Mathematical Sciences Research Institute

Final Report

on the

Mathematical Sciences Research Institute

2016 Undergraduate Program (MSRI-UP)

supported by

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2016 Mathematical Sciences Research Institute – Undergraduate Program (MSRI-UP)

Annual Report

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2016 Mathematical Sciences Research Institute – Undergraduate Program (MSRI-UP)

Final Report

1. Introduction

The Mathematical Sciences Research Institute Undergraduate Program (MSRI-UP) is a comprehensive program for undergraduates that aims to increase the number of students from underrepresented groups in mathematics graduate programs. MSRI-UP includes summer research opportunities, mentoring, workshops on the graduate school application process, and follow-up support.

The primary objective of the MSRI-UP is to identify talented students, especially those from underrepresented groups, who are interested in mathematics and make available to them meaningful research opportunities, the necessary skills and knowledge to participate in successful collaborations, and a community of academic peers and mentors who can advise, encourage, and support them through a successful graduate program. We achieve this through an intensive six-week summer program of mathematics research and other activities, along with maintenance of relationships with participating students for years beyond the summer program.

The MSRI-UP is coordinated by an experienced team of five directors, consisting in 2016 of Professors Federico Ardila of San Francisco State University, Duane Cooper of Morehouse College, Maria Mercedes Franco of Queensborough Community College (CUNY), Herbert Medina of Loyola Marymount University, and Suzanne Weekes of Worcester Polytechnic Institute. The directors collaborate continuously and annually rotate direct leadership of the program. The program is supported by the leadership and staff of the Mathematical Sciences Research Institute in Berkeley, site of each summer's six-week program.

The **2016 MSRI-UP** ran from June 11 through July 24 with 18 students studying and researching Sandpile Groups. The summer program was staffed by lead director Prof. Suzanne Weekes, research leader Professor Luis Garcia Puente of Sam Houston State University, postdoctoral fellow Dr. Ashley Wheeler, and graduate students Natalie Hobson and Jacob Russell-Madonia.

During the previous 9 summers (2007-2015), 151 students conducted 51 small group research projects in Computational Mathematics, Experimental Mathematics, Coding Theory, Elliptic Curves and Applications, Mathematical Finance, Enumerative Combinatorics, Algebraic Combinatorics, Arithmetic Aspects of Elementary Functions, and Geometric Combinatorics Motivated by the Social Sciences. Most MSRI-UP participants who have graduated college proceeded to enter graduate programs in the mathematical sciences. In 2017, the MSRI-UP, if funded, will continue with 18 new undergraduates conducting research projects in Algorithmic Algebraic Geometry, led by Professor J. Maurice Rojas of Texas A&M University.

2. Funding Information

The funding available to administer the 2016 MSRI-UP is summarized as follows:

1. National Security Agency $124,890[1]
2. The National Science Foundation $120,721[2]

In addition, the MSRI provided much additional support by allowing MSRI-UP to use classrooms, offices, and computers; by facilitating transportation; and providing administrative assistance.

3. Recruitment, Application and Admissions Procedures

The directors began recruiting for the 2016 MSRI-UP at the MAA MathFest in August 2015 and at the annual national conference of the Society of Chicanos/Hispanics and Native Americans in Science (SACNAS) in Washington, DC in October 2015. The directors distributed fliers and talked to dozens of students and faculty about the program. The MSRI-UP home page also provided information about and applications for the program. Recruitment of students also occurred that fall at the Math Alliance's Field of Dreams conference and then in January at the Joint Mathematics Meetings, specifically at the MAA's minority chairs breakfast, sessions of the National Association of Mathematicians (NAM), and the MAA Student Poster Session.

[1] Grant number H98230-16-1-0033.
[2] Research Experience for Undergraduates (REU) program grant number DMS-1156499.

The on-line application, which resided on the mathprograms.org site, consisted of four items: a completed student application form, transcripts, a statement of interest, and a letter of recommendation. The 2016 MSRI-UP received more than 500 applications.

Directors Ardila, Cooper, Franco, Medina, and Weekes, reviewed each application and evaluated it using four criteria: 1) the student's grades in mathematics courses; 2) the student's mathematical background; 3) the statement of interest; and 4) the letter of recommendation. Based on these criteria, directors gave each applicant a score between 0 and 10. The scores were averaged, and this score served as the initial measure for evaluating each applicant. The directors then proceeded to discuss individual applications and eventually reached a consensus on the students invited to join the program.

4. Summary of Participant Demographics

Table 1 details some demographic information of the eighteen MSRI-UP students of the 2016 program. The student participants were diverse by race and ethnicity, as well as by the types and geographic regions of their undergraduate institutions. The co-directors paid special attention during the selection process to attain racial and ethnic diversity and gender balance. Achieving this type of diversity and gender balance is important for creating the academic and research environment explained below and for achieving one of the MSRI-UP objectives.

5. Housing and Lodging for the Students

The students were housed in Stern Hall dormitory at the University of California, Berkeley. On weekdays, lunch was served at MSRI. The lunches at MSRI were shared with graduate students, and faculty participating in other MSRI summer programs. This allowed students to meet mathematicians at different stages of professional development. The students and the program's graduate students had breakfast and dinner at the dining facilities in the dormitories. Sharing meals with their MSRI-UP peers promoted mathematical discussions and enhanced the collaborative and intellectual environment of MSRI-UP.

Table 1

2016 Mathematical Sciences Research Institute (MSRI-UP)

Student Data

Undergraduate Institution and State/Country
Cal Poly Pomona
CUNY - Borough of Manhattan Community College
East Los Angeles College
Harvard College
Haverford College
Humboldt State University
Mount Holyoke College
North Carolina A&T State University
Princeton University
Reed College
San Francisco State University
Spelman College
University of Arizona
University of California, Berkeley
University of Puerto Rico at Cayey
Wentworth Institute of Technology
Wesleyan University
William Marsh Rice University

Gender	
Male	9
Female	9
Major	
Mathematics/Applied Mathematics	18
Ethnicity	
Black/African American	4
Hispanic/Latino	11
White	1
Pacific Islander	2

6. Pre-Research Seminar

During the first full week and part of the second week of MSRI-UP, students participated in a pre-research seminar consisting of lectures, tutorials, and problem-solving sessions. Professor Garcia Puente planned the seminar so that he and the program staff could familiarize students with motivation and fundamental concepts of the field of Sandpile Groups and also the main techniques that they would need to work on their research topics.

The pre-research phase was conducted in the Baker Boardroom, an excellent classroom-type facility at MSRI. Appendix A of this report gives the program calendar with the structure of the six weeks of the program.

Students worked on homework assignments a bit on site at the MSRI but mostly in evenings in the residence hall with the programs graduate student assistants present as an available resource. Frequently, problem study groups were assigned and shuffled so that each student had the opportunity to actively work with almost all of the other 17 students, and so that the students and the program staff could identify partnerships that collaborated well or poorly.

7. Research Projects, Technical Reports, Posters, and MSRI Student Presentations

The focus of MSRI-UP is undergraduate research. From the third week till the end of the program, each student worked exclusively on an undergraduate research project in the field of Sandpile Groups that was carefully designed by the research leader, Prof. Garcia Puente. There were six groups of three students. Students wrote technical reports and presented the results of their research in the MSRI-UP Final Presentations on the final Friday of the program. Video recording of the presentations are available on the program website.

At the end of the second week of the program, students received descriptions of their possible research projects. The students were requested to rank their top project choices and to provide any additional information that they believed would be helpful to the program staff when defining the research teams. The staff composed the research teams, satisfying student preferences as much as possible while paying attention to interpersonal dynamics revealed in the previous two weeks.

During the research phase of MSRI-UP, students worked in the offices assigned to them at MSRI. Professor Garcia Puente oversaw all the work of all six groups and postdoctoral fellow, Prof. Ashley Wheeler, supervised two research teams, as did each of the two graduate assistants, Natalie Hobson and Jacob Russell-Madonia. The undergraduates summarized their progress daily to the four research staff members daily and each team met their mentors separately at MSRI, and at the dorms. During the program, MSRI-UP participants were introduced to some of the techniques that are used while conducting successful research in the mathematical sciences. Indeed, students learned to work as part of a research team, develop an effective faculty advisor-student relationship, use computer software as tools, use the internet as a resource, prepare and deliver an oral presentation, write a mathematics paper (technical report), and use LaTeX, including the Beamer package for presentations.

The outcome of all the students' hard work resulted in six technical reports and recorded oral presentations. The program of final research presentations is included as Appendix B to this report. Appendix C gives the abstracts for each of the 6 research projects. The recorded presentations are available at http://www.msri.org/web/msri/pages/msri-up-2016-presentations.

8. Evaluation of Student Work

Close interaction with students allowed the academic staff to give individuals feedback on their work throughout the program. During the pre-research seminar, homework assignments were reviewed by the academic staff and the students were given written and oral feedback individually. During the research phase, each of the six research teams gave prepared informal oral and written summary progress reports to the program staff. The groups met separately with their co-advisors during the day.

The research advisors gave students written feedback on drafts of their technical reports. The academic staff and Dr. Weekes met with the teams for weekly formal oral presentations during the weeks prior to the final presentations, helping the research teams with elements of substance and style in their deliveries.

Program staff met regularly with Professor Weekes to discuss the progress of and any concerns about individual and teams of students.

9. Colloquium Series

The 2016 MSRI-UP hosted five mathematicians for a colloquium series: Dr. Rekha Thomas, University of Washington; Dr. Nicolas Flores Castillo (MSRI-UP 2011 graduate assistant); Dr. Candice Price (MSRI-UP 2008 & 2009 graduate assistant, MSRI-UP 2013 postdoc), University of San Diego; Dr. Natalie Durgin (MSRI-UP 2007), Spiceworks; Dr. Illya Hicks, Rice University. The colloquium series stimulated the mathematical interests of the students and gave them a glimpse of current mathematical research. In addition to this, the speakers provided the students with additional role models and expanded their network of mentors. In particular, each speaker was asked to share personal stories, "offering reflections on your own journey to mathematics and advice for them to consider on their journeys." The speakers' schedules were arranged to maximize opportunities for them to engage the undergraduates in informal conversation, and many students took advantage of the opportunity to listen, ask, and learn, including joining the undergraduates on an excursion at week's end.

We note that 3 of the speakers have been involved in MSRI-UP – one as an undergraduate and two as part of the MSRI-UP staff. The 2016 post-doc, Ashley Wheeler, was also a graduate assistant in the 2009 MSRI-UP. We made an effort to have this significant

presence of former program participants serving in advanced roles during the summer. The intent was to foster a feeling in the students that they are part of something special, this MSRI-UP family, and that much that the directors' hope for them is, indeed, achievable.

10. Graduate School Preparation

Dr. Colette Patt, Director of Diversity Programs in the Physical Sciences at the University of California, Berkeley visited MSRI-UP and gave a workshop on applying for graduate school and attaining fellowship funding for graduate school. The workshop addressed questions/issues such as the significant differences between masters and doctoral programs, the funding opportunities available for most graduate programs, and the benefits of obtaining a graduate degree. In addition to this basic information, Dr. Patt also presented successful techniques for applying to graduate school. She discussed the elements that constitute a good statement of purpose, the types of professors from whom one should seek letters of recommendation, and successful techniques for addressing not-so-stellar semesters. Dr. Patt also discussed successful strategies for compiling a winning national fellowship application. She also provided the students with related written material. Her presentation and the information she provided were well received by the program students.

Prof. Richard Laugesen of the Department of Mathematics at the University of Illinois Urbana-Champaign attended the students' final presentations of the last day of the program. At the end of the day, he talked to the students about choosing grad programs, applying to graduate schools, and discussed the UIUC math program. Several MSRI-UP alum are now enrolled in the UIUC graduate program.

We also held 2 **graduate student panels** where graduate students told of their experience in graduate school, their paths to their program and dissertation topics, and fielded questions from the undergraduate students. The first one was held at the end of the second week of the program and featured a graduate student entering his second year of the PhD program at UC Berkeley who is an alum of WPI and had started his undergraduate years at a community college, and two graduate students who were participants in the concurrent MSRI graduate program "Harmonic Analysis and Elliptic Equations on real Euclidean Spaces and on Rough Sets". That panel was moderated by the MSRI-UP's two graduate student assistants. The second panel was held on the last week of the program and held over lunch. The panel featured

three MSRI-UP alumni who were attending the graduate program, "An Introduction to Character Theory and the McKay Conjecture": Patrick Cesarz (MSRI-UP 2007), Ana Berrizbeitia (MSRI-UP 2008), and Megan Ly (MSRI-UP 2010). The panelists told of their road to and in graduate school and they also opened up to discuss their struggles and challenges.

11. Additional Workshops & Panels

The program held workshops that were devoted to the development of other skills. Prof. Weekes delivered a presentation and led a discussion on making *effective oral presentations*. She also provided students with a guideline for making Beamer presentations.

The graduate students held Sage workshops to get students familiar with the Sage open source mathematical software package that the students all needed to use for their research. These skills were needed as MSRI-UP students prepared their technical report and transparencies using LaTeX, gave an end-of-program oral presentation using Beamer presentation slides, and used LaTeX to prepare their research posters.

The program presented two panel discussions by current graduate students for the undergraduates. The panels were moderated by the program's two graduate student assistants. The first graduate student panel featured graduate students who were on site for one of the MSRI's summer graduate student workshops; the second featured mathematics and statistics doctoral students at various stages from the University of California, Berkeley.

A *career panel* featured four scholars with mathematical sciences Ph.D.s engaged in careers other than mathematical research. Panelists were Dr. Natalie Durgin (MSRI-UP 2007) who works as a data scientist at Spiceworks, Dr. Luis Serrano who worked as a Software Engineer at Google and was transitioning to Udacity, and Dr. Rebecca Hartman-Baker of Lawrence Berkeley National Labs. The guests drew many questions during the panel.

The program also held *Lunch Discussions* where we all sat together over our lunch hour to have informal discussion with a mathematician who told us about her/his career path and who fielded questions from the students. We hosted Prof. Emille Lawrence of University of San Francisco (MSRI-UP 2009 post-doc 2009), Prof. Candice Price (University of San Diego, MSRI-UP 2008 & 2009 graduate assistant, MSRI-UP 2013 postdoc), Prof. Rebecca Garcia of Sam Houston State University, and Prof. Yanir Rubinstein (University of Maryland, MSRI Visitor)

12. Recreational/Cultural Activities

In addition to all the academic activities described above, MSRI-UP students were treated to several recreational activities. These carefully-planned recreational and cultural activities were essential to MSRI-UP's success, as they helped to build the MSRI-UP mentored community, as all staff participated in the activities with the students. This gave everyone the opportunity to put mathematics aside for a few hours to connect with each other on a more personal level. Prof. Weekes and Prof. Garcia Puente brought their children along on several of these excursions. It was important for the MSRI-UP students to see the other dimensions of the lives of the faculty.

The 2016 MSRI-UP group activities went to the San Francisco's Pier 39 and also had a tour of the city via motorized cable car; the Exploratorium; the Santa Cruz Beach and Boardwalk; the Berkeley Botanical Gardens; an Oakland A's baseball game; and the group had a fourth of July picnic at Cordornices Park in Berkeley.

13. Program Evaluation During MSRI-UP

Informal formative evaluation in the program started the first day of the program through conversations with students and staff. Frequently during the program, Professor Weekes met individually with each one of the students and staff of the program, conducting extensive discussions with Professor Garcia Puente to learn about and share opinions regarding the research component. During the meetings with staff and students, the lead director had the opportunity to have more close contact with the students and staff, to listen to specific concerns, and to provide individual mentoring to the students. The graduate students' close interaction with the students enabled them to gather informal feedback that also led to adjustments to improve the program.

The program staff had regular weekly meetings to discuss individual and group progress, and they held several impromptu lunch or other daytime meetings as issues arose that would benefit from immediate discussion and resolution. At the final staff meeting, individual student's performances were discussed at length.

14. End-of-Program Evaluation

Each MSRI-UP student was required to complete a comprehensive, end-of-program, online evaluation. Indeed, the evaluation was an online instrument shared by numerous summer REU programs; a couple of additional evaluation prompts were added specifically for the MSRI-UP students. The evaluation form had both year-to-year formative evaluation questions designed for soliciting feedback in order to improve future institutes and summative-evaluation questions to measure the effectiveness of MSRI-UP in accomplishing the program objectives. The quantitative results of the end-of-program evaluation are provided in Appendix D.

Post-program conversations between the MSRI-UP staff and the directors indicated that the staff felt that the institute was successful in accomplishing its objectives.

15. Post-Summer Conferences

MSRI-UP has a substantial post-summer component. There is funding for students to attend academic conferences to present their research. In addition, each year the onsite director keeps students informed of conference opportunities and funding sources for attending such conferences.

All six research teams were represented at the Society for the Advancement of Chicanos/Hispanics and Native Americans in Science (SACNAS) National Conference in October, 2016 in Long Beach, CA where 12 students delivered poster presentations of their summer research at the SACNAS conference. Some students were able to attend the Modern Math Workshop held at the Institute for Pure and Applied Mathematics (IPAM) at UCLA that preceded the conference. A few students also attended the Field of Dreams Conference which is organized by the National Math Alliance and was held November 2016 in St. Louis, Missouri. Eight students gave poster presentations of their summer research at the 2017 Joint Mathematics Meetings in Atlanta, GA in January 2017 at the MAA Student Poster Session.

16. Evidence Suggesting Long-Term Success of Program

In the 10 years of MSRI-UP, 57 research projects have been completed by 169 students (85.3% from underrepresented minority groups). Of the 145 MSRI-UP alumni who have completed their undergraduate degrees, 114 students (78.6%) continued to graduate programs. Of these 114 students, 15 have completed their Ph.D. degrees, 63 are currently pursuing Ph.D.

degrees, 31 have completed their Master's degrees and joined the workforce, and 5 are currently pursuing Master's degrees.

The fifteen PhD recipients are Drs. Talea Mayo, Natalie Durgin, Luis de la Torre, Gina-Maria Pomann from MSRI-UP 2007; Drs. Loraine Torres-Castro, Natasha Cayco, Gerard Koffi, Marcos Ortiz, Bobby Wilson, Nathan Kallus, and Alexander Moll from MSRI-UP 2008; Drs. Caitlyn Parmelee, Leyda Almodóvar from MSRI-UP 2009; and Drs. Alexander Diaz and Dan Eckhardt from MSRI-UP 2010 and 2011, respectively.

17. Conclusion

Like the nine summers that preceded it, reviews of the MSRI-UP from its students, staff, and guests have been overwhelming positive. The program is certainly perceived as an overall success, though the real fruit—that of achieving the program's primary goal *to increase the number of graduate degrees in the mathematical sciences, especially doctorates, earned by U.S. citizens and permanent residents by cultivating heretofore untapped mathematical talent*—is starting to be realized.

The long-term data that will confirm that the MSRI-UP objectives contribute towards the goal of increasing the number of Latinos/Chicanos, African-American and Native Americans earning graduate degrees in the mathematical sciences will unfold over several years ahead. The directors are committed to maintain the relationships developed with each cohort of students in the program in order to monitor and collect data on the MSRI-UP students' academic progress and, whenever possible, to provide them with additional academic opportunities.

APPENDIX A
2016 PROGRAM SCHEDULE

	Monday 13-June	Tuesday 14-June	Wednesday 15-June	Thursday 16-June	Friday 17-June	Saturday 18-June
8:30 - 9:00	8:15 and 8:45 Charter Bus from Evans Hall/Hearst Mining Circle	8:40 or 9:10 "H Line" Shuttle from Evans Hall	8:40 or 9:10 "H Line" Shuttle from Evans Hall	8:40 or 9:10 "H Line" Shuttle from Evans Hall	8:40 or 9:10 "H Line" Shuttle from Evans Hall	
9:00- 9:30	9:15-10 Welcome, IDs,					
9:30 -10:00	photos, keys, bus passes	9:30 - 12:00 Sandpiles Lecture 2	9:30 - 12:00 Sandpiles Lecture 3	9:30 - 12:00 Sandpiles Lecture 4	9:30 - 12:00 Sage Tutorial 2	
10:00 - 10:30						
10:30 - 11:00	10:15 - 12:00 Sandpiles Lecture 1					
11:00 - 11:30						
11:30 -12:00						
12:00 - 12:30	Lunch	Lunch	Lunch	Lunch	Lunch	
12:30 - 1:00						**PIER 39 AND CABLE CAR TOUR**
1:00 - 1:30				Library Orientation	1:00 - 2:00	
1:30 - 2:00	1:00 - 3:00	1:00 - 3:00	1:00 - 3:00	Group 1 1:00 - 1:40	Group Theory	
2:00 - 2:30	Group Theory Lecture 1	Sage Tutorial 1	Group Theory Lecture 2	Group 2 1:40 - 2:20	2 - 3:30 Colloquium	
2:30 - 3:00				Group 3 2:20 - 3:00	REKHA THOMAS	
3:00 - 3:30	Tea	Tea	Tea	Tea		
3:30 - 4:00	3:30 - 5:10	3:30 - 5:10	3:30 - 5:10	3:30 - 5:10	Tea	
4:00 - 4:30	Problem Solving	Problem Solving	Problem Solving	Group Theory	4:00 - 5:10	
4:30 - 5:00	Session 1	Session 2	Session 3		Problem Session 5	
5:00 - 5:30						
5:30 - 6:00	Shuttle to Mining Circle 4:55, 5:25, 5:55, 6:25	Shuttle to Mining Circle 4:55, 5:25, 5:55, 6:25	Shuttle to Mining Circle 4:55, 5:25, 5:55, 6:25	Shuttle to Mining Circle 4:55, 5:25, 5:55, 6:25	Shuttle to Mining Circle 4:55, 5:25, 5:55, 6:25	

	Monday 20-June	Tuesday 21-June	Wednesday 22-June	Thursday 23-June	Friday 24-June	Saturday 25-June
8:30 - 9:00	8:40 or 9:10 "H Line" Shuttle from Evans Hall	8:40 or 9:10 "H Line" Shuttle from Evans Hall	8:40 or 9:10 "H Line" Shuttle from Evans Hall	8:40 or 9:10 "H Line" Shuttle from Evans Hall	8:40 or 9:10 "H Line" Shuttle from Evans Hall	**EXPLORATORIUM**
9:00- 9:30						
9:30 -10:00	9:30 - 12:30 Sandpiles Lecture 6	9:30 - 12:00 Sandpiles Lecture 7	9:30 - 12:00 Sandpiles Lecture 8	9:30 - 12:00 Sandpiles Lecture 9	9:30 - 12:00 Introduction to Research Projects	
10:00 - 10:30						
10:30 - 11:00						
11:00 - 11:30						
11:30 -12:00						
12:00 - 12:30	Lunch	Lunch	Lunch	Lunch	Lunch	
12:30 - 1:00						
1:00 - 1:30					1:00 - 2:00 Grad School Panel	
1:30 - 2:00	1:00 - 3:00 Group Theory	1:00 - 3:00 Sage Tutorial 3	1:00 - 3:00 Sandpiles Lecture 8	1:00 - 3:00 Sandpiles Lecture 10	2 - 3:30 Colloquium NICOLAS FLORES	
2:00 - 2:30						
2:30 - 3:00						
3:00 - 3:30	Tea	Tea	Tea	Tea		
3:30 - 4:00	3:30 - 5:10	3:30 - 5:10	3:30 - 5:10	3:30 - 5:10	Tea	
4:00 - 4:30	Problem Solving Session 5	Problem Solving Session 6	Problem Solving Session 7	Problem Solving Session 8	Introduction to Research Projects	
4:30 - 5:00						
5:00 - 5:30						
5:30 - 6:00	Shuttle to Mining Circle 4:55, 5:25, 5:55, 6:25	Shuttle to Mining Circle 4:55, 5:25, 5:55, 6:25	Shuttle to Mining Circle 4:55, 5:25, 5:55, 6:25	Shuttle to Mining Circle 4:55, 5:25, 5:55, 6:25	Shuttle to Mining Circle 4:55, 5:25, 5:55, 6:25	

	Monday 27-June	Tuesday 28-June	Wednesday 29-June	Thursday 30-June	Friday 1-July	Saturday 2-July
8:30 - 9:00	8:40 "Hill Line" Shuttle	8:40 "Hill Line" Shuttle	8:40 "Hill Line" Shuttle	8:40 "Hill Line" Shuttle	8:40 "Hill Line" Shuttle	
9:00- 9:30		9:00-11:00	9:00-11:00	9:00-11:00	**Student Formal Beamer**	
9:30 -10:00	Research Assignments	20 min team	20 min team	20 min team	**Presentations**	
10:00 - 10:30		daily update blackboard	daily update blackboard	daily update blackboard		
10:30 - 11:00		presentations to	presentations to	presentations to	9:10 - 9:30 9:40 -10:00	
11:00 - 11:30	Team Meetings	MSRI-UP staff	MSRI-UP staff	MSRI-UP staff	10:10-10:30 10:40-11:00	
11:30 -12:00		+ research	+ research	+ research	11:10-11:30 11:40 -12:00	
12:00 - 12:30	Lunch	Lunch	Lunch	Lunch	Lunch	
12:30 - 1:00	EMILLE LAWRENCE				CANDICE PRICE	
1:00 - 1:30		Cloud computing	*Making Effective*		1:00 - 2:00	**SANTA CRUZ BEACH AND BOARDWALK**
1:30 - 2:00	1:00 - 3:00	Aaron Hale	*Presentations* - SLW	1:00 - 3:00	Team Meetings	
2:00 - 2:30		2:00-3:00			2 - 3:30 Colloquium	
2:30 - 3:00	Team Meetings	Team Meetings	Team Meetings	Team Meetings	*CANDICE PRICE*	
3:00 - 3:30	Tea	Tea	Tea	Tea	Knot Theory & Biology	
3:30 - 4:00					Tea	
4:00 - 4:30						
4:30 - 5:00	3:30- 5:10	3:30- 5:10	3:30- 5:10	3:30- 5:10	4:00 - 5:10	
5:00 - 5:30	Team Meetings	Team Meetings	Team Meetings	Team Meetings	Team Meetings	
5:30 - 6:00	Shuttle to Mining Circle	Shuttle to Mining Circle	Shuttle to Mining Circle	Shuttle to Mining Circle	Shuttle to Mining Circle	
	4:55, 5:25, 5:55, 6:25	4:55, 5:25, 5:55, 6:25	4:55, 5:25, 5:55, 6:25	4:55, 5:25, 5:55, 6:25	4:55, 5:25, 5:55, 6:25	

	Monday 4-July	Tuesday 5-July	Wednesday 6-July	Thursday 7-July	Friday 8-July	Saturday 9-July
8:30 - 9:00		8:40 "Hill Line" Shuttle	8:40 "Hill Line" Shuttle	8:40 "Hill Line" Shuttle	8:40 "Hill Line" Shuttle	
9:00- 9:30		9:00-11:00	9:00-11:00	9:00-10:30	**Student Formal Beamer**	
9:30 -10:00		20 min team	20 min team	Team Meetings	**Presentations**	
10:00 - 10:30		daily update blackboard	daily update blackboard			
10:30 - 11:00		presentations to	presentations to	10:30 - 12:00	9:10 - 9:30 9:40 -10:00	
11:00 - 11:30	**COOKOUT AT**	MSRI-UP staff	MSRI-UP staff	Colette Patt	10:10-10:30 10:40-11:00	
11:30 -12:00	**CODORNICES PARK**	+ research	+ research		11:10-11:30 11:40 -12:00	
12:00 - 12:30		Lunch	Lunch	Lunch	Lunch	Berkeley
12:30 - 1:00						Botanical Gardens
1:00 - 1:30				1:00 - 3:00	1:00 - 2:00	
1:30 - 2:00		1:00 - 3:00	1:00 - 3:00	20 min team	Career Panel	
2:00 - 2:30				daily update blackboard	2 - 3:30 Colloquium	
2:30 - 3:00		Team Meetings	Team Meetings	presentations	NATALIE DURGIN	
3:00 - 3:30		Tea	Tea	Tea		
3:30 - 4:00					Tea	
4:00 - 4:30						
4:30 - 5:00		3:30- 5:10	3:30- 5:10	3:30- 5:10	4:00 - 5:10	
5:00 - 5:30		Team Meetings	Team Meetings	Team Meetings	Team Meetings	
5:30 - 6:00		Shuttle to Mining Circle 4:55, 5:25, 5:55, 6:25	Shuttle to Mining Circle 4:55, 5:25, 5:55, 6:25	Shuttle to Mining Circle 4:55, 5:25, 5:55, 6:25	Shuttle to Mining Circle 4:55, 5:25, 5:55, 6:25	

	Monday 11-July	Tuesday 12-July	Wednesday 13-July	Thursday 14-July	Friday 15-July	Saturday 16-July
8:30 - 9:00	8:40 "Hill Line" Shuttle	8:40 "Hill Line" Shuttle	8:40 "Hill Line" Shuttle	8:40 "Hill Line" Shuttle	8:40 "Hill Line" Shuttle	
9:00- 9:30	9:00-11:00	9:00-11:00	9:00-11:00	9:00-11:00	**Student Formal Beamer**	
9:30 -10:00	20 min team	20 min team	20 min team	20 min team	**Presentations**	
10:00 - 10:30	daily update blackboard	daily update blackboard	daily update blackboard	daily update blackboard		
10:30 - 11:00	presentations to	presentations to	presentations to	presentations to	9:10 - 9:30 9:40 -10:00	
11:00 - 11:30	MSRI-UP staff	MSRI-UP staff	MSRI-UP staff	MSRI-UP staff	10:10-10:30 10:40-11:00	
11:30 -12:00	+ research	+ research	+ research	+ research	11:10-11:30 11:40 -12:00	
12:00 - 12:30	Lunch	Lunch	Lunch	Lunch	Lunch	
12:30 - 1:00					REBECCA GARCIA	
1:00 - 1:30		12 - 1:30 Colloquium				
1:30 - 2:00	1:00 - 3:00	ILYA HICKS	1:00 - 3:00	1:00 - 3:00	1:00 - 3:00	
2:00 - 2:30						
2:30 - 3:00	Team Meetings	Team Meetings	Team Meetings	Team Meetings	Team Meetings	
3:00 - 3:30	Tea	Tea	Tea	Tea	Tea	
3:30 - 4:00						
4:00 - 4:30						
4:30 - 5:00	3:30- 5:10	3:30- 5:10	3:30- 5:10	3:30- 5:10	3:30- 5:00	
5:00 - 5:30	Team Meetings	Team Meetings	Team Meetings	Team Meetings	Team Meetings	
5:30 - 6:00	Shuttle to Mining Circle	Shuttle to Mining Circle	Shuttle to Mining Circle	Shuttle to Mining Circle	Shuttle to Mining Circle	
	4:55, 5:25, 5:55, 6:25	4:55, 5:25, 5:55, 6:25	4:55, 5:25, 5:55, 6:25	4:55, 5:25, 5:55, 6:25	4:55, 5:25, 5:55, 6:25	
					OAKLAND A'S Baseball Game 6pm	

	Monday 18-July	Tuesday 19-July	Wednesday 20-July	Thursday 21-July	Friday 22-July	Saturday 23-July
8:30 - 9:00	8:40 "Hill Line" Shuttle	8:40 "Hill Line" Shuttle	8:40 "Hill Line" Shuttle	8:40 "Hill Line" Shuttle	8:40 "Hill Line" Shuttle	
9:00- 9:30					**Final Presentations**	
9:30 -10:00					**MSRI-UP 2016**	
10:00 - 10:30	9:30 - 12:00	9:30 - 12:00	9:30 - 12:00	9:30 - 12:00	9:30 - 10:15	
10:30 - 11:00					10:20 - 11:05	
11:00 - 11:30			Team Meetings	Team Meetings	11:10 - 12:00	
11:30 -12:00	Team Meetings	Team Meetings				
12:00 - 12:30	Lunch	Lunch	Lunch	Lunch	Lunch	
12:30 - 1:00	YANIR RUBINSTEIN		MSRI-UP Alum Panel			
1:00 - 1:30					**Final Presentations**	
1:30 - 2:00	1:00 - 3:00	1:00 - 3:00	1:00 - 3:00	1:00 - 3:00	**MSRI-UP 2016**	
2:00 - 2:30					1:05 - 1:50	
2:30 - 3:00	Team Meetings	Team Meetings	Team Meetings	Team Meetings	1:55 - 2:40	
3:00 - 3:30	Tea	Tea	Tea	Tea	2:45 - 3:30	
3:30 - 4:00					Tea	
4:00 - 4:30					Richard Laugesen	MSRI-UP
4:30 - 5:00	3:30- 5:10	3:30- 5:10	3:30- 5:10	3:30- 5:10	Grad School & UIUC	Closing Dinner
5:00 - 5:30	Team Meetings	Team Meetings	Team Meetings	Team Meetings		
5:30 - 6:00	Shuttle to Mining Circle 4:55, 5:25, 5:55, 6:25	Shuttle to Mining Circle 4:55, 5:25, 5:55, 6:25	Shuttle to Mining Circle 4:55, 5:25, 5:55, 6:25	Shuttle to Mining Circle 4:55, 5:25, 5:55, 6:25	Shuttle to Mining Circle 4:55, 5:25, 5:55, 6:25	

Appendix B

MSRI-UP 2016

Sandpile Groups

Final Research Presentations

Friday 22nd July, 2016

Baker Boardroom, MSRI

9:15	Welcome and Introduction
9:30	"On the Accessibility Numbers in the Sandpile Monoid of a Graph" **Ernest Castorena, Dominika Palinko, Cecily Santiago**
10:10	"The Sandpile Group of a Thick Cycle Graph" **Diane Christine Alar, Jonathan Celaya, Micah Henson**
10:50	Break
11:05	"On the Sandpile Group of a Circulant Graph" **Anna Comito, Jennifer Garcia, Justin Rivera**
11:45	Lunch
1:00	"Combinatorial and Algebraic Properties of Generalized Crown Graphs" **Carlos Angrinsoni Santiago, Angel Burr, Ruben Hurtado**
1:40	"The Avalanche Polynomial of the Complete Bipartite Graph" **Karlie Elliott, Drisana Mosaphir, Maleek Richardson**
2:20	Break
2:35	"Bijections Between the Recurrent Sandpiles of an Eulerian Digraph and Its Reverse" **Tafari James, Casandra Monroe, Ricardo Rojas-Echenique**

MSRI
Mathematical Sciences Research Institute

See http://www.msri.org/web/msri/pages/msri-up-2016-projects for project abstracts.

MSRI - UP

On the Accessibility Numbers in the Sandpile Monoid of a Graph

Students: Ernest Castorena, Dominika Palinko, Cecily Santiago
Advisors: Prof. Luis Garcia Puente, Prof. Ashley Wheeler

The Sandpile Group of a Thick Cycle Graph

Students: Diane Christine Alar, Jonathan Celaya, Micah Henson
Advisors: Prof. Luis Garcia Puente, Prof. Ashley Wheeler

On the Sandpile Group of a Circulant Graph

Students: Anna Comito, Jennifer Garcia, Justin Rivera
Advisors: Prof. Luis Garcia Puente, Natalie Hobson

Combinatorial and Algebraic Properties of Generalized Crown Graphs

Students: Carlos Angrinsoni-Santiago, Angel Burr, Ruben Hurtado
Advisors: Prof. Luis Garcia Puente, Natalie Hobson

The Avalanche Polynomial of the Complete Bipartite Graph

Students: Karlie Elliott, Drisana Mosaphir, Maleek Richardson
Advisors: Prof. Luis Garcia Puente, Jacob Russell-Madonia

Bijections Among the Recurrent Sandpiles of an Eulerian Digraph and Its Reverse

Students: Tafari James, Casandra Monroe, Ricardo Rojas-Echenique
Advisors: Prof. Luis Garcia Puente, Jacob Russell-Madonia

Appendix C

On the Accessibility Numbers in the Sandpile Monoid of a Graph

Students: Ernest Castorena, Dominika Palinko, Cecily Santiago
Advisors: Prof. Luis David Garcia Puente, Prof. Ashley K. Wheeler

Abstract: Combinatorists study sandpile groups within the Abelian Sandpile Model, conceived in 1987 by the physicists Bak, Tang, and Wiesenfeld to describe the phenomenon of self-organized criticality. According to the model, we fix a graph with one distinguished vertex called the sink. We assign to each non-sink vertex an amount of "sand" a non-negative integer. If a vertex has an amount of sand greater than or equal to its outdegree then it topples, meaning it sends a grain of sand to each of its adjacent vertices. A sequence of toppling may result, but the presence of the sink, which we do not allow to topple, ensures the process terminates. The result is a stable sandpile. Under the operation stable addition, the combining of sandpiles and allowing toppling until stable, the set of stable sandpiles on a graph forms a monoid.

Within the sandpile monoid are the well-studied recurrent sandpiles, which themselves form a group. A sandpile is recurrent means it can be accessed via sand addition and toppling by any other stable sandpile. However, little is known about the remaining stable sandpiles, called transients, or their structure within the monoid. The accessibility number of a sandpile gives the number of stable sandpiles that can access it. For example, the accessibility number of a recurrent is the order of the monoid, the accessibility number of a super accessible transient (SAT) is the difference between the order of the monoid and the order of the group, etc. Accessibility numbers dictate a hierarchy in the monoid which we describe by "nexi". In particular, we study the class of c3po sandpiles, (an affectionate working name with a backstory) whose accessibility numbers equal the number of non-SAT transients. We explicitly exhibit, and then prove, uniqueness of a c3po sandpile for certain classes of trees including paths, stars, and potted plants.

The Sandpile Group of a Thick Cycle Graph

Students: Diane Christine Alar, Jonathan Celaya, Micah Henson
Advisors: Prof. Luis David Garcia Puente, Prof. Ashley K. Wheeler

Abstract: The set of stable sandpiles on a graph, equipped with stable addition, combining sand from two configurations and then allowing the system to topple until stable, forms an abelian monoid. The subset of stable sandpiles which can be accessed by any other sandpile in the monoid via stable addition forms a group called the sandpile group.

In this project we examine the thick n-cycle graph, the cycle of n vertices with multiedges allowed. We prove that the ith invariant factor of the sandpile group is the greatest common divisor (gcd) of the products of the edge multiplicities taken i at a time, divided by the gcd of those taken i-1 at a time; with the first invariant factor equaling the gcd of the edge multiplicities and the last equaling the quotient of the number of spanning trees by the gcd of the (n-2)-products of the edge multiplicities. A number of corollaries follow – for example, it is immediate that the sandpile group does not depend on the permutation of the edge multiplicities. Cori and Rossin have shown that a planar graph and its dual graph have isomorphic sandpile groups and so we also get the sandpile groups of the duals to thick cycles, such as the book graphs. Our main theorem is one of the first general results describing the sandpile group of a family of non-regular multigraphs.

On the Sandpile Group of Circulant Graphs

Students: Anna Comito, Jennifer Garcia, Justin Rivera
Advisors: Prof. Luis David Garcia Puente, Natalie Hobson

Abstract: Circulant graphs are of interest in many areas of mathematics, particularly geometric group theory, because of the beautiful cyclic symmetries they display. These graphs have adjacency matrices that are circulant and can be defined from a set of integer generators A={a_1, …, a_m}, on a fixed number of n vertices, denoted C_n(A). Given any graph, one can construct a matrix, called the Laplacian matrix, from the data of the degree and adjacencies of each vertex. The cokernel of this matrix determines the sandpile group of the graph. The order of the sandpile group is always equal to the number of spanning trees of the graph. In this sense, the sandpile group is a more subtle invariant. It has been shown that the number of spanning trees of circulant graphs with a given set of generators follows a recursive formula. One can then ask if this structure is reflected in the corresponding sandpile groups as well. Previous results on the sandpile group for C_n(1,2) seem to infer this may be the case.

In this project, we create a database of isomorphism classes and sandpile groups for a large collection of circulant graphs. From our database, we are able to conclude that such nice structure is not always preserved in the sandpile group and hence the sandpile group is a more elusive graph invariant. We further focus our attention to the case C_n(1,3) in order to determine the explicit structure of the sandpile group for this family of graphs.

Combinatorial and Algebraic Properties of Generalized Crown Graphs

Students: Carlos Angrinsoni-Santiago, Angel Burr, Ruben Hurtado
Advisors: Prof. Luis David Garcia Puente, Natalie Hobson

Abstract: In this project we study the combinatorial and algebraic properties of the generalized crown graphs. Such a graph is a regular bipartite graph defined by two parameters, *n* the number of vertices in each disjoint set and *r* the degree of each vertex. We have observed that this family of graphs includes many previously well-studied graphs such as complete bipartite graphs, prism graphs, and Möbius ladder graphs.

In our work, we construct an explicit isomorphism to show that a generalized crown graph is a circulant graph when *r* is even or the parity of *r* and *n* are equal. Circulant graphs are well studied and our isomorphism provides a portal to understanding such cases. We show, however, that generalized crown graphs in the other cases are indeed not circulant yet they seem to display many nice combinatorial properties similar to circulant graphs. Particularly, the number of spanning trees of a circulant graph follows explicitly defined recursive formulas. Our investigations show this appears to be the case for all generalized crown graphs as well. We study in depth the first unexplored generalized crown graph of this type, for $r=5$ and *n* even, in order to make conclusions about combinatorial and algebraic properties.

The Avalanche Polynomial of the Complete Bipartite Graph

Students: Karlie Elliott, Drisana Mosaphir, Maleek Richardson
Advisors: Prof. Luis David Garcia Puente, Jacob Russell-Madonia

Abstract: As an established example of a dynamical system exhibiting self-organized criticality, the dynamics of sandpiles on a graph have garnered much interest. For a given recurrent sandpile on a graph, the simplest dynamics which can be achieved arise from adding one grain of sand to a vertex and stabilizing. The resulting sequence of vertex topplings is called a principal avalanche and understanding the distribution of these principal avalanches is critical for understanding the dynamics of the whole sandpile model. To study this distribution, we can calculate the multivariate avalanche polynomial, which encodes the size, frequency and large scale structure of all principle avalanches on the graph. General formulas for avalanche polynomials have been computed for several families of graphs including complete graphs, wheel graphs, cycles, and trees. We build off of these examples as well as the work of Duke and Le Borgne to calculate a general form of the multivariate avalanche polynomial for the case of complete bipartite graphs.

Bijections Between the Recurrent Sandpiles of an Eulerian Digraph and Its Reverse

Students: Tafari James, Casandra Monroe, Ricardo Rojas-Echenique
Advisors: Prof. Luis David Garcia Puente, Jacob Russell-Madonia

Abstract: An Eulerian digraph is a directed graph where the indegree of each vertex is equal to the outdegree. After designating a single vertex of an Eulerian digraph as a sink, the set of recurrent sandpiles on the graph forms a finite abelian group whose isomorphism class can be calculated based on the Laplacian matrix of the graph. Given a directed graph, we can also construct its reverse graph by reversing the direction of each edge. In general, there is no relationship between the group of recurrent sandpiles of a directed graph and its reverse. However, in the case of Eulerian digraphs we have the salient property that the Laplacian of the reverse graph is equal to the transpose of the Laplacian of the original graph. This allows us to conclude the two groups of recurrent sandpiles are isomorphic. While this isomorphism shows that the number of recurrent sandpiles on an Eulerian digraph and its reverse are equal, the two sets of sandpiles can look quite different. Further, the isomorphism does not provide an explicit bijection between these two sets. We discuss a few possible natural bijections between the recurrent sandpiles on an Eulerian digraph and its reverse, including a map which has the combinatorial property of preserving the number of grains of sand on each sandpile.

Instrument Analysis

On this page, you can view and download a summary of results from one or more SALG instruments. You can also view results across instruments.

Results displayed for the following instrument:

ID	Open Close	Instructor	Course	Semester	Description	N
74998	Sat Jul 23, 2016 Wed Jul 27, 2016	Suzanne Weekes	MSRI-UP 2016	Summer 2016	Evaluation of the MSRI-UP on-site experience	19 download

If you'd like to aggregate data across instruments, you can add another instrument to this analysis.

Cross-tabulate questions [?]

Frequency distributions of scale results

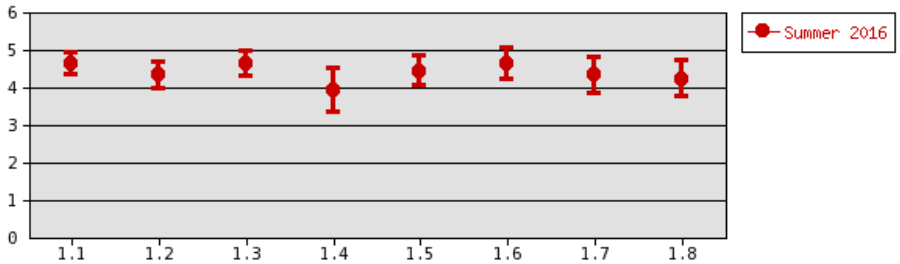
The table below lists the percentage of students responding in each category, along with the mean and number of responses for that item. If you'd like an more detailed analysis, click on the 'details' link to the right of that item.

Gains in THINKING AND WORKING LIKE A MATHEMATICIAN OR A STEM PROFESSIONAL: APPLICATION OF KNOWLEDGE TO RESEARCH WORK.

1. How much did you GAIN in the following areas as a result of your most recent research experience?	1:no gains	2:a little gain	3:moderate gain	4:good gain	5:great gain	9:not applicable	Mean	N	
1.1 Analyzing data for patterns.	0%	0%	11%	16%	74%	0%	4.6	19	details
1.2 Figuring out the next step in a research project.	0%	5%	0%	47%	42%	5%	4.3	18	details
1.3 Problem-solving in general.	0%	5%	0%	26%	68%	0%	4.6	19	details
1.4 Formulating a research question that could be answered with data.	5%	0%	16%	26%	26%	26%	3.9	14	details
1.5 Identifying limitations of research methods and designs.	0%	0%	16%	21%	47%	16%	4.4	16	details
1.6 Understanding the theory and concepts guiding my research project.	5%	0%	0%	21%	74%	0%	4.6	19	details
1.7 Understanding the connections among mathematical disciplines.	5%	0%	5%	37%	47%	5%	4.3	18	details
1.8 Understanding the relevance of research to my coursework.	5%	0%	16%	26%	53%	0%	4.2	19	details

Summary of scale results

The graphic below lists the mean and confidence interval (±3 times the standard error) for each item.

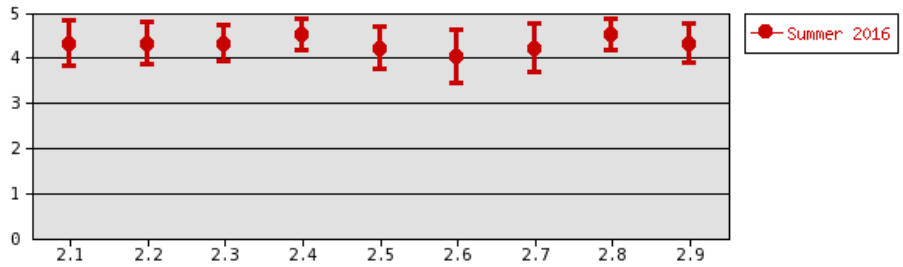


PERSONAL GAINS RELATED TO RESEARCH WORK

2. How much did you GAIN in the following areas as a result of your most recent research experience?	1:no gains	2:a little gain	3:moderate gain	4:good gain	5:great gain	9:not applicable	Mean	N	
2.1 Confidence in my ability to do research.	5%	0%	16%	16%	63%	0%	4.3	19	details
2.2 Confidence in my ability to contribute to mathematics.	5%	0%	11%	26%	58%	0%	4.3	19	details
2.3 Comfort in discussing mathematical concepts with others.	0%	5%	11%	32%	53%	0%	4.3	19	details
2.4 Comfort in working collaboratively with others.	0%	0%	16%	16%	68%	0%	4.5	19	details

2.5 Confidence in my ability to do well in future math courses.	5%	0%	11%	37%	47%	0%	4.2	19	details
2.6 Ability to work independently.	5%	11%	11%	21%	47%	5%	4.0	18	details
2.7 Developing patience with the slow pace of research.	5%	5%	11%	26%	53%	0%	4.2	19	details
2.8 Understanding what everyday research work is like.	0%	5%	0%	32%	63%	0%	4.5	19	details
2.9 Taking greater care in conducting procedures in the lab or field.	0%	0%	11%	21%	32%	37%	4.3	12	details

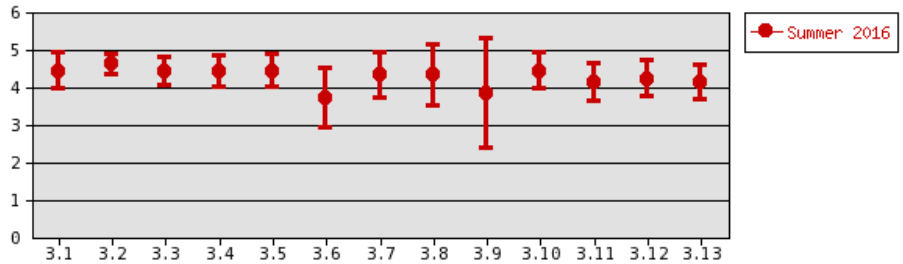
Summary of scale results
The graphic below lists the mean and confidence interval (±3 times the standard error) for each item.



Gains in SKILLS

3. How much did you GAIN in the following areas as a result of your most recent research experience?	1:no gains	2:a little gain	3:moderate gain	4:good gain	5:great gain	9:not applicable	Mean	N	
3.1 Writing mathematical reports or papers.	5%	0%	11%	16%	68%	0%	4.4	19	details
3.2 Making oral presentations.	0%	0%	5%	26%	68%	0%	4.6	19	details
3.3 Defending an argument when asked questions.	0%	0%	16%	26%	47%	11%	4.4	17	details
3.4 Explaining my project to people outside my field.	0%	5%	16%	16%	63%	0%	4.4	19	details
3.5 Preparing a mathematics poster.	0%	0%	5%	21%	26%	47%	4.4	10	details
3.6 Keeping a detailed lab notebook.	5%	5%	11%	16%	21%	42%	3.7	11	details
3.7 Conducting observations in the lab or field.	0%	5%	5%	16%	32%	42%	4.3	11	details
3.8 Using statistics to analyze data.	0%	0%	11%	0%	21%	68%	4.3	6	details
3.9 Calibrating instruments needed for measurement.	5%	5%	0%	0%	21%	68%	3.8	6	details
3.10 Working with computers.	5%	0%	11%	21%	63%	0%	4.4	19	details
3.11 Understanding journal articles.	5%	5%	11%	37%	42%	0%	4.1	19	details
3.12 Conducting database or internet searches.	0%	11%	5%	32%	42%	11%	4.2	17	details
3.13 Managing my time.	0%	16%	0%	42%	42%	0%	4.1	19	details

Summary of scale results
The graphic below lists the mean and confidence interval (±3 times the standard error) for each item.

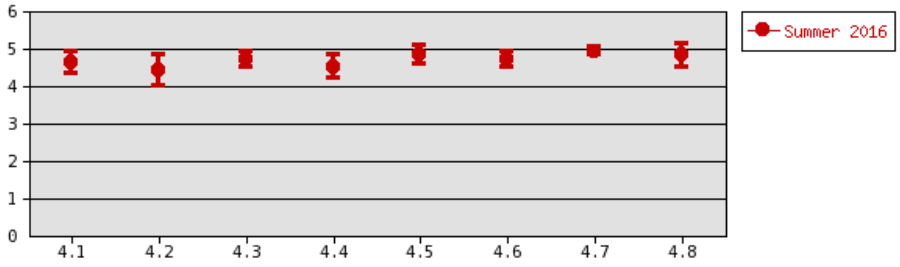


The following questions ask about your overall research experience and about any changes in your attitudes or behaviors as a researcher.

4. During your research experience HOW MUCH did you:	1:none	2:a little	3:some	4:a fair amount	5:a great deal	9:not applicable	Mean	N	
4.1 Engage in real-world mathematics research	0%	0%	11%	16%	74%	0%	4.6	19	details
4.2 Feel like a mathematician.	0%	5%	11%	26%	58%	0%	4.4	19	details
4.3 Think creatively about the project.	0%	0%	0%	26%	74%	0%	4.7	19	details
4.4 Try out new ideas or procedures on your own.	0%	0%	11%	26%	63%	0%	4.5	19	details

4.5 Feel responsible for the project.	0%	0%	5%	11%	84%	0%	4.8	19	details
4.6 Work extra hours because you were excited about the research.	0%	0%	0%	26%	74%	0%	4.7	19	details
4.7 Interact with mathematicians from outside your school.	0%	0%	0%	5%	95%	0%	4.9	19	details
4.8 Feel a part of a mathematics community.	0%	5%	0%	5%	89%	0%	4.8	19	details

Summary of scale results
The graphic below lists the mean and confidence interval (±3 times the standard error) for each item.

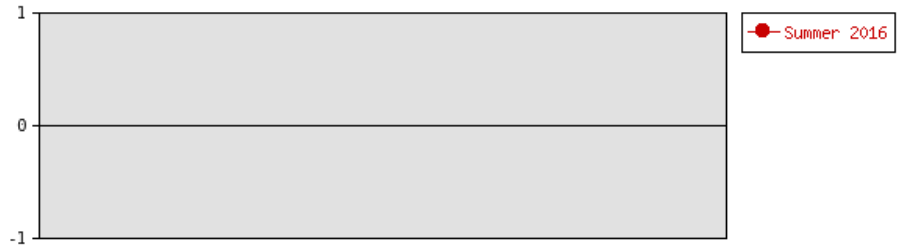


5. What year are you in college?	1:Freshman/rising sophomore	2:Sophomore/rising junior	3:Junior/rising senior.	4:Senior	5:Other	:	Mean	N
5.1 I am a:	0%	26%	63%	11%	0%		--	19 details

Summary of scale results
The graphic below lists the mean and confidence interval (±3 times the standard error) for each item.

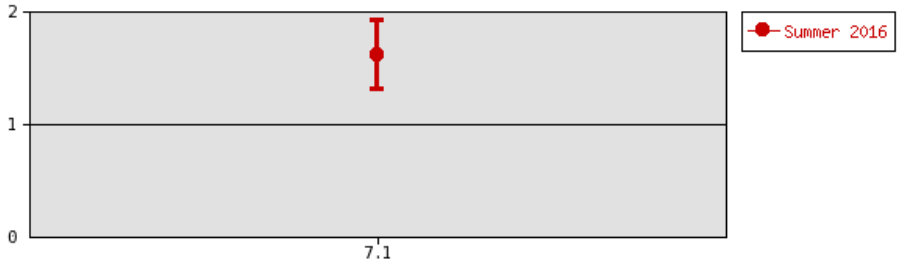
6. GPA	1:3.5 - 4.0	2:3.0 - 3.49	3:2.5 - 2.99	4:2.0 - 2.49	5:Below 2.0	6:Don't know	Mean	N
6.1 What is your GPA?	79%	21%	0%	0%	0%	0%	--	19 details
6.2 What is your GPA in your math courses?	84%	11%	5%	0%	0%	0%	--	19 details

Summary of scale results
The graphic below lists the mean and confidence interval (±3 times the standard error) for each item.



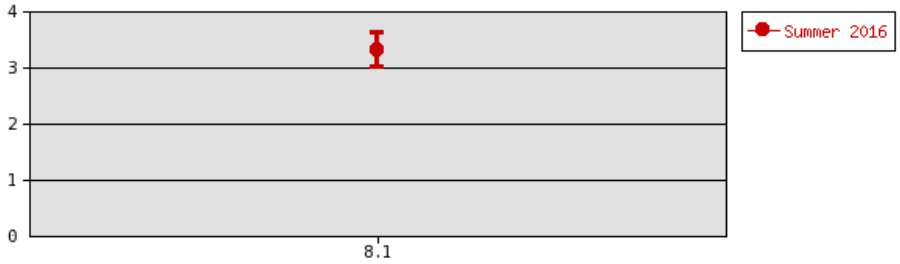
7. Summer research	1:Never participated	2:1 summer	3:2 summers	4:3 summers	:	:	Mean N
7.1 How many times have you participated in SUMMER research, excluding this one?	47%	42%	11%	0%			1.6 19 details

Summary of scale results
The graphic below lists the mean and confidence interval (±3 times the standard error) for each item.



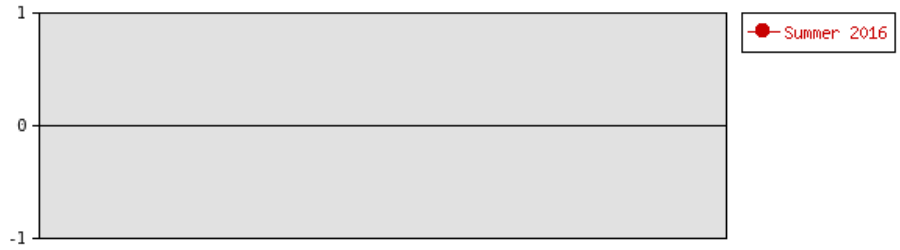
8. Stipend	1:Not at all important	2:Slightly important	3:Important	4:Very important	: :	Mean	N	
8.1 How important was the stipend or money you were paid in allowing you to do research?	0%	11%	47%	42%		3.3	19	details

Summary of scale results
The graphic below lists the mean and confidence interval (±3 times the standard error) for each item.



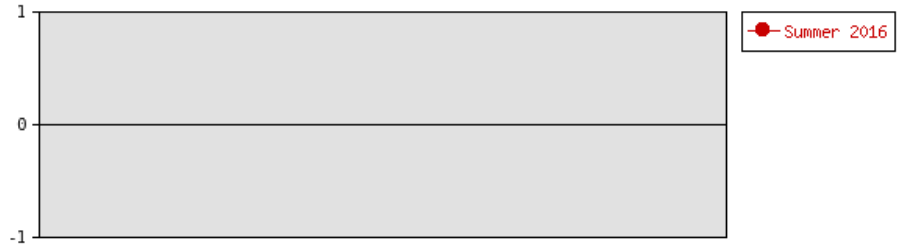
9. Gender	1:Male	2:Female	3:Decline to answer	: : :	Mean	N	
9.1 What is your gender?	47%	53%	0%		--	19	details
9.2 Other	Enter codes for text answers				--	--	

Summary of scale results
The graphic below lists the mean and confidence interval (±3 times the standard error) for each item.



10. Race	1:Native American	2:Asian American	3:African American	4:White	5:Other	6:Decline to answer	Mean	N	
10.1 What is your race?	0%	5%	16%	42%	26%	11%	--	19	details
10.2 Other	Enter codes for text answers						--	3	details

Summary of scale results
The graphic below lists the mean and confidence interval (±3 times the standard error) for each item.



11. Ethnicity	1:Hispanic	2:Non-Hispanic	3:Decline to answer	: : :	Mean	N	
11.1 What is your ethnicity?	53%	37%	11%		--	19	details

Summary of scale results
The graphic below lists the mean and confidence interval (±3 times the standard error) for each item.

Citizenship

12. What is your citizenship status?	1:US Citizen	2:US Permanent Resident	3:Decline to Answer	4:Other : :	Mean	N	
12.1 Citizenship	100%	0%	0%	0%	--	19	details
12.2 Other	Enter codes for text answers				--	--	

Summary of scale results
The graphic below lists the mean and confidence interval (±3 times the standard error) for each item.

13. Other demographics	1:Yes	2:No	3:Decline to answer	: : :	Mean	N	
13.1 Are you a first generation college student?	47%	53%	0%		--	19	details
13.2 Are you a student at a 2-year community college?	11%	84%	5%		--	19	details
13.3 Do you have a disability?	0%	95%	5%		--	19	details

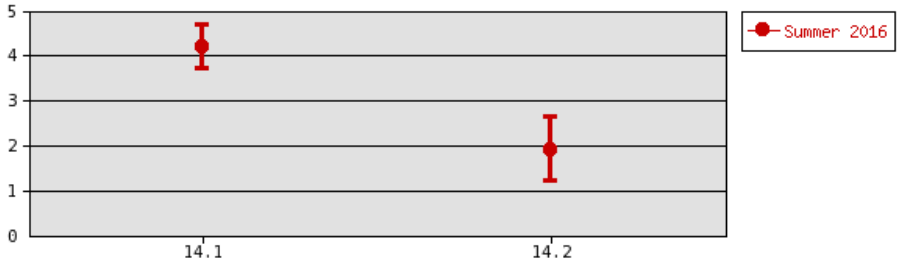
Summary of scale results
The graphic below lists the mean and confidence interval (±3 times the standard error) for each item.

Research experience

14. Compared to your intentions BEFORE doing research, HOW LIKELY ARE YOU NOW to:	1:not more likely	2:a little more likely	3:somewhat more likely	4:much more likely	5:extremely more likely	9:not applicable	Mean	N	
14.1 enroll in a Ph.D. program in science, mathematics or engineering?	0%	11%	16%	16%	58%	0%	4.2	19	details
14.2 enroll in a masters program in science, mathematics or engineering?	63%	0%	11%	5%	11%	11%	1.9	17	details
14.3 Other. Please state your intended degree and, compared to your intentions BEFORE doing research, HOW LIKELY YOU ARE NOW to enroll in a graduate program leading to an advanced degree.	Enter codes for text answers						--	14	details

Summary of scale results

The graphic below lists the mean and confidence interval (±3 times the standard error) for each item.



MSRI-UP: research project, background

15. Please reflect on these aspects of your MSRI-UP research and pre-research experiences.		Mean	N	
15.1 Are you satisfied with your project topic, or do you wish you had requested or been assigned to a different problem? Please explain.	Enter codes for text answers	--	18	details
15.2 Are you satisfied with your project teammates, or do you wish you had requested or been assigned different people with whom to work? Please explain.	Enter codes for text answers	--	18	details
15.3 Please *compare*, positively or negatively, your *team* research to the work you may have produced and the experience you think you would have had working *by yourself* on the project.	Enter codes for text answers	--	18	details
15.4 In what ways was the advisement and guidance you received most effective or least effective?	Enter codes for text answers	--	17	details
15.5 Was the pre-research background phase (Week 1 plus) of the program "just right", or do you have suggestions that would have made it more effective to you? (e.g., move faster or slower, assign more homework or less homework, have more lectures or fewer lectures, etc.)?	Enter codes for text answers	--	18	details

MSRI-UP: exposure, professional development, community building,...

16. Please take time to write a bit about these aspects of the 2016 MSRI-UP and what they meant to you--what you found informative, inspiring, valuable, worthwhile, useful, useless, fun, special, etc.--mathematically or otherwise and individually or collectively (e.g., you can address the impact of a specific visitor or the impact of the set of visitors). Each reply is capped at 2000 characters.		Mean	N	
16.1 COLLOQUIA: a) Prof. Rekha Thomas; b) Dr.	Enter codes for text answers	--	16	details

Nicolas Flores Castillo; c) Prof. Candice Price; d) Dr. Natalie Durgin; e) Prof. Illya Hicks				
16.2 GRADUATE SCHOOL & FELLOWSHIP WORKSHOP: a) Dr. Colette Patt (July 7); b) Prof. Richard Laugesen (July 22)	Enter codes for text answers	--	16	details
16.3 GRADUATE STUDENT PANELS: A) Panel 1 (June 24); B) Panel 2 with MSRI-UP Alum (July 20)	Enter codes for text answers	--	16	details
16.4 CAREER PANEL: Dr. Natalie Durgin, Dr. Luis Serrano, Dr. Rebecca Hartman-Baker on July 8	Enter codes for text answers	--	16	details
16.5 SATURDAY EXCURSIONS: Pier 39 and Cable Car Tours; Exploratorium; Santa Cruz Beach and Boardwalk; Cookout at Cordonices Park; Berkeley Botanical Gardens; Oakland A's baseball game	Enter codes for text answers	--	16	details

Other MSRI-UP-specific prompts

17. Lastly, please answer these questions.		Mean	N	
17.1 *Mathematically,* what was the most valuable or memorable experience or incident during MSRI-UP to you?	Enter codes for text answers	--	17	details
17.2 *Otherwise,* what was the most valuable or memorable experience or incident during MSRI-UP to you?	Enter codes for text answers	--	17	details
17.3 Is there anything regarding any aspect of the program that you wish you had known *before* June 11 (arrival date)?	Enter codes for text answers	--	17	details
17.4 What advice would you give to a friend *applying* to the 2017 MSRI-UP and to a friend *accepted* to our program?	Enter codes for text answers	--	17	details