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RESEARCH

- **Mathematical Systems Theory:** Hypergraph analytics and high-order networks; computational topology; order, lattice, and hierarchy theory; multidimensional graphs and databases; interval analysis; multi-relational networks.
- **Semantic Technology:** Mathematical analysis of semantic systems; high performance semantic graph databases; ontology analysis; ontology integration.
- **Generalized Information Theory:** Uncertainty quantification, possibility theory, Dempster-Shafer evidence theory.
- **Computational Biology:** Bio-informatics, bio-ontologies, biological semiotics.
- **Systems Science and Cybernetics:** Complex systems, simulation theory.
- **Cybernetic Philosophy:** Computational semiotics, semiotic modeling, evolutionary theory.

Applications in cyber analytics, computational proteomics, computational metabolomics and combinatorial chemistry, decision support, reliability analysis, blockchain and cryptocurrency, law enforcement, mass spectrometry, and nuclear safeguards.

EDUCATION

- **PhD 1994 in Systems Science, SUNY at Binghamton**
  Dissertation: *Possibilistic Processes for Complex Systems Modeling*, **Advisor:** George Klir
- **MS 1989 in Systems Science, SUNY at Binghamton**
- **BA 1985 in Mathematics and Cognitive Science, Oberlin College**
  High Honors: Cybernetics and Cognitive Science.
  Systems Theory, Semiotics, Linguistics, Philosophy, Artificial Intelligence; minor in Religion.

CURRENT POSITIONS

- **Pacific Northwest National Laboratory, National Security Directorate, Seattle, Washington**
  Chief Scientist for Knowledge Sciences
  Principal investigator, line manager, and technical leader: supervisory responsibility for on average 15 staff scientists and research associates, management responsibility for on average $2.0M annual research budget; thought leader for applied data science research; liaison with Laboratory leadership, and multiple academic, government, research, and corporate partners.
- **Binghamton University (SUNY), Binghamton, New York**
  Visiting Professor of Systems Science
- **Portland State University, Portland, Oregon**
  Adjunct Professor of Systems Science

PAST RESEARCH POSITIONS

- **Team Leader, Pacific Northwest National Laboratory, 2021-2023**
  Mathematics of Data Science team, Mathematics, Statistics, and Data Science (MSDS) Group, Artificial Intelligence and Data Analysis Division. Supervisory and managerial responsibility for team of research scientists, postdocs, and students.
- **Team Leader, Los Alamos National Laboratory, 2002-2007**
  Knowledge and Information Systems Science team, Information Sciences Group (CCS-3), Computer, Computational, and Statistical Sciences Division. Technical, supervisory, and budgetary managerial responsibility for team of research scientists, postdocs, and students.
- **Visiting Faculty, University of New Mexico, Civil Engineering Department, 2002-2007**
- **Acting Team Leader, Los Alamos National Laboratory, 2000-2002**
  Distributed Knowledge Systems and Modeling; Modeling, Algorithms, and Informatics Group (CCS-3). Research leadership in knowledge systems, bioinformatics, data mining, and agent-based modeling.
- **Member of the Technical Staff, Los Alamos National Laboratory, 1998-1999**
  Research and development in distributed knowledge systems, data mining applications, and agent-based modeling of sociotechnical systems.
- **Postdoctoral Research Associate, Los Alamos National Laboratory, 1996-1998**
  Data mining; fraud detection; multidimensional knowledge discovery; generalized information theory. Supervisors: Judith Hochberg, Chris Barnes.
- **NSF Postdoctoral Research Associate, NASA Goddard Space Flight Center, 1994-1996**
  Qualitative modeling, possibilistic modeling; spacecraft diagnostics and trend analysis; Discrete EVent Systems (DEVS) Modeling. Supervisor: Walter Truszkowski.
- **Graduate Fellow, NASA Goddard Space Flight Center, 1991-1994**
  Graduate Fellowship in support of dissertation research: possibilistic qualitative modeling, model-based diagnosis of spacecraft systems.

TEACHING APPOINTMENTS AND EDUCATIONAL ACTIVITIES

- **Independent Study, Binghamton University (SUNY), Fall 2023**
  Supervised "Topics in High Order Discrete Structures".
- **Independent Study, Binghamton University (SUNY), Spring 2023**
  Designed and taught "Introduction to Computational Discrete Mathematics".
- **Mathematics Research Community, AMS/NSF, 2022**
  Co-organizer, "Models and Methods for Sparse (Hyper)Network Science",
  https://www.ams.org/programs/research-communities/2022MRC-HyperNet.
- **Mentor, Mathematics, University of Washington, 2020**
  Designed and led Washington Experimental Mathematics Laboratory (WXML) project "Generalized Linear Algebra Over Tensors" for mixed graduate/undergraduate program.
- **Instructor, Computer Science, University of New Mexico, Los Alamos, 1997**
  Instructor for "Introduction to UNIX" and "Advanced UNIX".
- **Instructor, Southern Maine Technical College, South Portland, Maine, Spring 1993**
  Designed and taught "Programming in ANSI C".
- **Instructor, AGS Information Services, Endwell, New York, 1990**
  Instructed corporate programming staff in the ANSI C programming language.
- **Instructor and Teaching Assistant, SUNY at Binghamton, 1987-1991:**
  - **Continuing Education, Course Design and Instruction:** ANSI C Programming.
  - **Systems Science, Instructor:** Fundamentals of Mathematics, Intro to Systems Science.
  - **Systems Science, Teaching Assistant:** AI; Information Systems Design; Inductive Modelling Methodologies; Systems Optimization; Discrete Structures; microcomputer support.

ADVISING

PhD STUDENT SUPERVISION

- **PhD Advisor:** Kevin Stoltz, Binghamton University (SUNY), Systems Science, 2022-present.

POSTDOCTORAL SUPERVISION

- **Postdoctoral Supervisor:** Dr. Audun Myers, Michigan State University, Mechanical Engineering. Zigzag persistence of temporal hypergraphs, 2021-2023.
- **Postdoctoral Supervisor:** Dr. Emilie Purvine, Mathematics Department, Rutgers University. Order theory, information theoretical methods of knowledge discovery in OLAP databases, 2011-2012.
- **Postdoctoral Supervisor:** Dr. Sinan al-Saffar, U NM. Threat Anticipation Initiative, 2009-2010.
- **Supervisor, Director of Central Intelligence Postdoctoral Fellowship:** Dr. Chris Orum, "Semantic Interoperability Technologies in Security Organizations", Trusted Information Sharing Program, 2005-2007.

GRADUATE COMMITTEE MEMBERSHIP

- **PhD Committee:** Marcus Harris, *Bayesian Networks and Reconstructability Analysis Models of the Northest Power Grid*, Systems Science, Portland State University, 2017-2022.
- **External PhD Committee Member:** Bartosz Pankratz, *Community Detection in Complex Networks: Synthetic Models and Algorithms Supported By Node Embeddings*, Toronto Metropolitan University, Mathematical Modeling and Methods, Toronto, 2022.
- **PhD Committee (alternate):** Sergio Jurado, *Hybrid Methodologies for Electricity Load Forecasting*, Universitat Poliecnica de Catalunya, Barcelona, 2021.
- **PhD Committee:** Sunil Donald, *The Development of Empirical Possibility Distributions in Risk Analysis*, Civil Engineering, University of New Mexico, 2003.
- **PhD Committee:** Kari Sentz, Systems Science, Binghamton University, 2002-2003.
- **MS Committee:** Gregory Chavez, *Optimization of Possibility Distribution Algorithms*, Department of Civil Engineering, University of New Mexico, 2002.
- **PhD Committee:** Johan Bollen, *A Cognitive Model of Adaptive Web Design and Navigation*, Department of Psychology, Free University of Brussels, 2001.
- **MS Committee:** Thomas Prang, *Unsupervised Data Mining in Nominally Supported Databases*, Department of Systems Science and Industrial Engineering, Binghamton University, 1998.

STUDENT SUPERVISION

- **Student Supervision:** Robert Green, Albany University, Mathematics. 2021-present.
- **Student Supervisor:** Elizabeth Sprangel, Iowa State University, Mathematics. Directed hypergraph analytics and temporal order merging, 2021-2022.
- **Student Supervisor:** Audun Myers, Michigan State University, Mechanical Engineering. Zigzag persistence of temporal hypergraphs, 2021-present.
- **Student Supervisor:** Nicholas Landry, University of Colorado, Boulder. Hypergraph contagion modeling in HyperNetX. 2021.
- **Student Supervisor:** Adam Brown, Mathematics, University of Utah. Topolgical sheaf models for multi-sensor integration. 2018.
- **Student Supervisor:** Stephen Ranshous, Computer Science, North Carolina State University. Directed hypergraph models of cryptocurrency transaction networks. 2017.
- **Student Supervision:** Sinan Aksoy, Mathematics, University of California at San Diego. Hypergraph extensions to network science. 2016.
- **Student Supervision:** Brett Jefferson, Mathematical Psychology, Indiana University. Topological interpretations of hypergraph-structured data sets. 2016.
- **DHS Research Fellow:** Emilie Purvine, Mathematics Department, Rutgers University. Order theory, information theoretical methods of knowledge discovery in OLAP databases, 2008-2010.

- **Student Supervision:** Los Alamos National Laboratory, 1996-2007, instructed, supervised, and advised multiple graduate and undergraduate students on research and software systems development

BUSINESS EXPERIENCE

- **Software Consultant:** ABB Environmental, Portland, Maine, Summer 1994.
- **Computer Consultant:** Binghamton, New York, 1987-1994.
  Small business information systems design and development.
- **Computer Manager:** Pryme-Line Distributors, Binghamton, New York, 1987-1991.
- **Software Engineer:** Computer Consoles Inc., Reston, Virginia, 1986-1987.
- **Systems Analyst:** Contractors Managment Systems, Reston, Virginia, 1979-1986.

HONORS AND AWARDS

- **Outstanding Performance Award:** For leading hypergraph visualization capability development for USG research sponsor, Pacific Northwest National Lab, 2021.
- **Author of the Year Nominations:** National Security Directorate, Pacific Northwest National Laboratory, 2013, 2017.
- **First Distinguished Lecture in Data Science:** School of Electrical Engineering and Computer Science and the Mathematics, Washington State University, Pullman WA, 2015.
- **NSF Earth Cube Fieldtrip:** Selected to be a participant in the Earth-Centered Communication for Cyberinfrastructure Field Trip, 2015.
- **Outstanding Performance Award:** For leading the Discovery 2020 Short Course on Semantic Data Analysis, Pacific Northwest National Lab, 2013.
- **Senior Membership:** Association for Computing Machinery, elevated 2012.
- **Runner Up Winning Team, Billion Triple Challenge:** Leader of 2010 Semantic Web Challenge submission, International Semantic Web Conference, Shanghai.
- **Nomination, Best Paper Award:** 2004 Intelligent Systems for Molecular Biology Conference (ISMB 04), "The Gene Ontology Categorizer", with SM Mniszewski, AG Fulmer, and GH Heaton
- **Distinguished Performance Award:** Large Team Award for IRS Fraud Detection Project, Los Alamos National Laboratory, September 1997.
- **National Academy of Sciences Postdoctoral Research Awards:**
  - **NASA Goddard Space Flight Center** *Possibilistic Qualitative Model-Based Diagnosis and Trend Analysis of Spacecraft Systems*, Contract # NASW 4352, 1994-1996.
  - **NIST Statistical Engineering Laboratory** *Possibilistic Representations of Measurement Combination Problems*, awarded simultaneously, declined.
- **Graduate Student Researchers Program Fellowship:** NASA Goddard Space Flight Center, 1991-1994. Advisor: Walter Truszkowski.
- **Dissertation Year Fellowship:** SUNY at Binghamton, 1991.
- **Vickers Memorial Award:** International Society for the Systems Sciences, 1991; Member, Vickers Memorial Honorary Society, Vickers Award Selection Committee.
- **Conference Scholarship:** Gordon Research Conference on Control and Communications in Complex Systems, 1990.
- **High Honors:** Studies in Systems Science and Cognitive Science, Oberlin College, 1985.
- **Independent Major:** Cognitive Science, Oberlin College, 1983-1985.

AFFILIATIONS

- Association for Computing Machinery (ACM, Senior Member)
- American Mathematical Society (AMS)
- American Society for Cybernetics (ASC)

FUNDING HISTORY AND RESEARCH EFFORTS

- **Advanced Data Analysis for Proliferation Detection, the Next Generation (ADAPD-TNG):** US Department of Energy, 2023-present.
- **Multi-Source Heterogeneous Information in Knowledgebases (KBase):** US Government Sponsor, PI. 2021-present.
- **Topological Data Analysis for Cyber Analytics:** US Government Sponsor, 2021-present.
- **Principia Cybernetica Project:** Founder and Member of the Editorial Board for this project in the collaborative development of a distributed hypertext corpus for evolutionary theory and cybernetic philosophy, `http://pcp.vub.ac.be`, 1989–present.
- **Identification of Molecular Samples via Relational Hypergraph and Topological Models of Multi-Dimensional Mass Spectral Data (Chyper)**: Pacific Northwest National Lab, Directed Research and Development, PI. 2021-2023.
- **Topological Analysis of Machine Learning Models (BLACKTOP):** US Government Sponsor, 2021-2023.
- **Hyperthesis: Topological Hypothesis Management in a Hypergraph Knowledgebase**: DARPA/I2O/Active Interpretation of Disparate Alternatives (AIDA), PI. Effort with Georgetown and American Universities. 2018-2022.
- **S&T Tech Futures**: US Special Operations Command (USSOCOM). Hypergraph visualization methods for multicriteria decision making. 2021.
- **Hypergraph Cyber Analytics:** Department of Homeland Security. Hypernetwork science methods for DNS data analysis. 2021.
- **Causal Inference and Machine Learning Methods for Analysis of Security Constraints in Security Constrained Unit Commitment:** Pacific Northwest National Lab, Directed Research and Development. 2019-2021.
- **Hypernetx:** US Government Sponsor, PI. Hypergraph analytics methods, libraries, and visualization. 2018-2021.
- **Detecting and Predicting Risk From Unknown Biological Threats Through Open-source Data Fusion:** Pacific Northwest National Lab, Directed Research and Development. Hypergraph analytics of computational biology data. 2018-2021.
- **Human Movement Simulation for Automated Contact Tracing Validation and Infection Front Prediction:** Pacific Northwest National Lab, Directed Research and Development. PI. Effort with MIT Lincoln Labs, NSA, and American University. 2020.
- **Hybrid Hierarchical Data:** US Government Sponsor, PI. High performance hypergraph analytics methods and software libraries. 2018-2020.
- **Export Control Multilateral Project:** DOE/NNSA/NA-24, PI. Distributed cryptographic ledgers for export control processes. 2017-2020.
- **Data Sculptor Linked Data:** Air Force Research Laboratory (AFRL). Performance characteristics and SPARQL optimization of triple stores. 2019-2020.
- **DROWHUNT: Finding Rare Events in Cyber:** Pacific Northwest National Lab, Directed Research and Development. Functional programming and categorical methods for integrated content mining. 2018-2019.
- **Exploring the Potential Application of Blockchain Technologies to International Safeguards:** DOE/NNSA/NA-24. Distributed cryptographic ledgers for nuclear regulatory compliance. 2016-2020.
- **Topological Information Fusion:** US Government Sponsor, PI. Sensor fusion using topological sheaves. 2018-2019.

- **Abstract Hypergraph Machine:** US Government Sponsor, PI. High performance hypergraph analytics libraries. 2017-2018.
- **Super Identity for Non-Person Entities:** Department of Homeland Security, Science and Technology. Information integration for ID management. 2017-2018.
- **Performance Modeling on Property Graphs:** US Government Sponsor. Performance modeling of labeled graph algorithms on massive graph databases. 2016-2017.
- **Topological Data Modeling: Advanced Analytics Program:** Defense Threat Reduction Agency (DTRA), PI. Topological methods for heterogeneous information integration. 2015-2017.
- **Conglomeration of Heterogeneous Content Using Local Topology (CHCLT):** DARPA Defense Science Office (DSO)/Simplifying Complexity in Scientific Discovery (SIMPLEX). PNNL PI. Sheaf-theoretical heterogeneous information integration. 2015-2017.
- **Scalable Modeling of Network Flows for US-CERT:** DHS/S&T. Information theoretical analysis of cyber network flows. 2015-2017.
- **Digital Currency Graph Forensics to Detect Proliferation Finance Patterns:** Pacific Northwest National Lab, Directed Research and Development. Technical lead and PI. Graph mining digital currency graphs for money laundering patterns. 2014-2017.
- **Topological Analysis for Graph Systems:** Pacific Northwest National Lab, Directed Research and Development. Topological modeling of cyber graph systems. 2014-2017.
- **Topological Data Modeling: High Performance Analytics of Complex Cyber Data:** US Government Sponsor, PI. Computational scaling of topological data models. 2015-2017.
- **Enabling Exploratory Graph Analytics:** US Government Sponsor. Languages and visual interaction methods for massive semantic graphs. 2015-2016.
- **Topological Semantic Sensor Integration:** DARPA Information Integration Office (I2O), PI. Topological modeling of discrete sensor systems. 2014-2015.
- **Semantic Databases for High Performance Platforms:** US Government Sponsor, PI. Semantic graph databases and analysis on massive multi-threaded high performance architectures. 2010-2015.
- **Discrete Mathematical Foundations for Cybersecurity:** Pacific Northwest National Laboratory, Directed Research and Development, PI. Network science for foundational modeling of cyber systems. 2013-2014.
- **Semantic Workflows for Signature Discovery:** Pacific Northwest National Laboratory, Directed Research and Development, PI. Ontological integration of information sources in signature discovery workflows. 2011-2013.
- **Advanced Analytics Assistants:** Battelle Memorial Institute, PNNL PI, Tech Lead. Natural language interfaces to information networks for social systems representations. 2011-2012.
- **Ontology Analytics:** USG Special Programs Sponsor, PI. Metrics for ontology analysis. 2009-2012.
- **Semantic Driven Knowledge Discovery and Integration:** Dept of Energy, Office of Biological and Environmental Research. Semantic technologies for systems biology knowledgebase. 2010-2011.
- **Nonproliferation Ontologies:** Dept of Energy, National Nuclear Security Administration, Office of Simulations, Algorithms, and Modeling. Ontology development for model integration. 2009-2011.
- **Threat Anticipation Initiative:** Battelle Memorial Institute, PNNL Lead, PNNL Tech Lead, Research Thrust Lead, Knowledgebase Thrust Lead, Cruller Pilot Lead. Knowledgebase integration and evidence association against hypotheses. 2007-2011.
- **Radiation Portal Monitoring Program (RPMP):** DHS, Customs and Border Protection, task lead for knowledge discovery. View discovery in multidimensional databases. 2008-2009.
- **Generalized Data-Driven Analysis and Integration:** Department of Homeland Security, Science and Technology. LANL PI, tech lead. 2005-2009.
- **Host-Pathogen Interactions (Pathomics) in Avian Influenza:** Los Alamos National Laboratory Directed Research and Development. Ontological protein function annotatoin. 2006-2007.
- **Ontologically Enabled Semantic Network Databases:** Department of Homeland Security, Science and Technology, LANL PI. Knowledge extraction, ontology management, and machine learning

technology for semantic networks. 2005–2007.

- **Theoretical and Computational Pathomics:** Los Alamos National Program Development. Knowledge systems technologies for analysis and management of host-pathogen interactions and social effects of infectious disease, 2004–2007.
- **Protein Function Inference:** Los Alamos National Laboratory Directed Research and Development. Mathematical measures in spaces of bio-ontological function. 2002–2006.
- **Epistemic Uncertainty Modeling:** Department of Energy, Accelerated Strategic Computing Initiative. LANL PI. Random set and probability bounds methods for risk analysis simulation verification and validation. 2000–2006.
- **Integrated Knowledge Engine (IKE):** USSTRATCOM. Bayseian networks and domain modeling for horizontal integration. 2004–2005.
- **Generalized Uncertainty Quantification for Engineering Modeling:** Los Alamos National Laboratory, ASCI Verification and Validation. 2003-2005.
- **Critical Infrastructure Protection/Decision Support System:** Department of Homeland Security, Science and Technology. Qualitative modeling and uncertainty quantification. 2003–2004.
- **Bio-Ontology Development:** DARPA, LANL PI. Exploratory program development. 2004.
- **LSI Study Group for Discovery, REAsoning and Modelling of Knowledge Applied to GEnomics (DREAMKAGE):** Engineering and Physical Sciences Research Council, UK. 2003-2004.
- **Cellular Pathway Discovery Through Natural Language Knowledge Systems:** Cooperative Research And Development Agreement on Knowledge Management, Proctor & Gamble Corporation, PI for Knowledge Systems. 2002–2004.
- **Significance and Generality in Ontologically Structured Lexical Databases:** Los Alamos National Laboratory Directed Research and Development, PI. 2002–2003.
- **Knowledge Discovery and Dissemination (KDD):** Los Alamos National Laboratory, PI for Computer Science Division. 2002–2003.
- **Active Recommendation Systems for a Library Without Walls:** Los Alamos National Laboratory Research Library. Adaptive semantic information systems for recommendation in computer-human interactive library systems. 1999–2003.
- **Advanced Knowledge Integration In Assessing Terrorist Threats:** Los Alamos National Laboratory Directed Research and Development, PI for Computer Science. Formal concept analysis in analyzing relational data. 2002.
- **Knowldege Management:** Cooperative Research And Development Agreement on Knowledge Management, Xerox Corporation, PI. 2000–2001.
- **Decision Structures of Socio-Technical Organizations:** Physical Science Laboratory, NM State University, PI. Modeling of agent community interaction with sociotechnical systems. 1999–2000.
- **Electronic Fraud Detection System (EFDS):** IRS. Data mining algorithms for fraud detection in electronically filed tax returns. UNIX/C, Matlab/S+, ProC/PL-SQL/Oracle, X/Motif. 1996-1999.
- **Computer-Aided Systems Theory–General Information Theory (CAST-GIT):** Classes for random sets; possibilistic distributions and histograms; and both general and possibilistic processes. UNIX, Centerline C++, Booch Components. 1992-1996.
- **Data Analysis and Systems Modeling Envrionment (DASME):** NASA Goddard Space Flight Center, PI. Discrete EVent Systems (DEVS) modeling, possibilistic measurement. UNIX, X-Windows, Motif, Centerline C++, Booch components. 1994-1996.
- `CYBSYS-L@BINGVMB.CC.BINGHAMTON.EDU`: Founder and moderator of this Electronic Mailing List for Systems Science and Cybernetics. `Internet/BITNET/LISTSERV`, 1989-1994.

SCIENTIFIC ORGANIZATION, PEER REVIEW, AND SERVICE

Journals

- **Current Editorial Boards:** *Int. J. General Systems*
- **Past Editorial Boards:** *Adv. in Complex Systems; Biosemiotics; J. Applied Systems Studies; Springer Science Reviews*
- **Reviewing History:**
  - *Bioinformatics; Biosystems; BMC Bioinformatics; Complexity International*
  - *Computational and Mathematical Organization Theory; Information Fusion*
  - *Foundations of Science; IEEE Trans. on Fuzzy Systems; SIAM Reviews;*
  - *New Ideas in Psychology; IEEE Trans. on Systems, Man, and Cybernetics;*
  - *Information Sciences; Entropy; Int. J. of Fuzzy Sets and Systems;*
  - *Int. J. of Human-Computer Studies; Applied Ontology*
  - *Int. J. of Uncertainty, Fuzziness, and Knowledge-Based Systems; Trends in Microbiology*
  - *Risk Analysis; Reliability Engineering and System Safety; J. Web Semantics*
  - *Society for Computer Simulation Trans. on Simulation; Systems Research*
  - *J. of the Intelligence Community Research and Development; J. Biomedical Semantics*
  - *Data Mining and Knowledge Discovery; J. Biomedical Informatics; Symmetry*

Boards

- **Advisory Board:** Command, Control, and Interoperability Center for Advanced Data Analysis (CCICADA), Rutgers University, 2013-2019.
- **Advisory Board:** Global Brain Institute, Free University of Brussels, 2012-present.

Panels and Committees

- **American Society for Cybernetics:** Nominations Committee, 2021-present.
- **Pacific Northwest National Laboratory:** Laboratory Directed Research and Development (LDRD), National Security Directorate Seed Panels, 2016.
- **Dept. of Energy, Advanced Scientific Computing Research (ASCR):** Cybersecurity Workshop committee, 2015.
- **Pacific Northwest National Laboratory:** Laboratory Directed Research and Development (LDRD), Open Call, 2014.
- **SBIR Reviewer:** DOE/NA-22, 2010-2014.
- **Pacific Northwest National Laboratory:** Sandpit Mentor, Analysis in Motion Initiative, 2013.
- **Netherlands Organisation for Scientific Research (NWO):** Veni grant proposal reviewer, Innovational Research Incentives Scheme, 2012.
- **Dept. of Homeland Security:** Review committe, DHS/S&T Center of Excellence for Visualization and Data Analytics (CVADA)
- **National Science Foundation Panel:** Division of Information and Intelligent Systems grants review, 2008, 2010.
- **European Research Area Network (ERA-NET) Reviewer:** Complexity-NET program, 2010.
- **NIST and NIH Planning Workshop:** Workshop on Methods and Metrics for Ontology Evaluation, Washington, DC, 2008.
- **National Science Foundation Panel:** Science and Engineering Information Integration and Informatics (SEIII) Program, 2005-2007.
- **Dept. of Homeland Security:** Institute for Discrete Sciences, University Affiliate Centers, 2006.
- **Los Alamos National Laboratory:** Laboratory Directed Research and Development (LDRD), Exploratory Research (ER) panels:
  - Computer Science, Knowledge Discovery, and Software Engineering, 2005

  - Theoretical Biology, 2003
  - Computer Science and Software Engineering, 2001-2002
- **DARPA Workshop on Computable Semantics for Complex Biological Systems:** Participant, March, 2005.
- **First and Second DARPA Workshops on Bio-Ontologies:** Chair, February and June, 2004.
- **UK Engineering and Physical Sciences Research Council:** Grant reviewer, 2004.
- **University of California Discovery Grants:** Life Sciences and Information Technology Program, 2003.
- **Pacific Northwest National Laboratory:** Laboratory Directed Research and Development (LDRD), external reviewer in Computational Science and Engineering Initiative, 2002.
- **Netherlands Organisation for Scientific Research:** Research Programme for the Cognitive Sciences, 2002.
- **National Science Foundation:** Information Technology Research (ITR) Initiative, 2001.

Conferences and Workshops

- **Program Committee:** Workshop on Algorithms and Models for the Web Graph (WAW), 2020, 2023-2024.
- **Program Committee:** AAAI Conference on Artificial Intelligence (AAAI), 2023, 2024,
- **Session Co-Organizer:** "Graph Representations and Algorithms in Biomedicine", Pacific Symposium on Biocomputing, 2022.
- **Program Committee:** "Workshop on Applications of Topological Data Analysis to Data Science, Artificial Intelligence, and Machine Learning", SIAM Int. Conf. on Data Mining, 2022.
- **Co-Organizer:** Mathematics Research Community (MRC) workshop for Business, Industry and Government (BIG) on Models and Methods for Sparse (Hyper)Network Science, 2022.
- **Program Committees:** Conf. on Artificial General Intelligence, 2008-2009, 2012, 2014-2015, 2020-2022.
- **Co-Organizer:** Special session on "Combinatorial Approaches to Topological Structures and Applications", Joint Mathematics Meeting, Seattle, WA, January, 2022.
- **Co-Organizer:** Special session on "Combinatorial Approaches to Topological Structures and Applications", Joint Mathematics Meeting, Washington, DC, January, 2021 (virtual).
- **Organizer:** Minisymposium on "Hypergraph Analytics", SIAM Conf. on the Mathematics of Data Science, Cincinnati, OH, April, 2020 (cancelled for COVID).
- **Program Committee:** IEEE Int. Conf. on Fuzzy Systems (FUZZ-IEEE), 2014-2015.
- **Organizer:** Workshop on Complexity for Big Data (C4BD), IEEE BigData Conference, 2014.
- **Program Committees:** Bio-Ontologies SIG, ISMB, 2008-2009, 2011-2014.
- **Program Committees:** IEEE International Conference on Semantic Computing, 2007-2012, 2014.
- **Program Committees:** International Symposium on Imprecise Probability Theory and Applications (ISIPTA), 2011, 2013.
- **Program Committees:** Conference on Hybrid AI Systems (HAIS), 2010-2011.
- **Program Committee:** AAAI 2013 Fall Symposium on Semantics for Big Data, Arlington, Virginia, November, 2013
- **Program Committee:** 1st International Workshop on Privacy in Semantic Technologies (PriSet), co-located with K-CAP 2013, Banff, Canada, 2013.
- **Program Committee:** 2012 Joint Workshop on Scalable and High-Performance Semantic Web Systems (SSWS+HPCSW 2012), to be held at the 2012 International Semantic Web Conference (ISWC 2012), Boston, MA, 2012.
- **Session Chair, Program Committee:** Session on Semantic Technologies, First Annual Chesapeake Large-Scale Analytics Conference (CLSAC), Annapolis, Maryland, 2012.
- **Program Committee:** 2011 American Medical Informatics Association (AMIA) Annual Symposium, 2011.

- **Program Committee:** First Workshop on High-Performance Computing for the Semantic Web (HPCSW), collocated with the 8th Extended Semantic Web Conference, Crete, 2011.
- **Workshop Co-Chair:** Workshop on Complex Queries in Semantic Graph Databases, Seattle, 2011.
- **Workshop co-Chair:** Session on Hybrid Artificial Intelligence Systems Based on Lattice Theory, 5th Int. Conf. on Hybrid AI Systems (HAIS), San Sebastian, Spain, 2010.
- **Session co-Chair:** Session on Data Analysis, Data Analytics, and Visualization, joint PNNL/UW/WSU Data Intensive Research Analytics Center (DIRAC) Workshop, University of Washington, 2010.
- **Program Committee:** 2nd International Conference on Advanced Intelligence (ICAI), 2010.
- **Program Committee:** 2010 ACM International Conference on Bioinformatics and Computational Biology (ACM-BCB), 2010.
- **Program Committee:** AAAI Spring Symposium on Technosocial Predictive Analytics, 2009.
- **Program Committees:** Intelligent Systems for Molecular Biology (ISMB), 2004-2008.
- **Program Committees:** IEEE Int. Conf. on Systems, Man, and Cybernetics, 2005-2007.
- **Program Committee:** 2007 Conference of the North American Association for Computational Social and Organization Science (NAACSOS 07), Emory College, Atlanta, June, 2007.
- **Program Committee:** Workshop on "Social Network Analysis and Conceptual Structures: Exploring Opportunities", 5th International Conference on Formal Concept Analysis (ICFCA), Clermont-Ferrand, France, February, 2007.
- **Program Committee:** 2007 Joint Conference on AI, Simulation and Planning in High Autonomy Systems (AIS) and Conceptual Modeling and Simulation (CMS), Buenos Aires, February, 2007.
- **Program Committee:** 2006 Joint Biolink and 9th Bio-Ontologies Meeting (JBB), 2006 Conference on Intelligent Systems for Molecular Biology (ISMB 06), Fortaleza, Brazil, August, 2006.
- **Organizing Committee:** Workshop on Machine Self-Replication, 10th International Conference on the Simulation and Synthesis of Living Systems (ALife X), Bloomington, Indiana, June, 2006.
- **Program Committee:** Workshop on the Semantic Web for the Life Sciences, 2006 Pacific Symposium on Biocomputing (PSB 06), Hawaii, January, 2006.
- **Organizing Committee:** DHS Institute for Discrete Sciences (IDS) Workshop on Data Integration and Dissemination, Washington, DC, November, 2005.
- **Program Committee:** Fourth European Conference on Computational Biolgoy (ECCB 05), Madrid, September, 2005.
- **Program Committee:** 2005 International Conference on Human-Computer Interface Advances for Modeling and Simulation (SIMCHI 05)
- **Program Committee:** 2004 IEEE International Conference on Computational Cybernetics (ICCC 04), Vienna, September, 2004.
- **International Advisory Board:** 2004 Workshop on Performance Metrics for Intelligent Systems, National Institute of Standards and Technology, Gaithersburg, MD, August, 2004.
- **Program Committee:** 2003 International Symposium of Uncertainty Modeling and Analysis (ISUMA 03), University of Maryland, September, 2003.
- **Program Committee:** Workshop on "Distributed Computing Architectures for Digital Libraries", 31th International Conference on Parallel Processing (ICPP), August, 2002.
- **International Advisory Board:** 2002 Workshop on Performance Metrics for Intelligent Systems, National Institute of Standards and Technology, Gaithersburg, MD, August, 2002.
- **Program Committee:** Wshop on Epistemic Uncertainty, Sandia National Lab, August, 2002
- **Program Committee:** 2002 Conference on AI, Simulation and Planning, Lisbon, April, 2002
- **Program Committee:** Workshop on "Theoretical Fundamentals of Intelligent Systems: Computational Semiotics", Joint Conference on Information Systems, Duke University, March 2002
- **Workshop Chair:** Los Alamos Workshop on Novel Approaches to Uncertainty Quantification, February, 2002.

- **Program Committee:** 2002 World Congress on Virtual Worlds and Simulation, January, 2002.
- **Executive and Scientific Committees:** First International Conference on Intelligent Networks and Social Evolution (Global Brain 1), Brussels, July 2001
- **International Advisory Board:** 2000 Workshop on Performance Metrics for Intelligent Systems, National Instiute of Standards and Technology, Gaithersburg, MD, August, 2000.
- **Program Committee:** 2000 World Congress on the Systems Sciences, Toronto, July, 2000.
- **Program Committee:** 2000 Conference on AI, Simulation and Planning, University of Arizona, Tucson, March, 2000.
- **Program Committee:** 1999 IEEE International Symposium on Computational Intelligence in Robotics and Automation, Monterey, California, 1999.
- **Program Committee, Workshop Co-Chair:** Workshop on "Semiotics of Autonomous Information Systems", 1998 Conference on Intelligent Systems and Semiotics, National Institute of Standards and Technology, Gaithersburg, Maryland, September, 1998.
- **Workshop Organizer and Co-Chair:** Workshop on Emergent Semantic and Computational Processes in Distributed Information Systems, Los Alamos National Laboratory, Los Alamos, New Mexico, August, 1998.
- **International Program Committee, Workshop Chair:** Workshop on "Semiotic Methods of Information and Knowledge Processing", 1997 Conference on Intelligent Systems and Semiotics, National Institute of Standards and Technology, Gaithersburg, Maryland, September, 1997.
- **Program Committee, Workshop Chair:** Workshop on "Uncertainty Representation in Decision-Making Systems", conference on *Intelligent Systems: A Semiotic Perspective*, National Institute of Standards and Technology, Gaithersburg, Maryland, October, 1996.
- **Program Committee:** Thirteenth European Meeting on Cybernetics and Systems Research; co-chair, Symposium on Systems Methodology; Vienna, April 1996.
- **Program Committee:** Conference on AI, Simulation and Planning in High Autonomy Systems, San Diego, March 1996.
- **Organizing Committee:** 1996 Conference of the Washington Evolutionary Systems Society.
- **Organizing and Scientific Committees:** International Workshop on the Foundations and Applications of Possibility Theory (FAPT '95), University of Ghent, December, 1995.

INVITED PRESENTATIONS

- "Temporal Hypergraphs: Analysis and Dynamics", 2024 Joint Math Meetings, San Francisco, January, 2024.
- "Relational Models of Complex Systems: Hierarchy and Topology of High Order Interactions", Binghamton Center of Complex Systems Seminar, Binghamton University, September, 2023.
- "Hyergraph Modeling and Topological Approaches in HyperNetX", Workshop on Modelling and Mining Complex Networks as Hypergraphs, Toronto Metropolitan University, May, 2023.
- "A Gentle Introduction to Hypegraph Analytics Using HyperNetX", Fields Institute, Toronto, May, 2023.
- "Relational and Networked Knowledge Bases", Summer Conference on Applied Data Science (SCADS 2023), North Carolina State University, May, 2023.
- "High Order Networks and Computational Topology", Binghamton University Network Science Seminar, November, 2021.
- "Hypergraphs for Cyber Analytics", Sandia National Laboratories, July, 2021.
- "Introduction to Hypergraph Analytics and Computational Topology", Ryerson University Department of Mathematics Colloquiumm, October, 2020.
- "Introduction to Hypergraph Analytics and Computational Topology", plenary talk at the 17th Workshop on Algorithms and Models for the Web Graph (Warsaw), September, 2020.
- "Mathematical Adventures in Multidimensional Data: From Incidence Tensors to Lattice-Valued Schema Hypergraphs", Data Science Day, Washington State University, February, 2020.

- "Hypernetworks for Complex Systems Analysis", Plenary talk at the Workshop on Hypergraph Theory, Applications, and Challenges, University of Salerno, Italy, November, 2019.
- "Hypergraph Analytics", Tutte Institute for Mathematics and Computing, Canadian Communications Security Establishment, January, 2019.
- "Seeking A Categorical Systems Theory via the Category of Hypergraphs", NIST Workshop on Applied Category Theory, Gaithersburg MD, March 2018.
- "Hypergraph Analytics: High Dimensional Data Analysis from a Graph Theoretical Perspective", RIT Golisano College of Computing and Information Science PhD Colloquium/Rochester IEEE Computer and Computational Intelligence Socieites, Rochester, NY, October 2017.
- "Finite Topologies for the Data Sciences?", Data Science Day, Western Sectional Meeting AMS, Washington State University, Pullman, WA, April 2017.
- "Description Sheaves for Topological Information Fusion", AMS Special Session on Computational Topology, Western Sectional Meeting, Washington State University, Pullman, WA, April 2017.
- "Generalized Multi-INT Integration", 2016 Innovation Summit, Peterson Air Force Base, Colorado Springs, December 2016.
- "On Beyond Graphs: Multidimensional Graph Structures for the Data Sciences", GraphFest 2016, Washington DC area, August 2016.
- "Semantically Enriched Expressive Graph Structures" (with Nick Cramer), DTRA Advanced Analytics Program Multi-Lab Technical Meeting, Livermore, CA, February, 2016
- "Some Fundamentals of Data Modeling", NSF Earth-Centered Communication for Cyberinfrastructure Field Trip, Bishop, CA, August 2015.
- "There's a Hole in My Data! Topological Modeling of Multidimensional Heterogeneous Information Systems", first Distinguished Lecture in Data Science, school of Electrical Engineering and Computer Science and the Mathematics, Washington State University, Pullman WA, May 2015.
- "Topological Multi-Modal Integration" (with Michael Robinson), DARPA Workshop on Multi-Modal Integration, Arlington, VA, March 2015.
- "Discrete Mathematical Approaches to Graph-Based Traffic Analysis", 2015 Chesapeake Large Scale Analytics Conference (CLSAC), Annapolis, MD, October, 2014.
- "Discrete Mathematical Approaches to Graph-Based Cyber Traffic Analysis", ICERM Wshop. Mathematics of Data Analysis in Cybersecurity, Providence, RI, October, 2014.
- "Modeling Global Control Systems: Formal Approaches to Understand What a Global Brain Could Be", Evolution, Complexity, and Cognition Group, Free University of Brussels, May, 2014.
- "Building Scalable Technologies for Semantic Database Analysis", SIGSem group, US Government Special Program Sponsor, April, 2014.
- "Semantic Graph Database Analytics: Complex is the New Big Data", Los Alamos Information Science and Technology Center, December, 2013.
- "Challenges of Uncertainty Aggregation in Hybrid Databases", Workshop on Aggregation of Uncertain Knowledge at Scale (AUKS), John Hopkins University/Physical Science Lab, February, 2012.
- "Intervals, Orders, and Rank", Dagstuhl seminar 11371, Uncertainty modeling and analysis with intervals: Foundations, tools, applications, Dagstuhl Castle, Germany, November, 2011.
- "Order Metrics for Ontology Analysis", Center for Clinical Investigations, Case Western Reserve University, February, 2011.
- "Hierarchical Systems Theory", Systems Science Seminar Series, Systems Science Program, Portland State University, May, 2010.
- "Lattice Theory for Knowledge Discovery in National Security Data", special session "Real Numb3rs: Mathematical Technologies for Counterterrorism and Border Security", 2010 Annual Meeting of the American Association for the Advancement of Science (AAAS), February, 2010.
- "Ontology Alignment Evaluation", meeting of the Test and Evaluation group for IAPRA/KDD, San Diego, October, 2009.
- "Order Theory for Knowledge Systems Analysis", Computer Science Department, University of Illinois,

Chicago, January, 2009.

- "Order Theory for Knowledge Systems Analysis", Mathematics Department, Technical University of Dresden, November, 2008.
- "Order Theory and Technology for Ontology Analysis and Management", National Security Agency, knowledge systems group, August, 2008.
- "Ontologies and Semantic Hierarchies for Biomedical Knowledge Technology", National Science Foundation, Engineering Information Integration and Informatics program, November, 2007.
- "Semantic Graphs and Ontologies: A Hierarchy Theory Approach", Institute for Discrete Sciences Workshop on Associating Semantics with Graphs, Homeland Security Center for Dynamic Data Analysis, DIMACS, Rutgers University, April, 2007.
- "Measuring Semantic Space: Order Theory for Knowledge Discovery and Integration", First GlaxoSmithKline Lecture on Ontology, Logic and Cognitive Science Initiative, Department of Philosophy and Religion, North Carolina State University, November, 2006
- "Order Theoretical Analysis of Social Hierarchies", Third Conference on Mathematical Methods for Counterterrorism, Washington DC, September, 2006.
- "Order Interval Rank for Order Theoretical Knowledge Discovery", Mathematics department, New Mexico State University, September, 2006.
- "Semantic Hierarchies as Ordered Data Objects", Extended MetaData Registry project (XMDR) project meeting, Lawrence Berkeley National Laboratory, Berkeley, California, July, 2006.
- "Reconstructibility Analysis as an Order Theoretical Knowledge Discovery Technique", special session on Reconstructibility Analysis, 2006 International Conference on Complex Systems, Boston, July, 2006.
- "Order Theoretical Knowledge Discovery for Homeland Defense", Second Conference on Mathematical Methods for Counterterrorism, Benedict College, Columbia, South Carolina, November, 2005
- "Poset Metric Approaches to the Management of Large Semantic Hierarchies", Computer Science Department, University of Manchester, July, 2005.
- "Management of Quantified Semantic Taxonomies for Biothreat Response", DIMACS Working Group on Order-Theoretic Aspects of Epidemiology, Rutgers University, March, 2005.
- "Order Theoretical Approaches to Automated Functional Annotation Using Bio-Ontologies", Orion Integrated Biosciences Virtual Seminar on Genomics and Bioinformatics, November, 2004.
- "Order Theoretical Knowledge Discovery", DIMACS Workshop on Applications of Order Theory to Homeland Defense and Computer Security, Rutgers University, September, 2004.
- "Combinatorial Knowledge Discovery for Bio-Ontology Management", Stanford Medical Informatics Colloquium, May, 2004.
- "Combinatorial and Lexical Approaches to Bio-Ontology Management", Computer Science Department, Manchester University, February, 2004.
- "Ontologies for Knowledge-Based Science: Building a Computational Semiotics", Information Science and Technology Colloquium Series, NASA Goddard Space Flight Center, Greenbelt, Maryland, November, 2003.
- "Multi-Poset-Based Ontologies for Real-World Knowledge Discovery", Computer Science Department, Old Dominion University, Norfolk, Virginia, September, 2003.
- "Meta-System Transition Theory" (with Valentin Turchin and Ben Goertzel), "Semiotic Closures and Autonomic Systems", "Semiotic Agent Systems and Second Order Cybernetics", Autonomic Computing Summit, IBM Academy of Technology, IBM TJ Watson Research Center, Yorktown Heights, New York, May, 2002.
- "Systems Science via Computational Semiotics and Generalized Information Theory", Center for Intelligent Systems, Binghamton University, Binghamton, New York, May, 2002.
- "Novel Uncertainty Quantification Methods Based on Generalized Information Theory", Uncertainty Quantification Working Group, LANL, Los Alamos, New Mexico, March, 2002.
- "Network Worlds: From Link Analysis to Virtual Places", 2002 Workshop on Virtual Worlds and Simulation (VWSim02), San Antonio, Texas, January, 2002.

- "Systems Concepts for the Simulation of Ultra-Large Networks", NSF Workshop on Modeling and Simulation of Ultra-Large Networks, November, 2001.
- "What Could We Mean By An 'Intelligent Web' ", Second `en.red.ando` Conference on the Intelligent Web, Barcelona, October, 2001.
- "How Distributed Knowledge Systems Facilitate Social Control in Semiotic Agent-Based Architectures", Wshop on Intelligent Networks and Social Evolution, Free University of Brussels, July, 2001.
- "A Semiotic Systems Approach to Knowledge Integration Environments and Technologies", National Security Agency, Fort Meade, MD, February, 2001.
- "A Semiotic Critique of the Limits of Formal Models", 2001 Workshop on Virtual Worlds and Simulation (VWSim01), Phoenix, Arizona, January, 2001.
- "A Semiotic Systems Approach to Distributed Knowledge Environments", Working group on a Distributed Knowledge Repository, SRI International AI Lab, Menlo Park, CA, July, 2000.
- "Agent Modeling from a Semiotic Perspective", Dagstuhl seminar on Agent-Oriented Software Approaches in Distributed Modeling and Simulation, Dagstuhl Castle, Germany, July, 1999.
- "Beyond Classical Information Theory: Non-Probabilistic and Semiotic Approaches to Representing Information Systems", post-graduate course on Information Warfare, Independent University; National Defense Institute; Lisbon, May, 1999.
- "Levels of Control and Closure in Complex Semiotic Systems", 7th Annual Washington Evolutionary Systems Conference, Ghent, Belgium, May 1999.
- "Semiotics in Systems Theory: What We've Been Missing", Washington Evolutionary Systems Society Microsymposium on Semiotics in Science and Engineering, Washington, DC, September 1998.
- "Empirical Approaches to General Information Theory", Department of Statistics, University of New Mexico, February 1997.
- "Semiotic Aspects of Control and Modeling Relations in Complex Systems", 1996 Workshop on Control Mechanisms for Complex Systems, New Mexico State University, December 1996.
- "General Information Theory and Cybernetic Modeling", Computer Research and Applications Group, Los Alamos National Lab, New Mexico, February 1996.
- "The Systems Science Approach to Interdisciplinary Studies", Center Leo Apostel, Free University of Brussels, December 1995.
- "The Principia Cybernetica Project for Evolutionary and Cybernetic Theory", Washington Evolutionary Systems Society, Washington, DC, November 1995.
- "Two Concepts of Variety in Systems Descriptions", Center for Social and Organizational Learning, George Washington University, Washington, DC, September 1995.
- "Qualitative and Possibilistic Modeling", Center for Social and Organizational Learning, George Washington University, Washington, DC, March 1995.
- "Possibilistic and Fuzzy Modeling", Special Interest Group on Artificial Intelligence, NASA Goddard Space Flight Center, Greenbelt, Maryland, November 1994.
- "Possibility Theory and Possibilistic Automata", Department of Systems Science, Johannes Kepler University, Linz, Austria, July 1991.

SOFTWARE SYSTEMS

- **HyperNetX:** Exploratory data analytics and visualization of hypergraph-structured data. `https://github.com/pnnl/HyperNetX`
- **Chapel Hypergraph Library (CHGL):** High performance hypergraph analytics. `https://github.com/pnnl/chgl`
- **Taxonomy Package (TaxPac):** Experimental methods and measures for ontology and taxonomy analysis. See: CA Joslyn and A White: (2009) "Taxonomy Package (TaxPac): An Experimental Mathematics Environment for Knowledge Systems Analysis", *PNNL Technical Report PNWD-4084*
- **POSet Ontology Categorizer (POSOC):** Categorization algorithm for large taxonomic databases like the Gene Ontology (GO), `http://www.c3.lanl.gov/posoc`

PATENT APPLICATIONS

- **A Mathematical Framework for Representing Role-Based Events and Computing Scores:** Patent application 2012.
- **Methods for Discovering Analyst-Significant Portions of a Multi-Dimensional Database:** Patent application 2010.

PUBLICATIONS

Long Publications and Editing

- (With Søren Brier, eds.) Special issue on "Information and Semiotics", *Biosemiotics*, v **6**:1, 2013.
- (With F Heylighen and V Turchin, editors) *The Quantum of Evolution: Towards a Theory of Meta-System Transitions*, Gordon and Breach, New York, 1995. (Special issue of *World Futures: The Journal of General Evolution*, v. **45**:1)
- *Possibilistic Processes for Complex Systems Modeling*, Binghamton University (SUNY), PhD Thesis, UMI Dissertation Services Publication # 9434056, 1994. Abstract: *Dissertation Abstract Index*, v. 55-08B.

Preprints and Submissions

- (With Colby, Sean; Shapiro, Madelyn; Bilbao, Aivett; Broeckling, C; Lin, Andy; Purvine, Emilie): (2023) "Introducing Molecular Hypernetworks for Discovery in Multidimensional Metabolomics Data", https://www.biorxiv.org/content/10.1101/2023.09.29.560191v1, submitted, 2023.
- (With Praggastis, Brenda; Aksoy, Sinan; Arendt, Dustin; Bonicillo, M; Purvine, Emilie; Shapiro, Madelyn; and Yun, Ji-Young): "HyperNetX: A Python Package for Modeling Complex Network Data as Hypergraphs", https://arxiv.org/abs/2310.116 26, submitted, 2023.
- (With Rawson, Michael G; Myers, Audun; Green, Robert; Robinson, M): "Formal Concept Lattice Representations and Algorithms for Hypergraphs", https://arxiv.org/abs/2307.116 81, 2023.
- (With Michael Robinson, Chris Capraro, Emilie Purvine, Brenda Praggastis, Stephen Ranshous, Arun Sathanur) "Local Homology of Abstract Simplicial Complexes", `arXiv:1805.11547`, 2018.
- (With Katheleen Nowak) "Ubergraphs: A Definition of a Recursive Hypergraph Structure", *PNNL Technical Report PNNL-26402*, `arXiv:1704.05547`, 2017.
- (With Emilie Purvine, Michael Robinson): (2015) "A Category Theoretical Investigation of the Type Hierarchy for Heterogeneous Sensor Integration", *PNNL Technical Report PNNL-25784*, `arXiv:1609.02883`, 2017
- (With Emilie Hogan and Alex Pogel) "Conjugacy and Iteration of Standard Interval Valued Rank in Finite Ordered Sets", `arXiv:1409.6684`, 2015.
- (With Chris Orum) "Valuations and Metrics on Partially Ordered Sets", `arXiv:0903.2679`, 2009.

Peer Reviewed and Invited Publications

143. (With Jenne, Helen; Aksoy, Sinan G; Best, Daniel; Bittner, A; Henselman-Petrusek, Gregory; Myers, Audun; Seppala, Garret; Warley, Jackson; Young, Stephen J; Purvine, Emilie): "Stepping Out of Flatland: Discovering Behavior Patterns as Topological Structures in Cyber Hypergraphs", *The Next Wave*, in press, 2024.

142. (With Ortiz-Munoz, Andres; Edgar, DRV; Kosheleva, O; Kreinovich, Vladik): "Causality: Hypergraphs, Matter of Degree, Foundations of Cosmology", in: *Proc. 2023 Annual Conf. North American Fuzzy Information Processing Society (NAFIPS 2023)*, https://scholarworks.utep.edu/cs_techrep/1790/, 2023.

141. (With Myers, Audun; Bittner, Alyson S; Askoy, Sinan G; Roek, G; Jenne, Helen; Kay, Bill; Seppala, Garret; Young, Stephen; Purvine, Emilie AH): "Malicious Cyber Activity Detection Using Zigzag Persistence", in: *IEEE Dependeable and Secure Computing Wshop. on AI/ML for Cybersecutiry (AIML 23)*, https://arxiv.org/abs/2309.08010, 2023.

140. (With Zhou, Youjia; Jenne, Helen; Brown, Davis; Shapiro, M; Jefferson, Brett; Henselman-Petrusek, Gregory; Praggastis, Brenda; Purvine, Emilie; and Wang, Bei): "Comparing Mapper Graphs of Artifical Neuron Activations", in: *IEEE Wshop. on Topological Data Analysis and Visualization (TopoInVis)*, at *IEEE VIS*, http://www.sci.utah.edu/~beiwang/publications/ Compare_Activations_BeiWang_2023.pdf, 2023.

139. (With Reyes, Hector A; and Kreinovich, Vladik): "Graph Approach to Uncertainty Quantification", *Deep Learning and Other Soft Computing Techniques. Studies in Computational Intelligence*, v. 1097, pp. 253-283, Springer, https://doi.org/10.1007/978-3-031-29447-1_23, 2023.

138. (With Purvine, Emilie AH; Brown, Davis; Jefferson, Brett; Praggastis, Brenda; Rathore, Archit; Shapiro, Madelyn; Wang, Bei; Zhou, Youjia): "Experimental Observations of the Topology of Convolutional Neural Network Activations", in: *Proc. 37th Assoc. for the Advancement of Artificial Intelligence Conf. on AI (AAAI 23)*, v. 37:8, pp. 9470-9479, https://doi.org/10.1609/aaai.v37i8.26134, 2023.

137. (With Myers, Audun; Kay, Bill; Purvine, EAH; Roek, Gregory; Shapiro, Madelyn): "Topological Analysis of Temporal Hypergraphs", in: *Proc. Wshop. on Analysis of the Web Graph (WAW 2023), Lecture Notes in Computer Science*, v. **13894**, pp. 127-146, https://link.springer.com/chapter/10.1007/978-3-031-32296-9_9, 2023.

136. (With Chrisman, Brianna S; Varma, Maya; Maleki, Sephideh; Brbic, M; Zitnik, Marinka):"Graph Representations and Algorithms in Biomedicine", in: *Pacific Symposium on Biocomputing 2023*, ed. RB Altman, L Hunter et al., pp. 55-60, World Scientific, Sinagpore, https://doi.org/10.1142/9789811270611_0006, 2023

135. (With Liu, Xu T; Firoz, Jesun; Lumsdaine, Andrew; Aksoy, Sinan; Amburg, Ilya; Praggastis, Brenda; Gebremedhin, Assefaw): "High-Order Line Graphs of Non-Uniform Hypergraphs: Algorithms, Applications, and Experimental Analysis", *36th IEEE Int. Parallel and Distributed Processing Symp. (IPDPS 22)*, https://doi.org/10.1109/IPDPSW50202.2020.00112, 2022.

134. (With Aksoy, Sinan G; Hagberg, Aric; Kay, Bill; Purvine, Emilie; Young, Stephen J): "Models and Methods for Sparse (Hyper)Network Science in Business, Industry, and Government", *Notices of the AMS*, v. FEB 22, pp. 287-291, https://www.ams.org/journals/notices/202202/rnoti-p287.pdf, 2022.

133. (With Liu, Xu T; Firoz, Jesun; Lumsdaine, Andrew; Aksoy, Sinan; Praggastis, Brenda; Gebremedhin, Assefaw): "Parallel Algorithms for Efficient Computation of High-Order Line Graphs of Hypergraphs", in: *2021 IEEE 28th International Conference on High Performance Computing, Data, and Analytics (HiPC 2021)*, https://doi.ieeecomputersociety.org/10.1109/HiPC53243.2021.00045, 2021.

132. "Semiotic and Physical Requirements on Emergent Autogenic System", *Biosemiotics*, v. **14**, pp. 665-667, https://doi.org/10.1007/s12304-021-09469-1, 2021.

131. (With Kvinge, Henry; Jefferson, Brett A; and Purvine, EAH): "Sheaves as a Framework for Understanding and Interpreting Model Fit", *Wshop. on Topology, Algebra, and Geometry in Computer Vision, ICCV 2021*, https://openaccess.thecvf.com/content/ICCV2021W/TAG-CV/html/Kvinge_Sheaves_as_a_Framework_for_Understanding_and_Interpreting_Model_Fit_ICCVW_2021_paper.html, 2021.

130. (With Feng, Song; Heath, Emily; Jefferson, Brett; Kvinge, Henry; McDermott, Jason E; Mitchell, Hugh D; Praggastis, Brenda; Eisfeld, Amie J; Sims, Amy C; Thackray, Larissa B; Fan, Shufang; Walters, Kevin B; Halfmann, Peter J; Westhoff-Smith, Danielle; Tan, Qing; Menachery, Vineet D; Sheahan, Timothy P; Cockrell, Adam S; Kocher, Jacob F; Stratton, Kelly G; Heller, Natalie C; Bramer, Lisa M; Diamond, Michael S; Baric, Ralph S; Waters, Katrina M; Kawaoka, Yoshihiro; Purvine, Emilie): "Hypergraph Models of Biological Networks to Identify Genes Critical to Pathogenic Viral Response", *BMC Bioinformatics*, v. 22:287, https://bmcbioinformatics.biomedcentral.com/articles/10.1186/s12859-021-04197-2, 2021.

129. (With Aksoy, S; Callahan, Tiffany J; Hunter, LE; Jefferson, B; Praggastis, B; Purvine, EAH; Tripodi, IJ): "Hypernetwork Science: From Multidimensional Networks to Computational Topology", in: *Unifying Themes in Complex Systems X: Proc. 10th Int. Conf. Complex Systems*, ed. D. Braha *et al.*, pp. 377-392, Springer, https://doi.org/10.1007/978-3-030-67318-5_25, 2021.

128. (With Frazar, Sarah; Goychayev, Rustum; and Randall, Alysha M:) "Developing an Electronic Distributed Ledger for Transit Matching", in: *Proc. Institute for Nuclear Materials Management Annual Meeting, 2020*, https://www.abstractsonline.com/pp8/#!/9161/presentation/130, 2020.

127. (With Aksoy, Sinan G; Marrero, Carlos O; Praggastis, B; Purvine, Emilie AH:) "Hypernetwork Science via High-Order Hypergraph Walks", *EPJ Data Science*, v. **9**:16, https://doi.org/10.1140/epjds/s13688-020-00231-0, 2020.

126. (With Firoz, Jesun; Jenkins, LP; Praggastis, B; Purvine, Emilie; Raugas, Mark:) "Computing Hypergraph Homology in Chapel", in: *2020 IEEE Int. Parallel and Distributed Processing Symp. Workshops (IPDPSW 20)*, pp. 667-670, https://doi.org/10.1109/IPDPSW50202.2020.00112, 2020.

125. (With Aksoy, Sinan; Arendt, Dustin; Firoz, J; Jenkins, Louis; Praggastis, Brenda; Purvine, Emilie AH; Zalewski, Marcin): "Hypergraph Analytics of Domain Name System Relationships", in: *17th Wshop. on Algorithms and Models for the Web Graph (WAW 2020), Lecture Notes in Computer Science*, v. **12901**, ed. Kaminski, B *et al.*, pp. 1-15, Springer, https://doi.org/10.1007/978-3-030-48478-1_1, 2020.

124. (With Charles, L; Deperno, C; Gould, N; Nowak, K; Praggastis, B; Purvine, EA; Robinson, M; Strules, J; Whitney, P): "A Sheaf Theoretical Approach to Uncertainty Quantification of Heterogeneous Geolocation Information", *Sensors*, v. **20**:12, pp. 3418, https://doi.org/10.3390/s20123418, 2020.

123. (With Aksoy, Sinan; Arendt, Dustin; Jenkins, L; Praggastis, Brenda; Purvine, Emilie; Zalewski, Marcin): "High Performance Hypergraph Analytics of Domain Name System Relationships", in: *Proc. HICSS Symp. on Cybersecurity Big Data Analytics*, http://www.azsecure-hicss.org/, 2019.

122. (With Firoz, Jesun; Jenkins, LP; Zalewski, Marcin; Raugas, Mark V): "Graph Algorithms in PGAS: Chapel and UPC++", in: *Proc. 2019 Conf. on High Performance Extreme Computing (HPEC 2019)*, https://doi.org/10.1109/HPEC.2019.8916309, 2019.

121. (With Robinson, Michael; Smart, J; Agarwal, K; D Bridgeland, A Brown, S Choudhury, Brett Jefferson, Norman Kraft, Brenda Praggastis, Emilie Purvine, William P Smith, Dimitri Zarzhitsky) "Hyperthesis: Topological Hypothesis Management in a Hypergraph Knowledgebase", in: *Proc. 2019 Text Analytics Conference (TAC 2018)*, https://tac.nist.gov/publications/2018/papers.html, 2019.

120. (With Sarah Frazar and Amanda Sayre) "Identifying Safeguards Use Cases for Blockchain Technology", *Symp. on Int. Safeguards: Building Future Safeguards Capabilities*, Vienna, https://conferences.iaea.org/event/150/contributions/5422/, 2018.

119. (With Louis Jenkins, T Bhuiyan, Sarah Harun, Chris Lightsey, Sinan Aksoy, Tim Stavenger, M Zalewski, and H Medal) "Chapel Hypergraph Library (CHGL)", in: *2018 IEEE High Performance Extreme Computing Conf. (HPEC 2018)*, IEEE, Waltham, MA, DOI:10.1109/HPEC.2018.8547520, 2018.

118. (With EAH Purvine, S Aksoy, K Nowak, B Praggastis and M Robinson) "A Topological Approach to Representational Data Models", in: *Human Interface and the Management of Information. Interaction, Visualization, and Analytics (HIMI 2018), Lecture Notes in Computer Science*, v. **10904**, ed. S Yamamoto and H Mori, pp. 90-109, Springer-Verlag, https://doi.org/10.1007/978-3-319-92043-6_8, 2018.

117. (With Arun Sathanur, Sutanay Choudhury, and Sumit Purohit) "When Labels Fall Short: Property Graph Simulation via Blending of Network Structure and Vertex Attributes", in: *Proc. ACM Int.*

Conf. on Information and Knowledge Management (CIKM 2017), pp. 2287-2290, ACM, Singapore, https://doi.org/10.1145/3132847.3133065, 2017.

116. (With Stephen Ranshous, Sean Kreyling, Kathleen Nowak, N Samatova, C West, S Winters) "Exchange Pattern Mining in the Bitcoin Transaction Directed Hypergraph", in: *Proc. 2017 Conf. Int. Financial Cryptography Association (Bitcoin 2017), Lecture Notes in Computer Science*, v. **10323**, ed. M Brenner *et al.*, pp. 248-263, Springer-Verlag, https://doi.org/10.1007/978-3-319-70278-0_16, 2017.
115. (With Emilie Purvine and Alex Pogel) "Interval-Valued Rank in Finite Ordered Sets", *Order*, v. **34**:3, pp. 491-512, https://doi.org/10.1007/s11083-016-9411-2, 2017.
114. (With Emilie Purvine) "Information Measures of Frequency Distributions with an Application to Labeled Graphs", in: *Advances in the Mathematical Sciences: Research from the 2015 Assoc. for Women in Mathematics Symp.*, v. **6**, ed. Gail Letzter *et al.*, pp. 379-400, Springer-Verlag, New York, https://doi.org/10.1007/978-3-319-34139-2_19, 2016.
113. (With Praggastis, Brenda; Purvine, Emilie; Sathanur, A; Robinson, Michael; Ranshous, Stephen): "Local Homology Dimension as a Network Science Measure", in: *SIAM Workshop on Network Science, Abstracts Book*, pp. 86-87, https://www.siam.org/meetings/ns16/ns16_abstracts.pdf, 2016.
112. (With Wong, Pak Chung; Haglin, David; Gillen, David; Chavarria, D, Vito Castellana, Alan Chappell, Song Zhang) "A Visual Analytics Paradigm Enabling Web-Scale Graph Exploration", in: *Proc. IEEE Symp. on Large Data Analysis and Visualizaztion (LDAV 2015)*, pp. 57-64, IEEE CS Press, https://doi.org/10.1109/LDAV.2015.7348072, 2015.
111. (With Emilie Hogan and Michael Robinson) "Towards a Topological Framework for Integrating Semantic Information Sources", in: *2014 Conf. on Semantic Technologies in Intelligence, Defense and Security (STIDS 2014), CEUR-WS*, v. **1304**, pp. 93-96, http://ceur-ws.org/Vol-1304/, 2014.
110. (With Wendy Cowley, Emilie Hogan, Bryan Olsen) "Discrete Mathematical Approaches to Graph-Based Traffic Analysis", in: *2014 Int. Wshop. on Engineering Cyber Security and Resilience (ECSaR14)*, Stanford, 2014.
109. (With Eric Goodman, Edward Jimenez, David Haglin, Sinan al-Saffar, Dirk Grunwald) "Optimizing Graph Queries with Graph Joins and Spinkle SPARQL", in: *2014 IEEE Int. Conf. on Big Data*, pp. 17-24, https://doi.org/10.1109/BigData.2014.7004463, 2014.
108. (With Emilie Hogan, Patrick Paulson, Elena Peterson, Eric Stephan, Dennis Thomas) "Order Theoretical Semantic Recommendation", in: *2nd Int. Wshop. on Ordering and Reasoning (OrdRing 2013), at ISWC 2013, CEUR-WS*, v. **1059**, pp. 9-20, http://ceur-ws.org/Vol-1059/, 2013.
107. (With Zapata, Francisco; Kreinovich, Vladik; and Hogan, Emilie): "Orders on Intervals Over Partially Ordered Sets: Extending Allen's Algebra and Interval Graph Results", *Soft Computing*, v. **17**:8, pp. 1379-1391, https://doi.org/10.1007/s00500-013-1010-1, 2013.
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- (With Audun Myers and Emilie Purvine) "Temporal Hypergraphs: Analysis and Dynamics", *Joint Math Meetings (JMM 2024)*, 2024.
- "Hyergraph Modeling and Topological Approaches in HyperNetX", Workshop on Modelling and Mining Complex Networks as Hypergraphs, Toronto Metropolitan University, May, 2023.
- "A Gentle Introduction to Hypegraph Analytics Using HyperNetX", Workshop on Algorithms and Models for the Web Graph (WAW), Fields Institute, Toronto, May, 2023.
- (With Green, Robert E; Myers, Audun; Rawson, MG; Magnan, Van; Lagoda, Evgeniya; English, Sean; Nash, Evan; Battistella, Enzo; Robinson, Michael): "Permissible Walks in Attributed Hypergraphs", *Joint Math Meetings (JMM 2023)*, https://meetings.ams.org/math/jmm2023/meetingapp.cgi/Paper/22323, 2023.
- (With Kay, WW; Aksoy, Sinan G; Baird, Molly; Best, DM; Jenne, Helen; Potvin, CD; Roek, Greg; Seppala, Garrett; Young, Stephen; Purvine, Emilie), "Hypergraph Topological Features for Autoencoder-Based Intrusion Detection for Cybersecurity Data", *ML4Cyber Wshop., Int. Conf. Machine Learning 2022*, https://icml.cc/Conferences/2022/ScheduleMultitrack?event=13458#collapse20252, 2022.
- (With Myers, Audun; Purvine, Emilie AH; and Shapiro, Madelyn), "Topological Analysis of Temporal Hypergraph Data", *2002 SIAM Conf. on Math of Data Science*, 2022
- (With Purvine, Emilie AH; Bilbao, Aivett; Broeckling, Corey; Colby, S; Lin, Andy; Metz, Tom; Shapiro, Madelyn): "Introducing Molecular Hypernetworks for Exploration of Multi-dimensional Metabolomics Data", *70th American Society for Mass Spectrometry Conf. on Mass Spectromety and Allied Topics (ASMS 22)*, 2022.
- (With Purvine, Emilie AH; Bilbao, Aivett; Broeckling, Corey; Colby, S; Lin, Andy; Metz, Tom; Shapiro, Madelyn): "Introducing Molecular Hypernetworks for Exploration of Multi-dimensional Metabolomics Data", *Society of Environmental Toxicology and Chemistry Conf. on Nontarget Analysis for Environmental Risk Assessment*, 2022.
- (With Jefferson, Brett; Praggastis, Brenda; Purvine, E; Shapiro, Madelyn; Wang, Bei; Zhou, Youjia): "Topology of Machine Learning Applications", *2022 Joint Math Meetings*, (virtual), 2022.
- (With Frazar, Sarah; Goychayev, Rustum; and Randall, Alysha M), "Developing a Distributed Ledger For Transit Matching: An Early Prototype", *Hashing the Atom: Exploring Blockchain Solutions for Global Security*, 2021.
- "Finite Topologies and Hypergraphs: Essential Tools for Network Science", *2021 Joint Math Meetings*, https://meetings.ams.org/data/handout/math/jmm2021/Paper_3484_handout_724_0.pdf, (virtual), 2021.
- (With Frazar, Sarah; Goychayev, Rustum; and Randall, Alysha M): "Developing a Distributed Ledger For Transit Matching: An Early Prototype", *Hashing the Atom: Exploring Blockchain Solutions for Global Security*, 2021.
- (With Firoz, Jesun; Liu, Xu; Lumsdaine, Andrew; Praggastis, Brenda; Gebremedhin, Assefaw): "A Framework for Efficient Line Graph Computation for Hypergraphs", Poster at SIAM Conf. on Applied and Computational Discrete Algorithms (ACDA21), 2021.
- (With Kvinge, Henry; Jefferson, Brett A; and Purvine, EAH): "Sheaves as a Framework for Understanding and Interpreting Model Fit", Poster at 4th Int. Conf. Applied Category Theory (ACT 2021), 2021.

- "Mathematical Adventures in Multidimensional Data: From Incidence Tensors to Lattice-Valued Schema Hypergraphs", *Data Science and Image Analysis Conf.*, Washington State University, Pullman, WA, 2020.
- (With Feng, Song; Heath, Emily JF; Jefferson, BA; Kvinge, Henry; McDermott, Jason; Mitchell, Hugh; Praggastis, Brenda; Purvine, Emilie AH): *Hypergraphs and Topology for Biological Data Analysis*, in: *2020 Joint Mathematics Meetings*, Denver, CO, 2020.
- (With Purvine, Emilie AH; Feng, Song; Jefferson, Brett; Mitchell, Hugh D; McDermott, Jason E; Praggastis, Brenda L): "Hypergraph Analytics for Computational Virology", in: *ISCB Rocky 2019 Conference*, Aspen, CO, 2019.
- (With Emilie Purvine and Mark Raugas) "Towards a Functorial Approach to Dynamic Topic Modeling", *Joint Math Meeting*, Baltimore, MD, 2019.
- (With Emilie Purvine, Adam Brown, Brenda Praggastis, and Michael Robinson) "Applications of Topology for Information Fusion", *MAA Indiana Section Meeting*, Hanover IN, 2018.
- (With Emilie Purvine, Michael Robinson, and Brenda Praggastis) "Open Problems in Sheaves of Measured Data", *Workshop on Bridging Sheaves and Statistics*, IMA, Minneaopolis MN, 2018.
- (With Emilie Purvine and Michael Robinson) "A Category Theoretical Investigation of the Type Hierarchy for Heterogeneous Sensor Integration", *NIST Workshop on Applied Category Theory*, Gaithersburg MD, 2018.
- (With Emilie Purvine and Michael Robinson) "Seeking A Categorical Systems Theory via the Category of Hypergraphs", *NIST Workshop on Applied Category Theory*, Gaithersburg MD, 2018.
- (With Sinan Aksoy, Brenda Praggastis, Emilie Purvine, Michael Robinson, and Marcin Zalewski) "Hypergraph Analytics for Multidimensional Information Systems", in: *2018 Conference on Data Analytics (CODA 2018)*, Santa Fe, NM, 2018.
- (With Emilie A Purvine, Michael Robinson, and Brenda Praggastis) "Partially Ordered Sets and Finite Topologies", *SIAM Conference on Discrete Mathematics*, Denver, CO, 2018.
- "Finite Topologies for the Data Sciences?", *Data Science Day, Western Sectional Meeting AMS*, Washington State University, Pullman, WA, April 2017.
- (With Emilie A Purvine, Paul Bruillard, Chris Capraro, Chase Dowling, Vidit Nanda, Brenda Praggastis, Michael Robinson, Arun Sathanur) "Topological Data Analysis at PNNL", in: *Women in Computational Topology*, 2017.
- (With Sarah Frazar, Sam Winters, Sean Kreyling, CL West, M Schanefein, AM Sayre) "Exploring the Application of Shared Ledge Technology to Safeguards and Other National Security Topics", in: *Inst. for Nuclear Material Management 58th Annual Meeting*, Vienna, 2017.
- (With Sarah Frazar, Ken Jarman, Sean Kreyling, Curt West, Sam Winters, Amanda Sayre, and Mark Schanfein) "An Exploratory Study on Potential Safeguards Applications for Shared Ledger Technology", *IAEA Emerging Technologies Workshop: Trends and Implications for Safeguards*, IAEA, Vienna, `https://inis.iaea.org/search/search.aspx?orig_q=RN:49074898`, PNNL Technical Report PNNL-26229, 2017.
- (With Emilie A Purvine, Brenda Praggastis, and Michael Robinson) "Dualities and Combinatorics of Simplicial Sheaves of Vector Spaces on Finite Topologies", in: *SIAM Central States Section Meeting*, Fort Collins, CO, 2017.
- "Description Sheaves for Topological Information Fusion", *AMS Special Session on Computational Topology, Western Sectional Meeting*, `PNNL-SA-125775`, Washington State University, Pullman, WA, April 2017.
- (With Kathleen Nowak, Brenda Praggastis, Emilie Purvine, Michael Robinson) "Computations for Local and Pseudo Sections in Real-World Sheaves", *2017 Joint Math Meetings*, `https://jointmathematicsmeetings.org/amsmtgs/2180_abstracts/1125-55-1181.pdf`, 2017.

- (With Chin, George; Jefferson, Brett; Nowak, Katy; Brenda Praggastis, Michael Robinson, Emilie Purvine, Stephen Ranshous, Arun Sathanur): "On Beyond Graphs: Multidimensional Graph Structures for the Data Sciences", *Graphfest 2016*, 2016.
- (With Purvine, Emilie A; Robinson, Michael) "Categorification in the Real World", *2016 Joint Mathematics Meetings*, `http://jointmathematicsmeetings.org/amsmtgs/2181_abstracts/1116-l1-1922.pdf`, 2016.
- (With Purvine, Emilie A; Olsen, Bryan) "Data Fusion Enhancing Netflow Graph Analysis", *Flocon 2016*, Daytona Beach, FL, 2016.
- (With Dowling, Chase; Kreyling, Sean; Ranshous, Stephen; Curtis West, Amanda White): "Transaction Hypergraph Models for Pattern Identification in the Bitcoin Blockchain", *Financial Cryptography and Data Security 2016 (IFCA 2016)*, Barbados, 2016.
- (With Lauren Charles-Smith, Vidit Nanda, Chris Deperno, Nicholas Gould, Katy Nowak, Brenda Praggastis, Emilie Purvine, Michael Robinson, Arun Sathanur) "Topological Data Modeling for Integration of Complex, Heterogeneous Information", *2016 Conference on Data Analysis (CoDA 2016)*, 2016.
- (With Emilie Purvine and Michael Robinson) "There's a Hole In My Data! Topological Modeling of Multidimensional Heterogeneous Information Systems", *PNNL Technical Report PNNL-SA-109932*, First Distinguished Lecture in Data Science, School of Electrical Engineering and Computer Science and the Mathematics, Washington State University, Pullman WA, 2015.
- "Some Fundamentals of Data Modeling", *NSF Earth-Centered Communication for Cyberinfrastructure Field Trip*, 2015.
- (With Michael, Emilie Purvine, Chris Capraro) "Analysis of Heterogeneous Sensor Data Using Local Topology", in: *Science of Multi-Int Integration (SOMI 2015)*, 2015.
- (With Cowley, Wendy; Hogan, Emilie; and Olsen, Bryan) "Discrete Mathematical Approaches to Traffic Graph Analysis", *Flocon 2015*, 2015.
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- (With Hogan, Emilie; Paulson, Patrick; Peterson, E; Eric Stephan, Dennis Thomas) "Ontology Metrics for Semantic Recommendation of Information Integration Tasks", in: *Science of Multi-Intelligence Wshop (SOMI 2013)*, 2013.
- (With Emilie Hogan) "Distances in Partial Orders for Knowledge Discovery", *Lewis and Clark College Mathematics Department Colloquium*, 2013.
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- (With M Gregory, L McGrath, P Paulson, and KM Verspoor) "Semantic Hierarchies: Induction, Measurement, and Management", *2008 NSF Symp. on Semantic Knowledge Discovery, Organization and Use*, Courant Institute, New York University, New York, November, 2008.
- (With DDG Gessler, KM Verspoor, B Koester, and S Schmit) "Integrating Semantic Data Sources for Disease-Implicated Gene Discovery", *5th Annual Rocky Mountain Regional Bioinformatics Conf. (Rocky 07)*, 2007.

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- (With SM Mniszewski, KM Verspoor, and JD Cohn) "Improved Order Theoretical Techniques for GO Functional Annotation", poster at *Intelligent Systems for Molecular Biology (ISMB 05)*, 2005.
- (With KM Verspoor, JD Cohn, and SM Mniszewski) "Nearest Neighbor Categorization for CASP Function Prediction", poster at *Intelligent Systems for Molecular Biology (ISMB 05)*, 2005.
- (With J Cohn, KM Verspoor, and SM Mniszewski) "Predicting Protein Function Using Nearest Neighbor Categorization", *2nd Annual Rocky Mountain Regional Bioinformatics Conf. (Rocky 04)*, 2004.
- "Reports On Two Recent Bio-Ontology Workshops", in: *Proc. 7th Annual Bio-Ontologies Meeting, ISMB 04*, 2004.
- "Multi-Poset-Based Approaches to Bio-Ontologies", *First ISCB Rocky Mountain Regional Bioinformatics Meeting*, 2003.
- (With JM Booker, TM Ross, F Hemez, MC Anderson, and B Reardon) "Quantifying Total Uncertainty and Performance Margin in Assessing the Reliability of Manufactured Systems", *Fifth Tri-Laboratory Engineering Conference*, 2003.
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- (With SM Mniszewski, AW Fulmer, and GG Heaton) "Structural Classification in the Gene Ontology", in: 6th Bio-Ontologies Workshop, Intelligent Systems for Molecular Biology (ISMB 03), Brisbane, June, 2003.
- (With KM Verspoor and G Papcun) "Interactions Between the Gene Ontology and a Domain Corpus for a Biological Natural Language Processing Application", in: in: 6th Bio-Ontologies Workshop, Intelligent Systems for Molecular Biology (ISMB 03), Brisbane, June, 2003.
- (With SM Mniszeiski, AW Fulmer, and GG Heaton) "Measures in Ontological Spaces of Biological Function", poster at the *Pacific Symposium on Biocompuating PSB 03*, 2003.
- (With WL Oberkampf) "Uncertainty Quantification of Simulation Codes Using Probability Intervals", poster at the *Workshop on Quantification of Uncertainty in Physics Simulations*, Los Alamos National Laboratory, 2002.
- "The Bio-Ontological Challenge: Representations of, and Measures in, Lattice-Valued Spaces", presented at the *2002 Workshop on Enabling Concepts for Systems Biological Modeling*, Santa Fe, 2002.
- "Link Anlaysis of Social Meta-Networks", presented at the *2002 Conf. on Computational Analysis of Social and Organizational Systems (CASOS 02)*, 2002.
- "A Semiotic Critique of the Limits of Formal Models", *2001 Workshop on Virtual Worlds and Simulation (VWSim01)*, 2001.
- "Systems Concepts for the Simulation of Ultra-Large Networks", *NSF Workshop on Modeling and Simulation of Ultra-Large*, Tucson, 2001.
- "What Could We Mean By 'Global Brain': How Distributed Knowledge Systems Facilitate Social Control in Semiotic Agent-Based Architectures", presented at the *Workshop on Intelligent Networks and Social Evolution*, Brussels, 2001.
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- "Network Dynamical Approach to Articial Life: Morowitz' Challenge", poster at *1995 European Conf. on Artificial Life*, 1995.

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- (With Frazar, S; Goychayev, R; Randall, AM; Meville, A; Whattam, K): "Exploration of Potential Application of Distributed Ledger Technology for Managing Transactions Under Joint Technology Development and Transfer Agreements", *PNNL Technical Report PNNL-30525*, 2020
- (With Frazar, S; Goychayev, Rustum; and Randall, Alysha M): "Transit Matching Blockchain Prototype", *PNNL Technical Report PNNL-29527*, 2020.
- (With Frazar, Sarah; Singh, RK; and Sayre, AM:) "Evaluating Safeguards Use Cases for Blockchain Technology", *PNNL Technical Report PNNL-28050*, 2018.
- (With Frazar, Sarah; Winters, Sam; Kreyling, Sean; West, CL; Schanefein, M; Sayre, AM): "Exploring the Application of Shared Ledger Technology to Safeguards and Other National Security Topics", in: *Institute for Nuclear Materials Management 58th Annual Meeting*, Inst. for Nuclear Materials Mgmt., Indian Wells CA, PNNL-SA-126685, 2017.
- (With Sarah Frazar, Ken Jarman, Sean Kreyling, Curtis West, Sam Winters, Amanda Sayre, March Schanfein) "An Exploratory Study on Potential Safeguards Applications for Shared Ledger Technology", *IAEA Emerging Technologies Workshop: Trends and Implications for Safeguards*, IAEA, Vienna, `https://inis.iaea.org/search/search.aspx?orig_q=RN:49074898`, PNNL Technical Report PNNL-26229, 2017.
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