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Inaugural Holder of the Halicioglu Chair in Computer Architecture at UC San Diego Named

Computer Scientist Hadi Esmaeilzadeh Named Inaugural Holder of the Halıcıoğlu Chair in Computer Architecture at UC San Diego

Hadi Esmaeilzadeh, a professor of computer science at the University of California San Diego, is building the computer architecture that will enable the artificial intelligence and machine learning technologies of the future. He is expanding his work by collaborating with colleagues at the Center for Machine-Integrated Computing and Security at the Jacobs School of Engineering at UC San Diego.

This year, Esmaeilzadeh becomes the inaugural holder of the Halıcıoğlu Chair in Computer Architecture at UC San Diego. The $1 million chair is part of a larger $18.5 million gift made in 2013 to the Department of Computer Science and Engineering at UC San Diego. The chair provides a dedicated source of funds, in perpetuity, for the chair holder's scholarly activities as well as support for graduate students.

"I'd like to congratulate Hadi Esmaeilzadeh for his incredible research accomplishments. He has the powerful ability to make research advances that are fundamental, and at the same time, relevant for industry," said Albert P. Pisano, Dean of the UC San Diego Jacobs School of Engineering.

The chair is named after Taner Halıcıoğlu, an alumnus of the Department of Computer Science and Engineering at UC San Diego and the donor who made the generous gift. An early Facebook employee who joined the social media company in 2004 when it had only 15 computer servers and 250,000 users, Halıcıoğlu also worked at eBay and Blizzard Entertainment, and is now a private investor as well as a lecturer in the department. He serves on the alumni boards of both the university and the Department of Computer Science and Engineering.

“It’s my honor and pleasure to recognize Taner Halıcıoğlu’s incredible generosity,” said Pisano. “The wisdom and battle-tested insights he shares with UC San Diego students are invaluable. Thank you, Taner.”

Building the AI and machine learning stack of the future

Two things have propelled AI and machine learning to the next level: One has been the advances in algorithms, but the second one has been advances in processor microarchitecture, Esmaeilzadeh explained. The amount of computation that is required to actually get something decent done with AI algorithms is so massive that without proper support from processor architecture, that level of performance would not be possible.

Esmaeilzadeh and colleagues have warned that in the future, multicore processors and general purpose processors will not be enough to sustain computation-hungry machine learning applications and the increasing levels of performance that we expect out of our phones, laptops and other devices. Esmaeilzadeh was the first author of a highly-cited 2011 paper outlining this dilemma, which was reported on in *The New York Times*.

To cope with this problem, companies like Microsoft and Google have since turned to specialized chips and programmable accelerators for certain types of applications. But it can be difficult to maintain specialized hardware that keeps up with changes in the algorithms and applications of AI and machine learning.

“How do we bridge this gap between specialized hardware and these ever-evolving algorithms? This has been the challenge that I have been focusing on,” Esmaeilzadeh said.

In his research and in his role as associate director for industry research at the Center for Machine-Integrated Computing and Security at the Jacobs School, Esmaeilzadeh’s approach has been to develop what he calls algorithm-defined specialized computing stacks. “We are going to the origins of these AI applications, and understanding the mathematical and

theoretical foundations of their algorithms," he explained. "When we understand that, we can design specialized computing stacks which constitute programming languages, compilers, runtime systems, operating systems, and also microprocessor architecture."

For example, last year, Esmaeilzadeh's research group released DnnWeaver 2.0, an open source framework that runs on field-programmable gate arrays, or FPGAs—a type of integrated circuit that is programmable for more flexibility. The method deploys deep neural networks that consume 10 times less power than the state of the art. By providing a full-stack approach, researchers also considerably lowered the barrier to entry for using FPGAs, which usually are difficult to program. Researchers showed how DnnWeaver can be used to track objects in real time from a camera mounted on a small drone. Applications for the platform include robotics used everywhere from eldercare, to retail, to agriculture. Researchers envision that the platform could be used in drones that monitor livestock, for example.

Esmaeilzadeh received his Ph.D. from the University of Washington, and was an assistant professor at the Georgia Institute of Technology before joining the UC San Diego Computer Science and Engineering faculty in 2017. He has received several awards during his career, including the Air Force Young Investigator Award in 2017; two Qualcomm Research Awards and two Microsoft Research Awards in 2017 and 2016; two Google Research Faculty Awards in 2016 and 2014; and the Lockheed Inspirational Young Faculty Award in 2016. This year, he was named the IEEE Technical Committee on Computer Architecture's "Young Computer Architect" of the year for his contributions to new computer architectures that underlie the growing success of artificial intelligence and machine learning applications.

The endowed chair is part of a 2013 gift to the Department of Computer Science and Engineering at UC San Diego of $18.5 million that also funds teaching labs, supports graduate students and expands mentoring and tutoring programs for the next generation of undergraduates.

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