Graduate Student Involvement with the DIMACS-DIMATIA-Renyi Project on Combinatorial Methods

DIMACS has a joint research project on combinatorial methods with two leading research centers in Europe. DIMACS, DIMATIA in Prague, Czech Republic, and the Renyi Institute in the Hungarian Academy of Science, Budapest, Hungary have joined in a tripartite project involving three research working groups:

- Algebraic and Geometric Methods in Combinatorics
- Extremal Combinatorics
- Graph Colorings and their Generalizations

The groups each meet once a year, once in each location.

The first working group concentrates on two broad areas of research: algebraic methods involving the study of homomorphisms of graphs, with special emphasis on problems arising from statistical physics, and problems of combinatorial geometry. The working group on extremal combinatorics concentrates on two general topics, extremal graph theory and extremal problems arising from combinatorial search and testing. The working group on graph colorings and generalizations investigates such topics as T-colorings, list colorings, L(2,1)-colorings, and set colorings, with an emphasis on the graph coloring concepts that arise from channel assignment problems.

Graduate students from all three partners have been actively contributing participants in these groups and even involved in organizing meetings. Eight students from Rutgers have made presentations and attended various meetings. Stephen Hartke was co-organizer of the first meeting of the Graph Coloring group in October, 2003. Fourteen graduate students and three undergraduates from Hungary, Czech Republic, Poland, and Britain have been participants. Adam Marcus, a Fulbright Fellow is also included in our list of graduate student participants.

Participating in this program has had a profound effect on the development of these students. This effect is best understood in their own words. Below are some selected comments from the students.

Ian Levitt, Rutgers, had this to say about his participation in the meeting on Algebraic and Geometric Methods in Combinatorics in Budapest in April, 2004:

"I would like to begin by heartily thanking Dr. Latka, Dr. Roberts, and all of the organizers and administrators who made it possible for me to attend this conference. It was an invaluable experience for me and I am deeply grateful for the opportunity. It came at an important time in my graduate education. I have recently passed the general requirements for the PhD program and am now beginning to focus my attention. This conference was the perfect way to 'shop around' for ideas and to see what is happening in a range of fields. Indeed, the conference helped solidify my commitment to doing Hungarian-style combinatorics, i.e. extremal and probabilistic. I was able to have

excellent conversations with some mathematicians that I otherwise would not have been able to meet. For example, I spent a day with two of Szemeredi's former students, Ryan Martin and Gabor Sarkozy, during which we had much excellent mathematical discussion. Gabor had some open problems that we discussed, and Ryan had some suggestions for my summer reading list. Some of the talks which were especially interesting to me were those given by Lovasz, Rucinski, Simonovits, and Tardos. Lovasz's talk was especially exciting, and I am looking for ways in! These four talks have given me much to research and become acquainted with. Finally, I would like to note that another important benefit of this conference was that it enabled me to become familiar with the Hungarian language. It may seem like a small thing, but being in Hungary is the best way to know Hungarian, and it is important to me to be comfortable with the language since I expect to be involved with its speakers. I wanted to add that another benefit was that the trip provided a great opportunity to bond with my fellow graduate students. Probably the best conversations (mathematical and otherwise) during the whole trip came between Vince, Nick, Bill, and myself, and these came rather frequently." Ian Levitt, Rutgers

William Cuckler's reaction to the same meeting was as follows:

"The title of my talk was Hamiltonian cycles in regular tournaments, which was about recent work on a lower bound of the above. The talk generated some interest from the participants of the conference, including Dr. Rucinski who asked for a copy of the paper. The talk could prove invaluable to my career because it allowed me to establish such contacts and made my result known to many prominent discrete mathematicians. Also, I got the opportunity to practice my speaking skills in a more formal environment and the comments that the participants offered me will help me to improve on my ability to speak at future seminars and conferences. Besides my talk, there were other aspects of the conference that were valuable to my development as a discrete mathematician. The talks showcased the recent developments of combinatorics; many open problems and recent techniques were presented that could prove valuable to me in the future. One open problem that I spent some time on and may spend more time on in the future is an extremal problem presented by Dr. Gabor Tardos at the problem session. The new ideas presented were a stimulant to learn more about some different areas of combinatorics that I knew little of before. For example, Dr. Lovasz gave an inspiring talk on graph homomorphisms, statistical physics and quasirandom graphs that demonstrated the use of semidefinite matrices to solve many combinatorial problems. I intend to learn more about the ideas contained in this talk as perhaps they could prove important in the future direction of research." William Cuckler, Rutgers

That Budapest meeting also favorably impressed Nick Weininger, Rutgers:

"I gave a 30-minute talk entitled 'Correlation properties of some random colorings.' This was the first talk I'd ever given at a conference outside the United States, and also the first time I'd used computer-projected slides; thus it was an educational experience in several respects. After the talk, I had a couple of productive discussions with audience members (Ryan Martin, Gabor Simonyi, Jeff Kahn) about one of the open problems I'd

mentioned at the end of the talk. As a result of these discussions, I realized that one of the conjectures I'd made was not true in its full generality, and managed to prove some small yet not totally trivial special cases of another. Among the talks I attended, Laszlo Lovasz's stands out as particularly interesting and useful. The results he presented are potentially applicable to several of the problems I'm working on—the random-homomorphism problem I talked about, for one, and also an inequality involving Ising model partition functions. Jeff Kahn, Aart Blokhuis, and I had a useful discussion of a problem Jeff presented at the end of his talk." Nick Weininger, Rutgers

Nick has been a very active participant in these working group meetings. Here is his reaction to the meeting on Algebraic and Geometric Methods in Combinatorics in December, 2002 and the meeting on Graph Colorings and their Generalizations meeting in August, 2004:

"The talks at the first Prague conference in December '02 introduced me to the notion of graph homomorphisms, a topic I find really interesting, and led me eventually to formulate one of the problems I've been working on for much of the last year. This is the question of correlation properties of random homomorphisms which I mentioned as an open problem at the end of my talk in Budapest in April. By the time of the second Prague meeting in August of this year, I'd made some progress on this problem-- thanks in part to conversations in Budapest-- and my talk at that meeting focused on it. I thought that talk was very well received, and I had a number of useful conversations about the problem afterward with Jan Kratochvil, Jarik Nesetril, and Matt DeVos. In particular, Prof. Nesetril pointed me to some relevant recent papers by him and others. One of these contained a lemma which I was able to generalize in order to solve some nontrivial special cases of the homomorphism correlation problem; this will form part of the thesis I am now beginning to prepare. So, all in all, these conferences have been a demonstrable, significant aid to my research efforts." Nick Weininger, Rutgers

William Cuckler, Rutgers, also attended the Extremal Combinatorics meeting in April, 2003 in Budapest and remarks:

"The talks gave me a very broad perspective of combinatorics. Many different topics were covered, expanding on what I learned in combinatorics classes. This broad perspective was especially helpful to me because I was a second year student trying to narrow my focus on a specific area of combinatorics. The topics that interested me the most were Turan-type problems (discussed by Dr. Furedi) and forbidden submatrix problems (discussed by Dr. Tardos). I read more about both topics after the conference and discussed them with Professor Komlos and other graduate students, including Paul Ellis and Stephen Hartke. The other graduate students and I also discussed many of the open problems that were presented. This discussion was particularly valuable to Paul Ellis and me because we learned a lot from Stephen Hartke who, as a more advanced student, often had greater insight into the problems." William Cuckler, Rutgers