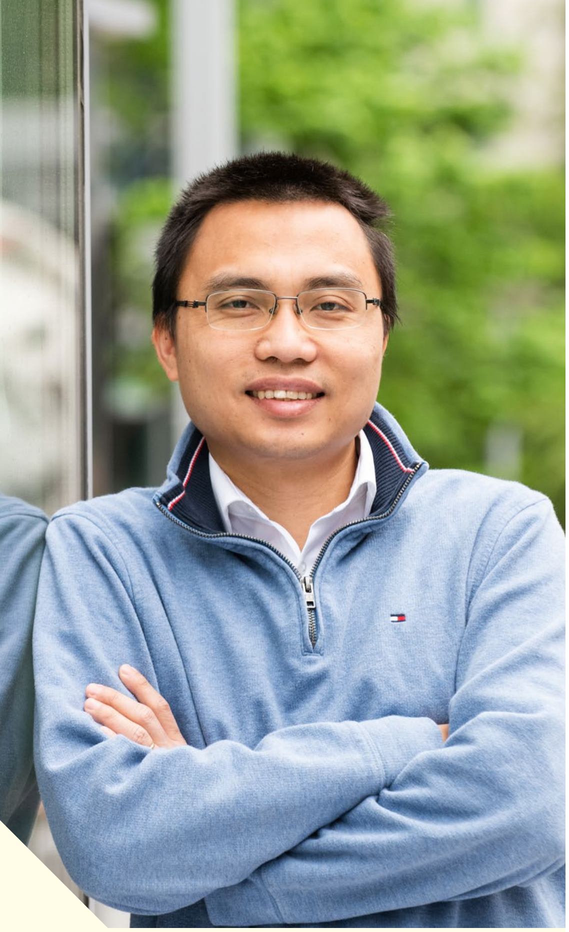

JOY ASICO

NEW FACULTY MEMBER

Multitasking in Bedlam:

Data-driven Decision-making Over Multi-Agent Systems Under Uncertainty

How can we control a fleet of drones in a chaotic environment? Wildfires, power outages, hacker attacks, crowded highways, and storms cannot always be predicted or controlled. But ECE researchers like Thinh T. Doan, an assistant professor, are designing new approaches to boost the agility of multi-agent systems thrust into these rapidly evolving, dangerous situations.

FUNDAMENTALS FOR PRACTICAL APPLICATIONS

Doan, who joined ECE in August 2020, is using data-driven techniques like machine learning and reinforcement learning to design efficient, robust multi-agent systems that perform reliably when a situation goes haywire. He is developing a mathematical framework for solving multi-task reinforcement learning problems.

"The goal of multi-task reinforcement learning is to train agents (or systems) to learn several closely related tasks concurrently, and then we can exploit their similarity to improve the learning in individual tasks," said Doan. "This will help us find the best solutions for a variety of real-world needs."

DOAN'S DRONES IN DANGER ZONES

In one study, Doan is investigating reinforcement learning techniques that would enable drones to make complicated decisions autonomously and collaboratively. Using data collected in flight, a fleet of drones could decide to stay close together, optimizing signal strength, or to sacrifice signal stability in order to cover a larger area.

"The ability to make collective split-second decisions like these could make all the difference in unpredictable, dangerous missions like wildfire tracking," said Doan.

By its very nature, fire doesn't lend itself to neat, predictable models, so most wildfires

INTRODUCING

THINH T. DOAN

- Postdoctoral fellow, Georgia Tech, 2018-2020
- Ph.D., electrical and computer engineering, University of Illinois, Urbana-Champaign, 2018
- M.S., electrical and computer engineering, University of Oklahoma, 2013
- B.S., automatic control, Hanoi University of Science and Technology, 2008

> "The ability to make collective split-second decisions…could make all the difference in unpredictable, dangerous missions like wildfire tracking"
>
> –Thinh T. Doan

are still being tracked by manned helicopters—a high-risk, expensive undertaking. In recent years, researchers have been developing autonomous drones to take on this task. An important component of this effort is successfully employing data-driven approaches, like reinforcement learning, to teach drones how to make efficient, collaborative decisions, explained Doan.

"However, we still don't have a good understanding of the theory," said Doan. "We are trying to close this gap by providing a bridge between theory and practice, which will help researchers design more efficient solutions for the problem."

FINDING THE STRONGEST SIGNAL IN WIRELESS TRANSMISSION

Doan's work also has applications in 5G networks. Researchers are always seeking ways to minimize interference and establish more reliable wireless communications. Doan is collaborating with ECE's Lingjia Liu to design a robust policy for wireless transmission in the 5G network. They are using data-driven approaches to identify the base stations that can transmit the strongest signal and inform good wireless policy.

MITIGATING CYBERATTACKS IN DISTRIBUTED SYSTEMS

Doan is also developing efficient, robust distributed optimization algorithms to mitigate cyberattacks in complex, large-scale systems like the power grid and autonomous vehicles.

"For example, in July 2015, a cybersecurity concern prompted a recall in Fiat Chryslers," said Doan. "And hackers could remotely target Jeep Cherokees via the entertainment system."

To protect complex systems from malicious behavior, Doan is designing a decentralized optimization algorithm with a targeted fault tolerance, which will allow non-faulty agents to mitigate false information from faulty agents.

Ultimately, the data-driven techniques Doan and his team are developing will have far-ranging implications across fields like cybersecurity, robotics, intelligent transportation systems, and wireless communications.

"In the end, we are still engineers, looking for ways to contribute to the problems of daily life," said Doan.