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Research Statement

My research interests include software architecture, software engineering, software testing, and statistical behavioral analysis of software systems. The theme of my research is the scientific exploration of software development processes with the twin goals of improving how we model problems and of improving how we design and implement computer-based solutions.

My current research focuses on the collaborative development of cyber infrastructure to encode and support the data processing and associated workflows employed in the earth sciences. To that end, in 2008 I founded and currently direct the Cyber Infrastructure and Development Lab for the Earth Sciences (CIRDLES, www.cirdles.org). CIRDLES is funded with both NSF and private funds. In 2010 I was awarded as Principal Investigator the first year of a three-year multi-institution NSF grant entitled “Collaborative Research: Analytical Techniques and Software: Development of Cyber Infrastructure to Support Laser-Ablation ICP Mass Spectrometry” to support CIRDLES.

This research addresses several important scientific problems, including:

1. The design and implementation of an end-to-end software system that is accepted by the uranium-lead geochronological community as a “gold standard” that unifies different approaches to data acquisition, processing, and archiving and that can be extended to other geochronological systems; and
2. The discovery of best practices for collaboration between software engineers and members of another scientific domain to design and implement open-source, perpetually-improving software systems that support data-processing workflows in that scientific domain.

I am making advances in solving these and related problems with the development of two open-source software programs: *Tripoli* and *U-Pb_Redux*. *Tripoli* interfaces with commercially available mass spectrometers using standardized protocols, statistical filtering and interactive visualizations to aid the scientist in preparing raw data for analysis using *U-Pb_Redux*. *U-Pb_Redux* orchestrates the analyst’s workflow using novel interactive visualizations and provides rigorous and transparent data-reduction and uncertainty propagation for supporting data interpretations. Finally, *U-Pb_Redux* supports the production of publication-ready graphics and data tables, the archiving of results, and the comparative compilation of archived results that will support a new era of cooperative science. Together, these programs form a cyber infrastructure that is already adopted by several labs.

CIRDLES also provides jobs and internships for undergraduates. Details about collaborators, students, workshops, publications, and international community participation are located at: www.CIRDLES.org .