

An International REU Program: A Student Perspective

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This past summer, together with eight other U.S. undergraduates, we participated in a Research Experiences for Undergraduates Program, "United States–Hong Kong REU in Numerical Analysis and Scientific Computing with Applications in Applied Science and Engineering." This program, which was supported by a National Science Foundation grant, ran for eight weeks, from May 29 to July 21. Each member of our group—five female and five male students—came into the program with a different mathematical background. We represented the Colorado School of Mines, Colorado State University at Pueblo, Davidson College, Illinois Institute of Technology, Loyola College in Maryland, New College of Florida, Regis University, Taylor University, and the University of California at Berkeley.



Working full-time on their research projects, the REU students still found time to explore Hong Kong. Shown here are Nicholas Dovidio of Davidson College and Samantha Summerson of UC Berkeley.

The program was centered in the Mathematics Department at Hong Kong Baptist University and was coordinated by Dr. Michael Ng of HKBU and Dr. Graeme Fairweather of the Colorado School of Mines, principal investigator on the NSF grant. We lived on the HKBU campus in the NTT International House, which offered all of the amenities of an American hotel. Its location was ideal—several modes of transportation as well as restaurants and shopping were within easy walking distance.

We worked directly with professors from three different Hong Kong universities, with the assistance of Dr. Fairweather. One group of three students and a group of two students worked at HKBU under the guidance of Dr. Ng and Dr. Tao Tang, respectively. A two-student team worked at City University with Dr. Wei Wei Sun, and the remaining three students worked with Dr. Raymond H. Chan of the Chinese University of Hong Kong and, while he was traveling, with Dr. C.S. Tong of HKBU. During the time we spent with these professors, their assiduous graduate students also provided us with very welcome assistance.

The four groups worked on different projects, in each case with the objective of honing their research skills. One group focused on developing efficient spectral solutions to the Gierer–Meinhardt system of partial differential equations in two dimensions. Another group worked on high-resolution image reconstruction using wavelet algorithms. For the third project, two students were asked to find a method for subgroup clustering. The students worked separately to test their different approaches and compare their results. The fourth project consisted of a spectral analysis of finite difference differentiation matrices. Although not every group finished the REU with ground-breaking results, we all gained a great deal from our involvement in this research program and from the opportunity to collaborate with the participating Chinese professors.

Some of us plan to continue working on the projects we began in Hong Kong. For example, members of the group working on the Gierer–Meinhardt model have presented their results at their respective universities. These presentations were enlightening: Nicholas Dovidio, speaking at Davidson, received excellent suggestions concerning the solution of a highly structured matrix system. This research group is still in contact with Dr. Tao Tang and hopes that their work will lead to a publication.

Samantha Summerson has also continued her work on wavelets at UC Berkeley. Her research with Dr. Chan on the reconstruction of images with wavelet algorithms was her first encounter with wavelets; realizing in the course of the research how useful wavelets can be, she wanted to learn more about the theory behind these tools. After studying some textbooks on wavelets, she found the subject compelling enough to make it the subject of her senior thesis this fall. Specifically, her thesis is on multiresolution analysis of wavelets and applications with two-dimensional images; she is working under the supervision of Dr. Alberto Grünbaum of UC Berkeley.

Along with our research projects, we were integrated into the greater Hong Kong mathematical community, attending conferences and meeting internationally distinguished mathematicians from Hong Kong and overseas. In particular, we participated in the 2nd International Conference on Structured Matrices, held at HKBU, where we heard talks on a variety of topics, such as image restoration and almost block diagonal linear systems. We had the chance to interact with conference participants informally on a memorable boat cruise

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around some of Hong Kong's islands and at the conference banquet, which was held in Hong Kong's only revolving restaurant, high above Hong Kong Island. In these more personal settings, conference speakers enthusiastically talked with us about their research.

On another occasion, we met Dr. Gene Golub of Stanford University, who was visiting the Chinese University of Hong Kong. At a private tea arranged for us, we all had the opportunity to share with Dr. Golub our current research as well as our future goals. Subsequently, we attended a seminar he presented at CUHK on the history of numerical linear algebra. He gave a fascinating account of the development of the field over the past half century and the influential people who have contributed to the area.



Along with the opportunity to work with researchers at three Hong Kong universities, the REU students found themselves "integrated into the greater Hong Kong mathematical community," which at times meant interacting with distinguished visiting mathematicians. One such visitor, Gene Golub of Stanford University (partially obscured in the back row), met with the group at the Chinese University of Hong Kong.

Near the end of our stay, one group attended the dissertation defense of Qiao Zhonghua (now a postdoc at North Carolina State University), who had helped many in the group with their research projects. This experience was especially meaningful to those students. Hearing a PhD defense is not an experience that students from a liberal-arts background tend to have at their home institutions.

The benefits of this program were more than mathematical; we also learned much about Hong Kong culture and made some local friends. On our first day, we were greeted by a group of undergraduate students from HKBU who showed us their campus and gave us a tour of the exciting Kowloon Peninsula. Although we were doing research full-time, we somehow managed to find time to explore Hong Kong; we saw many of the local sights, including the 10,000 Buddha Temple, Victoria Peak, and the Po Lin Monastery, and shopped at several of the famous street markets. The Chinese students taught us how to count in Cantonese, along with some useful Cantonese expressions, including "hello," "thank you," and "cheaper," which eased our interactions with locals and our travel around Hong Kong.

Overall, the trip was an extraordinary experience; by working in an international environment, we were able to see firsthand how interconnected the mathematical community really is. Our engagement in re-search on numerical analysis and scientific computing has encouraged us to further our careers in the mathematical sciences. The program was enriching both academically and culturally, which made it a unique and beneficial opportunity for us to have, as budding mathematicians and young adults.

Acknowledgments

We are indebted to our Hong Kong mentors and to everyone who made our survival abroad possible, especially Claudia Chui, executive secretary in HKBU's Mathematics Department, and Dr. Fairweather.

Nicholas Dovidio is majoring in mathematics at Davidson College with a concentration in computer science. He expects to graduate in May 2007 with a BS with honors, after which he plans to attend graduate school in computer science. His long-term career goal is to found his own software firm. Samantha Summerson is majoring in applied mathematics, with an emphasis on systems theory, at the University of California, Berkeley. She will graduate with a BA with honors in December 2006. She plans to begin graduate work in applied mathematics or signal processing in the fall of 2007, hoping eventually to obtain a PhD and have a career in research.

NSF REUs: Exploring the Options

The National Science Foundation's Research Experiences for Undergraduates program supports active research participation by undergraduate students in any area of research funded by NSF. REU projects involve students in meaningful ways in ongoing research programs or in research projects designed especially for the purpose.

Two mechanisms for support of student research are available: (1) REU Sites are based on

independent proposals to initiate and conduct projects that engage a number of students in research. REU Sites can be based in a single discipline or academic department, or on interdisciplinary or multidepartment research opportunities with a coherent intellectual theme. Proposals with an international dimension are welcome. A partnership with the Department of Defense supports REU Sites in DoD-relevant research areas. (2) REU Supplements can be requested for ongoing NSF-funded research projects or can be included as a component of proposals for new or renewal NSF grants or cooperative agreements. Undergraduate student participants must be citizens or permanent residents of the U.S. or its possessions.

Additional information can be found at http://www.nsf.gov/crssprgm/reu/reu_search.cfm.

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