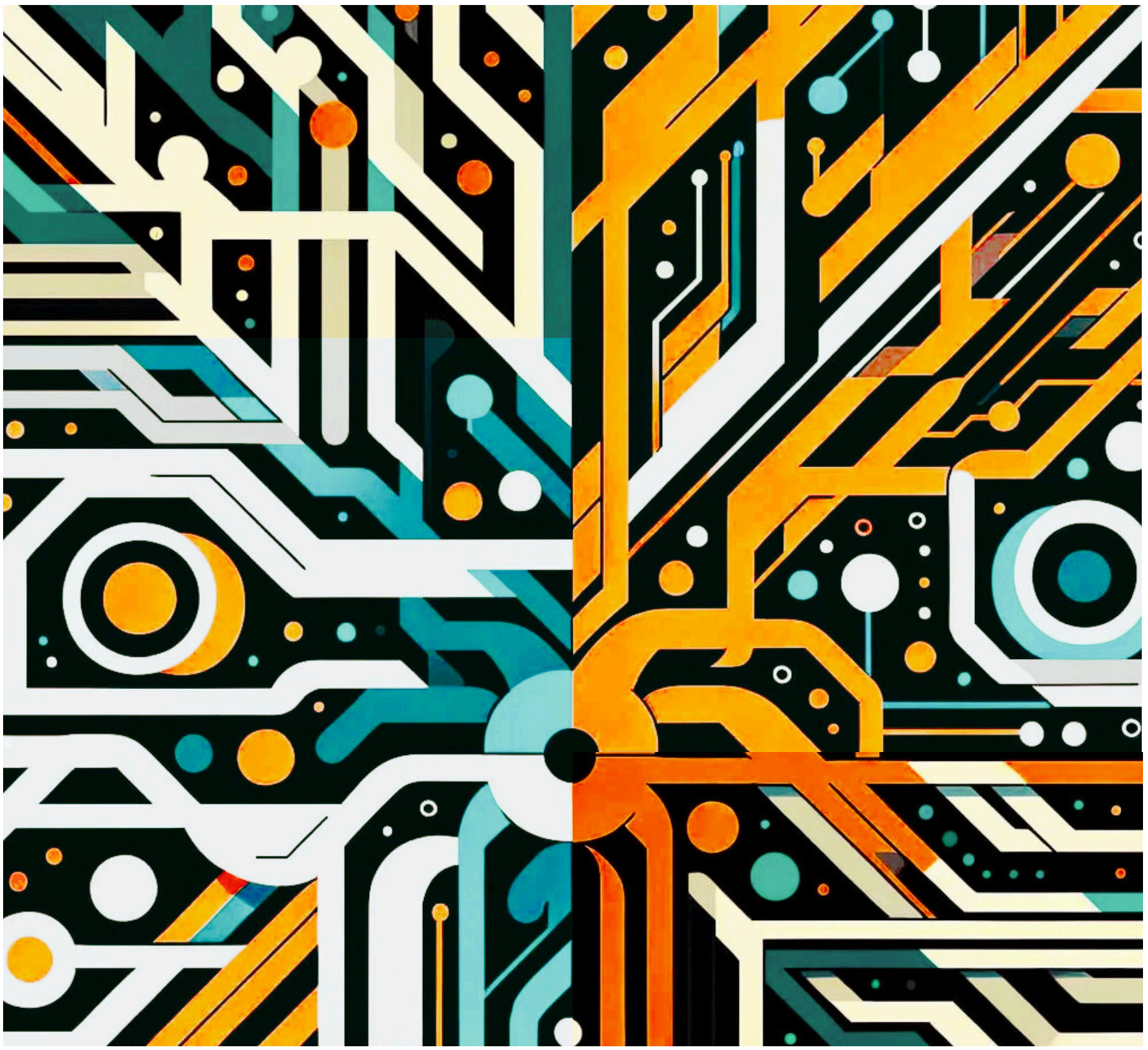
AI DECISION LOGIC

So you have chosen...*Wait, why did you choose that?*



A PRIMER FOR THE CURIOUS

and for THOSE WHO WILL EVALUATE RISK IN SYSTEMS THEY DIDN'T BUILD

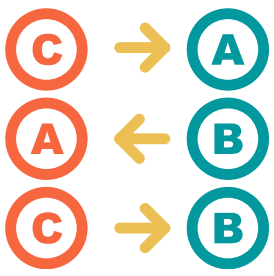
Shoshana Rosenberg

A. DE STATEMENTS. PRIVACY

AT THE BEATING HEART OF EVERYTHING FROM WHETHER OR NOT I HAVE A FIFTH CUP OF COFFEE TO THE ALGORITHMS THAT FOLKLORE MUSES MIGHT SOON TAKE OVER THE WORLD LIES...

DECISION LOGIC

This primer is intended to give you a comprehensive look at the mechanics of algorithmic decision making, covering a broad spectrum that includes:



1. **Boolean logic - The OG of logic.**
2. **Multi-valued logic - Because life isn't just yes or no**
3. **Fuzzy logic - Not as cuddly as it sounds**
4. **Probabilistic logic - Playing the odds**
5. **Temporal logic – Timing is everything**
6. **Deontic logic - Should you really do that?**
7. **Defeasible logic - For when you might change your mind**
8. **Abductive logic - The Sherlock Holmes special**
9. **Inductive logic - Making the leap past logic**
10. **Analogical reasoning - A is to B as C is to...wait, what?**

As ever, I try here to illustrate how these logics play out in the real world, especially through the lenses of Diversity, Equity, and Inclusion (DEI) and Privacy. An understanding of decision logic equips us to evaluate and inform AI systems that prioritize ethical considerations and data security. Decision logic, together with fairness metrics and privacy frameworks, form the tightrope between making decisions that are fair, inclusive, and just- and ensuring the systems themselves protect our personal information in a world that's a little too interested in oversharing.

Boolean logic, as you will see, is the simplest and most limited form of decision logic - but when used in layers and with weighting and logical operators it can help move us beyond binary thinking to create more equitable systems...while probabilistic logic can protect (or compromise) our privacy in ways we're only beginning to fully understand...

This primer is intended as an initial toolkit for understanding the 'why' and the 'how' of algorithmic decision making – which becomes indispensable in an era where AI decisions has increasingly far-reaching consequences.

STATEMENTS

Shoshana Rosenberg

FUNDAMENTAL/BASELINE LOGICS

Its's like this/ it's like this- it's like that.

BOOLEAN LOGIC

FUNDAMENTAL TO THE OPERATION OF DIGITAL CIRCUITS AND SOFTWARE, BOOLEAN LOGIC USES BINARY VALUES (0 OR 1, TRUE OR FALSE) TO EXECUTE LOGICAL OPERATIONS.

Imagine trying to enter a password. It either grants access (true) or denies it (false), with no in-between- or an online form that rejects entries unless all mandatory fields are filled.

Boolean logic is the cornerstone of computational logic, making decisions based on strict true/false conditions.

Privacy Implications
This binary approach can safeguard against unauthorized access but may also lead to excessive data collection.

DEI Impact ✨
The rigidity of such rules and their application might not accommodate diverse user needs, risking exclusion.

MULTI-VALUED LOGIC

USED IN SCENARIOS WHERE DECISIONS AREN'T JUST TRUE OR FALSE AND ACCOMODATE A RANGE OF (FIXED) TRUTH VALUES. (TRUE, FALSE, UNKNOWN, NOT APPLICABLE, ONLY ON TUESDAYS)

In a product (or movie) review system, ratings aren't just thumbs up or down but can range from one to five stars.
The "truth" values are more granular, though still selected from a fixed set of options.

Multi-valued logic embraces the "maybes" of the world.

Privacy Implications
Allows for nuanced data handling, potentially offering users more granular control over their privacy settings, but also of tremendous value in setting granular data access controls and permissions in a multi-level security system. Multi-valued logic can also help determine the level of anonymization or handling required for different types of data.

DEI Impact ✨
By recognizing more than two states, some multi-valued logic-based review systems can better accommodate and better reflect the diversity of user experiences and perceptions. Multi-valued logic systems can also reinforce biases by attempting to categorize individuals, necessarily simplifying complex identities to fit within pre-established options.

Shoshana Rosenberg

LOGICS FOR COMPLEXITY AND UNCERTAINTY

We're far from the shallow now.

FUZZY LOGIC

FUZZY LOGIC ALLOWS FOR REASONING WITH DEGREES OF TRUTH RATHER THAN FIXED BINARY CHOICES, APPLYING "FUZZY" TRUTH VALUES BETWEEN 0 AND 1.

Consider a thermostat that adjusts the temperature not just to "hot" or "cold," but understands "slightly warm" or "a bit chilly"-or a credit scoring system assesses 'risk' not just as 'high' or 'low' but on a spectrum, allowing for more nuanced decisions.

Fuzzy logic aims to capture the nuances between the absolute true and false of Boolean logic, more closely mirroring human reasoning.

Privacy Use
By assessing data in degrees, fuzzy logic can support nuanced and contextual privacy controls, reducing the risk of binary overreach.

DEI Benefit
Enables systems that aim to reflect the complexity of human identities and situations, enhancing fairness.

TEMPORAL LOGIC

TIME MATTERS HERE.

Imagine an autonomous vehicle deciding whether to slow down or stop based on the traffic light's change from green to yellow to red. Temporal Logic is frequently applied in planning and scheduling AI systems where the order of actions is crucial.

Decisions depend on sequences of events or their timing.

Privacy Concern
Temporal data can reveal patterns about a person's life, raising privacy considerations.

DEI Benefit
Can be used to ensure time-based decisions do not disproportionately affect certain groups, promoting equity in service delivery.

DEONTIC LOGIC

FOCUSES ON WHAT IS PERMITTED, OBLIGATORY, OR FORBIDDEN WITHIN A SYSTEM.

Ideal for a digital content management system to determine if a user has the rights to access, modify, or distribute content.

The logic of duty and permission. It is key in AI systems governance, ethical AI, and legal reasoning AI, providing a formal framework for encoding ethical principles and rules into AI systems.

Privacy Use
Helps enforce data access controls, ensuring only authorized actions are permitted with user data.

DEI Impact
Can support the enforcement of technical policies that enshrine fairness and protect against discrimination, supporting equal rights and access for all users.

PROBABILISTIC LOGIC

THIS LOGIC TYPE EXTENDS CLASSICAL LOGIC BY INCLUDING PROBABILITY THEORY, ALLOWING SYSTEMS TO MAKE INFORMED DECISIONS BASED ON THE PROBABILISTIC OUTCOMES OF DIFFERENT ACTIONS.

When your email filters spam, it's not just labeling emails as spam or not based on rigid rules, but on the probability they're spam given their content, certain keywords, sender reputation, and user interactions (or lack thereof). Another example is the dreaded autocorrect and predictive texting that learn from our typing habits to suggest the next word.

Probabilistic logic integrates the likelihood of various outcomes into the decision-making process, enabling reasoning under uncertainty.

Privacy Risk
Systems based on probabilistic logic (personalized advertising or the detailed financial analysis of credit scoring) might inadvertently learn or infer sensitive information, posing privacy risks.

DEI Impact
If not carefully managed, probabilistic logic (for instance when used in facial recognition or predictive policing algorithms) can reinforce biases present in training data, potentially perpetuating stereotypes.

DEFEASIBLE LOGIC

IDEAL FOR SITUATIONS WHERE CONCLUSIONS CAN BE REVOKED WHEN FACED WITH STRONGER, CONTRADICTING EVIDENCE.

Think Netflix or Spotify or any recommendation system that adapts its suggestions as it learns more about user preferences.

With Defeasible Logic it's all about changeable decisions based on new information.

Privacy Risk
Dynamic decisions based on accumulating data might lead to over-collection of personal information

DEI Benefit
Its adaptability can be leveraged to correct biases as they are identified, promoting fairness.

ADVANCED REASONING AND LEARNING APPROACHES

ABDUCTIVE LOGIC

ABDUCTIVE LOGIC IS USED IN DIAGNOSTIC SYSTEMS WHERE THE GOAL IS TO INFER THE MOST PROBABLE CAUSE FROM OBSERVED EFFECTS.

Medical diagnosis AI inferring possible diseases from a set of symptoms uses abductive logic.

Abductive reasoning looks for the most likely explanation.

Privacy Concern
The inference process (here again) may lead to assumptions or inferences of sensitive information about individuals based on limited data.

DEI Impact
Needs careful calibration to avoid reinforcing stereotypes based on incomplete or biased data sets.

INDUCTIVE LOGIC

POWERS MACHINE LEARNING BY GENERALIZING FROM EXAMPLES TO LEARN RULES.

An AI learning to recognize spam emails based on patterns in previously identified spam.

From specific instances to general principles.

Privacy Risk
Learning from user data risks unintended privacy invasions if sensitive patterns are exposed.

DEI Concern
If training data is biased, the inferences may perpetuate or amplify these biases.

ANALOGICAL REASONING

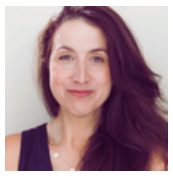
DRAWS PARALLELS BETWEEN NEW SITUATIONS AND KNOWN CASES TO MAKE DECISIONS.

Imagine an AI job applicant review system that compares job candidates to successful employee profiles in similar roles, or a system that applies legal precedents in AI-driven legal advice, where decisions are based on similarities to previous cases.

Making connections between similar scenarios.

Privacy Implication
Relies heavily on historical data and inferences, which can be a privacy minefield if not handled with care.

DEI Impact
Analogical reasoning can either mitigate or magnify biases based on the selection of comparable cases.



Shoshana Rosenberg

Now that we have taken a whirlwind tour through the world of decision logic- *with a special nod to the deontic logic that will someday keep our AI overlords in check...***stay tuned for our next stop:**

Decision Trees and Random Forests and Markov and Monte Carlo and Multi-Criteria decision making- oh my. *(Because why make a decision based on one criterion when you can agonize over multiple conflicting objectives at once?)*

The logical techniques we covered here are much the fundamental rules of the road...while decision trees and their ilk are closer to the specific routes and paths we take to reach our (decision/prediction/output) destination.

But why should any of this matter to you, dear reader? **In this brave new world of data driven everything, knowing a thing or two about decision tools and techniques is a bit of a superpower-** and even if you aren't fully mired in AI governance- it never hurts to level up.

A.DE STATEMENTS PRIVACY

A.I., **Privacy** and **DEI** have a high level of interdependence and interconnectedness and are continuously evolving.

All three are tied directly to ethics, fundamental human rights, the future of work, and decision making and bias, which means:

YOU AREN'T ON THE SIDELINES OF THESE THINGS.

YOU ARE CRUCIAL TO THEM BEING WHAT THEY SHOULD.

Do you want to know more?

STATEMENTS

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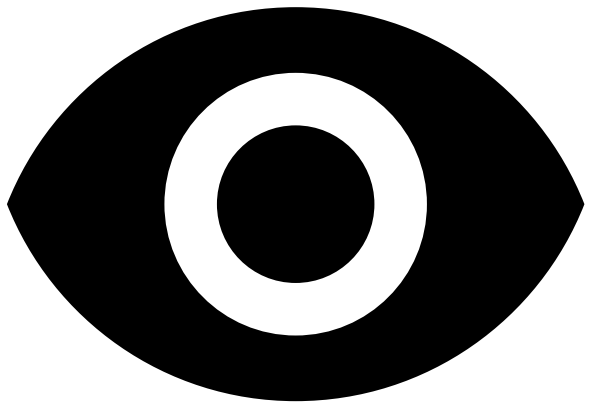

A.I. DETECTS STATE PRIVACY

Shoshana Rosenberg