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Innovation Scholar Zenna Tavares Wants to Give Machines Common Sense

~ Newest Zuckerman Institute investigator draws on logic, philosophy and mathematics to create algorithms with the ability to reason. ~

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NEW YORK – There are many kinds of questions that people are good at answering – but that artificial intelligences still struggle with. Consider a simple scenario of cause and effect: A child throws a stone, and a window breaks. Anyone with common sense can easily understand that the rock caused the window to shatter.

But there's currently no machine that can make such causal inferences effectively, said Zenna Tavares, PhD.

As the inaugural innovation scholar at Columbia's Zuckerman Institute, Dr. Tavares hopes to change this. Sponsored jointly by Columbia's Zuckerman Institute and Data Science Institute, Dr. Tavares is helping to create machines that reason about the real world, with all its complexity and ambiguity, in ways inspired by the human mind and brain itself.

"I want to understand the principles that underpin human higher-level cognition — reasoning, causality, concepts, abstraction — and hope to explore how these get instantiated by the brain," said Dr. Tavares. "Columbia's Zuckerman Institute is a great place to do this work because it brings together experts in neuroscience, theory and interdisciplinary approaches to studying the mind, the brain and behavior."

The Innovation Scholars program aims to advance a diverse cohort of talented early career scholars into academic and non-academic positions. Scholars are welcomed for up to five years as a research scientist with principal investigator status at the Zuckerman Institute, with broad-ranging collaboration and mentorship opportunities, including guidance from faculty hosts and a committee of advisors.

Operating at the intersection of brain science, computer science, cognitive science, logic and philosophy, Dr. Tavares aims to develop machines that can reason in a more human way. As an MIT postdoctoral researcher, he worked on algorithms that run simulation models in reverse to infer what situations could have yielded the observed data. He's fascinated by the Copernican Revolution: how scientists such as Kepler and Galileo discovered laws of the universe. In a recent project he's using

it as a case study for how humans build new models of the world around them, and as a grand challenge for machines that can reason. Incorporating not only human traits but human values, he also wants to develop algorithms that assess intent, fairness and trustworthiness.

“I could not think of a better person to launch the Innovation Scholars program than Zenna Tavares,” said Rui Costa, DVM, PhD, CEO and director of Columbia’s Zuckerman Institute. “His creative, intersectional science and his remarkable humanity are exactly what we want to foster with this program.”

A former Fulbright Scholar, Dr. Tavares earned a master’s in biomedical engineering with neurotechnology from Imperial College London, a master’s in electronic engineering with Japanese at the University of Nottingham and Osaka University, and a PhD in cognitive science and statistics from MIT.

His research seeks to distill into mathematical principles the mental strategies we use to reason. That starts with writing new programming languages that offer a richer vocabulary for representing information and logical relationships.

“When people talk about programming languages, like Javascript or Python, they think of them as tools to do things,” said Tavares. “But I think about them as languages of thought, ways of representing things about the world.”

During his graduate studies at MIT, Dr. Tavares wrote a new programming language tailor-made for counterfactual reasoning. Imagine a doctor who loses a patient. The doctor wonders: Should I have prescribed a different treatment? They draw on their observations about the patient to hypothesize about what could have happened differently, to pose counterfactuals.

Dr. Tavares’ language, Omega, provides syntax and methods for exploring cause and effect and assessing such what-if scenarios. It can be used to create models that incorporate knowledge from the world and make probabilistic and causal inferences.

This work is already beginning to have a real-world impact. For example, a health organization in Tanzania recently started using Omega to help make medical diagnoses. Others have used the language to figure out how biomolecules react.

“Often, research projects like this stay in the lab,” said Dr. Tavares. “It’s incredibly rewarding to see people start to use this in a practical sense.”

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