punish an innocent person by mistake.

We might attack the argument using the four methods as follows:

- **Attack the premises**: Is it always possible that an innocent person is executed by mistake? It might be argued that in some crimes there were many independent witnesses. Perhaps the criminal was apprehended right away at the crime scene, and the whole crime was recorded on surveillance video. There is therefore little doubt that the person being caught is guilty.
- **Attack the reasoning**: Even if mistakes are always possible, this is just one consideration and it does not immediately follow that capital punishment is wrong. Maybe there are many other considerations in support of capital punishment. We need to balance these factors before deciding whether capital punishment is acceptable or not.
- **Attack the conclusion**: Punishment should be proportional to the crime. Capital punishment is not wrong because this is what justice requires in the case of hideous crimes.
- **Give an analogous argument that is obviously bad**: With imprisonment, it is also possible to punish an innocent person by mistake. But it would be absurd to stop sending people to jail because of this.

Of course, there is a lot more we can say about capital punishment. The responses just given might not be very convincing, and you need not agree with any of them. They serve only to illustrate the fact that many arguments can be attacked in more than one way.

12.3 ARGUMENT ANALYSIS: CHECKLIST

The analysis of argument is one of the most basic parts of critical thinking. To sum up, there are three main steps:

1. Clarify the argument.
2. Evaluate the argument.
3. Think about further relevant issues.

We have already discussed many aspects of this process. The table below lists some of the main tasks involved. You can use this as a checklist when you want to analyze an argument systematically. It would be good to internalize these steps as part of your natural thinking habit:

Step	Tasks and questions
1. Clarify the argument	Identify premises and conclusion. Clarify the keywords. Simplify the argument using your own words. Draw an argument map.
2. Evaluate the argument	Is the argument a good one? Are the premises plausible? Is the argument valid or inductively strong? Any fallacy in the argument? (See Chapter 19.) Any reason to think that the conclusion is false? Any obvious counterexample?
3. Explore further issues	How good is the argument overall? How important is the argument? Is the conclusion surprising? Can the argument be repaired or improved? Are there other arguments with similar conclusions? What about arguments with the opposite conclusion? Can the argument be applied elsewhere? Any further information that might be relevant?

EXERCISES

12.1 Are these statements true or false?

a) Not all sound arguments are good arguments.

b) Some inductively strong arguments are not good arguments.

c) If a good argument is invalid, it also cannot be inductively weak.

d) A good argument that is not inductively strong must be valid.

e) A sound argument can contain irrelevant premises.

f) If an argument is inductively weak, it cannot be a good argument.

g) If an argument is not good, it is either inductively weak or unsound.

12.2 Which of these arguments are question begging?

a) I like anything that is sweet. Chocolate ice cream is sweet. So I like chocolate ice cream.

b) I like chocolate ice cream because chocolate ice cream is what I like.

c) I like chocolate ice cream best, because it is my favorite ice cream.

d) I ordered chocolate ice cream, because it is my favorite ice cream, and I always order my favorite ice cream.

12.3 Apply the direct and indirect methods to criticize these arguments:

a) Cloning animals or human beings is unnatural, so it is wrong and we should not do it.

b) We should not trust scientists because they keep on changing their theories. Today they say that this is true. Tomorrow they come up with a different theory and say something else.

c) It is useless to punish students because they will always make mistakes.

12.4 Evaluate these arguments and in particular pay attention to any hidden assumptions.

a) Low taxation is desirable because it has lots of benefits. It is good for business and investment, and the citizens are likely to be happier.

b) The universe could not have existed forever. Radioactive material will decay until they cease to become radioactive. Since the universe still contains radioactive material, there must have been a beginning. Otherwise all the radioactive material will have long been gone already.

c) Indira donated $2 million to the Democratic Party and only $500,000 to the Liberal Party. So she is probably going to vote for the Democratic Party.

CHAPTER 13

SCIENTIFIC REASONING

Science is regarded as one of the greatest achievements of human beings, alongside art, music, and literature. Technology is a product of science, and it has a huge impact on our lives. But the core of scientific methodology is hypothesis testing, an essential part of critical thinking.

Broadly speaking, hypothesis testing is a matter of gathering evidence to select the best hypothesis. (In this book, a hypothesis is the same as a theory or a claim—a statement that can be either true or false.) But hypothesis testing is not just for scientists. In any type of career, we have to solve problems, and hypothesis testing helps us find the best solutions to our problems. Suppose your mobile phone is not working. Is the battery dead or is the phone broken? You try to recharge it to see if it works. If it does the phone wasn't broken. This is hypothesis testing. Or think about how to improve your health. What should you eat and what exercises should you do? You need to gather information and evaluate different theories before coming up with a plan. This also involves hypothesis testing.

There are two noteworthy features about hypothesis testing. First, it is based on evidence, not on gut feelings, tradition, popularity, authority, or personal preferences. Second, hypothesis testing is fallible, and it is often difficult to prove that a theory must be correct. Our evidence might be tainted without our knowledge,

or perhaps the evidence is inconclusive. This does not mean we should give up scientific reasoning. We do our best to identify the theory that has the highest probability. It is too bad if we turn out to be wrong, but such is the uncertainty of life. This is like investing in the stock market. Nobody can predict the future accurately all the time. But someone who is correct 70% of the time will already be doing very well.

Scientific reasoning and investment

George Soros is one the world's wealthiest hedge fund managers. In 1992, he famously traded against the Bank of England. He won and made a huge profit, and Britain was forced to give up its fixed exchange rate. Soros attributed a large part of his investment successes to the use of scientific reasoning. Before he makes a trade he formulates a hypothesis about what is happening in the market. He then tests his hypothesis, and if the market goes against it he immediately cuts his losses. He gives this advice about making reliable investment decisions: Talk to people who have the opposite view, and see if you change your mind afterward. This is a good piece of advice to combat confirmation bias (We discuss confirmation bias on page 189).

13.1 THE DEAR METHOD

We now look at the four main steps in hypothesis testing. We call this the DEAR method, which reminds us of the first letter of the keyword in each of the four steps.

1. **Define** the hypothesis to be tested.
2. Collect the **evidence** for and against the hypothesis.
3. List all the **alternative** hypotheses.
4. **Rank** them and pick the best one to accept.

Where do these hypotheses come from in the first place? The answer is that they can come from anywhere. They might arise from the problems that we are trying to solve or from observations that we have made. For example, we might have seen lots of white swans and so we wonder whether it is true that all swans are white. However, what makes a hypothesis scientific is not how it comes about. A scientific hypothesis is a clearly specified statement that can be tested in principle. Many scientific theories have been inspired by dreams or wild speculations. They can still be acceptable if we have good evidence showing that they are true.

13.1.1 Step 1: Define the theory to be tested

The first step of hypothesis testing is to define clearly the hypothesis that is to be evaluated and make sure we know what it means. If the meaning of a hypothesis is unclear, it will be difficult if not impossible to test it. Here are a few things to bear in mind:

- **Clarify keywords**: Some people think that everyone is surrounded by an aura field, a field of energy. To test this hypothesis, we need an explanation of what an aura energy field is. Is it the same as the electromagnetic energy that is studied in physics? If so then there are ways to test its presence. In fact this is probably true since our bodies have warmth and so they emit heat, which is a form of electromagnetic energy. But then the aura field is not something very remarkable. On the other hand, if this is not what is meant by an aura field, then further clarification is needed. Otherwise there is no way to test the hypothesis and we have no reason to believe it. We might as well say there is an invisible and undetectable unicorn dancing on everyone's head.
- **Be precise**: A more precise hypothesis is less likely to be misunderstood. Take the claim that gold is a good investment. Its meaning is not obscure, but more precision will provide better guidance. Are we supposed to buy real physical gold, or stocks that are linked to gold? Is this good investment for the short or long term? What kind of return are we talking about? Taking these concerns into account might give us a more concrete claim, such as investment in physical gold or gold stocks will beat inflation and perform better than major stock markets in the next five years.
- **Clarify the scope of the hypothesis**: The scope of a claim is the range of things the claim is supposed to be true of. Take the claim "swans are white." Is this true of *all* swans, most of them, or just some of them? The scope of the claim makes a big difference as to the evidence we need to check whether the claim is true. "All swans are white" is false because there are black swans in Australia. But if the claim is changed to "some swans are white," the existence of black swans becomes irrelevant and what matters is whether you can find at least a few white swans. But consider also "most swans are white." Knowing that there are white swans and black ones will not help us decide whether it is true. We need a detailed statistical survey to find out. As you can see, the scope of a theory makes a big difference to the evidence needed to test it.

13.1.2 Step 2: Gather the evidence for and against the theory

To evaluate a hypothesis, we gather all relevant evidence.

- **There are two types of evidence**: Supporting evidence are facts that increase our confidence in a hypothesis. Counterevidence are facts that de-

crease our confidence. Generally speaking, a piece of supporting evidence provides a reason for thinking that the hypothesis is true. This happens when some fact obtains which is what we should expect given the hypothesis. Counterevidence is the opposite. For example, the hypothesis that all swans are white implies that the next swan we see will be white. So if we do see a white swan, that counts as supporting evidence, and if we see a black swan, that would be counterevidence. Or take a different example. There being lots of dark clouds is supporting evidence for the hypothesis that it will rain soon. If the air pressure is low, that is another piece of supporting evidence. But a bright and clear sky will be counterevidence instead. What if it is a windy day? This is neither supporting evidence nor counterevidence since wind makes no difference to the likelihood of rain.

- **Evidence can differ in strength**: Seeing a single white swan is weak supporting evidence that all swans are white. Finding lots of white swans in different countries would be much stronger evidence. But this is not *conclusive evidence*, evidence that proves or disprove a hypothesis beyond reasonable doubt. Unless you have seen all the swans there are, you can never be sure that they are all white. On the other hand, seeing a single black swan does count as conclusive counterevidence against the hypothesis that all swans are white. So when we gather evidence we have to decide two things: first, whether it is supporting evidence or counterevidence, and second, whether the evidence is weak, strong or conclusive. The assessment of the evidence will affect our confidence in the hypothesis.
- **The more evidence the better**: Finding more evidence in support of a hypothesis means we can be more confident that it is true. So avoid relying on a single piece of evidence. But remember that a hypothesis can be wrong even if we have lots of supporting evidence that is not conclusive. Furthermore, human beings are prone to pay more attention to evidence that agrees with their own opinions. So if you agree with a hypothesis, make a special effort to come up with counterexamples, and seek out people who disagree with you to see if they know of counterevidence that you do not.

13.1.3 Step 3: List all the alternative theories

The world is a complicated place and things are often not what they seem. When we have a theory that seems to explain the evidence, we should actively consider whether there are alternative theories that provide even better explanations. If you have a severe stomachache, it might be due to something you just ate. But it could also be acute appendicitis, which can be life threatening.

An alternative theory is one that is (1) distinct from the theory you are considering and (2) broadly consistent with the evidence you have observed. For example, it is now widely acknowledged that the Earth's temperature is increasing, and this global warming is caused by pollution and other human activities. But an alternative theory to consider is that the temperature increase is only part of the natural

fluctuation in climate. Sometimes the Earth gets cooler and sometimes it gets hotter. It just so happens we are in the hotter period but it has little to do with us.

Sometimes we can rule out an alternative theory by getting more evidence. To decide whether global warming is due to natural climatic fluctuations, scientists look at historical records and ice core samples to measure the extent of natural temperature variation in the past and see whether this accounts for recent global warming, and the conclusion is negative—global warming is due to recent human activities.

Coming up with alternative theories requires knowledge and imagination, and the truth might not be obvious. Human beings are often affected by biases, and they view the world through perspectives they are most attached to. Some people like to invoke the supernatural whenever there is something that is puzzling—for example, a butterfly refused to fly away after Daddy passed away so it must have been his reincarnation. Others like to resort to divine command, such as it is God's will. Still others like to blame things on their favorite target, saying it is the fault of the government / the society / my teacher / my parents / my girlfriend, and so on. Good scientific reasoning requires us to actively challenge our default explanation. This is not just a matter of being open-minded. We need the courage to accept that our most favorite or most comfortable point of view might not be the correct one.

13.1.4 Step 4: Rank the theories and pick the best one

Once we have come up with a list of alternative theories, we can evaluate them carefully and pick the one that is most plausible. This method of reasoning is known as **inference to the best explanation**, which is of the following form:

> We have a set of evidence E.
> $X, Y, Z, \ldots$ are all theories compatible with E.
> X provides the best explanation of E.
>
> ---
>
> X is most likely to be true.

But how do we find out which theory provides the best explanation? The answer is that we need to appeal to more general theoretical considerations:

13.1.5 Predictive power

Predictive power is about the quantity and quality of the predictions made by a theory. Quantity is about the number of predictions that can be made. A theory that generates no prediction at all fails the minimal requirement for a scientific hypothesis. A claim that cannot be tested can perhaps still be meaningful. It might even be true. But if we believe the claim, it only can be a matter of faith and not reason since there is absolutely no evidence to justify the belief.

The quality of prediction is about precision and accuracy. If an astrologist predicts that an old man is going to die within 20 years on the basis of the position of

the planets, and the man dies 10 years later, this is not too impressive. But suppose the astrologist predicts that the man will be crushed to death by a jet engine falling from the sky exactly 20 years and one day later. If the prediction turns out to be right, this would be a very impressive accomplishment. A few more of such correct predictions, we might even become believers of astrology!

When the predictions of a theory turn out to be wrong, it is possible to save the theory by challenging some of the **auxiliary assumptions**. These are assumptions we make about the theory or about the experimental setting that helps us generate the prediction. For example, to test the hypothesis that water freezes at 0°C, we can use a thermometer to measure the temperature of ice, but the auxiliary assumption here is that the thermometer is accurate.

When a theory fails to be confirmed by evidence, one way to save the theory is to reject some of these auxiliary assumptions. For example, some people claim they have telepathic abilities that enable them to read other people's minds. When being tested repeatedly in an experimental setting, they inevitably fail to perform better than others who are simply guessing. A frequent response of the defenders of telepathy is to challenge the auxiliary assumption that the experimental setting will not interfere with telepathic activities. They might say that the scientists carrying out the experiments have hostile and negative thoughts that interfere with the concentration and abilities of these practitioners. This justification (or excuse) is called an **ad hoc hypothesis**, one that is introduced solely to avoid disconfirmation of a theory.

It is of course legitimate to question auxiliary assumptions when a hypothesis has been disconfirmed. But the challenge should be motivated by good reasons. A secondary school student repeating a well-known scientific experiment might obtain results contrary to expectation. But this is probably because there is something wrong with the setup and not because a well-established theory has been proven wrong. Introducing ad hoc hypotheses need not be objectionable since they could turn out to be true. What is objectionable is to save a theory from refutation by introducing ad hoc hypotheses one after another, without making a serious attempt to find concrete and rigorous ways to test the theory.

13.1.6 Mechanism

Sometimes two events can be correlated without there being a direct causal link between them. There might be a positive correlation between ice cream sales and the number of shark attacks in Australia, but it does not mean selling more ice cream causes sharks to attack human beings. This correlation might seem strange until we note that shark attacks happen more often in the summer when more people eat ice cream. This underlying explanation allows us to understand the link between the correlated events.

In general, we should choose theories that explain the causal mechanisms between events. Understanding the details of the mechanisms allows us to generate more predictions to test the theory and make other discoveries. It might also help us forge connections with the rest of our scientific knowledge.

13.1.7 Fruitfulness

The last point about mechanism is related to fruitfulness—whether a theory helps us make surprising or unexpected predictions that turn out to be correct and whether the theory helps us detect and explain connections that we would not have noticed otherwise.

Consider the theory of plate tectonics, which says that the surface of the earth is covered by a series of plates floating on a viscous mantle and moving in relation to one another. After the theory was first developed in the 1960s, it generated a host of new predictions and explanations which were subsequently confirmed. For example, geologists were able to gain new insights as to why earthquakes tend to be concentrated along oceanic trenches and spreading ridges (because they correspond to frictional boundaries between plates), why marine animal fossils can be found on mountains thousands of meters above sea level (the plates pushed up against each other forming mountains), and why the eastern part of South America seems to fit together nicely with western Africa (they were once together but pushed apart by divergent plate movements).

13.1.8 Coherence

There are two kinds of coherence. First, a theory should be internally coherent—that is, logically consistent. It is possible that a useful theory is not fully consistent when it is first proposed. But inconsistency does tell us it is not completely true, so it should be revised and improved somehow.

The other aspect of coherence is that good theories should be consistent with other well-confirmed theories and facts. If a purported discovery contradicts well-established theories, the default response ought to be that the discovery is mistaken. Strong evidence is needed to think otherwise. For example, people such as Uri Geller claim they can bend metal spoons with their minds. This certainly goes against commonsense and science. A simpler explanation is that magic or fraud is involved. To reject this more mundane explanation, we need to carefully test these people under stringent conditions, and nobody has managed to pass such tests so far. A lot of alternative medicine and claims about the supernatural should be treated with similar caution.

Coherence is sometimes a matter of consistency with commonsense as well. This is particularly true of a lot of advertisements and scams. If something is too good to be true, it probably is. An advertisement might say if you attend a very expensive lecture, you will be taught a unique investment method that can double your money within a year. The advertisement might even be accompanied by testimonies from former students who vouch for the effectiveness of the method. But just think: a return of 100% is an absolutely amazing achievement, and if their method really works, wouldn't it be better for them to use the method themselves to make money rather than teach these classes? The same is true of advertisements promising that you can lose weight easily without having to exercise or change your diet. Or online scams in which strangers offer to deposit millions of

dollars into your bank account. The fact that these solicitations do not disappear probably indicates that there are still many people who fall for them.

13.1.9 Simplicity

Roughly speaking, a simple theory is one with fewer assumptions and that posits fewer entities than its competitors. Many scientists believe strongly that we should search for simple theories if feasible. Albert Einstein once said, "Nature is the realization of the simplest that is mathematically conceivable."

But why should we prefer simple theories? Is there any reason for thinking that the world is more likely to be simple than complicated? The value of simplicity as a theoretical virtue is disputed by many, and it would be impossible to settle the debate here. However, simple theories have a number of advantages. First, they are often easier to apply, so there is a practical reason to prefer a simpler theory. Second, a complicated theory postulating lots of different entities would require more evidence to support it. Finally, looking for simple theories coincide with the search for unifying causal mechanisms in our explanations. They help us understand the connections between different areas and offer a deeper explanation of the world.

Weeping statues and miracles

There are frequent reports of miracles by which religious statues wept tears or blood. People would come and worship the statutes and some even have claimed that the statues cured their illnesses. For example, in 2002, a Virgin Mary statue near Perth, Australia, wept red tears for nearly five months, attracting lots of pilgrims. It is of course logically possible that a miracle had occurred, but the alternative explanation is that the tears were the result of either a hoax or natural causes (such as rust or melting paint). It is interesting that the tears in this particular case were found to be a mixture of vegetable oil and rose oil. When the statute was removed and placed under observation so that nobody could tamper with it, the tears stopped. The vegetable and rose oil could of course still be a miracle. But if we apply the inference to the best explanation, taking into account considerations such as simplicity and coherence, the supernatural explanation is not the most plausible one.

13.2 RELYING ON EXPERT OPINION

We cannot possibly know everything, and inevitably we need to rely on other people's analyses and opinions, especially when it comes to scientific or technical matters. But deferring to an expert does not mean we can stop thinking criti-

cally. In particular, we should check whether the expert is *credible, accurate,* and *unbiased.* Here is a checklist of questions to think about:

- **What exactly is the expert's opinion?** Sometimes media headlines can misrepresent an expert's opinion. A scientist might say there is some weak evidence suggesting a correlation between *A* and *B*, but the headline might simply say "*A* causes *B*." So check the actual evidence carefully.

- **Is the expert in the right field?** Information is more reliable when it comes from an expert who knows the topic well. In 2008, Europe's CERN laboratory was about to activate a giant particle collider for studying subatomic physics. But according to German chemist Otto Rössler, the experiment should not proceed because it might create mini blackholes that could destroy the Earth. Rössler might be an expert in chemistry, but it does not mean he is equally an expert in particle physics. The collider is now in use and luckily we are still here.

- **Is the expert reliable? Does he or she have a good reputation?** Sometimes the expert is anonymous, so we cannot verify the reliability of the expert. So be careful with information from web pages and blog posts with no citation. Furthermore, doctorate degrees and special titles might not mean much. Even experts can often get things wrong, so it will be useful to know the past record of their opinion.

- **What is the context in which the opinion is made?** We have seen that quotes can be taken out of context. And sometimes people are joking, being emotional, or not being serious for some other reason. An opinion expressed informally might be more of a hunch than a judgment made in a public forum. An opinion expressed by an official and reputable professional organization is more weighty than one from an unknown scientist. A study published in a well-known journal probably has gone through a more rigorous review process than an unpublished report.

- **Do other authorities in the same field agree with the opinion?** We should be cautious if authoritative experts disagree with each other. The credibility of an opinion increases when it is free from any serious dispute among independent experts in the same area. This is one reason why it is a good idea to get a second opinion when you are deciding what to do with a serious medical condition. Of course, with about seven billion people in the world, you can expect disagreement on just about every issue. We would need to evaluate the extent of the disagreement and the arguments on both sides.

- **Is there any conflict of interest?** If a tobacco company says smoking is healthy, the claim does not have a lot of credibility since the company would benefit from lying. Similarly, if a software company commissions an expert who then publishes a report saying that the company's operating system is the most secure one in the market, we should be somewhat skeptical of the

report. However, it does not mean we should totally discount an opinion totally whenever a vested interest is involved. We need to consider each case individually. First, we should evaluate the evidence given for the opinion carefully and see if independent experts agree. Second, sometimes people also have a vested interest in telling the truth because they might lose more in the long run when being caught lying.

- **Is there any other source of bias?** An opinion can be biased even if the person making the opinion does not stand to gain any material benefit. For example, if someone knows a person involved in a dispute, the relationship might affect his judgment as to who is right or wrong in the dispute. Objectivity can also be affected when someone is being emotional or in a heated discussion. Sometimes academics align themselves with a particular school of thought, and they might be dismissive of alternative perspectives. This can also be a source of bias that affects their reliability.

It should be pointed out that these criteria for evaluating credibility are supposed to be general guidelines and not absolute laws. Take for example the principle that a credible opinion should be free from disagreement. This is not meant to suggest that the majority is always right. Many scientific revolutions come about precisely because certainly individuals insist on their own beliefs. It has also been suggested that those who follow the majority in the stock market are most likely to be losers in the long run and that the real winners are independent thinkers who often hold contrary opinions. However, if we insist on accepting an opinion *even though some of these guidelines are violated, it must be because we have* very good independent reasons for thinking that the opinion is correct.

Bertrand Russell's skepticism

Philosopher and Nobel Laureate Bertrand Russell (1872–1970) has some sensible advice about deferring to experts (Russell, 1935):

> The scepticism that I advocate amounts only to this: (1) that when the experts are agreed, the opposite opinion cannot be held to be certain; (2) that when they are not agreed, no opinion can be regarded as certain by a non-expert; and (3) that when they all hold that no sufficient grounds for a positive opinion exist, the ordinary man would do well to suspend his judgment.
>
> These propositions may seem mild, yet, if accepted, they would absolutely revolutionize human life.

EXERCISES

13.1 For each passage below, identify the main conclusion and the evidence given to support the conclusion. Read the passage carefully and see if there are hidden assumptions or further issues that should be considered, and whether there might be relevant possibilities and alternative explanations that would undermine the conclusion.

a) Little Johnny went to a buffet and ate a lot. There were pancakes, fried rice, and chicken and all other kinds of goodies. Little Johnny was completely full and felt that he could eat no more. But then they started serving ice cream, and Little Johnny could not resist and ate a whole sundae. Right afterward he started having a stomachache. That ice cream sundae must have been contaminated or there was something wrong with it.

b) An advertisement for children's vitamins introduces a person as "Doctor Kim" who then says she recommends the vitamins. So these vitamins must be good for children.

c) With the economy going strong, many commercial websites have been created to enable people to shop online with ease. People who used to go shopping by driving can now order products from their homes, which will be sent to them by mail or through delivery companies. If this trend continues, we should start to see a significant reduction in the use of petrol.

d) Crystals have healing power. A young woman who often had rashes on her face was told to wash her face using water in which an amethyst crystal has been left overnight. To test whether the crystal water is really effective, she was told to wash her face using just the water, and refrain from using any soap, cream, medication, or makeup. The woman was unhappy about not being able to use makeup, since she was fond of it, but she agreed to the experiment eventually. To her surprise, after using the crystal for three weeks, her rashes completely disappeared.

e) Listening to Mozart's music is going to make your kids smarter and develop better cognitive skills. In a research published in the prestigious journal *Nature*, scientists compared three groups of college students who listened to 10 minutes of either (1) a Mozart sonata, (2) relaxation music, or (3) silence. The students who listened to Mozart did better than the rest in an abstract/spatial reasoning test conducted immediately afterward. The subjects did not have significant differences in terms of pulse.

13.2 The Scholastic Aptitude Test (SAT) is a test of verbal and reasoning skills, which is held more than once every year. Many (but not all) U.S. universities require applicants to take the test. It has been noted that the average test score of the candidates has declined over the years. One proposed explanation is that the candidates are performing less well because the quality of education has dropped. See if you can come up with a few alternative explanations.

13.3 Some people claim to have a special sixth sense that enables them to see and communicate with ghosts. Since other people cannot see these ghosts, is this an untestable claim? If not, how would you test it?

13.4 A man said he has special psychic power and can affect people's minds. He asked a scientist to think of a number between 1 and 20, and then tell him what it is. The scientist said he was thinking about the number 18. The man then took off his own left shoe and his sock, and the scientist was surprised to see that the number 18 was written on the man's foot. The man explained that he wrote it beforehand and manipulated the scientist's consciousness to make him think about the number 18. The scientist found this difficult to believe but there was no way the man could have written the number down while they were talking. Assuming all these facts, how would you explain the successful prediction if it was not due to the man's psychic power? How would you test these various explanations?

13.5 Discuss and evaluate these claims about science.

a) We accept lots of things in science even though they cannot be proven. That shows that faith is also an essential part of science, just like religion. It is therefore wrong to criticize a religion by saying that it has no solid proof.

b) Psychology is not a science because psychologists cannot predict human behavior with 100% accuracy.

c) Science uses induction. On the other hand, logic uses deduction.

13.6 ☒ In testing a theory it is important to think about its consequences. Consider the biblical theory that there was a huge flood on Earth about 5,000 years ago, wiping out all animals and people except Noah, his seven family members and the animals he carried on the ark. If this were true, what consequences might we be able to observe? For example, think about what the geological data might say, and how the devastation would affect human history and archaeological records. If all humans and animals came from the survivors on the ark, what might this mean for genetic diversity and the geographical distribution of animal species?

CHAPTER 14

MILL'S METHODS

In science and everyday life, we think a lot about causes and effects. Knowledge about causation allows us to understand the world, make predictions, and change things. In this chapter and the next one we shall discuss some of the principles of causal reasoning. First we start with a set of rules known as "Mill's methods." They were formulated by the famous English philosopher John Stuart Mill (1806–1873), who wrote on a wide range of topics from logic and language to political philosophy. When we have an observed effect E, we can use Mill's methods to find its cause by following this procedure:

1. Identify a set of *candidate causes* — events or conditions that happened before E, and one of them is suspected to be the cause of E.
2. Collect information about a range of situations involving these candidate causes, and determine whether E occurred afterward in these situations.
3. Based on the information collected, use one of the five rules below to infer the cause of E.

Let us now look at the five rules one by one and see how they are applied.

14.1 THE METHOD OF AGREEMENT

> If two or more situations leading to an effect E has only one event C in common, then C is the cause of E.

Situation	Candidate causes			Effect
	A	*B*	*C*	*E*
1	✓	✗	✓	✓
2	✗	✓	✓	✓
3	✓	✓	✓	✓

The method of agreement is the rule stated above, and the table illustrates how the rule can be applied. We want to find the cause of E, which was present in three situations corresponding to the three rows of the table. A, B, and C are the candidate causes that preceded E. The ticks in the first row indicate that in situation #1, A and C were followed by E. Because B did not occur in that situation, the method of agreement rules out B as the cause of E. The second situation rules out A. C is the only candidate cause common to all three situations. Applying the method of agreement, the conclusion is that C caused E.

To give a more concrete example, suppose your family went to a dinner buffet and all of you had stomach problems afterward. Different people might have eaten different things, but suppose the only thing that everybody has eaten was raw oysters. It would be reasonable to infer that the oysters caused the stomach problems. For another example, consider patients who suffer from AIDS, which weakens the immune system and makes deadly infections more likely. Despite their different backgrounds, it was discovered that all AIDS patients have been infected by HIV. So the conclusion was that HIV causes AIDS.

The method of agreement is commonly used in causal reasoning, but note that if we discover a cause using this method, it does not tell us whether the cause is *causally sufficient* for the effect. In other words, the identified cause on its own might not be enough to bring about the effect. Even though we now know that HIV causes AIDS, this does not mean that everyone with HIV must get AIDS. In fact many people with the virus have not developed AIDS. Understanding why this is the case will help us find a cure for AIDS.

14.2 THE METHOD OF DIFFERENCE

> If one group of situations leads to an effect E, but another group does not, and the only difference between the two groups is that C is present in the former but not the latter, then C is the cause of E.

Suppose a mobile phone is not working, but it works fine when the battery is replaced. Since the only thing that is different is the battery, it was probably the

Situation	Candidate causes			Effect
	A	*B*	*C*	*E*
1	✓	✗	✓	✓
2	✓	✗	✓	✓
3	✓	✗	✗	✗

cause of the problem. Consider also the table above. We cannot apply the method of agreement because *A* and *C* are both present when *E* occurred, so the rule does not tell us which is the cause. But applying the method of difference, *E* did not occur in situation 3, and the only difference with #1 and #2 was the absence of *C*. So we can infer that *C* is the cause of *E*.

The method of difference appears to be rather simple, but it plays a very important role in science, often under the guise of **control experiments**. In a control experiment in which you want to investigate if *C* is the cause of some effect, you set up two experimental situations that are exactly the same, except that *C* is present in one but not the other. Suppose you add some fertilizer to a plant and you notice that it grows extremely tall. How can you be sure that it is the fertilizer that caused it to grow quickly and not the water or the soil in which the plant is grown? A good control experiment is to place an identical plant (the so-called control group) next to it and give it the same water and soil, keeping everything the same except that it does not get any of the fertilizer. If it does not grow as quickly, then we can conclude that the fertilizer was indeed the cause.

In conducting a control experiment, it is important to make sure that you keep every variable the same other than the condition that is suspected to be the cause. If for example you use a different type of plant as your control group, and put it in a different room, then if it does not grow as tall it might simply be due to the nature of the plant or the different environment (for example, less sunshine), and not the lack of the fertilizer.

Of course, it might be difficult and expensive to ensure that all relevant conditions are the same in a control experiment. To show that playing the piano improves a child's IQ, you need to find two groups of children who are exactly the same except that one group learns the piano and the other group does not, and check whether there is a bigger increase in IQ in the first group. But children have different family backgrounds, personalities, and innate intelligence, so it is of course impossible to ensure that the two groups are *exactly* the same. What psychologists can do is to *control for the differences* by ensuring that the two groups are as similar as possible, or use special statistical techniques to analyze the results. But even though good control experiments are hard to come by, they are crucial for obtaining trustworthy results. (See also the discussion of control experiments in medicine on page 136.)

14.3 THE JOINT METHOD

Suppose one group of situations leads to an effect E, but another group does not. If C is the only factor common to situations in the first group, and it is also the only factor that is absent from all the situations in the second group, then C is the cause of E.

Situation	Candidate causes				Effect
	A	*B*	*C*	*D*	*E*
1	✓	✓	✓	✓	✓
2	✓	✗	✓	✗	✓
3	✓	✗	✗	✓	✗

In a way, the joint method is a combination of both the method of agreement and the method of difference. If you look at the table above carefully, you will see that neither the method of agreement nor the method of difference can be applied directly. Situations 1 and 2 have more than one candidate cause in common, so no conclusion can be drawn about the cause. The method of difference cannot be applied because the three situations differ in more than one candidate causes. But combining both methods, we end up with a more powerful rule, which can be applied to this example. This joint method can be formulated more simply as follows: If C is the only candidate cause that is present when and only when E occurs, then C causes E.

14.4 THE METHOD OF CONCOMITANT VARIATIONS

If variation in some factor C is followed by variation in an effect E, then C is the cause of E.

Situation	Candidate cause	Effect
	C	*E*
1	✓	✓
2	✓✓	✓✓
3	✓✓✓	✓✓✓

The general idea behind this principle is that an effect can change by changing its cause. Suppose the number of people suffering from asthma attacks goes up when air pollution becomes very bad. When air quality improves, the number of

such attacks drops. Because there is this correlation in variation, we conclude that air pollution causes asthma attacks.

A version of the method of concomitant variations is employed in medicine to investigate whether certain substances have a beneficial or harmful effect. To show that an effect exists, we look for a **dose-response relationship**, showing that the size of the effect is affected by the amount of the substance. For example, to show that mercury is toxic, we provide evidence that a larger amount of exposure to mercury (dose) is followed by more severe allergic reactions or nerve damage (response). Note that the application of the method does not require that an increase in C must always correspond to an increase of E. The relationship can also be an inverse one, such as increasing the dosage of a painkiller decreases the number of headaches. What is important is that variation in the cause has some predictable linkage to variation in the effect.

14.5 THE METHOD OF RESIDUES

> If a set of conditions causes a range of effects, and some of the effects can be explained by some of the earlier conditions, then the remaining effects are caused by the other remaining conditions.

The idea behind the method of residues is to identify causes by elimination. Suppose you discover that two books are missing from your room, and only two people have been there recently. You ask one of them and he confesses that he "borrowed" just one book without asking. If you trust his answer it would then be reasonable to conclude that the other visitor had taken the second book. As Sherlock Holmes said in one of the detective novels, "When you have eliminated the impossible, whatever remains, however improbable, must be the truth."

The method of residues is often used to discover new causes. If we can explain only part of an effect, it might be because there is some unknown cause that plays a role. This was actually how the planet Neptune was discovered. In the 19th century, astronomers could account for the orbits of all the planets known at that time except for Uranus. Leverrier, a French mathematician, concluded that there must be some other cause that explain Uranus's special situation. He thought this could only be explained if there was an unknown planet that affected Uranus, and it eventually led to the discovery of Neptune.

14.6 LIMITATIONS OF MILL'S METHODS

Mill's methods should come as no surprise, as these rules articulate some of the principles we use implicitly in causal reasoning in everyday life. But it is important to note their limitations:

- **The true cause might not be any of the candidate causes.** Mill's methods start with a preselected set of candidate causes. If the true cause of the ef-

fect is not among them, obviously the five rules will not yield the correct result. Of course, we can always expand or change the list of candidate causes. But Mill's methods will be more effective when we already have a good idea about what the possible causes of the effect might be.

- **The effect might have more than one cause.** Mill's methods can fail spectacularly when more than one candidate cause can bring about the same effect. It might be true that everybody who ate oysters got sick. But perhaps the oysters were fine, and it was the salad and the noodles that had gone bad. It just so happened that everyone ate either salad or noodles. But the method of agreement will give us the wrong result.[1]

- **Causation can be indeterministic.** Throwing a rock at a window might cause it to break, but not always. A heart attack can result in death, but again not every time. Mill's methods can give the wrong results when dealing with probabilistic causes. Take the joint method for example, where the cause is supposed to be the condition that occurs when and only when the effect is present. This rules out causes that do not determine their effects but that make them highly probable.

Having noted some of the limitations of Mill's methods, it should be said that they remain important tools of scientific reasoning. They do not guarantee that you will find the real cause of an effect, but they are good heuristics to try out in causal investigations.

EXERCISES

14.1 Which of Mill's method is used in the following pieces of reasoning?

a) Pressure decreases productivity, because the more pressure I suffer from, the less work I am able to do.

b) You were fine when you ate the pudding last week. The pudding this week was no different, except that I put in alcohol. So if you had an allergic reaction this time it must have been the alcohol.

c) Amie thinks that drinking warm milk before bed makes her sleep better. She tried lots of things like listening to relaxing music, meditation, reading a book, and even combinations of these methods. But every time after drinking warm milk she slept soundly, and nothing else worked.

d) Two identical cars were being driven in the same way along the same route, except that one of them has less pressure in the tires. It turns out that this car ends up using more fuel to travel the same distance. So inadequate tyre pressure causes a higher fuel consumption.

[1] Mill's methods can actually be used to identify causes that are combinations of events. What we need to do is to expand the list of candidate causes so that it includes combination of events, such as "salad or noodles" being one single candidate cause. But we might need to consider more situations before we can conclude which event or combination of events is the cause.

14.2 Consider the table in Section 14.3 used to illustrate the joint method. Was any situation redundant? In other words, was there any situation in the table that could have been removed, but the same conclusion could still be derived using the resulting information?

14.3 In each table below, find the cause of E and explain which of Mill's methods is being used. If none of them can be applied, explain why.

a)

Situation	Candidate causes				Effect
	A	*B*	*C*	*D*	*E*
1	✓	✓	✗	✓	✓
2	✓	✗	✓	✗	✓
3	✗	✓	✗	✗	✓

b)

Situation	Candidate causes				Effect
	A	*B*	*C*	*D*	*E*
1	✓	✗	✗	✓	✗
2	✓	✓	✗	✓	✓
3	✗	✓	✓	✗	✓
4	✗	✗	✗	✓	✗

c)

Situation	Candidate causes				Effect
	A	*B*	*C*	*D*	*E*
1	✓	✓	✗	✓	✗
2	✓	✗	✗	✗	✗
3	✗	✗	✓	✓	✓
4	✓	✓	✗	✓	✗

d)

Situation	Candidate causes				Effect
	A	*B*	*C*	*D*	*E*
1	✓	✓	✗	✓	✓
2	✓	✓	✗	✗	✗

e)

Situation	Candidate causes			Effect
	A	*B*	*C*	*E*
1	✓	✓	✗	✗
2	✗	✓	✓	✓
3	✗	✓	✗	✗

14.4 Are these statements true or false?

a) In every situation in which the method of difference gives the correct answer, the joint method will also give the correct answer.

b) To apply the method of difference, we need information about at least two different situations, one in which the effect occurred, and the other in which it did not.

CHAPTER 15

REASONING ABOUT CAUSATION

In the last chapter we discussed Mill's methods and their limitations. Here are some further issues to consider about causation. In many situations, causes are correlated with their effects. An event C is said to be **positively correlated** with E when the presence of C increases the probability that E will also occur. C is said to be **negatively correlated** with E when C decreases the probability of E. If C has no effect on the probability of E, then C is not correlated with E, or C is **independent** of E. So for example, the appearance of lightning is positively correlated with thunder, negatively correlated with a clear sky, and presumably not at all correlated with the day of the week.

Correlation is about how often two things are associated with each other, so it is a matter of degree. Lightning is inevitably followed by thunder,[1] and there is no thunder without lightning. This is 100% or a perfect correlation. Smoking is positively correlated with lung cancer, but obviously not all smokers will get cancer. Indeed, a low correlation between two types of events does not rule out causation in particular instances. A hunter might fail to shoot his prey most of the time, but when he succeeds his shot will be the cause of the animal's death.

[1] Although you might be too far away to hear it.

Similarly, most people are fine after taking aspirin, and there is only a low positive correlation between aspirin and allergic reactions. But aspirin does cause allergic reactions in about 1% of the population.

If a low correlation does not preclude causation, then is a high correlation sufficient for causation? Not at all! Confusing positive correlation with causation is a common mistake in causal reasoning. Even if C does not cause E, there can be many reasons why C is positive correlated with E. Here are the main possibilities:

- The correlation between C and E is purely an accident.
- E causes C and not the other way round.
- C does not cause E but they are the effects of a common cause.
- The main cause of E is some side effect of C rather than C itself directly.

This is not to say that data about correlation are irrelevant to causation. As a matter of fact correlation is often a guide to causation. But we need to rule out the alternative possibilities listed above if we want to infer causation on the basis of positive correlation. Let us discuss these cases further.

15.1 WHY CORRELATION IS NOT CAUSATION

15.1.1 Accidental correlation

Sometimes high correlation is the result of not having enough data. Suppose I have been in only one car accident my whole life, and that was the only time I ever wore red trousers. There is a perfect correlation between the color of my trousers and my being involved in a car accident, but this is just a coincidence. Correlation data are more useful when they involve a large range of cases.

But still we need to be careful. It has been suggested that the sea level in Venice and the cost of bread in Britain have both been generally on the rise in the past two centuries (Sober, 1988). But it is rather implausible to think that the correlation is due to some underlying causal connection between the two cases. The correlation is presumably an accident due to the fact that both have been steadily increasing for a long time for very different reasons.

There is also a kind of accidental correlation known as *spurious correlation* (or Simpson's paradox) that has to do with the aggregation of statistical data. It is a rather interesting but somewhat technical topic. If you are interested you can read more about it on our companion website.

15.1.2 The causal direction is reversed

Sometimes C is correlated with E not because C causes E, but because E causes C. Drug users are more likely to suffer from psychiatric problems. This might be because drug use is the cause, but perhaps preexisting psychiatric problems cause people to turn to drugs. Correlation by itself does not tell us which of these

two stories (if any) is correct.[2] It is important to bear this in mind when reading newspaper accounts of scientific research. Scientific research might tell us only that drug use is positively correlated with psychiatric problems, but reporters who should know better might instead write, "drugs make you depressed and crazy." The word *make* suggests causation but this might not actually be supported by the data.

When two causal factors or variables reinforce each other, we have a **causal loop**. For example, there is a correlation between health and GDP growth in many countries. This is because on one hand, healthy citizens work longer and better, contributing to economic growth. On the other hand, higher GDP brings about better living conditions and medical care, improving health as a result. So health and GDP growth are **mutually reinforcing**. It is possible that one variable has a more significant effect on the other. However, it would require sophisticated statistical techniques to determine which is which.

A **vicious circle** happens when a causal loop makes a bad situation even worse. Take stage fright for example. Becoming nervous and stressful when you are performing can make you perform less well, and this might in turn make you even more nervous, affecting your performance further. Catastrophe ensures if the vicious circle is not broken.

15.1.3 Hidden common causes

Sometimes C and E are correlated not because one causes the other but because there is a hidden condition X that causes both C and E. For example, children who wear bigger shoes tend to have better reading skills. Do shoes somehow promote brain growth? Presumably not. The more mundane explanation is that older children read better, and they have bigger feet. So growth is the hidden common cause that leads to both bigger shoes and better reading skills. Or suppose the drinking of bottled water instead of tap water is correlated with healthier children. Is this because bottled water is cleaner, and ordinary tap water contains harmful impurities? Not necessarily. Perhaps this is just because wealthier parents can afford higher-quality care and food for their children, and being more cautious, they choose to buy bottled water even if tap water is just as good.

15.1.4 Causation due to side effect

In some cases where C correlates with E because C occurs together with some other condition or side effect that actually causes E. The causal contribution from C to E might be nonexistent or of lesser importance. The **placebo effect** is a good example of causation due to side effect. It refers to the real or felt improvement in a patient's condition that is due to beliefs about the treatment rather than the medical efficacy of the treatment itself. It is suggested that when patients believe that they have taken medicine, this is enough to make many of them feel better or

[2] Most likely there is causation in both directions.

suffer from less pain, even when the treatment being given (such as a cornstarch pill) has no medical benefit. In fact, it has been reported that a larger pill has a more pronounced placebo effect, and colored pills are better than white ones, and that injections are even better!

The extent and mechanism of the placebo effect is still under study, but this is one reason why it is necessary to include a control group in testing a drug. Subjects in the control group would be given an inert pill without being told that this is the case, and the difference in response in the normal and control groups can then provide a more reliable estimate as to the effectiveness of the drug.[3]

Placebo Surgery

It is surprising that the placebo effect applies not just to drugs but to surgery as well. In Moseley et al. (2002), over 100 patients suffering from a knee problem (osteoarthritis) were given either real surgery or fake surgery (in which the knee received only a superficial cut). The patients were not told whether they were given a real surgery or not. But in the following two-year period, both groups reported the same amount of pain and improvement in function. In another study, researchers studied whether transplanting human embryonic cells into the brain would improve Parkinson's disease (McRae et al., 2004). All the patients had small holes drilled into their skulls. Half of them were given the transplant, but the patients did not know whether they had it or not. Yet a year later, those who believed that they had the real transplant reported a better quality of life, *whether or not they actually had the surgery*! This is a powerful demonstration of the placebo effect, and a good reminder of the importance of double-blind studies. It also raises a difficult ethical question: Should doctors exploit placebo effects more often in medical treatments? But is it ethical to lie to patients about the nature of their treatment?

In scientific research, it is important to investigate side effects to ensure that experimental results are reliable. For example, studying captive animals might not give a true picture of the behavior of wild animals because putting animals in a confined environment might change their habits, which is a form of side effect. In other situations, experimental procedures can introduce contamination or artifacts that affect the results. The following are other cases of side effect causation relating to human beings:

[3]An even better version of this approach is to adopt a **double-blind study** in which neither the patient nor the doctor know whether the real pill or the fake one has being given. This is to avoid the doctor leaking relevant information to bias the expectation of the patient.

- An example in social science and industrial psychology is the **Hawthorne effect**. This refers to the fact that people tend to change their behavior when they know they are being studied. In particular, they might work harder or perform better in an experimental setting.
- People react to new things differently, and this produces a **novelty effect**. Once the novelty wears off, their behavior might return to normal. For example, some schools claim that students behave better and learn better when they switch their drab school uniforms to colorful Hawaiian shirts. Although there might have been a real correlation between the colorful shirts and the better performance, this might just be due to the novelty of the new arrangement. To show that wearing Hawaiian shirts can somehow really improve learning and behavior, we would check whether the improvement still remains after the novelty is gone.
- The **pygmalion effect** originated from a study where teachers were told that some of their students were above average even though they were randomly selected with the same average abilities. But the subjective expectation of the teachers somehow led to better performance by these students later on. The result has been replicated in other contexts, and this has important implications for education and management.

15.2 GOOD EVIDENCE FOR CAUSATION

We have looked at many reasons why correlation might not amount to causation. To establish causation then, it is important to eliminate these alternative hypotheses. But what kind of positive evidence can we obtain to support causation?

15.2.1 Look for covariation and manipulability

First of all, data about covariation are particularly useful. Recall Mill's method of concomitant variations. If changes in one event correspond to changes in another event, then this makes it more probable (though not conclusive) that one causes the other. When we suspect smoking causes lung cancer, the fact that cigarette smokers have a higher cancer rate than nonsmokers is only one piece of evidence. It becomes even more convincing when it is discovered that the death rate from lung cancer increases linearly with the number of cigarettes smoked per day.

Covariation is even stronger evidence when it can be directly manipulated and not just being passively observed—we vary some aspects of the cause and see how it affects the effect. For example, hitting the key of a piano causes a sound to be made. We can be sure of the causal connection because we can change the timing and the loudness of the sound by controlling when and how we hit the piano key. This makes it extremely unlikely that the correlation is accidental or due to some other explanation. In reality, manipulating correlation can sometimes be difficult or even unethical to do. To study how smoking leads to lung cancer, it would be

immoral to request some subjects to smoke more cigarettes and see if they are more likely to get cancer!

15.2.2 Look for a reliable model of causal mechanism

A **causal mechanism** is a series of objects, processes, or events that explain how a cause leads to its effects. Using the piano as an example again, hitting the key causes a felt-covered hammer to strike a steel string. This causes the string to vibrate, and the vibration in turn causes air molecules to move, which is the sound we hear. This causal process explains how the keys can create music, and a breakdown in any step of the causal process might result in no sound being produced.

Nearly all instances of causation involve underlying causal mechanisms.[4] A causal mechanism explains why there is causation and helps us make predictions about what would happen when the system changes. For example, the story about the causal mechanism in a piano explains why a louder sound is heard when we hit the key harder, because this means the string would vibrate with a larger amplitude, making a louder sound.

This is why the search for causation is often tied to the search for causal mechanisms. One way to show that C causes E is to offer a theory of causal mechanism that leads from C to E, and try to provide evidence to support this theory. This way of establishing causation is particularly important when we are dealing with events that are difficult or impossible to repeat.

Of course, it is possible to obtain strong evidence for causation even when we lack detailed knowledge of the underlying mechanism. For example, we now know that infection by HIV is the cause of AIDS, but this discovery took place before detailed knowledge of how it is that the virus causes AIDS through interfering with the immune system, and even up till now there are still gaps in our understanding of the exact causal mechanism. Similarly, it has long been known that there is a correlation between smoking and lung cancer, but it took nearly 50 years to identify the causal mechanisms whereby the chemical compounds in cigarette smoke trigger the cellular changes that result in lung cancer.

15.3 CAUSATION IS COMPLICATED

We have discussed a lot about searching for *the* cause of an effect. However, the world is a complicated place and events can interact with each other, often making it difficult if not impossible to find the one true cause. Here are some useful terms for making more fine-grained distinctions between causes:

[4]Nearly all, because there might be exceptions when it comes to causation in quantum mechanics involving action-at-a-distance, where remote particles seem to be able to affect each other without any apparent causal mechanism. There is also the philosophical question of whether there is a most basic level of causal mechanism.

- **Causal relevance**: Suppose a student failed a course. She might have been lazy or having personal problems. Or perhaps she was ill on the day of the exam. All these factors could have contributed to her failure. They were all *causally relevant*, each being *a* cause of her failure but none being *the* cause. The most important one is the *primary* or *central* cause.
- **Causally necessary and sufficient conditions**: X is *causally necessary* for Y when Y would not happen without X, and X is *causally sufficient* for Y when X by itself is enough for Y. Water is causally necessary but not sufficient for our survival, and moving electric charges are sufficient but not necessary for the presence of a magnetic field.[5] But X can be causally relevant to Y even if X is neither causally necessary nor sufficient for Y.
- **Triggers**: A *triggering cause* (or *trigger*) is a cause that starts off a chain of events leading to an effect. Whereas a *structural cause* (or *standing condition*) is a background condition that is causally relevant to the effect but which on its own is not sufficient for it. For example, an electric spark in a kitchen with a gas leak can result in an explosion. Here, the spark is the trigger, and the flammable gas is the standing condition.
- **Proximity**: A *proximate cause* happened at a time near the occurrence of the effect, whereas a *distal cause* happened much earlier.
- **Randomness and causal determination**: A random event is one that is not causally determined by what happened earlier. To say that an event is determined is to say that it must occur given what has happened earlier and the physical laws of our universe.

EXERCISES

15.1 For each of these correlations, think of at least two alternative causal explanations.

a) Children who eat breakfast perform better at school.

b) A six-year study of more than a million adults ages 30 to 102 showed that people who get only 6 to 7 hours of sleep a night have a lower death rate than those who get 8 hours of sleep.

c) There is a moderate correlation between milk drinking and cancer rate across societies.

d) Smokers are 1.6 times more likely to think of killing themselves than non-smokers.

e) Students who smoke are more likely to have lower grades at school.

f) Students who use Facebook more often have lower grades.

g) People who smile sincerely more often tend to live longer.

h) People who go jogging regularly are less likely to suffer from depression.

[5] A simple magnet can produce a magnetic field without electricity.

i) Teenagers who use alcohol, marijuana, or other illegal drugs are much more likely to experience psychiatric disorders, especially depression, in later years.

15.2 Which of these conditions are mutually reinforcing? Can you give some more examples?

a) stock prices going down, panic selling

b) heating a piece of metal, the piece of metal expanding

c) anxiety, not being able to sleep

15.3 According to Reichenbach, a famous philosopher, if two events X and Y are correlated, then either X caused Y, or Y caused X, or they are the joint effects of a common cause. What is wrong with this claim according to the principles discussed in this chapter?

15.4 The philosopher John Mackie proposed this theory of causation: X causes $Y = X$ is an insufficient but necessary part of a condition that is itself unnecessary but sufficient for Y.

a) Suppose Akiko stepped on Bella's toe and this caused Bella's toe to bleed. Explain how this example of causation satisfies Mackie's definition.

b) Can you think of any counterexample or objection to the proposal? This is a difficult question, but do give it a try!

15.5 Can you give an example where an event X is causally relevant to Y even though X is neither causally necessary nor sufficient for Y?

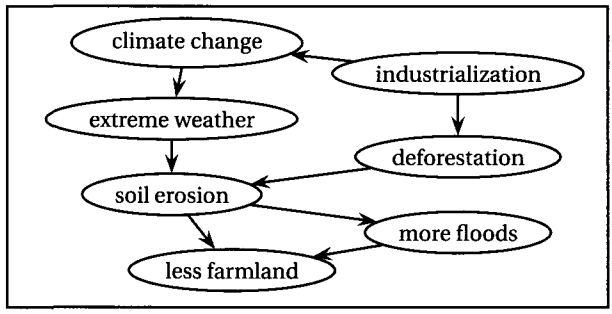
15.6 ☒ See if you can come up with examples of causal mechanisms from the subjects that you have studied or are familiar with.

CHAPTER 16

DIAGRAMS OF CAUSAL PROCESSES

Causal processes are often complicated. Here are some diagrams that can make them easier to understand. They are also useful in giving presentations.

16.1 CAUSAL NETWORKS

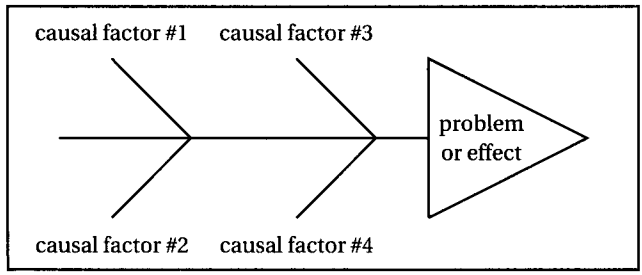


In a causal network diagram, nodes represent events and arrows link causes to effects. The diagram above shows the process of soil erosion. We can also use

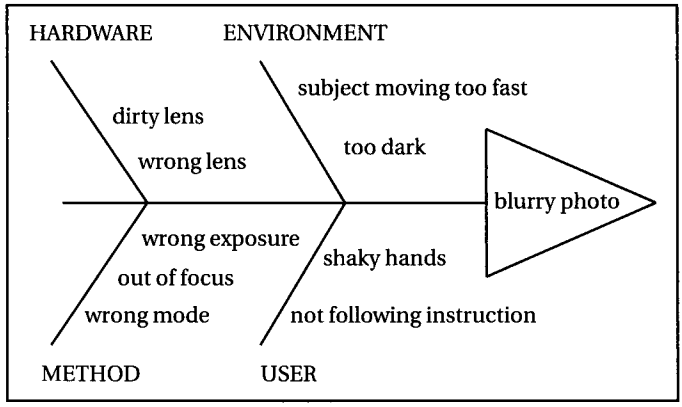
annotated arrows to provide more information about the causal links. For example, a positive sign [+] next to an arrow linking A to B indicates that A increases the probability of B. A negative sign [−] indicates that A decreases the probability of B. One might even assign numerical probabilities. With enough information, we can calculate the probabilities relating other events, and predict how the system respond to changes. This is known as a **Bayesian network** or **Bayes net**. But causal diagrams are not just for scientists. They are useful for showing causal interactions in many other areas. For example, a diagram might use arrows to link together different art movements to show how they have influenced each other.

16.2 FISHBONE DIAGRAMS

The diagram below shows the general structure of a **fishbone diagram**, so-called because of its shape:



These diagrams are also called *cause and effect diagrams*, and they were made popular by Kaoru Ishikawa, a Japanese professor who used them in quality management. Such diagrams help us visualize and classify the causal factors that contribute to an effect. We start with a diagram that resembles a fish skeleton and place the problem or issue to be investigated at the fish head. We then add branches corresponding to different categories of causal factors. Specific factors under a category are then listed along the branches. The following example shows some of the main reasons why a user ends up taking a blurry photo with a camera:

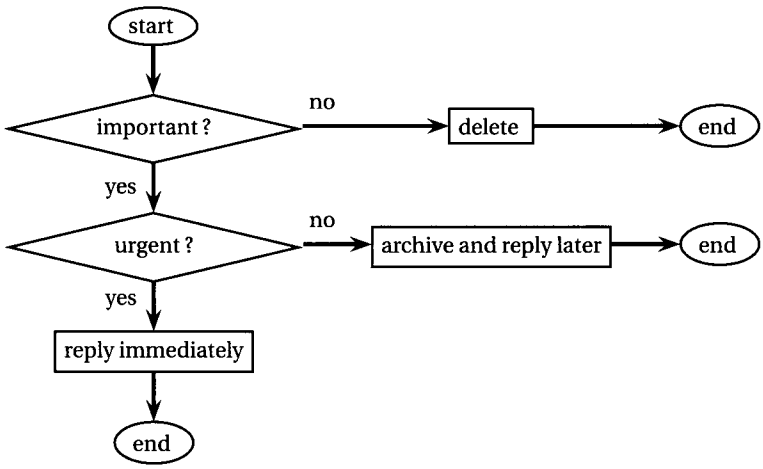


A fishbone diagram is useful when it is possible to provide a simple classification of the different types of causes that lead to an effect. The choice of categories is crucial if the diagram is to provide an informative analysis of the overall situation. For example, if you want to improve your performance in a certain area, the relevant categories might include skill, training, environment, and personality. Here are some standard ones in business and management:

Acronym	Field	Categories
6Ms	manufacturing	machines, methods, material, measurements, manpower (people), mother nature (environment)
4Ps	service industries	policies, procedures, people, plant (technology)
4Ps	marketing	product, pricing, promotion, place

16.3 FLOWCHARTS

A **flowchart** is a diagram using connected shapes to represent the steps of a complex process, some of which might involve actions and decisions. The example below describes how a busy person ruthlessly deals with the flood of emails in his inbox:



The chart says that unimportant emails are deleted. Important but nonurgent ones are set aside to be replied later. Otherwise a reply is sent right away.

Originally, flowcharts were used in computer science to describe the different steps of a computer program. But because flowcharts are useful for describing

complex procedures, they are now routinely used in many other areas as well, from customer service to medical diagnosis. Writing down a flowchart forces us to be clear about the different steps of a procedure. It can then be used as the basis of discussion, to see how a process can be improved. It can be also used as a recipe for different people to follow to ensure uniformity in how a task is to be completed. Furthermore, if more than one person is involved in completing a task, we can use a flowchart to assign people different parts of the task, so that each person knows exactly what his or her responsibilities are.

EXERCISES

16.1 Suppose someone thinks that playing violent video games does not cause violent behavior. Rather, having a violent personality causes people to play lots of these games and engage in violence. Draw a causal network diagram showing the causal processes involved.

16.2 Consider these five steps for a pedestrian to cross the road safely, in random order: "look left and right," "stop at the curb," "walk across quickly," "wait a few seconds," "check if the road is clear" Draw a flowchart for the whole process using only these steps.

16.3 ☒ Go online and search for "getting things done flowchart." *Getting Things Done* is a system created by David Allen that helps people become more systematic and productive at managing tasks. If you do not know what it is, look at the flowchart and read a bit more to see what the different steps are. See if this system is useful for you.

16.4 ☒ To find out more about the meanings of the different flowchart symbols, do an Internet search on "standard flowchart symbols."

16.5 ☒ Draw a causal network diagram and a fishbone diagram for a topic that you are interested in.

CHAPTER 17

STATISTICS AND PROBABILITY

Many people think of **statistics** as a scary subject involving lots of numbers and equations. While it is true that statistics can be quite technical, the subject remains highly relevant to modern life. For example, before booking a hotel, we might check the number of good and bad online reviews. When we make investment decisions, we might also review the relevant financial and statistical data first. In this chapter we shall discuss some general principles for interpreting statistical studies, without going too much into the mathematical details.

Many statistical studies investigate **samples**. We study a sample to infer general conclusions about a **population**, the set of things we are interested in. Suppose we want to find out whether heavy metal contamination in vegetables is a serious problem in China. The population is then all the vegetables in the whole of China. But it is obviously impossible to test all of them. So instead we collect a variety of vegetables from different places in China. This is our sample and we shall measure the amount of heavy metal contaminants in this batch. If the study is done well, it will give us a good picture of the overall situation in China. However, if the study is not done correctly, it might not just be a waste of time and money. Policy decisions based on a bad study can have harmful consequences.

17.1 EVALUATING SURVEYS AND SAMPLING STUDIES

Here are some questions we should ask if we want to evaluate a statistical study.

17.1.1 What exactly is the finding? What do the keywords mean?

First of all, focus on the main conclusion. What is the significance? What is the most important finding? How is it formulated? How are the keywords defined?

- Distinguish between the actual results and their interpretation. For example, many reports confuse correlation with causation. A blog article might say that sleeping more makes your life shorter, which is a claim about causation. But the actual statistics might tell us only that adults who sleep 8 or more hours a day have a higher death rate than those who sleep 6 to 7 hours. These correlational data are not about causation at all. (Perhaps less healthy people sleep more, so sleeping more does not directly cause death.)
- Check the definitions of key concepts. A survey might say that 27% of university students are Christians. But what does being a Christian mean? Is it just a matter of saying that you are? Or does it involve regular church attendance? Is a Mormon a Christian? Statistics are more informative when it is clear how the main variables are actually measured and defined.

17.1.2 How large is the sample?

When we extrapolate from a sample to the population, a larger sample is likely to give a more accurate conclusion. If a restaurant wants to find out whether its customers enjoy the food and service, it would not be enough to solicit the view of just one customer. On the other hand, spending extra money and time on a larger sample size might not be worth it if a smaller one would do just as well.

It is not easy to determine the optimum sample size. Partly it depends on the size of the population and the level of precision required of the results. (See Section 17.1.5 below.) Other relevant factors include the variability of the population.

17.1.3 How is the sample chosen?

How the sample is selected affects greatly the reliability of the conclusions. A sample should be **representative** of the population, in the sense that the features being studied are distributed in the same way in both the sample and the population. If you want to find out how often people exercise, it would be wrong to interview only people at the local gym, since they probably exercise a lot more. This constitutes what we call a **biased sample**.

We should check carefully how a sample is chosen to see if there are hidden biases. For example, some online surveys allow people to submit their opinions more than once. They might also attract people who are more computer savvy, have more free time, and are more willing to give their opinion.

A good way to minimize biased sampling is through **random sampling**, by which each sample is selected randomly from the population. Given an adequate sample size, this method is highly likely to result in a representative sample. But even with random sampling, we should be careful of potential biases in the results due to the fact that some selected individuals might not be reachable (for example, in a telephone survey) or are not willing to participate.

Statistics and advertisements

Many advertisements cite statistical surveys. But we should be cautious because we usually do not know how these surveys are conducted. For example, toothpaste manufacturer Colgate once had a poster that said "More than 80% of dentists recommend Colgate." This seems to say that most dentists prefer Colgate to other brands. But it turns out that the survey questions allowed the dentists to recommend more than one brand, and in fact another competitor's brand was recommended just as often as Colgate! No wonder the UK Advertising Standards Authority ruled in 2007 that the poster was misleading and it had to be withdrawn.

A similar case concerns a well-known cosmetics firm marketing a cream that is supposed to rapidly reduce wrinkles. But the only evidence provided is that "76% of 50 women agreed." But what this means is that the evidence is based on just the personal opinion from a small sample with no objective measurement of their skin condition. Furthermore we are not told how these women were selected and whether there was any double-blind study conducted. Without such information, the "evidence" provided is pretty much useless. Unfortunately such advertisements are quite typical, and as consumers we just have to use our own judgment and avoid taking advertising claims too seriously.

17.1.4 What method is used to investigate the sample?

If a sample is investigated using a biased method, the statistical results can be unreliable even if the sample is representative. There are various ways this might come about:

- **Social desirability**: Suppose a teacher selects some students randomly and asks whether they have cheated in exams. This survey will underestimate the extent of cheating since students are unlikely to admit to cheating to their teacher. We generally want to portray ourselves positively and are reluctant to confess to undesirable attitudes or activities. This is especially true when we are questioned directly or when we have doubts about the confidentiality of the results.

- **Leading questions**: These are questions that are formulated in such a way that answers are likely to be skewed in a certain direction. For example, "Do you want to give vitamin pills to your children to improve their health?" is likely to solicit more positive answers than the more neutral "Do you intend to give vitamin pills to your children?" (See also the discussion about anchoring in Section 20.2.1.)

- **Observer effect**: It is often difficult to conduct a statistical study without affecting the results in some way. People might change their answers depending on who is asking them. Animals change their behavior when they realize they are being observed. Even measuring instruments can introduce errors. We just have to be careful when we interpret statistical results.

17.1.5 What about the margin of error?

Many statistical surveys include a number known as the **margin of error**. This number is very important for interpreting the results. The concept is a bit difficult to grasp, but it is worth the effort, especially if you are a journalist or someone who has to report statistics or make decisions based upon them.

The margin of error arises in any sampling study because the sample is smaller than the whole population, and so the results might not reflect the reality. Suppose you want to find the average weight of a Korean by weighing a random sample of Koreans. The average weight of your sample would be the statistical result, which might or might not be the true result—the average that is calculated from the whole Korean population. If you do manage to weigh the whole population, then your statistical result will be the same as the true result, and your margin or error will be zero indeed (assuming there are no other sources of error like faulty weighing machines.)

When the sample is smaller than the population, the margin of error will be larger than zero. The number reflects the extent to which the true result might deviate from the estimate. The margin of error is defined with respect to a **confidence interval**. In statistics, we usually speak of either the 99% confidence interval, the 95% confidence interval, or the 90% confidence interval. If the confidence interval is not specified, it is usually (but not always!) 95%.

Suppose an opinion poll about an upcoming election says that 64% of the people support Anson, with a margin of error of 3%. Since the confidence interval is not mentioned, we can assume that the margin of error is associated with the 95% confidence interval. In that case, what the poll tells us is that the 95% confidence interval is $64 \pm 3\%$. What this means is that if you repeat the poll 100 times, you can expect that in 95 times the true result will be within the range specified. In other words, in 95% of the polls that are done in exactly the same way, the true level of support for Anson should be between 61% and 67%.

There are at least two reasons why it is important to consider the margin of error. First, if the margin of error is unknown, we do not know how much trust we should place in the result. With a small sample size and a large margin of error, the

true result might be very different from the number given. The other reason for considering the margin of error is especially important when interpreting changes in repeated statistical studies over a period of time, especially opinion polls. Suppose 64% of the people support Anson this month, but the number drops to 60% the next month. How seriously should we take this to indicate that support for Anson is slipping away? If the margin of error is say 5%, then the new finding is within the 95% confidence interval of the earlier result ($64 \pm 5\%$). It is therefore quite possible that there is actually no change in the opinion of the general public, and that the decrease is due only to limited sampling.

Finally, it should be emphasized that the margin of error does not take into account biases or methodological errors in the design and execution of the study. So these problems can still be present in a result with a low margin of error!

17.2 ABSOLUTE VS. RELATIVE QUANTITY

When we interpret statistics, it is important to distinguish between absolute and relative quantity. **Absolute quantity** refers to the actual number of items of a certain kind. Here are some examples:

- The number of female professors at Beijing University.
- The number of computer programmers in India.

On the other hand, a **relative quantity** is a number that represents a comparison between two quantities, usually a ratio or a fraction, or a number that measures a rate comparing different variables:

- The ratio between female and male professors at Beijing University.
- The percentage of computer programmers among workers in India.

This distinction is important because meaningful comparisons often require information about the right kind of quantity. Suppose the number of violent crimes this year is a lot higher than that of 10 years ago. Does it mean our city has become more dangerous? Not necessarily because the higher number could be due to the increase in the population. We need to look at the relative quantity, such as the number of violent crimes per 1,000 people. If this number has actually dropped over the same period, the city has probably become safer despite the higher number of crimes! Similarly, drivers between the age of 20 and 30 are involved in more car accidents than drivers who are between 60 and 70. Is this because older people drive more safely? Again not necessarily. There might be more younger drivers, and they might also drive a lot more. We should compare the number of car accidents per distance traveled rather than the absolute number of accidents.

A misleading use of relative quantity

In April 2010, an oil rig in the Gulf of Mexico owned by British Petroleum (BP) exploded and a huge amount of oil started leaking from the deep sea and BP was unable to stop the spill. In a newspaper interview, Tony Hayward, who was the chief executive of BP, tried to downplay the consequences of the leak. He said that the amount of leaked oil and dispersant used to tackle the oil slick is small compared with the very big ocean (Martel, 2010):

> The Gulf of Mexico is a very big ocean. The amount of volume of oil and dispersant we are putting into it is tiny in relation to the total water volume .

This is a rather disingenuous use of relative quantity. The amount of spill might be rather small compared with the total volume of the ocean in the Gulf of Mexico, and even smaller when compared with all the water in the world, but it is still a huge amount of pollution that can affect a lot of people and animals and bring about terrible environmental destruction.

The absolute vs. relative distinction is particularly important in healthcare. The risks associated with illnesses, drugs and medical treatments can often be specified in absolute or relative terms. Take these two headlines:

- New miracle drug lowers liver cancer risk by 50%!
- New drug results in 1% drop in liver cancer risk!

The first headline is presumably a lot more impressive, but both can be correct in describing the result of a clinical trial. Imagine two groups of normal people, 100 in each group. The first group took the drug to see if it reduced the number of liver cancer. After 10 years, 1 out of 100 developed liver cancer. The other control group took a placebo pill and 2 out of 100 had liver cancer after 10 years. The absolute risk of getting liver cancer is 2% for those without the drug, and 1% for those taking the drug. So the second headline correctly describes the reduction in absolute risk. But reducing 2% to 1% amounts to a relative risk reduction of 50%. So the first headline is correct as well.

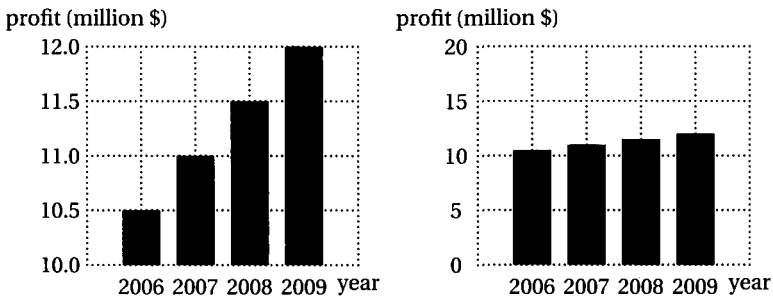
Why should we care about whether risk information is presented in absolute or relative terms? First of all, note that information about relative risk tells you *nothing* about absolute risk. If eating farmed salmon increases your chance of getting a certain disease by 100%, this sounds very scary. But this relative increase tells you nothing about the absolute likelihood of getting the disease. If the disease is extremely rare, the chance of getting it can remain negligible even after it has been doubled.

So be careful of advertisements for drugs and medical treatments. The two headlines above give very different impressions. Hasty decisions based on incomplete data can be dangerous, especially because drugs and treatments can have undesirable side effects. If taking the new liver cancer drug causes more headaches and other health problems, the 1% reduction in absolute risk might not be worth it.

17.3 MISLEADING STATISTICAL DIAGRAMS

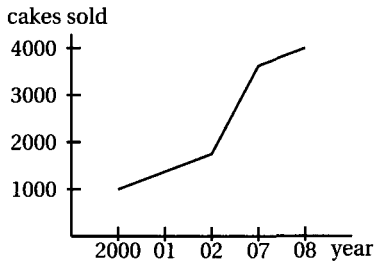
Diagrams can often make it easier to understand and summarize statistical data. Trends and patterns can become more prominent. But the suggestive power of diagrams can also be abused when data are presented in a misleading way. Here are some common tricks that we should be aware of.

First, when a chart has horizontal and vertical axes, check the origin of the axes carefully to see whether they start from zero. Take these two diagrams below:

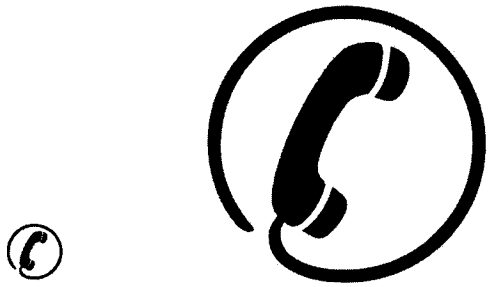


The two diagrams present the same data regarding the profit earned by a certain company from 2006 to 2009, the only difference being that the vertical axis of the diagram on the left does not return to zero. A careless person taking a quick glance at this diagram might get the impression that profit has dramatically increased a few times over a few years, when in fact it has only increased slightly. Obviously, if a chart fails to label the axis, then it is even worse!

Apart from the origin of an axis, we should also check its scale. Consider this diagram showing the number of cakes sold by a shop from 2000 to 2008:



On the face of it, the picture seems to indicate that there was a sudden surge in cake sales. But this is actually an illusion because the horizontal time axis is not evenly scaled. The period 2002 to 2007 is compressed compared to the other periods, giving the erroneous impression that the rate of growth has abruptly increased when in fact the growth in sales might have been rather steady.



1980: 9,947 calls 2000: 50,105 calls

The diagram above shows that the number of emergency calls received by a hospital has increased about fivefold between 1980 and 2000. This is represented pictorially by the fact that the diagram on the right is five times taller than the left one. But the problem is that subjectively, our perception of the relative difference depends on the *area* instead of just the height. Since the diagram on the right is also five times wider, its area is actually $5 \times 5 = 25$ times larger than the diagram on the left. The result is that looking at such the diagram, the readers have the impression that the increase is a lot more than just five times.

17.4 PROBABILITY

It is no exaggeration to say that probability is the very guide to life. Life is full of uncertainty, but we have to plan ahead based on assumptions about what is likely or unlikely to happen. In all kinds of professions, assessments of probability and risks are of critical importance—forecasting sales, calculating insurance needs and premiums, determining safety standards in engineering, and so on.

In this section, we are not going to discuss the mathematics of probability. If you are interested, there are many textbooks and websites you can consult (including the companion website). Instead we shall focus on some of the main reasoning mistakes about probability.

17.4.1 Gambler's fallacy

The **gambler's fallacy** is the mistaken belief that the probability of an event might increase or decrease depending on the pattern of its recent occurrences, even though these events are independent of each other. The name comes from the

fact that lots of people make this mistake when they gamble. For example, the probability of a fair coin landing on heads is ½. But suppose you toss the coin four times and it landed on heads each time. Someone who thinks it is more likely to be tails next time so that things will "balance out" is committing the gambler's fallacy. This is because the probability of a fair coin landing heads is just the same as the probability of landing tails, whatever the past results might have been. Similarly, it is also a fallacy to think that a series of four tails is more likely to be followed by yet another tail because the tail side is "hot."

A good real-life example of the gambler's fallacy might be when people choose numbers for a lottery. Let's say the winning numbers of the last lottery are 2, 4, 18, 27, 29, 36. Most people would choose a *different* set of numbers when they play the lottery, thinking that their combination is more likely to win than the previous winning combination. But this is a fallacy, because if the lottery is a fair one, all combinations are equally likely, or better, equally unlikely!

A very dangerous manifestation of the gambler's fallacy is the **hot hand fallacy**. This happens when a gambler wins a few times in a row, and he thinks he is on a lucky streak. As a result, he thinks he is more likely to win than lose if he continues to gamble. But this is a fallacy because the probability of him winning the next round is independent of his past record. It is a dangerous fallacy because very often these gamblers start to feel they are invincible and so they increase their wager and end up losing all their money.

17.4.2 Regression fallacy

Regression fallacy is a mistake of causal reasoning due to the failure to consider how things fluctuate randomly, typically around some average condition. Intense pain, exceptional sports performance, and high stock prices are likely to be followed by more subdued conditions eventually due to natural fluctuation. Failure to recognize this fact can lead to wrong conclusions about causation.

For example, someone might suffer from back pain now and then but nothing seems to solve the problem completely. During a period of very intense pain, the patient decided to try alternative therapy like putting a magnetic patch on his back. He felt less pain afterward and concluded that the patch worked. But this could just be the result of regression. If he sought treatment when the pain was very intense, it is quite possible that the pain has already reached its peak and would lessen in any case as part of the natural cycle. Inferring that the patch was effective ignored a relevant alternative explanation.

Similarly, sometimes we are lucky in the sense that things go very well, and other times we are unlucky and everything seems to go wrong. This is just an inevitable fact of life. But if we read too much into it, we might think we need to do something to improve our luck, and look for solutions where none is needed, such as using crystals to boost our karma. Of course, it is important to reflect on ourselves when things are not working well since it could be due to personal failings such as not working hard enough. What is needed is a careful and objective evaluation of the situation.

17.4.3 Amazing coincidences

Here is a story about an amazing coincidence (Michell and Rickard, 1977):

> In 1975, a man was riding a moped in Bermuda and was killed by a taxi. A year later his brother was riding the same moped and died in the same way. In fact he was hit by the same taxi driver, and carrying the same passenger!

There are many stories about similar coincidences.[1] Some are quite creepy and makes you wonder whether there might be any hidden meaning to them. This is a normal reaction since human beings naturally seek patterns and explanations. But we should not ignore the fact that improbable things do happen simply as a matter of probability. Otherwise we might end up accepting rather implausible theories. Here are some examples:

- It is claimed that some photos of the explosion of the World Trade Center Towers during the terrorist attack on September 11, 2001 seem to show the face of the devil in the smoke. But given the amount of video footage and photos that were taken, it is not surprising that some parts of the smoke might be seen to resemble something else.
- The *Bible Code* is the idea that the Bible includes hidden messages about important world events and predictions about the future. To decode the messages, arrange the letters of the Hebrew Bible text in an array leaving out spaces and punctuation marks. Then start from a location in the text, and selects every nth letter from that location either forward or backward. You might then be able to find references to famous Jewish people, former U.S. President Bill Clinton, Hitler, and so on. However, the problem is that given a huge number of letters, it is not surprising that some random combination of these letters can produce meaningful words or even sentences. People have shown that the same can be done with Tolstoy's *War and Peace* and the novel *Moby Dick*.

A useful reminder relevant to this topic is **Littlewood's law**, named after J. E. Littlewood (1885–1977), a Cambridge mathematician. According to this so-called law, miracles happen quite frequently, around once a month. Littlewood's argument starts with the definition of a miracle as an exceptional event with an extremely low probability of one in a million. But suppose a person is awake for eight hours a day, seven days a week, and experiencing about one event per second (watching a particular scene on TV or hearing a sound). Such a person will experience about one million events in 35 days, and so we expect this person to encounter a miracle about once a month! Of course, you might protest that a miracle must be some kind of *meaningful* event, or perhaps an event with an even lower probability. But whatever the details might be, Littlewood's point is that

[1] Search for "amazing coincidences" on the web.

seemingly miraculous events are bound to happen given lots of random events. This is a fact about statistics, even if it might be difficult (or disappointing) to believe otherwise.

EXERCISES

17.1 Discuss and evaluate these claims and arguments related to statistics:

a) The average man has about 3 sexual partners. The *Playboy* magazine interviewed 217 of its male reader and their average number of sexual partners is 2.9.

b) It is bad reasoning for a cook to check the quality of a big pot of soup by tasting just a spoonful because the sample size is too small.

c) Statistics indicate that if people like you take up smoking, they will increase their chance of getting lung cancer by 100%. Since you do smoke, you have a 100% chance of getting lung cancer.

d) Married Korean men like to spend their holidays with their families. In a survey carried out last Sunday outside the Toys R Us store at the Nuzzon mall in Seoul, 76% of married men surveyed said that they prefer to spend their holidays with family members.

e) I have counted about 34 students skipping Professor Awful's class, but only 6 for Professor Funny. So it is probably true that Professor Funny's class is more interesting.

f) According to a study presented by KO Management research at the World Economic Forum, 72% of respondents who rate their organization highly for actively promoting health and well-being also rate it highly for encouraging creativity and innovation. As we can see, if companies want to become more creative and innovative, they need to promote employee health and well-being.

g) The store advertisement says that the average price of their video games is $9. I have exactly $10 with me, so the majority of the games should be within my budget.

h) A new drug for preventing heart attacks offers a 20% improvement compared with the standard one! It is twice as expensive, but it is worth it.

17.2 Are the sentences in each pair equivalent to each other?

a) 68% teenagers voted. 32% teenagers did not vote.

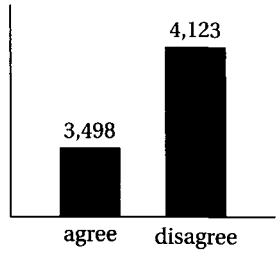
b) 30% strongly approve. 70% strongly disapprove.

c) Unemployment is up 6%. Unemployment is at 6%.

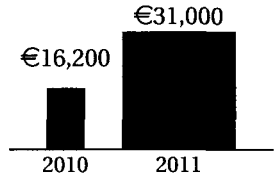
d) GDP growth is declining. GDP growth is weak.

17.3 Consider the following diagrams and see if they are misleading in any way.

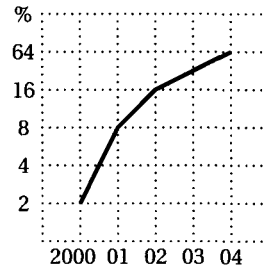
a) This chart shows the number of people surveyed who agree or disagree with building a new tunnel:



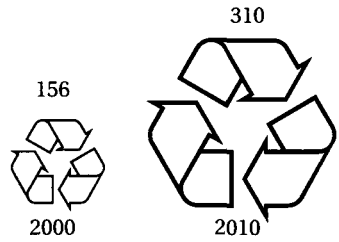
b) This chart shows a company's profits in 2010 and 2011.



c) Failure rate in a class from 2000 to 2004.

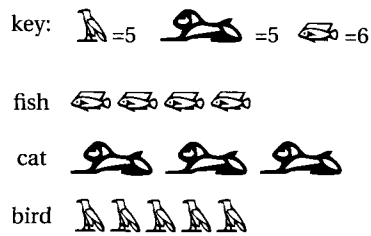


d) A chart showing the number of households in a village participating in a recycling scheme in 2000 and 2010.

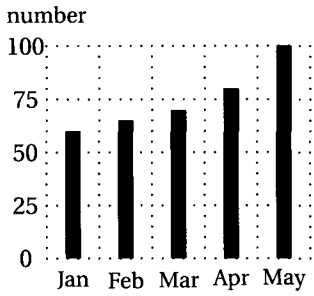


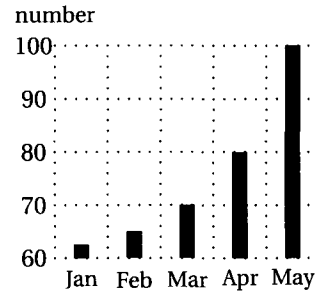
e) Average length of fish caught in a river.

f) Number of pets kept by students in a school.



17.4 Coco has been working for five months at a car showroom and her boss has just asked her to report on the number of cars she has sold. Which of the following two charts should she use? Why?





17.5 Evaluate these arguments about probability:

a) It is a completely random matter whether the bus passes by the building at noon. But it did pass by the building at noon five times in a row the past five days. *So it is less likely to pass by the building at noon again today.*

b) The bus passes by the building every 90 minutes. I have been standing here by the building for at least 10 minutes but I have not seen the bus yet. So the longer I stay, the more likely it is that the bus will show up within the next minute.

17.6 Consider this information: Linda is 31 years old, single, outspoken, and very bright. She majored in philosophy. As a student, she was deeply concerned with issues of discrimination and social justice and also participated in antinuclear demonstrations. Rank the three situations below by their probability starting with what you think is the most likely one.

1. Linda is a banker.
2. Linda is a bank teller.
3. Linda is a bank teller and is active in the feminist movement.

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CHAPTER 18

THINKING ABOUT VALUES

Ludwig Wittgenstein is one of 20th century's most influential philosophers. In a letter to a student, he wrote,

> What is the use of studying philosophy if all it does for you is to enable you to talk with some plausibility about some abstruse questions in logic, etc., and if it does not improve your thinking about the important questions of everyday life?" (Malcolm, 2001, p.35)

What Wittgenstein said about philosophy applies equally to critical thinking. It would be sad indeed if studying critical thinking helps us solve logic puzzles, but it does not improve our everyday thinking.

Many of the important questions about everyday life are about values. Values are standards or ideals with which we evaluate behavior, people, or situations. We admire certain people because their lives exemplify the values we approve of, such as kindness or perseverance. But values also affect our choices. Some people treasure freedom, so much so that they are willing to die defending it. But others might prefer stability and harmony. The values we adopt are influenced by our personality, experience and culture. But because we often feel strongly about our own values, value differences can unfortunately lead to hatred and violence.

It is therefore important to be able to think about values in a clear and cool-headed way. It would be very disappointing if critical thinking cannot help us in this task. So this chapter is an application of critical thinking to some of these issues about values. The aim is to introduce some principles and concepts that I hope are useful for thinking about values and morality. It is up to you to decide for yourself exactly which set of values to adopt.

18.1 DIFFERENT TYPES OF VALUES

We might classify values into three types: personal, aesthetic, and moral. Aesthetic values concern the evaluation of art and literature, and standards for beauty. We will not be saying much about them in this book. Personal values are values accepted by individuals that affect how they evaluate things and make decisions about their lives. In many cases the choice and ranking of personal values is up to the individual in question. Some people value independence over relationships, whereas others are just the opposite and they prefer spending more time with friends and family even if that means more compromises and less privacy. Most of us would agree this is a matter of individual choice and lifestyle. However, here are some points to bear in mind:

- Knowing someone's most basic personal values is crucial for understanding that person. The same goes for understanding ourselves. People who regard pleasure as their most important value will behave very differently from others who treasure relationships, achievements, or social recognition.
- Knowledge and experience help us make a more informed choice about values and lifestyle. We can think more imaginatively and realistically about the possibilities available to us. We might even become happier and more flexible if we know there are other ways to live a happy and meaningful life.
- Consistency is important for personal values. Conflicts among values create confusion in decision making. Adopting values incompatible with your character might result in unhappiness, such as chasing fame and fortune because you were told to do so, when in fact you do not find them fulfilling. (Of course this does not mean we should never change our character.)

There is also the issue of whether your personal values are consistent with moral values. Moral values correspond to objective standards in ethics that are supposed to be universal and apply to everyone. They govern how we should interact with each other, and they determine when something is morally right or wrong. For instance, when we affirm the right to free speech, or that slavery is wrong, we are presupposing the importance of freedom as a moral value. Such moral values impose constraints on our personal values. The origin, nature, and objectivity of moral values is of course a hotly debated issue. But what seems clear is that some system of shared values is unavoidable if human beings are to cooperate and live peacefully with each other.

18.2 MORAL VALUES AND NORMATIVITY

Morality is **normative**. Normative claims are about what *should or should not* happen, or what is *good or bad*. The fact that something *is* the case does not imply that it *ought to be* the case. It is a fact that many children are dying of starvation, but it is not something that ought to happen. Similarly, many things that ought to happen actually don't. Government officials should avoid corruption, but sadly that is not always the case. These examples illustrate an important distinction between moral vs. factual statement. The former is about what the world should or should not be like, what ought or ought not to happen. The latter is about what the world is actually like. Logically, they seem to be independent of each other.

This has two consequences in regard to moral reasoning. First, whether something is factually true is logically independent of its moral status. Suppose someone claims that eating babies will make your skin more beautiful. You might think the idea is disgusting, but this does not mean the claim is false. Maybe baby meat contains special chemicals that rejuvenate skin cells. Whether this is factually true is independent of the question of whether we should try it out. Similarly, it has been suggested that decriminalizing drugs will result in fewer crimes. This is a factual claim about the causal consequences of a certain legal policy. Whether this is true or false is independent of the question of whether decriminalization is morally justified or not.

The second observation to bear in mind about the moral vs. factual distinction is that we should be careful of arguments that use purely descriptive assumptions to derive a normative conclusion. Here are some examples:

- There is nothing wrong being selfish because everybody is selfish.
- Woman should stay at home and look after children because this has always been part of the social tradition.
- Eating meat is fine because we are more intelligent than other animals.
- Governments should not provide social welfare because survival of the fittest is just part of nature.

In all these cases, a moral conclusion is derived from a purely factual claim. But factual claims by themselves have no normative implications. The four arguments above all require additional **value assumptions** in conjunction with the empirical facts to derive the normative consequences:

- If everyone is doing it, then what they are doing cannot be wrong.
- All social traditions ought to be preserved.
- If X is more intelligent than Y, then it is fine for X to eat Y.
- Whatever that happens to animals in nature should also happen to humans in society.

Once these assumptions are pointed out we can see if they are acceptable. For example, should all social traditions be preserved in a modern society where equality is important? Should geniuses be allowed to eat idiots? It is a mistake to try to derive normative conclusions solely on the basis of descriptive claims. This mistake is known as **the naturalistic fallacy**. This is not to say that empirical facts are irrelevant to morality. It is a fact that alcohol impairs driving, and this is one reason why it is wrong to drive after heavy drinking.[1] So getting the facts right *is* important for moral reasoning, but we should also be alert to the additional value assumptions needed to derive the normative conclusions.

18.3 MORALITY AND GOD

Many people think morality is possible only if God exists. According to this line of thought, God is the basis of morality. Without God, there is no difference between right and wrong. "If God does not exist, everything is permitted."[2]

But what does it mean to say that God is the basis of morality? One explanation is that morality is determined by God's wishes and commands. Murder and adultery are wrong because God says we should not kill or commit adultery. Love, on the other hand, is good because God tells us to love each other. But there is a big problem with this **divine command theory of morality**, a problem first noted by Socrates. The problem is that it makes morality quite arbitrary. What if God says that murder and adultery are good? According to the divine command theory, in that case we ought to commit murder and adultery. But surely morality is not so arbitrary. Someone might reply that God would not command us to do these things because he knows that they are wrong. But this implies that God is no longer the basis of morality, since it is not completely up to God what he commands us to do.

This is not an argument against the existence of God. Nor is it an argument against the idea that God created the universe and all human beings. It is rather an argument against the view that morality is determined solely by God's commands. More generally, the argument tells us that authority cannot be the basis of morality. Even if there are people or higher beings who display profound power and virtues, ultimately we should use our own critical thinking and judgment to decide whether we should follow their teachings or not.

18.4 MORAL RELATIVISM

Moral relativism is a popular view about the nature of morality. It says that moral judgments about right and wrong are never objectively true or false. Instead, actions are right or wrong relative to particular societies, persons, traditions or

[1] But there is also the assumption that actions are wrong if they are likely to harm innocent people.
[2] This quote is often attributed to Dostoevsky, but he never said this and neither does it appear in his novels.

perspectives. For example, some people think abortion is wrong, whereas others think it is fine. Who is correct? Moral relativism says there is no objectively correct answer. Abortion is acceptable relative to some perspectives and wrong relative to others. There is no ultimate or universal perspective from which to decide whether abortion is really right or wrong. Here are some arguments people use to support moral relativism:

- Moral relativism reflects toleration and open-mindedness. Since there is no single true morality, we should tolerate and respect other people's moral opinions even if they are very different from ours.
- Moral relativism is confirmed by the fact that there is a wide diversity of moral beliefs across culture and time.
- When people disagree about objective facts we can use scientific experiments and observations to resolve the disagreement. But there is no scientific method for dealing with moral disagreement, and this must be because morality is relative and not objective.

Many people find these arguments attractive, but they are actually controversial and problematic. To begin with, it is a big mistake to think that moral relativism supports toleration and respect. If moral relativism were really true, whether we should respect other people would also be a relative matter. Relative to some perspectives, maybe we should despise or even kill people who disagree with us. If it is objectively true that we should respect other moral perspectives, this would be an objective moral truth, in which case moral relativism is wrong!

Some moral relativists might say they are only affirming toleration and respect from their own perspective. But the problem is that from other perspectives, intolerance might be desirable or even mandatory, and relativism does not provide a way to engage the other party in a rational discussion. For example, someone might think abortion is wrong relative to his moral theory, and that all violent means are justified to prevent women from having abortions, including the killing of doctors and nurses who participate in the operation. For a moral relativist, such a position is just as valid as thinking that abortion should be protected, and so no reason can be given to stop any such violent campaign against abortion. It is therefore a big mistake to think that moral relativism supports any kind of liberal moral outlook. This does not show that moral relativism is wrong. But it implies that under relativism, any nonliberal or absurd position is just as valid as any other.

As for diversity in moral opinion, it is true that people in the past have held very different views from ours today. Furthermore, in today's pluralistic societies, people often disagree vehemently about morality. But note that first of all, people often take themselves to be disagreeing about what the *truth* is about moral matters. If morality is just a matter of opinion, there is no need for strong disagreement. More important, the existence of widespread disagreement does not entail the lack of objectivity. People in the past disagreed about whether the Earth

is flat or spherical. Even if they could not resolve their disagreement, it does not mean the shape of the Earth is a matter of opinion. Obviously, there is a whole lot more to be said about objectivity and relativism in morality. We have touched only on some of the relevant issues. Please refer to the companion website if you want to read more about this topic.

18.5 MORAL ABSOLUTISM, RELATIVISM, AND CONTEXTUALISM

But one issue worth discussing further is that moral relativism should not be confused with **moral contextualism**, the claim that what is right or wrong depends on the particular situation in question. For example, a contextualist might refuse to judge whether abortion is right or wrong because she thinks abortion is acceptable in some situations (such as pregnancy due to rape) but not acceptable in other situations (as in pregnancy based on free choice). But this position is not relativism, for it is supposed to be an objective fact that abortion is permissible in cases of rape. A moral relativist will however insist that it is still a relative matter whether abortion is permissible for rape victims.

Contextualism urges us to be cautious in regard to moral claims. Is lying wrong? That depends on the situation. Lying to small children is often of little consequence. Is killing wrong? Not when this is the only way to defend yourself. In thinking about morality, we should take into account special situations. But being cautious does not amount to moral relativism.

Moral absolutism with respect to a particular action is incompatible with both moral contextualism and moral relativism concerning the same action. Moral absolutism about an action X is the view that X is right (or wrong) regardless of the situation and the potential consequences.

For example, the famous German philosopher Immanuel Kant (1724–1804) was a moral absolutist in regard to telling the truth. He said that lying is always wrong, regardless of consequences. In the essay "On a Supposed Right to Lie from Altruistic Motives," Kant said we should not lie, even if there is a murderer at the door asking whether the innocent victim he wants to kill is in the house. The moral absolutist might perhaps say we should also call the police or to warn the victim, but the bottom line is that we should never lie.

Understandably, many people find Kant's position bizarre, and there are probably very few people who think lying is always wrong. But moral absolutism in regard to other actions are not uncommon. Consider also the 1987 United Nations Convention against Torture and Other Cruel, Inhuman or Degrading Treatment or Punishment. The second paragraph of Article 2 says,

> No exceptional circumstances whatsoever, whether a state of war or a threat of war, internal political instability or any other public emergency, may be invoked as a justification of torture.

A moral absolutist against torture will agree with this rule. It says explicitly that torture should never be allowed. Even if a terrorist has planted a bomb that

is about to kill many innocent people, we should not torture the terrorist to find out where the bomb is. In light of the rise in terrorism, many people are likely to disagree with this intuition. But one justification for the absolute prohibition against torture is that allowing exceptions would lead to abuse. In any case, other examples of moral absolutism are not hard to find. Many people think that incest is always wrong, even if the parties involved genuinely love each other and they are never going to have children. Similarly, many people are moral absolutists in regard to abortion, rape, homosexuality, or sex with animals. It is not the purpose of this book to discuss whether these absolutist positions can be justified or not. But you should realize that you do not have to be a moral relativist to reject moral absolutism. Furthermore, you can consistently be an absolutist in regard to one action but not another—for example, rape is never acceptable, and abortion is sometimes acceptable and sometimes not. Admittedly, this makes things rather complicated—it is consistent to think that some things in morality are relative, some other things are absolute, and the rest depends on context. But this is fine. We should avoid the temptation to think that moral reasoning is easy.

18.6 THINGS TO AVOID IN MORAL DISCUSSION

Moral disagreement is widespread and often difficult to resolve. It is crucial that we can debate with other people calmly and rationally to achieve progress and understanding. Here are some unhelpful moves to avoid:

- **Avoid verbal abuse and name calling**. See how debates on Internet forums quickly escalate into flame wars. Think of constructive ways to get people see things differently.
- **Do not be dogmatic**. Find reasons to support your viewpoint. Avoid arguments based on religion because other people might not share your belief. Appeal to common ground to resolve differences. Think of solutions that people will regard as fair.
- **Do not confuse differences in taste with moral disagreement.** Actions that are morally wrong can be disgusting, but not all disgusting acts are wrong. Sometimes we find things disgusting only because of differences in taste or culture. Some people like urinating on other people as part of the sex act. This might seem disgusting, but it does not mean it is morally wrong. When we judge something to be wrong, it should be based on a legitimate reason and not simply due to a difference in taste.
- **Avoid factual errors**. Moral arguments often appeal to empirical facts, even if facts are not logically sufficient to establish a moral principle. An important part of moral thinking is to make sure that we get our facts right. First of all, what is the evidence? Second, what if those facts are wrong? How will this affect my moral judgment? For example, many people argue against homosexual couples adopting or having children, claiming that the children

will be confused and will suffer from psychological problems. If this is factually correct, it might be an argument against gay adoption. But it turns out that this popular assumption is mistaken. Children raised by gay couples seem just as happy and well adjusted compared to those who grow up in heterosexual families.[3]

- **Avoid slippery-slope arguments.** Some people like to argue that if something is allowed (or prohibited), it would open a floodgate and more extreme things will also have to be allowed (or prohibited), which are not acceptable. Thus people argue that if homosexual marriage is allowed, then we should also let people marry their pets or their own children. Or sometimes people criticize laws that require drivers and passengers to wear seat belts. They say it leads to a nanny state where the government would start requiring people to do all sorts of things, like eating healthy food, exercising, and brushing their teeth. These **slippery-slope arguments** would be convincing only if it were indeed true that one thing inevitably leads to another, but that is often not the case. We might have to draw an arbitrary line at some point, but it does not mean that no line can be drawn.
- **Avoid double standards.** It is easier to find fault with other people than to recognize our own mistakes. We often impose high moral standards on others but not on ourselves. Research suggests that power and authority can make people more hypocritical. Avoiding a double standard is important for maintaining objectivity and healthy relationships. Many religious traditions and ethical theories include some version of the Golden Rule—do to others what you would like to be done to you. Following this rule too strictly can of course be problematic. I might want to eat durian every day, but imposing the same treatment on others might amount to torture! But the general idea behind the principle is that morality involves reciprocity, fairness and consideration of other people's perspectives.

18.7 FOUR TYPES OF MORAL ARGUMENTS

Thinking about morality is hard and disagreement is common. So it is important to give reasons for our moral beliefs. Even when disagreements cannot be resolved, we can at least understand each other better. In the following sections, we look at four main types of arguments that can be used to justify a moral belief.

18.7.1 Arguments based on moral principle

A **moral principle** is a general rule about some aspects of morality, such as when it is morally right (or wrong) to do something—for example, killing innocent people

[3]A recent study (Gartrell and Bos, 2010) even suggests that teenagers of lesbian parents in the United States have fewer behavioral problems!

is wrong. An argument based on moral principle typically has two premises—one about the features of a certain action, and another a moral principle about the moral status of those features:

> *X* has features *A*, *B*, *C*.
> It is wrong to do something that has features *A*, *B*, *C*.
> ---
> *X* is wrong.

Here is an example:

> Cheating in exams is unfair and dishonest.
> It is wrong to do something that is unfair and dishonest.
> ---
> It is wrong to cheat in exams.

The second premise in the argument is a moral principle that offers a deeper reason for the conclusion. When we use moral principles to justify our opinions, it forces us to reflect about our moral beliefs and helps us discover inconsistencies. However, our beliefs often depend on the complicated details of particular situations. This makes it very hard to formulate moral principles that capture our moral beliefs accurately.

One famous moral principle is the **harm principle**, which is about the scope of freedom. It says that people should be free to do whatever they want unless they harm other people.[4] So if you drink too much and end up with a headache and feeling sick that is your own business and nobody has the right to stop you. But you should not be allowed to drink and drive because you are likely to cause accidents and harm innocent people, and this violates the harm principle. Or we might appeal to the harm principle to limit free speech as in prohibiting false advertising since it might harm consumers. But note that harm is different from annoyance. Physical injury, pain, and psychological damage are instances of harm, but merely being annoyed by someone's dirty fingernails is not.

How do we determine whether a moral principle is acceptable or not? First of all, we can try to defend a principle by showing that it comes from even more basic principles that we accept. For example, we might argue that the harm principle should be accepted because freedom is an extremely important value, and people should have as much freedom as possible. The harm principle maximizes our freedom as long as we do not infringe on other people's freedom.

There is also an indirect way to defend a moral principle, which is to show that it is consistent with our other moral opinions. In the argument about cheating, we invoked the principle that unfair and dishonest actions are wrong. We might say it is plausible because the same applies to stealing. It is also wrong, unfair and dishonest.

[4]The principle was formulated by the philosopher John Stuart Mill, the same one who proposed the methods of causal reasoning we discussed earlier.

Similarly, we can criticize a moral principle either by showing that it is incompatible with more basic principles or show that it is inconsistent with widely shared moral opinions. Take the harm principle again. It might be pointed out that we do stop people from harming themselves. Think about seat belt laws and stopping people from committing suicide. So perhaps the harm principle needs to be refined further.

18.7.2 Arguments based on moral arithmetic

Many moral arguments conclude that something should be done because on balance, there are more reasons supporting it than against it. For example, you might decide to lie to your friend that you have to work on Saturday and cannot meet her. On one hand, it is not nice to be dishonest to your friend. On the other hand, it is a harmless lie. More important, maybe you have to accompany another friend to the hospital, and you have promised to keep it confidential.

Of course, the balance of reasons is often difficult to determine precisely. What is important in these calculations is to explicitly list the reasons on opposite sides. Are they really legitimate and relevant? What are the harms and benefits? Are some reasons more important than others? How do the alternatives relate to your values and moral principles?

One important and common type of moral arithmetic is **consequentialist reasoning**. This is a matter of deciding what is right to do based purely upon the projected consequences and in particular picking the choice that maximizes the net balance of good consequences over bad consequences.[5] Take water chlorination as an example. Adding chlorine to the water supply will introduce carcinogens and increase the number of people getting cancer. But a lot more people will die or suffer from waterborne diseases if we do not add chlorine. On balance then, water chlorination is the right choice.

18.7.3 Arguments based on rights

Rights are central to the legal system and our modern understanding of morality. Some rights are basic and common to all human beings. The UN declaration of human rights says that "everyone has the right to life, liberty and security of person." Rights are entitlements to do certain things or entitlements against other people that they do certain things. For example, property right over your bicycle means you can use it any way you want, and that other people cannot use it or take it away from you without your permission.

Rights serve to protect our interests, and they are often seen as "utility trumps." The idea is that if I have the right to do something, then I should be allowed to do it even if not doing it will bring more social benefits. If I own a Picasso painting

[5]Many arguments based on *public policy* are of the same kind. These arguments typically conclude that certain options should be pursued because all things considered, they are likely to bring about the best consequences for the society as a whole.

and hence have property right over it, I am entitled to display it in my own home rather than a museum, even though fewer people will enjoy it. Rights, of course, are crucial for the protection of minority interests.

However, most rights have restrictions and are not **absolute**. You can use your bike anyway you want, but it does not give you the right to run it into other people or park it outside the fire station. We all have the right to free speech, but it does not mean we can talk loudly in the cinema. Also, having the right to X does not immediately entail that the government or other people should provide you with X. You have the right to travel outside the country, but the taxpayers do not have the duty to buy you an air ticket.

Some people seem to think morality is exhausted by rights. "I am a good person because I have never violated other people's rights." But many philosophers argue that morality goes beyond just the protection of rights. We should not violate other people's rights, but morality also recognizes that there are things we ought to do even if we are not morally required to do them. Virtuous actions belong to this category.

Talking about virtues might seem old-fashioned, but many virtues are morally valuable character traits that many of us recognize and admire, such as courage, integrity, honesty, fairness, and generosity. We are not required to be nice or helpful, and failure to do so need not violate anybody's rights. If an old lady is carrying a heavy bag, it might be argued that I have no duty to help her. Even if I refuse to help, I have not violated her rights. But if nobody is around to help out, it would reflect very badly on my character if I don't.

18.7.4 Arguments from analogy

Many moral arguments are based on analogy, where we compare two similar situations and argue that our moral judgment about the first situation should apply equally to the second. For example, many people argue that illegal download of songs and videos is similar to stealing, and so equally wrong. Or consider the analogy that being a prostitute is like being a dancer or a yoga teacher, using one's body to make other people happy and getting paid in return. Since there is nothing wrong being a dancer or a yoga teacher, being a prostitute is also acceptable.

One way to criticize an analogical argument is to show that the things being compared are not relevantly similar. So if you disagree with the conclusion that prostitution is fine, perhaps you can argue that prostitution reinforces the suppression of women and leads to exploitation and human trafficking. This is not true of dancing or yoga, so they are not really analogous.

EXERCISES

18.1 ☒ Consider the harm principle again. Can you think of cases in which we allow someone to harm other people? What about other examples of stopping people from harming themselves?

18.2 ☒ Our major decisions and habits are heavily influenced by our most basic personal values. See if you can identify your own. Are you motivated mainly by pleasure, purpose, or personal relationships? What about your closest friends? Think about the values that might have influenced your major decisions. You can discuss with them to see if you agree with the assessment.

18.3 Here is a difficult theoretical question. Consider the statement "He is good at solving mathematical problems." Is this a normative statement?

18.4 Discuss this argument:

> You believe that torture is never justified, and you think that abortion is always wrong. But you think that lying is sometimes right and sometimes wrong. So you are a moral absolutist and a moral contextualist at the same time. So you are logically inconsistent.

18.5 Consider the following dialogues. Try to formulate the more general moral principles that Jill might be appealing to, and think about possible exceptions to these principles:

a) JACK: I am not going to the party with you.
JILL: But you should because you promised!

b) JILL: I am going to play drums in my room.
JACK: You will annoy the neighbors.
JILL: But it is my own apartment!

c) JACK: Look, an umbrella! It's raining so let's take it.
JILL: But it is not yours and you haven't asked the owner!

18.6 For each set of statements below, see if they are logically equivalent:

a) You do not have a moral duty to save a drowning person.
You have a moral duty not to save a drowning person.

b) You do not have the right to enter the building.
It is not the case that you have the right to enter the building.

c) You must disclose any conflict of interest.
It is not the case that you must not disclose any conflict of interest.

18.7 Evaluate these arguments:

a) Killing children is murder.
But abortion is not the same as killing children.
So abortion is not murder.

b) We have the right to use foul language.
Therefore it is right for us to use foul language.
Since we ought to do what is right,
it follows that we ought to use foul language.

18.8 According to Shickle (2000), there are three situations in which we think it is acceptable to lie:

> if overwhelming harm can only be averted through deceit; complete triviality such that it is irrelevant whether the truth is told; a duty to protect the interests of others.

Can you think of cases to illustrate these situations, and can you think of a fourth situation in which it might be acceptable to lie?

18.9 David is a moral relativist, and he has this to say about bullfighting. Do you think his position is consistent? Why or why not?

> I think bullfighting is cruel and wrong. But what is wrong relative to my standard need not be wrong relative to other people's standards. There are plenty of people who enjoy bullfighting, and for me, what I think I should do is to respect their very different point of view. Bullfighting is not wrong relative to their perspective, and that's all I can say.

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CHAPTER 19

FALLACIES

The word *fallacy* is often used to describe a popular mistaken belief. "Fat is bad" might be said to be a fallacy, since many people do not know that some fats are good for health. However, such factual mistakes are not regarded as fallacies in critical thinking. In this book, a **fallacy** is a mistake that violates the principles of correct reasoning. Under this definition, a person can commit a fallacy without making any factual error. Suppose someone argues as follows:

Some cats have short tails.
Some cats have black hair.

Some cats have short tails *and* black hair.

This is not a good argument because the conclusion does not follow from the premises. It is quite possible that those cats with short tails are different from those with black hair. Of course, as a matter of fact, some cats have both short tails and black hair. So the premises and the conclusion are all true. But this is still a bad argument. Someone who accepts this argument would indeed be committing a fallacy, but it involves no mistake about empirical facts.

One further clarification: Many critical thinking textbooks define a fallacy as a bad or unreliable *argument.* But many commonly recognized fallacies do not take the form of an argument. For example, a contradictory claim is often regarded as fallacious, but a single claim is not an argument. Similarly, as we shall see, a question with an inappropriate assumption can also be a fallacy, but a question is not an argument. But both cases involve a mistake about the principles of correct reasoning. So our broader definition might be better.

19.1 CLASSIFYING FALLACIES

The classification of fallacies went back as far as Aristotle (384–322 B.C.E.) in Greece and Xúnzǐ (around 310–220 B.C.E.) in China. Fallacies can be classified in all sorts of ways and there is no single correct classification system. In this book we divide fallacies into four types:[1]

Type of fallacy	Nature
inconsistency	making an inconsistent or self-defeating claim
inappropriate assumption	assuming something without good reason; ignoring relevant alternatives
irrelevance	appealing to irrelevant information
insufficiency	evidence too weak to support conclusion

One advantage of this scheme is that it lays out in a simple and intuitive manner the main ways in which a fallacy comes about. This is practically useful because we can go through the list when we suspect a fallacy has been committed. Note that these four categories of fallacies are not meant to be exclusive. A really bad argument can commit more than one fallacy!

19.2 FALLACIES OF INCONSISTENCY

Fallacies of inconsistency are cases in which someone proposes or accepts a claim that is contradictory or self-defeating.

19.2.1 Contradiction

A contradiction entails both a statement and its negation. "It is raining and it is not raining" is a blatant contradiction, but the contradictions we encounter in real life are usually not as explicit. Consider this claim: We cannot know anything

[1]This classification scheme is borrowed from Dr. T. M. Lee, who taught philosophy at the Chinese University of Hong Kong.

because we realize from our experience that perception is unreliable. This is a contradiction because if we realize that perception is unreliable then there is at least one thing we do know!

As discussed earlier (see Section 7.1.1), sometimes contradictory claims can be understood charitably to mean something else. When we say someone is both right and wrong, this is fine if it means the person is right about one thing but wrong about another. What we really want to say is not logically inconsistent.

19.2.2 Self-refuting claims

A **self-refuting** statement is like a contradiction, but not quite. If someone says "I cannot speak any English," this is self-refuting because the speaker has just spoken an English sentence! But strictly speaking it is not contradictory because the sentence describes a logically possible situation—it is possible not to know any English. What is not possible is to *speak* that sentence truly. Or consider the remark "I do not want to comment on my despicable ex-boyfriend." This is again not a contradiction—it is logically possible that someone says nothing about a despicable ex-boyfriend. It is nonetheless self-refuting because to *say* that someone is despicable is in effect to pass a comment. A self-refuting claim is not contradictory, but the very act of making the claim makes it false.

It might not be hard to avoid explicit contradictions and self-refuting claims. But it is a lot more difficult to detect inconsistent beliefs, especially in our personal life. We might crave success and recognition, but are unwilling to work hard. Or perhaps we desire love and friendship, but we do not want to open up ourselves. Such unresolved inconsistencies can bring about a lot of pain and suffering.

19.3 FALLACIES OF INAPPROPRIATE ASSUMPTION

Fallacies of inappropriate assumption are fallacies for which an assumption has been made, but the assumption is not justified in the context in question.

19.3.1 Circular and question-begging arguments

In a **circular** argument, the conclusion also appears as a premise—for example, life sucks because it does. Sometimes the conclusion might not be exactly the same as the premise: We should study literature because literature is a worthwhile subject. But this is still circular because in effect the conclusion is equivalent to the premise—what is a worthwhile subject if not one that people should study? Circularity might also apply to a series of arguments rather than a single argument, as in the following example.

> God is perfect because this is what the Bible says.
> The Bible cannot be wrong because it is the word of a perfect God.

All circular arguments are question begging, but the reverse is not true. Consider this argument:

> Marriage is by definition between a man and a woman.
> Therefore, gay marriage is unacceptable.

This is strictly speaking not a circular argument because the conclusion is not equivalent to the premise (it rules out not just gay marriage but also marriage with children and pets for example). But the argument still begs the question against those who support gay marriage because these supporters surely would not agree to the proposed definition. The definition might be popular, but this is precisely what gay activists are challenging. For it is not clear why marriage cannot be understood more broadly as a pact of lifelong commitment between two adults supposedly deeply in love, without regard to gender identity. So this argument is problematic because it assumes something its opponent is likely to deny. To defend this argument, reasons should be given for the definition of marriage. Of course, it can be difficult to decide whether an argument begs the question because people might disagree about whether the assumptions are reasonable.

19.3.2 False dilemma

In **false dilemma**, a set of alternatives is assumed without good reason to be the only ones worth considering. For example, an argument might assume either P or Q is true, when in fact there are other realistic possibilities. Two examples:

- Is human nature good or evil? Before jumping to a conclusion, note that the question assumes (a) there is such a thing as human nature, and (b) it is either good or evil. Are they really justified? Maybe there is no fixed nature and it all depends on the environment. Or perhaps some people have a good nature and others an evil one. And can human nature be morally neutral? These are all alternatives we should explore.
- The famous historian and Christian apologist C. S. Lewis argued that since Jesus claimed to be God, either Jesus was telling the truth, he was mad or an evil liar. But Jesus said intelligent things and taught about love and kindness, so he cannot be mad or evil. So Jesus must be God. To evaluate this argument, consider whether there are other alternatives. First, the argument assumes Jesus was a real historic figure and not a myth. Is this correct? Even if he did exist, is the Bible's account of his life accurate? Also, should we agree that Jesus was either God, mad, or evil? Is it possible he was not mad but sincerely mistaken?

19.3.3 Loaded questions

Fallacies of inappropriate assumption also include **loaded questions**. "Did you wash your hands after killing the victim?" presupposes that you did kill the victim.

If you answer either yes or no, you confess that you are a killer. But if it has not been proven that you have killed anyone, it would be wrong to force you to give either an affirmative or a negative answer. A loaded question combines more than one question that should be broken up: Did you kill the victim? If so, did you wash your hands afterward?

19.4 FALLACIES OF IRRELEVANCE

In **fallacies of irrelevance**, irrelevant information is used in reasoning or a discussion. Personal attack (ad hominem arguments) is one example, in which a claim is criticized not by evaluating the claim itself but by attacking the background or the character of the person who made the claim:

> BUSINESSMAN: The government should lower profit tax.
> COMMENTATOR: No way. You say that because you are a greedy capitalist.

It might be true that the businessman is greedy, but the personal attack is irrelevant to the issue of whether the tax should be lowered. A rational discussion about the correctness of the businessman's claim should focus on the real issues instead. Would the proposal cause more harm than good? Does the current tax rate hinder the economy, or is it already very low? This is not to say that motive and character are always irrelevant. It is legitimate to consider these factors if they bear on the reputation and reliability of the person.

There are many related fallacies by which something is argued to be true based on an inappropriate appeal to irrelevant sources. Here are some such arguments:

- It has been an established tradition in the Japanese town of Taiji to hunt and kill thousands of dolphins every year. It is therefore wrong for foreigners to criticize it. (appeal to tradition)
- Arthur Conan Doyle, who created Sherlock Holmes, probably had a drinking problem. His father was an alcoholic. (fallacy of origin, or equivalently, genetic fallacy)
- MIT Professor Negroponte said (in 2010) that physical books will be dead in five years. So that must be true. (appeal to authority)

It is not always a fallacy to appeal to tradition, origin, or authority. But we should do so only if we have good independent reasons for taking them into account. We should not follow traditions blindly. But if traditions promote harmony or other positive values, we might have a reason to preserve and respect them. Appealing to origin can also be legitimate—a fish from a heavily polluted lake is likely to be polluted as well, but only because we know nasty chemicals can transfer from the water to the fish. Likewise, we should not trust an expert just because he or she is famous, as there are other factors to consider as well (recall Section 13.2).

19.4.1 Irrelevant responses and diversions

Suppose a teenager was caught climbing into a lion's cage at the zoo, and he explained that nothing happened to him last time he did it. This is an irrelevant excuse because he was unharmed only because he was lucky, and it does not distract from the fact that what he did was dangerous and unauthorized.

Irrelevant responses can be amusing, but they often distract from the main issue. In a press conference, a reporter might question the legitimacy of a police raid. In response, the spokesperson simply reads out a set of rules about when a raid is legally authorized. This is irrelevant because the question is not about what the legal procedures are but whether they have been duly followed. Irrelevant responses are used to deflect criticisms or as a delaying tactic.

A lot of marketing and advertising is premised on our susceptibility to the fallacy of irrelevance. Product names are carefully chosen for their positive connotations. We have shampoos called Rejoice and condom names such as Featherlite and Paradise. Celebrities are given lots of money to endorse products or be photographed with them. When we go shopping, we are more likely to buy something if the price tag includes a much higher price that has been crossed out. But more generally, filtering out irrelevant considerations make a big difference to our happiness. Sometimes we care too much about what other people think of us and how well-off we are compared with others. Too much attention to these issues can take us away from the people and goals we really care about.

19.5 FALLACIES OF INSUFFICIENCY

Fallacies of insufficiency apply to arguments, for which the premises are too weak to support the conclusion, even if they are relevant. There are lots of fallacies in this category. Here are some of the more common ones:

- **Hasty generalization** (or overgeneralization): This is the mistake of thinking that a few limited cases we have observed are representative of the whole situation. Suppose someone argues that it is useless to go to university because successful entrepreneurs such as Bill Gates (Microsoft), Steve Jobs (Apple), and Zuckerberg (Facebook) all dropped out of university. This is too hasty because not everyone end up as entrepreneurs, and there are many entrepreneurs other than these three famous ones.

- **Ignoring alternatives**: This overlaps with the fallacy of false dilemma, already discussed. A lot of reasoning in science and everyday life is a matter of inferring a conclusion based on limited evidence. Think of cases in which we try to establish the cause of an illness by observing the symptoms. Many different hypotheses might be compatible with the evidence, some more plausible than others. Our conclusion will be too weak if we fail to consider all relevant alternatives before selecting the one we think is most probable.

- **Invalidity due to wrong argument pattern**: Sometimes people think the conclusion of their argument must be true given their premises but the argument is in fact not valid. This might be due to a misunderstanding about the patterns of arguments that guarantee validity.
- **Weak analogy**: Analogical reasoning is common and very useful, but we need to make sure that the things being compared are relevantly similar. (See Chapter 21 for further discussion.)

19.6 A LIST OF FALLACIES

There are lots of different fallacies that we have not discussed. Here is a list of some common ones for your reference:[2]

- **Affirming the consequent**: Deducing P from the premises "if P then Q" and "Q"—for example, If he is sleeping, then he is at home. He is at home. So he is sleeping.
- **Appeal to ignorance (ad ignorantiam)**: The fallacy of deciding that a theory has to be true because there is no evidence proving that it is not. An example would be deciding that ghosts exist because nobody has managed to prove that they don't. Many people offer a similar argument for the existence of space aliens. But the problem is that lack of refutation is just that—we lack *conclusive* evidence that the theory is false. But this does not make the theory true or probable. It is consistent with there being lots of evidence that the theory is more likely to be false.
- **Appeal to pity (ad misericordiam)**: Invoking pity in an argument even when it is not relevant to the conclusion. For example, I may argue that my quarrel with my uncle was not a factor in causing his heart attack, because it would make me feel really bad it it were so. But my feelings on the matter are obviously irrelevant to the true cause of my uncle's heart attack. This is not to rule out that pity may be relevant in other situations, such as deciding whether to punish a child.
- **Appeal to popularity (ad populum)**: Claiming that a theory or belief is plausible because it is accepted by a lot of people. An example would be if someone in the Middle Ages were to claim that the sun must go around the Earth because that was the most popular theory of the time. Obviously, whole populations of people can be mistaken about the truth of a matter.
- **Begging the question (petito principii)**: Begging the question is the fallacy committed when someone assumes the truth of the conclusion in the premises that are meant to prove the conclusion. For example, if I argue that abortion is wrong because abortion is murder, I am actually begging

[2]Some of these entries were written by Kelly Inglis. I am grateful for her assistance.

the question. Murder, after all, is a wrongful killing, hence stating that abortion is murder already assumes that abortion is wrong.

- **Biased sample**: Using a biased sample is fallacious because the results of a biased sample cannot be reliably generalized to a larger population. A biased sample is a sample that has been selected in a way that makes it unrepresentative of the group it is meant to reflect. For example, a survey might be held in which people near a church on Sunday are asked if they believe in God. If this survey is then reported to represent the general population, the results will be deceptive, because the people near a church on Sunday are more likely to believe in God than are the general population. Perhaps 80% of people near a church on a Sunday believe in God, but only 50% of the entire population believe in God.

- **Complex question**: Also known as a **loaded question**. This is a question that inappropriately presupposes certain facts in a certain context, in such a way that a simple yes or no answer cannot suffice to deny the presupposed facts. For example, the question "Do you still cheat on tests?" presupposes that the person being asked used to cheat on tests. If he says no, he implicitly confirms that he used to cheat on tests, and if he says yes, he confirms that he used to cheat on tests and further states that he is still cheating on tests. The question is entirely proper if being asked in a conversational context where it is known that the person being asked has cheated before. But in a context where this has not been accepted, the question is fallacious. To avoid the fallacy, one can break the original question into two parts: "Have you cheated on tests in the past? If so, do you still cheat?"

- **Composition**: Assuming that the whole contains the same properties as each of its parts individually contain. For example, you may think that chocolate tastes good, cheese tastes good, and beer tastes good, but it doesn't follow that if you make a dessert consisting of chocolate, cheese, and beer, that it will taste good to you. The whole may have a radically different character than the constituent parts considered separately.

- **Denying the antecedent**: The fallacy of deducing "not-Q" from the premises "if P then Q" and "not-P". Example: If there is God, then there is a hell. There is no God. So hell does not exist.

- **Division**: The fallacy of assuming that each part of a whole contains the same properties as the whole itself. For example, it would be a mistake to assume that all the components of a fast car are themselves fast or that all the brushstrokes of a beautiful painting are themselves beautiful. The whole is more than (or less than, or otherwise different from) the sum of its parts.

- **Equivocation**: Equivocation consists of changing the meaning of a word in the course of an argument, without acknowledging the change in meaning. For example, someone might argue that there is no need for legislation ensuring the equal treatment of citizens, because people are naturally differ-

ent from one another and will just as naturally be treated differently by others. However, this is equivocation on the word *equal*. Legislation to ensure the equal treatment of others refers to all people, regardless of differences of race, sex, or religion, receiving equal rights under the law. It does not mean people should treat each other the same way in all situations.

- **Etymological fallacy**: Believing that the original meaning of a word or the original word from which a contemporary term derives represents the real meaning of a word. For example, it is incorrect to argue that the true meaning of *malaria* is "bad air" (with the further implication that bad air is the cause of malaria), simply because the roots of the word literally mean "bad air" in Greek. It would likewise be a mistake to believe that Hong Kong must have a clean and sweet-smelling harbor because the name *Hong Kong* literally means "fragrant harbor." Meanings of words change over time, and the contemporary meanings of words cannot be restricted to their original meanings when they were first coined.
- **False dilemma**: The fallacy of seeing only two alternatives (or a restricted number of alternatives) and representing these two alternatives (or restricted number of alternatives) as exhaustive, when, in fact, other alternatives are possible. For example, if someone tells you that if you don't love China then you hate China, they are presenting you with a false dilemma. It is also possible to be neutral toward China or to like it in some respects and dislike it in other respects.
- **Gambler's fallacy**: The fallacy of believing that two or more events that do not influence each other are in fact related, such that, for example, a string of unlikely coincidences influences the likelihood of further similar coincidences occurring. For example, a gambler might believe that the fact that red has come up on the roulette wheel 14 times makes it more likely for black to come up next. Really, however, the turn of the roulette wheel is completely random, and the roulette wheel has no memory of how many times a certain color or number has recently appeared (assuming, of course, that the casino is honest and the roulette wheel is not rigged.) (See Section 17.4.1 for further discussion.)
- **Genetic fallacy**: The fallacy of supposing that if X originally comes from Y, X must have the same properties as Y. An example would be assuming that carrot juice must be crunchy because it derives from carrots, which are crunchy. In arguments, the genetic fallacy often takes the form of rejecting an idea because the source of the idea is objectionable, such as arguing that eugenics is wrong because the Nazis promoted eugenics, and the Nazis were bad.
- **Hasty generalization**: A hasty generalization is the error of forming a general rule on the basis of too small a sample. An example would be if Sarah decided that all men were pigs based on her experience with two piggish men.

- **Non sequitur**: *Non sequitur* in Latin means "it does not follow." A non sequitur is any argument for which the conclusion does not follow from the premises. Of course, this applies to lots of arguments, including many of the fallacies on this list, and the reasons the conclusions do not follow might be very different in each case. Non sequitur is more often used by a speaker to point to an an obviously bad argument—for example, "Britney is a great singer because I love her."

- **Personal attack (ad hominem)**: The fallacious mode of attacking an argument by attacking the character of the person supporting the argument. An example would be to say that Newton's laws of physics should not be accepted because Newton was a nasty person.

- **Post hoc, ergo propter hoc**: The fallacy of assuming that because X followed Y, Y caused X. For example, the fact that after John kissed a frog, his wart disappeared does not prove that kissing the frog cured John's wart. It could just be an accident. Even cases in which X reliably follows Y, however, do not show that Y causes X. (See Section 15.1.)

- **Red herring**: An issue that is brought up in an argument but that is actually irrelevant to the main issue under discussion and that serves to distract attention from the main issue. A red herring often seems to provide some additional force for the argument in a misleading way. If, for example, in the course of an argument about the unhealthiness of eating meat, a supporter was to say that eating animals is cruel, this would be a red herring, as the ethical issue of eating meat has no bearing on the health implications of eating meat.

- **Slippery-slope**: A slippery-slope argument is an argument to the effect that if one accepted a claim C_1, then one should also accept a related claim C_2, and accepting C_2 would commit one to claim C_3, and so on, until one ends up committed to a claim Z that is obviously unacceptable.

  An example of a slippery-slope argument is the argument that one should not take aspirin to relieve a headache, because taking a drug to relieve a unpleasant feeling necessarily leads to taking sleeping pills for sleeplessness, and then Valium for anxiety, followed by Prozac for depression, cocaine for sluggishness, ecstasy for boredom, and so on, until all of one's life is reduced to a drug-induced haze, buffered from unpleasant experiences.

  In itself, a slippery-slope argument need not be objectionable. It becomes a fallacious argument when the connections between the intermediate claims are dubious or when there are so many steps between C_1 and Z such that it is not plausible that C_1 is likely to lead to Z.

- **Strawman**: Attributing to an opponent an exaggerated and indefensible claim that seriously misrepresents the opponent's position for the purpose of defeating her. An example would be for an opponent of euthanasia to argue that it is just wrong to kill the old and the sick to get rid of them. But

this misrepresents euthanasia which affirms mercy killing only for humanitarian reasons in a very limited range of cases under tight scrutiny.

- **Two wrongs make a right**: This is the argument that two wrong things cancel each other out, or that one wrong action justifies another wrong action. An example would be to argue that it is okay to pollute the environment because other people do it too, or that, since Russia once invaded Afghanistan, the United States was also justified in invading Afghanistan at another time.

- **Wishful thinking**: Believing something because you want it to be true. For example, many people believe in the existence of heaven or an afterlife because they think life would be meaningless if we disappear forever when we die, and this short and fleeting life is the only one we have. But even if we agree that it would be good for heaven to exist, this is not a reason for thinking that it actually does.

- **Weak analogy**: An argument that rests on a comparison between two things that are similar only in a few inessential aspects but that also have important dissimilarities. For example, one might say that eating refined sugar is like eating poison. Although the two are similar in that they are both bad for your health, the analogy is weak because it ignores the tremendous difference in scale between the harmful effects of the two types of substances.

EXERCISES

19.1 These definitions are taken from some textbooks on critical thinking. Compare them with the definition in this book and see if you agree with them.

a) A fallacy is "a bad argument of one of the types that have been agreed to be so bad as to be unrepairable."

b) A fallacy is "an unreliable inference. ... because fallacies are inferences, they tend to *appear* as reasonable."

c) "A fallacy is a defect in an argument that consists in something other than merely false premises."

19.2 See if these passages contain any fallacies? If so explain the mistake.

a) I could not find my cup after Brat left the room. He must have stolen it.

b) There are only two types of people in the world. Either they are your friends or they are your enemies.

c) The Loch Ness monster obviously exists. Scientists have not been able to show that it does not exist.

d) This soup has to be tasty because all its ingredients are tasty.

e) Statistics show that more car accidents happen during the day than at night. So it is safer to drive at night.

f) All penguins speak French. All turtles are penguins. So all turtles speak French.

g) All my Facebook friends are also your Facebook friends. Many of your Facebook friends are idiots. Therefore, many of my Facebook friends are idiots.

h) People who think that men and women are equally intelligent should remember that most scientists are men.

i) People think that the *Mona Lisa* is beautiful but they do not know why. The answer is that every part of her face is beautiful, especially her smile.

j) Hawking is a scientist and an atheist. So it is not the case that no scientist is an atheist.

k) I believe we are on an irreversible trend toward more freedom and democracy — but that could change.

l) You should vote for me. I believe our children are the future so I am going to make sure there will be more schools and more teachers. Other candidates might say the same thing, but they have no fiscal responsibility, and they are going to end up with runaway budget deficits. I, on the other hand, promise you that no services will be cut, and since our educational system is already most efficient, there will not be extra spending on education.

m) Either little Josep or Cinta ate the gelato. But little Josep was asleep the whole afternoon. So it must have been Cinta.

19.3 Some authors classify fallacies into formal and informal ones. Do some research and see if you can explain the distinction.

19.4 ☒ If you have time, write down any fallacy that you come across in your daily life. Do this for a while and see if you become better at detecting fallacies.

CHAPTER 20

COGNITIVE BIASES

Before we begin our discussion, here are a few warmup exercises. We shall refer to these questions later on. Write down your answers, and perhaps get your friends to answer them as well:

1. Which is more likely in your country: death from lung cancer or traffic accident?

2. Are there more words in English that begin with the letter *k* than words with *k* as the third letter?

3. Eritrea is an African country. Do you think its population is above or below 50 million? Estimate its current population. Just guess how many people there might be, even if you do not know the country well.

4. Do you drive? If so, how would you rate your driving skill? Above average or below average? Which percentile?

5. How would you rate your critical thinking skills? Which percentile would you put yourself?

These questions all relate to **cognitive biases**, which are widespread and persistent psychological tendencies detrimental to objectivity and critical thinking. In recent years, scientists and economists have discovered a long list of cognitive biases, many of which are surprising and difficult to avoid.

20.1 MEMORY BIASES

Information that is more vivid, recent, and easier to recall can bias our reasoning. Take the first warmup question. Many people think they are more likely to die from traffic accident than from lung cancer, but this is not true in most developed countries. It is easy to get it wrong because traffic accidents are more vivid and are mentioned more often in news. Similarly, many people mistakenly believe that there are more English words that begin with k than words having k as the third letter, probably because it is easier to think of words that begin with k. These are cases of the **availability bias**, by which people estimate frequency and probability based on how easy it is to recall an example. Vivid and recent events are easier to recall, but the problem is that they might not be the most frequent or representative ones. Here are some related cases:

- **People think emotional or dramatic events are more likely.** Most people overestimate the chance of being attacked by sharks while swimming, or they believe (mistakenly) that ground transport is safer than flying.
- **People give more weight to firsthand experience than statistics.** Knowing a few healthy people who do not exercise might lead us to think that exercises are not useful, even if the statistics say otherwise. Similarly, anecdotes and hearsay from friends can affect us more than research findings.
- **Imagining an outcome makes us think it is more likely to happen.** In one famous study, people were more likely to think a candidate would win an election when they had been asked to imagine that candidate winning. The converse of this finding is that many people refuse to believe things they find painful or unpleasant to imagine. This is a form of denial—for example, some parents refuse to accept that their children abuse drugs even when there is plenty of evidence.
- **People respond more positively to familiar things.** The **exposure effect** is that we often prefer faces, sounds and words we have encountered more frequently. One study shows that people exposed to banner ads on a web page developed more positive feelings toward the advertised product. The effect is present even though the subjects did not pay much attention to the ads and did not click on them (Fang et al., 2007). There are of course limits to the exposure effect. You can be sick and tired of a song you have heard a thousand times, and you probably do not want to see your boss all day. It has been suggested that the exposure effect is stronger when unfamiliar items are presented briefly, reaching a maximum effect after a while.

- **Recent experiences have a greater impact than earlier ones.** This is known as the **recency effect**. This is perhaps one reason why many lawyers present their most important witnesses near the end of the trial.

20.2 CONTEXT BIAS

A **context bias** is a bias in our judgment triggered by irrelevant features of the situation in which the judgment in made. These features might have to do with the way a problem is presented, or are features of the environment that have very little to do with the problem we are trying to solve.

20.2.1 Presentation effects

What is interesting about the third warmup question is that the 50 million figure in the question has a big influence on the answers that people come up with. Typical guesses might be between 30 and 100 million. Now ask your friends the same question, but replace the 50 million with the more accurate estimate of 5 million. The average answer is likely to be much smaller. However, surely the question does not imply in any way that the number mentioned is close to the correct answer. This is an illustration of **anchoring**, where we arrive at our judgments by making minor adjustments to some arbitrary reference point given to us (the anchor). We can therefore manipulate judgments by changing the reference point.

In a vivid demonstration of the anchoring effect, MIT professor Dan Ariely asked his students to write down the last two digits of their Social Security number (a form of identity in the United States). The students then bid on items such as wine and chocolates in an auction. It turns out that those who wrote down a higher number are more willing to offer a higher bid, sometimes by almost 100 percent. Clearly their perception of what counts as a fair price had been unconsciously biased by some completely irrelevant information.

In sales and marketing, the anchoring effect can be used to influence consumers. Some researchers asked real estate agents to inspect a house and estimate its value. Earlier, some agents were given a higher list price, some a lower one. The list price is the anchor that affected the agents' estimates, even though the agents were supposed to be experts. On average, those who saw the higher list price gave a higher estimate. When asked, they also denied having taken the list price into account. Instead, they would cite features of the property to justify their estimates (Northcraft and Neale, 1987).

The anchoring effect also offers lessons for business negotiations. The traditional wisdom is that you wait for the other party to make a move first, because the offer tells you what he or she might be thinking. But research suggests that a party making the first offer can sometimes gain an advantage by skewing the final outcome through anchoring (Galinsky, 2004).

Here are more examples of how context affects our decisions without our conscious awareness:

- Subjects who are told that a wine is expensive are likely to find it more pleasant. They often like it better than an identical wine that is labeled as cheaper!
- The purported origin of a wine affects not just its perceived quality but also the perceived quality of the food served with the wine. In one study, two groups of restaurant customers were given the same free wine. One group was told that the wine was from South Dakota. The other group was told that it was from California, which is more famous for wine. As expected, the California group rated the wine higher. But these customers also liked the food better, ate 11% more food, and were more likely to come back again.
- People judge instructions to be easier to follow when they are printed using a font easier on the eyes. In one study, subjects estimated it would take 8 minutes to complete a set of exercise instructions printed using an easy-to-read Arial font. But those in another group who read the same instructions in a difficult-to-read font thought it would take a full 15 minutes (Song and Schwarz, 2008).
- Many studies link the pronunciation of names to risk assessment. When subjects were given completely fictitious names of food additives, those that were easier to pronounce (magnalroxate) were regarded as less harmful than ones which are harder to pronounce (hnegripitrom). Meanwhile, amusement park rides with names that are difficult to pronounce (tsiischili) were considered to be more exciting and sickness inducing than rides with easy-to-pronounce names (chunta). These results are obviously relevant to marketing and advertising.
- The use of **agent metaphors** affect how people predict the stock market. If the stock market is described using words that apply to living things rather than inanimate objects, people expect the stock market to follow the trend suggested by those words. So if a stock is said to have "jumped," "fought its way upward," or "climbed up," people are more likely to think it will continue to move up. In contrast, merely saying that the stock has "increased" has no such effect (Morris et al., 2007). Researchers speculate that we interpret actions indicating future intentions and behavior. Whatever the underlying explanation might be, this clearly is a pitfall we should avoid in making financial decisions.

20.2.2 Framing

The **framing effect** is a well-established cognitive bias. It is about how the formulation of a problem (frame) can affect decision making.[1] In particular, people value avoiding losses over acquiring gains, so much so that we might feel differently about the same choice depending on whether it is described in terms of loss

[1]Sometimes the notion of a frame also includes the set of implicit assumptions people use in approaching the problem.

avoidance or gain. To simplify a bit, suppose a patient is deciding whether to undergo surgery to treat a serious illness. If she is told there is a 10% chance of dying from the operation, she is less likely to agree to surgery than when being told the operation has a 90% survival rate. But the two descriptions are of course equivalent, since dying means not surviving.

Such results are surely important for healthcare policies and investment decisions, but their relevance extends to management as well. One recent study suggests that the fear of loss is a more powerful motivator than the prospect of gain. Workers who are told they have already received a bonus will work harder to avoid the bonus being taken away, compared to others who are told they will receive a bonus later if they work hard (Hossain and List, 2009).

How smell affects the mind

It should come as no surprise that our senses affect our emotions and judgments, but recent research has discovered some rather surprising linkages. In regard to smell, clean smell seems to promote kindness and cooperation. In one experiment, subjects in a room sprayed with citrus-scented cleaning liquid were more likely to reciprocate trust and were more interested in volunteering for charity work. In other experiments, the smells of perfume and coffee made people more likely to help strangers. Some researchers have studied the effects of smell on shopping behavior. In one study, men and women stayed longer in a shop and spent more money when the shop was scented with a fragrance specific to their gender. So watch out when you go shopping!

20.3 EVIDENTIAL FAILURES

We now look at cognitive biases in which people fail to use information and evidence correctly. **Confirmation bias** is very persistent and well documented. It is the tendency to interpret the world to fit our existing beliefs, ignoring or neglecting counterevidence. Sometimes this can be somewhat deliberate. When we quarrel with our friends, we might recall their past mistakes vividly, but are reluctant to acknowledge our own. Confirmation bias can also operate unconsciously outside of emotionally charged situations. When people test their beliefs, they are usually more interested in looking for supporting evidence, and they do not spend enough time searching for opposing information and counterexamples (Hart et al., 2009). This is the **myside bias**.

For example, students who write essays defending a claim they already accept typically present only supporting reasons, paying little attention to potential objections. The myside bias is perhaps one reason why people retain superstitious beliefs. If a person believes that Friday the 13th is an unlucky day, that person is

more likely to notice accidents happening on that day. But he might pay less attention when that day passes by and nothing bad has happened. This selective attention to evidence makes it more difficult to give up unwarranted beliefs. We end up being more confident of our own beliefs than we should be.

The **belief perseverance effect** is the phenomenon that once we believe something, we often keep on believing it even when faced with contrary evidence. In one experiment, subjects were asked to read suicide notes to see which of them were real. Some of the subjects were told they were very good at detecting real suicide notes. Others were told they were not very accurate. They were then informed that they had been lied to and that the information about their accuracy was fake. The subjects were then asked to guess what their actual performance was. It turns out that those who were told they were highly accurate would still rate themselves higher than those who were told they were inaccurate.

In another famous study, two groups of college students were selected, one in favor of capital punishment and the other opposed to it. They then evaluated data describing two research studies (made up by the experimenters). The data contained two conflicting sets of results, one supporting the efficacy of capital punishment as a deterrent to crime, and another refuting its efficacy. Despite the fact that the two groups were looking at the same set of data, they found the data supporting their own position much more convincing that the disconfirming data. In other words, the two groups actually increased their confidence in their positions even though they looked at the same evidence!

There are also many other cognitive biases related especially to our understanding and interpretation of evidence about probability. We discussed some of them in Section 17.4.

20.4 EGO BIASES

Ego biases concern our self-perception and how we see others in relation to ourselves. They include attempts to distort reality to protect our ego or self-esteem. A familiar example is **rationalization**, using false excuses to justify our actions. When a speculator profits from a rising stock market he might attribute his success to his investment skills. But when he loses money he might blame it on bad luck or market manipulation. And when his short-term gamble does not pay off, he avoids blaming himself by saying that he invests for the long-term. Or consider **overconfidence**, which often leads to hasty decisions. Overconfidence also manifests itself in the **above-average effect**. In many domains, the majority of people think they are above average in that domain. But it is logically impossible that they are all correct! Some examples:

- More than 50% of drivers think they drive better and safer than average (Svenson, 1981).
- Business managers usually regard themselves as more capable than the typical manager (Larwood and Whittaker, 1977).

- Most students consider themselves to be more popular than average (Zuckerman and Jost, 2001).
- In a spelling test, subjects who think they are 100% certain of their answers are correct only 80% of the time (Adams and Adams, 1960).
- More than 50% of students taking a reasoning test think their results will be in the top half of the group. Furthermore, those who performed worst overestimated their results by the largest margin (Kruger and Dunning, 2002).
- People generally rate themselves as more objective than average, and as being less susceptible to biases than their peers (Pronin et al., 2002).

It has been suggested that this above-average effect is particularly prominent when we think a certain skill is easy for us. If you think something is difficult for you (juggling or computer programming), you might underestimate your ability instead. In general then, to get an accurate picture of our abilities, we should rely on objective measures rather than subjective perception.

The above-average effect is closely related to the **optimism bias**, a tendency for people to be overoptimistic about their plans. This includes students overestimating the number of job offers, or underestimating the likelihood of failing an exam. During economic crises, many financial analysts overestimate company profits and underestimate the duration of a recession. The optimism bias is often at work when in a large project, cost and completion time exceed original estimates. In a recent study, researchers find when people feel more powerful they underestimate by a larger margin the time it takes for them to complete a task! But the good news is that when people have to give two estimates—one in an ideal world and another for how they will actually perform, people are able to come up with more realistic predictions.

Power seems to affect our judgments as well. An intriguing recent experiment indicates that power induces moral hypocrisy in the form of double standards. When people have power and think they are entitled to it, they are harsher when it comes to judging other people's moral lapses, but they are more willing to let themselves off when they do the same thing (Lammers et al., 2010). One might wonder about the implications for politicians and managers.

20.5 COMBATING COGNITIVE BIASES

In this chapter we have looked at only a limited number of cognitive biases. It would of course be nice if we could minimize their effects on us. But since most of them affect our judgments without our conscious awareness, this is not easy to do. Here are some concrete ways to fight back.

- **Enhance your awareness**: Learn more about when cognitive biases happen and how to lessen their impact.
- **Think harder**: Think more carefully and systematically. For example:

  - Avoid framing biases by adopting different perspectives. Formulate a question or problem in different ways. Think about how other people would response.
  - Actively consider contrary evidence and unpopular alternatives. Think about both pros and cons. Talk to people who disagree with you.
  - Be systematic. Use reliable methods and data where possible, such as using information about statistics and probability or adopting a reliable framework for thinking about a problem.
  - Plan ahead and allow enough time to understand a problem. Avoid hasty decisions.

- **Use feedback and experience**: Record the reasons for your decisions so you can understand why you succeed or fail later on, and use the information to improve yourself. Learn from role models.
- **If you can't beat them, join them**: We can turn cognitive biases to our advantage by exploiting weaknesses in others. Many cognitive biases have obvious implications for marketing, management, social policy, and many other areas.[2]

Cognitive biases and gender discrimination

Although equality between men and women is now widely accepted, gender stereotypes and biases can still have a huge impact. The result is that especially for high-status jobs, women are less likely to be hired and have a lower salary, fewer promotions, and less authority. In academia, for example, more women get papers accepted by journals when the reviewers do not know the identity of the author. Similarly, whether a CV has a male or female name makes a big difference to the evaluation of the CV, even if everything else in the CV is identical. In fact, when people make hiring decisions, gender discrimination actually *increases* when they are asked whether they are making an objective hiring decision (Uhlmann and Cohen, 2007). This suggests that even when people honestly claim they support gender equality, their behavior and decisions can still be affected by powerful unconscious biases.

[2]See for example Thaler and Sunstein (2008). The book offers lots of suggestions about how cognitive biases can be a positive force.

EXERCISES

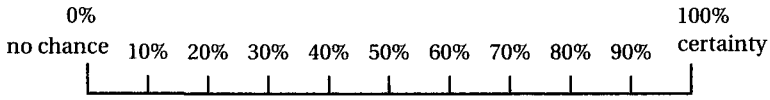
20.1 ☒ Ask your friends some of the warmup questions at the beginning of this chapter. See if you think they are affected by the cognitive biases discussed.

20.2 ☒ Related to the phenomenon of cognitive bias is the case of implicit or unconscious associations. For example, we might have certain preferences for skin color that we are not aware of, or we might unconsciously associate skin color with certain personality traits even if we do not conscious believe we do. The Harvard website http://implicit.harvard.edu has some interesting discussion and online demonstrations that you can try.

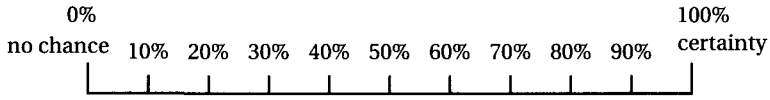
20.3 Many authors suggest that we should be humble about ourselves, in view of the many cognitive biases we might suffer from. But does it mean we should underestimate our own ability, which would be the opposite of overconfidence?

20.4 Come up with an estimate of probability for the following questions. Indicate the probability on the scale provided. Answer both questions before checking the answer section.

a) What is the probability that you will have an accident when you travel overseas in the coming year?



b) What is the probability that your overseas travels will be accident free in the coming year?



20.5 For this question, try to spend *no more* than five seconds to come up with a rough guess of the answer. Your task is to solve this problem:

$$8 \times 7 \times 6 \times 5 \times 4 \times 3 \times 2 \times 1 = ?$$

20.6 Suppose you ask people to judge how likely it is that they will be the victim of a violent crime. Do you think their answers might be affected by how often they watch violent TV shows?

20.7 Wishful thinking is a fallacy because merely thinking about something or believing it to be true is not sufficient to make it come true. However, there are actually some exceptions to this rule. Can you think of any?

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CHAPTER 21

ANALOGICAL REASONING

In an analogy, we compare one thing with another. We might describe a person as being like a fox, a prickly rose, a robot, a hurricane. Love is said to be a disease, a game, a drug, a heatwave, and "a smoke made with the fume of sighs" (Shakespeare's *Romeo and Juliet*). Less poetically, a physicist might compare an atom to the solar system—electrons revolve around a nucleus at the center like planets go around the sun.

In this chapter, we focus on the use of analogy in explanation and argument.[1] The first point to note is that words such as *similar* and *like* have incomplete meaning. Saying that two things are similar has a concrete meaning only with respect to some standard of comparison. Pick any two objects, and they are bound to be similar in some way. A washing machine is like a pigeon—they both occupy space, produce waste, and are noisy. An informative analogy should make it clear *how* two things are similar—that is, what their common properties are. Former U.S. President Ronald Reagan once said "Government is like a baby" which on its own is rather incomprehensible. But then he added, "an alimentary canal with

[1] LIterary theory distinguishes between metaphors, similes and allegories. They are all based on resemblances, and we treat them all as analogies here.

a big appetite at one end and no sense of responsibility at the other," which immediately made the remark a witty and memorable one about government overspending.

Identifying common properties is very important in analogical arguments, where we argue that because X is similar to Y, something that is true of X is also true of Y. Here are some examples of arguments by analogy:

- This new pair of shoes is like my old pair. My old shoes were very comfortable. So this new pair is probably comfortable as well.
- It is wrong to enter somebody's home uninvited. Hacking into their computers is similar. So unauthorized hacking is also wrong.
- You are just like my friend. He likes rock climbing. So I think you will too.

These arguments all have the same form:

X is similar to Y.
X has property P.

Y also has property P.

But as we said earlier, we should be explicit about how two things are actually similar. In an analogical argument, this means identifying the properties common to X and Y that explain why the conclusion is plausible. Let's try this with our three arguments:

- This new pair of shoes is like my old pair. They are made by the same company. My old shoes were very comfortable. So this new pair is probably comfortable as well.
- Hacking into a computer is similar to entering a home uninvited. In both cases we are trespassing into other people's property without permission. Since it is wrong to enter someone's home uninvited, it is also wrong to hack into other people's computers.
- You are just like my friend. You both enjoy outdoor physical activities. My friend likes rock climbing. So I think you will too.

The underlined sentences identify the common properties, and the reasoning becomes clearer. An explicit analogical argument therefore has this form:

X is similar to Y in that they have common properties $S_1, S_2 \ldots S_n$.
X has property P.

So Y also has property P.

Ideally, when you come across an analogical argument, you should see if it can be formulated in such a way. This format explicitly highlights the common prop-

erties that support the conclusion. This is perhaps the most important part of analogical reasoning because it helps us understand why an analogy is supposed to work. The argument must highlight important aspects of similarity, if the analogy plays any role at all in supporting the conclusion. Then you can start evaluating the argument, using the principles below.

21.1 EVALUATING ANALOGICAL ARGUMENTS

There is no mechanical method for evaluating analogical arguments, but here is a checklist of the main criteria:

- **Truth**: Are the two things really similar in the way described? Obviously, an argument is not acceptable if it has a false premise. In the third argument above, if it turns out that you do not like outdoor activities and much prefer sleeping in bed, then you are not like my friend and the argument should be rejected.
- **Relevance**: Are the shared properties relevant to the conclusion? Even when the source and target are similar, the properties they share must be relevant to the conclusion for the analogical argument to be acceptable. In other words, having the shared properties increases the probability of having the inferred property. To use a concrete example, suppose we change the third argument above slightly:

  > You are just like my friend since you both like to eat chocolates.
  > My friend likes rock climbing.
  > ---
  > You will also like rock climbing.

  This is clearly a lousy argument, even if the premises are true. A preference for chocolate does not make a person more likely to enjoy rock climbing. In other words, the common property is simply irrelevant to the inferred property. Notice that we need to use our commonsense and background knowledge to determine relevance. It is not enough to focus on the argument only. For example, if scientists discover that the majority of people who like chocolates actually enjoy rock climbing, then our background knowledge has changed, and this argument would become more convincing. This shows that analogical reasoning is typically a kind of inductive reasoning.
- **Number and diversity**: Are there many shared properties of different types? The strength of an analogical argument depends not just on the relevance of the shared property. The *number* of shared properties makes a difference also. If both you and my friend enjoy outdoor activities, and in addition you are both agile, with good physical strength and balance, then it is more likely that you will like rock climbing. In short, finding more relevant properties shared by the source and the target can strengthen an analogical argument.

Furthermore, the argument is more convincing if the relevant properties are of different kinds. For example, having strong arms is relevant to rock climbing, having strong legs also, and of course strong fingers as well. But these are all traits of the same kind. Analogical arguments are stronger when they are based on shared relevant properties of different kinds.

- **Disanalogy**: Are there significant differences between the things being compared? An analogical argument that seems strong can still be undermined if there are important dissimilarities between the source and the target. You might be agile and physically fit, and enjoy outdoor activities just like my friend, but if you are afraid of heights and my friend is not, this one critical difference makes it very unlikely that you will enjoy rock climbing. So be very careful when you evaluate an analogical argument. Even if it appears convincing and the items being compared share lots of relevant properties, it can still be refuted by a single disanalogy.

21.2 TREATING LIKE CASES ALIKE

Analogical arguments are prominent in legal and moral thinking. One reason is that we want to be consistent and fair. As Aristotle puts it, justice requires "treating like cases alike." If a man and a woman have similar abilities and performance but the man is given a higher salary, we are inclined to think that this is unjust. Similarly, if two people committed similar crimes and their situations are analogous, it would be unfair for one to receive a much heavier punishment.

Are there exceptions to the rule that we should treat like cases alike? Suppose I decide to donate money to help sick children instead of starving refugees. The two causes are similar in that they are both worthy of support, yet I am not wrong if I donate money to one but not the other. Or consider two students competing for just one scholarship. Both are brilliant and equally accomplished and deserving, and in the end the scholarship went to one of them chosen by a random lottery. Should the unsuccessful candidate complain of injustice? Surely not.

One thing we might say about these examples is that if we look deeper, the cases being compared are not really the same. In the first example, the difference is that I prefer helping children to refugees, and this is a morally relevant difference because I have the right to spend money as I wish. In the second example, the students are different because one of them won the lottery and the other did not. This is again a relevant difference because when resources are limited, it is legitimate to pick a recipient randomly if they are equally worthy. So the rule that we should treat like cases alike is safe after all.

A critical and conscientious thinker would use analogies to reflect on the reasons behind his moral opinions. For example, animals are helpless and not very clever, just like young children. So why eat animals but not children? What is the relevant difference between them? Or consider the case of abortion. If a woman has the right to remove a tooth, why can't she have an abortion to remove a fetus? Is it because a fetus has the potential to develop into a human being? But a

tooth contains nerve cells that perhaps can also develop into a person given the right kind of technology. Thinking about these similarities and differences helps us understand more deeply the basis of our moral judgments.

EXERCISES

21.1 ☒ For each pair below, think of ways in which they are alike and ways in which they are dissimilar.

a) life, a chess game

b) babies, old people

c) society, family

21.2 Which of these are analogical arguments?

a) A good man is hard to find. It is like trying to nail jelly to a tree.

b) Ice skating is like in-line roller skating. You are good at in-line skating and have good balance. So you should be good at ice skating too.

21.3 See if you can think of dissimilarities between the things being compared that might undermine these analogical arguments.

a) A fetus is just a lump of cells. Nobody complains if you wash your hands and lose a few cells from your body. So abortion is no big deal.

b) Taxation is wrong. It is just like robbery, seizing people's property against their will.

c) Many people criticize popular magazines for sensationalism and for emphasizing sex and gossip. But they are only responding to public demand. Blaming them is like blaming the weather report for bad weather.

21.4 ☒ Evaluate the following analogical arguments:

a) If you pump too much air into a ballon, the pressure will eventually make the ballon burst. So a person will just crack when there is too much pressure.

b) Soldiers are like the ants in a colony. They should just do whatever they are supposed to do without questioning, and be ready to sacrifice for the greater good.

c) If someone needs to share my kidney to survive, I have the right to refuse even if it means he will die. Similarly, a woman has the right to terminate her pregnancy, even if it means the death of the fetus.

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CHAPTER 22

MAKING RATIONAL DECISIONS

Good decisions are crucial to a successful and fulfilling life. It is true that many decisions can be made quickly without much thought. But if we are not careful, hasty decisions about career, relationship, or investment can ruin our life.

Many people make decisions based on gut feelings. "I knew I wanted to marry her the moment we met." The advantage of intuitive decisions is that they are quick, and we might feel more confident because the decision aligns with our feelings. But sometimes our feelings are mixed and inconsistent, and affected by biases and irrelevant factors. For important decisions, we need a better system. This is not to say we should ignore our emotions. It would be unwise (and sad) to marry someone without regard to feelings. But emotions and gut feelings should not be the *only* basis for making important decisions.

So what makes a good decision? Some people think a decision must have been well made if it has a good outcome. This is dangerous because a bad decision can have a happy ending by accident, but you cannot count on being lucky all the time. Instead, we should focus on the reliability of the **decision process** itself. This is the thinking process that produces the decision. A reliable thinking process does not guarantee that every decision will have a good outcome. What it does is to make good outcomes more likely, which means fewer costly mistakes.

22.1 A GOOD DECISION PROCESS

The basic outline of a good decision process is as follows:

1. Think generally about how the decision should be made.
2. Do some research.
3. Come up with a list of options.
4. Evaluate their pros and cons and pick the best option.
5. Prepare for contingencies.
6. Monitor progress and learn from the results.

It looks simple enough—list your options, evaluate them, and pick the best one. However, the simplicity is deceptive. Discipline and care are needed to make it truly effective. Let us look at these steps more closely one by one.

Step 1: Think generally about how the decision should be made

Modern life is fast paced and we are always under pressure to make quick decisions. But hasty decisions might mean spending more time and money to deal with the bad consequences later. So before making up your mind, think generally about your task. As the American philosopher and educator John Dewey once said, "A problem well stated is a problem half solved." Here are some relevant questions to ask:

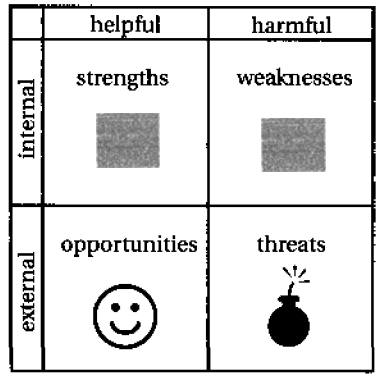
- **Can I delegate?** Why burden yourself if other people can make good decisions on your behalf? Of course, if you always defer to others, you will not learn to think independently on your own.
- **How much time should I spend thinking about this?** Life is too precious to be spent worrying about trivial things. Overthinking is as much a sin as not thinking enough!
- **What is the central issue? Which is the most important decision?** Some decisions depend on others, and the more basic decisions should come first. For example, before deciding how to invest your money, you should first decide how much to invest and how much risk you can take.
- **Is there anything that might have a negative effect on my decision?** Decisions can be biased. Think about whether there is anything in the current situation that might affect your objectivity. Making major decisions when you are being emotional is usually not a good idea. Postpone the decision if you can, or execute the decision later when you are calmer.

Step 2: Do some research

Information usually helps us make better decisions. Think of shopping in the age of the Internet. Before you buy an expensive item, it is a good idea to check online reviews and compare prices. You might find a better deal elsewhere, or come across something even better.

This is true of making decisions as well. You can start by doing some research: find out whether other people have been in a similar situation, and see what you can learn from them. If your decision involves a special area of knowledge, you can read more about it.

There are many types of decisions. Some are relatively circumscribed like deciding whether to buy a new TV. On the other hand, **strategic decisions** are more general and high-impact decisions about the future direction of a person or an organization. They might be about whether a company should invest in a new market, or in the case of an individual, whether to change career. In these situations, it is a good idea to do a **SWOT analysis** before making a major decision:



SWOT is an acronym for strengths, weaknesses, opportunities, and threats. These four factors are used to analyze an individual or organization. Strengths and weaknesses correspond to the good and bad aspects that are relatively internal to the entity in question. Opportunities and threats correspond to the positive features and potential problems in the external environment.

The SWOT framework offers a systematic approach for assessing an organization, especially when formulating future plans. When a company is deciding how to expand its business or face off competitors, it might start with a SWOT analysis. But the SWOT method is also useful for individuals. Many people live a busy life with little time for reflection. SWOT is a useful tool we can use now and then to step back and review where we are in life and where we want to go.

Step 3: Come up with a list of options

Having surveyed the current situation, the next step in the decision process is to list all available options—that is, all the realistic action plans that can be pursued.

So if you are trying to decide where to go for vacation, you should make a list of the activities and places you are interested in, such as, snorkeling in Malaysia, hiking in Nepal, or skiing in New Zealand. In making such a list, we should pay attention to the following points:

- **Feasibility and likelihood of success**: Are the action plans realistic? Do any of them violate any given constraints (too expensive, takes too long to implement, illegal, and so on)?
- **Adequate choices**: People are busy and many decisions have to be made quickly. On one hand we should think really hard so that there are genuine alternatives to choose from. On the other hand, having too many options to consider can be confusing, and it can become difficult to evaluate each option adequately.
- **Exclusive vs. complementary alternatives**: Some plans exclude others. If you have a limited budget, buying a car means you cannot renovate your apartment. But some plans complement each other. You can improve a product by better marketing, providing discounts, and improving quality, all at the same time. So always see if you can combine good options.

Step 4: Evaluate the options and pick the best one

When we have a set of options available to us, it is time to pick the best one. But what counts as "the best"? There is no single correct answer, because it depends in part on your values, priorities, and risk appetite. In academic decision theory, one fundamental decision rule is that of *maximizing expected utility*. This is the idea that when we make a decision and there are different choices, each choice has a set of possible outcomes with different probabilities. We can calculate mathematically the "expected utility" of a choice, which roughly measures the net gain (or value) we are expected to get from that choice. Then we are supposed to pick the choice that has the highest expected utility.

The problem with this procedure is that in real life the probabilities and utilities are often difficult to determine. Of course, if the outcomes are more-or-less certain, as in choosing what to eat in a restaurant, the decision is relatively easy since you just choose what you like most. There might be more than one item you like, and you might have a hard time picking just one, but picking any one of them will be a rational choice. More generally, what we should do when we make decisions is to list the pros and cons of each option available to us (the reasons supporting the option and the reasons against it). We then pick the option that on balance has the most reasons in its favor.

Call this the **Benjamin Franklin method**. Franklin (1706–1790) was one of the Founding Fathers of the United States, a famous politician, businessman, printer, scientist, and inventor. In his letter to the scientist Joseph Priestley, he suggested that many decisions are difficult because we do not have all the relevant information before us. One thing we can do is to write down the pros and cons of an

option in two columns. Opposing reasons of equal weight can be "canceled out." We can then determine whether on balance there are more reasons in support of the option, and act accordingly:

> [D]ivide half a Sheet of Paper by a Line into two Columns, writing over the one Pro, and over the other Con. Then during three or four Days Consideration I put down under the different Heads short Hints of the different Motives that at different Times occur to me for or against the Measure. When I have thus got them all together in one View, I endeavour to estimate their respective Weights; and where I find two, one on each side, that seem equal, I strike them both out: If I find a Reason pro equal to some two Reasons con, I strike out the three. If I judge some two Reasons con equal to some three Reasons pro, I strike out the five; and thus proceeding I find at length where the Ballance lies; and if after a Day or two of farther Consideration nothing new that is of Importance occurs on either side, I come to a Determination accordingly (Franklin, 2009).

Here is an example. Suppose you are looking for work and you have three options: join a large stable company or an exciting small internet startup. Or maybe borrow money and setup your own business. We can then write out the pros and cons of each option in a table:

Option	Pros	Cons
join big company	good pay stable job generous health benefits lots of holidays	less interesting work rigid company culture
join startup	exciting work big potential payoff valuable experience	long hours relocate to different city demanding boss uncertain prospects
start own business	be my own boss exciting valuable experience	must borrow money lack of experience untested business plan

Evaluating the options require some care. If you simply count the pros and cons, it might appear that option 1 is the best (4 pros minus 2 cons = 2 net pros), option 3 ranks second (3 pros and 3 cons), and option 2 is the worst. But as Benjamin Franklin pointed out in his letter, the pros and cons can have different **weights** in the sense that some considerations are more important than others. If you are young and have just finished university, you might give a higher priority to gaining new and exciting experience. Perhaps you would not mind working very hard and taking a risky career move, as long the potential return is high. So joining

the startup might be the best choice. But if you are 10 years from retirement and have a family to look after, it is understandable that you might want to be more conservative and prefer the first option instead. The "best" choice will depend on one's values and risk tolerance, and might be different for different people.

In some decisions, the criteria for the best choice can be specified by a list of criteria. In these situations, the Benjamin Franklin method can be applied more systematically using a score table. The idea is to evaluate each option according to the same set of criteria, assign a score, and then pick the option with the highest score. For example, choosing a car might depend on factors as safety, price, fuel economy, and design. For each car model you are considering, you can give it a score with respect to each of these factors (say from 1 to 5):

Model	Safety	Price	Fuel	Design	Sum total
Honda	2	5	4	1	12
Toyoto	4	4	5	3	16
Volkswagon	4	3	4	3	14
BMW	3	2	3	4	12

For each choice, we add up the individual scores to come up with a final score. This gives us a ranking of all the choices, and we then pick the one with the highest score. The advantage of this method is that it helps us evaluate a large amount of information in a systematic way. The score assignment is of course subjective and cannot be absolutely accurate. But the systematic procedure makes the decision process very clear, and minimizes inconsistency and arbitrary judgment. This decision method is suitable for situations that involve multiple criteria that are relatively clear, such as ranking candidates in an interview.

This method can be further modified in various ways. For example, the criteria can have different weights to reflect their relative importance. So if having a good design is more important than the other factors, we can multiply the design score by a certain factor (for example, 2) before adding to the grand total.

Step 5: Prepare for contingencies

The famous Murphy's law says: If something can go wrong, it will. Accidents happen despite our best planning. The projector might stop working during a presentation. Your printer can run out of ink just when you have to meet an urgent deadline. Good planning helps you anticipate problems and minimize their damage. Li Ka Shing is a successful Hong Kong businessman with a net worth of about US$21 billion. He was the 14th richest person in the world in 2010 according to *Forbes* magazine. He said risk management is a crucial part of his success, and that he spends 90% of his time thinking about the worst possible problems that might affect his business. How much time do *you* spend thinking about potential disruptions to your plans? Here is a list of things to consider in contingency planning:

- **Anticipate problems**: List 10 bad things that might happen and think about what to do in these cases. Think about the worst possible scenario.
- **Strengthen the weakest link**: The weakest link is the most vulnerable part of a project and can most easily undermine the success of the whole. Many projects also have at least one bottleneck somewhere, a place (or person!) that has the largest effect on slowing down the whole project. Monitor such places closely.
- **Include a safety margin**: Predictions about the future are notoriously inaccurate. Have a flexible plan that tolerates inaccuracies in your predictions and assumptions.
- **Prepare a backup plan**: In case the original one fails miserably.

Estimating task completion time

People are often too optimistic about the time it takes for them to complete a task. So much so, that Douglas Hofstadter, the famous author of *Gödel, Escher, Bach*, named a law after himself:

> Hofstadter's law: It always takes longer than you expect, even when you take into account Hofstadter's law.

One theory is that when people estimate the time it takes to complete a task, they make their prediction by imagining the different steps they have to take, but they fail to imagine the more pessimistic scenarios where things go wrong. However, it has been suggested that people are generally still too optimistic about completion time when they are explicitly asked to think about potential obstacles (Newby-Clark et al., 2000). Looks like a confirmation of Hofstadter's law!

Step 6: Monitor progress and learn from the results

A good decision process does not end with the moment the decision is made. First, we need to monitor how the decision is implemented to see if any followup is needed. You might have already decided where to go for vacation, but did your travel agent remember to book the tickets for you? Is there any news about your destination (for example, epidemics, earthquakes, strikes) that you should know about? Do you need to execute your backup plan instead?

More important, even when the whole project has been completed, we should review the process to see what we have done right or wrong, so that we can do better next time. For example, when we make investment decisions, we should keep records and write down the reasons for our decisions so we can review our

successes and failures. Human beings are prone to be overconfident and they often forget about their own mistakes. But as the philosopher George Santayana said, "Those who refuse to learn from history are condemned to repeat it."

22.2 EVALUATING DECISIONS: A SUMMARY

We have discussed the outline of a systematic decision process. This gives us a framework for evaluating decisions as well. Basically, here are the main elements in our decision process:

1. A definition of the decision that has to be made.
2. A list of the options available.
3. A list of the pros and cons of the options.
4. A set of criteria for the best option.
5. A conclusion identifying the best option according to the criteria.

A good decision process requires all five parts being implemented correctly. Use the following checklist to see if any mistakes have been made. Think of them as five different ways to criticize a decision:

1. **Is it clear what we have to decide? Which is the most important or urgent decision?** Meetings or discussions can go on forever without any decision being made. At some point we need to refocus on the main issue.
2. **Are all the options realistic? Are there other options we should consider?** Many people rely on what they are most familiar with. Or they stop looking for options when they think they have the right answer. Thinking creatively and expanding our options can often lead to better alternatives.
3. **Have we overlooked any good / bad consequences of an option?** Failure to identify the important consequences of an option can undermine the whole decision process. Solution: more thinking, more research, more discussion.
4. **Is there any special criteria for the decision we should be aware of?** This part of the decision is often implicit. But sometimes there are special criteria the best option has to satisfy—for example, it has to be one that the boss will approve, it has to fall within a given timeframe and budget, it should minimize risk. Any such criteria should be made explicit.
5. **Have the criteria been applied wrongly?** People can agree about the decision criteria and the options but still disagree about which is the best option. Maybe someone picked the wrong option because she was careless. Or maybe she misunderstood the nature of an option. But sometimes it is difficult to balance the pros and cons qualitatively. We cannot always resolve

such disagreements. The best way to proceed is to lay out the differences as clearly as possible.

22.3 TYPICAL PROBLEMS IN DECISION MAKING

Apart from the five issues discussed in the previous section, there are also psychological biases and problematic attitudes that affect the reliability of our decisions. Here are some of the more pervasive ones we should avoid:

- **Plunging in**: This is the problem of making decisions too quickly. To deal with this problem we can follow the decision process recommended in this chapter. Very often people make quick decisions because they trust their intuitions. But we have said that intuitions can be biased and inconsistent. Furthermore, if we are not conscious of the basis of the intuition, we cannot justify our decision to other people. This is not to say intuitions are worthless. They are essential to countless small decisions. Many experts also rely on intuitions, but they usually take years to cultivate and are restricted to areas that they know exceptionally well. In any case, we should objectively verify whether our intuitions are reliable.
- **No system**: We can make bad decisions even after a lot of thinking. This can happen when the thinking is messy. Sometimes people think about irrelevant or unimportant issues, or they are not able to organize information systematically, which makes it difficult to evaluate the options available. Again the solution is to follow the system here, and structure the whole decision process accordingly.
- **Decision paralysis and procrastination**: Decision paralysis is the inability to make up one's mind. Procrastination is needlessly putting off tasks that have to be done promptly. Their causes vary greatly—perfectionism, fear of failure and uncertainty, and so on—but the result is a lower productivity. It is important to understand their psychological sources and find realistic ways to cope with them.
- **Failure to execute**: Sometimes we have no trouble reasoning about our decisions but we fail to implement them. We might be lazy, forgetful, or our emotions get the better of us. Many addicted gamblers know they should avoid gambling, but when they are in a casino, they are overwhelmed by the thrill and their own compulsion.
- **Framing bias**: A frame is a set of perspectives and assumptions we use to look at a problem. They make a huge difference to how decisions are made. A wrong frame might mean ignoring good alternatives, or solving the wrong problem! Consider a company with a telephone hotline for customers to get help about its products. But the hotline is so busy that customers have to wait a long time to be served. A manager might frame the problem as one

about how many more hotline operators she should hire. But this way of framing the issue ignores other relevant ones. Are the customers calling because the products are of low quality? Are the products too difficult to use? Could a product website or better documentation remove the need to call the hotline? When we make a decision, we should approach the problem from different angles to understand it better.

- **Overconfidence**: Most people overestimate their ability (see Section 20.4). This is bad for decision making because it means people think less about the different aspects of the decision and how things can go wrong.

- **No learning**: Many people are poor decision makers because they fail to learn from past mistakes. Learning from experience is important, and this includes understanding our strengths and weaknesses. We have broken down the decision process into six steps. Think about how much time you spend on each step and whether you are particularly good or bad with any of these steps. Also, think of at least one good decision and one bad decision you have made and try to explain what you have done right or wrong. See whether these are recurrent themes in your decision making and take concrete steps to improve your decision making process.

- **Sour grapes mentality**: This is a matter of changing one's values and objectives solely to make oneself feel better about the outcome of a bad decision. Suppose you are trying to decide whether to buy mobile phone model A or model B. You did not do your research properly and bought model A on impulse and are now regretting it. So you try to convince yourself that you actually like A better than B. Of course, there is nothing wrong with changing your mind, or even changing your mind to make yourself feel better. What is wrong is to let rationalization becomes a habit, to the extent that we do not learn from our mistakes and fail to improve our thinking.

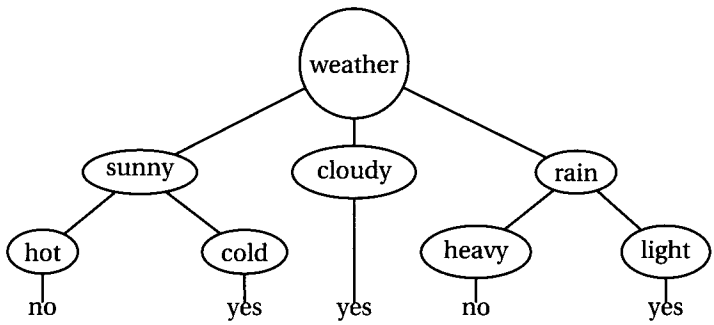
- **Obsession with sunk costs** — Sunk costs refer to time, money or other resources that have been spent on a project and that cannot be recovered regardless of one's decisions. Economics suggests that they should be ignored in future rational decisions. Yet people often think: "I cannot give up now because I have committed so much already". This is even when giving up is likely to bring more benefits. For example, a person might cling on to an unfulfilling relationship, although it would be better for him to put an end to it right away. Or someone might have put a lot of money into a failing investment, and continues to do so even when abandoning it would be more rational economically. There are many reasons why we overemphasize sunk costs—sentimentality, wishful thinking, fear of failure, and so on. But the problem is that we end up foregoing better opportunities.

Hard and soft decision making

In the chapter about cognitive biases, we discussed how smell affects the mind. There is also some interesting research about how tactile sensations affect decision making without our conscious awareness (Ackerman et al., 2010). In one experiment, subjects were asked to review the same CV from a job candidate. It was found that when the CV was held on a heavy rather than a light clipboard, the candidate was judged to be more qualified and had a more serious interest in the job. In a different mock haggling experiment, people's negotiation tactics were affected by the type of chair they sat on. Those who sat in soft, cushioned chairs were more flexible and more likely to raise their bids, whereas people who sat on hard chairs were more rigid about their offers. So if you want to negotiate a tough deal, sit on something hard!

22.4 VISUALIZING DECISIONS

It is often difficult to think through a complicated decision involving lots of choices and consequences that interact in all sorts of ways. As in the analysis of arguments, a diagram can be useful in giving a clearer picture of the problem. They are known as **decision trees** or **decision diagrams**. The following diagram tells us whether to go jogging depending on the weather:



These diagrams are more useful when dealing with complicated decisions. They can also be used to map out the reasons for and against the different options, and their various consequences. See our companion website for more details.

EXERCISES

22.1 There is a new flu epidemic that is spreading and people are worried. Scientists have developed a vaccine but it is not 100% effective. In addition there are reports that some people have developed allergic reactions as a result. You are deciding whether to be vaccinated. What information should you gather to help you make the decision?

22.2 Imagine a country preparing for the outbreak of an unusual Asian disease, which is expected to kill 600 people. Two alternative programs to combat the disease have been proposed. Assume that the facts given below are correct. If you have to choose either program A or B, which would it be?

- If program A is adopted, 200 people will be saved.
- If program B is adopted, there is a one-third probability that 600 people will be saved and a two-thirds probability that no people will be saved.

Have you made the choice? If so you may continue and consider programs C and D below. Again your task is to pick one out of the two. Which one would it be?

- If program C is adopted, 400 people will die.
- If program D is adopted, there is a one-third probability that nobody will die, and a two-thirds probability that 600 people will die.

22.3 Which of the following is more likely a reflection of sunk cost reasoning?

a) The tickets for this 3D movie were very expensive, and yet the movie is very bad. It would be much better to leave now and do something else, but since we have paid so much, it's a pity not to finish the movie so let's stay.

b) This sausage was so expensive and yet it is completely tasteless. I could finish eating it or throw it away. But that is not going to do me any good. So I could give it to the dog and perhaps it might enjoy it.

22.4 ☒ A few questions for reflection:

a) Carry out a SWOT analysis for yourself to review your current situation—for example, about your job or studies.

b) Think about some of your major decisions in your personal life or in your work, including both good and bad decisions. Are you able to identify what makes these decisions good or bad? What can you learn from these cases? Think about how the decisions were made and how the decision processes compare with the Benjamin Franklin method.

c) Repeat this exercise but now think about some major decisions that *other people* have made, especially if these are people you know and you know how those decisions were made.

d) To what extent do you follow the Benjamin Franklin method when you make decisions? Is there any particular step that is your weak point?

e) Make a point to apply the Benjamin Franklin method in some real-life decisions you have to make. Try this a few times and see if you find the method useful.

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CHAPTER 23

WHAT IS CREATIVITY?

When it comes to **creativity**, we often think about great scientific discoveries or famous works of art. But creativity is not just for artists and scientists. We need creativity to solve the countless problems we encounter in our workplace and in our daily life. Whether you are a student writing a term paper or a company CEO expanding your business, a creative mind brings better results. Psychologists also tell us that people are happier when they can exercise creativity in their work. The good news is that there are concrete steps you can take to make yourself more creative, and this is what this and the next chapter is all about.

Where do new ideas come from? The simple answer is that new ideas are just old ones combined in new ways. A mobile phone is an old landline phone without the wire. A smart phone is a mobile phone with powerful computer functions. Beethoven's *Moonlight Sonata* is a creative masterpiece, but what makes it unique is the arrangement of the musical notes, not the individual notes that all composers know. Einstein had the creative insight to put together the famous equation $E = mc^2$, but the concepts of energy, mass, and the speed of light were familiar to all physicists. In some sense then, it is true that there is nothing new under the sun.

The observation that new ideas come from old ones is of practical importance, because it tells us that creativity requires knowledge. Creativity does not happen in a vacuum. Our imagination depends partly on what we know. If you know very little, you can only recombine a few ideas to get new ones. When you know more, the combination of new ideas you can come up with increases exponentially. We often forget that creative achievements are built on past successes by other people. Without Newtonian physics, Einstein probably would not have discovered relativity. Newton himself famously said, "If I have seen a little further it is by standing on the shoulders of giants." To create something new, it helps to know what other people have done and which things work and which do not. It is not surprising that creative types are eager learners and they often read a lot, of everything. Remember Mark Twain's famous quote that "The man who does not read has no advantage over the man who cannot read."

Creativity and knowledge

These days, education reforms often emphasize creativity and are critical of rote learning. But we should not forget that creativity relies on knowledge and information as raw material. Bill Gates, chairman of Microsoft, said, "You need to understand things in order to invent beyond them." Steve Jobs, the CEO of Apple, which is regarded as one of the most innovative companies in the world, has this to say about creative people:

> [T]hey were able to connect experiences they've had and synthesize new things. And the reason they were able to do that was that they've had more experiences or have thought more about their experiences than other people have. Unfortunately, that's too rare a commodity. A lot of people in our industry haven't had very diverse experiences. They don't have enough dots to connect, and they end up with very linear solutions, without a broad perspective on the problem. The broader one's understanding of the human experience, the better designs we will have (Wolf, 1996).

Coming up with something new in itself is not hard, but it is not sufficient for creativity. It is easy to think of new ways to combat global warming that nobody has thought of before: kill half the people in the world or switch on all air-conditioners to cool the air. These ideas might be new, but they are just stupid, and producing 1,000 of them will not make you a creative person. Creativity is a matter of coming up with new ideas that are also *useful.*

This brings us to the important role of critical thinking in promoting creativity. First, we use critical thinking to analyze a problem and identify the limitations of existing solutions. So we know what a better solution might look like. And when we have a new solution, critical thinking helps us determine whether it re-

ally works. Actual creative process involves trial and error. We might have to fail a thousand times before hitting on the best solution. Good critical thinking enables us to learn from our mistakes and solve our problems more efficiently. In business, a distinction is often made between a creative idea and an *innovation*—an idea becomes an innovation when it is implemented and brings about substantial commercial success or social impact. This crucial process of creating a practical impact also requires good critical thinking.

It is sometimes said that critical thinking is bad for creativity because critical thinking kills off new ideas before they are fully developed. However, this is a serious misconception. Critical thinking does not tell us to reject ideas before they are fully tested. It also does not tell us to think and analyze nonstop. If suspending judgment can sometimes promote creativity, it would be rational to do so.

Many people seem to think that creativity is a matter of waiting for inspirations and that inspirations come more readily to geniuses than ordinary people. Our discussion about the role of knowledge and critical thinking tell us that this is not correct. Also, some psychologists suggest that creative people usually have above-average IQs, but beyond an IQ of 120, extremely high IQ makes little difference to the degree of creativity. And if we look at the case histories of famous creative geniuses, we find that they are often hardworking and disciplined, and their successes broadly follow the 10-year rule discussed earlier (see Section 1.3.2). Mozart is a good example. The popular legend is that he was a genius who created wonderful music without effort. The truth is that whatever innate talents he had, he worked extremely hard all through his life. Mozart's father taught him music when he was a kid, and by the time Mozart was 28, his hands were already deformed because of the constant practice and composing. This dedication and hard work produced a database of musical knowledge and ideas Mozart could draw on again and again. Mozart himself emphasized this fact in a letter to a friend,

> People err who think my art comes easily to me. I assure you, dear friend, nobody has devoted so much time and thought to composition as I. There is not a famous master whose music I have not industriously studied through many times (Tharp, 2003, p.27).

23.1 THE CREATIVITY CYCLE

Although there is no algorithm for generating new and useful ideas, there is actually a lot we can do to become more creative. Creative people are often diligent, disciplined, and highly focused. Many have a daily work routine that they steadfastly follow. The work ethic is motivated and sustained by a passion about their work. Ultimately, you have to discover for yourself what you love to do, and the kind of environment and lifestyle that make you more productive. But whatever the details, the work cycle often follows a four-step procedure: [1]

[1] See Young (1975), a short and well-written book about this work process. German physiologist and physicist Hermann von Helmholtz (1821–1894) had a similar idea.

Step 1: Preparation

Start by gathering information about your problem. This might mean going to the library, searching the web, talking to people, or collecting data or other items. Keep everything you have found in a way that you can access them easily, whether in a notebook, a box, or a computer. At this stage, you just collect whatever might be relevant without too much filtering or analysis. This is not as simple as it sounds. Sometimes people are too impatient, and they want to make great discoveries even when they do not know enough. Others might be unwilling to explore unfamiliar territory and so fail to gather the data they need. So broaden your mind and think about all possible sources that might help you in your task.

Step 2 : Exploration

At some point, we need to stop collecting and start analyzing and digesting what we have collected. This might mean trying to classify the material, reorganize them, look at them from different perspectives, and trying to connect ideas and draw conclusions. The aim is to use the connections to come up with a new and useful idea. In the next chapter, we shall look at a list of thinking techniques that can help us accomplish this, but remember that this part of the creative process requires a lot of concentration, analysis, and patience. If possible, avoid all distractions and devote 100% of your attention to the task for a long period of time. A few things might then happen. First, we might get some preliminary ideas and conclusions about what might or might not work. So make sure that you always have a notebook ready in case you need to record your thoughts. Writing them down can make the ideas clearer, and we can build on them or revisit them later. Second, we might discover gaps in the collected material. If so we need to fill in these gaps ourselves or collect some more data. Finally, it can get mentally exhausting trying to find order in chaos. But do not give up so soon even if you do not seem to be getting anywhere. Keep trying and come up with a few more observations. Go further than where you think you can go, and when you absolutely cannot continue, you have earned your well-deserved break.

Step 3 : Incubation

This is when you leave your task aside, relax, and forget about what you have been doing, and just wait. Many of us might have had the experience of being unable to solve a problem, but after a good night's sleep the solution came up suddenly the next morning. Or an idea might come to you while you are listening to music, taking a shower, or watching a movie. For some strange reason, a period of inactivity after intensive thinking does seem to promote creativity. The fact that sleep enhances creativity is well documented. Some people say it is because it gives a chance for the unconscious mind work on the problem. But maybe a period of timeout helps us look at the problem with a fresh eye. But whatever the explanation might be, working as hard as we can and then taking a break appears to be

an effective strategy for most people. You need to find some activity (or inactivity) that stimulates your imagination most. Of course, there is no guarantee that taking a break will produce a creative idea inevitably. In that case, we need to go back to either step 1 or 2 and try again.

Step 4 : Verification

Once we have obtained some promising ideas, we should check whether they really work and whether they can be improved further. When we are dealing with a problem that requires a complex solution, it is very rare that the first solution we come up with is the perfect one. If the proposal turns out not to work, we should try to understand why, so that we can avoid similar mistakes in the future. Even when we have found the perfect solution, we can always review the whole creative process to see how we can repeat the success.

Although we often read about the successes of creative people, we usually pay less attention to their failures. But many successful people are successful precisely because they are willing to take risks and fail, or they have failed spectacularly but have managed to learn from their failures and rise above them. What is important is that we know why we fail and learn from our mistakes. Here are some main reasons why people fail in their creative endeavors:[2]

- **Failure due to lack of knowledge**: New ideas are based on past knowledge. Your idea might not be successful if you do not know enough, or you lack the relevant skills. Response: Learn more.
- **Failure of concept**: This means there is something fundamentally wrong with the initial idea or theory. Whether in science or in art, creativity always contains an element of luck. Sometimes we discover that our favorite approach turns out to be a dead end, but only after considerable time and resources have been spent. Response: Tough luck. Ditch the approach decisively and quickly, and move on to something else.
- **Failure of judgment**: You can have the right idea, but make the wrong decision in executing and developing it. Maybe you were careless about the details. Maybe you did not work fast enough and other people beat you to it. Again you might also just be unlucky and made the wrong call. Response: Reflect and improve your work process, especially if you have failed the same way before.
- **Failure of attitude**: Forging a new path where others have not gone before requires courage and the right balance of attitude. Fear of failure causes us to abandon an idea before it comes to fruition. Complacency makes us think we can get away with mediocrity without significant sacrifice. Denial results in a stubborn refusal to abandon a hopeless project and a failure to

[2]The list is adapted from Tharp (2003), a wonderful book on creativity. Highly recommended.

remedy our own weaknesses. Response: Work harder to avoid failure. Allow yourself to fail in private and learn from the mistakes so it is less likely for you to fail in public and look foolish. Be brutally honest to yourself and listen to people you can trust, even if you do not like what they have to say.

The creativity formula at work

The work habits of many creative people seem to follow the creativity formula very closely. A recent example is Andrew Wiles, a mathematician famous for proving Fermat's Last Theorem in 1995. The well-known theorem is easy enough to be understood by a 10-year-old, but nobody had been able to prove it for 300 years. Wiles spent 8 years working on the proof, and this is how he worked:

> I used to come up to my study, and start trying to find patterns. ... I would wake up with it first thing in the morning, I would be thinking about it all day, and I would be thinking about it when I went to sleep. Without distraction, I would have the same thing going round and round in my mind. ... When I got stuck and I didn't know what to do next, I would go out for a walk. ... Walking has a very good effect in that you're in this state of relaxation, but at the same time you're allowing the sub-conscious to work on you (PBS, 2010).

Another example is the prolific British philosopher Bertrand Russell (1872–1970), who won the Nobel Prize in literature in 1950 :

> It appeared that after first contemplating a book on some subject, and after giving serious preliminary attention to it, I needed a period of sub-conscious incubation which could not be hurried and was if anything impeded by deliberate thinking. ... Having, by a time of very intense concentration, planted the problem in my sub-consciousness, it would germinate underground until, suddenly, the solution emerged with blinding clarity, so that it only remained to write down what had appeared as if in a revelation (Russell, 2003).

EXERCISES

23.1 ☒ There is no standard test that measures creativity, and it is not clear if such a test is even possible. But this does not stop psychologists from trying. One short test is to generate as many possibilities as possible within a limited time, the

more the better. You can also try to think of ideas that no one else might think of. Here are some exercises to try out. You have three minutes for each question.

a) Think of as many uses as you can for a pencil.

b) Consider the typical Barbie doll, a plastic doll with clothes and movable limbs. Think of ways to improve it so that it is more fun to play with.

c) Imagine that people do not need to sleep anymore. Think of as many consequences as you can.

d) Imagine that people could transport themselves from one place to another just by twitching their fingers. What might happen as a result?

23.2 Imagining new possibilities is an essential part of creative thinking. Think about ways to deal with these problems.

a) Jack and Jill have been dating but now they quarrel all the time when they meet up. Still, they do not want to break up completely yet.

b) We need more prisons, but no additional money should be spent on the prison system.

23.3 A hiker started walking up a mountain at 1:00 p.m. along a path. He reached the top at 6:00 p.m. and camped there for the night. The next day at exactly 1:00 p.m., he walked down along the same path, and reached the starting point at 6:00 p.m.. It is not known whether he stopped along the way, or how fast he was walking. Is there enough information to determine whether there was a point on the path where he passed by at the same time on both days?

23.4 ☒ Try to gain better insight into your own creative thinking. Here are some questions to think about:

a) Recall a situation in which you had to try very hard to solve a difficult problem. What did you do? Was your method similar to the creativity formula? How could you have done it better?

b) What kind of environment is most conducive to your creativity?

c) Is there any specific area where you want to become more creative? Who are the successful people in this area? Can you read more about them and see what you can learn from them? Have you put in about 10,000 hours of training or study in this area? If not, roughly how many more hours do you need?

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CHAPTER 24

CREATIVE THINKING HABITS

A crucial step in the creativity cycle is to actively explore the connections between ideas. Tons of books have been written about this topic,[1] and in this chapter we highlight some of the more useful thinking techniques. We call them *creative thinking habits* to emphasize two points. First, a thinking habit is a way of thinking that has become second nature. By making it a habit to apply these techniques we can make our minds more flexible and so more creative. Second, a way of thinking becomes a habit only after extended practice. The emergence of a new idea might only take seconds, but the thinking habits that allow the idea to emerge can take years of hardwork and discipline to cultivate.

24.1 CREATIVE THINKING HABITS

All these thinking habits are based on one fundamental principle—a new idea is made up of old ideas combined in a new way. The simplest way to do this is by adding, replacing, or subtracting ideas. Suppose you sell simple hamburgers

[1] Polya (1971) is a classic on creativity in problem solving.

made of a bun and a beef patty in the middle. To explore new products, you can add one more beef patty in the middle for those who love meat (addition). Or you can replace the beef patty with chicken, mushrooms, or even ice cream (replacement)! Or you can sell just the patties without the bun for people to cook at home (subtraction).

24.1.1 SCAMPER

SCAMPER is a mnemonic for a list of ways to get new ideas.[2] The instructions are pretty self-explanatory. There is of course some overlap in the instructions—for example, *modify* is so general as to include all the other cases. But the point is that the distinct wordings might inspire us to think along different directions.

Letter	Method
S	substitute something
C	combine it with something else
A	adapt something to it
M	modify or magnify it
P	put it to some other use
E	eliminate something
R	reverse or rearrange it

One way to apply SCAMPER is to draw up a list of features about the thing or problem you are working on. It can be a list of activities for a school open day, or a list of features of a website you are trying to develop. When you have written it down you can go through the SCAMPER instructions one by one and see whether there is anything that can be changed so that you might end up with something better. Let's say we want to design a table. We can apply SCAMPER to come up with some interesting designs:

- **Substitute**: Substitute the typical material for making tables with unusual material, such as recycled paper.
- **Combine**: A table top that is a computer touch-screen or an aquarium.
- **Adapt**: Use an antique door as a table. Or the stump of a tree as the leg.
- **Modify / magnify**: A table with lots of very thin legs?

[2]Michalko (2006) is a good book which talks more about SCAMPER and related techniques.

- **Put to some other use**: A table with adjustable height that can double as a bed. A table with different removable tops (such as a chessboard) for different functions.
- **Eliminate**: How about a table with no legs? It might hang from the ceiling. Or it can be supported by an extended arm attached to the wall.
- **Reverse**: Change how people sit. Make a big ring-like table with a hole in the middle so people can sit inside as well.

24.1.2 Analogy

George de Mestral (1907–1990), a Swiss inventor, took his dog for a walk one day, and when he came back he noticed that the seeds of the burdock plant had attached themselves to his clothes. Using a microscope to examine the seeds, he noticed they are covered with tiny hooks that cling to fur and fabric. De Mestral realized that this could form the basis of a new type of fastener. The result was Velcro, consisting of two strips of fabric, one covered with small hooks, and the other with lots of tiny loops. When pressed together, the two pieces join together strongly, but can be easily separated. These reusable fasteners can now be found in sportswear and all kinds of products around the world.

The story of Velcro is a good example of analogy at work. By seeing how the burdock seed might be analogous to a manmade fastener, an idea was borrowed from nature and turned into a product. Mimicking nature is a powerful technique in creative thinking, especially in engineering. Many biological features serve useful functions as a result of evolution, and these ideas can often be borrowed to solve analogous problems in engineering.

Analogies are important not just for technical inventions. When we face a difficult problem, it is often useful to compare it to similar problems that we were able to solve. Or we might try to solve a simpler version of the problem first, and see if it would provide any useful hints.

24.1.3 Brute search

Sometimes the solution to a problem is to be found in a long list of possible solutions, and we just have to try them out one by one until we find the one that works. This can be a rather boring and frustrating process, but we should not underestimate the power of brute search. Chess for example requires creativity and imagination. But supercomputers can search many steps ahead to check the pros and cons of a particular chess move, and chess programs can now defeat most human beings and sometimes even the best players in the world.

A good example of the use of search is when inventor Thomas Edison (1847–1931) was designing the electric light bulb. One crucial task was the search of a suitable filament that conducts electricity well enough to give off light, but that will not burn up or melt as a result. So he tried all sorts of organic and inorganic

material, testing over 6,000 different types of material. This is what he said about the endeavor:

> The electric light has caused me the greatest amount of study and has required the most elaborate experiments. ... Although I was never myself discouraged or hopeless of its success, I can not say the same for my associates. ... Through all of the years of experimenting with it, I never once made an associated discovery. It was deductive. ... The results I achieved were the consequence of invention—pure and simple. I would construct and work along various lines until I found them untenable. When one theory was discarded, I developed another at once. I realized very early that this was the only possible way for me to work out all the problems (Churchill, 1905).

As we can see, creativity is not always a matter of waiting for inspiration. It sometimes requires going through possible solutions patiently. The Nobel laureate physicist Richard Feynman (1918–1988) has even suggested that this is one way to become a genius!

> You have to keep a dozen of your favorite problems constantly present in your mind, although by and large they will lay in a dormant state. Every time you hear or read a new trick or a new result, test it against each of your twelve problems to see whether it helps. Every once in a while there will be a hit, and people will say, "How did he do it? He must be a genius!" (Rota and Palombi, 2008).

Note that the search technique need not be a haphazard process, trying out whatever that pops into your mind one at a time. An efficient search process often involves a systematic classification of the different types of solutions, followed by an analysis of their special features, so that a more efficient search strategy can be devised. For example, to formulate an investment strategy, we can start with an overview of the different types of investment classes: real estate, commodities, equities, bonds, currency, and so on. After deciding what to invest in, we can do a more detailed search within the selected classes to identify the best investment opportunities. When it comes to creativity in solving problems, the generation of new ideas and careful analysis often go hand in hand.

24.1.4 Perspective shift

When Einstein was asked which single event was most helpful in developing his theory of relativity, he answered, "figuring out how to think about the problem." The perspective we use to approach a problem has a profound effect on the kind of solution we come up with. This is why it is important to examine a problem from multiple perspectives. We get a more comprehensive picture and might come up with better ideas. Here are some contrasting perspectives to explore:

- **Positive vs. negative**: The pros and cons of a proposal, supporting evidence vs. counterevidence, gain vs. loss.

- **Fact vs. value**: What is currently happening vs. what should be happening, what a person is doing vs. what he or she ought to be doing.
- **People**: Adopt the perspectives of other relevant parties, for example, teacher vs. student; employer vs. employee vs. client. Try to understand their different concerns and priorities.
- **Discipline**: Insights and analyses from different theoretical disciplines, such as politics, economics, law, psychology.
- **Level**: A complex system can be understood at different levels. Same for theories and proposals. Think of policies (such as public health) at the international, national, institutional, social, family, and personal levels.
- **Order**: Sometimes it is easier to solve a problem by working backward. We might be able to infer what must come first if we know the final step.
- **Timescale**: Long term, medium term, short term. A problem that seems important right now can be quite insignificant in the long run.
- **Types of solution**: Quick-fix solutions might work only for a little while and suffer from other problems. Ideal or perfect solutions can be impractical or expensive. We might modify and combine them to come up with a solution that is effective and realistic.
- **Change focus of question**: Think about the different parts of a problem. Take the question, "Why did Adam eat the apple?" Shift emphasis by asking: Why *Adam* (and not someone else)? Why did he *eat* the apple (as opposed to, say, save it for later)? Why did he eat *the apple* (and not an orange)?

When we are dealing with problems in our own lives, sometimes what is needed is not an alternative solution but a different attitude. Here, a change of perspective can have a profound effect on the way we react emotionally to our problems. There is the saying that given the same glass of water, an optimist is someone who sees a glass that is already half-full, whereas a pessimist grumbles that the glass is still half-empty. When we are in a difficult period and there is nothing much we can do, we feel better if we think about the positive aspects rather than the negative ones. Instead of dwelling on obstacles that we cannot remove, we might lessen our frustration if we think of them as opportunities for personal growth and stamina training. When we feel we are not as fortunate as other people, we might remind ourselves that many people are in an even worse situation. These suggestions are not meant to encourage us to ignore problems or to adopt a sour grapes mentality. They should rather be seen as important ways to bring about positive attitudes and emotions to deal with the inevitable frustrations of life.

24.2 BRAINSTORMING AND GROUP CREATIVITY

The creative individual is not always the lone inventor. Many so-called creative geniuses were nurtured by a supportive family or mentor, or they might collab-

orate with others within an organization. These days, more than ever, developing a successful idea often requires teamwork from people with different areas of specialized knowledge. Promoting and managing group creativity is therefore an increasingly important task.

Brainstorming is a method for generating ideas in a group. It was first popularized by Alex Osborn, an advertising executive, around the 1950s. It has now become a standard technique used by companies and organizations. In a typical brainstorming session, participants are supposed to create a relaxed and uninhibited atmosphere to come up with as many ideas as possible, including far-fetched ones. The initial objective is to simply to collect the maximum number of ideas. At this stage it is crucial not to criticize or evaluate these ideas for fear of inhibiting the expression of ideas. But after a sufficient number of ideas has been collected, they can then be examined, thrown away, combined or improved on to find the best solution to a problem.

However, the effectiveness of brainstorming is controversial. Some researchers in social psychology even argue that individuals working in isolation will achieve better performance than if they brainstorm together. Here are some relevant considerations about the limitations of brainstorming.

- Various factors can diminish the effectiveness of brainstorming. There is the problem of production blocking—only one person can speak at a time, during which other ideas might get forgotten or ignored. Some people might be shy. Others want to avoid criticism, or they succumb to conformity. There is also the possibility that members have less incentive to think really hard and contribute because they can free ride on other people's effort. Finally, once a good idea has emerged, group members might naturally fixate on it and so fail to discover an even better idea.

- **Groupthink** is a more extreme problem where the pressure to conform hinders critical analysis and creativity, resulting in poor decision making. The symptoms might include self-censorship, suppression of dissent and stereotyping of outsiders who disagree, and the illusion that the group is infallible and morally superior.

- Related to the phenomenon of groupthink is the observation that a tight-knit group with a fixed set of people is detrimental to creativity. These members are likely to feel more comfortable with each other, but they might also mistakenly perceive themselves as creative. Research suggests that we might improve the creativity of a group by introducing outsiders, although this might decrease the comfort level of the group members (Nemeth and Ormiston, 2006).

There are still many controversies about the effectiveness of brainstorming, but the bigger picture suggested by empirical research is that unstructured brainstorming is unlikely to enhance creativity. Brainstorming might be more suitable when dealing with manageable real-life problems that require different people to

pool together their knowledge. Even then the brainstorming session should be properly organized to make the thinking process more effective. Whether we are talking about an individual or a group, creativity involves a delicate balance between freedom and discipline. Here are some measures that might be useful for more effective brainstorming:

- An impartial group leader to structure the discussion without introducing biases.
- A devil's advocate to challenge assumptions.
- Consultation with outside experts.
- Break up a big group into smaller ones for discussion before reporting back.

24.3 CREATIVITY AND SELF-MANAGEMENT

Ellis Torrance (1915–2003) was an American psychologist famous for his work on creativity. He developed a test of creative thinking that is widely used to evaluate creativity in children. In one large-scale longitudinal study, he followed the lives of lots of people as they progressed from children to adults, and tried to understand the secrets behind a successful and creative career. His findings were published in Torrance (2002), but the following remark in the preface is particularly striking:

> It became obvious that after thirty years, other things became more important than intelligence, creativity, and academic achievement—such characteristics as persistence, courage, tolerance of mistakes, feeling comfortable as a minority of one, not being well-rounded, and having a sense of mission. I have coined the term "Beyonder" to describe such people, and call the above traits "Beyonder Characteristics."

At first, it might seem paradoxical to be told that creativity is not the most important condition for having a successful creative career. But the reason is perhaps that having lots of creative *achievements* over a long period of time requires more than just the *mental capacity* to think creatively. The other character traits mentioned play an even more important role in translating your capacity to deep and lasting successes.

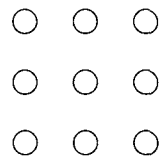
This is one reason why we emphasize the importance of attitude and practice in this book. Lifelong excellence in thinking requires more than just knowledge of the principles of critical and creative thinking. You need to have the passion to improve yourself through application and practice, and only then will these thinking techniques make a big difference to your life. Drawing upon his own research, Torrance wrote the following *Manifesto for Children* on how to live more creatively. These inspiring words seem a fitting end to this book, but they ought to be the beginning of a lifelong journey of learning and self-discovery:

Ellis Torrance on creativity

1. Don't be afraid to fall in love with something and pursue it with intensity.
2. Know, understand, take pride in, practice, develop, exploit, and enjoy your greatest strengths.
3. Learn to free yourself from the expectations of others and to walk away from the games they impose on you. Free yourself to play your own game.
4. Find a great teacher or mentor who will help you.
5. Don't waste energy trying to be well rounded.
6. Do what you love and can do well.
7. Learn the skills of interdependence.

EXERCISES

24.1 In this exercise, your task is to connect all nine dots in the diagram using only four straight lines, to be drawn in one continuous stroke without the pen ever lifting off the paper. How would you do it?



24.2 Refer to the nine-dot diagram again.

a) Can you connect all nine dots using only three straight lines with no lifting of the pen?

b) Do you think it is possible to do it with just one line?

24.3 ☒ Suppose there is a bakery that sells cookies. Business is fine but could be better. Apply the SCAMPER technique to think of ways to improve business which might be worth exploring.

24.4 ☒ Go through the seven items in Torrance's *Manifesto for Children.* Have you been following these guidelines? To what extent? Is there any item which you think you ought to pay more attention to? What concrete steps can you take to make this happen?

24.5 ☒ We have talked a lot in book about how critical thinking and creativity are relevant to our careers. But more generally, good thinking is crucial for the future of humanity. Think about this quote from Csikszentmihalyi, a famous author on creativity:

> Humanity needs a creativity that can help us find our place in this evolving cosmos, so that we can respect one another, live together peacefully, and not destroy one another in order to feel good about ourselves.

What is your own perspective on these issues? Do you think you are able to contribute to these goals in any way?

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SOLUTIONS TO EXERCISES

SOLUTIONS FOR CHAPTER 1

1.1 Issues to think about: Is a single example about bees enough to draw a conclusion about human reasoning? Is the persistence of the bees a reflection of intelligence and logical thinking?

1.2.a Critical thinking is not solely a matter of finding fault. It also includes finding good reasons to support a conclusion. Finding fault can also be constructive if we learn from the mistake.

1.2.b First of all, it is debatable whether relationships and connections are more important. Perhaps it depends on the individual and the line of work? Also, even if these things are more important, does it follow that critical thinking is not useful? Critical thinking can help you build better relationships and connections.

1.2.c Many important decisions should not be made hastily and critical thinking is crucial. See Chapter 22. Also, even quick decisions can improve with good critical thinking.

1.3 This longer definition provides a lot of detail, but it fits with the simpler definition of critical thinking in this book. Thinking clearly and rationally involves the kind of activities and values that are listed in the quote.

1.5 As you might guess, the first four are good attitudes and the next four are not. They are meant to help you reflect on your own thinking process. You can also think about whether

any of these traits are present in the behavior of the people around you. If so, how do these traits affect their thinking and decisions?

SOLUTIONS FOR CHAPTER 2

2.1.a The second statement is stronger. Being good requires more than just avoiding evil deeds.

2.1.b The first statement does not entail the second. You might like lobsters as pets or you think they are cute, but it does not follow you want to eat them.

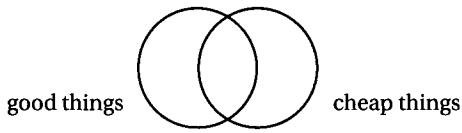
2.1.c The food might be made from ingredients that already contain preservatives and no additional ones need to be added. The first statement is then true but the second one is false.

2.1.d The second statement implies that one should not say anything at all. The first statement has no such implication. Note that the first statement does *not* say that if the police are *not* here, one can say anything. Why?

2.1.e The first statement gives the permission but does not require that you kiss the bride. The second one does.

2.1.f The second statement is consistent with the possibility that some people are sick. But not the first one.

2.1.g They are actually equivalent but just formulated differently. See the diagram below where the left circle represents good things and the right circle represents cheap things. The overlapping area would be things that are both good and cheap. Both sentences are saying that there is nothing in this group. So in a sense they do have the same meaning.



2.1.h Note that the second sentence does not imply there are many restaurants. It can still be true if The French Laundry is the only restaurant left in the world.

2.3 Here is the annotated version: Harry's abilities must be seen to be believed (since you won't believe that he is so incapable). The amount of material he knows will surprise you (how can he know so little?). It would be very hard to find someone as capable as he is (everyone else is more capable). He has left a deep impression on all the teachers in the department (they all remember his dismal performance). You would be fortunate if he works for you (since he normally fails to work at all).

2.4.a The students found it difficult to understand the long explanation given by the teacher.

2.4.b The tense situation turned explosive earlier this month when the international administration ordered a raid on Herzegovacka Bank. The administration was put in place after the 1995 peace accord that ended the war in Bosnia.

2.4.c We can give away the four empty bamboo baskets in the basement to charities. (Should we leave out *empty*?)

2.4.d Anaïs bought a large and red Toyota minivan.

2.4.e Apple designed a special laptop with a case made from a single piece of aluminum.

SOLUTIONS FOR CHAPTER 3

3.1.a Precising.

3.1.b Reportive.

3.1.c Persuasive.

3.1.d Reportive.

3.1.e Precising.

3.2.a You can hate yourself. It is also possible to hate someone without wanting to harm them or ruin anything.

3.2.b Ungrammatical. Biology is a subject or discipline, not a situation or a period of time.

3.2.c Circular definitions.

3.2.d Poetic, but as a definition too metaphorical. Also, loving someone (for example, one sidedly) can be a painful rather than a happy experience.

3.2.e First, you can love yourself. Second, two people can love each other but not being very good at doing all the things being listed, such as a child loving her parents.

3.2.f You can be angry at yourself.

3.2.g A bomb might be designed not to hurt people but destroy buildings.

3.4 They are both cases of the etymological fallacy.

3.5 One main problem is that the information might be publicly available and has been released legally. Trading based on such open information is surely not insider trading.

3.6.a Domestic violence = Any violence between current or former partners in an intimate relationship. The parts that are left out are further clarifications.

3.6.b The second definition seems to rule out isolated acts of violence because it requires that domestic violence forms a pattern. This is too strong. But it is wider than the first definition in including violence within family-type relationships that might not be "intimate." This might be better if we want to include violence between family members, such as between siblings or parents and children.

3.7.a Teaching sex education at school might make some students unhappy but it is not sexual harassment.

3.7.b Sexual harassment might not involve the offer of any benefit and is not restricted to unwelcome advances from a superior.

3.8 First, what is a receptacle if not a container? Second, it is not so clear what count as a wall. A container that consists of half a sphere does not seem to have "a plurality of walls," but it is nonetheless a container.

SOLUTIONS FOR CHAPTER 4

4.1.a True.

4.1.b False.

4.1.c True.

4.1.d False.

4.1.e True.

4.2.a True.

4.2.b True.

4.2.c False.

4.2.d False! *Hint*: What if all the students were not intelligent?

4.2.e True.

4.2.f True.

4.2.g False.

4.2.h True.

4.2.i False.

4.2.j True.

4.2.k False.

4.3.a Sufficient condition.

4.3.b Necessary condition.

4.4.a Exclusive but not exhaustive. Inflation can remain stable.

4.4.b Exclusive but not exhaustive.

4.4.c Assuming it is possible to be both happy and sad (about different things) at the same time, they are neither exclusive nor exhaustive.

4.5.a Choice 2.

4.5.b Choice 5. We are not told what their starting salaries were.

4.5.c Choice 3. Elia ate 4 and Maddalena ate 2.

4.6 The argument starts with the claim that studying is necessary for passing, and mistakenly infers that it is sufficient for passing.

SOLUTIONS FOR CHAPTER 5

5.1.a Is everyone talking about the photo or just the model? Here are two reformulations: (1) Here is a photo of a model. Everyone is talking about this model. (2) Here is a photo of the model. Everyone is talking about this photo. Try to rewrite the other sentences in the same exercise so that they are no longer ambiguous.

5.1.b Is it the car or the tree that is in front of the house?

5.1.c During the merger, the new CEO promised to avoid layoffs; The new CEO promised to avoid layoffs as long as the merger is in progress.

5.1.d How many puppies are being sold in total? 10 or 11?

5.1.e *Brains* is ambiguous. It might mean the organ or talented people.

5.1.f Being able to think clearly is going to help us learn better; Clearly, being able to think helps us learn better.

5.1.g Are we talking about students who play video games often, or are we saying that students who play video games are the ones who often have poor grades?

5.1.h Do you have to bring your identity card with your passport?

5.1.i The word *bank* is ambiguous in English, but not in this sentence since there is no reason why the speaker has suddenly shifted the meaning of the word.

5.2.a A comedy is a story or a performance where lots of funny things happen.

5.2.b Civil engineering is a discipline or profession and not a person so it cannot have any "experience." Perhaps the author meant "the experience of civil engineers" or "the history of civil engineering"?

5.2.c The students in my class are smarter than *those in* the other classes.

5.3.a Talking to Ann gave Peter the idea to build a house.

5.3.b Our current educational system assumes that students enjoy lectures.

5.4.a Incomplete meaning — higher than whom?

5.4.b Ambiguous — Did Rita get the flu four days ago, or was the kid ill four days ago?

5.4.c Incomplete meaning — Better than what? More butter than what? Cookies from other people or the previous version?

5.4.d Ambiguous — Was the day of marriage also a sad day?

5.4.e Treating people differently is not sufficient for discrimination. The treatment has to be unjust or based on prejudice.

5.4.f Better for what purpose? Sometimes it is better to lie to patients about their medical condition because it might make their situation worse.

SOLUTIONS FOR CHAPTER 6

6.1.a The observation that the truth of a sentence depends in part on its meaning does not support relativism. Relativism denies that a sentence is objectively true *even after* we have fixed what it means and says.

6.1.b A difference in opinion does not amount to relativism, as long as some of them are right and those who disagree are wrong.

6.1.c If it is true that we never have direct access to reality (whatever that means) then that is again an objective truth. But objectivity is compatible with the formulation and development of theories being affected by culture and perspectives. It is just that the truth and falsity of a theory should depend on reality and is not a relative matter.

6.2 Only d, f, g and h are statements.

6.3 Analytic: f, i. Empirical: a, b, c, e, g. Value: d, h.

SOLUTIONS FOR CHAPTER 7

7.1.a The first and the third statements are equivalent, and they both entail the second statement, but not the other way round.

7.1.b The first statement entails the second one, but not the other way round.

7.1.c These statements are logically independent of each other. You can build a phone designed and launched by others, or you can just design it for another company. Or you can launch a phone built and designed by other people.

7.1.d The second statement entails the first, but the other way round. You fail to stay off the bridge if you run rather than walk across it.

7.1.e The first and third statements are equivalent.

7.1.f The first two are equivalent.

7.1.g Not logically equivalent.

7.1.h Yes.

7.1.i No.

7.1.j No. It is consistent with the second statement that Ronaldinho is famous for something other than being a soccer player.

7.1.k No. The second statement says that not everything is impossible. It entails that something is possible, but not that *everything is possible*, which is what the first sentence says.

7.2.a Can be consistent if *new* means "recently purchased."

7.2.b Inconsistent.

7.2.c Consistent. The statements entail that he is not guilty.

7.2.d Inconsistent. If something is known then it must be true. It is the things we *think* we know that can be wrong. So we didn't really know them.

7.2.e Inconsistent.

7.2.f Inconsistent. If you think human actions are free, which statement will you reject?

7.3.a Are the motherboards and memory chips also Intel ones?

7.3.b (a) Either I shall visit Sophie and you will visit Sandra, or he will visit Sonia. (b) I shall visit Sophie, and either you will visit Sandra or he will visit Sonia.

7.4.a It is not the case that hang gliding is dangerous.

7.4.b It is not the case that I am afraid.

7.4.c It is not the case that belching is polite.

7.4.d It is not the case that you are Einstein.

7.5.a Inclusive.

7.5.b Exclusive.

SOLUTIONS FOR CHAPTER 8

8.1.a A thunderstorm is coming. Therefore, you should stay at home.

8.1.b All Maoists are communists. All communists are Marxists. Therefore, all Maoists are Marxists.

8.1.c You can barely keep your eyes open. Therefore, you should not drive.

8.1.d If he wants to go out with me he would have called. He did not call me. Therefore, he is not interested in me.

8.1.e Not an argument.

8.1.f You might get hit by a car if you jaywalk. The police might fine you if you jaywalk. Therefore, you should not jaywalk.

8.1.g If the solution is acidic, the litmus paper would have turned red. The litmus paper has not turned red. Therefore, the solution is not acidic.

8.2 Something like the following: (Premise 1) Art students do not understand modern art in the beginning. (Premise 2) To understand modern art, one must study art history. (Conclusion) Art students must begin by studying art history.

8.3 The conclusion of the other argument is that there is no simple way to measure whether on balance religion has more positive or negative consequences. But the argument does not spell out explicitly why this conclusion follows. Presumably it is supposed to be obviously true.

SOLUTIONS FOR CHAPTER 9

9.1 All possible except the second situation.

9.2.a False.

9.2.b False

9.2.c True.

9.2.d True.

9.2.e False.

9.2.f True.

9.2.g False. False premises in a valid argument can give a true conclusion.

9.2.h False.

9.2.i True.

9.2.j True.

9.2.k True.

9.3.a Not valid.

9.3.b Not valid.

9.3.c Not valid. Maybe Angelo is not the *only* cheap restaurant.

9.3.d Valid.

9.3.e Not valid.

9.3.f Not valid.

9.3.g Not valid.

9.3.h Not valid.

9.4 There are lots of things we might say about this passage. But in light of what we have discussed in the chapter, one point that is of special relevance is that embracing non-duality seems to be self-refuting. To embrace non-duality rather than duality is to make a distinction, and this is inconsistent with giving up all distinctions!

9.5 When we say "If P then Q. Q. Therefore P." is not a pattern of valid argument, we are saying that *not every* argument of that form is valid. But this does not rule out the possibility that *some* arguments of that form are indeed valid—for example, when Q is identical to P, we have "If P then P. P. Therefore P." This is circular but valid. Compare the situation with modus ponens, in which every argument of the the same form is valid.

SOLUTIONS FOR CHAPTER 10

10.1 Although Holmes suggests that each step of his reasoning "clearly" follows from the previous one, the whole chain of reasoning is inductive in character since the intermediate conclusions do not appear to follow deductively from earlier assumptions. For example, Holmes assumed that the doctor injured his arm while serving in the tropics. But this is just a guess, and he could easily have been wrong.

10.2.a It will still be valid and sound.

10.2.b Not necessarily, and here is an example. Argument #1: Tom Thumb suffers from dwarfism. Therefore, Tom Thumb does not have above-average height. Argument #2: Tom Thumb is 20 years old. Therefore, Tom Thumb is over 1.2 meters tall.

10.3.a Not valid, since it is a prediction about the future based on past experience. An example of a premise that would weaken the argument: But for some reason there are a lot more visitors to these resorts this year.

10.3.b Valid.

10.3.c Not valid.

10.3.d Valid.

10.4 Both statements 2 and 3 would make the argument stronger, but presumably statement 3 would give the argument a higher inductive strength. Whereas statement 1 will lower the inductive strength.

SOLUTIONS FOR CHAPTER 11

11.1.a Gold is a metal. All metals conduct electricity. Therefore, Gold conducts electricity.

11.1.b God does not exist. If there is no God, life has no meaning. So life is meaningless.

11.1.c Noam is a thinker. A person is either a thinker or a doer, but not both. So Noam is not a doer.

11.1.d Hidden assumption: If x is heavier than y and z cannot lift x, then z cannot lift y. Or equivalently: If a person cannot lift an object, that person cannot lift anything heavier than that object.

11.1.e The whole building collapsed. There were people in the building when it collapsed. If there were people in the building when it collapsed, then probably many of them died. So probably many people died.

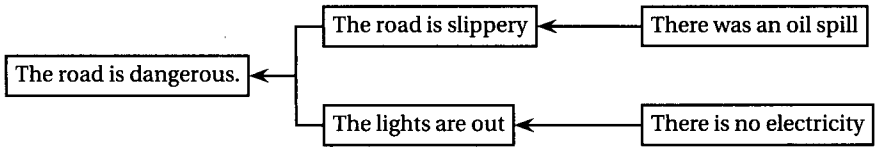
11.1.f This is normally a fallacy, unless it is further assumed that there is no other way to become a member.

11.1.g I ate ketchup today. Ketchup is made of tomatoes. Tomatoes are fruits. If I ate something made from a fruit, then I ate fruit. Therefore, I ate fruit today.

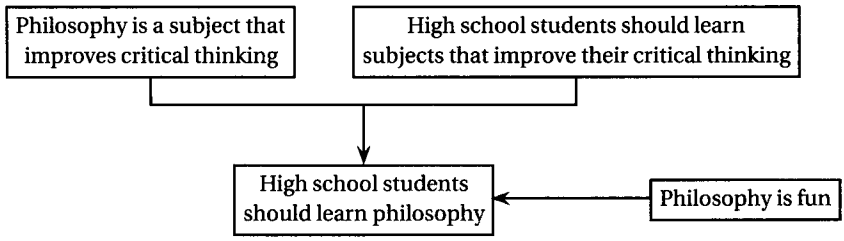
11.1.h There are different ways to formulate the hidden premises. This is a suggestion: (1) The majority of criminal activities have to do with selling or possessing illegal drugs. (2) Imposing the death penalty on selling and possessing illegal drugs is effective in getting rid of these activities. (3) We should impose the death penalty on a crime if the crime is a major source of criminal activities and the penalty is effective in eliminating these activities.

11.2.a

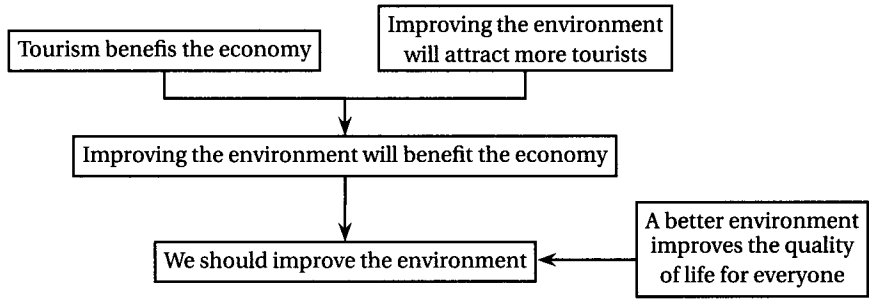
11.2.b



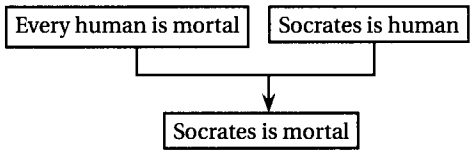
11.3.a



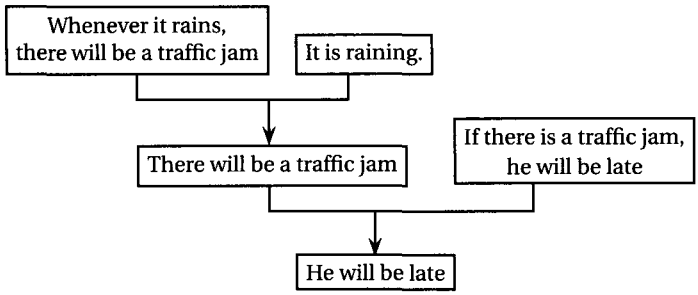
11.3.b Further hidden premises might be added to the argument map below. Do you know where they should be?



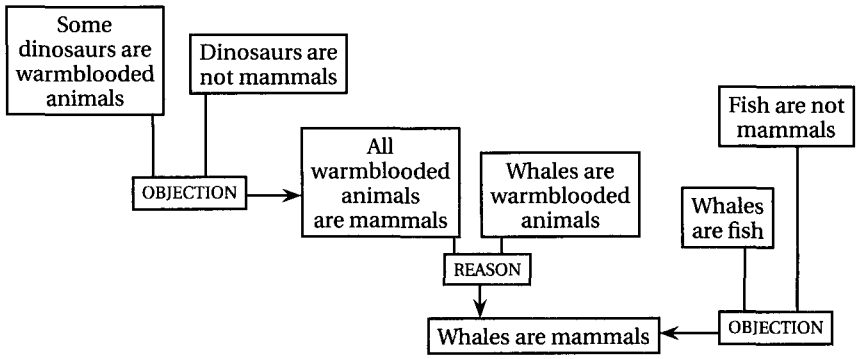
11.4.a



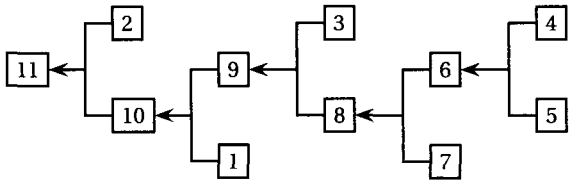
11.4.b It is possible that your version is different.



11.4.c



11.5



SOLUTIONS FOR CHAPTER 12

12.1.a True.

12.1.b True. The premises can still be implausible.

12.1.c True.

12.1.d True.

12.1.e True.

12.1.f True.

12.1.g False.

12.2.a Not question begging.

12.2.b Yes, question begging.

12.2.c Question begging, since your favorite is just what you like best.

12.2.d This is not a circular argument, because you might not always order your favorite—for example, you order lobster ice cream not because you like it but just to see what it tastes like.

12.3.a (1) It *might* be argued that the existence of identical twins is a kind of natural cloning. (2) Just because something is unnatural does not mean it is wrong. (3) Cloning gives us valuable scientific knowledge and medical technology so it should not be prohibited. (4) Name your favorite unnatural activity.

12.3.b (1) Attack the premise: Not all scientific theories are given up after a while. Scientists continue to maintain that the Earth is smaller than the Sun and that there are atoms and molecules. (2) Attack the reasoning: Scientists might change their theories because they have come up with more accurate ones. So the fact that theories change does not imply that we should not rely on them. (3) Attack the conclusion: It is unwise not to rely on scientific advice about many safety issues, such as whether certain things are poisonous or whether a building is safe.

12.3.c (1) Attack the premise: Some students learn quickly and won't make mistakes. (2) Attack the reasoning: The conclusion does not follow because punishment might have other benefits. Or they might make *fewer* mistakes even if they still make them. (3) Attack the conclusion: Punishment leads to better discipline and fewer *big* mistakes so it is useful. (4) Give an analogous argument: Putting prisoners in jail is useless because people will always commit crimes.

12.4.a There are two issues to consider: First of all, what do we mean by *low*? Is this measured in absolute terms (for example, less than 15%) or in comparison with taxation rates in other countries? Second, the argument assumes that the benefits are good enough to outweigh any disadvantages that might arise, such as less government income.

12.4.b Some main assumptions: (a) There was only a finite rather than infinite amount of radioactive material. (b) Radioactive material started existing for as long as the universe has existed. (c) When radioactive material has disappeared, new radioactive material will not come into existence again.

12.4.c Some relevant assumptions: (1) The amount of Indira's donation to a party reflects the strength of her preference. (2) She is going to vote in according to her preference. (3) She did not donate similar or larger amounts of money to other parties.

SOLUTIONS FOR CHAPTER 13

13.1.a A simpler alternative explanation is that he had a stomachache simply because he ate too much, and there was nothing wrong with the sundae. Or perhaps there was something wrong with the other food he ate. It could just be a coincidence that the stomach trouble started after eating the sundae.

13.1.b A few issues: (1) There is no way to check the credentials of this doctor. (2) The doctor probably received some benefit for appearing in the advertisement, so this is a potential source of bias. (3) The doctor did not say why she recommended the vitamins—for example, could it be just for the taste? (4) Even if it is a sincere recommendation because of the health benefits of the vitamins, this is just one recommendation and we need to see what other experts think.

13.1.c Relevant issues: (1) What is the percentage of people who go shopping by driving? How many of them are ordering online instead? No data are given here. (2) Will the delivery of products also involve a significant amount of fuel consumption? (3) Even if online shopping decreases the consumption of petrol, will other activities end up consuming more petrol given the growth of the economy?

13.1.d One problem is that the conclusion is only supported by a single case. But the more serious problem is that the rashes could have been the result of an allergic reaction to the makeup. When the woman stopped using makeup, her condition improved but it might have nothing to do with the crystal.

13.1.e The research cited is real and comes from Rauscher et al. (1995). But notice that the experiment was conducted on college students and not children. Also, although the effect was present immediately after the listening experience, there was no indication that the effect will persist or be permanent. (In the actual experiment the effect disappears after about 15 minutes.) So there is not enough evidence to show that listening to Mozart will make kids smarter and develop better. Maybe the students were bored with the other two sound recordings and this affected their performance. Note that the result does not tell us whether other pieces from Mozart or other composers will also have this effect.

13.2 Here are just a few suggestions. Think about the kind of evidence you would need to determine if any of them is correct. (1) A greater number of less capable students are taking the test, dragging down the average. Maybe in the past only the top universities require the test, and there were more top students among the test candidates. (2) Presumably the questions in the test change from time to time. Maybe the test is getting more and more difficult? (3) Perhaps there have been changes in the administration of the test which affect the statistics? For example, maybe in the past there were more people taking the test more than once. If there are fewer of these people, this might change the average score.

13.3 There are different ways to test them. For example, we can put two of these people together where there might be a ghost, and ask them to report independently the characteristics of the ghost. If their descriptions agree, that would be confirming evidence. Or we can try to get them to communicate with the ghost and see if they can obtain information that cannot be explained any other way. So science is not necessarily against the existence of supernatural phenomena.

13.4 One explanation is that the man was just lucky, but this is not too likely. The simpler and more plausible explanation is that the man has got all 20 numbers written down in various places on him, and depending on what his audience comes up with, he reveals the appropriate number, for example, on his left foot, on a piece of paper in his right pocket, or on his left wrist. To test whether this is the case, we can search him beforehand or ask him to guess the number from a much larger range or have him write down beforehand the number he is going to implant in the audience's mind.

13.5.a It is indeed wrong to criticize a theory on the grounds that there is no proof that it is correct, if by that we mean the theory lacks conclusive evidence that entails the theory. But it would still be rational to accept a theory if it had plenty of evidence indicating that it was highly likely to be true. This is why it is also wrong to say that scientific theories that have not been proven true are accepted solely on the basis of faith, because these can be theories that have plenty of supporting evidence and can offer useful predictions.

13.5.b A theory does not fail to be scientific just because it does not offer 100% accurate predictions. It could be that the theory is fine, but it is difficult to get precise data to make predictions in conjunction with the theory. A scientific theory can also make statistical and probabilistic predictions without being able to predict every single event accurately.

13.5.c It is wrong to think of science and logic as completely distinct. Science also relies on logic including deduction. Scientists need logic to discover the implications of their theories, generate predictions, and check for inconsistencies, among other things.

SOLUTIONS FOR CHAPTER 14

14.1.a The method of concomitant variations.

14.1.b The method of difference.

14.1.c The joint method.

14.1.d The method of difference.

14.2 Situation 1.

14.3.a None can be applied, since there is no single cause common to all situations in which E occurred. It could be that E has multiple or complex causes, or its cause is not among the list here.

14.3.b B, according to the joint method.

14.3.c C, according to the joint method.

14.3.d D.

14.3.e C.

14.4.a True. Given the more general joint method, there is no need for the method of agreement or the method of difference.

14.4.b True.

SOLUTIONS FOR CHAPTER 15

15.1.a (1) Eating breakfast enhances cognitive abilities. (2) Families in which children are not given breakfasts are less likely to provide a good environment for the children's cognitive development.

15.1.b (1) Sleeping more causes more illnesses. (2) People who are less healthy and more likely to die tend to sleep more.

15.1.c (1) Drinking milk increases the chance of getting cancer. (2) Countries in which people drink more milk are richer and provide better healthcare and the citizens are less likely to die prematurely. They are more likely to die from cancer due to a longer lifespan.

15.1.d (1) Smoking causes neurophysiological changes that make people suicidal. (2) People who are depressed or stressful are more likely to have thoughts about suicide and also more likely to take up smoking.

15.1.e (1) Smoking impairs attention and learning and so leads to lower grades. (2) Students with learning difficulties or personal problems are more likely to smoke, and their problems cause them to get lower grades.

15.1.f (1) Using Facebook somehow impairs those skills that are useful for getting good grades. (2) The better students spend more time studying and less time on Facebook.

15.1.g (1) Genuine smiling causes good physiological effects that lead to longevity. (2) Smiling and longevity are the common effects of health and a positive personality.

15.1.h (1) Jogging improves one's mood through some neurophysiological mechanism. (2) People who suffer from depression are less inclined to go jogging.

15.1.i Since the disorders happened later, it would not be plausible to say that the disorders cause them to use drugs and alcohol! One explanation is that drugs and alcohol affect the brain and cause psychiatric problems. Another explanation is that there are genetic factors that underlie both.

15.2 The first and third ones.

15.3 The correlation could be accidental or it might be a case of side effect causation.

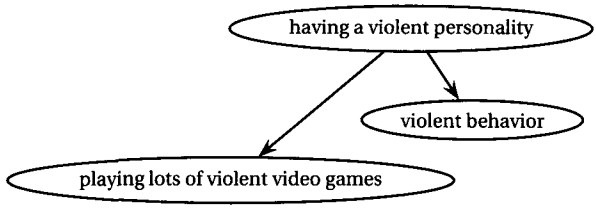
15.4.a Stepping on the toe in itself is not sufficient for bleeding, but together with other conditions (sharp heel, high pressure) they are sufficient to cause bleeding. But the whole set of sufficient conditions is not necessary for bleeding since you can cause bleeding by cutting instead.

15.4.b For example, Akiko's mother giving birth to Akiko is a necessary part of a whole set of conditions that lead to Bella's bleeding, but we do not want to say that the birth caused the bleeding.

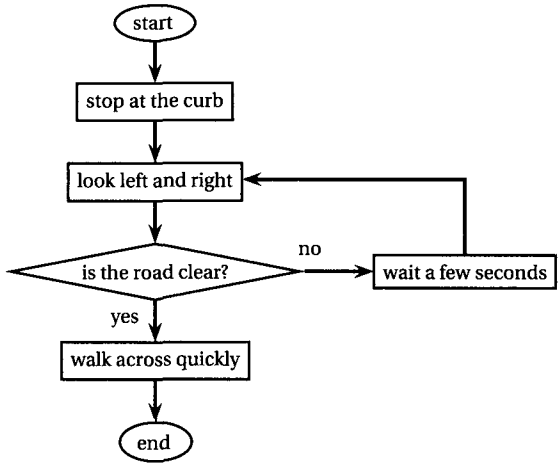
15.5 There are lots of examples, such as a child receiving a present and this makes her happy. Receiving a present is not sufficient for happiness because she must also like the present. It is not necessary because she can also be happy when she plays with her friends.

SOLUTIONS FOR CHAPTER 16

16.1



16.2



SOLUTIONS FOR CHAPTER 17

17.1.a Readers of *Playboy* (and those willing to be interviewed) might not be representative of the male population as a whole. One might wonder whether these subjects are more likely to exaggerate when being interviewed.

17.1.b This inference is not unreasonable if the sample is a representative one. But this might not always be true—the soup might need stirring after ingredients have just been added.

17.1.c Not a good argument. It confuses the relative increase in risk (the 100% in the first sentence) with the absolute risk (the second one).

17.1.d The sample is not as representative as one might like, since the men were interviewed outside a toy shop on a Sunday. They were more likely to be family-minded people.

17.1.e There are many reasons why students skip lectures, such as time-tabling issues. But the other problem with the argument that has to do with statistics is that no information is

given about student number. A larger class will have more students skipping, and it is the ratio that should be compared, not the absolute number.

17.1.f There are no data about the sample size and the number of companies surveyed. But the more serious problem is that the data cited are about only a correlation between two ratings by the respondents. There is no evidence of the direction of causation, and in fact no data at all about the actual qualities (for example, the degree of creativity) that the ratings are supposed to reflect.

17.1.g This question concerns a topic we have not discussed in this chapter. If *average* means "arithmetical mean", then a $9 average is compatible with there being lots of very expensive games and lots of very cheap ones. So it does not follow that most of the games are under $10. To learn more, go online and search for "mean", "median" and "mode".

17.1.h Whether it is worth the higher price depends of course on lots of things: how rich you are, whether there are side effects, and so on. But it might also be useful to check the reduction in risk in absolute terms. A reduction of the heart attack rate from 2.5% to 2% is a 20% reduction, but the 0.5% difference is not so impressive any more.

17.2.a Yes.

17.2.b No. Some people might have no opinion. Others might approve or disapprove, but not strongly.

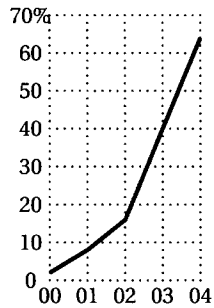
17.2.c "Up 6%" is a comparison, "at 6%" is not.

17.2.d GDP still increases if GDP growth is weak, but not when it is declining.

17.3.a There is no vertical scale, and it does not seem to start from zero. According to the figures shown, the number of people who disagree is only about 18% more than the number of those who agree. But the difference in height conveys a very different and misleading impression.

17.3.b Again there is no vertical scale. Also, the width of the second bar has changed for no reason. The profit has nearly doubled, which corresponds to the difference in height, but the unmotivated change in width gives the inaccurate impression that the profit has increased by a lot more than that.

17.3.c The vertical scale is strange and as a result gives the misleading impression that the increase in failure rate has slowed down, when in fact the opposite is true:



17.3.d The number of households has roughly doubled, which corresponds to the difference in height. But the difference in area in the two symbols gives the impression that the increase might be a bit more than that.

17.3.e No scale and no unit, and it is not clear whether the difference in width in the column means anything.

17.3.f Problem 1: The symbols do not uniformly all represent the same number, which makes comparison more difficult. Problem 2: The sizes of the symbols do not match the number they represent—for example, the cat is larger than the bird but they both indicate 5.

17.4 This is a bit hard to say. The two charts are the same except for the origin of the vertical axis. The second chart looks more impressive because the growth in sales seems exponential, but at the same time it also makes people think that the first few months are comparatively dismal.

17.5.a This is the gambler's fallacy.

17.5.b The reasoning is correct.

17.6 This exercise is adapted from a famous experiment by psychologists Amos Tversky and Daniel Kahneman. The first choice is an irrelevant decoy. What is crucial is that the third choice *cannot* be more probable than the second. But many people rank the third choice as more probable than the second, which is the **conjunction fallacy**. The third sentence is a conjunction of the second sentence plus an extra condition. So the third sentence must have a lower probability than the second one (unless the extra condition is certain, in which case they have the same probability).

SOLUTIONS FOR CHAPTER 18

18.3 It is tempting to say that it is a normative statement because it has the word *good* in it. But normative statements are supposed to have implications about what the world ought or ought not to be like, or they tell us something about which things are valuable or undesirable. By these standards the statement is not normative. It does not say anything about whether solving mathematical problems is a good or valuable thing. (Compare: He is good at murdering innocent people.) We might perhaps regard it as a factual statement that is rather vague. The statement tells us that he is generally accurate in coming up with solutions to these problems, but it is not clear exactly how accurate he is. This is like the statement "he is tall." It is an empirical or factual statement, but it is not very precise either.

18.4 Contextualism and absolutism are about specific types of behavior. You can consistently be a contextualist about an action X and an absolutist about a different action Y. But it is inconsistent to accept both contextualism and absolutism about the same action.

18.5.a If a person promised to do something, he should do it.

18.5.b A person has the right to do whatever he or she wants within her own property, even if it causes annoyance to people outside.

18.5.c A person should not take something that does not belong to him or her without the owner's permission.

18.6.a Not equivalent, and if moral duties do not conflict with each other, then the second statement entails the first.

18.6.b Equivalent.

18.6.c Not equivalent. The second statement is consistent with it being up to you whether to disclose, but not the first one.

18.7.a A very straightforward invalid argument. Compare: Cats are animals. But dogs are not cats. So dogs are not animals.

18.7.b The first argument is not valid because it equivocates between two meanings of *right.* Having the right to do something in the sense of being entitled to do it does not entail that it is morally right to do it (that it ought to be done).

18.8 *Hint:* What about important matters relating to one's own privacy?

18.9 It seems to be a consistent moral relativist position. David did not say that everyone ought to respect other points of view. If so that would be inconsistent. He said this is only what he should do.

SOLUTIONS FOR CHAPTER 19

19.1.a The quote is from Epstein (1999). Agreed by whom? And why must a fallacy be unrepairable? An argument relying on very weak evidence is a fallacy but it can become a good argument if more evidence can be provided.

19.1.b The quote is from Rudinow and Barry (2007). We have argued that a fallacy need not be an inference or argument. One might also object to the claim that fallacies tend to appear to be reasonable because they are inferences. Circular inferences are fallacious but they need not appear to be reasonable.

19.1.c This definition is from Hurley (2006). The author includes complex question and false dichotomy as fallacies, but neither is an argument.

19.2.a Maybe the cup has been lost already, or maybe it is just hidden somewhere. But this need not be a fallacy if the person making the argument has good reason for ruling out these and similar possibilities.

19.2.b False dilemma.

19.2.c Something not being proven to be false is not a good enough reason to think that it is true.

19.2.d This is the fallacy of composition. The tasty ingredients might not combine well with each other.

19.2.e Fallacy. People drive more during the day.

19.2.f Not a fallacy, but a valid argument with false premises.

19.2.g It is a fallacy and not a good argument. Maybe those Facebook friends of yours who are idiots are not my Facebook friends.

19.2.h Fallacy. There might be many other better explanations of why most scientists are men.

19.2.i Fallacy of composition.

19.2.j Not a fallacy.

19.2.k If something is irreversible how can it change? This quote is often attributed to former U.S. Vice President Dan Quayle.

19.2.l This seems like a case of fallacy of inconsistency. If the educational system is already very efficient, it will be impossible to have more schools and teachers without putting in extra money.

19.2.m Not a fallacy, unless there is good reason to think that other alternatives have been ignored.

19.3 Formal fallacies are fallacies that can be defined purely by their form or logical structure, such as denying the antecedent and affirming the consequent. Informal fallacies are fallacies that are defined not by their logical structure but by their content—for example, appeal to pity or confusing correlation with causation.

SOLUTIONS FOR CHAPTER 20

20.3 We can be humble even if we have an accurate picture of our own ability, such as knowing our actual weaknesses and recognizing that we all make mistakes, that nobody is perfect, and that we can learn from other people and improve ourselves further.

20.4 This is a test of consistency in risk assessment. Whatever your answers were, they should add up to 100%, because either you have an accident when you travel, or your travels will be accident free. But given that these two questions were placed so closely together in a chapter about cognitive biases, you might be more alert and find this too obvious. But many people do get this wrong.

20.5 In one experiment, students who answered this question gave an average estimate of about 2,250. But some other students were asked to solve the same problem, which is formulated as follows:

$$1 \times 2 \times 3 \times 4 \times 5 \times 6 \times 7 \times 8 = ?$$

The average answer this time turned out to be 512! The explanation is that when the students did not have time to do a complete calculation, they looked at the first few numbers

and computed a rough estimate and made some adjustments. Their answers were therefore biased by the presentation of the problem. By the way, the correct answer should be 40,320.

20.6 There is indeed a correlation. People who watch more violent TV are more likely to believe that the world is a violent place. This fits in well with the idea of availability discussed in the chapter. See Gerbner et al. (1980).

20.7 When you think "I exist," that is sufficient to make it true since you cannot think without existing. Similarly, when you think "I am thinking about lunch," your very act of thinking makes it true that you are thinking about lunch! There are also cases where collective wishful thinking might make something true—if enough people think that stocks will go up, they might end up pushing the market higher, even if this is divorced from the financial fundamentals. It is of course possible that things will come crushing down eventually.

SOLUTIONS FOR CHAPTER 21

21.2.a No. Just an analogy.

21.2.b Yes.

21.3.a First, the fetus has a greater potential to develop into a human being. Second, depending on the stage of development, the fetus might be able to have conscious experiences and perhaps even feel pain.

21.3.b At least two differences: Taxation repays some of the money that the government spends on basic services provided to the society. Also, taxation can have a redistributive element if some of the money goes to people who are less fortunate.

21.3.c One significant difference is that weather reports do not affect the weather, but the contents of magazines can affect what people think and do.

SOLUTIONS FOR CHAPTER 22

22.1 Here are some of the questions you should ask: How serious is the flu? Is it very contagious? How effective is the vaccine if it is not 100%? Is it expensive to get one? How serious are the allergic reactions? Are they life threatening? Which people are more likely to get the flu or the allergic reaction? How many people have taken the vaccination?

22.2 If you read the choices carefully, you might notice that program C is just a reformulation of program A, and D a reformulation of B. So ideally your choices should be the same in both cases to be consistent. But psychologists have found that many people pick A instead of B, and D instead of C. The usual explanation is that people generally are risk aversive when it comes to gain (hence preferring A to B), and risk seeking when it comes to losses (preferring D to C). But the experiment also illustrates the power of *framing*—people can make very different decisions in regard to the same problem depending on how the problem is formulated.

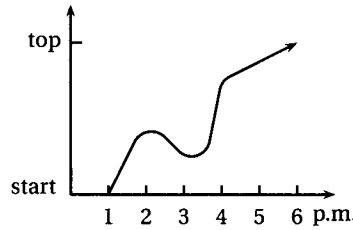
22.3 Only the first example.

SOLUTIONS FOR CHAPTER 23

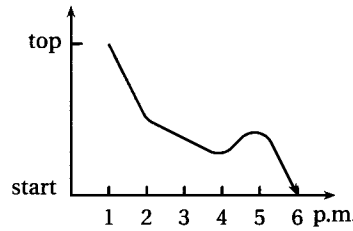
23.2.a Some options: Get some advice from friends or see a counsellor. Meet up less regularly.

23.2.b One possibility: Make the system more efficient so that savings can be used to build more prisons.

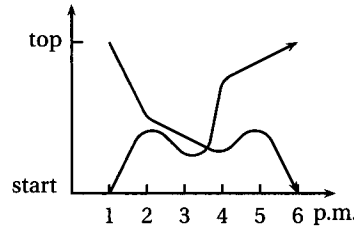
23.3 Thinking about the problem abstractly might seem difficult, but the solution is very easy if you represent it correctly with a diagram. Start with a diagram showing the altitude of the hiker at various times on his way up. It might look something like this:



The diagram for the descent might look like this:



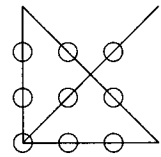
If you superimpose the two diagrams, it is easy to see that there must be at least one point where the two curves intersect. It does not matter how fast the hiker was going or whether he stopped more than once.



This is an illustration of how representing a problem in the right way—using the appropriate visualization aid—can make the problem easier to solve. This is why changing perspectives is so crucial for creativity.

SOLUTIONS FOR CHAPTER 24

24.1



Many people drawing lines only within the area circumscribed by the dots. But the puzzle does not say the straight lines cannot extend outside the dots, and in fact the solution requires you to do so. When we solve problems we often have implicit assumptions about what might or might not be feasible, and what the solution might look like. We need to ensure that these assumptions are not unfounded or else they stop us from discovering the more innovative and effective ideas. This is why many people say that creativity involves thinking outside the box, breaking away from self-imposed constraints.

24.2.a Hint: The lines have to be very long, and remember that the lines do not have to go through the center of the dots.

24.2.b This is somewhat a trick question admittedly, but it can be done if you tear the page out and roll it up!

Bibliography

Ackerman, J., Nocera, C., and Bargh, J. (2010). Incidental haptic sensations influence social judgments and decisions. *Science*, 328(5986):1712–1715.

Adams, P. and Adams, J. (1960). Confidence in the recognition and reproduction of words difficult to spell. *The American Journal of Psychology*, 73(4):544–552.

BBC (2010). Job applications "full of errors". Available at: http://news.bbc.co.uk/2/hi/business/6226439.stm. Accessed July 19, 2010.

BBC News (2003). Online jargon buster takes bull by the horns. Available at: http://news.bbc.co.uk/2/hi/business/3014702.stm. Accessed June 15, 2010.

Churchill, A. (1905). Edison and his early work. *Scientific American Supplement*, 59:2451–2452.

Cucherat, M., Haugh, M., Gooch, M., and Boissel, J. (2000). Evidence of clinical efficacy of homeopathy. *European Journal of Clinical Pharmacology*, 56(1):27–33.

Economist (2010). Economist debates: Religion. Available at: http://www.economist.com/debate/days/view/591. Accessed October 7, 2010.

Epstein, R. (1999). *Critical thinking.* Wadsworth, Belmont, MA.

Fang, X., Singh, S., and Ahluwalia, R. (2007). An examination of different explanations for the mere exposure effect. *Journal of Consumer Research,* 34(1):97–103.

Franklin, B. (1772/2009). *Memoirs of the life and writings of Benjamin Franklin.* Timber Wood Publishing.

Galinsky, A. D. (2004). Should you make the first offer? *Negotiation,* 7:9–11.

Gartrell, N. and Bos, H. (2010). US national longitudinal lesbian family study: Psychological adjustment of 17-year-old adolescents. *Pediatrics,* 126(1):28–36.

Gerbner, G., Gross, L., Morgan, M., and Signorielli, N. (1980). The "mainstreaming" of America: Violence profile no. 11. *Journal of Communication,* 30(3):10–29.

Hart, W., Albarracín, D., Eagly, A., Lindberg, M., Merrill, L., and Brechan, I. (2009). Feeling validated versus being correct: A meta-analysis of selective exposure to information. *Psychological Bulletin,* 135(4):555–588.

Hawking, S., Thorne, K., Novikov, I., Ferris, T., and Lightman, A. (2003). *The Future of Spacetime.* Norton, New York.

Hossain, T. and List, J. A. (2009). The behavioralist visits the factory: Increasing productivity using simple framing manipulations. NBER Working Paper Series s15623, National Bureau of Economic Research, Inc.

Hurley, P. (2006). *A Concise Introduction to Logic.* Wadsworth, Belmont, CA.

James, W. (1907/1995). *Pragmatism.* Dover Publications, New York.

Kruger, J. and Dunning, D. (2002). Unskilled and unaware of it: How difficulties in recognizing one's own incompetence lead to inflated self-assessments. *Academic Psychiatry,* 26(1):49–49.

Lammers, J., Stapel, D., and Galinsky, A. (2010). Power increases hypocrisy. *Psychological Science,* 21(5):737–744.

Larwood, L. and Whittaker, W. (1977). Managerial myopia: Self-serving biases in organizational planning. *Journal of Applied Psychology,* 62(2):194–198.

Malcolm, N. (2001). *Ludwig Wittgenstein: A Memoir.* Oxford University Press, Oxford, UK, 2nd edition.

Martel, F. (2010). BP CEO: Gulf of Mexico Is a "very big ocean", amount of oil from leak Is "tiny". Available at: http://www.mediaite.com/online/bp-ceo-gulf-of-mexico-is-a-very-big-ocean-amount-of-oil-from-leak-is-tiny/. Accessed July 27, 2010.

McRae, C., Cherin, E., Yamazaki, T., Diem, G., Vo, A., Russell, D., Ellgring, J., Fahn, S., Greene, P., Dillon, S., et al. (2004). Effects of perceived treatment on quality of life and medical outcomes in a double-blind placebo surgery trial. *Archives of General Psychiatry*, 61(4):412–420.

Michalko, M. (2006). *Thinkertoys: A Handbook of Creative-Thinking Techniques.* Ten Speed Press, Berkeley, CA.

Michell, J. and Rickard, R. J. M. (1977). *Phenomena: A Book of Wonders.* Pantheon, New York.

Morris, M., Sheldon, O., Ames, D., and Young, M. (2007). Metaphors and the market: Consequences and preconditions of agent and object metaphors in stock market commentary. *Organizational Behavior and Human Decision Processes*, 102(2):174–192.

Moseley, J., O'Malley, K., Petersen, N., Menke, T., Brody, B., Kuykendall, D., Hollingsworth, J., Ashton, C., and Wray, N. (2002). A controlled trial of arthroscopic surgery for osteoarthritis of the knee. *The New England Journal of Medicine*, 347(2):81–88.

Nemeth, C. and Ormiston, M. (2006). Creative idea generation: Harmony versus stimulation. *European Journal of Social Psychology*, 37(3):524–535.

Newby-Clark, I., Ross, M., Buehler, R., Koehler, D., and Griffin, D. (2000). People focus on optimistic scenarios and disregard pessimistic scenarios while predicting task completion times. *Journal of Experimental Psychology: Applied*, 6(3):171–182.

Northcraft, G. and Neale, M. (1987). Experts, amateurs, and real estate: An anchoring-and-adjustment perspective on property pricing decisions. *Organizational Behavior and Human Decision Processes*, 39(1):84–97.

Oppenheimer, D. (2006). Consequences of erudite vernacular utilized irrespective of necessity: Problems with using long words needlessly. *Applied Cognitive Psychology*, 20(2):139–156.

PBS (2010). Solving fermat: Andrew wiles. Available at: http://www.pbs.org/wgbh/nova/proof/wiles.html. Accessed July 19, 2010.

Peters, T. and Waterman, R. (1982). *In Search Of Excellence: Lessons from Americans Best Running Companies.* Harper & Row, New York.

Polya, G. (1971). *How to Solve it: A New Aspect of Mathematical Method.* Princeton University Press, Princeton , NJ.

Pronin, E., Lin, D., and Ross, L. (2002). The bias blind spot: Perceptions of bias in self versus others. *Personality and Social Psychology Bulletin*, 28(3):369–381.

Rauscher, F., Shaw, G., and Ky, K. (1995). Listening to Mozart enhances spatial-temporal reasoning: towards a neurophysiological basis. *Neuroscience Letters*, 185(1):44–47.

Rota, G. and Palombi, F. (2008). *Indiscrete Thoughts*. Birkäuser, Boston, MA.

Rothbard, M. (2010). Ten ethical objections to the market economy. Available at http://www.mises.org/story/1469. Accessed July 19, 2010.

Rudinow, J. and Barry, V. (2007). *Invitation to Critical Thinking*. Wadsworth, Belmon, CA.

Russell, B. (1935). On the value of scepticism. In *Sceptical Essays*, pages 27–29. Allen & Unwin, London.

Russell, B. (2003). How I write. In Bone, A., editor, *The Collected Papers of Bertrand Russell*, volume 28, pages 102–104. Routledge, London, UK.

Scriven, M. and Paul, R. (1987). Statement for the national council for excellence in critical thinking. Presented at the 8th Annual International Conference on Critical Thinking and Education Reform.

Shickle, D. (2000). On a supposed right to lie [to the public] from benevolent motives—Communicating health risks to the public. *Medicine, Health Care and Philosophy*, 3(3):241–249.

Sober, E. (1988). The principle of the common cause. In Fetzer, J., editor, *Probability and Causality: Essays in Honor of Wesley C. Salmon*, pages 211–228. Reidel, Boston.

Song, H. and Schwarz, N. (2008). If It's hard to read, it's hard to do. *Psychological Science*, 19(10):986–988.

Svenson, O. (1981). Are we all less risky and more skillful than our fellow drivers? *Acta Psychologica*, 47(2):143–148.

Thaler, R. and Sunstein, C. (2008). *Nudge: Improving Decisions about Health, Wealth, and Happiness*. Yale University Press, New Haven.

Tharp, T. (2003). *The Creative Habit: Learn it and Use it for Life*. Simon and Schuster, New York.

Torrance, E. (2002). *The Manifesto: A Guide to Developing a Creative Career*. Ablex, New York.

Twardy, C. (2004). Argument maps improve critical thinking. *Teaching Philosophy*, 27:95–116.

Uhlmann, E. L. and Cohen, G. L. (2007). "I think it, therefore it's true": Effects of self-perceived objectivity on hiring discrimination. *Organizational Behavior and Human Decision Processes*, 104(2):207–223.

Wolf, G. (1996). Steve jobs: The next insanely great thing. *WIRED*, 4(2).

Young, J. W. (1975). *A Technique for Producing Ideas.* Crain, Chicago, 3rd edition.

Zuckerman, E. and Jost, J. (2001). What makes you think you're so popular? Self-evaluation maintenance and the subjective side of the "friendship paradox". *Social Psychology Quarterly*, 64(3):207–223.

INDEX