

DIMACS Center
Rutgers University

DIMACS Reconnect 2005 Programs

Report

March 2006

The DIMACS Reconnect Program aims to reconnect to the mathematical sciences research enterprise faculty whose primary responsibility is teaching undergraduates. A leading expert introduces participants to a current research topic relevant to the classroom through a series of lectures. The participants are involved in writing materials useful in the classroom, with the possibility of following up by preparing these materials for publication in the DIMACS Educational Modules Series.

This program, organized primarily around summer conferences, offers the opportunity for junior faculty as well as mid-level and senior faculty to advance to research questions in a new area of the mathematical sciences. Participants also acquire materials and gain ideas for seminar presentations and for undergraduate research projects.

The Reconnect Program is also aimed at reconnecting faculty to the mathematical sciences research enterprise by involving them in a leading research center. There are opportunities to follow up after the summer conference by getting connected to DIMACS researchers and other DIMACS programs throughout the year.

The program features a “satellite” component whereby the programs run at DIMACS become the training ground for other college faculty to observe the program and subsequently run a similar program at their own institutions in the succeeding summer. There are currently seven institutions that have run or have agreed to run Satellite Reconnect programs: Salem State College and the Illinois Institute of Technology in summer 2003, Lafayette College and St. Mary's College in summer 2004, Montclair State University and Spelman College in summer 2005, and Morgan State University in summer 2006.

Ia. Participants from the 2005 program

Participants:

Montclair State University Program

Atif Abueida, University of Dayton
Michael Ackerman, Bellarmine University
Eliana S. Antoniu, William Patterson University
Mariah Birgen, Wartburg College
Brad Chin, West Valley College
Sul-Young Choi, LeMoyne College
Peter Coughlin, University of Maryland
Mike Daven, Mount Saint Mary College
Andy Felt, University of Wisconsin-Stevens Point
Karolyne Fogel, California Lutheran University
Michael Gargano, Pace University
Jose H. Giraldo, Texas A & M University--Corpus Christi
Eric Gottlieb, Rhodes College
Matthew Haines, Augsburg College
James Hamblin, Shippensburg University
Stephen Kennedy, Carleton College
Miyeon Kwon, University of Wisconsin-Platteville
Teresa D. Magnus, Rivier College
Steven Morics, University of the Redlands
Kathryn Nyman, Loyola University Chicago
Kathleen Offenholley, Brookdale Community College
Kay B. Somers, Moravian College
Angela Spalsbury, Youngstown State University
Janet L. Stonick, SUNY Orange

Irfan Ul-Huq, University of Wisconsin-Stout
Robert W. Vallin, Slippery Rock University
Jennifer Wilson, Eugene Lang College
Japheth Wood, Chatham College

Spelman College Program

Edith Adan-Bante, University of Southern Mississippi/Gulf Coast
Robert Bozeman, Morehouse College,
Sylvia Bozeman, Spelman College
Daniel Burkett, Indiana University of PA
Sukmoon Chang, Capital College, Penn State University
Pinyuen Chen, Syracuse University
Ezra Halleck, New York College of Technology
Ivaylo Ilink, Rhodes College
Kimberly Jenkins, Transylvania University
Alexander Kheyfits, Bronx Community College/CUNY
Sunghee Kim, Gettysburg College
Katrina Palmer, Appalachian State University
Charles Pierre, Clark Atlanta University
Leming Qu, Boise State University
Zhizhang Shen, Plymouth State University
Brett Sims, Morehouse College
Desmond Stephens, Florida A & M University
Irfan Ul-Haq, University of Wisconsin-Stout
Roselyn Williams, Florida A&M University
Connie Yu, New Jersey City University

Organizers:

Montclair State University Program

Arup Mukherjee, Montclair State University
Fred S. Roberts, DIMACS, Rutgers University
Christine Spassione, Reconnect Program Coordinator, DIMACS

Spelman College Program

Fred Bowers, Spelman College
Asamoah Nkwanta, Morgan State University
Fred S. Roberts, DIMACS, Rutgers University
Christine Spassione, Reconnect Program Coordinator, DIMACS

Main Speakers:

Montclair State University Program

Donald G. Saari, Institute for Mathematical Behavioral Sciences, University of California, Irvine

Spelman College Program

Martin Lindquist, Columbia University
Lawrence Shepp, Rutgers University

Guest Speaker:

Montclair State University Program

Michael A. Jones, Department of Mathematical Sciences, Montclair State University

Consultant from Minority Institution:

Abdul-Aziz Yakubu, Howard University

2006 Satellite Reconnect - Morgan State University

Organizers:

Asamoah Nkwanta, Morgan State University
Fred S. Roberts, Rutgers University

Main Speaker:

Abdul-Aziz Yakubu, Howard University

Ib. Participating Organizations

Rutgers, The State University of New Jersey, Princeton University, AT&T Labs – Research, Bell Labs, NEC Laboratories America, Telcordia Technologies, Illinois Institute of Technology, Salem State College, Lafayette College, St. Mary’s College of California, Spelman College, Montclair State University, Morgan State University, Stevens Institute of Technology, Rensselaer Polytechnic Institute, Georgia Institute of Technology, Avaya Labs, HP Labs, IBM Research, Microsoft Research.

II. Project Activities

During this year of the grant, two summer 2005 Satellite Reconnect programs were held, at Montclair State and Spelman. We followed up the summer 2002, 2003 and 2004 DIMACS (Rutgers) programs, the 2003 Satellite programs at Illinois Institute of Technology and Salem State College and the 2004 Satellite programs at Lafayette College and St. Mary’s College by staying in touch with the participants and helping them with the modules they started in summer 2002, 2003 and 2004. We worked with the organizers of the summer 2006 Satellite program, providing “training” and guidance.

Reconnect Satellite Conference 2005: Montclair State University

Topic: Mathematics of Elections and Decisions

Main Speaker: Donald G. Saari, Institute for Mathematical Behavioral Sciences, University of California, Irvine

Guest Speaker: Michael A. Jones, Department of Mathematical Sciences, Montclair State University

Organizers:

Arup Mukherjee, Montclair State University
Fred S. Roberts, DIMACS Rutgers University

We do voting and elections all the time, starting from that kindergarten class when our teacher asked for a “show of hands.” Sounds simple, but is it? We know from too many examples, and from Arrow's Theorem, which asserts, “No election rule is fair,” that this can be a complicated topic. During this conference, the speaker introduced “the mathematics of voting” to see how the muscle power of mathematics and computer science can resolve many complex issues in elections including results that are surprising and discouraging.

Topics covered include showing how to understand (and create) all possible voting paradoxes that could occur with any of the standard methods, a discussion of how symmetry groups help us understand decision procedures, commentary on the mathematics and algorithms of strategic and manipulative

behavior (which showed participants how to “win” during their next departmental discussion), and a discussion showing that the famous Arrow's Theorem does not mean what we have believed it to mean for the last half century. Other discussions showed how all of this material extends to topics such as “power indices” (a way to measure the political power of a group), economics, and even statistics.

While the research frontier of this topic involves complicated material, it turns out that it is possible to package even recently found conclusions in a manner that can be presented in undergraduate courses. In one of the sessions, the speaker showed how even simple algebra and combinatorics can be used to construct surprising paradoxes. He also indicated how to tie in this material with orbits of symmetry groups from algebra. The material on strategic behavior included both notions from symmetry groups and basic geometry involving gradients.

All of this led to material that is surprising, entertaining, and highly educational for undergraduates.

Reconnect Satellite Conference 2005: Spelman College

Topic: The Mathematics of Medical Imaging

Main Speakers: Lawrence Shepp, Dept. of Statistics, Rutgers University, and Martin Lindquist, Columbia University

Organizers:

Fred Bowers, Spelman College
Asamoah Nkwanta, Morgan State University
Fred S. Roberts, DIMACS Rutgers University

Modern medicine depends on CAT scanners and MRI scanners for the diagnosis of brain tumors and other diseases and on functional MRI and PET scanners for determining normal metabolism. Each of these medical technologies relies on basic and elegant mathematics, which were studied in detail both rigorously and via computer simulations during this conference.

CAT scanners depend upon the mathematical theorem (proven by Radon in 1917) that a density, $f(x,y)$, in two-dimensional (x,y) space is determined uniquely if one knows the “X-ray projection” of f in every direction. The vertical X-ray projection is just the integral of $f(x,y)$ over y with x held fixed. The conditions on f for Radon's theorem to hold are minimal: the Radon transform or X-ray projection, Pf , simply has to be defined. On the other hand, if one is measuring the Radon transform of f , then one knows Pf only approximately and not for all X-ray projections, but only for a finite sample; this makes things interesting.

MRI, fMRI scanners, and PET scanners also depend on elegant mathematics and the basic ideas were developed in lectures. Participants maximized what they got from the conference by not only studying the rigorous theory but also writing the engineering algorithms used in medical scanners. Before the start of the conference, participants were strongly encouraged to duplicate two simple computer programs. The first program is the basic 50-line program used in all CAT scanners (participants got as much help as needed in doing this), the so-called convolution-back-projection algorithm. Once they had this program written they made sure that it was correct by using it to “reconstruct” the density $f(x,y)$ of an artificial model they chose. The “measured values” of the X-ray projection of the chosen density were computed by a second, data-generation program, that they wrote (again with help). The original density and the reconstructed density were then displayed and compared. They were then able to see how much the fact that the Radon transform has only been finitely sampled has distorted the original image. This experiment familiarized participants with the field of imaging, which depends upon and exploits the ability to visualize an entire array of numbers in parallel. They were also then ready to understand the theory behind the algorithms and behind PET, MRI, and fMRI.

Larry Shepp discussed CAT and PET in the first half of the conference; Martin Lindquist discussed MRI and fMRI in the second half.

Reconnect Satellite Conference 2006: Morgan State University

Topic: Simple and Complex Discrete-time Population Models in Ecology and Epidemiology

Main Speakers: Abdul-Aziz Yakubu, Howard University

Organizers:

Asamoah Nkwanta, Morgan State University

Fred S. Roberts, DIMACS Rutgers University

The study of population dynamics raises questions whose answers require an understanding of the four basic demographic processes: immigration, emigration, birth and death. The inclusion of population structure, spatial heterogeneity or mating systems, is dictated by the specifics of each question being asked. Mathematical models are a useful tool and a model's details and level of complexity depend on the nature of the questions being asked. The overall abstract structure of a mathematical model can be simple, but the consequences for the population dynamics can be rich and often requires sophisticated computer simulation methods to analyze. These problems and models have captured the imagination of generations of computer scientists and mathematicians.

In some biological populations, such as most animal and plant species, population growth is a discrete-process, and discrete-time models are more appropriate in studying their population dynamics. However, simple discrete-time population models are capable of generating complex dynamics such as period-doubling bifurcations route to chaos, multiple attractors with fractal basin boundaries, strange or chaotic attractors, and so on. This conference used population models in ecology and epidemiology to motivate discrete-dynamical system concepts and discussed the related computational issues.

III. Project Findings

Although work on specific research projects is not a main goal of the Reconnect program, we do hope that some of the participants will be stimulated to return to research activity. We have some indication that this has indeed happened and that the research is sustained over many years. A few examples are given below.

At the July 2004 Satellite Reconnect Conference at St. Mary's College, California, Joseph O'Rourke (Smith College) reconnected the participants to research in Folding and Unfolding in Computational Geometry, resulting in several ongoing collaborations. O'Rourke is working via email, conferences, and visits with seven Reconnect participants. We have documented the initial results of these collaborations in earlier reports. These collaborations have been sustained for several years now and continue to yield results. Mirela Damian (Villanova University), Robin Flatland (Siena College), and O'Rourke have been working on unfolding special classes of orthogonal polyhedra. An unfolding of a polyhedron is produced by cutting the surface and flattening to a single, connected, planar piece without overlap (except possibly at boundary points.) It is a longstanding unsolved problem to determine whether or not every polyhedron may be unfolded. Damian, Flatland, and O'Rourke developed an algorithm for unfolding any orthogonal polyhedron (one whose faces meet at right angles) of genus zero. The cuts are not necessarily along edges of the polyhedron, but they are always parallel to polyhedron edges. Portions of the unfolding are rectangular strips that, in the worst case, have a thinness that is a function of the number of vertices of the polyhedron.

As a result of their participation in the June 2005 Satellite Reconnect Conference at Montclair State University on the Mathematics of Elections and Decisions, Michael Ackerman (Bellarmine University),

Sul-Young Choi (LeMoyne College), Peter Coughlin (University of Maryland), Eric Gottlieb (Rhodes College), and Japheth Wood (Chatham College) began a collaboration and have produced a nice mathematical result on the effects of voter preferences being partially ordered. They are in the process of writing two papers. Classical voting theory considers voter preferences in which the candidates are totally ordered. However, in settings such as the election of committees, partially ordered preferences may be more natural. Ackerman, Choi, Coughlin, Gottlieb, and Wood developed an algorithm to extend well-known voting methods to these situations. They extended Saari's model to semiordered preferences and investigated a common generalization of the braid arrangement.

IV. Project Training/Development

Training and career development were major goals of the program. See section on Human Resource Development for comments of faculty participants on the impact Reconnect had on their careers. One of the major goals of this project is to involve others in learning how to run such "reconnect" experiences. Many of our organizers have never run a conference or a summer program before and the first time is a real learning experience. Just as Arup Mukherjee, Montclair State University, and Fred Bowers, Spelman College, participated in organizing and running earlier Reconnect programs before organizing and running their own in 2005, Asamoah Nkwanta, Morgan State University, was actively involved in the 2005 program in preparation for the 2006 program at Morgan State.

V. Outreach Activities

Many of the activities that Reconnect participants have taken back to their campuses are of an outreach nature, involving interdisciplinary programs and seminars, with clubs, talks, etc. (See also the section on Human Resource Development and on Contributions within Discipline and the list of talks.) Katrina Palmer, Appalachian State University, used the material she developed as a participant in the Spelman Satellite Reconnect conference to present a talk to female high school students on the mathematics of medical imaging for the Women in Math Day at Appalachian State University in October, 2005.

One of the effects of having a Satellite Reconnect conference at a historically minority institution such as Spelman is to raise issues in the minds of participants that may lead to future initiatives to broaden participation in the STEM disciplines. For example, here is one comment:

My participation in Reconnect made me "rethink the need to prepare undergraduates in a minority institution for a career in research. How do we bridge the big gaps?!" Connie Yu, New Jersey City University, Spelman 2005

A major emphasis in the project is to reach out to minority faculty and minority institutions. Each summer, we have had observers from schools with a heavy minority enrollment. In summer 2004, this observer was Fred Bowers, Spelman College. In summer 2003, the observers were Ermelinda De La Vina, University of Houston-Downtown, and Yewande Olubummo, Spelman College. In summer 2002, the observers were Sylvia Bozeman, Spelman College, and Asamoah Nkwanta, Morgan State College. This aspect of the project has been highly successful. It led to Professor Bozeman asking if she could run a Reconnect program at Spelman. This was arranged for summer 2005 when the organizer of a satellite program scheduled for Oakland University moved to another university and took a dean's position. We replaced the Oakland program with a Spelman program. Professor Nkwanta then also asked if he could run a satellite program at Morgan State, which is now scheduled.

VI. Papers

Jonathan Berry, Daniel Hrozencik, Shrisha Rao and Zhizhang Shen, "Finding the median set of tree structures in synchronous distributed systems," in *the Proc. of, the ISCA 20th International Conference on Computers and Their Applications(CATA-2005)*, New Orleans, LO, March 16-18, 2005, pp. 7-12.

Jonathan Berry, Daniel Hrozencik, Shrisha Rao and Zhizhang Shen, "Finding the median set of tree structures in synchronous distributed systems," DIMACS Technical Report 2004-07, 2004.

Jonathan Berry, Daniel Hrozencik, and Shrisha Rao, "Finding central sets in synchronous distributed systems," in *Pro. of the 17th International Conference on Parallel and Distributed Computing Systems (PDCS-2004)*, San Francisco. CA, Sept. 15-17, 2004, pp. 201-208.

Mark Bollman, Jie Chen, William Hough, and Dawn Strickland "Mathematics of auction theory, its application on ebay," in preparation.

Mirela Damian, Robin Flatland, and Joseph O'Rourke, "Unfolding Manhattan towers," *17th Canadian Conference on Computational Geometry*, Aug. 2005, Windsor, Ontario, pp. 211-214.

Mirela Damian, Robin Flatland, and Joseph O'Rourke, "Epsilon-unfolding orthogonal polyhedra," *Smith Technical Report 082*, Feb. 2006. arXiv cs.CG/0602095, to be submitted to *Aikiyama/Pach Festschrift*, Mar. 2006.

Mirela Damian, Robin Flatland, Henk Meijer, and J. O'Rourke, "Unfolding well-separated orthotrees," *15th Annual Fall Workshop on Computational Geometry*, University of Pennsylvania, Nov. 2005, pp. 23-25.

Mirela Damian, Robin Flatland, and Joseph O'Rourke, "Grid vertex-unfolding orthogonal polyhedra," arXiv cs.3013175, September 2005. *23rd Annu. Sympos. Theoretical Aspects Comput. Sci. (STACS)*, Marseille, France. *Lecture Notes in Computer Science*, Volume 3884, Springer, Berlin/Heidelberg, Feb. 2006, pp. 264-276.

Julie Glass, Bin Lu, and Joseph O'Rourke, Jianyuan K. Zhong, "A 2-chain can interlock with an open 11-chain," *Geombinatorics*, to appear, 2006.

Michael L. Gargano and Lorraine L. Lurie, "Swarm intelligence, self organizing maps, and a new hybrid method," *Proceedings of the 35th Southeastern International Conference on Combinatorics, Graph Theory, and Computing*, submitted.

Michael L. Gargano and Lorraine L. Lurie, "A hybrid classification model," *Proceedings of the 36th Southeastern International Conference on Combinatorics, Graph Theory, and Computing*, to be submitted.

Michael L. Gargano, Lorraine L. Lurie, Lixin Tao, and Sung-Hyuk Cha, "Ant colonies, self-organizing maps, and a hybrid classification model," *Proceedings of Student/Faculty Research Day*, CSIS, Pace University, May 7, 2004.

Bruno Guerrieri, "Byers' algorithm applied to Voronoi diagrams on the sphere," in preparation. OLD KEEP

Bruno Guerrieri, "Medial axis algorithm for 2D polygons," in preparation.

Mike Pelsmajer, Martyn Mulder, and K. Brooks Reid, "Axiomatics for the center function on trees," in preparation.

Mike Pelsmajer, Martyn Mulder, and K. Brooks Reid, "Generalized centrality in trees," submitted to Journal of Graph Theory.

Jamiru Luttamaguzi, Michael Pelsmajer, Zhizhang Shen and Boting Yang, "Integer programming methods for several optimization problems in graph theory," in *the Proc. of, the ISCA 20th International Conference on Computers and Their Applications(CATA-2005)*, New Orleans, LO, March 16-18, 2005, pp. 50-55.

Zhizhang Shen, "Alleviation of the impact of the apex nodes in the pyramid structures," *Applied Mathematics and Computation* 169.1 (2005) 157-178.

Japheth Wood, Eric Gottlieb, Sul-Young Choi, Michael Ackerman, and Peter Coughlin, "When voter preferences are partially ordered," in preparation.

Japheth Wood, Eric Gottlieb, Sul-Young Choi, Michael Ackerman, and Peter Coughlin, "A hyperplane arrangement arising from partially ordered voting preferences," in preparation.

VII. Other Products

Talks

Michael Ackerman, Sul-Young Choi, Peter Coughlin, Eric Gottlieb, and Japheth Wood (presenter), "When voter preferences are partially ordered," Special Session on Universal Algebra and Order, 2005 Fall Central Section Meeting, Lincoln, NE, October 23, 2005

Michael L. Gargano, Lorraine L. Lurie, Lixin Tao, and Sung-Hyuk Cha, "Ant colonies, self-organizing maps, and a hybrid classification model," Proceedings of Student/Faculty Research Day, CSIS, Pace University, May 7, 2004.

Eric I Gottlieb (presenter), Japheth Wood, Michael Ackerman, and Sul Young Choi, "A hyperplane arrangement arising from partially ordered voting preferences," AMS Special Session on the Many Lives of Lattice Theory, the Theory of Ordered Sets, and Universal Algebra, Joint Mathematics Meetings, San Antonio, TX, January 13, 2006.

Colleen Livingston (presenter), and Steven Morics, "Voronoi diagrams and scheduling forest rehabilitation," The Mathematical Association of America North Central Section Spring 2003 Meeting, Macalester College, St. Paul, MN, April 26, 2003.

Colleen Livingston, "Introduction to Voronoi diagrams," University of Dayton, high school mathematics contest, March 2004.

Colleen Livingston, "Fortune's algorithm for Voronoi diagrams," University of Dayton, math colloquium, March 2004.

Katrina Palmer, "Mathematics of Medical Imaging," Women in Math Day, Appalachian State University, October 22, 2005.

Katrina Palmer, "Mathematics of Medical Imaging," invited Talk for CSEMS, Appalachian State University, November 2, 2005.

Talks by students mentored by faculty who participated in Reconnect

Mathew Broussard, "Geometric representations for 4 player voting scenarios," Southern California Conference on Undergraduate Research, University of California, Riverside, November 19, 2005. Student of Karrolyne Fogel, California Lutheran University, Montclair State 2005.

James Pierce, "A linear time algorithm for finding a p-center of a tree," Undergraduate Mathematics Day, University of Dayton, OH, November 5, 2005. Student of Michael J. Pelsmajer, Illinois Institute of Technology, Lafayette 2004.

James Pierce, "A linear time algorithm for finding a p-center of a tree," Midwest Theory Day, University of Wisconsin-Milwaukee, December 10, 2005. Student of Michael J. Pelsmajer, Illinois Institute of Technology, Lafayette 2004.

James Pierce, "Fast algorithms to find centers in tree," Chicago Area Undergraduate Research Symposium, The Chicago Cultural Center, Chicago, Illinois, April 1, 2006. Student of Michael J. Pelsmajer, Illinois Institute of Technology, Lafayette 2004.

Modules

The participants produced first drafts of classroom modules. Here is a list of topics and authors for each conference:

Montclair State University Program (2005)

Karrolyne Fogel, Kay Somers, Angela Spalsbury, Jennifer Wilson
"Geometry of Power Indices"

Eliana Antoniou, Brad Chin, Andrew J. Felt, Jose H. Giraldo, Miyeon Kwon, Kathleen Offenholley, Irfan Ul-haq, Robert W. Vallin
"Voting Systems"

Kathryn Nyman, Matthew Haines, Stephen Kennedy, Steven Morics, Brittany Shelton
"First-Year Experience in Mathematics and Political Choice"

James Hamblin, Teresa Magnus, Atif Abueida, Mike Daven
"Linear Algebra and Elections"

Peter Coughlin, Eric Gottlieb, Japheth Wood, Michael Ackerman, Sul-Young Choi
"When Voter Preferences are Partially Ordered"

Mariah Birgen, Janet Stonick
"Voting Projects for Linear Algebra"

Michael Gargano
“Phylogenic Concensus using Genetic Algorithms”

Spelman College Program (2005)

Edith Adan-Bante, Robert Bozeman, Alexander Kheyfits, Katrina Palmer
“Studying Tomography: Starting with the Basics”

Here is a list of modules from earlier Reconnect Conferences that are either being reviewed for consideration in the series or are currently being edited for the series.

Lafayette College (2004)

Sally Cockburn, Ben Coleman, Bruce Mattingly, Kay Somers
“Some Problems are NP-Harder Than Others”

St. Mary’s College (2004)

Mirela Damian, Robin Flatland, Lynn Stauffer, Marcelo Sztainberg
“Edge Unfolding of Polyhedra”

Reva Kasman, Teresa Moore
“Folding Polygons to Polyhedra”

DIMACS (Rutgers University) Program (2004)

Frederick Adkins, Zhongyuan Che, Kristin Pfabe, Dina Sokol
“Finding Repeats within Strings”

Kavita Bhatia, Lifang Hsu, Eileen Lee
“Phylogenetic Trees from DNA Data using the UPGMA Method”

Pamela Cutter, L. Carl Leinbach, Kah Loon Ng
“Searching DNA Strands”

Jean Taylor
“Using BLAST”

Illinois Institute of Technology Program (2003)

Atif Abueida, Mike Ackerman, Sul-Young Choi
“Centrality and Anti-Centrality In Trees”

Erin Boyer, Benjamin V. C. Collins, Mark A. Mills
“An Examination of 2-Centers and 2-Medians of Graphs”

DIMACS (Rutgers University) Program (2003)

Atif Abueida, Mike Daven, Dan Ilaria

“Motivational Examples for Introducing and Teaching Discrete Math”

DIMACS (Rutgers University) Program (2002)

Pallavi Jayawant, Martha Kosa, Christine Shannon

“Reconstructing Curves from Sample Data: Implementing Algorithms using Delaunay Triangulations”

Colleen Livingston, Sarah Hodges, Steve Morics (2002 participant no longer on module)

“Rehabilitating after a Forest Fire: Voronoi Diagrams and Scheduling Algorithms”

Here is a list of modules from earlier Reconnect Conferences that the writers would like to be considered in the future (once they have a better draft):

St. Mary’s College (2004)

Barbara Kaiser, Amanda Serenevy, Don Shimamoto

“Lang’s Tree Algorithm for Origami Design”

James Factor, Hieu Nguyen

“Linkages as Applied to Protein Folding”

Sarah Greenwald, Jill McGowan, Val Pinciu

“Unfolding and Folding Polyhedra”

Bruno Guerrieri

“Voronoi Diagrams and Medial Axes”

DIMACS (Rutgers University) Program (2004)

Nwojo Nnanna Agwu, Pai-Hsi Huang, Wasin So, Boting Yang

“Algorithms for Finding Maximal Scoring Segment”

Salem State College Program (2003)

Steven Leonhardi, Jim Sauerberg, Lidia Luquet

“Reed Solomon Codes: An Application of Linear Algebra”

Illinois Institute of Technology Program (2003)

Jonathan Berry, Daniel Hrozencik, Shisha Rao, Zhizhang Shen

“Finding Central Sets in a Synchronous Distributed System”

Peter Christopher, Dawit Haile, Michael Pelsmajer, Shane Redmond

“Central Sets in Trees (Where is the ‘Middle’ of a Tree?)”

DIMACS (Rutgers University) Program (2003)

Charles Hamaker, Martha Kosa, Michael Olan

“Chord: A Case Study Utilizing Data Structures to Support Scalable P2P Internet Applications”

DIMACS (Rutgers University) Program (2002)

Michael Olan, Donal MacVeigh, Darren Narayan (no longer on module)
“Voronoi Diagrams and Delaunay Triangulations: Data Structures and Algorithms”

Websites

<http://dimacs.rutgers.edu/reconnect/>

VIII. Contributions within Discipline

The “discipline” of this project is computer science, broadly speaking, with related areas of the mathematical sciences and biomathematics. Most of the research results discussed were in the fields of discrete mathematics and theoretical computer science, broadly defined. While research results are a contribution of course, the main results that have come out of the program are lectures by participants back on their own campuses or at professional meetings, new courses or pieces of courses, undergraduate research projects, new seminar series, etc. These bring current research in computer science and related mathematics into the classroom and extra-classroom educational programs. The most important contribution to the disciplines of discrete math and theoretical computer science in particular, and to the discipline of mathematical sciences broadly speaking (including all areas of mathematics, computer science, operations research, statistics, etc.) and biomathematics was the opening up of new horizons to some very dedicated college professors and, in turn, their students of all backgrounds. Here are some relevant comments we received from program participants.

“Even though this was my first DIMACS workshop, it has already affected me in several ways. I currently have an undergraduate mathematics student writing his undergraduate research project under my direction on voting theory. Although his project is primarily expository, he is writing from a different angle than most on this topic. My sabbatical application for Spring 2007 was approved. While I still need to narrow my focus, I plan to work in the area of voting theory. Atif Aboueida, Mike Daven, James Hamblin, and I have continued to work on the module that we submitted to you last month. It was good to see a number of DIMACS subgroups gathering at the San Antonio Joint Mathematics Meetings. I've also had a proposal to develop and give a Junior Year Seminar course on mathematical voting theory approved (to be offered Spring 2008). The information and contacts from the DIMACS workshop will prove very useful!” Teresa D. Magnus, Rivier College, Montclair State 2005.

“My participation in the summer 2005 program has had two direct impacts on students already: one summer research project looking at all possible outcomes for power distributions from a 4person voting game, and one senior capstone project looking at the likeliness of a run-off election having outcomes where the final winner was unexpected based on the first round of voting. The summer research student presented his work at the Southern California Conference of Undergraduate Research (SCCUR). I am on sabbatical in the fall and plan to give a seminar on voting theory and/or power indices, and well as investigate the area further as part of my research topic. My module group is planning to pursue publishing our module.

The conference also had a unplanned side effect: I assumed the department chair position this past fall. I was very nervous about the position and especially dreading it since my predecessor was leaving the department and would not be around to give advice. Through talks with participants at the conference I came to view the position more as an opportunity and the fall semester turned out great. When difficult issues arose I often thought of stories or advice I had heard at the conference and was able to make better

decisions because of the broader perspective.” Karrolyne Fogel, California Lutheran University, Montclair State 2005.

“Here are some concrete things I have done or am doing that stemmed from the DIMACS conference at Spelman last summer.

Impact on career:

I presented what I learned at Appalachian State University to students and faculty (geared more towards students)

I have been working collaboratively with the others I met at the conference on the paper we were asked to write.

Impact on teaching:

I incorporated a small tomography module into my liberal arts math course.

I have a student that may be doing some undergrad research related to what I learned at the conference.

I am developing a junior honors course on medical imaging with another faculty member.”

Katrina Palmer, Appalachian State University, Spelman 2005

As a result of her participation in the 2005 Reconnect conference on the Mathematics of Elections and Decisions, Karrolyne Fogel, California Lutheran University, began work on creating a SIGMAA (Special Interest Group of the Mathematical Association of America on) on elections and voting issues.

We received a variety of other comments from participants about follow-up activities. Here are some examples that illustrate the continuing impact of Reconnect on those who participated in earlier years.

“During the past academic year, I have directed 3 student research projects (2 undergraduate, one master's) using topics that are directly related to the project theme of integer programming. I will be teaching a master's level course in linear programming during the upcoming summer term and expect to incorporate some of the project material into this course.” R. Bruce Mattingly, Lafayette College 2004.

“The main effects have been that I've been keeping in occasional contact with Joe O'Rourke about research problems arising from the material at the St Mary's Reconnect. Also, as a result of the program, I feel more confident about supervising student research and will be sponsoring two students this summer to work on mathematical folding and unfolding questions.” Don Shimamoto, Swarthmore College, St. Mary's 2004.

IX. Contributions -- other Disciplines

A major area of emphasis in the Reconnect program is on applications of methods of computer science and, more generally, of the mathematical sciences, to other disciplines. The tone was set with the summer 2002 program on Voronoi diagrams and applications. The lectures by Scot Drysdale (Dartmouth College) emphasized applications to such areas as Archaeology and Anthropology, Astronomy, Biology, Ecology and Forestry, Cartography, Crystallography and Chemistry, Geography, Geology, Geometric Modeling, Marketing, Metallurgy, Meteorology, Pattern Recognition, Physiology, Robotics, and Zoology. The summer 2003 programs all had interdisciplinary components. The centrality topic at Illinois Institute of Technology featured a major emphasis on facility location problems. The coding theory topic at Salem State is a fundamentally interdisciplinary one with connections to many disciplines in engineering, for example. The resource sharing protocols topic at DIMACS (Rutgers) dealt with applications such as Web

TV and “small world” networks, which arise in the social sciences, the biological sciences, etc. The program on computational biology at DIMACS (Rutgers) 2004 was interdisciplinary by its very nature. The experimental algorithmics topic at Lafayette included real-world discrete optimization problems arising in problems ranging from transportation to manufacturing. The folding and unfolding topic at St. Mary’s included real-world materials applications. The summer 2005 programs also had major interdisciplinary components. Donald G. Saari of the Institute for Mathematical Behavioral Sciences at UC Irvine explored the mathematics of elections and decisions at the Montclair State Reconnect Conference. He introduced “the mathematics of voting” to show how the muscle power of mathematics and computer science can resolve many complex issues in elections. Lawrence Shepp and Martin Lindquist presented the mathematics of medical imaging at Spelman College. Modern medicine depends on CAT scanners and MRI scanners for the diagnosis of brain tumors and other diseases and on functional MRI and PET scanners for determining normal metabolism. Each of these medical technologies relies on basic and elegant mathematics and computer algorithms. The summer 2006 program will continue the interdisciplinary theme with the topic of Simple and Complex Discrete-time Population Models in Ecology and Epidemiology at Morgan State University.

Not surprisingly, the emphasis on interdisciplinarity is reflected in some of the comments from Reconnect participants. Here is an example from a 2005 participant:

The most valuable experience as a participant in Reconnect was “learning a new area of research and seeing connections between disciplines... It has given me more confidence in my abilities to do research at a publishing level.” Kimberly Jenkins, Transylvania University, Spelman 2005

X. Contributions -- Human Resource Development

A major emphasis in the project is to reach out to minority faculty and minority institutions. We expand on our efforts in this direction in the section on Outreach Activities.

The Reconnect program has already had an effect on the lives and careers of many participants. Here is a sample of feedback we recently received about this, starting with the comments from one of the lecturers.

“I was very impressed with Reconnect 2005, with the Spelman people, and especially with the teachers who signed up. They all worked hard and I would like to think they learned a lot about medical imaging.” Larry Shepp, Rutgers University, Principal Lecturer, Spelman 2005

“I have been wanting to get my feet wet in applied mathematics and I now feel that I am closer to that goal.” Ezra Halleck, New York College of Technology, Spelman 2005

“I was motivated to put a lot of energy into investigating a topic. After years of putting most of my time into teaching, it was good to reconnect to the research modality. I am inspired to continue research in some form.” Robert Bozeman, Morehouse College, Spelman 2005

“The (Reconnect) topic required revisiting many topics in higher mathematics and learning to connect them to real life applications. This workshop inspired me to attend more content-focused professional conferences and even organize others.” Sylvia Bozeman, Spelman College, Spelman 2005

“I feel prepared to investigate further the area of medical imaging. The workshop raised several interesting questions that could form the basis for further research. The expertise and enthusiasm of the speakers made this workshop an engaging experience. The program generated many stimulating discussions and ideas... The workshop has already suggested ideas that can be included in my courses

and some ideas could be used in independent studies/research projects.” Anonymous comment from exit questionnaire, Spelman 2005.

“The DIMACS conference was wonderful. I felt renewed at the end -- the part of myself that does math was reawakened. My group sent in a module, and I used significant parts of it in my online liberal arts math class. I liked the approach much better than what is in the standard textbook, and I think my students got more out of the unit the new way I presented it.” Kathleen Offenholley, Brookdale Community College, Montclair State 2005.

“I feel the Reconnect Workshop at Montclair State University last summer (2005) was very beneficial... I recently completed a successful job search. My participation in the Reconnect workshop, recent related research results, and mathematical activity with potential for undergraduate research was mentioned several times during interviews.” Japheth Wood, Chatham College, Montclair State 2005.

We continue to get feedback from participants in earlier Reconnect conferences about the ongoing impact of the program on their careers.

“The Reconnect program, and for that matter every program that I have attended at DIMACS, has been really educational. I have written several papers, become a better teacher, have gotten seminar speakers for my University, I have incorporated my new knowledge both pedagogically, and education wise into my teaching. I run the math seminars at Pace University.

Every year I worry that I will not have enough speakers. But through my contacts made at DIMACS and reconnect, I always manage to get 10-12 different speakers a year. I have been taping these seminars so that the talks and mathematics seminars are not just a one-day event. These tapes are available for anyone who wants to use them in their classroom.

I feel that I finally belong to a great math resource that goes both ways. I take from it what I need to be a better teacher, and give to it in my research and seminars. I cannot thank this program and DIMACS enough for being such a great math resource. If I have inspired my students, it is from everything that I have learned from this program.” Lorraine Lurie, Pace University, DIMACS 2003

“I have made good use of the content we learned at Rutgers. Based on my experience at Reconnect 2004, I decided to apply for a one-semester sabbatical from my mathematics teaching position to pursue additional graduate coursework in the area of Biomedical Informatics. I was accepted to the University of Pittsburgh's Center for Biomedical Informatics. I completed four graduate courses in their program during the Fall 2005 semester and am currently working on a research project. Having participated in the Reconnect gave me motivation, but more importantly, the necessary pre-requisite material needed to successfully take courses in Bioinformatics. Additionally, I have been able to use the instructional module that we developed through the Reconnect several times in classes that I teach. I am thankful for the opportunities I have had that were a direct result of attending the Reconnect.” Frederick Adkins, Indiana University of Pennsylvania, DIMACS 2004.

“I just submitted a manuscript for publication, coauthored with K.BrooksReid and H.M.Mulder, speakers at the 2003 Reconnect at IIT. Our collaboration began at the meeting. We also have a short note in the pipeline, although perhaps we'll expand it into a full paper.

Currently I have an internal grant from IIT, supporting two students, which is to study extensions of the same topic. One student is an undergraduate and has given 2 talks about his work, and will give another in a couple weeks.” Michael Pelsmajer, Illinois Institute of Technology, Lafayette 2004.

“The Reconnect program has had a positive effect on my career. Over the past 10 years, my opportunities to engage in research have been limited due to administrative responsibilities as an assistant dean and a department chair. The program helped me to direct my own efforts to spend some time on current research.” R. Bruce Mattingly, SUNY Cortland, Lafayette College 2004.