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 2008, 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 10 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 2008, fifteen participants were accepted. The average GPA in the mathematical sciences for this summer's participants was 3.765. Seven of the participants were African American, one was Hispanic and seven were Caucasian. Ten 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.

Samuel Ivy, Brett Jefferson, Michele Josey, Cheryl Outing, Clifford Taylor and Staci White joined Dr. Edray Goins to study elliptic curves. The number theory group considered elliptic curves in their paper **"4-Covering Maps on Elliptic Curves with Torsion Subgroup $\mathbf{Z}_2$ x $\mathbf{Z}_8$".** In this research group, they considered elliptic curves over $\mathbb{Q}$ with the torsion subgroup Z_2 x Z_8. In particular, they discussed how to determine the rank of the curve $E : y^2 = (1-x^2)(1-k^2 x^2)$, where $k = (t^4 - 6t^2 + 1)/(t^2 + 1)^2$ and $t = 9/296$. They used a 4-covering map $\hat{C}'_{d_2} \to \hat{C}_{d_2} \to E$ in terms of homogeneous spaces for $d_2 \in \{-1, 6477590, 2, 7, 37\}$. They provided a method to show that the Mordell-Weil group is $E(\mathbb{Q}) \cong Z_2 \times Z_8 \times \mathbb{Z}^3$, which would settle a conjecture of Flores-Jones-Rollick-Weigandt and Rathbun.

In the algebra research group, Megan Boggess, Tiffany Jackson-Henderson, Isidora Jimenez, and Rachel Karpman looked at "**The Structure of Unitary Cayley Graphs"** In their paper they explored structural properties of unitary Cayley graphs, including clique and chromatic number, vertex and edge connectivity, planarity, and crossing number.

Megan Bernstein conducted an individual search into "**Representations of Graphs by Rings".** A graph is representable by a ring if its vertices can be labeled with distinct ring elements so the difference of the labels is a unit in the ring if and only if the vertices are adjacent. Megan explored representation by rings composed of the direct products of cyclic rings, including an upper bound on the representation number for a graph with a fixed number of vertices and representation numbers for various families of graphs.

The statistics group took on the issue of real estate prices in their paper, "**Using Real Figures to Invest in Real Estate: A Multivariate Statistical Analysis of the US Housing Market".** Angela Buck, Takisha Harrison, Linden Johnson and Holly Sontag took a statistical look at the cost of housing for that average American. For many Americans, investing in property is a quick and easy way to make money. The real estate game has become a very popular phenomenon, even for those without a millionaire's wallet. However, due to recent struggles in the economy, for some, investing has become more of a burden than a success story. Using multivariate statistical analysis techniques such as Principal Component Analysis, Factor Analysis, and Discriminant Analysis, they determined the factors having the most effect on housing markets. They also discovered which of the 50 US states' housing markets are likely to provide a stable or risky investment for those wishing to dabble in real estate.

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, SUMSRI faculty endeavored to encourage those who attend SUMSRI to pursue advanced degrees.

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