Algorithms: Society's Invisible Puppeteers

Joanna F. DeFranco, Penn State Great Valley School of Graduate Professional Studies

Jeffrey Voas, IEEE Fellow

Nir Kshetri, University of North Carolina at Greensboro

Religions have always had an impact on humanity. Although not comparable with religion, today's virtual world offers a lesser influencer: algorithms.

Remember the "wizard" behind the curtain in the classic movie *The Wizard of Oz*? The curtain was unintentionally opened by Dorothy's dog, and the "wizard" was revealed. Dorothy then heard a voice that said, "pay no attention to the man behind the curtain." Fast forward 80 years and consider computer algorithms to be "wizards" behind curtains, and the dog was a whistleblower on the Potemkin village.

Algorithms are integrated in many (or most) aspects of our lives such as stock markets, airplanes, air traffic control, automobiles, medical devices, and so on. But does the public really understand or care how they work? Or is society simply a puppet, following along with whatever content or plan the wizards wants the public to believe?

Algorithms are just rules that are implemented into code. For example, the facial-recognition feature on a phone uses an algorithm to analyze the size and position of a person's facial features to grant or deny access to a device. Another example is an Internet search algorithm that analyzes a user's search criteria to return targeted content. Are search criteria all that the algorithm uses to determine the content to send to the user? No. Search engines also collect and analyze search history, page visits, advertisements clicked on, and more (maybe it's listening to your conversations or looks at cookies stored by other applications as well) to create a user profile that

EDITOR IN CHIEF **JEFFREY VOAS**
IEEE Fellow; j.voas@ieee.org

IN THIS ISSUE

Artificial intelligence and machine learning continues to capture the imagination of our authors, readers, and myself. In *Computer*, we continue to receive many submissions in this area. In this issue, we feature three machine learning articles that have been waiting to be published.

In "Federated Learning: The Pioneering Distributed Machine Learning and Privacy–Preserving Data Technology," the authors examine a new class of machine learning models (pioneered by Google) that are trained on distributed data sets. This article reviews federated learning in terms of a federated data infrastructure for privacy-preserving data access as well as federated machine learning applied to distributed data sets. The authors argue that their main contribution places their approach in perspective to other data science technologies. The article discusses privacy challenges facing data analytics and the relationship of their technology to other data infrastructure technologies. The article also discusses which emerging machine learning algorithms impact federated learning.

In "Deep Conversational Recommender Systems: Challenges and Opportunities," the authors review recommender systems and how to take advantage of natural language processing. The article specifically focuses on a conversational recommender system (CRS). Unlike traditional recommender systems with content-based and collaborative filtering approaches, the authors describe new, emerging CRS models that learn users' preferences through interactive dialogue conversations. They provide a summarization of the recent evolution of CRSs and show where deep learning approaches that were applied to CRSs have produced good results. The article discusses challenges in the development of deep CRSs, explains the current state of the practice, and ends with discussing future directions.

In "Algorithm Auditing: Managing the Legal, Ethical, and Technological Risks of Artificial Intelligence, Machine Learning, and Associated Algorithms," the authors discuss how corporations have become concerned about algorithms and how the algorithms could expose them to corporate-reputation damage. They cite examples such as Volkswagen's Dieselgate, Knight Capital's bankruptcy (from a glitch in its algorithmic trading system), and Amazon's artificial intelligence (AI) recruiting tool showing bias against women. They argue that eventually, AI algorithms will be limitless, and those algorithms will make decisions with minimal human intervention. The article proposes auditing of algorithms to ensure that algorithms are more legal, ethical, and safe. The authors foresee a new industry emerging that audits and assures algorithms. In summary, I hope you enjoy this issue. And please feel free to contact me anytime about the articles featured in *Computer*.

—*Jeffrey Voas, Editor in Chief*

ultimately pushes more targeted advertisements to you. Sound innocent? You decide.

A key problem occurs when algorithms make critical decisions or are programmed to push specific information to the public. At that point, society needs to understand and question the true intent behind the algorithm. Consider the 2008 financial collapse. This recession was one of the worst economic declines in history. Blamed on low interest rates, easily obtained credit, insufficient regulations, and subprime mortgages, the United States lost US$7.4 trillion in stock wealth from July 2008 to March 2009.[3] However, you need to dig a little deeper and discuss the root cause of this downturn and ask, "why were the interest rates low?" "Why was it so easy to get credit?" In other words,

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"why was the risk bar set so low on these financial decisions?" The answer is because the decisions were based on information produced by a particular software algorithm, a fact not well highlighted in the back story behind the 2008 economic collapse. The algorithm behind the risky decision making by financial

"experts" was a formula known as the *Gaussian copula function*. This algorithm calculates and models complex financial risk,[5] and it played a major role in the spread of subprime mortgages.[4] The interesting part

public microscope. The accusations made by the whistleblower are based on the financial gain by a sift-and-sort algorithm to determine the content users will most engage with for the longest time.[1] The Facebook whis-

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here is that it worked beautifully for approximately five years, making it "possible for traders to sell vast quantities of new securities, expanding financial markets to unimaginable levels."[5] But there were limitations to the method that were ignored, and the market tanked.

Another example of potentially dangerous algorithms is those implemented in social media platforms. These platforms can use algorithms to disseminate whatever they want, and sometimes this includes dis- and misinformation. The motive could be for an improved user experience (what they think the user likes), or the motivation could be financial gain, political agenda, and malice. As Reyes stated, "Algorithms have never been more influential, yet our collaborative understanding of how they transform massive networks of cultural power has not kept pace."[4]

A Facebook whistleblower recently put Facebook's algorithms under the

tleblower stated that there were many times the algorithms were optimized to increase profits for Facebook rather than what was best for the common good.[2] Social media is known to be innately addictive, so it is clearly unethical to push content to exploit people's emotions and reactions just to keep them on a website longer (to click on more ads). (We don't think this story has been fully told yet.)

To summarize, society needs to be better aware of how much algorithms control. The algorithm curtain can be opened, but only if society opts to pay attention. And never forget, there is always a person behind the puppeteers. Who's pulling your strings? **C**

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JOANNA F. DeFRANCO is an associate professor of software engineering at the Penn State Great Valley School of Graduate Professional Studies, Malvern, Pennsylvania, 19355, USA. Contact her at jfd104@psu.edu.

JEFFREY VOAS, Gaithersburg, Maryland, USA, is the editor in chief of *Computer*. He is a Fellow of IEEE. Contact him at j.voas@ieee.org.

NIR KSHETRI is a professor of management in the Bryan School of Business and Economics at the University of North Carolina at Greensboro, Greensboro, North Carolina, 27412, USA, and the "Computing's Economics" column editor for *Computer*. Contact him at nbkshetr@uncg.edu.