

Chapter 1

Introduction: What is Critical Thinking

Understanding, Learning, and Teaching Critical Thinking

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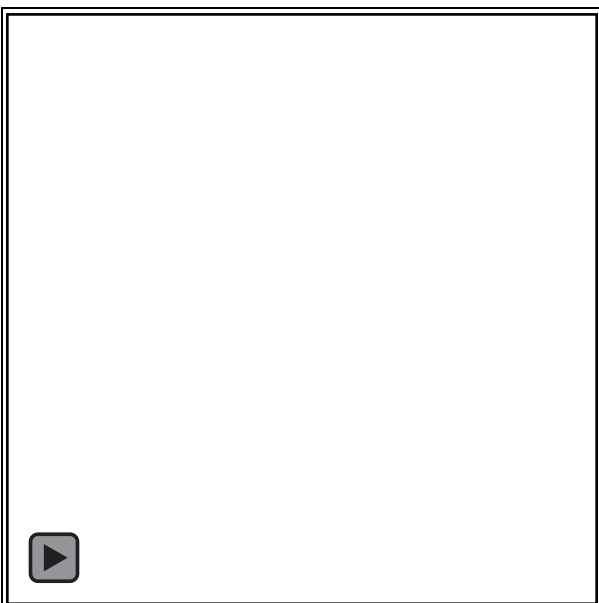
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1.1 Introduction

Most textbooks and teachers of critical thinking take the same general approach to the topic: Critical thinking courses and instructors typically focus almost exclusively upon the extraction, evaluation, and creation of arguments--primarily arguments of a specific kind (deductive arguments). Thus, the standard approach to critical thinking focuses almost exclusively on isolated cases of formalized reasoning, i.e., the extraction and evaluation of arguments. While the extraction and evaluation of arguments is an important skill, this text and course take a broader, more holistic approach to critical thinking. In this chapter, I present my own view of critical thinking. I discuss the strengths and limitations of critical thinking instruction as well as the typical misconceptions present in many textbooks, classes, and curriculum design. I likewise present the approach adopted in this text and the reasons for adopting that approach.

1.1.a Critical Thinking Courses are not a Panacea for Reasoning

Cast in the least flattering light, many standard critical thinking texts and instructors propagate two false assertions regarding the benefits of critical thinking courses. These demonstrably false suppositions lurk implicitly in most critical thinking texts, in the thoughts of many instructors, and in the minds of those who design curriculum. What are these suppositions? **(1) Simply by taking a critical thinking course students can dramatically and uniformly improve as thinkers as well as gain immunity from a wide array of reasoning errors.** **(2) The ability to dramatically and uniformly improve reasoning exhausts the subject matter of critical thinking and constitutes the sole source of its utility.** The discussion of actual human reasoning abilities throughout this text reveals the stunning inaccuracy of these widely held beliefs regarding critical thinking. Indeed, the supposition that taking a critical thinking course can cure bad reasoning proves as ill-conceived and implausible as the supposition that taking an ethics course can cure serial killers like Ted Bundy and John Wayne Gasy of their psychopathy. Furthermore, the two above assumptions ignore the many other features that shape one's perception and reasoning within a given problem context. For example, how one conceptualizes a situation serves to highlight certain information and renders other information opaque. Hence, as later chapters note, context influences human inferences. Effective critical thinkers must also possess other knowledge, habits, and skills--like effective decision-making skills.



Richard Wiseman's Color Changing Card Trick video. Click to start video. From: [Youtube](#)

But, before painting a more nuanced picture of effective critical thinking, let's finish the discussion of why a critical thinking course cannot dramatically and uniformly improve human reasoning. The challenges to improving human reasoning and decision-making stem from three central features of human cognition. **First**, millions of years of evolution have shaped the structure and functioning of the human brain, influencing human reasoning processes operating across a wide variety of circumstances. **Evolutionary selection has resulted in a number of innate, automatic, and largely unconscious human reasoning and decision-making tendencies. These innate, automatic, and largely unconscious reasoning tendencies constitute the core set of the inference strategies one initially employs under many, if not most, circumstances.** One might usefully think of

one's native reasoning abilities as hardwired by genetics so as to dispose one towards adopting certain styles of problem-solving. The story, of course, proves more complicated than this simple analogy. Nevertheless, consistently modifying, discarding, or overriding one's most basic reasoning strategies proves extremely difficult for humans. **Second**, humans have a relatively small working memory. One can think of working memory much like the RAM in a computer; one's brain uses working memory to hold and operate upon information when consciously solving problems or making decisions. Human working memory proves small enough that the information available to humans in a given problem-solving context quickly exhausts working-memory capacity. **Working memory capacity, as a result, places strong limitations on every human's ability to adapt and respond flexibly in problem-solving and decision-making.** The **third** barrier to improving reasoning lies in the inherent complexity of many of the problems humans must solve. **The real-world presents us with many complicated problems that prove challenging to solve in a reasonable amount of time and with limited resources.** Many features of a given problem can affect its complexity. Examples of problem complexity and the limits such complexity place on effective reasoning and decision-making emerge throughout the text, but the color changing card trick video (above) provides a simple example of complexity resulting from too much information overwhelming working memory. In short, the real-world presents us with many complicated problems that prove challenging to solve in a reasonable amount of time and with limited resources.

1.1.b Native Human Reasoning Abilities are Relatively Inflexible

The three challenges to improving reasoning also provide an explanation for why simple instruction on reasoning and decision-making often cannot dramatically improve people's performance on such tasks. Instruction can do little to alter innate, automatic, and largely unconscious human reasoning tendencies. Genetics and development largely determine such tendencies; millions of years of evolution have essentially hardwired these dispositions into the very structure and functioning of your brain. Likewise, instruction has little impact on the complexity of real-world inference and decision problems. The good news is that the insights of multiple millennia of intelligent and thoughtful people have yielded alternative strategies that often prove effective in many cases where innate reasoning and judgment tendencies fall victim to systematic errors. However, once again genetics and development limit one's ability to consistently adopt such strategies. In many cases, the paucity of working memory resources limits one's capacity for adaptive responses. Specifically, in order to employ an alternative strategy in making an inference or a decision in a specific case one must have the adequate reserve working memory capacity necessary to recognize the potential difficulties posed by the situation, inhibit one's innate dispositions, and execute the alternative strategy using conscious inference. Sadly, people normally lack sufficient working memory reserves to regularly and reliably execute such alternative strategies.

1.1.c Native Human Reasoning Abilities Have Strengths and Weaknesses

Reasoning and decision-making tendencies—whether innate or learned—are neither inherently good nor bad. Rather, these tendencies—like almost all choices and strategies—combine strengths and weaknesses. Understanding the strengths and weaknesses of native as well as invented reasoning and decision-making strategies constitutes one of the major organizational themes of this course and lectures. Understanding how humans naturally approach problems opens a window of opportunity for adaptation. As will become clear, however, that window proves much smaller and opens much less frequently than people suppose.

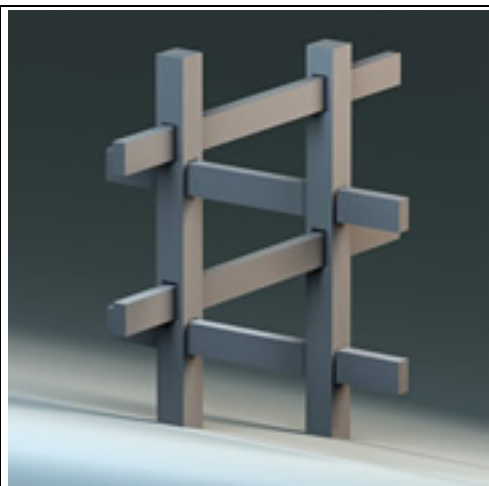
1.1.c.1 Tradeoffs

What exactly does it mean to say that reasoning and decision-making tendencies--like almost all choices and strategies--combine strengths and weaknesses? Let's consider an example. Suppose you want to buy a new laptop computer. You likely have many different features that you find desirable—speed, ease of use, battery life, cost, and so on. No one candidate computer likely optimizes every feature on your list. Faster computers cost more, so you must trade price for speed. Laptops with smaller screens tend to have better battery life, making you trade display size for battery life. Such choices represent trade-offs between different features. Similarly, you probably use your computer in different circumstances and for different purposes. If you like to watch movies on your computer, you might desire a larger screen for that purpose. You may not have access to plugs in class, so you might want better battery life during school hours. You might play games sometimes, so that speed proves highly desirable for your gaming. But you might also write papers and chat often—tasks that don't require high-speed computing. Thus, whatever trade-offs you make, you will likely find that your new laptop or phone functions better for some uses and worse for others.

The human brain is like your computer in this way. Human evolution has shaped your brain so that it can perform many tasks in many circumstances. Humans rely on a number of innate, automatic, and largely unconscious human reasoning tendencies. The human brain likewise has many relatively fixed elements of its architecture. Just like your computer, your brain represents trade-offs between various desirable features. Many of the chapters and lectures that follow discuss the sorts of trade-offs and circumstances that have come to shape humanity's native reasoning and decision-making abilities. These chapters also discuss how these different trade-offs result in various strengths and weaknesses in human native reasoning abilities.

1.1.c.2 Assumptions

Recall that earlier I listed three central features of human reasoning and decision-making that pose challenges to improving human performance. The second and third features act as constraints on all cognitive task performance. The evolution of both the human brain and the innate tendencies that drive human problem-solving reflect strategies to solve problems given these constraints. Specifically, all organisms must solve problems with finite resources and within a finite timeframe. Likewise, in order to utilize information to adaptively respond organisms must solve increasingly complex inferential and decision problems. In addition to illustrating how organisms must adapt to solve complex problems with finite resources human visual object



Impossible object picture. From: [Thinking at the margin](#)

recognition it reveals the complexity of even seemingly effortless problems. In good conditions humans can recognize an object in their visual field as well as determine its relative size and position in depth within about 300 milliseconds. The ability to recognize objects and place them in 3D space within a third of a second is a quite complex problem. To solve the problem the brain must infer objects and their relative positions in 3D space from an array of light intensity values collected by cells at the back of your eyes. Part of that ability depends upon the assumptions. For instance, the visual system assumes that local junctions between the edges of objects will prove consistent with one another. At first glance the object to the left appears normal.

However, when focusing your attention on the first and second rungs between the posts it becomes clear that these rungs violate the consistency constraint. The top rung requires

parallel vertical posts in depth with the rightmost post farther away from the viewer. The second rung requires that the posts are parallel in breadth and at equal depth from the viewer. So, to solve the difficult problem of inferring objects and their relative positions in 3D space from an array of light intensity values the brain makes assumptions about how edges come together in space. Relying upon assumptions that simplify problems helps organisms to solve complex problems with limited resources in finite time. However, the cost of this strategy becomes clear when one realizes that situations violating those assumptions can lead to mistakes that are often difficult for the organism to detect and correct. Indeed, knowing that the above object is impossible does not result in your seeing it differently.

1.2 The Potential of Critical Thinking

So, innate unconscious automatic tendencies drive many aspects of human reasoning, limiting one's ability to modify one's reasoning strategies. Working memory provides real limits on the quantity and complexity of information that humans can consciously process. Many, many real world problems represent incredibly complex inferences. Together these facts might appear to undermine any benefit one might receive from a critical thinking course. On the contrary, these facts do not render critical thinking courses useless or unimportant—quite the opposite. Making a consistent and effective effort to become a more competent, literate thinker and decision-maker has tremendous benefits that accumulate throughout one's life. Indeed, the compounding of benefits across time or across many individuals allows critical thinking to attain the status as one of the most important courses students ever take. For example, experts at the [U.S. Department of Commerce Economics and Statistics Administration](#) estimate that the decision to seek a university degree results in wages, on average, totaling about 2.24 million dollars over a 40-year working lifetime compared to 1.31 million for the average worker having a high school diploma.^{1, 2} In other words, a single decision could, on average, nearly double your lifetime earnings. In more concrete terms, the differences in the possible outcomes of a single decision (going to college) can result in an average yearly difference in mean wages of \$23,256 (\$32,862 per year versus \$56,118) for each year of one's working lifetime.

1.2.a Truth and Falsity of Individual Beliefs as the Goal of Critical Thinking

Typical justifications of critical thinking given in textbooks usually focus exclusively upon the impact of having true beliefs versus having false beliefs. True beliefs have positive value because they provide insight into the world. True beliefs help to guide one's actions and decisions so that one's behavior and decisions can reliably and effectively result in positive outcomes. False beliefs, in contrast, have negative value in that false beliefs misrepresent the world. False beliefs can result in unproductive or wasteful behavior and decisions. False beliefs can likewise corrupt other beliefs and thought processes.



Modern recreation of the Norse site at L'Anse aux Meadows from [Wikipedia](#)

To illustrate the negative value of false beliefs as well as the potential of false beliefs to negatively impact one's actions and decisions consider the example of Columbus Day: The United States created Columbus Day as a federal holiday in 1937 and still recognizes Columbus Day as an official holiday. Argentina (1917), Colombia (1921), Chile (1922), Mexico (1928), and Venezuela (1921) all have similar holidays.³ Yet, historians have long known that some of the most common beliefs about Columbus--beliefs that might provide a rationale for such a holiday--are patently false. For instance, despite the continuing popular misconception, scholars no longer recognize Columbus as the European

discoverer of the Americas. In 1874, Norwegian Professor Rasmus Bjørn Anderson argued that Norwegians discovered the Americas. Since the early 1960s scholars identified [Bjarni Herjólfsson](#)⁴ as the first European to sight the Americas in 986 ACE. While Herjólfsson never landed his ship, [Leif Ericson](#)⁵ bought Herjólfsson's ship and retraced Herjólfsson's course to become the first European to discover and land on the Americas in 1000 ACE. Ericson and his extended family lived in Newfoundland for approximately ten years, where archeologists have excavated and reconstructed the settlement.⁵⁻⁷

Likewise, scholars do not identify Columbus as the first European to identify the Americas as a continent since others realized that the Americas were a new continent before Columbus. German cartographer [Martin Waldseemüller](#)⁸ teamed with an Alsatian German colleague [Matthias Ringmann](#)⁹ to create their *Universalis Cosmographia* (1507), the first map identifying an American continent. Waldseemüller and Ringmann name the continent "America"—why? They named the continent after [Amerigo Vespucci](#).¹⁰ Vespucci, a Florentine merchant, went on at least two voyages to the Americas. When Vespucci's (possibly altered) letters appeared in print, his observations indicated that the landmass he explored had many features (e.x. sheer immensity) inconsistent with the Indies. When cartographer [Gerardus Mercator](#)¹¹ also named the continent "America" in his 1538 map it led to the general adoption of that name.¹²⁻¹⁴



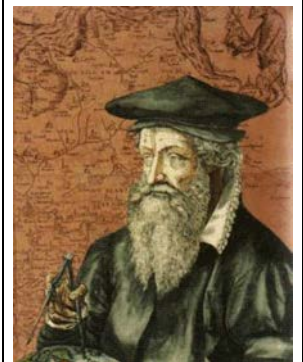
Dióscoro Teófilo Puebla Tolín's 1862 depiction of Columbus landing in the new world, entitled, *First Landing of Columbus on the Shores of the New World*. From: [Wikipedia](#)



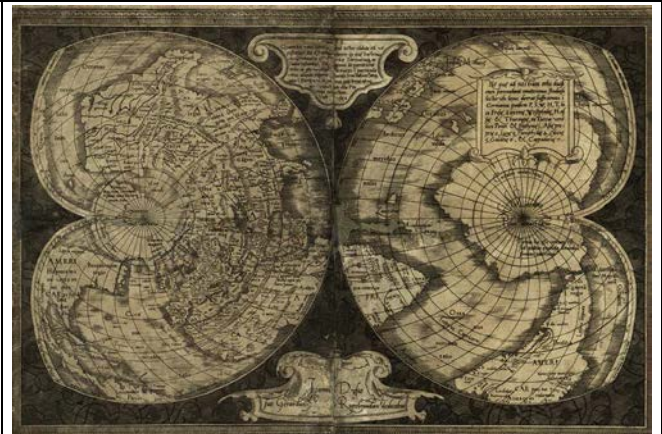
Portrait of Amerigo Vespucci (1454 -1512) From: [Smithsonian Magazine](#)



Portrait of Martin Waldseemüller (c.1470-1520) From: [Behring Film](#)



Drawing of Gerhard Mercator (1512-1594) From: [Maths for Europe](#)



(Left) Gerard Mercator's 1538 World Map on double Cordiform Projection. From: [Geographical Library Digital Collection](#). **(Right)** Martin Waldseemüller's 1507 *Universalis cosmographia secundum Ptholomæi traditionem et Americi Vespucii aliorv que Iustrationes*. From: [Cornell University Library Map Collection](#)

Likewise, many people think that Columbus championed the belief that the world was round against the then-prevalent belief in a flat world. Indeed, people often believe that Columbus set out on his voyage to disprove the flat Earth hypothesis. These beliefs also lack any factual basis. Educated Europeans did not generally believe that the earth was flat when Columbus sailed on his voyage. Surprisingly, the belief in a round Earth

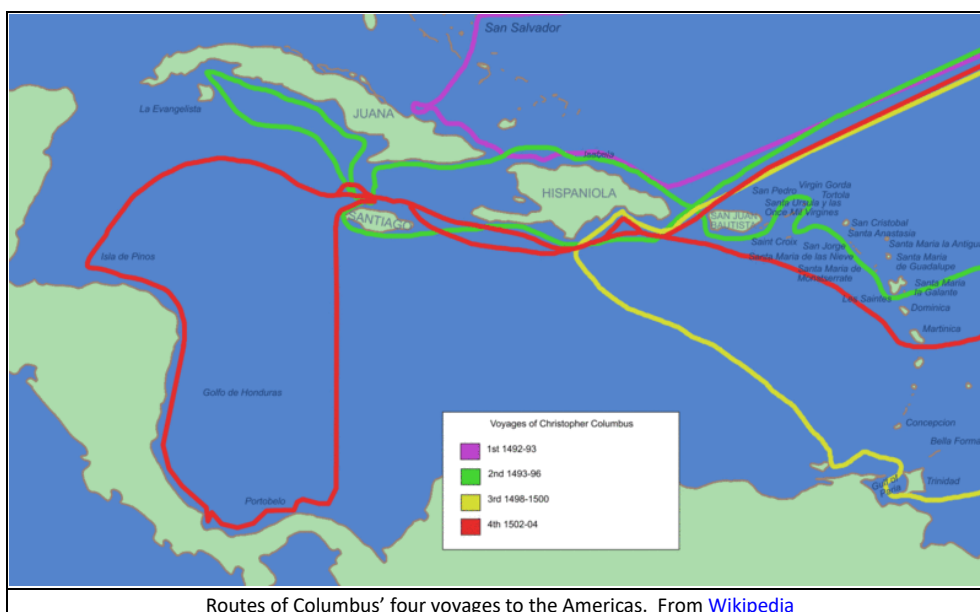
dates back to, at least, the ancient Greek philosophers Plato and Aristotle.¹⁵⁻¹⁹ [Eratosthenes of Cyrene](#) quite accurately estimated the Earth's diameter in 240 BCE (between 2% and 16% error).^{15, 20} Columbus' disagreement with other navigators of his time concerned how far he would have to sail to reach India--not the Earth's shape.

Finally, popular and even academic sources often portray Columbus as a great explorer and great man. Unfortunately, Columbus' actual and well-documented behavior reveals a greedy, ruthless, despotic, and malicious person. Columbus, it would seem, personifies some of the worst exploitive and imperialistic attitudes of the Europeans during this rather dark period of history.^{21, 22} Howard Zinn summarizes Columbus' treatment of the indigenous peoples of Haiti as follows:²¹

When the Spaniards took prisoners they hanged them or burned them to death. Among the Arawaks, mass suicides began, with cassava poison. Infants were killed to save them from the Spaniards. In two years, through murder, mutilation, or suicide, half of the 250,000 Indians on Haiti were dead. When it became clear that there was no gold left, the Indians were taken as slave labor on huge estates, known later as *encomiendas*. They were worked at a ferocious pace, and died by the thousands. By the year 1515, there were perhaps fifty thousand Indians left. By 1550, there were five hundred. A report of the year 1650 shows none of the original Arawaks or their descendants left on the island. (pp. 4-5).

In addition to cruelty and exploitation European explorers introduced diseases to the continent for which the indigenous population had no immunity. By some estimates 80 to 90 percent of the indigenous population died from diseases introduced from Europe.^{23, 24}

Columbus's own beliefs regarding the circumference of the Earth illustrate the negative value of false beliefs. Columbus' belief regarding the circumference of the Earth was false. He estimated the distance to India to be about 1/6 the actual distance. Worse still, due to the limitations in navigation during the 15th and 16th centuries, Columbus could not have discovered his error until he had sailed beyond the point of no return. Sailors of that time had no good way of measuring longitude (east-west position). Columbus could not have discovered his terrible miscalculation until it was far too late to turn back.^{12, 17-19, 25} If not for blind luck Columbus and his crew would have all died on the voyage. In short, Columbus' false belief misrepresented the world and led to potentially disastrous actions.



Similarly, Columbus falsely believes that he has reached the Indies despite the fact that the Caribbean islands offer none of the goods for trade that he expects. The indigenous inhabitants do not match what was known of the inhabitants of the Indies. Moreover, Columbus did not actually reach the American continent until his third voyage and never realized that he had

found a new continent. The consequences of Columbus' mistaken beliefs regarding his actual location and his actions to secure goods in order to satisfy his investors are, in part, chronicled above.

In summary, false beliefs regarding the motives, actions, character, and outcomes of Christopher Columbus' voyages have led to holidays celebrating his "accomplishments." False beliefs have distorted people's perception of the world leading to the unproductive and wasteful behavior of devoting a national holiday to Columbus. The discussion of Columbus serves only as a model for the impact of true and false beliefs. For example, students should be able to develop parallel illustrations of the positive value of true beliefs and the potential of true beliefs to reliably contribute to positive outcomes based upon historical or personal experiences.

1.2.b Beliefs and Decisions Generate Cumulative Positive and Negative Value

So, true beliefs tend to have positive value and contribute to more reliable and more robustly positive outcomes. False beliefs tend to have negative value and tend to undermine the likelihood of positive outcomes. Authors usually frame the discussion of the value of critical thinking in one of two ways: Many authors portray the positive impact of true beliefs on the critical thinker's life. Other authors note the negative impact of false beliefs upon the critical thinker's life and/or the lives of other people. Both arguments have merit, but only represent a miniscule portion of the total picture. Still, it is useful to review how such arguments go.

1.2.b.1 The Compound Benefits/Costs Argument for Critical Thinking

Imagine that this course allows you to form 14 good beliefs or make 14 good decisions each year for the rest of your life—say, 50 years. During your fifty years you will have made 700 good decisions. To illustrate the impact of even such a modest improvement in thought and decision processes, let's consider the cumulative nature of such benefits. Let's assign the immediate benefit of each good belief or choice you make to the positive impact of a single dollar. The cumulative benefit of each choice equals the cumulative benefit resulting from investing that dollar at 6% interest. At the end of 50 years, your modest investment of 700 dollars would have earned interest of \$4,566.47 giving you a total of \$5,266.47. In other words, the indirect or cumulative benefits (the investing income) of your 700 choice-dollars results in an approximate increase in benefit of 752% or 751 dollars for each initial dollar of immediate benefit. This simple investment illustration has a real basis in fact. This [New York Times](#)²⁶ article reports on one finding in a large literature linking education to increased happiness, health, longevity, income, as well as having other significant benefits. More generally, a large body of data dating back to the 1970s illustrates the predictive power of a college education on longevity, health, happiness, income and other desirable life outcomes.^{2, 27-31} Studies have even shown links between brain size, learning, stress, and longevity in other animals such as birds.³²⁻³⁴

One can likewise extrapolate the above argument to illustrate the impact upon others of adopting correct, well-evinced beliefs. Imagine that you receive the dollar and interest from each of your beliefs as before, but also that everyone in the world benefits from your beliefs. Of course, they will not benefit as much as you in most cases, but people tend to underestimate the impact of their actions upon others. Let's play it safe and assume that people benefit on average a mere 1/100th of one cent from a given belief you form. Since there are approximately 7.8 billion people on the planet, the net value equals \$780,000.00. That seems like a staggering and impossible number, but some beliefs do affect everyone on the planet-- even if just a little. Consider the fact that every gallon of gasoline a person uses introduces **twenty pounds** of carbon dioxide

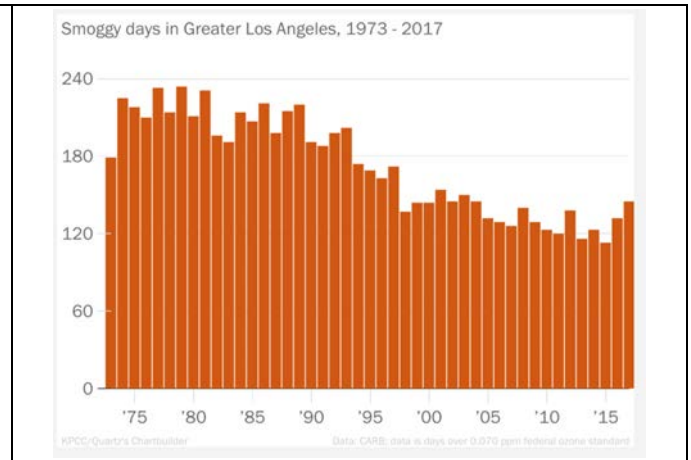
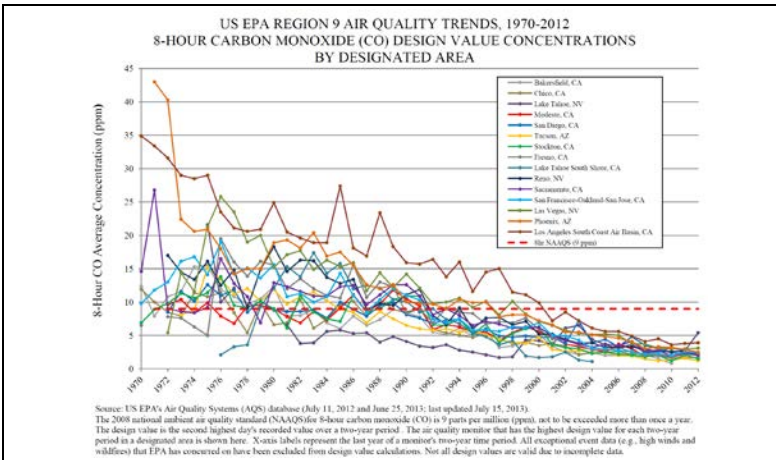


Chart from 2017 [EPA](#)

Chart from the [LAist.com](#)



(Above) 1952 Cars on South Broadway Place, Los Angeles in 1952. **(Below)** 1948 smog causes wrecks in LA. From: [Business Insider](#)



(Above) LA Civic center January 6, 1948. From: [UCLA Library Special Collections](#)
(Below) 1964 LA from the [LAist.com](#)



(Above) Motorcycle messengers 1955 From: [Timeline.com](#) **(Below)** Man wears gas mask on Broadway 1958. From: [Waterandpower.org](#)



(Above) Century City towers 1980 From: [UCLA Library Special Collections](#) **(Below)** Hollywood in 1995. From: [Business Insider](#)



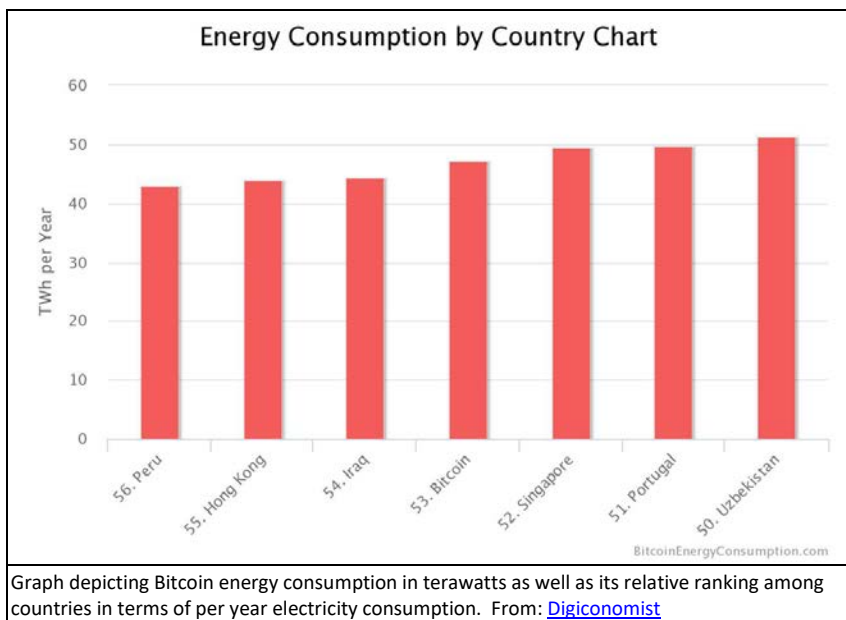
(CO₂) into the atmosphere.³⁵ This seemingly large amount of CO₂ emissions comes not just from burning the gasoline; it includes discovering the oil, drilling for the oil, refining it, transporting it, etc.. Given this fact, the simple choice of just riding your bike to school can reduce CO₂ emissions by more than your car's weight in a single year even if you drive a fuel-efficient car. Similarly, a recent estimate for solar panels on my house predicted that solar panels would lower my carbon footprint by 117 tons or approximately twice the weight of my house—the equivalent of driving a small car around the Earth's circumference nearly 16 times or planting 4,660 trees. Suppose that everyone on the planet decreased their carbon emissions by a single pound a year. The resulting reduction would equal approximately 4 million tons each year. Indeed, though Los Angeles continues to have the worst air quality of any major city in the US, tougher pollution and mileage standards enacted by the EPA and state beginning in the 1970s have resulted in dramatic, if imperfect, improvements in air quality. The pictures above show how severely smog affected Los Angeles from the late 1930s through the end of the 20th century—even driving some to non-ironically don gas masks.

The value of reducing one's driving or installing solar can have collateral positive effects as well. For instance, when people drive fewer miles it results in fewer cars on the road, reducing traffic congestion, lowering traffic

fatalities, and decreasing infrastructure costs. California, to take a case, currently levies a 41.7 cent per gallon gas tax on top of an 18.4 federal gas tax to help pay for infrastructure. Yet, the ASCE rates 50% of California's roads as in poor condition.³⁶ Reduced driving could allow California to more effectively meet the infrastructure needs of its citizens. Similarly, lowering pollution would also positively impact human health. Studies of *in utero* exposure to air pollution can include negative effects on lung function, lower birth weight and size, increased premature birth rates, and higher rates of intrauterine mortality.³⁷⁻³⁹ Traffic-related pollution is thought to be linked to slower cognitive development in school children.⁴⁰ Researchers also associate air pollution with neurological, cardiovascular, as well as respiratory illnesses and mortality. Scientists now estimate that air quality exceeds poor sanitation and lack of potable water as the number one cause of premature death worldwide.⁴¹⁻⁴³ The World Health Organization estimates that poor household air quality causes nearly four million premature deaths each year worldwide.⁴⁴ A recent review of the scientific literature concludes that limiting global emissions to a level that would result in a 2.7 degree Fahrenheit rise in global temperature would decrease air-pollution related mortality by 150 million people world-wide.^{45, 46} In the United States the Michael Greenstone and colleagues estimate that every 100 microgram decrease of total suspended particles per cubic meter results in a an average three years of added life per person.⁴⁷ Greenstone's calculation credits air quality improvement since the 1970s with adding eighteen months to the average US citizens' life, twenty months to the average Angelinos life, and a surprising 47.8 months to the life of the average resident of Mobile, Alabama.

The impact of choices on air quality demonstrates the power of time, numbers of agents, and collateral effects to compound the value or disvalue generated by our beliefs and choices. You will potentially live a longer and healthier life thanks to the choices of obscure scientists in a newly-formed governmental agency some fifty years ago. Furthermore, when one considers the impact of one's beliefs and decisions upon future generations, the potential value of a given belief or choice increases even more. The beliefs of people who helped to develop statistics, for instance, will impact everyone on the planet every day of their lives for the rest of the history of the human race. Of course, not everyone has such significant ideas, but one's beliefs have real impact upon oneself and upon others.

Finally, students should note that one can make the same sort of compounding effects argument with regard



to the negative impact to oneself or others when forming false beliefs. One can, for example, observe the compounded impact of false beliefs and/or poor decisions regarding diet: The U.S. (as well as many other industrialized countries) has seen a dramatic increase in the incidence of obesity together with a rise in obesity-related health problems. According to one study cited by the [Center for Disease Control](#), the roughly 35% of Americans that fall into the obese category and paid an average of \$1,429 more in health costs

than non-obese Americans in 2008.^{48, 49} The study's authors estimate medical costs related to obesity in the United States at 187 billion dollars per year.^{48, 49} One can likewise find compound negative impacts to the Earth's climate resulting from false beliefs and/or poor decisions regarding transportation, manufacturing and distributing goods, as well as building materials and standards. To take a case, researchers estimate that cryptocurrencies like Bitcoin and Ethereum have a staggering cost in terms of energy consumption. By some estimates, a single Bitcoin transaction uses enough energy to power your house for a month and computing the solution to the proof-of-work algorithm ("mining" a Bitcoin) generates 17,637 to 28,600 pounds of CO₂ per coin for a total of 23,066 kilotons of CO₂ per year.⁵⁰⁻⁵² In 2017 researchers estimated that the Ethereum network consumed as much electricity as the country of Cyprus.⁵³

1.2.c Optimal vs Suboptimal vs Satisficing Decisions

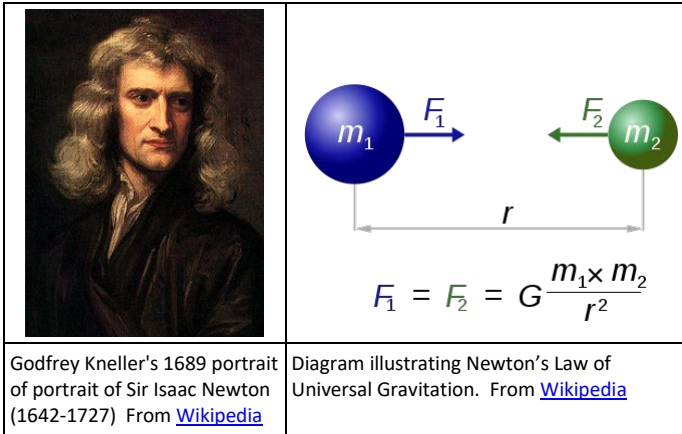
The compound benefits arguments make the point that even small numbers of small changes—inflection points in one's life—can dramatically impact the overall quality of one's life and the lives of others. However, these arguments are not sufficiently nuanced. To start, let's consider decisions: The above argument and illustrate examples might seem to implicitly rely upon our making optimal choices. Optimal decisions minimize risk/collateral damage while maximizing value; they minimize cost and maximize benefit. You don't have to make optimal decisions in order for those decisions to create a positive impact. Suboptimal decisions are not all equal. A choice may fall short of the standard of maximizing benefits while minimizing cost—it may prove suboptimal—yet still represent a significantly better choice than one might have otherwise made. Indeed, in his 1956 paper, *Rational Choice and the Structure of the Environment*, Herbert Simon introduces the name "satisficing" for a concept that he had been working with since 1947.^{54, 55} Simon tells his readers:⁵⁴

Both from these scanty data and from an examination of the postulates of the economic models it appears probable that, however adaptive the behavior of organisms in learning and choice situations, this adaptiveness falls far short of the ideal of "maximizing" postulated in economic theory. Evidently, organisms adapt well enough to "satisfice"; they do not, in general, "optimize." (p.129)

Satisficing choices, then, are suboptimal choices that nevertheless balance cost to benefit in an acceptable fashion. For instance, you might not feel you have time to engage in the recommended 150 minutes of moderate exercise each week. Nevertheless, studies have shown that even much lower levels of exercise on a regular basis results in improved health, mental state, and so on. Thus, choosing to walk even 10 minutes a day is a better choice than choosing to forgo exercise. Pushing one's choices towards the more optimal range, even if they fall short of optimality, still improves outcomes.

1.2.d Highly vs Poorly Evinced Individual Beliefs

Arguments like the one rehearsed above provide support for the potential positive impact of a critical thinking course. Yet, such arguments lack sufficient nuances. One's beliefs need not prove definitively true or false to have a positive or negative impact within the context in which one employs those beliefs. Often times adopting a well-evinced belief (or even an adequately evinced belief) can have a tremendous impact upon oneself and others. **A well-evinced belief has high levels of intersubjectively verifiable evidence supporting it. Intersubjectively verifiable evidence consists of evidence that other people have or could check.** For instance, scientific data counts as intersubjectively verifiable evidence since scientists can (and do) repeat experiments, test alternative hypotheses, etc.. Consider the impact during the 17th century of Newton's law of universal gravitation introduced in his [*Philosophiæ Naturalis Principia Mathematica*](#) (1686).⁵⁶⁻⁵⁸ Newton's law



$[F = G(m_1 \cdot m_2)/r^2]$ states that the gravitational force, F , between two bodies equals the product of their respective masses, $m_1 \cdot m_2$, and the gravitational constant, G , divided by the square of the distance between the centers of their masses, r . Scientists no longer consider Newton's law a complete or adequate theory of gravity. General and special relativity supplanted Newton's view early in the 20th century. In short, Newton's Law of Universal Gravitation is not actually true. Nevertheless, the adoption of Newton's

law in the 17th century changed the world. Newton's law models the gravitational attraction between objects fairly well under many circumstances. Thus, Newton's Law of Universal Gravity, though incorrect, proves incredibly beneficial from the 17th century right up to the beginning of the 20th century. Newton's law benefits humanity, not by being true, but by being highly-evinced and extremely useful; **its value lies in its being the most reasonable belief given the evidence at the time.**

Consider, for contrast, an example of poorly-evinced belief: Hyperoxygenation is one name for a cancer therapy based upon the idea that cancer results from inadequate levels of oxygen. Practitioners of hyperoxygenation try to treat cancer by increasing the exposure of cancer cells to oxygen--typically by giving people substances like hydrogen peroxide, germanium sesquioxide, and ozone. Though people do believe in, and have paid money to get hyperoxygenation therapy, no intersubjectively verifiable evidence supports it. In fact, though scientists have studied hyperoxygenation, none use the common therapies offered, nor does any evidence support its efficacy in cancer treatment.⁵⁹⁻⁶⁴ Indeed, this poorly-evinced belief in hyperoxygenation therapy poses a potential danger in that some of the chemicals, like germanium sesquioxide, can prove toxic. Pursuing hyperoxygenation therapies instead of better-evinced, effective cancer treatments might well cost people their lives or additional years of life. Moreover, people might waste their money on such treatments at a time when they most need money.

1.2.e Lack of Knowledge and/or Research Abilities

So, one ought to form well-evinced and true beliefs. One ought likewise to avoid false and poorly-evinced beliefs. However, these truisms do not exhaust the practices an effective thinker and decision maker must cultivate. One must also learn about diverse and important areas of human activity and knowledge. One must likewise develop the skills and resources necessary to discover important information in a timely fashion and to verify or fact-check the information one encounters. For example, Representative Ron Paul (R-TX) and others often advocate the abolishment or dramatic reform of the Federal Reserve Bank. I have even known people who advocate such measures. Yet, none of the people with whom I have talked regarding abolishment of the Federal Reserve actually know what functions the Federal Reserve Bank performs. One person did not even know crucial functions of the Federal Reserve System, like processing financial transactions between banks. You could not use a credit card or write a check without the Federal Reserve System.

The people I've talked to regarding the Federal Reserve Bank are not stupid. Nor are most of these people closed-minded or extremely partisan. The lack of knowledge by many critics of the Federal Reserve System even fails to imply that the US ought not reform or even abolish the Federal Reserve. Rather, the difficulty arises because these people advocate (or vote for people who advocate) a far-reaching policy without an

adequate understanding of the institution, its history, or its functions. These critics likewise usually lack an adequate proposal for fulfilling those functions in the absence of the Federal Reserve System. Issues like abolishing or reforming the Federal Reserve System affect the lives of all US citizens and one should try to get a basic grasp of such issues as they arise in public and political discourse. Very few people enjoy learning about the Federal Reserve System, but when such questions arise one must make an effort to inform oneself or risk negative, even disastrous outcomes.

In general, one must endeavor to fill-in the missing elements of one's understanding prior to advocating policies, supporting individuals who advocate those policies, and, generally, before taking important or significant actions of any kind. One ought also to make an effort to broaden one's understanding and increase one's depth of knowledge regarding a wide variety of topics. For instance, I would recommend that students take the time to read the Wikipedia page on the [Federal Reserve System](#).⁶⁵ The chapters discussing information ecosystems treat the topics of fact-gathering and fact-checking in greater detail.

1.2.f Beliefs Systems & Worldviews

In addition to individual beliefs, or lack thereof, the relationships between one's beliefs prove equally important in one's life. One can think of a **belief system** as a set of beliefs about some area. For example, one's religious beliefs constitute a belief system. One might have a set of beliefs about politics or romantic relationships. The individual beliefs one has within these collections of beliefs (belief systems) work together to help one negotiate and solve problems in the world. Such belief systems likewise help one to understand oneself and one's place in the world. Religious beliefs, for example, tend to shape one's understanding of oneself, the world, society, etc.. Truth or being **well-evinced** ranks high as an important property of such belief systems, but **consistency** proves important as well. As understood in this course, consistency refers to a relationship between individual beliefs, statements, or between all the elements of a belief system.

Specifically, two beliefs or statements prove consistent so long as it remains possible for both of the beliefs or statements to be simultaneously true. Likewise, belief systems prove consistent insofar as it remains possible for all the beliefs in that system to be simultaneously true. Beliefs and statements prove inconsistent insofar as it is impossible for all the beliefs or statements to be true at the same time. If one's beliefs do not prove consistent, then one runs the risk of engaging in inconsistent and unproductive behavior. For instance, the signatories of the declaration of independence tell its readers that, "We hold these truths to be self-evident, that all men are created equal, that they are endowed by their Creator with certain unalienable Rights, that among these are Life, Liberty and the pursuit of Happiness."⁶⁶ Unfortunately, that laudable belief did not extend to women, African Americans, and many other ethnic groups until much, much later.

Finally, **comprehensiveness** proves a highly desirable property of one's belief systems. An adequate belief system contains a sufficient amount and a sufficient variety of information to adequately guide one in one's typical or intended decisions and actions. Thus, people without a basic understanding of the functioning of the Federal Reserve System lack a belief system with minimally adequate comprehensiveness to evaluate the need for reform or abolition of the Federal Reserve System.

Together one's various belief systems combine with one's values and one's practices to form what one might call a person's **worldview**. One's worldview consists of something like those beliefs, values, and practices that constitute a person's understanding of themselves, society, and the universe as well as one's significance and role within society and the universe. As such, a worldview provides a vehicle through which an individual

conceptualizes and interprets themselves and the world. A worldview likewise facilitates one's prediction, understanding, and evaluation of the behavior of oneself and others; it guides one's expectations of how the world will change over time. Likewise, worldviews act as a background context helping reasoners to notice, evaluate, and assimilate new information. One might benefit from an individual belief, but one benefits even more from refining one's world view—one's whole system of beliefs about the world. One forms beliefs all the time, but the beliefs that help to create one's systematic understanding of one's own identity, one's position in society and the universe, the working of society and the universe, etc. have the greatest impact in that those beliefs explicitly or implicitly inform all of one's actions throughout one's life.

1.2.g Recognition of Opportunities and Possibilities

An example of how one's worldview impacts one's life can be found in the way in which one's worldview shapes one's perception of opportunity and possibility. For instance, suppose that you hold the false belief that immunizing your child against diseases such as Polio, Diphtheria, Measles, Mumps, and Rubella poses a greater risk to their health and longevity than the diseases themselves. Your child could become one of the approximately 6.4% of Californian kindergarten children estimated by the CDC to lack immunizations for these diseases.⁶⁷ Your false perceptions of possibility dramatically increase the likelihood that your child could die or suffer severe illness. Indeed, the CDC received a greater number of reports of measles cases in 2011 than in any other year for the previous 15 years.^{68,69} In January 2019 health officials declared an emergency in Clark county Washington due to a regional measles outbreak.⁷⁰ Public health researchers estimate the odds of your child dying from the measles at 1 in 3,000. In contrast, the odds of having a severe reaction to the measles vaccine are a mere 1 in 1,000,000.⁷¹

Recall the wage data discussed earlier. Women reading the [U.S. Department of Commerce Economics and Statistics Administration](#) publication, [Educational Attainment in the United States: 2007](#) will also find some rather depressing information about opportunities and possibilities for women in society. The report notes that,²

Men earned more than women at each level of educational attainment. ... At the high school diploma and bachelor's degree attainment levels, women earned about 65 percent of what men earned in 1987. In 2007, the percentage was 72 percent at the high school diploma level and 74 percent at the bachelor's degree level. (p.3)

On average, the data indicates that U.S. women have fewer employment opportunities with the same wage benefits as equally qualified men. Some small consolation comes in the form of the clear long-term trend towards greater wage equality. More importantly, this wage information can inform women in making career choices, help to prepare them for the obstacles they can expect in finding equitable wages, and impact their political choices. For instance, education matters more for women than men when it comes to earning power making higher education even more valuable to women.

Similarly, women and other advocates of fair pay should support the [Lilly Ledbetter Fair Pay Act of 2009](#) and those legislators who support it. The Lilly Ledbetter Fair Pay Act became federal law in 2009. It amends the [Civil Rights Act of 1964](#) to reverse the 2007 Supreme Court ruling in [Ledbetter v. Goodyear Tire & Rubber Co.](#). In the 2007 ruling the court held that the 180-day time limit to file a lawsuit regarding unfair pay begins on the

Figure 4.
Women's Median Earnings as a Percentage of Men's Median Earnings Among Full-Time, Year-Round Workers Aged 25 and Over by Educational Attainment: 1987-2007



Chart from [Educational Attainment in the United States: 2007](#) illustrating the median women's earnings as a percentage of the median man's earnings from 1987 to 2007.

date of the initial wage decision. In other words, one had 180 days from being hired to object to an unfair or discriminatory wage. The Lilly Ledbetter Act amends the Civil Rights Act so that the time limit in which to file a lawsuit begins 180 days after the most recent discriminatory paycheck, in effect allowing the time limit to rollover indefinitely until 180 days after the discriminatory wage practice ends.⁷²

In short, correctly recognizing opportunities and possibilities along with the associated benefits or pitfalls of such opportunities and possibilities can dramatically improve the quality of one's own life and the lives of others affected by one's beliefs and

decisions. Conversely, a lack of awareness of opportunities and possibilities can dramatically degrade the quality of life of oneself and others.

1.2.h Seven Potential Benefits of Critical Thinking Classes

As a result of the reflections above I suggest that a better, though still incomplete, assessment of critical thinking courses should notice that effective thinkers tend to exhibit seven highly desirable properties:

- (1) Effective thinkers understand the processes responsible for their native reasoning and decision-making.
- (2) Effective thinkers possess an awareness of the strengths and weakness of their native reasoning and decision processes.
- (3) Effective thinkers exhibit a greater awareness of the world as well as its multifarious opportunities and possibilities together with the benefits and pitfalls associated with those opportunities and possibilities.
- (4) Effective thinkers strive towards more highly evinced, complete, consistent, and integrated belief systems and worldviews.
- (5) Effective thinkers possess a set of skills that augment and complement their native reasoning abilities.
- (6) Effective thinkers develop and continue to refine as well as regularly utilize the skills, habits, and infrastructure necessary to remain informed and effective thinkers.
- (7) Effective thinkers continually develop, refine, and utilize their skills, habits, and infrastructure to facilitate better, more informed decisions yielding more highly-valued outcomes.

So, critical thinking courses really do have a great importance in one's education. Indeed, the desire to help people become more effective thinkers and decision makers motivates my teaching. Likewise, societies—particularly industrialized democratic societies—rely heavily upon informed, effective thinkers and decision makers in order for those societies to exist and function properly. Most democratic governments, as a result, provide for public education at all levels—k-12, undergraduate, and graduate—in order to ensure that their citizens possess the skills and knowledge essential for the existence and proper functioning of society.

1.3 The Realities of Critical Thinking

Critical thinking courses, therefore, have the potential to dramatically improve one's own life as well as the lives of every person, animal, and situation one affects. However, immediately before discussing potential benefits of critical thinking, I noted that most critical thinking textbooks, instructors, and curriculum developers share a common misconception regarding the impact of critical thinking instruction. Specifically, **they falsely suppose that simply by taking a critical thinking course, students can dramatically improve as thinkers and gain immunity from a wide array of reasoning errors.** The potential for increased positive outcomes in reasoning and decision tasks exists as does the cumulative compounding of positive worth. Likewise, critical thinking can potentially increase the depth and breadth of one's worldview in addition to exposing and repairing inconsistencies and informational lacunae. Nevertheless, a critical thinking course cannot dramatically alter one's brain architecture nor can critical thinking courses dramatically improve one's overall performance on reasoning and decision tasks by modifying one's innate, automatic reasoning and decision strategies.

1.3.a No Course Can Change the Basic Innate Architecture of Your Brain

In reality no course can change the basic innate architecture of someone's brain. Nevertheless, the above discussion demonstrates that even minimal improvements in one's reasoning and decision outcomes more than justify critical thinking courses. Thus, the oft inconvenient facts regarding one's innate strengths and weaknesses as a reasoner do not render critical thinking courses or the material presented therein useless or unimportant—just the opposite! However, one's innate strengths and weaknesses as a reasoner do impose constraints on one's ability to change one's reasoning patterns. Likewise, strengths and weaknesses result in costs as well as benefits for those attempting to modify their intellectual habits and techniques. Moreover, these innate strengths and weaknesses affect the possibility of utilizing the knowledge and tools presented in a critical thinking course. Thus, the strengths and weaknesses of reasoners do not dramatically change as a result of a critical thinking course. However, information about the strengths and weaknesses of human reasoners does change—I think dramatically—how one ought to structure and teach such courses.

1.3.b The Implications for Teaching and Learning Critical Thinking Material

Becoming a more competent, literate, effective thinker and decision-maker—like losing weight permanently or becoming more organized—requires changing how one approaches one's intellectual life. Such change proves effective only when based upon the following:

- (1) A comprehensive understanding of the potential benefits of the knowledge and tools presented in such courses.
- (2) Insight into how the inherent tendencies of human reasoning can result in bad reasoning, false or poorly evinced beliefs, and poor decisions.

(3) A genuine and enduring commitment to improve the way one gathers, organizes, and utilizes information.

To truly benefit from a critical thinking course one must also confront the real difficulties and limitations on one's ability to improve one's performance without becoming discouraged. Like losing weight or becoming organized, some people master the knowledge and tools in this course more easily than others. Do not get disheartened or disengage. No matter how unlikely it might seem during the course, every student can and will benefit from applying themselves to the material. Conversely, no matter how well you perform in the course, you cannot change the basic architecture of your brain, nor can you consistently show dramatic improvement.

1.3.b.1 Critical Thinking is a Lifetime Behavior Pattern

Taking a critical thinking course represents the first step in a never-ending process. In many ways, becoming a competent, literate thinker and decision-maker resembles recovering from drug or alcohol addiction; the mechanisms that would erode one's progress lurk ever-present and constantly active in one's brain and one's environment. Similarly, temptations to backslide into one's previous thinking and decision processes constantly arise in the world. Less dramatically, improving one's thinking and decision abilities is much like improving one's health and fitness. Improving one's health and fitness requires a constant effort; lapses in one's focus may occur, but only by adopting and maintaining a commitment to better inference and decision outcomes together with cultivating proper habits for restructuring one's intellectual life will one truly benefit in the long-run despite only marginal real improvement. Like so many activities in life, an episode of reasoning or decision-making performance is only possible because of preparation.

1.4 The Structure and Content of This Course

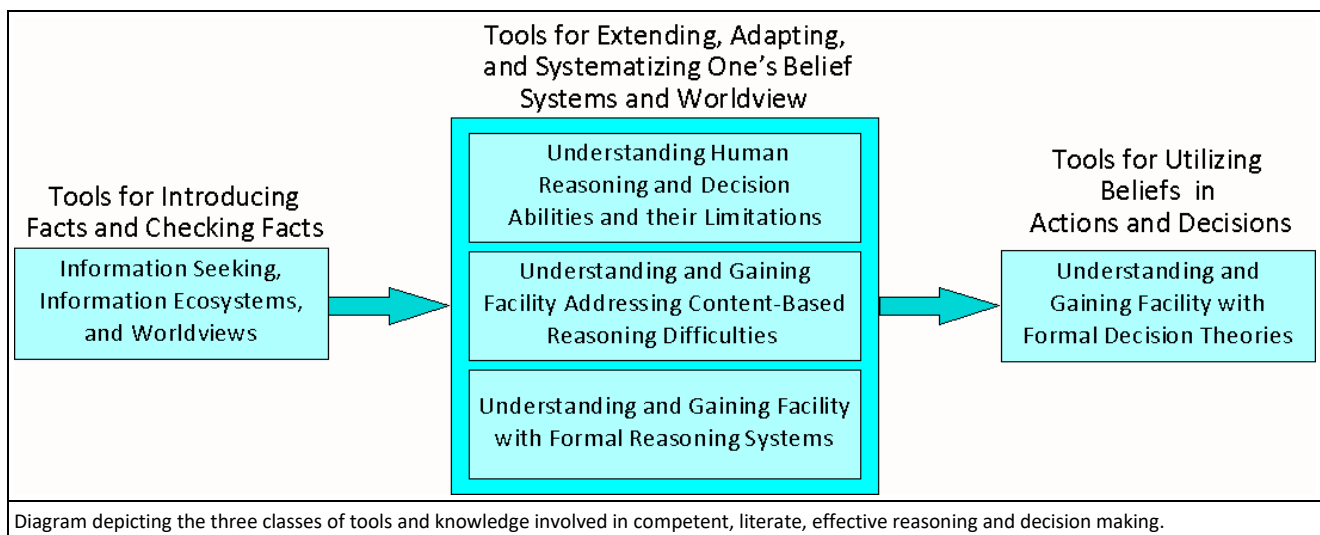
Often times critical thinking texts as well as instructors violate one of the central goals of critical thinking in the very manner in which they present the critical thinking material. Specifically, a central goal of critical thinking is to avoid forming beliefs or adopting significant courses of action for which one has little or no good reasons. Yet, textbooks and instructors regularly present material, expecting students to learn and believe that material, while providing little or no information as to the significance of that material. For example, critical thinking texts often include one or more chapters on formal (symbolic) deductive logic. Yet, these texts often never offer any explicit reasons why the students ought to learn these logical systems. Other times, the author or instructor offers only the benefits of such systems without any clear explanation of why the benefits outweigh the cost of learning and utilizing such systems. In fact, one finds very good reasons why, for instance, western civilizations have developed and continue to teach formal deductive logics. I have never read a critical think text—or formal logic text—that clearly and completely explains the value and limitations of these tremendous cultural gifts. I approach this course by clearly placing all of the techniques in a broader context of their relationship to native human reasoning abilities, their costs and benefits, and one's own ability to utilize them in one's daily life.

1.4.a Five Elements of the Practice of Competent, Literate Thinkers and Decision Makers

What will this class actually cover? This class focuses on five integral elements and associated practices required for being a competent, literate, and effective thinker and decision maker:

- (1) Information Seeking, Information Ecosystems, and Worldviews
- (2) Understanding Human Reasoning and Decision Abilities and their Limitations
- (3) Understanding and Gaining Facility Regarding Content-Based Difficulties in Reasoning and Decision-making
- (4) Understanding and Gaining Facility with Formal Reasoning Systems
- (5) Understanding and Gaining Facility with Formal Decision Theories

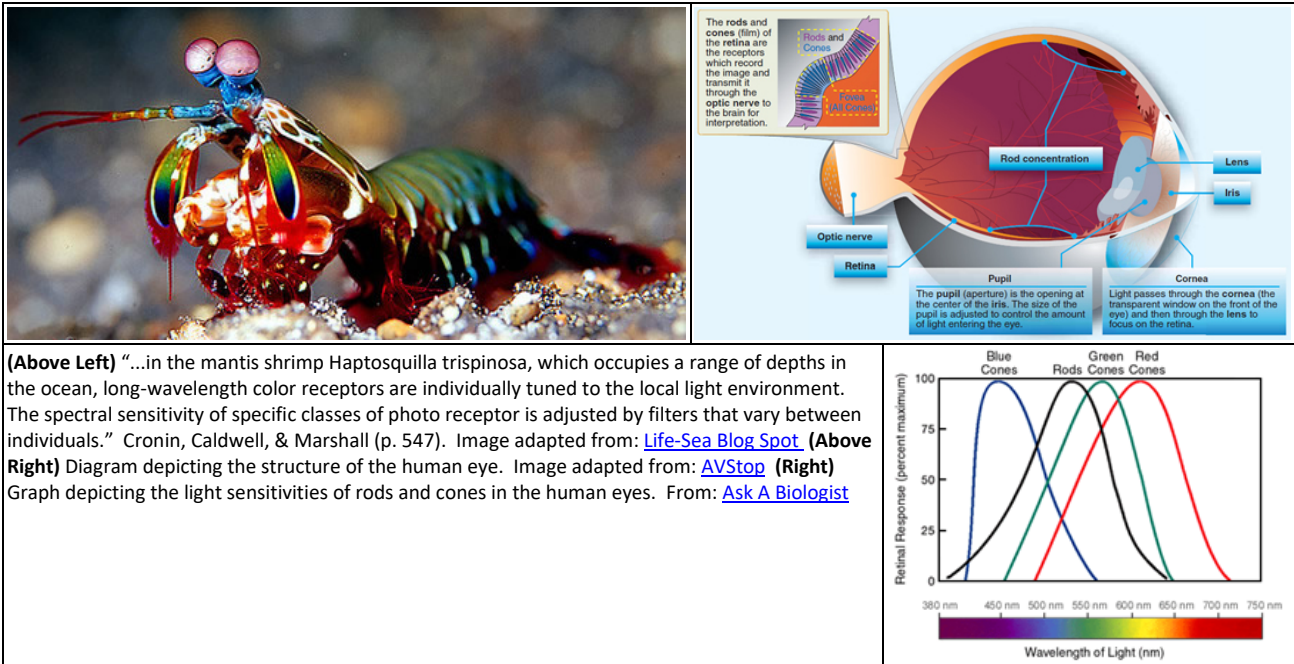
One can think of these five elements in terms of the respective roles each plays in one's overall intellectual life. Part of one's job as a critical thinker involves seeking new facts, introducing new facts into one's belief systems and worldview, as well as checking facts against the world. Once one begins to develop a body of beliefs, one needs tools to systematically organize one's beliefs into a consistent and comprehensive



worldview. One must also extend or adapt one's beliefs to cover new situations, as well as to detect and fill-in missing information. Finally, one's beliefs guide actions and inform decisions, so one needs tools that help to make better informed and more consistent decisions. Such tools help a person to act more effectively. As the class progresses, lectures focus on each of these categories and upon the individual elements and associated practices within each category.

1.4.a.1 Information Seeking, Information Ecosystems, and Worldviews

After this introductory chapter, the course and text begins in earnest with a chapter discussing one important aspect of reasoning and decision-making—actively informing oneself and checking one's facts. Information plays a key role in the human cognition and human thriving. Most forms of life employ mechanisms that facilitate adaptive reaction to the world. Such mechanisms have evolved into sensory organs and sensory systems in many animals. Humans, for instance, have multiple sensory organs and sensory systems. For example, humans have eyes and a visual system that processes visual information. However, human sensory organs and sensory systems do not stand out as particularly impressive examples of their kind. Consider the human eye. Each human eye has 120,000,000 light-sensitive cells called rods and cones. The human eye has



four distinct kinds of light-sensitive cells that cooperatively allow humans to see under a wide range of illuminations as well as seeing in color. The human eye should impress. Now, consider the eye of the mantis shrimp—an inaccurately named stomatopod. The eyes of some mantis shrimp species incorporate 16 different photoreceptor types—including 12 receptors for color vision. These receptors sense light ranging from the infrared to the ultraviolet. Retinal filters in the mantis shrimp eyes further tune the sensitivity of these 12 receptors. The remaining 4 photoreceptors sense [polarized light](#)⁷³ (light oscillating in the same orientation). The mantis shrimp eye structure allows each eye to see objects from three angles giving individual stomatopod eyes trinocular vision.⁷⁴⁻⁷⁷ In short, mantis shrimp eyes make human eyes look pretty limited and unsophisticated.

Given that other species often have superior sensory organs, why do humans, and not, say, mantis shrimp rule the world? Humans have advantages over many other species in gathering and utilizing information—humans possess highly developed brains and humans exist in a highly developed social organization. The second, third, and fourth chapters and lectures outline the creation and maintenance of an **information ecosystem**--a set of resources (places and/or people) one regularly consults to gather information, evaluate claims, or when pondering the adequacy of one's worldview.

Two exercises complement the material from the second chapter by helping students improve their student skills as well as their information gathering and fact checking abilities. The first exercise, [The Study Habbits Inventory](#), asks students to take a short quiz on their current study habits, after which they read a discussion of the reasons for the recommendations built into the quiz. The second exercise, [Information Awareness Assignment](#), asks students to explore a variety of alternative news and information sources from many countries and on many topics as well as to compare these sources with the most popular news sources.

1.4.a.2 Human Reasoning and Decision Abilities and their Limitations

After the discussion of information ecosystems, worldviews, and fact checking the fifth chapter turns to inferences. The fifth chapter discusses the nature of inferences and human inference abilities in particular. Textbooks present the culturally developed techniques for inference and decision making. However, most

textbooks devote little thought—really, not much more than superficial gestures—towards the significance and role of such culturally developed tools and knowledge. Indeed, many texts and instructors get the relationship between these techniques and the way in which humans normally reason totally wrong! Most often people tend to suppose that techniques like formal systems of inference merely codify the general practices employed by people in everyday life. In the fifth chapter, I note that culturally developed reasoning and decision techniques represent a group of strategies for thinking and problem-solving quite distinct from the processes humans natively employ. Moreover, many techniques like formal inference systems constitute a group of strategies that people actually have great difficulty consistently utilizing in their regular lives. Why then have these techniques been developed and taught? These culturally developed techniques emerge and continue precisely because they allow for the possibility of addressing the reasoning and problem-solving weaknesses inherent in the native practices of humans.

Logicians commonly categorize inferences into two categories—deduction and induction. The fifth chapter and corresponding lectures emphasize deductive inferences since students will learn about this variety of reasoning first. However, the course repeatedly returns to this central theme: Learned cultural techniques provide alternative inference and decision-making strategies that address weaknesses in innate human reasoning. Indeed, much of the discussion of techniques for reasoning and making decisions in this text finds its grounding in an understanding of the complementary relationship between those techniques and native human reasoning and decision-making abilities.

After discussing inferences, the lecture and chapter turn towards the formal and intersubjective medium for formulating and evaluating inferences—**arguments**. **Arguments**, unlike inferences, are artifacts constructed by humans for consumption by humans. Specifically, arguments are structured collections of individual declarative statements. As with any artifact, people construct arguments for specific purposes. In general, people create arguments for the primary purpose of displaying evidence or reasons and relating that evidence or reasons to a specific conclusion. In this way, arguments function as models or presentations of possible inferences. The sixth chapter and lectures discuss the purpose of arguments, the features of arguments that best fulfill that purpose, the varieties of argumentation, as well as the evaluative terms for arguments. The chapter utilizes this knowledge of arguments to cultivate a number of argument-related skills. Students refine their ability to recognize arguments in written text and speech and learn how to extract arguments. Students also learn how to put arguments into standard form so as to maximize the argument's clarity and impact. The chapter and lectures end by introducing a technique for the evaluation of certain kinds of arguments known as the counterexample method.

1.4.a.3 Gaining Facility Regarding Content-Based Difficulties in Reasoning

One of the important lessons from the examination of human reasoning abilities also serves to frame the next few chapters: Native human reasoning abilities are **highly contextualized**. What does “highly contextualized” mean? **The content of inferences and decisions as well as the context in which those inferences and decisions occur dramatically shapes human performance.** Referring to inferences as contextualized simply indicates the importance of content and context in these inferences. For example, when people agree with the conclusion of an argument they tend to find the argument compelling. Conversely, when people disagree with the conclusion of an argument, they tend to view that argument as deficient. Researchers call this particular content effect “[belief bias](#).”⁷⁸⁻⁸³ In contrast, decontextualized inferences and arguments operate relatively independent of the content of the inferences and arguments as well as the context in which they

appear. Addition serves as a handy example of a decontextualized inference. The inference $2 + 2 = 4$ holds true whether one adds apples, oranges, or points on an exam.

Native human inferences also exhibit some quite serious **resource constraints**. In general, a **resource constraint** results when some resource proves much less abundant than desirable. Human inferences and decision-making exhibit two major resource constraints linked to what psychologists call working memory: (1) Humans have definite and small limitations on the amount of information they can consciously process in working memory when making an inference,⁸³⁻⁸⁶ (2) Humans have similarly definite and small limitations in their ability to consciously represent and process complex relationships in working memory.⁸⁷⁻⁹¹ For instance, read the following series of numbers then close your eyes and try to repeat it: 2938575394759. If you could repeat the list perfectly, either your working memory exceeds pretty much every human to ever walk the planet or you used one or more techniques to help you remember larger amounts of information. Similarly, you have probably run into the constraints on information complexity when you tried to follow a long set of directions without writing them down.

Given the highly contextualized and constrained nature of native human inference processes, the class lectures and chapters naturally turn to discussions of the avenues through which content, context, and constraints can lead reasoners astray. Classes focus first upon sources of meaningfulness in human thought and the ways in which these different sources can introduce vagueness and/or ambiguity into communication as well as inferences and arguments. Thus, the seventh chapter concerns communication, meaning, and definitions. After outlining the difficulties of vagueness, ambiguity, and information distortion, the class explores the nature and variety of definitions. Humans use definitions to fix meaning for terms in communication and discourse. The chapter continues by contrasting human concepts with definitions. Both concepts and definitions serve to structure human understanding of categories, yet concepts operate in importantly different ways from definitions. The differences between definitions and concepts impact the utility of definitions in resolving ambiguities and vagueness in inference and argumentation. Likewise, concepts illustrate the tradeoffs that limit the ability to preserve information in inference and communication.

After discussing vagueness and ambiguity, the class turns to another content- and context-based challenge to good reasoning—**framing**. **Framing** refers to how an argument or problem gets presented to a reasoner. The central idea common to all ways in which researchers think about framing is that framing presents situations in a manner that leads our brain to naturally, innately, and unconsciously categorize those situations. Thus, framing can make information salient (standout and seem important) and/or make information obscure or seem irrelevant. Likewise, framing--the manner of presentation--of arguments or problems, can make problems easier to solve, or it can lead to systematic errors. Specifically, framing problems can introduce both mistakes in assessing the quality of inferences and mistakes in formulating arguments or solving problems. The material that these lectures and chapter cover often goes under the title of informal fallacies. These lectures address framing (presentation) problems by (1) familiarizing students with a variety of the most common informal fallacies, (2) discussing the ways in which the framing of an informal fallacy leads one to focus on the wrong information or adopt an inappropriate reasoning and/or evaluation strategy, and (3) drilling students on how to recognize and classify informal fallacies thereby potentially resisting the undue influence of framing. The introduction and presentation of informal fallacies occurs in a single chapter. However, the informal fallacies are grouped into classes to help students learn. For instance, social cognition, the inferences and strategies humans innately employ in their interactions with one another, constitutes an

important and often overlooked source of contextualization for inferences. The primary goal of social cognition consists in gaining insight into others and reacting appropriately within the constraints of a social context. While social cognition makes social existence possible, its goals often conflict with the goals of inferences, the construction of highly evinced worldviews, and decision making. The chapter and lectures on this topic outline the potential conflicts between the goals of a social animal and the goals of a critical thinker. Thus, the eighth chapter concludes the trilogy of chapters on content, context, and constraints presenting a variety of informal fallacies, calling attention to the ways in which the framing of the argument or inference can lead the reasoner to commit the fallacy by adopting an inappropriate inference strategy or focusing on the wrong information.

1.4a.4 Gaining Facility with Formal Reasoning Systems

After considering ambiguities, vagueness, constraints, framing, and social cognition as potential sources of content- and context-driven errors in inference and argumentation, the class focus changes again. The ninth chapter presents tools to compensate for such content- and context-driven native reasoning inabilities. Specifically, these tools compensate for contextualization by treating reasoning abstractly—by decontextualizing. Over the next module of the course and chapters cover several types of formal reasoning systems beginning with what researchers call a **formal deductive system**. Formal deductive systems exploit an insight researchers generally attribute to the ancient Greek philosopher, Aristotle. Aristotle examines a specific class of arguments and discovers that these arguments have two components—their logical form (the underlying relationships between ideas, classes, concepts, etc.) and their content (the specific contents, i.e., the specific ideas, classes, concepts, etc.). Aristotle as well as the philosophers and mathematicians that follow him develop systems for representing and evaluating the logical form—the underlying structure—of various types of arguments independently of the content of those arguments. These systems provide a tool for representing and evaluating arguments on the basis of their logical structure independent of content. Such systems are called formal deductive logics. Formal deductive logics provide students with tools for representing, evaluating, and formulating arguments with a very special quality—**validity**. Good (**valid**) deductive arguments have a structure such that the conclusion of the argument must be true whenever the evidence (premises) proves true. Thus, logicians use the term, "valid," as a positive evaluative term for deductive arguments. Specifically, valid arguments have a logical form (structure) such that if the premises of a valid argument are true, the conclusion must be true as well. The primary virtue of deductive logics consists in two properties: **(1)** Formal deductive logics allow humans to decontextualize inferences and arguments and thereby more accurately evaluate their logical form. **(2)** Formal deductive logics act to help humans to generate arguments that preserve the truth of the premises or evidence in the conclusion. In other words, a good formal deductive argument must have a true conclusion if its premises are true.

The chapters and lectures on deductive logics introduce two different formal deductive logical systems and provide guides as to how to employ these systems. The lectures emphasize that these systems merely present aspects of arguments in a manner that facilitates the evaluation of their logical form independent of content. In short, these systems operate by making certain features of arguments more prominent. One can think of them as working in a similar manner to, for instance, black lights. Black lights emit what scientists call soft



near ultraviolet light (usually around 400nm). Under such lights certain materials fluoresce, making them stand out vividly in a manner quite different from their appearance in normal light. By analogy, formal logical systems recode arguments to highlight their logical structure rather than their content.

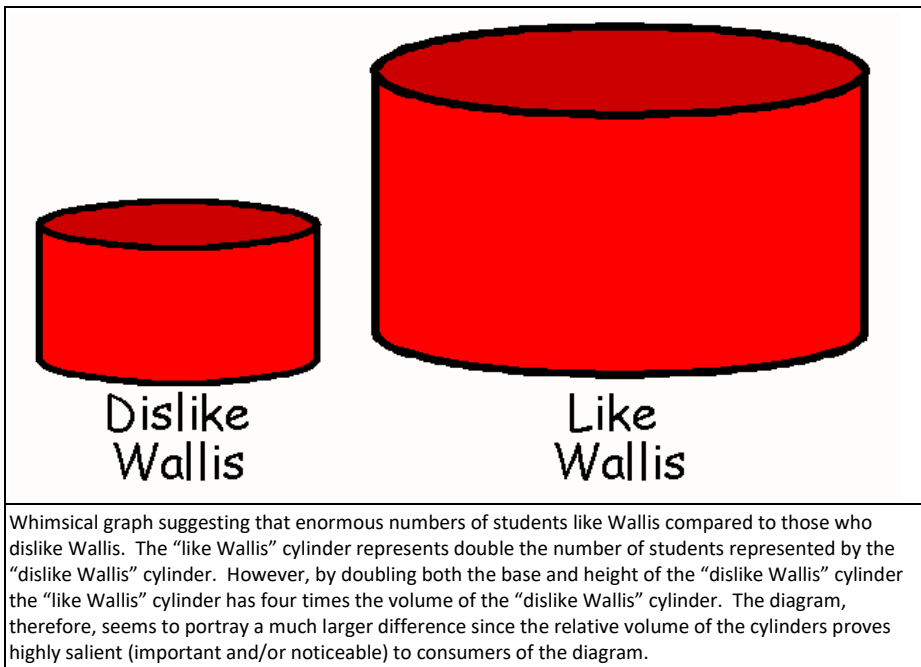
Understanding formal logical systems as a mere recoding of information for a specific purpose has three pay-offs. First, one comes to understand that formal logical systems operate to augment native human reasoning abilities so as to compensate for the inherent limitations of native human reasoning processes. Second, one can better understand the three central elements in the construction and

utilization of such systems. Third, one can assess how utilizing formal systems involves trade-offs and limitations--just as with one's native reasoning abilities.

After presenting two different formal deductive logics, the chapters and lectures turn towards what philosophers, logicians, mathematicians, and scientists call inductive inferences and the formal systems for making and evaluating inductive inferences. Inductive inferences differ from deductive inferences in that the truth of the evidence (premises) does not guarantee the truth of the conclusion in an inductive argument. Rather, good inductive inferences have the quality that the truth of the evidence (premises) makes the conclusion highly likely to be true.

Chapter eleven begins the treatment of inductive inference and formal systems for inductive inference by covering basic probability theory. Mathematicians develop and refine probability theory as a formal mathematical system for calculating the likelihoods of more complex events on the basis of the likelihoods of simpler events composing those complex events. The chapter on probability theory begins by introducing the three interpretations of probability; classical, frequency, and subjective interpretations. Each interpretation handles certain cases with great facility and each interpretation has cases that pose greater difficulties. By choosing among the different interpretations, students learn how best to estimate the probabilities of particular simple events. Students also recognize the trade-offs involved in their estimates of likelihood. Once students have a means of estimating the probabilities of simple events, the chapter introduces five basic rules students can easily use to calculate the probabilities of complex events from the probabilities of their constitutive simple events. The chapter also introduces one of the most famous theorems of probability: Bayes' Theorem. Students can utilize Bayes' Theorem update the probability of an event given new evidence for or against that event. Finally, the chapter introduces tools to help students analyze probability problems and formulate solution strategies.

Probability theory helped to give rise to modern statistics. Therefore, an understanding of probability theory allows students to better understand statistics. The first chapter on statistics explains the basics of what statisticians often call descriptive statistics.⁹² Descriptive statisticians develop tools for representing and learning about a population through organization, analysis, and presentation of data sets. As a result, the first



chapter and lectures on statistics discusses the central concepts and conventions one ought to use in organizing and presenting data.

The chapter likewise illustrates a number of ways in which improper presentation or analysis of data sets can lead to false beliefs about a population. For example, one’s choice of scales in creating a graph of a data set can dramatically affect how people perceive the trends in the data. The diagram below presents imaginary data indicating that twice as many students like

Wallis than dislike Wallis. Because the “like Wallis” cylinder has a doubled base **and** height, it has a volume eight-fold larger than the “dislike Wallis” cylinder. Relative volume proves highly salient in understanding such graphs. As a result, the diagram presents the data in a manner that misleadingly suggests a much larger differential between those who like and those who dislike Wallis. After discussing different aspects of descriptive statistics in the first chapter on statistics, the second chapter focuses upon what many statisticians call inferential statistics.⁹³ Inferential statistics utilizes relationships between populations and samples taken from those populations. A population is any large group of individuals or events from which a smaller subset, the sample, is taken. For instance, a poll might take a sample of 5,000 “likely voters” from the population—the totality—of “likely voters” in the US. The inferential statistics chapter outlines the basic inference technique by which statisticians infer the likely values for the frequency of some property or event in a population based upon the actual frequency in a sample. One can, for example, infer a range of frequencies of people who will likely vote Republican in an election from the actual frequency of people sampled who say they will vote Republican. Inferential statistics also provides powerful techniques for studying relationships between events, properties, and/or objects in a population. Causal relationships are chief among these relationships. The second chapter on statistics concludes by outlining one technique—the null hypothesis technique—widely used by researchers to explore causal relationships.

The third and final chapter on statistics turns to native human strategies for making inductive inferences. As with the treatment of other native human inference and decision abilities, students discover that native human strategies for inductive inference involve trade-offs. Specifically, innate human inference abilities prove susceptible to systematic error. The chapter on innate judgment heuristics illustrates how innate human inductive inference strategies relate to deductive inference strategies. Additionally, the chapter demonstrates how native human inference strategies for inductive inferences often utilize the same basic inference structure employed by statistics—inferring the likelihood of an event, property, object, or relation in the population from a sample. Human inference strategies differ from statistical practices in two important respects. (1) Whereas statisticians carefully sample a population for each inference, human inductive inference strategies use an individual’s experiences as a generic sample. (2) Human inference strategies also employ

different measures of sample frequency and assume a much less sophisticated relationship between the sample and the population. These differences between native human inference strategies and statistical inference strategies can result in human inference strategies generating systematic errors in many real-world situations where statistical inferences operate optimally.

1.4a.5 Gaining Facility with Formal Decision Theories

Recall the three categories of critical thinking tools and knowledge diagrammed above? As the term moves towards completion, lectures shift to the final category: Tools for Utilizing Beliefs in Actions and Decisions. Until this point, the class lectures focus upon techniques for fact-finding and fact-checking, estimating likelihoods, as well as augmenting and systematizing one's entire system of beliefs. These critical thinking tools facilitate increasing the size and reliability of one's belief systems by introducing new better-evinced facts, verifying facts, systematizing one's beliefs, making the systems consistent, and extending the systems through inferences to allow one to adapt to one's ever-changing world. "But," one might well ask, "does having consistent, well-evinced, and adaptable belief systems exhaust the value of critical thinking?" Most critical thinking textbooks and instructors would seem to think it does, since one rarely finds any additional material in textbooks or courses. I differ in that I suggest that utilizing one's belief system to guide one's actions and make decisions constitutes one of the primary functions of critical thinking. Lectures in this last section of the course introduce students to the basics of decision theory and actual human performance on decision tasks.

1.5 Final Thoughts

I close this chapter with some final thoughts regarding the material covered in the introduction. I particularly call student's attention to the next section on opinions and citations. Additionally, students will find a chapter summary, set of key terms and their definitions, suggested outcomes of their having read this chapter, and a bibliography of sources cited in the chapter.

1.6 Important Note: Opinions and Citations

During the course of this and future chapters students will notice that I express opinions on a variety of topics. For instance, some people might disagree with my above account of vaccinations and the issues surrounding childhood immunization. Critical thinking textbooks rarely present the author's opinion on topics outside of the narrow focus of the text. However, I disagree with this practice. Instructors and textbooks need to model critical thinking by illustrating how the skills and content of the course can help students to form and defend their opinions. Likewise, I feel that students benefit from seeing how the techniques and information in a given chapter have affected the instructor on a personal level. I, as a result, often express and argue for my opinions in class and in the text. **Students should in no way feel that they must adopt or even accommodate my opinions. Though I often present and offer arguments for my views, I have no interest in using this textbook or class as a forum for proselytizing. Student performance is in no way tied to their adopting any economic, religious, political, etc. view.** To the contrary, I encourage students who disagree to ask questions or challenge assertions I make in the text or in class lectures. Indeed, not only ought one to form responsible opinions, one ought to express and discuss one's opinions with others in a non-judgmental and constructive fashion. By sharing their opinions and their evidence for opinions people share information and perspectives that can enrich and inform all those involved. I personally have benefitted countless times in my life from people showing me that my beliefs were false or poorly evinced, by suggesting new sources, by offering

additional relevant facts, by presenting alternative perspectives, etc.. One of the benefits of human civilization comes from the way in which civilization facilitates one's own intellectual development. Failing to express one's opinions and listening to the opinions of others diminishes the potential of this tremendous resource. In fact, I would suggest that the ability to formulate opinions, support those opinions with evidence, and to thoughtfully and openly exchange opinions and arguments proves essential to the health of a diverse democratic society.

Likewise, this text uses extensive citations. Textbooks do not normally cite outside sources extensively because the material in textbooks is generally deemed "settled" or "uncontroversial." I adopt the practice of citing sources for two reasons: First, one way in which people can help each other in forming and verifying beliefs is by providing easy access to relevant information sources. Citing a reference is like sharing a recipe or a good route to school. Indeed, good citations provide one with a road map for investigating a topic. Second, in presenting our views to people it is important to note one's sources since not all sources are equally reliable. Often times the source of a piece of information proves as significant as the information itself. In general, I try to cite mostly non-technical, non-academic sources in the text that a student might easily find for themselves. I often link directly to articles on the web from the text to further facilitate student access to cited sources. I do not expect students to visit all of the linked material or watch all of the embedded or linked videos. Rather, I try to provide students with some access to material discussed in the textbook and lectures should students wish to learn more about a topic. As always, I appreciate and solicit student feedback on the all aspects of the text, even the citations.

1.7 Chapter Summary

In this chapter I summarize the structure of the course, contrasting it with the bulk of critical thinking materials and instruction. Three important themes emerge: (1) Human reasoning and decision making has a strong innate component limiting the ability of critical thinking courses to alter student performance; (2) All reasoning strategies—both innate and learned reasoning strategies--involve trade-offs resulting in strengths and weaknesses; (3) By understanding the relationship between innate and learned inference and decision strategies, their relative strengths and weaknesses, and the limits of one's ability to adapt one's reasoning and decision strategies to circumstances students gain a greater insight into both the importance of critical thinking and into the challenges involved in critical thinking.

The chapter develops more plausible and accurate arguments for the value of critical thinking courses in light of the severe limitations on improvement in reasoning and decision performance. One important theme emerges in these arguments: The benefits of critical thinking extend far beyond forming true beliefs and/or avoiding false beliefs. A better, though still incomplete, assessment of critical thinking courses notices that literate, effective thinkers and decision makers benefit from improvement in three sorts of intellectual outcomes; (1) better, more highly evinced, and integrated belief systems, (2) better, more informed decisions yielding more highly-valued outcomes, and (3) a greater awareness of the world and its multifarious opportunities and possibilities together with their associated benefits and pitfalls. Students also gain four important kinds of insights and skills; (1) a more systematic and proactive set of information gathering and fact-checking resources (an information ecosystem), (2) an understanding of the processes responsible for one's native reasoning and decision-making, (3) an awareness of the strengths and weakness of one's native reasoning and decision processes, and (4) a set of skills that augment and complement one's native reasoning and decision abilities.

This chapter also introduces the five topics covered in the course; (1) Information Seeking, Information Ecosystems, and Worldviews, (2) Understanding Human Reasoning and Decision Abilities and their Limitations, (3) Understanding and Gaining Facility Regarding Content-Based Difficulties in Reasoning and Decision-making, (4) Understanding and Gaining Facility with Formal Reasoning Systems, and (5) Understanding and Gaining Facility with Formal Decision Theories. These topics correspond to three categories of critical thinking tools; (T1) Tools for Introducing Facts and Checking Facts, (T2) Tools for Extending and Systematizing One's Worldview, (T3) Tools for Utilizing Beliefs in Actions and Decisions. The chapter also discusses the differences between the scope of the course and more traditional critical thinking courses. Finally, the chapter provides students with an outline of the topics covered in the course and the corresponding text.

1.8 Suggested Outcomes from Having Read This Chapter

After reading this chapter, you ought to try to answer the following questions. If you have trouble answering them, then return to the relevant sections.

- 1.) Could you define the key terms listed below in your own words? Can you give an example of your own to illustrate each of the terms?
- 2.) What are the three outcomes and the four insights and/or skills given as potential benefits of studying critical thinking? Can you give an example of your own to illustrate each of the terms?
- 3.) Could you formulate a version of the of the cumulative benefits argument given above for critical thinking course?
- 4.) Could you formulate a cumulative costs argument for critical thinking modeled on the benefits argument?
- 5.) How could having highly evinced beliefs prove as valuable as having true beliefs in some circumstances?
- 6.) How could a deeper understanding of possibilities and opportunities help a critical thinker?
- 7.) What is a worldview and why does the text emphasize worldviews more than single beliefs?
- 8.) Why ought one understand critical thinking as a lifestyle as opposed to a set of tools?
- 9.) What relationship does this chapter depict between one's innate reasoning strategies and the formal techniques taught in the course?

1.9 Some Key Terms

Arguments: Arguments are artifacts constructed by humans for consumption by humans. Specifically, arguments are structured collections of individual declarative statements intended to display evidence or reasons and to relate that evidence or reasons to a specific conclusion. In this way, arguments function as models or presentations of possible inferences.

Belief System: One can think of a belief system as a set of beliefs about some topic or area. For example, one's religious beliefs constitute a belief system. One might have a set of beliefs about politics or relationships—they too would count as belief systems. The beliefs one has within these collections of beliefs (belief system) work together to help one negotiate and solve problems in the world.

Consistency: As understood in this course, consistency refers to a property of beliefs, statements, etc.. Specifically, beliefs and statements are consistent so long as it remains possible for them all to be simultaneously true. Beliefs and statements prove inconsistent insofar as it is impossible for all the beliefs or statements to be true at the same time. If one's beliefs do not prove consistent, then one runs the risk of engaging in inconsistent and unproductive behavior. For example, if one believes that Sacramento is the capital of California and one believes that a state can have only one capital, then a belief that San Francisco is also the capital of California proves inconsistent with one's other beliefs.

Contextualized (Contextualization): A term used to describe how human reasoning is strongly shaped by the content of one's inferences or argument as well as the context of those inferences and arguments. For example, people tend to judge arguments as better when they agree with the conclusion of the argument and worse when they disagree with the conclusion. This particular content effect is called the belief bias.

Formal Deductive Systems: Formal deductive systems exploit an insight researchers generally attribute to the ancient Greek philosopher, Aristotle. Aristotle examines a specific class of arguments and discovers that these arguments have two components—their logical form (the underlying relationships between ideas, classes, concepts, etc.) and their content (the specific contents, i.e., the specific ideas, classes, concepts, etc.). Aristotle as well as the philosophers and mathematicians that follow him develop systems for representing and evaluating the logical form—underlying structure—of various types of arguments independently of the content of those arguments. These systems for representing and evaluating arguments on the basis of their logical structure independent of content are called formal deductive logics. The primary virtue of deductive logics consists in two properties: Formal deductive logics allow humans to decontextualize inferences and arguments and thereby more accurately evaluate their logical form. Formal deductive logics act to help humans to generate arguments that preserve the truth of the premises or evidence in the conclusion. In other words, a good formal deductive argument must have a true conclusion if its premises are true.

Five Elements of Competent, Literate Thinkers and Decision Makers:

- (1) Information Seeking, Information Ecosystems, and Worldviews
- (2) Understanding Human Reasoning and Decision Abilities and their Limitations
- (3) Understanding and Gaining Facility Regarding Content-Based Difficulties in Reasoning and Decision-making
- (4) Understanding and Gaining Facility with Formal Reasoning Systems
- (5) Understanding and Gaining Facility with Formal Decision Theories

Framing: Framing refers to how an argument or problem gets presented to a reasoner. The central idea of common to all ways in which researchers think about framing is that framing presents situations in a manner that leads our brain to naturally, innately, and unconsciously categorize those situations. Thus, framing can make information salient (standout and seem important) and/or make information obscure or seem irrelevant. Thus, framing—the manner of presentation—of arguments or problems, can make problems easier to solve, or it can lead to systematic errors.

Information Ecosystem: An information ecosystem consists of a set of places and/or people one regularly consults to gather information, evaluate claims, or when pondering the adequacy of one's worldview. Good information ecosystems should include straight news sources, analysis and commentary sources, fact-checking and debunking sources. These sources should provide information on a range of important topics like history, law, science, politics, economics, as well as current world, national and local events.

Inter-subjectively Verifiable Evidence: Inter-subjectively verifiable evidence consists of evidence that many or any person could possess or that they could check. For instance, scientific data counts as inter-subjectively verifiable evidence since scientists can and do repeat experiments, test alternative hypotheses, etc..

Comprehensiveness: The property of comprehensiveness proves a highly desirable property of belief systems. A minimally adequate belief system contains a sufficient amount and variety of information to adequately guide one in one's typical or intended decisions and actions. For example, people without a basic understanding of the functioning of the Federal Reserve System lack a belief system with minimally adequate comprehensiveness to evaluate the need for reform or abolition of the Federal Reserve System.

Logical Form: Logical form refers to the underlying structure of arguments and inferences—specifically, the underlying relationships between ideas, classes, concepts, statements, etc. when distinguished from and the content of those arguments, i.e., the specific ideas, classes, concepts, statements, etc.. One implication of logical form is that arguments about different topics can have identical logical forms. For instance, the two arguments below have the same logical form despite having different contents and despite the different truth values of their constitutive statements:

Argument 1

If dogs are cats, then Wallis is a genius.

Dogs are cats.

Conclusion: Wallis is a genius.

Argument 2

If this liquid is water, then it consists primarily of H²O.

This liquid is water.

Conclusion: This liquid consists primarily of H²O.

Shared Logical Form

If A is true, then B is true.

A is true.

Conclusion: B is true.

Resource Constraint: All human inferences utilize the memory and processing resources of one's brain. These brain resources are limited. A resource constraint results when the resources of one's brain prove much less abundant than desirable for solving certain problems. The two major resource constraints in human inference and decision making are limitations in the amount of information human inferences can reliably process and limitations in the complexity of the relationships between that information relevant to the inference or decision. For instance, to illustrate the constraints on human information capacity read the following series of

numbers then close your eyes and try to repeat it: 2938575394759. If you could repeat the list perfectly, either your working memory exceeds pretty much every human to ever walk the planet or you used a technique to help you remember larger amounts of information called "chunking". Similarly, you have probably run into the constraints on information complexity when you tried to following a long set of directions without writing them down.

Seven Potential Benefits of Critical Thinking Classes:

- (1) Effective thinkers and decision makers understand the processes responsible for their native reasoning and decision-making.
- (2) Effective thinkers and decision makers possess an awareness of the strengths and weakness of their native reasoning and decision processes.
- (3) Effective thinkers and decision makers exhibit a greater awareness of the world as well as its multifarious opportunities and possibilities together with the benefits and pitfalls associated with those opportunities and possibilities.
- (4) Effective thinkers and decision makers strive towards more highly evinced, complete, and integrated belief systems and worldviews.
- (5) Effective thinkers and decision makers possess a set of skills that augment and complement their native reasoning abilities.
- (6) Effective thinkers and decision makers develop and continue to refine as well as regularly utilize the skills, habits, and infrastructure necessary to remain informed and effective thinkers.
- (7) Effective thinkers and decision makers develop, continually refine and utilize their skills, habits, and infrastructure to facilitate better, more informed decisions yielding more highly-valued outcomes.

Validity: Logicians use the term, "valid," as a positive evaluative term for deductive arguments. Specifically, valid arguments have a logical form (structure) such that if the premises of a valid argument are true, the conclusion must be true as well.

Well-Evinced Belief: A well-evinced belief is a belief regarding some topic with high levels of inter-subjective evidence. The best evinced belief need not actually prove correct. Rather, a well-evinced belief represents both the best choice among competing beliefs in a particular circumstance and the choice with enough intersubjective evidence to raise its likelihood significantly above chance. Thus, a belief that ranks as a well-evinced belief in one circumstance may not retain that title in another circumstance. For instance, the odds of winning the grand prize in Powerball are 1 in 175,223,510.⁹⁴ Thus, with regard to any given ticket, a well-evinced belief one can adopt is the belief that the ticket will not win the grand prize. However, should one watch the Powerball drawing and see the lottery officials select the numbers on a ticket, the belief that that ticket will lose forfeits its status as a well-evinced belief.

Worldview: A worldview consists of those beliefs, values, and practices that constitute a person's understanding of themselves, society, and the universe as well as that person's significance and role within society and the universe. As such, a worldview provides a vehicle through which an individual conceptualizes and interprets themselves and the world. A worldview likewise facilitates our prediction, understanding, and evaluation of the behavior of ourselves and others; it guides our expectations of how the world will change

over time. Likewise, worldviews act as a background context helping reasoners to notice, evaluate, and assimilate new information.

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