UC SANTA BARBARA

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Harrison Tasoff

# Machine Learning, for Science

Increasingly available data and rising computational power have combined to usher in a new age of information. We seldom go a day without using some service powered by sophisticated techniques from the data sciences.

Machine learning is a set of techniques that has revolutionized the modern world. These approaches involve computer programs that analyze features in input data and develop their own ways of identifying relevant patterns and information. Its applications range from voice recognition in our cell phones and cars to internet searches and recommendation systems. However, scientists have only begun to tailor machine learning for effective use in scientific research.

To address these challenges, the U.S. Department of Energy has awarded a collaborative grant to a group of researchers, including UC Santa Barbara mathematician Paul Atzberger, to establish a new data science research center. The Physics-Informed Learning Machines for Multiscale and Multiphysics Problems — also known as the PhILMs MMICCs center — will innovate on existing machine learning techniques and develop new ones that are better adapted to problems in the sciences and engineering. The grant will provide $600,000 over four years to support Atzberger's research group at UC Santa Barbara.

"I am honored to be involved in the founding of this Department of Energy capability center on machine learning," Atzberger said. PhILMs will be a collaboration between Atzberger and his colleagues at Stanford University, Brown University, and MIT.

Many current machine learning methods attracting attention were developed to process languages or classify images. While these data-driven techniques work well, and currently provide state-of-the-art performance, they make very different assumptions than those that arise in scientific and engineering problems. For instance, a technique used to process language does not include principles like conservation laws for mass, momentum and energy, which are fundamental constraints in many physics problems, Atzberger said. Researchers need machine learning tools that incorporate more structure from subject knowledge into a technique’s framework.

To address these challenges, Atzberger’s team will develop mathematical frameworks and develop new machine learning methods incorporating such principles. They also plan to design a suite of new computational tools and make these available to the wider global research community.

“My hope is our center and research work can help accelerate the pace that machine learning approaches are adapted to address pressing problems in the sciences and engineering,” Atzberger said.

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## About UC Santa Barbara

The University of California, Santa Barbara is a leading research institution that also provides a comprehensive liberal arts learning experience. Our academic community of faculty, students, and staff is characterized by a culture of interdisciplinary collaboration that is responsive to the needs of our multicultural and global society. All of this takes place within a living and learning environment like no other, as we draw inspiration from the beauty and resources of our extraordinary location at the edge of the Pacific Ocean.