

University of Arizona Faculty and Students Explore Geosciences in the Classroom, the Lab, and the Field

Students and researchers in the Geosciences Department at the University of Arizona focus on understanding the earth’s structure and active tectonic processes using earthquake data. They analyze vast amounts of seismic data provided by Incorporated Research Institutions for Seismology (IRIS), a consortium of universities sponsored by the National Science Foundation, and data collected directly by university faculty and graduate students in the field using IRIS instruments.



A University of Arizona researcher installing an IRIS broadband seismic sensor to record earthquakes in Argentina.

Students apply inverse theory techniques to analyze and draw inferences about seismic data. “Our students use MATLAB to apply the theory they learn in the classroom,” says Dr. Randy Richardson, professor at the University of Arizona. “They then go on to apply their MATLAB expertise in research and throughout their careers.”

“The coursework complements our research initiatives very well,” adds Dr. Susan Beck, professor at the University of Arizona. “MATLAB helps students understand theory using manageable data sets, preparing them to handle huge amounts of data in the real world.”

THE CHALLENGE

“Our goal is to train students not only to understand the earth but also to excel technically and computationally,” says Beck. To achieve that goal, the department wanted a shared computational environment for teaching and research with a common nomenclature and the ability to reuse solutions on multiple operating systems.

In the past, students used Microsoft® Excel®, Fortran, C, and disparate tools for

class assignments and independent research. “Because I wasn’t an expert with every language and tool, I couldn’t always help them when they had problems,” says Richardson.

Further, limited lab resources made it difficult for students to work on assignments when and where it was most convenient for them. “Students had to work wherever they could get software access, which could be anywhere on campus. That meant I couldn’t always sit down with them to resolve a question,” notes Beck.

THE SOLUTION

The University of Arizona acquired a Total Academic Headcount (TAH) license, enabling students and faculty to use MATLAB®, Simulink®, and 48 add-on products campuswide.

Access to an intuitive, shared language and computational environment for data analysis has helped the department engage students in discovery through research in the classroom, in the lab, and in the field.

In the course Inverse Methods in Geophysics, students use MATLAB to

THE CHALLENGE

Enable students across the university to acquire computational skills and apply them in a wide range of disciplines

THE SOLUTION

Provide campuswide access to MathWorks tools and integrate them into a curriculum that complements ongoing research

THE RESULTS

- Access and communication improved campuswide
- Students presented with multiple career opportunities
- Worldwide collaboration enabled

complete all homework assignments. On some assignments they use scripts provided by Richardson; later in the course they write their own.

When studying covariance and correlation of errors, the students generate scatter plots of related variables in MATLAB. In a subsequent assignment, they apply first principles to solve a singular value decomposition problem, forming an ordered eigenvalue matrix in MATLAB.

Seniors and graduate students in the course Physics of the Earth use MATLAB to complete assignments on plate tectonics, rheology, and seismology. They perform vector rotation in MATLAB to understand plate rotations and reconstructions.

The students also use eigenvalues to rotate tensors and to calculate principal stresses and strains. In one of the final assignments, on gravity and magnetic problems, they use MATLAB to calculate spherical harmonics based on a truncated infinite sum of associated Legendre polynomials.

With graduate students, Beck images discontinuities in the earth from near the surface to as deep as 600 kilometers below the surface by analyzing years of data recorded at IRIS seismic stations. Beck is currently conducting research in South America, North America, and Turkey, using IRIS instruments to collect seismic data.

The students import seismic data into MATLAB and process it using algorithms they have developed or adapted from other researchers. They then use MATLAB plots to visualize the results and interactively adjust parameters to enhance signals, reduce noise, and test different seismic velocities.

“One of the major benefits of teaching a course with MATLAB is that the students not only learn the content, they also learn a valuable, marketable skill that will serve them well into the future.”

Dr. Randy Richardson, University of Arizona

Beck and her students currently use this approach to study the evolution of the Andes in South America.

THE RESULTS

■ Access and communication improved campuswide.

“The TAH license provided expanded access to MathWorks tools. As a result, we now have a common language and shared nomenclature, which has improved communication between students and professors,” says Richardson.

Beck adds, “The TAH license removed the resource limitations we were facing, and made it easier both on the research side of things and for the students in classes.”

■ Students presented with multiple career opportunities.

“Our students often receive multiple job offers, and go on to careers in academia, national labs, the oil industry, and other areas,” says Beck. “The ability to solve problems with MATLAB puts them in a good position no matter what opportunities they pursue.”

■ Worldwide collaboration enabled.

“We can collaborate more easily with researchers and students around the world because MATLAB is platform-independent,” says Beck. “Some of my former students have gone on to faculty positions in Argentina and Turkey, and we are still collaborating with them using MATLAB.”

Learn more about the University of Arizona: www.geo.arizona.edu

INDUSTRY

- Academia

APPLICATION AREAS

- Data analysis
- Mathematical modeling
- Algorithm development

PRODUCTS USED

- MATLAB®

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