AI in the College of Sciences

From advanced nuclear material studies to genome analysis and AI-driven classroom tools, AI is shaping the future of science education and innovation in the College of Sciences.

By Md Mohsin

Artificial intelligence (AI) is reshaping scientific research by processing large-scale scientific data and generating patterns, predictions and models. Amanda Fernandez, an assistant professor in the Computer Science Department at UTSA, describes AI as "technologies that are capable of learning, perceiving, scheduling, viewing, thinking, reasoning—essentially doing some form of human cognition." The College of Sciences is at the forefront of integrating AI into scientific studies–applying AI to nuclear material characterization, genome data analysis and bone marrow cancer detection.

In physics and astronomy associate professor Elizabeth Sooby's Extreme Environments Materials Lab at UTSA, researchers study materials used for advanced nuclear energy systems. They synthesize uranium compounds and perform high-temperature analyses. Fernandez's Vision & AI Lab collaborates with Sooby's lab to use computer vision to analyze micrographs, or images as data. If there is porosity in a sample that researchers in Sooby's lab have made, the researchers can label it in images. Then Fernandez's group trains a machine learning model to recognize what the pores look like and how to calculate pore density. "And it does pretty well," said Sooby. "We've had some projects with close to 90% pixel accuracy," which Sooby said is comparable to the repeatability of various researchers labeling the same phenomena.

In 2022, Sooby received an award funded by the U.S. Department of Energy's Office of Science Early Career Research Program. This prestigious recognition, with nearly $750,000 in grant funding over five years, was the first award of its kind to be received by a faculty member at UTSA. The grant supports Sooby's research on utilizing AI to study complex melting phenomena of uranium compounds while developing a technology to more efficiently discover and develop materials for high-temperature applications.

In the Department of Molecular Microbiology and Immunology, assistant professor Luan Vu plans to use AI to study immune system responses to respiratory infections early in life. Vu hypothesizes that severe respiratory syncytial virus (RSV) infection

during early life sets the stage for immune responses in the lungs later in life, potentially predisposing individuals to respiratory complications partly by causing changes in how certain genes are turned on or off in immune cells, known as epigenetic modifications. These changes do not alter the DNA sequence itself but affect how genes are expressed, which can have a lasting impact on immune cell behavior. AI can help in this process by analyzing vast amounts of genomic and epigenetic data to identify patterns, predict modifications and uncover regulatory mechanisms that would otherwise be time-consuming to detect. "Working together with assistant professor Yuxuan Du from the Electrical and Computer Engineering Department, we want to train an AI model to scan the entire genome of these cells to detect any such changes," explained Vu. "AI will allow us to efficiently identify specific modifications triggered by RSV infection, accelerating our understanding of epigenetic changes and revealing important insights that would be challenging to uncover using conventional methods."

Vu and Du are also collaborating with Dr. Vo Minh Hien from City Children's Hospital in Ho Chi Minh City, Vietnam, to use AI-cytology to detect bone marrow cancer in children. In the diagnosis process, bone marrow cells are collected and placed on a slide for assessment. Traditionally, this assessment is done manually by a pathologist, which can be time-consuming. AI-cytology assists by analyzing the digital slides, allowing for rapid classification and differentiation of cells. "We don't want AI to be playing the doctor; we want AI to assist them," emphasized Vu.

The AI-cytology system is trained to scan slides for cell type and morphology, identifying and counting different subsets of bone marrow cells while distinguishing between normal and abnormal cells. This analysis recognizes specific markers and abnormalities that are critical in diagnosing bone marrow cancers. The results are then provided to a pathologist, who makes the final diagnosis based on the frequencies of these different cell subsets, as classified by AI. This approach not only speeds up the diagnostic process but also helps improve accuracy by reducing the potential for human error during cell classification.

When it comes to using AI in the classroom, Fernandez is a proponent of introducing students to AI in their very first computer science class. With tools like Microsoft Copilot, which is the only UTSA-approved AI tool, students can learn the responsible use of LLM (large language models) before they begin experimenting with using it to write code. "As LLMs have become more prevalent in the last few years, I and other computer science educators have been investigating when and how to introduce them as a new tool to our students," explained Fernandez.

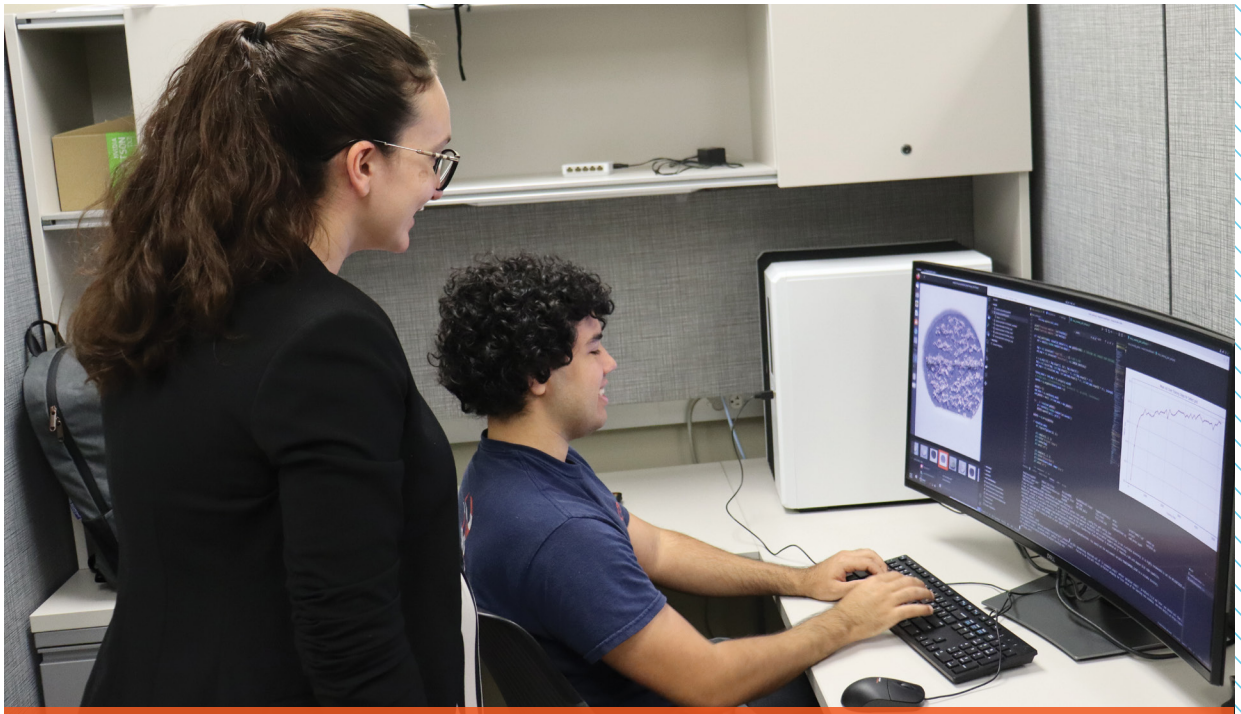
Fernandez has begun introducing AI to entry-level computer science classes due to the prevalence of these new tools as well as the fact that Copilot is built into many IDEs (integrated development environments) used for programming.

"There is significant work around creating AI chatbots for computer science courses; however, a few colleagues and I have been focusing on teaching students how to use these tools in a secure way."

Fernandez and other computer science faculty have designed smaller modules to introduce the basics of prompt engineering and software verification so that students know how to get the responses they need and are able to verify that the code created by the LLMs is correct and not malicious.

"We give higher-level guidance rather than specific tool-based instructions so that students can learn how to use any tool," added Fernandez.

The opportunities for using AI to assist with research at UTSA are endless. "Whatever we do, and when we want to expedite and do something more efficiently, AI can jump in and help us," said Vu. However, the growing presence of AI also brings challenges, particularly when it comes to effectively integrating AI into other fields of research. The challenge lies in combining AI with domain—specific expertise—ensuring that AI models are trained correctly, understanding the unique data



Fernandez helps a computer science student with a project that utilizes artificial intelligence to accelerate scientific discovery.

requirements of different fields, and bridging the knowledge gap between computer science and specialized areas like biology or clinical medicine. “That’s why we need to address these challenges through interdisciplinary collaboration,” explains Vu. Collaborations across UTSA College of Sciences departments help bridge these gaps, ensuring AI is seamlessly integrated into diverse areas of research to unlock its full potential. “Our lab has a lot of data,” said Sooby. “Dr. Fernandez has many great ideas on how to improve different machine learning methods, especially for computer vision, and so she leverages the data we have. Her AI tools help us use more of the data than we typically would. It may take up to 10 hours for a single image to be analyzed. We can analyze a couple of images and train the AI algorithm to analyze the rest, giving us better statistics on our data which helps us understand the results.”

Vu leads interdisciplinary AI research alongside Du and UTSA Ph.D. student Shayne Wang, while also collaborating beyond UTSA with Tran Thi Lan Anh, a genomic researcher at Ghent University in Belgium, and Ph.D. student Le-Xuan Thang at the University of Minho in Portugal. Together, they integrate diverse expertise to advance AI solutions and strengthen research across disciplines and borders, with the invaluable contributions of all team members driving their collective efforts.

Looking forward, integration with UT Health San Antonio may play a significant driving force for AI at UTSA. “I think there are going to be quite a number of applications that are going to open for the College of Sciences,” said Fernandez. “It is very difficult for us to integrate a lot of the biological data, such as anything that requires HIPAA [the federal law restricting release of medical information] compliance—they are experts on that side.”

UTSA’s commitment to using AI in scientific research, teaching and interdisciplinary collaboration positions the university as a leader in the field of computer science. With limitless opportunities and a growing emphasis on collaboration, the future of AI applications at UTSA will surely make impactful contributions across diverse disciplines.