

SUMSRI Journal

Introduction

The Summer Undergraduate Mathematical Sciences Research Institute (SUMSRI) is a program designed to prepare participants for the rigor and pace of graduate school. Because of the small number of African Americans, Latinos and Native Americans with doctoral degrees in the mathematical sciences, we are particularly interested in these undergraduate students. In order to prepare these students, the Institute offers short courses, research seminars and colloquia for seven weeks. It is an intense program in which the undergraduate participants learn what it means to focus entirely on mathematics and statistics as one would do during a graduate program. Each course, seminar and colloquia is designed to fulfill the following goals:

- Address the shortage of underrepresented minorities and women mathematicians by producing minority and women research mathematicians.
- Provide the participants with a research environment and improve their research abilities.
- Improve the participants' ability to work in groups and give them a long term support group.
- Provide role models.
- Improve the participants' technical writing skills.
- Give the participants an opportunity to give a talk and to write a technical research paper.
- Familiarize the participants about graduate school and inform them about available financial aid for graduate school.
- Make the participants an awareness of career opportunities in the mathematical sciences.
- Prepare the participants for the GRE.

This preparation will, hopefully, permit the SUMSRI participants to successfully compete and complete graduate school.

In the summer of 2007, the Institute offered research seminars in number theory, advanced algebra and multivariate statistics. Participants also attended workshops in mathematical writing, GRE preparation, two short courses in algebraic topology and real analysis as well as eleven colloquium talks.

Applications for participation in the institute came from across the nation. In order to be chosen, each applicant had to be a U.S. citizen or permanent resident and must have completed college level introductory mathematics and/or statistics courses and at least one proof-based mathematics course. Each applicant wrote a brief essay on why they wished to participate in the Institute. Two recommendation letters from faculty members from the applicant's home institution were received for each applicant. In 2007, fifteen participants were accepted. The average GPA in the mathematical sciences for this summer's participants was 3.72. Five of the participants were African American, three were Hispanic and seven were Caucasian. Eleven of the 15 participants were female.

Research seminar instructors suggested topics that would challenge students to work in teams, draw on their critical thinking and research skills, familiarize them with current literature on the topic, set parameters of the research and utilize computer modeling programs.

In Multivariate Statistics, Andrea Austin, Terrell Felder, and Lindsay Moomaw looked at **College Desirability**. The colleges and universities across the United States are all unique. To quantify how institutions of all sizes measure up, multivariate techniques of Principal Component Analysis, Factor Analysis, and Discriminant Analysis are used fittingly and effectively, producing a valid, unbiased evaluation of each school, and also a model to gauge any chosen seminary. The method of Principal Components reduces the number of variables, focusing on those with efficacy while Factor Analysis provides a data reduction to explain the variability of the college or university statistics. Finally, a Discriminant Analysis of the data classifies the schools and establishes a method of accurate prediction.

Christina McIntosh, Alicia Smith, Ashley Swandby did research into the health of Americans in their paper **“Risky Behavior: A Multivariate Statistical Analysis of the United States Based on Health Risk Factors”**. They studied a number of variables associated with health risk factors in the United States. They used the 2006 Centers for Disease Control’s Behavioral Risk Factor Surveillance System survey data to analyze each state based on these variables. They used Principal Component Analysis, Factor Analysis, and Discriminant Analysis in order to analyze the multivariate data. Furthermore, they provided a ranking of relative health for some of the states based on the analysis.

The algebra group discovered **“How Many Ways Can You Divide Zero?”** In their paper, Katherine Benson, Louis Cruz, Yesenia Cruz Rosado, Melissa Tolley, Bryant Watkins let $\Sigma(R)$ be the graph whose vertices are the nonzero zero divisors of a ring R and whose edges are pairs $\{u, v\}$ where $u \neq v$ and $u+v$ is a zero divisor. They explored basic properties of sum graphs including degree, planarity, coloring, cycles, and isomorphisms by studying examples and finding various patterns.

The number theory group delved more deeply into elliptic curves with their paper, **“A Statistical Analysis of 2-Selmer Groups for Elliptic Curves with Torison Subgroup $Z_2 \times Z_8$ ”**. Jessica Flores, Kimberly Jones, Anne Rollick, and James Weigandt considered elliptic curves over \mathbb{Q} with torsion subgroup $Z_2 \times Z_8$. These curves

are birationally equivalent to $y^2 = (1 - x^2)(1 - k^2 x^2)$ where

$k = (a^4 - 6a^2b^2 + b^4)/(a^2 + b^2)^2$ for some integers a and b . They performed a

computational analysis on the 3,148,208 curves corresponding to $|a|, |b| \leq 5000$.

The largest rank known in this family is $r = 3$; there are 13 examples in the literature.

They exhibited 3 more. In an attempt to find such curves of larger rank, they performed a statistical analysis of the distribution of the ranks of the 2-Selmer groups.

Final presentations of the research projects were given using Power Point slides. Members of the Miami University Mathematics and Statistics Department attended these presentations. It is hoped that many of these students will attend regional and national mathematics and statistics meetings in order to present the results of their work.

By providing this intensive research program, we endeavored to encourage those who attend SUMSRI to pursue advanced degrees.

ACKNOWLEDGMENTS

We wish to thank the National Security Agency and National Science Foundation for their continued financial support.

Special thanks are due to Miami University for its contributions, including classroom space, offices, and access to computer labs, cafeteria and library services and health center privileges. Participants were also able to use the university recreation center. The university waived most indirect costs and provided funds for some faculty salaries.

We also wish to thank our seminar directors: Drs. Edray Goins, Reza Akhtar and Vasant Waikar; our graduate assistants: Shelly-Ann Meade, Laura Lynch and Holly Attenborough; and the clerical staff of the Mathematics and Statistics Department for their generous assistance during the summer.