Sharing applied mathematics with the world

By Annette Hilton

Doctoral student Samantha Sherman had the unique opportunity to explore applied mathematics as an intern with the National Science Foundation's (NSF) Mathematical Sciences Graduate Internship (MSGI) Program. During her time with NSF MSGI, Sherman made significant contributions in her field and realized her future career path.

Samantha Sherman has been searching for ways to share her passion for mathematics with the world. Sherman graduated with a bachelor's degree in mathematics and went on to teach middle school math through AmeriCorps. After her AmeriCorps experience ended, Sherman enrolled in a doctoral degree in applied mathematics. "I wanted to learn how to make original contributions to subjects that could have an impact on a large audience," Sherman said. "Applied mathematics does just that."

Sherman thought her interests would be best suited to projects at a national laboratory. Wanting to gain experience and test whether pursuing a career at a national laboratory was right for her, Sherman applied to the National Science Foundation's (NSF) Mathematical Sciences Graduate Internship (MSGI) Program.

The NSF MSGI program offers research opportunities for mathematical sciences doctoral students to participate in internships at national laboratories, industries and other facilities. NSF MSGI seeks to provide hands-on experience for the use of mathematics in a nonacademic setting.

Stationed at Sandia National Laboratories in Livermore, California, Sherman tackled a project to speed up data analysis.

To do so, Sherman conducted research into tensors. In mathematics, a tensor is a multidimensional array with rules for its mathematical manipulation. A tensor can have one or more dimensions depending on how the tensor is being utilized. For example, a one-dimensional tensor is known as a vector, which can represent features of an object in a data-mining task. A three-dimensional tensor resembles a cube, and may be described as a higher-order matrix. The more complex the problem is being solved, the more dimensions are required of a tensor. Whenever a tensor is changed or manipulated, its components change accordingly by transformation laws. Essentially, tensors provide a mathematical framework for formulating, solving and analyzing problems.

Tensors are great tools to solve complex mathematical problems; but, because they are so complex, forming them can take significant computational time and expense. Sherman's goal was to find out if it is possible to obtain certain results from a special type of statistical tensor without having to actually build the entire tensor itself. The idea is to build a low-rank approximation of an empirical statistical moment tensor that is used in data analysis for understanding correlations between features in data mining analysis. Previous methods required forming the entire tensor in order to compute the low-rank approximation.

With the help of her mentor, Tamara Kolda, Ph.D., Sherman was able to develop a new way to compute a low-rank approximation without having to build the full tensor. In data analysis, it's a big win for improving the speed, cost and capabilities of the method.

The experience was also a significant accomplishment for Sherman personally. Before her internship, Sherman knew little about tensors. After only 10 weeks, she made substantial contributions to the field and gained valuable real-world experience in applied mathematics.

"I had a wonderful experience that has opened up many opportunities for me," Sherman said. "I am now certain I want to pursue a career at a national laboratory after graduation. This experience has solidified my career goals." Sherman returned to the University of Notre Dame to finish her doctoral degree in applied and computational mathematics and statistics. Upon graduation, she would like to pursue a career at a national laboratory to continue her contributions to applied mathematics on a large scale.

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