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Research Interests

In my research I aim to apply techniques of pure mathematics, specifically discrete math and combinatorics, in order to solve problems with real world applications. I use my knowledge of experimental mathematics and programming mathematics not only as a tool to explore problems and make conjectures, but also to prove results. My current research interests are in computer network modeling, graph algorithms, knowledge systems, and protein energy modeling.

Education

- Rutgers, The State University of New Jersey, New Brunswick, NJ

  PhD in Mathematics, May 2011
  Title: Experimental mathematics applied to the study of non-linear recurrences
  Advisor: Doron Zeilberger
- University of Wisconsin, Madison, WI

  B.S. in Mathematics, May 2006
  Graduated with Honors

Work Experience

Pacific Northwest National Laboratory

- Computational Mathematics Scientist, November 2012 - present
- Post Doctorate Research Associate, June 2011 - October 2012
- DHS Graduate Fellow, Summer 2008-Summer 2011

Rutgers, The State University of New Jersey

- DHS Graduate Fellow, Spring 2008 - Fall 2010
- Teaching Assistant, Fall 2007, Spring 2011
- Grader, Fall 2006 - Spring 2007

Wave Technologies

- Intern, Summer 2005, Summer 2006

University of Wisconsin - Madison

- Wisconsin Emerging Scholars, Student Assistant, Fall 2004 - Spring 2005
- Wisconsin Emerging Scholars, Tutor, Fall 2004 - Spring 2006
- Spatial Systems Laboratory, Undergraduate Researcher, September 2003-May 2004

Teaching Experience

Teaching Assistant (Rutgers University)

- Calculus II for the Mathematical and Physical Sciences, Spring 2011
- Precalculus Part I, Fall 2007

Student Assistant (University of Wisconsin - Madison)

- Calculus I, Fall 2004
- Calculus I, Spring 2005

Research Projects

- **A Multi-scale, Multi-Dimensional Graph Analytics Framework for Cyber Security:** Graph algorithms on multiscale graphs for cybersecurity applications; PNNL Directed Research and Development; Co-PI, FY13 start
- **Discrete Mathematical Foundations for Cyber Systems Analysis:** Cyber systems modeling using discrete mathematical objects; PNNL Directed Research and Development; Co-PI, FY13 start
- **Advanced Analytics Assistants:** Natural language interfaces to information networks for social systems representations; Battelle Memorial Institute with PNNL Lead; Researcher. 2011-2012
- **GRADIENT:** Graph analytics for computer network security; PNNL Directed Research and Development; Co-PI, 2011-present
- **Semantic Workflows for Signature Discovery:** Ontological integration of information sources in signature discovery workflows; PNNL Directed Research and Development; Researcher, 2011-present
- **Nanoscale Biomolecular Electrostatics:** Discrete mathematics and graph theory applied to find likely protein configurations; National Institutes of Health; Researcher, 2011-present
- **Threat Anticipation Initiative:** Knowledgebase integration and evidence association against hypotheses; Battelle Memorial Institute; Researcher, 2010-2011
- **Generalized Data-Driven Analysis and Integration:** Integrated OLAP knowledge discovery; DHS Science and Technology; Researcher, 2008-2009

Mentoring

- **Undergraduate Intern:** Wandrille Hubert, Mathematics and Electrical Engineering, Georgetown University and Columbia University. Graph theory applied to protein electrostatics, Summer 2012

Honors and Awards

- **Chosen participant** for American Mathematical Society's Mathematics Research Community in Discrete and Computational Geometry, June 2012
- **DHS Career Development Grant Fellowship**, Spring 2008 - Fall 2010
- **Violet Higgitt Frank Scholarship**, awarded May 2006
- **Chosen participant** for Summer Program for Women in Mathematics at George Washington University, Summer 2004

- **Chosen participant** for Summer Mathematics Program for Women at Carleton College, Summer 2003

Professional Activities

Professional Service

- **Co-organizer**, AMS Special Session on Discrete and Computational Geometry (Mathematics Research Communities session), January 2013
- **Founding member**, Postdoc Council, Pacific Northwest National Laboratory, July 2012 - present
- **Coach**, Marcus Whitman Elementary Math Club, October 2011 - present
- **Co-organizer**, DIMACS/CCICADA Student Workshop on Where the Mathematical and Computational Sciences Meet Society, April 2011
- **Co-organizer**, From $A = B$ to $Z = 60$, A Conference in Honor of Doron Zeilberger's 60th Birthday, May 2010
- **Co-coordinator**, DIMACS/DyDAn Seminar Series on Homeland Security, September 2008-May 2009
- **Judge**, Intel International Science and Engineering Fair Special Awards Judge for the Department of Homeland Security's University Programs, May 2008

Professional Membership

- American Mathematical Society, 2006 - 2008, October 2010 - present
- Society for Industrial and Applied Mathematics, October 2009 - present

Conferences Attended

An asterisk indicates that a talk or poster was presented at the conference.

- AMS/MAA Joint Mathematics Meetings*, San Diego, CA; January 2013
- Workshop on Algorithms for Threat Detection*, San Diego, CA; November 2012
- SIAM Annual Meeting*, Minneapolis, MN; July 2012
- AMS Mathematics Research Communities in Discrete and Computational Geometry, Snowbird, UT; June 2012
- AMS/MAA Joint Mathematics Meetings*, Boston, MA; January 2012
- AMS/MAA Joint Mathematics Meetings, New Orleans, LA; January 2011
- From A=B to Z=60: Conference in honor of Doron Zeilberger's 60th Birthday*, Rutgers University, Piscataway, NJ; May 2010
- CCICADA-wide Research Retreat, Morgan State University*, Baltimore, MD; March 2010
- AMS/MAA Joint Mathematics Meetings, San Francisco, CA; January 2010
- Statistical and Scientific Database Management Conference*, New Orleans, LA; June 2009
- AMS/MAA Joint Mathematics Meetings, Washington, DC; January 2009
- Building Bridges: A conference on mathematics and computer science in honor of László Lovász, Budapest, Hungary; August 2008
- Graduate Student Combinatorics Conference*, University if California - Davis; April 2008
- DHS University Network Summit and Student Day, Washington, DC; March 2008
- AMS Eastern Section Meeting, Rutgers University; October 2007

- AMS/MAA Joint Mathematics Meetings, New Orleans, LA; January 2007
- AMS/MAA Joint Mathematics Meetings, San Antonio, TX; January 2006
- AMS/MAA Joint Mathematics Meetings*, Atlanta, GA; January 2005

Patents

- Methods for Discovering Analyst-Significant Portions of a Multi-Dimensional Database: Patent application 2010.

Computer Skills

- Maple, Mathematica, Java, LaTeX, and R.

Publications

1. E. Hogan, N. Baker. Protein Energy Minimization Using Graph Theory, in preparation.
2. C. Joslyn, E. Hogan, A. Pogel. Ordered Set Interval Rank, in preparation.
3. E. Hogan, J. Johnson, M. Halappanavar. Graph Coarsening for Path Finding in Cybersecurity Graphs, *Proc. 8th Annual Workshop on Cyber Security and Information Intelligence Research*, 2013.
4. F. Zapata, V. Kreinovich, C. Joslyn, E. Hogan. Orders on Intervals Over Partially Ordered Sets: Extending Allen's Algebra and Interval Graph Results, to appear in *Soft Computing*
5. C. Joslyn, E. Hogan. "Intervals, Orders, and Rank", *Uncertainty modeling and analysis with intervals: Foundations, tools, applications (Dagstuhl Seminar 11371)*, v. 1:9, ed. Elishakoff IE et al., pp. 36-37, Leibniz Informatik, Dagstuhl, DE, `http://drops.dagstuhl.de/opus/volltexte/2011/3318`
6. E. Hogan, D. Zeilberger. A New Algorithm for Proving Global Asymptotic Stability of Rational Difference Equations, to appear in *Journal of Difference Equations and Applications*.
7. C. Joslyn, E. Hogan. Order Metrics for Semantic Knowledge Systems. In E.S. Corchado Rodriguez et al. (Eds.) *Hybrid Artificial Intelligence Systems 2010, Part II* (399-409). Lecture Notes in Artificial Intelligence 6077, 2010.
8. C. Joslyn, J. Burke, T. Critchlow, N. Hengartner, E. Hogan. View Discovery in OLAP Databases Through Statistical Combinatorial Optimization. In Marianne Winslett (Ed.) *Scientific and Statistical Database Management* (37-55). Lecture Notes in Computer Science, Volume 5566/2009.
9. P. Heideman, E. Hogan. A New Family of Somos-Like Recurrences, *Electronic Journal of Combinatorics*, 15(1), 2008.

Talks and Presentations

Conference Presentations

- "Visualizing semantic data through the use of partially ordered sets" Joint Mathematics Meetings, January 2012
- "An Algorithm to Prove Convergence of Sequences Produced by Rational Difference Equations" SMP Graduate Education Mentoring Program, January 2011
- "Experimental techniques applied to convergence of rational difference equations" From A=B to Z=60: Conference in Honor of Doron Zeilberger's 60th Birthday, May 2010
- "View Discovery in OLAP Databases Through Statistical Combinatorial Optimization" CCICADA Retreat Poster Session, Morgan State University, March 2010

- "Non-linear recurrences and the surprising sequences they can generate" SMP Graduate Education Mentoring Program, Joint Mathematics Meetings, January 2010
- "Somos and Somos-like Sequences: Surprising Integer Sequences" Graduate Student Combinatorics Conference, University of California - Davis, April 2008

Invited Talks

- "Applications of Graphs and Partial Orders at PNNL" SIAM Minisymposium on Applied, Computational, and Discrete Mathematics at National Laboratories and Federal Research Agencies at Joint Mathematics Meetings, January 2013
- "Distances in Partial Orders for Knowledge Discovery" Lewis & Clark College Mathematics Department Colloquium, November 2012
- "Graph-based Signature Discovery" SIAM Student Chapter Seminar at Colorado State University, October 2012
- "Graph Sparsification Methods in Cybersecurity" SIAM Annual Meeting, July 2012
- "Applied Mathematics at a National Laboratory" SMPosium, Carleton College, June 2012
- "Somos Sequences: Past and Present" New York Combinatorics Seminar, CUNY Graduate Center, March 2011
- "How Ontologies Can Be Used, and How Mathematicians Can Help" Swedish Delegation Visit, CCICADA, Rutgers University, November 2010
- "Experimental Techniques Applied to Convergence of Sequences Defined by Rational Recurrences" Graduate Student Seminar, Lehigh University, October 2010

University Seminars

- "Convergence of Rational Recurrences Using Experimental Methods", Graduate Student Combinatorics Seminar, Rutgers University, November 2010
- "Interval rank in Partially ordered sets" DHS Fellows Student-run Seminar Series, DIMACS, Rutgers University, October 2010
- "Non-linear recurrences which unexpectedly produce rational numbers" Experimental Mathematics Seminar, Rutgers University, March 2010
- "How Groebner bases can be used in combinatorics" Graduate Combinatorics Seminar, Rutgers University, February 2010
- "The Combinatorics of LEGOs" Graduate Pizza Seminar, Rutgers University, October 2009
- "Recurrences that Generate Surprising Numbers" Graduate Combinatorics Seminar, Rutgers University, October 2009
- "Planarity and Wagner's Conjecture" Graduate Combinatorics Seminar, Rutgers University, April 2009
- "The Laurent Phenomenon for Non-Linear Recurrences" Graduate Combinatorics Seminar, Rutgers University, October 2008
- "The Game of Hex and the Brouwer Fixed Point Theorem" Graduate Pizza Seminar, Rutgers University, March 2008
- "Somos and Somos-like Sequences" Graduate Combinatorics Seminar, Rutgers University, Nov. 2007.

Posters

- "Path-Finding in Cybersecurity Graphs to Detect and Defend a Pass-the-Hash Attack" Workshop on Algorithms for Threat Detection Poster Session, November 2012
- "Protein Energy Minimization Using Graph Theory" PNNL Postdoc Poster Session, July 2012
- "Hidden Combinatorics in Quadratic Recurrences" Undergraduate Student Poster Session at Joint Mathematics Meetings, Atlanta, GA, January 2005