# Anna Ritz

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**Research Interests:** Computational detection of structural variants (SVs) and somatic SVs; next- and third-generation sequence data analysis; improved representations of biological systems; computational reconstructions of signaling pathways.

## Education

Dec 2012 **Ph.D. Computer Science**, Brown University, Providence, RI.
*Algorithms for Identifying Structural Variants in Human Genomes.* [pdf]
Dissertation Advisor: Benjamin Raphael.

May 2008 **Sc.M. Computer Science**, Brown University, Providence, RI.
*A Minimum Description Length Approach to the Multiple Motif Problem.* [pdf]
Sc.M. Advisor: Benjamin Raphael.

Jun 2006 **B.A. Computer Science**, *Magna cum laude,* Carleton College, Northfield, MN.
Undergraduate and Research Advisor: David Musicant.
Senior Comprehensive Project: *A Language to Construct Graphical User Interfaces.* [link]
Senior Comprehensive Project Advisor: Amy Csizmar Dalal.

## Experience

Dec 2012–Present **Postdoctoral Research Associate**, Department of Computer Science, Virginia Tech.
Sponsor: T. M. Murali.

Sep 2006–Oct 2012 **Graduate Research Assistant**, Department of Computer Science, Brown University.

Jan 2012–May 2012 **Instructor**, Department of Computer Science, Brown University.

Jun 2004–Jun 2006 **Undergraduate Research Assistant**, Department of Computer Science, Carleton College.

## Honors and Awards

May 2013 **Symbolic Ph.D. Recipient** at Brown University. The symbolic degree recipient is nominated to represent all Ph.D. receipients in the presentation of degrees by the President of the University.

Jun 2008–Jun 2011 **NSF Graduate Research Fellowship Program (GRFP)** Fellow.

## Publications

### *Publications Under Review*

**Anna Ritz**, Christopher L. Poirel, Allison N. Tegge, Nicholas Sharp, Allison Powell, Kelsey Simmons, Shiv Kale, and T. M. Murali. Pathways on Demand: Automated Reconstruction of Human Signaling Networks.

**Anna Ritz**, Brendan Avent, and T. M. Murali. Signaling Hypergraphs.

### *Peer-Reviewed Publications*

**Anna Ritz**, Ali Bashir, Suzanne Sindi, David Hsu, Iman Hajirasouliha, and Benjamin J. Raphael. Characterization of Structural Variants with Single Molecule and Hybrid Sequencing Approaches. *Bioinformatics*, 2014. In press. [advanced access publisher link]

**Anna Ritz** and T. M. Murali. Pathway Analysis with Signaling Hypergraphs. Proceedings of the *Fifth ACM Conference on Bioinformatics, Computational Biology, and Health Informatics* 2014. 249–258. **Nominated for Best Paper Award.** [publisher link]

**Anna Ritz***, Allison N. Tegge*, Hyunju Kim, Christopher L. Poirel, and T. M. Murali. Signaling Hypergraphs. *Trends in Biotechnology*, 32(7), 356-362, 2014. *Joint first authors. [publisher link]

Layla Oesper, **Anna Ritz**, Sarah J. Aerni, Ryan Drebin, and Benjamin J. Raphael. Reconstructing Cancer Genome Organization. *BMC Bioinformatics* 2012. 13(Suppl 6):S10. Special Issue on the *Second Annual RECOMB Satellite Workshop on Massively Parallel Sequencing (RECOMB-seq) 2012*. [publisher link]

Ashley Stuckey, Andrew Fischer, Daniel H. Miller, Sara Hillenmeyer, Kyu K. Kim, **Anna Ritz**, Rakesh K Singh, Benjamin J Raphael, Laurent Brard and Alexander S. Brodsky. Integrated Genomics of Ovarian Xenograft Tumor Progression and Chemotherapy Response. *BMC Cancer* 2011. 11:308. [publisher link]

**Anna Ritz**, Pamela L. Paris, Michael M. Ittmann, Colin Collins, and Benjamin J. Raphael. Detection of Recurrent Rearrangement Breakpoints from Copy Number Data. *BMC Bioinformatics* 2011. 12:114. Special Issue on the *Second Annual RECOMB Satellite Workshop on Computational Cancer Biology (RECOMB-CCB) 2010*. **Highly accessed.** [publisher link]

Trevor O'Brien, **Anna Ritz**, Benjamin J. Raphael, and David H. Laidlaw. Gremlin: An Interactive Visualization Model for Analyzing Genomic Rearrangements. *IEEE Transactions on Visualization and Computer Graphics (Proceedings of the IEEE Information Visualization Conference (InfoViz) 2010)*. 16(6):918-26. [publisher link]

**Anna Ritz***, Ali Bashir*, and Benjamin J. Raphael. Structural Variation Analysis with Strobe Reads. *Bioinformatics* 2010. 26(10): 1291-1298. Special Issue on the *Conference on High Throughput Sequencing Methods and Applications (HiTSeq) 2010*. *Joint first authors. [publisher link]

Deborah S Gross, Robert Atlas, Jeffrey Rzeszotarski, Emma Turetsky, Janara Christensen, Sami Benzaid, Jamie Olson, Thomas Smith, Leah Steinberg, Jon Sulman, **Anna Ritz**, Benjamin Anderson, Catherine Nelson, David R Musicant, Lei Chen, David C Snyder, James J Schauer. ENCHILADA: Environmental Chemistry through Intelligent Atmospheric Data Analysis. *Environmental Modelling & Software* 2010. 25(6):760-769. [publisher link]

Vinh Nguyen, Lulu Cao, Jonathan T. Lin, Norris Hung, **Anna Ritz**, Kebing Yu, Radu Jianu, Samuel P. Ulin, Benjamin J. Raphael, David H. Laidlaw, Laurent Brossay, and Arthur R. Salomon. A New Approach for Quantitative Phosphoproteomic Dissection of Signaling Pathways Applied to T Cell Receptor Activation. *Molecular and Cellular Proteomics* 2009. 8: 2418-2431. [publisher link]

**Anna Ritz**, Gregory Shakhnarovich, Arthur R. Salomon, and Benjamin J. Raphael. Discovery of Phosphorylation Motif Mixtures in Phosphoproteomics Data. *Bioinformatics* 2009. 25(1):14-21. [publisher link]

Lulu Cao, Kebing Yu, Cindy Banh, Vinh Nguyen, **Anna Ritz**, Benjamin J. Raphael, Yuko Kawakami, Toshiaki Kawakami, and Arthur R. Salomon, Quantitative Time-Resolved Phosphoproteomic Analysis of Mast Cell Signaling. *Journal of Immunology* 2007. 179: 5864-5876. [publisher link]

Benjamin J. Anderson, Deborah S. Gross, David R. Musicant, **Anna M. Ritz**, Thomas G. Smith, and Leah E. Steinberg. Adapting K-Medians to Generate Normalized Cluster Centers. *Proceedings of the Sixth SIAM International Conference on Data Mining (SDM)* 2006. pp165-175. [pdf]

### *Other Publications*

**Anna Ritz**. Algorithms for Identifying Structural Variants in Human Genomes. *Ph.D. Dissertation*, Brown University, 2012. [pdf]

**Anna Ritz**. A Minimum Description Length Approach to the Multiple Motif Problem. *Sc.M. Thesis*, Brown University, 2008. [pdf]

Benjamin J. Anderson, David R. Musicant, **Anna M. Ritz**, Andrew Ault, Deborah S. Gross, Melanie Yuen, Markus Gaelli. User-Friendly Clustering for Atmospheric Data Analysis. *Technical Report* 2005a, Carleton College, 2005. [pdf]

## Presentations

### *Invited Presentations*

Signaling Pathway Analysis: from Graphs to Hypergraphs. Reed College, December 2014.

Signaling Hypergraphs. University of Arizona, November 2014.

Signaling Hypergraphs. Virginia Tech, October 2014.

Computable Representations and Automated Construction of Signaling Pathways. Carleton College, October 2013.

Improving Structural Variation Analysis with Next-Generation DNA Sequencing Data. *Cambridge Healthtech Institute's Fifth Annual Next-Generation Sequencing Data Analysis Conference*, August 2012.

Algorithms for Identifying Structural Variants in Human Genomes. University of Virginia, August 2012.

Algorithms for Identifying Structural Variants in Human Genomes. Mount Sinai School of Medicine, August 2012.

Algorithms for Identifying Structural Variants in Human Genomes. Simon Fraser University, July 2012.

Algorithms for Identifying Structural Variants in Human Genomes. Virginia Tech, July 2012.

### *Conference and Workshop Presentations*

**Anna Ritz**, Christopher L. Poirel, Allison N. Tegge, Nicholas Sharp, Allison Powell, Kelsey Simmons, Shiv Kale, and T. M. Murali. Pathways on Demand: Automated Reconstruction of Human Signaling Networks. *Seventh Annual RECOMB/ISCB Conference on Regulatory and Systems Genomics, with DREAM Challenges and Cytoscape Workshops*, November 2014.

**Anna Ritz** and T. M. Murali. Pathway Analysis with Signaling Hypergraphs. *Fifth ACM Conference on Bioinformatics, Computational Biology, and Health Informatics (ACM-BCB)*, September 2014.

Craig Estep, Jaeil Kim, **Anna Ritz**, and T. M. Murali. GraphSpace: Sharing and Collaborating through Networks on the Web. Poster presentation. *Fifth ACM Conference on Bioinformatics, Computational Biology, and Health Informatics (ACM-BCB)*, September 2014.

**Anna Ritz**, Ali Bashir, Suzanne Sindi, David Hsu, Iman Hajirasouliha, and Benjamin J. Raphael. Characterization of Complex Structural Variants with Single Molecule and Hybrid Sequencing Approaches. *Conference on High Throughput Sequencing Algorithms & Applications (HiTSeq 2014)*, a special interest group of *ISMB*, July 2014.

**Anna Ritz** and T. M. Murali. Signaling Hypergraphs for Pathway Reconstruction. Poster presentation. *Network Biology (NetBio)*, July 2014. **Took 2nd place in the poster competition.**

Christopher L. Poirel, **Anna Ritz**, Hyunju Kim, Allison N. Tegge, and T. M. Murali. Automated Reconstruction of Signaling Pathways. Poster presentation. *International Conference on Computational Cell Biology (ICCB)*, August 2013.

**Anna Ritz**, Suzanne Sindi, Ali Bashir, and Benjamin J. Raphael. A Probabilistic Method for Structural Variant Predictions from Strobe Sequencing Data. Poster presentation. *16th Annual International Conference on Research in Computational Molecular Biology (RECOMB)* and *Second Annual RECOMB Satellite Workshop on Massively Parallel Sequencing (RECOMB-seq)*, April 2012.

**Anna Ritz**. Algorithms for Identifying Structural Variants in Human Genomes. *Grace Hopper Celebration for Women in Computing*, November 2011.

**Anna Ritz**, Ali Bashir, Suzanne Sindi, and Benjamin J. Raphael. Algorithms for Resequencing and Assembly using Strobe Sequencing Data. *Cold Spring Harbor Personal Genomes Meeting*, September 2010. (Benjamin Raphael gave the presentation.)

**Anna Ritz**, Ali Bashir, and Benjamin J. Raphael. Structural Variation Analysis with Strobe Reads. *Conference on High Throughput Sequencing Analysis and Algorithms (HiTSeq)*, July 2010.

**Anna Ritz**, Ali Bashir, and Benjamin J. Raphael. Structural Variation Analysis with Strobe Reads. Poster presentation. *18th Annual International Conference on Intelligent Systems for Molecular Biology (ISMB)*, July 2010.

**Anna Ritz**, Pamela L. Paris, Michael M. Ittmann, Colin Collins, and Benjamin J. Raphael. Detection of Recurrent Rearrangment Breakpoints from Copy Number Data. *Second Annual RECOMB Satellite Workshop on Computational Cancer Biology (RECOMB-CCB)*, June 2010.

**Anna Ritz**, Gregory Shakhnarovich, Arthur R. Salomon, and Benjamin J. Raphael. A Minimum Description Length Approach to Multiple Motif Finding. Poster presentation. *Workshop for Women in Machine Learning (WiML)*, October 2007.

Benjamin J. Anderson, Deborah S. Gross, David R. Musicant, **Anna M. Ritz**, Thomas G. Smith, and Leah E. Steinberg. Adapting K-Medians to Generate Normalized Cluster Centers. *Sixth SIAM International Conference on Data Mining (SDM)*, April 2006.

**Anna Ritz**. The Manhattan Normalization Algorithm. Poster presentation. *ACM Special Interest Group on Computer Science Education (SIGCSE) Symposium*, February 2006.

### *Other Presentations*

**Anna Ritz**, Lulu Cao, Kebing Yu, Arthur Salomon, and Benjamin Raphael. Temporal Clustering of Protein Phosphorylation Networks. Poster presentation. Brown University 2007.

**Anna Ritz**. Broadening Enchilada: Generalizing the Particle Abstractions and Importation Devices. Poster presentation. Carleton College, 2006.

**Anna Ritz**. Clustering Algorithms: A New Look at Mass Spectra. Poster presentation. Carleton College, 2004.

## Teaching

### *Courses*

Spring 2012 **Introduction to Computation for the Humanities and Social Sciences** (CS0931). Brown University. [course website] (Course evaluations are available upon request.)
**Course Description:** CS0931 is an introductory computer science course aimed at non-computer science majors. The course provides students with the tools necessary to pose and solve non-trivial computational problems. 30 students took the class, including two freshmen, six sophomores, seven juniors, and 15 seniors.

### *Guest Lectures*

Spring 2014 **Hypergraph Algorithms and Applications** (CS6824), Virginia Tech.
Gave two lectures on signaling hypergraph theory.

Spring 2014 **Data and Algorithm Analysis** (CS4014), Virginia Tech.
Gave three lectures on greedy scheduling algorithms and greedy graph algorithms.

Fall 2013 **Computational Thinking** (CS6604), Virginia Tech.
Gave one lecture on my experiences teaching the Brown University course CS0931.

Fall 2011 **Introduction to Computation for the Humanities and Social Sciences** (CS0931), Brown University.
Gave one lecture on introduction to Python programming.

Fall 2011 **Topics in Computational Biology: Genomes, Networks, and Cancer** (CSCI2950-C), Brown University. Gave one lecture on structural variant detection.

## Mentoring

May 2014–Present **Nicholas Sharp**, undergraduate student, Virginia Tech.
*Project:* Algorithms for signaling pathway analysis in human genomes.

May 2014–Present **Brendan Avent**, undergraduate student, Virginia Tech.
*Project:* Developing a hypergraph algorithms library in Python; signaling hypergraph algorithms.

Sep 2014–Present **Divit Singh**, graduate student, Virginia Tech.
*Project:* GraphSpace, web-based network visualization and collaboration tool.

Jan 2013–Jun 2014 **Amy Olex**, graduate student, Virginia Tech.
*Project:* Algorithms for signaling pathway analysis in bioengineered liver tissues.

May 2014–Jun 2014 **Craig Estep**, graduate student, Virginia Tech.
*Project:* GraphSpace, web-based network visualization and collaboration tool.

## Professional Organizations

2014–Present ACM Special Interest Group in Bioinformatics, Computational Biology and Biomedical Informatics (SIGBio).

2012–Present ACM Special Interest Group in Computer Science Education (SIGSCE).

2011–Present Association for Computing Machinery (ACM).

2010–Present International Society of Computational Biology (ISCB).

## Service

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| Nov 2014 | **National Center for Women and Information Technology (NCWIT) Reviewer for the Award for Aspirations in Computing**. I will be reviewing applications for the Aspirations award for high school girls in computing. |
| Sep 2013–Present | **Association for Women in Computing (AWC) Member**, Virginia Tech. The AWC chapter at Virginia Tech aims to promote women in computing by providing a community for women in computer science and related fields. I have served on panels, attended guest lectures, and helped organize events with local high schools and middle schools. |
| Sep 2013–Jan 2014 | **Association for Women in Computing (AWC) Advisor**, Virginia Tech. I served as the interim faculty advisor while the faculty advisor, Dr. Deborah Tatar, was on sabbatical. |
| Nov 2011–Jan 2012 | **PhD Admissions Committee Member**, Brown University. I was selected to be on the first PhD admissions committee that allowed PhD candidates to review applications. |
| Jun 2009–Jun 2011 | **Family Days Coordinator**, International Institute of Rhode Island. I organized a day camp for refugee children and their families in the Providence area. I led a robotics session, where families could guide Roombas through a maze with a wii controller. |
| Jun 2008–Jun 2009 | **Speaker at Artemis**, Brown University. Artemis is a day camp for entering 9th grade girls organized by Brown undergraduates. I gave talks on pattern finding and computational biology. |
| Dec 2007–Feb 2008 | **Faculty Search Student Organizer**, Brown University. I served as a student member on the faculty search committee, particularly for candidates in the Center for Computational Molecular Biology (CCMB). I organized student meetings with each candidate and summarized the graduate student opinion for the faculty search committee. |
| Sep 2007 | **Graduate Orientation Organizer**, Brown University. I organized and ran graduate orientation the week before school began, arranging faculty speakers, meals, and other social events. |
| Sep 2007–Dec 2012 | **Women in Computer Science (WiCS) Member**, Brown University. The Brown chapter of WiCS included both undergraduate and graduate women in computing. I was both a mentee (2007-2009) and a mentor (2009-2012) in the WiCS mentoring program, I served on panels about applying for graduate school, and I helped organize social events. |
| Sept 2005–June 2006 | **Student Advisor**, Carleton College. |

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