Cognilytica Research

simMachines

Using Similarity-Based Machine Learning for Explainable AI

Briefing Note

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ABSTRACT

The more we involve AI in our daily lives, the more we need to be able to trust the decisions that autonomous systems make. However, it's becoming harder and harder to understand how these systems arrive at their decisions. Cognilytica believes that Explainable AI (XAI) is an absolutely necessary part of making AI work practically in real-world business and mission-critical situations. Rather than trying to make neural networks explainable, simMachines proposes an alternative to neural network approaches (and other machine learning approaches) that is inherently explainable using a nearest-neighbor based similarity-based approach to machine learning.

The Challenge of Explainable AI

The more we involve AI in our daily lives, the more we need to be able to trust the decisions that autonomous systems make. However, it's becoming harder and harder to understand how these systems arrive at their decisions. There are many different supervised and unsupervised ways of training AI systems with Deep Learning and Machine Learning, and these systems are guided with approaches in which a human or the system itself determines what is correct and incorrect. But once this system is operating, the human supervisors are no longer there, and so we don't know how the "black box" of the AI system is truly operating.

It's one thing to wonder how the system correctly understands handwriting or voice commands, but it's another thing to wonder why a drone selected a particular target, why a particular high-frequency stock trade was made, why a medical diagnosis was made, or why an autonomous vehicle decided to veer off its path. Some of these decisions have particularly significant consequences. As the consequences of mistakes and certain decisions become more significant, it becomes more important to have visibility into the inner workings of AI decision-making, or in other words, Explainable AI. The emerging area of XAI aims to address the black-box decision making of AI systems and provide a way to inspect and understand the decision-making steps and models that the AI system is using to make the decisions.

But what exactly do we want AI systems to explain? In general, AI implementers and users want the AI systems to answer these questions which we don't currently have answers to:

- Why did the AI system do that?
- Why didn't the AI system do something else?
- When did the AI system succeed?
- When did the AI system fail?
- When does the AI system give enough confidence in the decision that you can trust it?
- How can the AI system correct an error?

Cognilytica believes that XAI is an absolutely necessary part of making AI work practically in real-world business and mission-critical situations. Without it, AI will be used for either trivial activities or not at all.

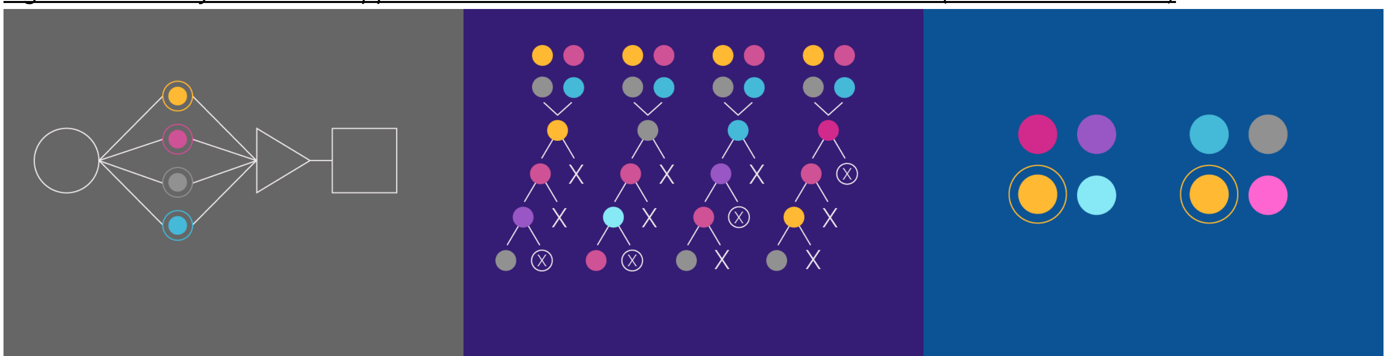
simMachines Overview

simMachines is revolutionizing the field of Explainable AI by providing the "why behind every prediction". The way they are doing it is quite unique. Instead of trying to bolt on explainable interfaces to Deep Learning or neural network learning algorithms, they are instead providing an alternative machine learning (ML) approach using something they call similarity-based machine learning. One of the benefits of this approach to ML is that it not only provides ML-based decisions, but it provides all the reasoning used in coming to those decisions.

The simMachines technology enables users to discover patterns and anomalies in structured and unstructured data. Through their approach to machine learning and training, the system can perform real-time recommendations, and consistent decisions with algorithms that allow users to predict the outcomes of future events and interactions. With every decision and determination made by the system is a corresponding "why" of a prediction, which allows their algorithms to comply with the most stringent Artificial Intelligence auditing rules and meet the needs of XAI.

The technology works by using a unique approach to machine learning. Instead of neural networks or graph/tree based learning structure, simMachines uses a set of nearest neighbor-based clustering, discovery, prediction and regression algorithms. Rather than trying to make neural networks explainable, simMachines proposes an alternative to neural network approaches (and other machine learning approaches) that is inherently explainable. Every prediction creates its own weighted factors and nearest neighbors. The below graphic, adapted from the simMachines website, explains their machine language approach versus the competition:

Figure 1: Similarity-Based ML Approach vs. Neural Networks and Decision Trees (source: simMachines)



Similarity-based ML vs. Neural Networks	***Similarity-based ML vs. Decision Tree/Graph ML***	***Similarity-based ML Approach***
"In neural networks, multiple inputs from neurons create an output. However, there is no way to know which input factor resulted in the output, so only the prediction can be provided, but not the explanation behind the predictions."	"Decision trees require use of large numbers of trees and gradient boosting methods to optimize. Single tree predictions aren't very accurate and gradient boosting is time consuming, hard to maintain, and cannot carry forward the factors behind their predictions, due to complexity."	"simMachines uses a proprietary similarity-based machine learning (nearest neighbor) method vs. decision trees or neural networks. The similarity of an object to another using statistical modeling techniques, as the Why factors behind the similarity of two objects. Historically, similarity-based approaches could not scale because of the Curse of Dimensionality. simMachines solves this problem."

The similarity-based approach to management of big data is not entirely new. It is often used in fields of marketing and customer segmentation. Their technology uses a "distance function" (metric and non-metric) to handle data in its native form and can handle both structured or unstructured data. They use a dynamic dimension reduction technique to identify the variables required to make an accurate prediction. Continuous learning enables constant measuring and adjustment of each action's predictive drivers. A side consequence of this is that the system determines the input variables that most strongly influenced the prediction, providing a level of transparency and explainability. The technology uses a clustering engine to group predictions together. Clients can create clusters for different purposes as needed, query across clusters, and compare clusters and segments together over time.

The below chart outlines how simMachines sees their similarity-based ML comparing to other methods:

Figure 2: simMachines Similarity-Based ML approach compared to others (source: simMachines). For a more legible version of the below graph, please visit the simMachines website.

Algorithm	Problem Type (Regression/ Classification)	Computational Scalability	Handles Date in Natural Form	Results interpretable by user?	Algorithm easily explained to others?	Average predictive accuracy	Performs well with small number of observations?	Training speed	Prediction speed	Amount of parameter tuning needed	Gives probabilities of class membership?	Handles Sparse Data
simMachines	Both	Yes	Yes	Yes	Yes	Higher	Somewhat	Fast	Fast	Some	Yes	Yes
Gradient Boosting	Both	Yes	No	No	No	Higher	No	Medium	Fast	Some	Yes	Yes
KNN	Both	No	Yes	Yes	Yes	Lower	No	Fast	Depends on n	Minimal	Yes	Yes
Linear Regression	Regression	No	Yes	Yes	Yes	Lower	Yes	Fast	Fast	None	N/A	Yes
Logistic Regression	Classification	No	Yes	Somewhat	Somewhat	Lower	Yes	Fast	Fast	None	Yes	Yes
Naive Bayes	Classification	Yes	Yes	Somewhat	Somewhat	Lower	Yes	Fast	Fast	Some	No	Yes
Decision Trees	Both	Yes	No	Somewhat	Somewhat	Lower	No	Fast	Fast	Some	Yes	Yes
Random Forests	Both	Yes	No	No	No	Higher	No	Slow	Moderate	Some	Yes	Yes
AdaBoost	Both	Yes	No	No	No	Higher	No	Slow	Fast	Some	Yes	Yes
Neural Networks	Both	Somewhat	No	No	No	Higher	No	Slow	Fast	Lots	Yes	Yes

Technology Details

The above section defines how the simMachines similarity-based ML approach differs from other ML approaches while providing the side benefit of explainability. Their approach is not meant to provide an explanation method for neural networks; it's providing an alternative to neural networks that are explainable.

To make their approach work and avoid the problems that similar approaches have had in the past, the company has developed several technological breakthroughs that enable performance improvements over other nearest neighbor approaches. These improvements include metric and non-metric distance functions that provide significant improvements in accuracy over traditional Euclidean distance as well as dynamic factor reduction that enables significantly faster response times for very large data sets of varying shapes.

Their product consists of the following components:

- **simSearch -** “Drives nearest neighbor distance calculations in “n” dimensional space. A library of distance functions provide flexible options to data scientists.”
- **simClassify -** “Creates predictions by assigning a predicted outcome to a class. Simple or complex predictions can be supported with full justification at the local level. simClassify can reveal the Why factors behind other algorithms by mirroring their predictions. Multiple predictions can be used together to solve specific problems.”
- **simCluster -** “Uses unsupervised clustering for analysis and data exploration and supervised clustering to create dynamic predictive segments. Parameters and distance functions can be adjusted by the user to refine segments. Dynamic predictive segments groups objects based by the most important shared characteristics for each segment which are revealed in weighted factor order. Segments and their associated characteristics change dynamically and in real-time based on new data.”
- **simRecommend** - “Drives dynamic recommendations in real time for optimizing customer interactions. simRecommend provides the Why factors to enable context and relevancy to be dynamically adjusted and applied during each interaction.”

Customer Use Cases & Value Propositions

As mentioned earlier, similarity-based machine learning approaches have been used for marketing, fraud, compliance, and other applications where fast decision making needs to be paired with an explanation context, and where nearest-neighbor approaches are sufficient to provide the needed value.

Clients for simMachines products include **American Express, Densu, Acxiom**, and others. The company is focused on providing solutions for marketing, technology, finance and other verticals. The below outlines just a few of the potential use cases for the product to highlight value for customers:

Marketing Use Cases

The company has its widest customer base in marketing applications. The primary use case is to improve customer segmentation beyond current static segmentation approaches (putting customers into general buckets) and focus on fine-grained and highly variable segmentation. Uses of simMachines technology for marketing in a variety of industries such as retail, financial services, and media include:

- Dynamic Predictive Segmentation - “Generate dynamic predictive segments by grouping similar predictions together. These innately contain highly actionable insights at a segment level. Granularity can be defined by the user, and full transparency enables users to see the machine-driven factors behind each segment, compare segments, trend segments over time, and forecast the future behavior of a segment.”
- Contextual Customer Experience Predictions - “Predictions anticipate what an individual customer will want, prefer, or need, dramatically improving the customer experience with “up to the moment” data fueling sub-second recommendations.”
- Customer Trending & Analysis - “Reveal patterns over time for gaining insight into customer trends. Whether its channel preferences, product usage, or customer level behavior, trending enables deep understanding and new insights.”

- Supply/Demand Forecasting - “Analyzing supply and demand forecast factors and predicting future demand curves at deep granular levels of detail can dramatically improve supply planning and sales results.”
- Anomalous Pattern Detection - “Similarity provides the ideal tool for identifying anomalous behavior, and the why provides unmatched insight into causes of such behavior revealing emerging trends and opportunities.”
- Call Center/Social Media Analysis - “Cluster and analyze the actual conversation and comment content vs. simply sentiment and type to understand with much greater depth what customers really think and say.”

Fraud & Compliance Use Cases

Other applications of the technology are in fraud and compliance use cases to determine if transactions are valid or actions comply with corporate and legal requirements. In these cases, not only is a determination needed about the validity of a transaction, but also a “why” answer to make sure that an incorrect answer is not provided. That would have negative business impact, such as inappropriately refusing a transaction, denying credit, or blocking access to an asset or resource. The explanations are often required by various laws and regulations to create audit trails and comply with legislative requirements for “explainable” algorithms, such as the European Union’s new General Data Protection Regulation going into effect in 2018.

Key capabilities for this use case include (source: simMachines):

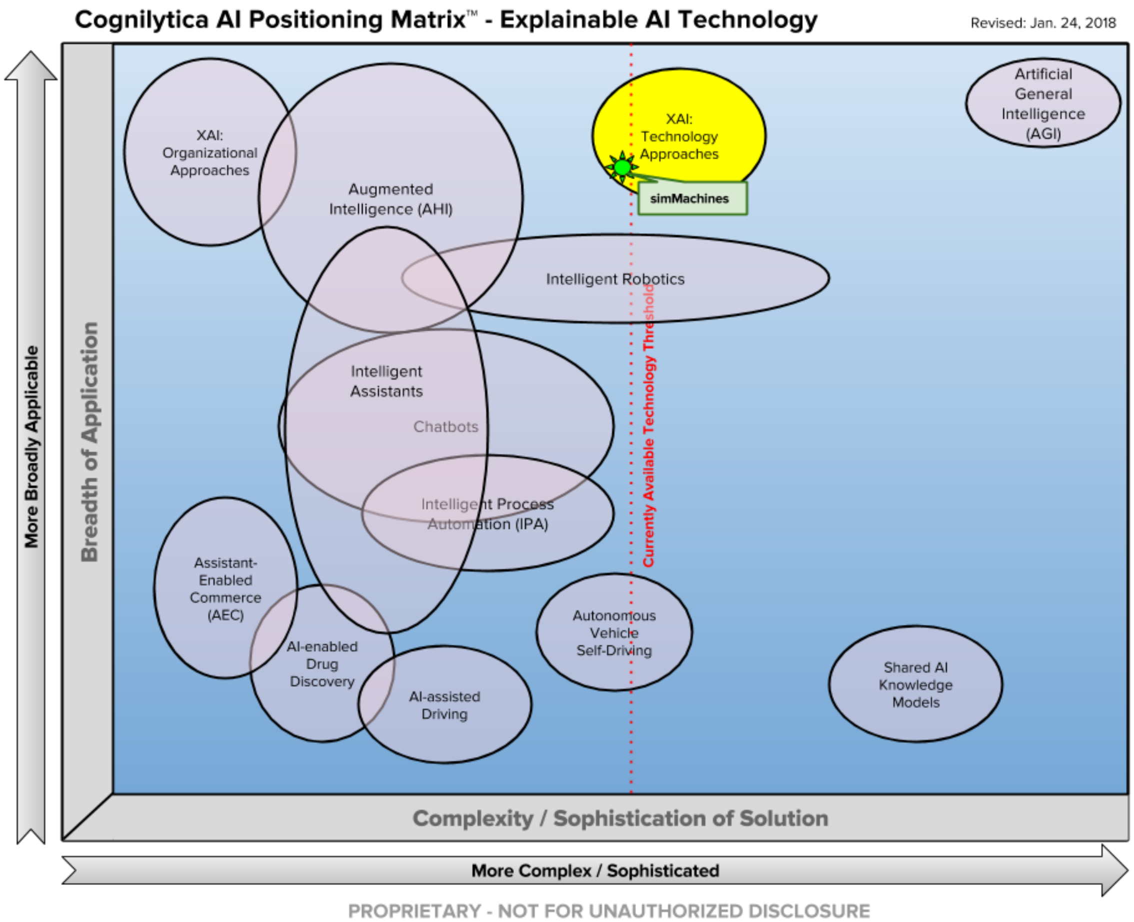
- Justification: “View the weighted factors behind each prediction to understand a prediction’s primary causes”
- Hypothesis: “Compare the gravity of a prediction’s unique factors to its opposite class to visually see its unique differentiators”
- Continuous Learning: “Continuous learning capability enables our algorithms to examine and adjust for local weighted factor differences between objects so that every prediction’s accuracy is further enhanced and automatically adjusts over time”
- Customer Validation: “Optimization of fraud detection and good customer detection are both important to ensure that as fraud detection rules are tightened, the degree to which a good customer is inadvertently identified as fraud is critical to avoid”
- Audit Trail: “Nearest neighbor object ID’s are captured and stored for every prediction so that they can be revealed to support each predictions identified weighted factors that were identified as the drivers”
- Selection & Output: “A restful API call is available for automating export of a prediction with or without its associated data to other systems.”

The simMachines products have additional value propositions for other industry applications in sales, recommendation, and other similar uses.

Company & Solution Profile

Company & Solution Profile (as of Jan. 2018)	
Company Name	**SimMachines**
Founded	**2012**
Company Stage / Funding	**Early-Stage Startup. Funding, undisclosed amount, backers include Microsoft Accelerator, VCapital.** (source: Crunchbase)
CEO	**Robert Zieserl**
Products	**simMachines Similarity-based ML**
Contact information	**222 W Merchandise Mart, Suite 1225** **Chicago, IL 60654** **info@simmachines.com** **www.simmachines.com**

Cognilytica AI Positioning Matrix™



The Cognilytica Take

Explainable AI (XAI) is poised to become one of the single most important requirements for making AI systems realistically implementable in the broadest possible range of applications. Without providing any context behind decisions and actions taken by AI systems and autonomous actors, it becomes harder to trust that the AI systems are doing what you want, when you want them to, or in a predictable way. As such, the industry absolutely needs to realize how critical and important XAI and its various implementations are to guaranteeing the ROI of their AI investments and preventing the premature "winter" of AI.

simMachines has a very interesting and compelling approach to XAI that addresses many of the requirements for explainability and transparency while at the same time providing the necessary machine learning required of a modern AI system. While one may think that the company's approach to ML means that it is not able to work with evolving neural network and graph-based approaches, the company tells us that this is not necessarily the case. simMachines has the ability to convert existing models built by other methods such as neural networks and decision trees into distance functions that mirror their predictions while providing the value of explainability through its technology. In this way, the simMachines solution can provide explainability for other algorithms using this approach.

As such, enterprise, public and private sector organizations exploring the need to adopt AI and ML in a transparent and explainable way should consider the simMachines offering as a component of their solution.

Related Research

- ➢ Explainable AI Research Report (CG007)
- ➢ Kyndi Briefing Note (CGBN0107)

About Cognilytica

Artificial Intelligence (AI) and related technologies will impact all industries and all corners of the world. Without insight into how AI will impact you and your business, you risk being left behind. Cognilytica is an analyst firm that provides real-world, industry and adoption focused market research, intelligence, advisory on Artificial Intelligence (AI) and related areas.

- Cutting through the Hype by Focusing on Adoption — Cognilytica cuts through the noise to identify what is really happening with adoption and implementation of AI in public, private, and academic settings. We focus on the usage of AI in the real world, not the buzzword hype.
- Industry-Leading Market Research — Market-level research on application, use cases, and comparative research on the state of AI adoption in the industry. Focusing on real-world adoption of AI technology and cutting-edge application.
- Advisory with Knowledgeable Experts — Get access to knowledgeable research analysts that spend their time immersed in the world of AI implementation and adoption.
- Research through Conversation — Cognilytica generates its research through direct conversation with industry thought-leaders, technology practitioners, and business decision-makers. We ignore the press releases and skip the hype to produce unique, original research through direct engagement.

- Deep Engagement Opportunities — Connect with peers, industry leaders, experts, and influential practitioners at subscriber-only exclusive workshops, events, and seminars aimed at advancing the state of your AI adoption.

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