Blair D. Sullivan

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Research Interests

Parameterized algorithms, structural graph theory, applied discrete mathematics, random graphs, parallel algorithm design, combinatorial scientific computing.

Professional Experience

Assistant Professor in Department of Computer Science, North Carolina State University, Raleigh, NC, August 2013 – present.

Research & Development Staff Member, Computer Science & Mathematics Division, Oak Ridge National Laboratory (ORNL), Oak Ridge, TN, July 2008 – August 2013.

Graduate Research Assistant, Princeton University, Princeton, NJ, September 2003 – June 2008.

Visiting Researcher, Renyi Institute, Budapest, Hungary, October 2007 – April 2008.

Graduate Student Intern, Microsoft Research Theory Group, Redmond, WA, Summer 2007.

U. S. Department of Homeland Security (DHS) Graduate Fellow Intern, Center for Engineering Science Advanced Research, ORNL, Summer 2004.

Undergraduate Researcher, Georgia Institute of Technology, Atlanta, GA, June 2001 – August 2003.

Education

Ph. D. in Mathematics, June 2008, Princeton University, Princeton, New Jersey. Thesis: *Extremal Problems in Digraphs.* Advisor: Paul D. Seymour.

M. A. in Mathematics, January 2005, Princeton University, Princeton, New Jersey. Specialized general exam topics: Algebraic Number Theory, Combinatorial Optimization, Matroid Theory.

B. S. Applied Mathematics, B. S. Computer Science *Summa Cum Laude*, minor in Economics, GPA: 4.0, May 2003, Georgia Institute of Technology, Atlanta, Georgia.

Grants Awarded

[1] Moore Investigator in Data-Driven Discovery. Principal Investigator. Gordon & Betty Moore Foundation, 2014 – 2019.

[2] PARSiNG: Parameterized Algorithms Respecting Structure in Noisy Graphs. Principal Investigator. Defense Advanced Research Projects Agency (DARPA) GRAPHS program, 2014 – present.

[3] Data Science Faculty Fellow. Principal Investigator. National Consortium for Data Science, 2014.

[4] Scalable Clustering Methods for Dynamic Health Data. co-Principal Investigator, with Alyson Wilson. North Carolina State University Research and Innovation Seed Fund, 2014.

[5] SPARTN: Sparse Projections Achieving Randomization in Tree-like Networks. Principal Investigator. DARPA GRAPHS program, 2012 – 2014.

[6] Connecting Combinatorial and Geometric Tree-Like Structure in Complex Networks. Principal Investigator. ORNL Laboratory Directed Research and Development program (LDRD) SEED Fund, 2011 – 2012.

[7] Scalable Graph Decomposition and Algorithms to Support the Analysis of Petascale Data. Principal Investigator. U.S. Department of Energy (DOE) Office of Advanced Scientific Computing Research (ASCR), 2009 – 2012.

[8] Extreme Scale Systems Center. Co-Principal Investigator for Graph Theory and Applied Mathematics, U.S. Department of Defense (DoD), 2008 – 2014.

[9] Scalable Graph Decomposition and Algorithms to Support the Analysis of Petascale Data. Oak Ridge Leadership Computing Facility (OLCF) Director's Discretion allocation - 250K hours on Jaguar, 250K hours on Smoky, March 2011.

[10] Hyperbolicity and Tree-like Structure in Networks. National Institute for Computational Science (NICS) Director's Discretion allocation - 250K hours on Nautilus, February 2012.

Publications

[1] P. Drange, M. Dregi, D. Lokshtanov, and B. D. Sullivan. On the threshold of intractability. *under review*, 2015. Pre-print available at http://arxiv.org/abs/1505.00612.

[2] A. Adcock, M. Mahoney, and B. D. Sullivan. Tree decompositions and social graphs. *under review*, 2015.

[3] A. Adcock, E. Demaine, M. Demaine, M.P. O'Brien, F. Reidl, P. Rossmanith, F. Sánchez Villaamil, and B. D. Sullivan. Zig-Zag Number Link is NP-Complete. *in press, Journal of Information Processing, January 2015*, 2015. Pre-print available at http://arxiv.org/abs/1410.5845.

[4] E. Demaine, F. Reidl, P. Rossmanith, F. Sánchez Villaamil, S. Sikdar, and B. D. Sullivan. Structural Sparsity of Complex Networks: Random Graph Models and Linear Algorithms. *under review*, 2015. Pre-print available at http://arxiv.org/abs/1406.2587.

[5] T. Goodrich, M. Farrell, N. Lemons, F. Reidl, P. Rossmanith, F. Sánchez Villaamil, and B. D. Sullivan. Hyperbolicity and Expansion of Random Intersection Graphs. *under review*, 2015. Pre-print available at http://arxiv.org/abs/1410.8196.

[6] M. P. O'Brien and B. D. Sullivan. Locally Estimating Core Numbers. *Proceedings of the 2014 IEEE International Conference on Data Mining (ICDM14)*, 2014. Pre-print available at http://arxiv.org/abs/1410.6793.

[7] R. A. Bridges, J. Collins, E. Ferragut, J. Laska, and B. D. Sullivan. Multi-Level Anomaly Detection on Streaming Graph Data. *under review*, 2015. Pre-print available at http://arxiv.org/abs/1410.4355.

[8] T. S. Humble, A. J. McCaskey, R. S. Bennink, J. J. Billings, E. F. D'Azevedo, B. D. Sullivan, C. F. Klymko, and H. Seddiqi. An Integrated Development Environment for Adiabatic Quantum Programming. *Computational Science & Discovery*, 7, 2014. Pre-print available at http://arxiv.org/abs/1309.3575.

[9] C. Klymko, B. D. Sullivan, and T. Humble. Adiabatic Quantum Programming: Minor Embedding With Hard Faults. *Quantum Information Processing*, 13(3):709–729, 2014. Pre-print available at http://arxiv.org/abs/1210.8395.

[10] A. Adcock, B. D. Sullivan, and M. Mahoney. Tree-like structure in large social and information networks. *Proceedings of the 2013 IEEE International Conference on Data Mining (ICDM13)*, 2013.

[11] A. Adcock, B. D. Sullivan, O. Hernandez, and M. Mahoney. Using OpenMP Tasking in Gromov Hyperbolicity Calculations. *Proceedings of the International Workshop on OpenMP 2013 (IWOMP), LNCS*, 2013.

[12] B. D. Sullivan et al. Integrated Network Decompositions and Dynamic programming for Graph Optimization (INDDGO). *open source software release*, 2012, 2013. http://github.com/bdsullivan/inddgo.

[13] B. D. Sullivan, D. Weerapurage, and C. Groer. Parallel Algorithms for Graph Optimization using Tree Decompositions. *Proceedings of the IEEE International Parallel and Distributed Processing Symposium (IPDPS), Workshop on Parallel Computing and Optimization (PCO13)*, 2013. Also available as ORNL-TM/2012/194.

[14] B. D. Sullivan. On a Conjecture of Andrica and Tomescu. *Journal of Integer Sequences*, 16, 2013. Pre-print available at http://arxiv.org/abs/1210.8437.

[15] C. Groer, B. D. Sullivan, and D. Weerapurage. INDDGO: Integrated Network Decompositions & Dynamic programming for Graph Optimization. Technical Report ORNL-TM/2012/176, Oak Ridge National Laboratory, 2012.

[16] C. Groer, B. D. Sullivan, and S. Poole. A Mathematical Analysis of the R-MAT Random Graph Generator. *Networks*, 58(3):159–170, 2011.

[17] P. Seymour and B. D. Sullivan. Counting Paths in Digraphs. *European Journal of Combinatorics*, 31(3):961–975, 2010. Pre-print available at http://arxiv.org/abs/1210.8424.

[18] B. D. Sullivan, C. Groer, and S. Poole. Computational Analysis of Two Graph Compression Algorithms. Technical Report ORNL/TM-2009/193, Oak Ridge National Laboratory, 2009.

[19] M. Chudnovsky, P. Seymour, and B. D. Sullivan. Cycles in Dense Digraphs. *Combinatorica*, 28(1):1–18, 2008. Pre-print available at http://arxiv.org/abs/math/0702147.

[20] M. Nathanson and B. D. Sullivan. Heights in Finite Projective Space, and a Problem on Directed Graphs. *Integers*, 8(A13), 2008. Pre-print available at http://arxiv.org/abs/math/0703418.

[21] B. D. Sullivan. A Summary of Results and Problems Related to the Caccetta-Haggkvist Conjecture. Technical Report 2006-13, American Institute of Mathematics, 2006. Pre-print available at http://arxiv.org/abs/math/0605646.

[22] V. Blair Dowling [Sullivan] and W. A. Dowling. Intellectual Property and Academia. *Journal of Business and Economics Research*, 1(4):103–109, 2003.

Honors

NC State Chancellor's Faculty Excellence Program, Data-Driven Science Cluster, May 2015 – present.

Moore Investigator in Data-Driven Discovery (2014); 1 of 14 selected from 1100.

National Consortium for Data Science Faculty Fellow (2014)

Best LDRD SEED Project Poster, Oak Ridge National Laboratory (2012)

Supplemental Performance Award, Oak Ridge National Laboratory (2009, 2011)

DHS Dissertation Grant (2006 – 2007)

DHS Graduate Fellowship (2003 – 2006)

Phi Kappa Phi Scholarship Cup, *Georgia Tech senior with most outstanding academic record* (2003)

Georgia Tech President's Scholar, *full tuition & stipend support* (1999 – 2003); Jo Baker Scholar (2003)

University System of Georgia Outstanding Scholar (2003)

Georgia Tech Outstanding Math Senior Award (2003)

J. C. Currie Outstanding Math Junior Scholarship (2001)

Professional Service

Organizing Committee, SIAM Conference on Discrete Mathematics (DM16), 2016

Organizer, Special Session, Association of Women in Mathematics Research Symposium, April 2015

Program Committee, SIAM Workshop on Network Science, 2015

Organizer, NC State Theory Seminar (`www.csc2.ncsu.edu/theoryseminar`), 2013 – present

Judge, NC State Women in Computer Science Research Symposium, 2014, 2015.

Program Committee, Society for Industrial and Applied Mathematics (SIAM) Workshop on Combinatorial Scientific Computing 2014 (CSC14), June 2014

Organizer of Research Cluster "Towards Efficient Algorithms Exploiting Graph Structure" at ICERM Semester on Network Science, Spring 2014

ORNL Women in Computing Advisory Board, 2012-2013

Organizer for mini-symposium "Treewidth: Connecting Fixed-Parameter Tractability, Graphical Models, and Sparse Linear Algebra" at SIAM Computational Science and Engineering (CSE13), 2013

Steering Committee for Graph500 Benchmark, 2010-2013

Co-organizer for mini-symposium "Anomaly Detection Methods and Applications" at SIAM Southeastern Atlantic Section Annual Meeting (SEAS13), 2013

Panelist/Moderator at National Labs Professional Development Workshop for Underrepresented Participants (NLPDev), 2012, 2013

ORNL Computer Science & Mathematics Division Awards Committee, 2012

Panelist for Math/CS Graduate Student Lunch & Learn series at Emory University, 2012

Panelist at Department of Homeland Security HS-STEM Career Pathways Conference, 2008, 2010.

Reviewer for Journal of the ACM (2011–12), Discrete Mathematics (2008–12), Combinatorics, Probability and Computing (2009–13), SIAM Journal on Discrete Mathematics (2011), DOE ASCR Applied Math Program (2009)

Teaching Experience

Instructor:

Automata, Languages and Computability (CSC 333), NC State University, Fall 2015.
Theory of Computation (CSC 707), NC State University, Fall 2014.
Automata, Languages and Computability (CSC 333), NC State University, Fall 2014.
Discrete Mathematics for Computer Scientists (CSC 226), NC State University, Spring 2014.
Introduction to Calculus & Analytic Geometry (MAT 101), Princeton University, Fall 2006.

Grader: Graph Theory (MAT 306), Princeton University, Spring 2006, Spring 2007.
Graded weekly proof-based homework sets for forty-five students.

Teaching Assistant: Calculus II (Math 1502), Georgia Institute of Technology, Fall 2001, Spring 2002.
Led recitation sections twice a week; graded homeworks and examinations.

Head Counselor: Program in Mathematics for Young Scientists, Boston University, Summer 2001.
Guided high school students in elementary number theory; graded problem sets; taught mini-course.

Mentoring

Current Ph.D. Students (NC State University):

Michael O'Brien (2013 – present)
Timothy Goodrich (2014 – present)
Andrew van der Poel (2014 – present)

Ph.D. Committees:

Sadia Sharmin, University of Bergen, August, 2014: "Practical Aspects of the Graph Parameter Boolean-width" (advisor: Fredrik Manne).
Aaron Adcock, Stanford University, June, 2014: "Characterizing, Identifying, and Using Tree-like Structure in Social and Information Networks" (advisor: Gunnar Carlsson)

Graduate Interns:

Aaron Adcock (Stanford University, 2011–2014): Computation of metrics for tree-like structure in massive real-world networks
Christine Klymko (Emory University, 2012): Graph Minor Embedding for Adiabatic Quantum Computing
Zhibin Huang (University of Georgia, 2010): Local search and computational treewidth

Undergraduates:

Yang Ho (NC State University), Summer 2015
Clayton Hobbs (NC State University), Spring 2015, Summer 2015
Nishant Rodrigues (NC State University), Summer 2015
Brandon Mork (NC State University), Spring 2015
Alex Chin (NC State University), 2013 – 2014. NCSU Undergraduate Research Grant Recipient
Matthew Farrell (Albertson College) & Timothy Goodrich (Valparaiso University) : DOE Science Undergraduate Laboratory Internships (SULI) program, Summer 2013

High School Math Thesis Students:

Megan Kelly and Neall Caughman (2012): "Comparing Methods for Dimensionality Reduction." Semifinalists in 2012 Siemens Competition in Math, Science, and Technology.
Gloria D'Azevedo (2010): "A Study of Elimination Orderings and Their Relevance to Treewidth in Graph Theory" won first place at Tennessee Junior Science & Humanities Symposium and third place in category at national JSHS competition.

Postgraduate:

Diego Galindo (2012): Layering-tree-based approaches to parallel tree decomposition
Charlotte Kotas (2012): Leveraging tree-like structure for sparse low-dimensional representations of graph data
Dinesh Weerapurage (2011 – 2012): Parallel dynamic programming algorithms for bounded treewidth graphs

Invited Presentations *(2007-present)*

[1] NetSci15, Zaragoza, ES *(June 2015)*.

[2] SIAM Workshop on Network Science, Snowbird, UT *(May 2015)*.

[3] AWM Research Symposium, Baltimore, MD *(Apr. 2015)*.

[4] Data Science Seminar, National Institute of Environmental Health Sciences (NIEHS), Research Triangle Park, NC *(Apr. 2015)*.

[5] Capital Area Theory Seminar, University of Maryland, Baltimore, MD *(Apr. 2015)*.

[6] Algorithms Seminar, Duke University, Durham, NC *(Apr. 2015)*.

[7] Princeton Program in Applied and Computational Mathematics (PACM) Colloquium, Princeton, NJ *(Feb. 2015)*.

[8] Center for Computing Sciences Seminar, Institute for Defense Analysis, Bowie, MD *(Feb. 2015)*.

[9] Computer Science Seminar, Emory University, Atlanta, GA *(Feb. 2015)*.

[10] Algorithms, Randomness, and Combinatorics (ARC) Colloquium, Georgia Tech, Atlanta, GA *(Feb. 2015)*.

[11] Special Session on Network Science, Joint Mathematics Meetings, San Antonio, TX *(Jan. 2015)*.

[12] AMS Southeastern Fall Sectional, Special Session on Recent Developments in Graph Theory and Hypergraph Theory, Greensboro, NC *(Nov. 2014)*.

[13] Atlanta Lecture Series in Combinatorics and Graph Theory, Atlanta, GA *(Nov. 2014)*.

[14] Johns Hopkins University Center for Imaging Science Seminar, Baltimore, MD *(Oct. 2014)*.

[15] RTP 180: Big Data, Research Triangle Park, NC *(Aug. 2014)*.

[16] University of Bergen Algorithms Group Seminar, Bergen, Norway *(Aug. 2014)*.

[17] RWTH Aachen Computer Science Seminar, Aachen, Germany *(Aug. 2014)*.

[18] Gordon and Betty Moore Foundation DDD Investigators Finalist Symposium, Palo Alto, CA *(July 2014)*.

[19] Los Alamos National Laboratory, CNLS Seminar, Los Alamos, NM *(June 2014)*.

[20] NCDS Data Innovation Showcase, Chapel Hill, NC *(May 2014)*.

[21] SAMSI Education and Outreach: Undergraduate Modeling Workshop, Raleigh, NC *(May 2014)*.

[22] Topology and Geometry of Networks & Discrete Metric Spaces Workshop, Institute for Mathematics and its Applications, Minneapolis, MN *(Apr. 2014)*.

[23] Tutorial at ICERM Research Cluster, Providence, RI *(Apr. 2014)*.

[24] AMS Southeastern Spring Sectional, Special Session on Graph Theory, Knoxville, TN *(Mar. 2014)*.

[25] Bertinoro Workshop on Algorithms & Graphs, Bertinoro, Italy *(Dec. 2013)*.

[26] RWTH Aachen Computer Science Seminar, Aachen, Germany *(Dec. 2013)*.

[27] SAMSI Education and Outreach: Undergraduate Workshop, Research Triangle Park, NC *(Oct. 2013)*.

[28] SAMSI Workshop on Social Network Data: Collection and Analysis, Research Triangle Park, NC *(Oct. 2013)*.

[29] Cumberland Conference 2013, Murfreesboro, TN *(May 2013)*.

[30] LANL CNLS Colloquium, Los Alamos, NM *(May 2013)*.

[31] MIT Combinatorics Seminar, Cambridge, MA *(Apr. 2013)*.

[32] Industrial Engineering Seminar, University of Tennessee, Knoxville, TN *(Apr. 2013)*.

[33] Computer Science Seminar, North Carolina State University, Raleigh, NC *(Mar. 2013)*.

[34] Georgia Tech Computational Science & Engineering (CSE) Seminar, Atlanta, GA *(Oct. 2012)*.

[35] Emory University SIAM Student Seminar, Atlanta, GA *(Oct. 2012)*.

[36] Duke University Applied Mathematics & Analysis Seminar, Durham, NC *(Oct. 2012)*.

[37] University of North Carolina at Chapel Hill Applied Mathematics Colloquium, Chapel Hill, NC *(Sept. 2012)*.

[38] ICIS Workshop: Graph and Hypergraph Problems in Computational Science, Park City, UT *(July 2012)*.

[39] Workshop on Massive Modern Data Sets (MMDS), Palo Alto, CA *(July 2012)*.

[40] Duke University Applied Mathematics Seminar, Durham, NC *(Apr. 2012)*.

[41] Large Graphs: Modeling, Algorithms, and Applications Workshop, Institute for Mathematics and its Applications, Minneapolis, MN *(Oct. 2011)*.

[42] ICIAM 2011, Combinatorial Scientific Computing Mini-Symposium, Vancouver BC *(July 2011)*.

[43] Virginia Bioinformatics Institute, Virginia Tech, Blacksburg, VA *(Sept. 2011)*.

[44] SAMSI Complex Networks Transitions Workshop, Research Triangle Park, NC *(June 2011)*.

[45] Sandia National Labs, Livermore, CA *(Nov. 2010)*.

[46] University of Georgia Computer Science Colloquium, Athens, GA *(Oct. 2010)*.

[47] SAMSI Complex Networks Opening Workshop, Research Triangle Park, NC *(Sept. 2010)*.

[48] Department of Energy ASCR AMR PI Meeting, Berkeley CA *(May 2010)*.

[49] ORNL Computer Science and Mathematics Division (CSMD) Advisory Board, Oak Ridge, TN *(June 2010)*.

[50] Rice CAAM Colloquium, Houston, TX *(Apr. 2010)*.

[51] Georgia Tech Combinatorics Seminar, Atlanta, GA *(Jan. 2010)*.

[52] University of Tennessee Mathematics Department Junior Colloquium, Knoxville, TN *(Sept. 2009)*.

[53] PROMYS 20th Reunion, Boston University, Boston, MA *(July 2009)*.

[54] AWM Workshop, AMS-MAA Joint Mathematics Meetings, Washington, D.C. *(Jan. 2009)*.

[55] Princeton-Oxford Graph Theory Workshop, Oxford University, Oxford, England *(June 2008)*.

[56] Oak Ridge National Laboratory, Oak Ridge, TN *(May 2008)*.

[57] AMS-MAA Joint Mathematics Meetings, San Diego, CA *(Jan. 2008)*.

[58] Alfred Renyi Mathematics Institute, Budapest, Hungary *(Nov. 2007)*.

[59] University of California, San Diego Combinatorics Seminar, San Diego, CA *(Oct. 2007)*.

[60] Microsoft Research Theory Group, Redmond, WA *(Oct. 2007)*.

[61] Simon Fraser University Discrete Math Seminar, Burnaby, BC *(Oct. 2007)*.

[62] Georgia Tech Graph Theory Seminar, Atlanta, GA *(Sept. 2007)*.

[63] Microsoft Research Theory Group, Redmond, WA *(Apr. 2007)*.

[64] Grad Student Combinatorics Conference, Seattle, WA *(Apr. 2007)*.

[65] 38th Southeastern International Conference on Combinatorics, Graph Theory, and Computing, Florida Atlantic University, Boca Raton, FL *(Mar. 2007)*.

[66] New York Number Theory Seminar, New York, NY *(Feb. 2007)*.

[67] Nassau Presbyterian Church Adult Education Series, Princeton, NJ *(Feb. 2007)*.

Other Conferences and Workshops

Dagstuhl Seminar "Bidimensional Structures: Algorithms, Combinatorics, & Logic" Wadern, Germany *(Mar. 2013)*

DARPA Big Data Colloquium, Arlington, VA *(Jan. 2013)*

DARPA Math Summit, Incline Village, NV *(Feb. 2012)*

Supercomputing SC11, Seattle, WA *(Nov. 2011)*

SciDAC 2010, Chattanooga, TN *(July 2010)*

SOS 14 Workshop, Savannah, GA *(Feb. 2010)*

DOE Genomics Workshop, Joint Genomics Institute, Walnut Creek, CA *(Jan. 2010)*

SIAM Annual Meeting, Denver, CO *(July 2009)*

Pacific Institute for the Mathematical Sciences Workshop on the Cycle Double Cover Conjecture, University of British Columbia, Vancouver, CA *(Aug. 2007)*

C&O@40 Conference, University of Waterloo, Waterloo, Ontario *(June 2007)*

Program for Women in Mathematics, Institute for Advanced Study, Princeton, NJ. Participant in 2003 (Mathematical Biology), 2005 (Geometry of Groups), 2006 (Zeta Functions).