A Logic That Betrays
Reasoning in Decision Making

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Abstract: This article challenges the widespread belief that logic, in particular the most accessible propositional and predicate logic, accurately models human reasoning. While formal logic serves as a rigorous tool for structuring arguments and ensuring validity, it does not reflect the psychological processes through which people actually think and decide. Beginning with historical developments in logic, from Aristotle's syllogisms to Frege's anti-psychologism, the article outlines how logic evolved as a normative discipline, divorced from empirical cognitive functioning. Cognitive science research provides robust evidence that human reasoning is shaped by heuristics, beliefs, and context-sensitive processes rather than strict rule-following. Empirical studies show that even educated individuals often fail to reason according to logical norms. Dual-process theories further clarify that intuitive (System 1) and analytical (System 2) thinking operate under different cognitive principles, with formal logic primarily aligned with the latter. Emotional and intuitive judgements, far from being irrational, often encode experiential knowledge essential for effective decision making. The article argues that overvaluing logic in personal, professional, and public contexts can lead to flawed or unrealistic decisions, as it overlooks the adaptive, affective, and socially influenced dimensions of human thought. Tools such as the PILOT method exemplify decision-support frameworks that integrate intuition with logical analysis. Ultimately, the article asserts that logic is a valuable ideal, not a descriptive account of reasoning. Recognising the limitations of logic as a model of thought enables more effective and human-centric decision making. Embracing both logical rigour and intuitive insight fosters better outcomes in real-world contexts where complexity, uncertainty, and human values prevail.

Keywords: Human reasoning, Formal logic, Cognitive biases, Dual-process theory, Decision making, Intuition, Heuristics

1. Introduction

Human beings have long been described as rational animals, yet the relationship between formal logic and actual human reasoning is far from straightforward. There is a widespread assumption that the principles of formal logic, especially propositional and predicate logic, mirror the way people naturally think and make decisions. This scholarly analysis critiques that assumption, arguing that while formal logic is invaluable for structuring arguments and clarifying reasoning, it does not reflect the cognitive processes humans use in everyday life or in complex decision making. Human reasoning is influenced by intuition, emotion, and heuristics, often diverging from the step-by-step, rule-based approach that formal logic dictates. By examining the historical development of logic as a formal discipline distinct from psychology, and by reviewing findings from cognitive science, we can see how logical reasoning differs from actual thinking. The implications of conflating the two are significant: overvaluing formal logic as a model for thought can be detrimental to personal choices, professional judgements, and public policy. In the sections that follow, we explore the evolution of formal logic, evidence from cognitive psychology on how people really reason, and why acknowledging the difference between normative logic and descriptive reasoning leads to better decision making practices.

Formal logic has its roots in ancient times, but its evolution over time shows a deliberate separation from the study of human thought processes. Aristotle's *Organon* (the instrument of thought) laid the groundwork for syllogistic logic as a tool to derive truthful conclusions from given premises (1984 / 400 BC). For many centuries, logic was seen as the laws of thought, a phrase suggesting that the rules of logic might be the rules by which minds operate. For example, Boole titled his work *An Investigation of the Laws of Thought* (1854). However, what philosophers and logicians came to understand was that these laws were not descriptions of how people actually think, but rather prescriptions for how they *ought* to think in order to reason correctly. By the late 19th century, a clear distinction was being drawn between psychology and logic. The English philosopher John Stuart Mill, for instance, treated logic as rooted in empirical mental processes to some extent, but this view came under attack. The German mathematician Gottlob Frege was a central figure in formalising logic and insisting on its separation from human psychology. Frege argued explicitly that logic's truths are independent of any individual's beliefs or reasoning habits. In one famous argument, Frege noted that the laws of logic would still hold even if in fact no one's reasoning ever accorded with them, treating them as objective principles rather than empirical generalisations about thought. He maintained that logical laws are *laws of truth*, not *laws of thinking* in a psychological sense. This anti-psychologistic stance, shared by other philosophers such as Edmund Husserl, helped establish logic as a formal discipline concerned with validity and inference, distinct from the study of how people actually think.

The historical movement away from psychologism (the idea that logic is grounded in psychological processes) meant that by the 20th century, logic was treated as part of mathematics or philosophy. Logicians developed symbolic systems (propositional calculus, predicate calculus, etc.) that could rigorously represent arguments. These developments were successful in their realm: modern formal logic underpins computer science and mathematics, precisely because it abstracts away from the quirks of human thought and focuses on ideal patterns of reasoning. But this success came at the cost of divorcing logic from everyday reasoning. As Frege and his successors made clear, the purpose of formal logic is not to *describe* how our minds reach conclusions but to provide a benchmark for how we *should* reach conclusions if we are reasoning perfectly. In other words, logic is supposed to provide normative standards, i.e. the gold standard for valid reasoning, and not a cognitive model of everyday thought. But this is the classic divide between descriptive and normative sciences. As in decision analysis, neither deliver, hence the betrayal. Fortunately, prescriptive sciences come to the rescue.

2. Formal Logic vs. Human Reasoning

The separation of logic from psychology underscores a key point: formal logic is normative, offering rules for correct reasoning, whereas human reasoning as studied by cognitive science is descriptive, illustrating how people actually think. The assumption that people naturally follow the rules of formal logic in their daily reasoning is not borne out by empirical evidence. In practice, human thinking often departs from the strictures of logical inference. One fundamental difference is that formal logic is content-blind and context-independent. It deals with abstract forms (such as in propositional logic **if** P **then** Q or in predicate logic **all** A **are** B; C **is** A; **therefore** C **is** B), regardless of the content of those statements. Human reasoning, by contrast, is deeply influenced by content and context. People find it much easier to reason correctly about familiar, meaningful content than about abstract symbols. A classic illustration comes from the domain of conditional reasoning. In a purely logical sense, the rule **if** P **then** Q is universally valid regardless of what *P* and *Q* stand for. Yet, when asked to evaluate or use this rule, people's performance varies dramatically depending on the scenario.

Wason's four-card selection task demonstrated this clearly (Wason, 1968). In the task, participants see four cards (for example showing Ace, King, 2, 7) and are given a rule to test, such as if a card has a vowel on one side, then it has an even number on the other side. Logically, to test this rule, one must check the card showing a vowel (to see if the other side is even) and the card showing an odd number (to see if the other side is a vowel), which corresponds to seeking potential counterexamples. Only a minority of people choose the correct combination of cards. In Wason's original study, fewer than 10% of participants found the correct solution, even though the reasoning involved is a straightforward application of logical implication. This striking result shows that people do not automatically apply formal logical principles (such as modus tollens) even in simple tasks. However, if the very same logical structure is embedded in a familiar context, performance improves. When the task is framed in terms of a social rule (for example, if someone is drinking alcohol, then they must be over 18 years of age), people perform much better, often correctly turning over the analogous "cards" in an underage drinker scenario (Cosmides and Tooby, 1992). Researchers found that when the content involves detecting a violation of a social or pragmatic rule (a context humans evolved to understand), the majority can solve the problem correctly. The underlying logical form is identical, but human reasoning is sensitive to whether the problem is meaningful or triggers an intuitive schema (such as a cheating-detection schema in the case of the drinking age rule). This content effect highlights that formal logic does not capture the full story of reasoning. Our minds are attuned to context in a way that formal logic deliberately is not.

Another key divergence is that humans often rely on *beliefs* and prior knowledge even in tasks of pure logic, sometimes to the detriment of logical correctness. In syllogistic reasoning (deducing a conclusion from two premises, as in classical Aristotelian logic), people show a belief bias. They are more likely to accept a conclusion if it is believable in real-world terms and to reject a conclusion if it is unbelievable, regardless of the logical validity of the argument (Evans et al., 1983). For instance, consider the syllogism: all flowers need water; roses need water; therefore, roses are flowers. This conclusion is logically invalid (roses could need water without being flowers, since many things need water), but it happens to be believable because we know roses are indeed flowers. Many people endorse this conclusion as true, effectively conflating truth with logical validity. Conversely, given a valid syllogism that leads to an unbelievable conclusion, people often incorrectly reject it. This indicates that human reasoning does not strictly adhere to logical form; it blends logical structure with content-based judgment. Our cognitive system does not function like a neutral logic engine. It is geared towards practical, and often heuristic, judgements about what is true in the real world.

Humans also exhibit *confirmation bias*, a tendency to seek or interpret evidence in ways that support existing beliefs rather than following a neutral logic of inquiry. Logically, one should test hypotheses by looking for potential falsification (as the Wason task demands), but people naturally tend to look for confirming instances. In everyday reasoning, once we have an idea in mind, we selectively notice and recall information that fits that idea and discount or forget information that contradicts it. This bias skews our reasoning process away from the logical ideal of objective evidence evaluation. Confirmation bias is closely tied to motivated reasoning. Our reasoning is often driven by goals (to defend our prior beliefs, to win an argument, to justify ourselves) rather than by a detached search for truth. As a result, two people with opposing initial beliefs can each use their reasoning skills to strengthen their own stance, even when faced with the same evidence, by interpreting that evidence in favour of their side. From a logic perspective, this is irrational, but from a psychological perspective it is a common strategy.

These systematic biases and deviations suggest that reasoning serves adaptive purposes for humans that are not the same as the purposes of formal logic. One provocative proposal by researchers Mercier and Sperber is that the primary evolutionary function of reasoning is not solitary truth-seeking, but social argumentation to justify oneself and to convince others (2011). According to this argumentative theory, humans evolved to use reasoning in a social context: we formulate arguments to support our own positions and evaluate the arguments others present. Under this view, biases such as confirmation bias are not just flaws; they are features of a reasoning system geared toward constructing persuasive arguments (confirming what we already believe and finding faults in others' arguments). In an argumentative context, it makes sense to draw on any evidence that supports your position and to downplay counter-evidence. While this theory is still debated, it reinforces the insight that our reasoning processes might be tuned for goals quite distinct from the dispassionate analysis that formal logic envisions. It explains why people can be perfectly capable of logical reasoning in some settings (e.g., picking apart someone else's flawed argument) yet fail to apply the same logic to their own beliefs because the cognitive impetus to do so is different in each case.

The descriptive reality, then, is that human reasoning is *rational* in a broader sense (we generally make sense of the world and navigate it successfully), but it is not strictly *logical* by the formal definition. Psychologists distinguish *systematic logic* and *heuristic reasoning*. Logic demands consistency and adherence to formal rules; human reasoning often seeks plausibility and uses shortcuts that usually work but occasionally lead us astray from a logical standpoint. In real-world decision making, people rarely lay out formal premises and deduce conclusions. Instead, they use a mix of intuition, rules of thumb, analogy, and sometimes partial analysis. These methods are usually effective in the environments we operate in, but they do not mirror a predicate calculus running in our heads.

3. Cognitive Science

Over the past several decades, cognitive psychologists have extensively studied human reasoning and judgment. The overwhelming consensus from this research is that actual reasoning often deviates from the canons of formal logic in systematic ways. Rather than being flawlessly logical, people show predictable biases and errors, but also adaptive heuristics that reflect the intuitive nature of our thought processes.

One line of evidence comes from the study of cognitive biases by Tversky and Kahneman. In a series of influential works (1974), they documented that people rely on heuristics when making judgements under uncertainty. These heuristics are generally useful, but they can lead to errors that violate formal principles of probability or logic. For example, when judging how likely something is, people often use the *representativeness heuristic*: they judge probability by how representative or typical an outcome seems. This can lead to the well-known conjunction fallacy, where people wrongly believe a specific scenario is more likely than a general one that logically includes that scenario as a broader category. In the famous Linda problem, participants read a description of a woman named Linda (who is said to be concerned with social justice, etc.) and are asked whether it is more probable that (a) Linda is a bank teller, or (b) Linda is a bank teller and active in the feminist movement. Option (b) is logically a subset of (a) since every feminist bank teller is a bank teller, so (b) cannot be more likely than (a). Nevertheless, typically around 85% of college students choose (b) as more likely, because the description of Linda fits the stereotype of a feminist, making that specific scenario feel more representative or plausible than Linda being a bank teller with no mention of feminism (Tversky and Kahneman, 1983). This is a direct violation of formal probability logic, demonstrating that intuitive reasoning can flout logical rules.

Tversky and Kahneman identified numerous biases of this kind: *availability bias* (overestimating the likelihood of events that come easily to mind, which is not a logically valid way to assess probabilities), *anchoring* (being unduly influenced by an initial value or reference point when making estimates, even if that reference is arbitrary), and others. These biases show that human judgment under uncertainty does not follow the normative models of logic or probability theory. Instead, people use heuristics that are fast and frugal but not infallible. Kahneman's popularisation of this research in *Thinking, Fast and Slow* (2011) emphasises that our intuitive thought (what he calls System 1) is prone to systematic errors precisely because it is not bound by formal rules of reasoning.

Another body of evidence comes from research on deductive reasoning problems given to ordinary people. Besides Wason's selection task and syllogistic reasoning mentioned earlier, studies have looked at how people handle logical connectives such as **if**, **and**, **or**, and **not**. The results often show that people have their own interpretations or mental models of these connectives that differ from the strict definitions in logic. For instance, in everyday language, **if** often implies a causal or pragmatic relationship, as in **if** you finish your homework **then** you can watch TV. That is not the same as the material implication of propositional logic. People's reasoning about such statements can be influenced by these pragmatic considerations (e.g., they might assume the converse **if not** P **then not** Q in contexts where that makes pragmatic sense, even though it is not logically valid). Overall, the psychology of reasoning indicates that without training, individuals do not automatically use the formal rules of logic in their thinking; they rely on a combination of linguistic cues, background knowledge, and pragmatic inference (Johnson-Laird and Byrne, 1991).

Johnson-Laird proposed the mental model theory of reasoning, which suggests that people reason by constructing concrete mental simulations of the situation described, rather than by applying abstract logical rules. According to this theory, when given premises, reasoners imagine scenarios (mental models) in which these premises are true and then see what conclusions would hold in those scenarios (Johnson-Laird, 1983). If a conclusion holds in all the mental models they construct, they accept it as logically following. If they can find a counterexample model, a scenario that fits the premises but in which the conclusion is false, they reject the conclusion. This process predicts certain errors: for example, if people only construct one or two models and those support the conclusion, they might accept the conclusion without realising there is another possible model in which the conclusion does not hold. The mental model theory aligns with the observation that people find it easier to reason with some content than with others. Some premises yield easily visualised scenarios, whereas others (especially abstract or highly counterintuitive premises) require complex models and a high load on the working memory. Johnson-Laird's work further solidifies the point that human reasoning is not literally following formal logical calculus; instead, it is using semantic and imaginative strategies to approximate logical outcomes, often successfully but sometimes failing on problems that are trivial for a formal logical system. Johnson-Laird also pointed out a computational reason why humans cannot purely be logical: many logical reasoning problems are computationally intractable if approached in a formal, brute-force way. As the number of premises or pieces of information grows, the combinations of possibilities explode exponentially, quickly exceeding the capacity of any human to consider. Thus, human cognition must use shortcuts and heuristics. We simplify, we consider only a few possibilities, we rely on typical cases, and we often stop when we find a solution that is good enough rather than exhaustively exploring all solutions. These strategies allow us to make decisions and inferences promptly, even if they occasionally lead to errors. In essence, because of cognitive and resource limitations, bounded rationality (Simon, 1957) is our condition: we aim to make reasonable decisions within our constraints, not to exhaustively follow logical principles on every occasion.

Dual-process experiments underscore these points as well. For instance, the Cognitive Reflection Test devised by Frederick (2005) presents simple riddles that have an immediately appealing but incorrect answer. One is: "A bat and a ball cost $1.10 in total; the bat costs $1.00 more than the ball; how much does the ball cost?" The intuitive answer is 10 cents, which is wrong as the derivation $c+(1+c)=1.1 \Rightarrow 2c=0.1 \Rightarrow c=0.05$ shows. There is actually no need for equation solving since imagining a coin to pay for the ball and another coin with the same value, plus a dollar note for the bat, yields two coins on top of the dollar. Each coin must then be a nickel (a 5-cent coin for us non-Americans). A majority of people (including elite university students) initially give the intuitive System 1 answer of 10 cents, and only a minority override their intuition to compute the correct answer 5 cents with System 2. This illustrates how strong the default to intuitive reasoning is, and how engaging logical reasoning requires conscious effort and cognitive motivation.

4. Dual-Process Theories

The contrast between intuitive, heuristic reasoning and deliberate, logical reasoning is encapsulated in dual-process theories of cognition. These theories provide a framework for understanding why humans often deviate from logical reasoning, yet also sometimes manage to reason logically. Psychologists have described two modes or systems of thinking: commonly known as System 1 and System 2 (Stanovich and West, 2000; popularised by Kahneman, 2011).

System 1 (the intuitive system) is fast, automatic, and often unconscious. It encompasses the kinds of processes that underlie heuristics and gut feelings, processes that are effortless and quick but not necessarily transparent to our conscious minds. System 1 draws on experience, associative memory, and emotion. It is what kicks in when we make a snap judgment or when something just feels right or wrong without our being able to articulate why. Because it operates with little effort, System 1 is our default mode of thinking in most situations. It is efficient and usually effective, but it is also the source of many cognitive biases since it often substitutes simple questions for harder ones and uses relevance and familiarity rather than formal analysis to arrive at conclusions. System 2 (the analytical system) is slow, effortful, and deliberate. It corresponds to what we typically mean by reasoning in a reflective sense, i.e. considering evidence, following steps of an argument, applying rules, and so on. Engaging System 2 requires concentration and mental resources, which are limited. System 2 is capable of following the rules of formal logic and probability (at least in principle), and people can use it to check and override the intuitions of System 1. For example, if one is trained in logic or statistics, one might override an intuitive answer with a logically derived answer in a tricky problem. System 2 is what a person uses to solve a math problem, to systematically compare options, or to carefully evaluate an argument's validity.

Dual-process theory explains many phenomena of reasoning. Most of the time, System 1 drives our thinking because it is less work; we are, in a sense, cognitive misers. System 2 may monitor and occasionally intervene. For instance, if we notice something off or if the situation explicitly demands careful reasoning (say, taking a math test or deliberating a major decision). However, System 2 can be lazy or prone to taking the path of least resistance, often simply endorsing what System 1 suggests unless it finds a clear error. Crucially, System 2 is aligned with the kind of reasoning formal logic represents, whereas System 1 is not. System 2 is capable of applying abstract rules such as those of propositional logic or computing numeric probabilities using formulas, whereas System 1 uses heuristics and associative shortcuts. This is why people can sometimes reason logically. When System 2 is engaged strongly enough or when an individual has the training and incentive to apply logical rules. But in the absence of those conditions, System 1 will govern the response, which often leads to the kinds of biases and errors discussed earlier.

For example, consider again the conjunction fallacy with Linda. A person may initially feel that a feminist bank teller is more fitting (System 1's intuition). If that person is highly attentive or numerate, they might pause and think: "Wait, that cannot be right, because any feminist bank teller is also a bank teller; the probability should be lower." That correction is the work of System 2 overriding System 1. Many people, however, do not perform that override in the Linda problem, because the intuitive answer comes quickly and seems satisfactory, and they do not realise a logical check is needed or they do not know how to do the probability calculation. Kahneman (2011) notes that even statistically sophisticated individuals can answer incorrectly if System 2 does not kick in at the right moment.

Dual-process models also shed light on belief bias in syllogisms: System 1 might generate a quick evaluation of the conclusion based on plausibility (this sounds true or this sounds false), and unless System 2 intervenes to systematically examine the logic, that evaluation will determine the person's answer. Overcoming belief bias requires a conscious effort to separate the logical form from one's world knowledge, a classic System 2 task that many participants in experiments do not fully succeed at. Thus, dual-process theory reinforces the point that formal logic is not an automatic framework running in our minds at all times; rather, the human mind has to invoke a special, effortful mode of thinking to approximate logical reasoning. Our intuitive mode, which dominates much of our waking life, operates on different principles. It is associative, context-dependent, and efficient, characteristics that make it very different from the systematic symbol manipulation of formal logic. Understanding this duality helps explain why we can be so smart and yet so illogical at times: our default brilliance is tuned to one kind of rationality (one that usually serves us well in everyday life), and it takes conscious work to enact the other kind of rationality that formal logic demands.

5. Intuition and Emotion

If human reasoning were only a story of bias and error, one might conclude that deviating from logic is simply a flaw. However, cognitive science and related fields have also highlighted the *adaptive* side of our intuitive, heuristic mode of thought. Our intuitive reasoning and emotional responses often serve us well, especially in complex, uncertain, or time-pressured situations where formal analysis would be impractical. Thus, it is important to recognise that the dominance of intuition and affect in human reasoning is not just a defect to lament, but a reality to understand and even leverage.

Emotion in particular plays a critical role in decision making. Damasio's work is illuminating in this respect (1994). Damasio studied patients with damage to parts of the brain (such as the ventromedial prefrontal cortex) that integrate emotion with cognition. These patients appeared normal in IQ and performed well on logical problem-solving tasks, but they had tremendous difficulty making decisions in real-life contexts. They could list pros and cons endlessly but struggled to arrive at a conclusion. In one case, a patient spent hours deliberating over mundane choices such as what date to schedule his next appointment, analysing trivial details logically but never feeling a clear preference for one option over the other. The lack of emotional input left him unanchored in decision making. Damasio's interpretation was that emotion provides an essential guide to what we value or prefer, something that a purely logical calculus, which treats all factors as neutral until assigned a value, cannot do by itself. He introduced the concept of somatic markers: emotional reactions (often unconscious) that become associated with decision options based on past experience, essentially marking them as good or bad options. These emotional signals help narrow down choices and highlight what is important to the decision-maker. In the absence of such signals, as with his patients, reasoning can become unmoored and indecisive.

Thus, emotion can be seen as a heuristic summary of experience: a quick affective appraisal that tells us that "This is probably a bad idea" or "This feels promising" by drawing on subtle cues and past outcomes. Emotions are not infallible, but they encapsulate information in a way that is usable by our minds under constraints. They often alert us to potential risks or opportunities faster than logical analysis could. For instance, a sudden feeling of distrust in a particular situation might be based on subtle cues that our conscious mind has not yet processed. Ignoring such gut feelings and insisting on purely logic-based analysis might mean overlooking important warning signs that our intuitive system has detected.

The interplay of intuition and analysis is also evident in expert decision making. Research into how experts make rapid decisions, such as firefighters approaching a dangerous fire or chess masters choosing a move, reveals that they do not typically compare all options logically. Instead, they rely on pattern recognition and gut responses honed by experience. A firefighter might intuitively sense that a building is about to collapse, without being able to verbalise the logical reasoning, and that intuition can be lifesaving. In such cases, intuitive reasoning leverages real-world regularities learned over time. It might look non-logical because it is not articulated in abstract terms, but it is often highly effective. What appears as a split-second hunch can be the result of the brain recognising a familiar pattern in the situation (perhaps the way the flames behave or a sound in the structure) that historically signalled collapse. Of course, intuition and emotion can mislead as well. Fear can be irrational and snap judgements can be biased or wrong. The point is not that intuition is superior to logic in general, but that each has strengths and weaknesses. Intuition is fast and frugal and often sufficient for everyday situations, and it incorporates experiential and emotional knowledge that logic might miss. Analytical reasoning is slower and more effortful, but it can handle novel problems or complex trade-offs more systematically and can catch mistakes that intuition overlooks.

Modern theories of decision making emphasise that the best outcomes often come from an integration of intuitive and analytical approaches. For instance, in complex personal decisions such as choosing a career or a place to live, a person might use analysis to list options, consider criteria, and weigh pros and cons (a logical approach), but after doing so, they might still rely on their feelings to actually make the final choice, i.e. selecting the option that *feels* right after ensuring it meets the key requirements. This synergy respects the role of logic in structuring the decision, while also acknowledging that personal values and satisfactions are ultimately subjective and must be felt. A purely rational choice that ignores one's emotions can backfire and a purely emotional choice that ignores logic can as well. The optimal process often engages both: as one article put it, a good decision involves a sequence or blend of both modes, where intuition contributes experiential wisdom and analysis provides logical structure, each checking the other's excesses.

One practical method that illustrates this integration is the PILOT decision-making approach, which explicitly incorporates an intuition check into a structured multi-criteria decision analysis (Danielson, 2021, 2021b). Decision-makers first go through logical steps of defining options and criteria, and then evaluating how each option scores on those criteria (a formal, System 2 process). But the PILOT method includes a step where decision-makers pause to consider their intuitive ranking of options, essentially asking, "After all this analysis, what does my gut feeling say?" If the intuitive feeling about the best option differs from the analysis, that discrepancy is explored further: maybe an important criterion was omitted, or perhaps the intuition is swayed by a bias. The final decision is made by humans, not by the numbers alone, allowing a consciously subjective override if something feels off even after analysis. This kind of hybrid procedure acknowledges that neither pure intuition nor pure analysis is sufficient; rather, they should inform each other.

Thus, human reasoning is richly intuitive and affect-laden, and this is not necessarily a flaw to be corrected but a reality to be understood. Our cognitive toolkit includes much more than formal logic. It includes instincts, emotions, and learned heuristics that have their own adaptive rationale, often referred to as "ecological rationality. They make sense given the environments in which we evolved and operate. Appreciating this can lead to better strategies for decision making than a single-minded insistence on formal logical reasoning in all circumstances.

6. The Limitations of Logic

Having distinguished between logic and human reasoning, it is important to acknowledge that formal logic does have great value. It just serves a different purpose than describing our cognitive processes. Formal logic is a cornerstone of rigorous thinking in mathematics, computer science, and philosophy. It provides a language and system to ensure consistency and to derive conclusions that reliably follow from premises. When used appropriately, logic can check our intuitions and catch errors.

For example, in mathematics and computer science, logical reasoning is indispensable. The design of digital circuits and computer algorithms is essentially an exercise in applied logic. Indeed, Boolean logic underlies the operations of every digital computer. In these domains, human intuition alone is not sufficient to ensure correctness; one must follow formal rules to avoid mistakes. Similarly, in law or formal debate, the logical structuring of arguments is key to ensuring that conclusions are well-supported. Logic forces clarity: by translating vague arguments into precise premises and conclusions, we can more easily spot where an argument might go wrong. It helps us avoid self-contradiction and illogical leaps. In these ways, formal logic acts as a tool for structuring reasoning and improving it.

However, the utility of formal logic does not mean our brains naturally use it, nor that it should be used to the exclusion of other thought processes. Just as a person uses a calculator for complex arithmetic rather than doing it all mentally, people use external logical frameworks (such as written work or software) to augment their reasoning, because raw human thinking is not automatically logical. We typically have to learn logic through education, and even then, applying it is effortful.

One limitation of formal logic is that it requires correct premises to yield correct conclusions. Humans often have incomplete or uncertain knowledge, and logic alone does not tell us how to gather or judge the truth of premises since that is an empirical matter. People might rigorously deduce conclusions that are perfectly logical given their beliefs, and yet be completely wrong because their initial beliefs (premises) were false or mis-specified. An overconfidence in one's logical reasoning might blind one to errors in the starting assumptions. A person can rigorously analyse a problem but still arrive at a poor decision if they mis-specify the parameters. In other words, logical reasoning is only as sound as the inputs it is given, and figuring out those inputs often relies on experience and intuition outside the logical calculation.

Another limitation is that formal logic deals poorly with nuance and degrees. Everyday reasoning often involves probabilities, uncertainties, and exceptions. Classical formal logic is black-and-white: a conclusion is either true or false given the premises. Human reasoning is comfortable with shades of grey. We easily think in terms of likelihoods, tendencies, and usualness. There are formal systems (such as probabilistic logic or fuzzy logic) that extend classical logic to handle uncertainty, but these too are far removed from what untrained humans are able to do. People rely on heuristics to make judgements about uncertainty (with mixed success, as we have seen), rather than explicitly applying probability theory or formal logic. Any method or tool that aims at supporting humans in thinking and decision making must meet people at their levels of reasoning and with concepts and procedures that align with humans, not formalisms.

Additionally, formal logic is monotonic. Adding more premises cannot invalidate a conclusion that followed from earlier premises (as long as there's no contradiction introduced). Human reasoning, by contrast, is often non-monotonic: we readily withdraw conclusions when new information suggests an exception or a changed context. Our common-sense reasoning allows for default assumptions that can be revised. For example, we may reason that birds fly, and a penguin is a bird, so penguins probably fly. This is until we learn that penguins are an exception. In classical logic, if one treated birds fly as a universal premise, one could not accommodate penguins do not fly without contradiction. Human reasoning handles this with ease by implicitly treating general rules as general (with assumed exceptions) rather than absolute.

Nonetheless, formal logic is an extraordinarily useful invention. It is the backbone of rigorous analytical thinking and has guided the development of many fields. It serves as an *ideal*, i.e. a way to measure arguments and ensure reliability. However, it is an idealisation. Humans can strive to be logical, and in certain tasks, we can approximate that ideal, but our baseline mode of operation is not that of a logical calculus. Instead, we have a more eclectic cognitive toolkit. Knowing the limits of logic's descriptiveness reminds us that logic is a *tool we use*, not the *mechanism by which we operate*. In real life, we blend logical reasoning with intuition, emotion, and tacit knowledge. We could indeed use some form of logic to check our reasoning and to structure arguments where appropriate, but we should not assume that our minds naturally run on formal logic, they do not. Part of this misconception falls on the part of the logicians themselves, who often tout logic as the purest and most correct form of reasoning, leading some students and laymen to believe this is the case. While it is in reality just good old marketing, everyone wants to promote what they are doing and make it sound important, to the degree that the world will almost collapse without that particular piece of knowledge or that particular skill.

7. Overvaluing Logic

Believing that formal logic perfectly represents human reasoning is not just a theoretical mistake; it can have practical consequences. If individuals or institutions expect decisions and behaviours to follow purely logical patterns, they may mispredict outcomes or prescribe ineffective solutions. We now consider the implications of this misconception in personal, professional, and public contexts.

7.1 Personal Decision Making

On a personal level, a person might aspire to make all their decisions rationally by relying solely on objective analysis, consciously ignoring their feelings or instincts. While careful analysis is generally a good thing, disregarding intuition and emotion can lead to choices that are misaligned with one's true preferences and needs. For example, someone might list pros and cons and choose a career path that looks best on paper (with the highest salary, prestige, and logical progression), only to find themselves miserable because the work does not suit their interests or values. The analysis might have overlooked how important creative fulfilment or work environment is for that individual, factors that do not easily boil down to a logical score. This scenario is common enough that career counsellors warn against choosing a job solely on logic. It illustrates that a decision can be objectively well-reasoned yet subjectively poor.

Emotions also act as an internal guidance system. If one feels a strong aversion to an option that otherwise seems logical, it is worth examining why. It could be signalling an overlooked risk or a value conflict. Likewise, a strong attraction or excitement toward a particular choice might signal an alignment with one's core interests or identity. Completely ignoring these signals in favour of an abstract logical calculus can lead one to make decisions that are technically efficient but personally unsatisfying or even untenable. For instance, in choosing a life partner, making a checklist of traits and logically evaluating candidates would miss the intangible chemistry and emotional compatibility that are crucial for a successful relationship. Overvaluing logic in such a deeply personal domain could yield a partnership that ticks all the boxes but lacks happiness.

Another issue is decision paralysis. As mentioned earlier, people who attempt to decide everything by exhaustive logical analysis can become overwhelmed by options and criteria, a state often called analysis paralysis. Without intuition to cut through the noise or signal a clear preference, every choice can become an overanalysed puzzle, making even trivial decisions burdensome. Allowing intuition or simple satisficing strategies to guide less critical choices can free up mental energy and lead to more satisfaction than laboriously calculating an optimal choice for each minor decision. In short, in personal contexts the key implication is that one should not ignore the human elements of decision making, i.e. the intuitive pulls, the emotional responses, and the subjective values. Overvaluing a Spock-like hyper-rational approach can lead to decisions that are logically sound but personally hollow. As human beings, we ultimately seek not just logically consistent lives, but meaningful and fulfilling ones, which requires integrating logic with our affective and experiential selves. The wisest personal decisions often emerge when one's head and heart are in agreement.

7.2 Professional Contexts

In the workplace and professional decision making, the use of formal logic can similarly lead to suboptimal outcomes. Business managers, for instance, might rely exclusively on analytical models (spreadsheets, quantitative metrics, and algorithms) to make decisions about strategy or operations, under the assumption that this is the most rational approach. While data and analysis are indispensable in modern management, an over-reliance on them can result in what some have called *measurement fixation*, focusing only on what can be quantified and plugging those numbers into logical models, while neglecting qualitative factors that are hard to quantify. Important considerations such as employee morale, customer trust, or brand reputation might be downplayed simply because they do not fit neatly into a formula. This narrow approach can yield decisions that look optimal on a balance sheet but fail in practice.

Professional judgment often requires knowing when to trust analyses and when to go with experience. Experienced leaders frequently speak of gut decisions, a term that might sound anti-rational, but often these are decisions grounded in tacit knowledge. A seasoned project manager might have a gut feeling that a project plan, though logically structured, will run into trouble due to team dynamics or stakeholder politics. If the organisation's culture dismisses such intuition unless it can be justified in a report, it risks missing out on the insights that formal analysis did not capture. Sometimes those intuitive warnings are exactly what prevent a disaster that no spreadsheet could predict.

In complex business problems, formal methods such as optimisation or cost-benefit analysis are helpful to structure thinking, but the final call often benefits from a layer of human wisdom. As noted earlier, multi-criteria decision tools used in industry allow the inclusion of subjective judgements, for example, scoring an option on strategic alignment or risk level, based partly on expert intuition. These tools acknowledge that not everything can be reduced to a single utility value. A decision-maker who insists on using only logical criteria might ignore the soft knowledge that does not fit the formula, potentially choosing an alternative that is technically best in model terms but fails in execution due to human factors.

Moreover, workplaces that idolise formal logic may inadvertently stifle creativity and innovation. Breakthrough ideas often do not come fully formed with logical proof of concept; they start as hunches or imaginative leaps. If a company culture demands a logical business case for every idea before it is explored, truly novel ideas (which by definition lack past data and logical assurance) may be strangled in the cradle. In contrast, companies that allow experimentation and intuitive brainstorming (followed by testing and analysis to validate the ideas) often advance further. Overvaluing logic might lead a team to reject a creative strategy because it does not align with past market research or the current model, only to be outmanoeuvred by a competitor who tried the unconventional approach.

On the flip side, logic is still crucial in professional contexts for preventing obvious mistakes and biases. The lesson is balance. A business that only values formal analytics might excel in optimisation but falter in adaptation and motivation. A business that only values gut instinct might seize opportunities quickly but also run aground by ignoring warning signs in data. The best leaders seem to combine analytical rigor with intuitive savvy. They might analyse a decision thoroughly, yet they also trust when their experience tells them something does not add up, even if they cannot fully articulate it logically. They use logic to inform and discipline their intuition, and intuition to inspire and double-check their logic.

To illustrate, consider corporate restructuring decisions like layoffs. A purely logical model might suggest that cutting 10% of the workforce will save X million dollars and minimally impact output according to efficiency metrics. Acting on this logic alone, a company might proceed with layoffs. If they fail to consider the human factor, the blow to morale, the loss of organisational knowledge, or the effect on remaining employees' loyalty, then the outcome might be a decline in productivity and innovation that undermines the intended savings. Many companies have found that aggressive cost-cutting by the numbers had hidden costs that a more holistic reasoning process would have considered. A more nuanced approach would use analytics to identify cost issues but then consult managers' on-the-ground intuition about team health and long-term capabilities before deciding how to address them.

7.3 Public and Policy Contexts

In government and public policy, assuming that citizens or officials will behave as perfectly logical actors has often led to flawed policies and unintended consequences. Public policy models traditionally were built on rational-actor assumptions. For example, economic models that predict people will respond to a tax or subsidy in a straightforward utility-maximising way. However, behavioural economics has repeatedly shown that real human responses can diverge from these logical predictions. People might ignore a beneficial incentive out of inertia, or they might react against a regulation out of a sense of reactance or perceived unfairness, even if compliance would be in their logical self-interest.

Policymakers have learned that rational communication alone is often ineffective. Simply providing information and assuming the public will logically update their beliefs and behaviours is often wishful thinking. For example, for many years health campaigns provided facts about the dangers of smoking, assuming people would make the logical decision to quit. Many did not, because addiction, social factors, and the way people process risk (often discounting future consequences) overrode pure logic. More recent public health interventions have employed strategies that account for human psychology: graphic warning labels that evoke emotion, smoking bans that change social norms, and so forth. These approaches acknowledge that emotion and social context drive behaviour as much as or more than logical deliberation.

Another example is retirement savings. Economically, it is logical for individuals to save sufficiently for retirement, especially if an employer offers matching contributions. Yet many do not save enough when it is an opt-in choice. Not because they have rationally decided to splurge now and suffer later, but often due to procrastination or the complexity of choosing a plan. Policymakers using insights into real behaviour changed many retirement plans to automatic enrolment with an option to opt out (rather than requiring opt-in). This subtle change (a classic nudge) dramatically increased participation rates, confirming that working with human tendencies yields better results than assuming purely logical behaviour (Thaler and Sunstein, 2008). In essence, understanding that people are *not* perfectly logical decision-makers led to a policy design that achieved the desired outcome more effectively.

When governments or institutions rely solely on formal analyses such as cost-benefit analysis, they might neglect important values that are hard to quantify. For instance, a purely economic analysis of a new infrastructure project might favour the option with the highest cost-return ratio. However, if that option has environmental downsides or public opposition, a strictly logical calculus might misjudge the viability. Decision analysis in the public sector is one response to this. It brings in various criteria (social, environmental, cultural) alongside economic ones. This makes the decision process less neat from a formal logic standpoint, but it better reflects the complex reasoning that a government must do in reality. Ignoring those other criteria because they do not fit a simple logical model can lead to public outrage or long-term costs (for example, public health costs or environmental clean-up) that the initial analysis ignored.

Overvaluing formal logic in the public sphere can also erode trust and communication. Officials who present policies with cold, logical arguments might fail to connect with the public who use different lenses to evaluate proposals (fairness, emotion, identity). A classically rational argument might say, "Policy X will maximise overall welfare." But an individual might think, "Policy X hurts people like me, even if it is logically beneficial on average, and that feels unfair." Dismissing that concern as illogical would be politically unwise; instead, policymakers need to engage with perceived fairness and find ways to address it (perhaps by tweaking the policy or compensating the losers) to arrive at a solution that is not only logically sound but also publicly acceptable. This insight has prompted innovations in policymaking, such as citizen juries or public consultations, where officials actively solicit the intuitive and value-based feedback of the community rather than solely relying on technocratic analysis. It is now well-understood that a policy that looks optimal in a model can fail if it does not account for how people actually behave or if it violates deeply held values.

Thus, in public contexts, the misconception that humans are strictly logical can lead to poor communication strategies, misguided expectations of behaviour, and policies that do not work as intended. The corrective is to incorporate a realistic model of human reasoning, one that includes cognitive biases, emotional drives, and social influences. By doing so, public decision making becomes more robust. Policies are designed not only to be logically coherent but also to be effective given how people really react. Public campaigns are crafted to appeal to both logic and emotion. In the end, this leads to better outcomes: citizens who feel understood and engaged, and policies that achieve their goals in practice, not just in theory.

8. Conclusions

Formal logic and human reasoning are, in effect, different languages. Formal logic is the language of idealised rationality, being precise, unambiguous, and rigorously structured, whereas human reasoning is the language of the mind: rich in nuance, influenced by memory and emotion, and geared towards practical survival and social interaction. The idea that one could be translated perfectly into the other is alluring but ultimately misguided. We have seen through historical insight that logic was deliberately defined in a way that strips away the vagaries of actual thought, and through cognitive science research that actual thought does not adhere to those stripped-down rules.

Understanding this divergence is not a call to abandon logic or to deem human thinking hopelessly irrational. Rather, it is a call to *contextualise* logic as one tool among many in the arsenal of reasoning. Logic is extremely useful for *evaluating* reasoning and ensuring arguments hold water, but it is not the *process* by which everyday judgements are made. Human reasoning is a complex mix of intuition, experience, emotion, and bounded rationality, with formal logic being more like a pattern we can impose on that tapestry for certain purposes. Recognising the gap between normative logic and descriptive reasoning allows us to navigate our mental lives more effectively. For one, it fosters intellectual humility. Knowing that even the smartest among us are prone to biases and leaps of intuition keeps us cautious about our own certitude. It motivates us to use tools such as writing out arguments, using checklists, or consulting others to catch mistakes our intuitive reasoning might miss. It also encourages empathy in disagreement: if someone reaches a different conclusion not because they're logically inept but perhaps because they have different experiences or values influencing their reasoning, dialogue can proceed more constructively.

In educational settings, appreciating this difference means we should teach not only the principles of logic and critical thinking but also awareness of cognitive biases and the importance of emotions in decision making. People can learn when to engage System 2 and how to question their System 1 impulses without expecting that we can or should function like purely logical machines. In the end, the goal is to improve reasoning and decision making by leveraging all our mental capacities: using intuition for what it is best at and analysis for what it is best at. In practical decision making, whether personal or organisational, it means embracing a balanced approach. Use analysis to ensure consistency and thoroughness, but also check whether the result aligns with intuitive judgment and experiential wisdom. Where they conflict, investigate the cause of the conflict rather than simply privileging one side. This wisdom-of-two-minds approach, combining the mind's logical and intuitive voices, tends to produce decisions that are both effective and satisfying.

Finally, by dispelling the myth that humans naturally reason like logical algorithms, we can design societal systems that accommodate human nature. This might mean creating choice architectures that guide better decisions (acknowledging our biases), fostering deliberative processes that allow emotional expression (acknowledging people's values), or simply communicating in a way that connects with how people actually think. In all cases, the outcome is a more human-centric application of reason. Formal logic remains one of humanity's achievements for structuring knowledge and argument, but it was never a psychological theory. Recognising its utility and its limits gives us the best of both worlds: we can continue to revere logic as a guiding ideal and a critical tool, while also embracing the full richness of human reasoning in our theories of mind and our approaches to decision making. In doing so, we pave the way for decisions and policies that are not only logically sound but also realistically workable and humanly wise. In essence, effective reasoning and decision making require us to engage both the heart and the mind, aligning our intuitive insights with our logical analyses.

References

Aristotle. (1984). Prior analytics. In J. Barnes (Ed.), *The complete works of Aristotle: The revised Oxford translation* (Vol. 1, pp. 39–113). Princeton University Press.

Boole, G. (1854). *An investigation of the laws of thought: On which are founded the mathematical theories of logic and probabilities*. Walton and Maberly.

Cosmides, L., & Tooby, J. (1992). Cognitive adaptations for social exchange. In J. Barkow, L. Cosmides, & J. Tooby (Eds.), *The adapted mind: Evolutionary psychology and the generation of culture* (pp. 163–228). New York, NY: Oxford University Press.

Damasio, A. R. (1994). *Descartes' Error: Emotion, reason, and the human brain*. New York, NY: G.P. Putnam's Sons.

Danielson, M. (2021). *Decision Making, Fast or Slow? The Tale of System X and System Y*. Unpublished manuscript, Stockholm University.

Danielson, M. (2021b). *The PILOT Method*. Unpublished manuscript, Stockholm University.

Evans, J. St. B. T., Barston, J. L., & Pollard, P. (1983). On the conflict between logic and belief in syllogistic reasoning. *Memory & Cognition*, 11(3), 295–306.

Frege, G. (1893). *Grundgesetze der Arithmetik, Band I* [Basic Laws of Arithmetic, Vol. I]. Jena: Hermann Pohle.

Frederick, S. (2005). Cognitive reflection and decision making. *Journal of Economic Perspectives*, *19*(4), 25–42.

Gigerenzer, G., & Todd, P. M. (1999). *Simple heuristics that make us smart*. New York, NY: Oxford University Press.

Johnson-Laird, P. N. (2010). Mental models and human reasoning. *Proceedings of the National Academy of Sciences, 107*(43), 18243–18250.

Kahneman, D. (2011). *Thinking, fast and slow*. London, UK: Allen Lane.

Kahneman, D., & Tversky, A. (1979). Prospect theory: An analysis of decision under risk. *Econometrica, 47*(2), 263–291.

Mercier, H., & Sperber, D. (2011). Why do humans reason? Arguments for an argumentative theory. *Behavioral and Brain Sciences, 34*(2), 57–74.

Simon, H. A. (1957). *Models of man: Social and rational*. New York, NY: John Wiley & Sons.

Stanovich, K. E., & West, R. F. (2000). Individual differences in reasoning: Implications for the rationality debate? *Behavioral and Brain Sciences, 23*(5), 645–665.

Thaler, R. H., & Sunstein, C. R. (2008). *Nudge: Improving decisions about health, wealth, and happiness*. New Haven, CT: Yale University Press.

Tversky, A., & Kahneman, D. (1974). Judgment under uncertainty: Heuristics and biases. *Science, 185*(4157), 1124–1131.

Tversky, A., & Kahneman, D. (1983). Extensional versus intuitive reasoning: The conjunction fallacy in probability judgment. *Psychological Review, 90*(4), 293–315.

Wason, P. C. (1968). Reasoning about a rule. *Quarterly Journal of Experimental Psychology, 20*(3), 273–281.