SHIRLY STEPHEN

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EDUCATION

University of Maine, Orono, ME USA *2016–2021*

Ph.D. in Spatial Information Science & Engineering (with a minor in Mathematics)

Thesis: *Improving Model Finding for Integrated Quantitative-Qualitative Spatial Reasoning with First-order Logic Ontologies*.

Advisor: Dr. Torsten Hahmann.

University of Maine, Orono, ME USA *2013–2016*

M.S. in Spatial Information Science & Engineering

Dissertation title: *Ontological Analysis and Formal Grounding of the Groundwater Markup Language (GWML2) with the Hydro Foundational Ontology (HYFO)*.

Advisor: Dr. Torsten Hahmann.

College of Engineering, Guindy, Anna University, Chennai, India *2007–2011*

B.E. in Geo-informatics Engineering

First Class Honors (ranked 3rd).

RESEARCH INTERESTS

Geospatial Knowledge Graphs, Spatial Representation and Reasoning, Ontologies, Semantic Web, Geo-AI, Geospatial Semantics, IoT, GIS Science for Emergency Management, Urban Analytics, Big Data, Spatial Data Mining and Knowledge Discovery. Earth Observations for Environmental Intelligence

RESEARCH PROJECTS

KnowWhereGraph is a framework that integrates a *knowledge graph* with *geo-enrichment* to deliver area briefings within seconds for any location on Earth. It is designed to enhance *environmental intelligence*, enabling decision-makers and data scientists to quickly enrich their data with billions of interconnected, up-to-date facts at the human-environment interface, thereby improving situational awareness for informed decision-making.

SAWGraph is an *Open Knowledge Network* that leverages using *Geospatial Knowledge Graph* technology to monitor and trace per- and polyfluoroalkyl substances (PFAS) and other contaminants in the nation's food and water systems. It integrates federal and other datasets to facilitate rapid analysis and informed decision-making regarding PFAS sources, testing, impacts, and risks. The precursor of this project was the *AIKnowsPFAS*, a NASA/NSF EPSCoR project.

The Urban Flooding Open Knowledge Network is an *information infrastructure* that integrates urban multiplex data to generate real-time and long-term *flood forecasts* across the continental U.S. This framework serves as a foundation for assessing the comprehensive impact of floods on cities, including cascading economic impacts and failures across infrastructure, ecosystems, and communities.

GWML2-FOL is a first-order logic formalization of the Groundwater Markup Language (GWML2), extending the *Hydro Foundational Ontology*. The analysis and stratification of this ontology revealed semantic ambiguities within GWML2, leading to terminological and semantic refinements to facilitate its integration with other semantic water representations.

SF-FOL [9] provides a formal representation of the OGC/ISO *Simple Feature Access* (SFA) standard by modeling geospatial information as a logical extension and restriction of the multidimensional qualitative spatial ontology CODI. This representation was then used for *joint qualitative reasoning* over geometric and qualitative spatial information, enabling advanced automated spatial reasoning.

Empowering Multi-Conceptual Spatial Reasoning with a Repository of Qualitative and Quantitative Spatial Ontologies encoded various *spatial conceptualizations* in first-order logic within a structured ontology repository. This structure enabled the automatic selection of the most suitable ontology for a specific spatial task, and to convert spatial information between different ontologies. The work advanced the understanding of how logical relationships can be utilized to formally compare the expressiveness of spatial ontologies, and how an ontology repository can be supplemented with information for automated knowledge conversion across diverse ontological frameworks.

WORK EXPERIENCE

Postdoctoral Scholar, University of California, Santa Barbara, CA, USA. *From September 2024*

National Center for Ecological Analysis and Synthesis (NCEAS).

Supervisors: Dr. Ben Halpern, Dr. Matt Jones, Dr. Krzysztof Janowicz

- Set to work on geospatial data processing, representation, search, and visualization using knowledge graphs, with a focus on knowledge representation and reasoning for geographic within the Permafrost Discovery Gateway project
- Co-PI for a grant focused on developing the KnowWhereGraph Open-Source Ecosystem (OSE); submission to the NSF 23:595: Geoinformatics Program under the Innovative Resources Track.

Research Scientist, University of Maine, Orono, ME, USA. *Since October 2023*

Spatial Knowledge and Artificial Intelligence Lab (SKAI) at the Department of Computer Science.

Supervisor: Dr. Torsten Hahmann

- Initiated and led collaborative discussions with leading federal agencies, including the EPA, CDC, FDA, USGS, and USDA, to identify critical gaps in geospatial data integration and analysis for PFAS research. Provided key expertise in data integration strategies and analytics, contributing to the development of the SAWGraph NSF grant proposal.
- Engaged in extensive discussions with subject matter experts from the EPA, and state Department of Environmental Protection Agencies (Maine, Colorado, Illinois, and New Hampshire) to understand environmental sampling processes, contamination sources, and contaminant movement. This critical knowledge informed the development of the Contaminant Observation Ontology (ContaminO) to align data modeling with project goals and national research priorities.
- Developed methods to aggregate and link PFAS sampling observations to the S2 Geometry. This linkage was then used to analyze PFAS contamination and movement within national water data by reasoning over data in the National Hydrological Data (NHD) as part of the Internet of Water knowledge graph.
- Developed ontologies and Python scripts for data translation to model and ingest PFAS sampling data from federal agencies within the knowledge graph.
- Developed an evaluation framework to benchmark the complexity of geospatial reasoning in large-scale knowledge graphs, with ongoing experiments to assess performance measurements of RDF-based GeoSPARQL querying.
- Advanced the SAWGraph project's objectives by presenting data findings and reports to the EPA and at research conferences (see presented talks section).
- Actively involved in the translation of EPA's CompTox Chemicals database into FAIR data, linking it to other datasets including analytical methods (AMAS), substance registry (SRS), and CDC's toxic exposure database.

Postdoctoral Scholar, University of California, Santa Barbara, CA, USA *August 2021–August 2024*

Space and Time for Knowledge Organization Lab (STKO) at the *Department of Geography.*

Supervisor: Dr. Krzysztof Janowicz

- Led the development of a reference ontology for the hazard and disaster domain, formalizing the United Nations Hazard Classification in collaboration with specialists from the ESIP cluster and the ENVO project. The resulting HIP Ontology has been well received by the disaster data management community, winning an award at FOIS 2024. I am currently collaborating with knowledge modelers, including Simon Cox (OGC member), to secure NSF funding for a workshop aimed at extending and standardizing this ontology for broader adoption in the linked data community, including the United Nations Disaster Risk Reduction team.
- Spearheaded the semantic integration of over 35 earth science datasets into KnowWhereGraph by developing domain-specific ontologies and Python scripts for modeling, cleaning, semantical lifting, and spatial integration. The scripts and ontologies are available through open-source licensing on GitHub.
- Coordinated with teams developing the public-facing geo-enabled faceted search interface, geo-visualization tool for Direct Relief, and crop assessment tool for the Food Industry Association. Led efforts to identify and formalize stakeholder requirements, ensuring that the ontologies designed accurately addressed their specific needs.
- Co-developed the pipeline for automated graph updates and formalization of causal links between disaster data in collaboration with Mitchell Faulk. These contributions were integral to the release of KWG V 3.0 (the Santa Barbara release), establishing it as one of the world's largest geospatial knowledge graph with advanced reasoning capabilities.
- Developed the comprehensive documentation for the KnowWhereGraph ontology, which serves as the foundational framework for the entire graph.

- Authored and co-authored multiple research papers, presented findings at international conferences, and organized workshops and tutorials.
- Developed an integration framework to connect all geospatial data in KnowWhereGraph with S2 Geometry grid cells, the Global Administrative Region dataset's gazetteer of places, and Wiki Data.
- Designed a metadata framework for comprehensive modeling and representation of provenance and data lineage at the subgraph level within KnowWhereGraph, ensuring traceability of individual data points and datasets..
- Led three weekly project meetings, coordinating the entire team to gather updates and drive progress toward project goals and NSF reviews. Responsibilities included planning, note-taking, communication, and delegation. Additionally, mentored a cohort of ten graduate students from four universities, ensuring their contributions aligned with project objectives.
- Played a key role in developing cross-graph integration: between KnowWhereGraph and the SPOKE Biomedical Knowledge Graph through node traversal via dereferencing, and established linkages with the Wen-OKN via federated querying.

Research Scientist, University of Maine, Orono, ME, USA. *February 2023 – September 2023*

Spatial Knowledge and Artificial Intelligence Lab (SKAI) at the Department of Computer Science.

Supervisor: Dr. Torsten Hahmann

- Played a pivotal role in establishing and expanding a collaborative research network in Maine, collaborating with key state agencies like the Maine DEP, Department of Fisheries and Wildlife, Maine Farmland Trust, and the Maine Drinking Water Authority.
- Led the integration and semantic fusion of fragmented state-level PFAS databases, including Maine EGAD sampling data, Maine Public Drinking Water, and sludge deposits data enabling the explicit capture of critical connections, such as the origin, spread, and remediation effects of PFAS.
- Developed a prototype knowledge graph using advanced knowledge graph and ontology engineering technologies, which significantly advanced the research objectives on PFAS contamination. This was primarily driven by my knowledge from KnowWhereGraph, and the output led to us getting a follow-up grant of about 3M through the NSF-Proto-OKN grant.
- Utilized cutting-edge AI-driven geospatial analysis tools to position Maine as a leader in addressing PFAS contamination, with a focus on ensuring the long-term sustainability of the state's agricultural sector.
- Contributed to the strategic direction and research capabilities of Maine's efforts to combat PFAS contamination, leveraging technical expertise to support environmental and public health initiatives.

Postdoctoral Scholar, Arizona State University, Tempe, AZ, USA *January 2021–July 2021*

Cyberinfrastructure and Computational Intelligence Lab at the *School of Geographic Science and Urban Planning.*

Supervisor: Dr. Wenwen Li

- Co-developed GeoGraphViz, the geospatial visualization interface for the KnowWhereGraph.
- Benchmarking and reviewing spatial graph repositories and their computational performance for spatial queries.
- Developing ontologies and data translation scripts for OpenFEMA's Disaster Declaration datasets.

Research Assistant, University of Maine, Orono, ME, USA. *March 2023–September 2023*

Spatial Knowledge and Artificial Intelligence Lab (SKAI) at the Department of Computer Science.

Supervisor: Dr. Torsten Hahmann

- Co-developed the prototype knowledge graph for PFAS analytics in the AIKnowsPFAS project.
- Developed ontologies and data translation python scripts for ingesting Maine EGAD's PFAS datasets into the graph.
- Developed ontologies for modeling the Facility Registry Service dataset, to analyze PFAS contamination sources in the graph.

Research Assistant, University of Maine, Orono, ME, USA.

National Center for Geographic Information Sciences (NCGIA). *October 2013–August 2014*

Supervisor: Dr. Kate Beard Tisdale

- Developed a semantically enhanced linked data gazetteer using Sesame RDF database for the USGS' NHD and NHD Plus datasets.

September 2014–May 2015

- Performed spatial statistical analysis to study the correlation between storms and the dynamics of shellfish pathogens.

Systems Engineer, Tata Consultancy Services, Hyderabad, India. *June 2011–August 2013*

- Co-developed a GIS mapping application and web services for integrating the GIS system with other modules in the RAPDRP (Restructured Accelerated Power Development and Reform Project).
- Implemented ArcFM auto updaters for tracing and network analysis functionalities.
- Co-developed electric utility application using SmallWorld Electric Office in the Magik development environment.

INTERNSHIPS

Graduate Research Intern, Rensselaer Polytechnic Institute, Troy, NY, USA *June 2018–August 2018*

Institute for Data Exploration and Applications (IDEA) Lab

- Wrote SWRL rules for breast cancer, and diabetes disease diagnosis for the HEALS, a joint IBM-RPI project.

Undergraduate Research Intern, Indian Space Research Organization, Bangalore, India

- Assisted on a project that modeled hourly evapotranspiration in urban areas (of India) using remote sensing and meteorological data – programming using MATLAB.

UNDERGRADUATE RESEARCH EXPERIENCE

Capstone Project *August 2007–May 2011*

- A GIS based approach for 3D urban traffic noise pollution modeling using ArcGIS. - *Presented at Geospatial World Forum, Hyderabad, India, Jan 19-21, 2011.*

Course Projects

- Automatic extraction of power lines from LIDAR data – *Presented at TECHUTSAV'09, a national technical symposium organized by Thiagarajar College of Engineering, Madurai, India*.
- Suitable site selection for disposal of municipal solid waste for Madurai district using ArcGIS. – *Presented at CIVILIZ'09, a national level technical Noorul Islam Institute, Tamil Nadu, India.*
- Qualitative determination of change in density of mangrove forests in Pichavaram using satellite temporal data using ERDAS and ENVI – *Presented at Celesta'08, a national level technical symposium organized by the Institute of Remote Sensing, CEG, Chennai, India*

TEACHING EXPERIENCE

Teaching Assistant

- COS 301: Programming Languages: Python (assisted Carol Roberts) *Fall 2017 & 2019*
- COS 250: Discrete Structures (assisted Dr. Torsten Hahmann) *Fall 2017 & 2019*
- SIE 509: Introduction to Geographic Information Systems (assisted Dr. Kate Beard) *Fall 2018*
- SIE 510: GIS Applications (assisted Dr. Kate Beard) *Spring 2018 & 2019*

Postdoc-student mentor

- Mentored 10 graduate students (2021-2024) working on the KnowWhereGraph project from Arizona State University, Kansas State University, Wright State University, and the University of California, Santa Barbara. Collaborated with their advisors, including Dr. Wenwen Li, Dr. Pascal Hitzler, Dr. Cogan Shimizu, and Dr. Krzysztof Janowicz, to guide their research on the following topics:
  - Python programming for geospatial data cleaning, processing, and integration using RDFLib.
  - Metadata-to-ontology translation.
- Mentored 2 graduate students (2023–present) working on the SAWGraph project under the supervision of Dr. Torsten Hahmann, providing guidance on the following topics:
  - Schema design in Yed Editor.
  - Ontology design and verification in Protégé environment.

COMPUTER SKILLS

- Programming Languages: Python (proficient), Java, C#, ASP.NET framework, Javascript, HTML, R, Prolog
- Tools/Products: ArcGIS Server and Desktop, QGIS, PostGIS, ERDAS, ENVI, Protégé, Several Triple stores (GraphDB, Jena, Sesame)
- Database Programming: ORACLE, MySQL, MS Access
- Semantic Technologies: RDF, RDFS, SPARQL, OWL, First-order logic
- Experience working with Git.

GRANTS/ FUNDING

Title: AIKnowsPFAS – Building a knowledge graph framework to address the advanced analytical needs around PFAS contamination in Maine,

PI Name: Dr. Torsten Hahmann, University of Maine

Name of Funding Organization: NASA/NSF

Role in Project: Senior Researcher

Date: January 2023 - September 2023

Title: Safe Agricultural Products and Water Graph (SAWGraph)

PI Name: Dr. Torsten Hahmann, University of Maine

Name of Funding Organization: NSF

Role in Project: Senior Personnel

Date: October 2023 - Current

AWARDS

- Best Paper Award at FOIS 2024 for the `Knowledge Explorer` [8].
- Best Paper Award at FOIS 2024 the `HIP Ontology` [2].

CONFERENCES/ TALKS (MOST RECENT)

- July 2024 – FOIS 2024. *SAWGraph - The HIP Ontology – a formal framework to support disaster risk reduction and management.*
- June 2024 – CEGIS Annual Research Meeting. *SAWGraph - Geo-spatially linking, aggregating, and analyzing PFAS contamination sources and occurrences*.
- May 2024 – KGC 2024. OKN Workshop. *Towards meta knowledge graphs: First step in integrating minimally overlapping knowledge graphs*

PROFESSIONAL SERVICE

Workshop Chair/Organizer

- First Workshop on Geospatial Knowledge Graphs (GeoKG) - KGC2022 - The Knowledge Graph Conference 2022, New York City, May 2022
- Workshop on Ontologies for the Disaster Domain (WOOD) - JOWO 2022. The Joint Ontology Workshops, Jönköping, Sweden, August 2022
- Environmental Data Integration and Intelligence Services using Knowledge Graphs - US2TS 2022, The 4th U.S. Semantic Technologies Symposium, Lansing MI, September 2022
- Reference ontologies for Natural Hazards and Disasters - US2TS 2022, The 4th U.S. Semantic Technologies Symposium, Lansing MI, September 2022
- A Walkthrough of the KnowWhereGraph: a Masterclass Session – KGC2023 – The Knowledge Graph Conference 2023, New York City, May 2023
- Knowing Where via Knowledge Graph–based GeoEnrichment – ISWC2023 – The 22nd International Semantic Web Conference, Athens, Greece, November 6-10, 2023.
- Open Knowledge Network – KGC2024 – The Knowledge Graph Conference, Cornell, New York, May 9, 2024.

Conferences – Session Chair

- People and Places, GIScience 2021 - The 11th International Conference of Geographic Information Science, Poznan, Poland, September 2021

Conferences and Workshops – Program Committee Member

- Spatial Ontologies for e-Science - The Vespucci Initiative 2015, Bar Harbor, ME, June 2015
- Geospatial Session - US2TS 2019, The 42nd U.S. Semantic Technologies Symposium, Durham NC, March 2019.
- 12th Workshop on Ontology Design and Patterns - WOP2021.

- The Second Spatial Data Science Symposium (SDSS2021), Virtual, September 2021.
- MK2022 Workshop on Modular Knowledge - co-located with the 19th Extended Semantic Web Conference (ESWC 2022), Greece, May 2022.
- The Third Spatial Data Science Symposium (SDSS2022), Virtual and Vienna (in-person), September 2022.
- The Web Conference (Web2021), Austin, Texas, May 2023.
- Formal Ontologies in Information Systems (FOIS2021), Quebec, Canada, September 2023.
- The Second International Workshop on Methods, Models, and Resources for Geospatial Knowledge Graphs and GeoAI – co-located with the 12th International Conference on Geographic Information Science, Leeds, UK, September 2023.
- Large Language Models for Knowledge Graph and Ontology Engineering, AAAI Fall Symposium Series, November 7-9, Arlington, VA, USA.
- The Joint Ontology Workshops, Formal Ontologies in Information Science 2024, July 15-19, Enschede, Netherlands.

Journal Review Board Member

- Semantic Web Journal
- Applied Ontology Journal
- Frontiers in Environmental Science
- Journal of Environmental Informatics
- Journal of Web Semantics

OTHER ACTIVITIES

- Student representative, Department of Computer Science, Graduate Student Government, UMaine (2015-2018)
- Vice President, International Student Association, UMaine (2016-2017)
- Vice President, South Asian Association, UMaine (2016-2018)
- Secretary, South Asian Association, UMaine (2015-2016)
- Secretary, ACM-W, UMaine (2017),
- President, Society of Geo-informatics Engineers (2010-2011)

PUBLICATIONS

Refereed conference papers:

[1] **Shirly Stephen**, Torsten Hahmann. "Formal Qualitative Spatial Augmentation of the Simple Feature Access Model". In: *Proceedings of the 14th International Conference on Spatial Information Theory (COSIT 2019)*. Regensburg, Germany, Sep 9-13, 2019.

[2] **Shirly Stephen**, Mark Schildhauer, Krzysztof Janowicz, Kitty Currier, Pascal Hitzler, Cogan Shimizu, Colby K. Fisher, Dean Rehberger. "The HIP Ontology: A Formal Framework to Support Disaster Risk Reduction and Management". In: *Proceedings of the 14th International Conference on Formal Ontologies (FOIS 2024)*. Enschede, Netherlands. Jul 15-19, 2024.

(Best Paper Award)

[3] Matthew P. Dube, Max J. Egenhofer, Joshua A. Lewis, **Shirly Stephen**, Mark A. Plummer. "Swiss Canton Regions: A Model for Complex Objects in Geographic Partitions". In: *Proceedings of the 12th International Conference on Spatial Information Theory (COSIT 2015)*, Santa Fe, NM, USA, Oct 12-16, 2015.

[4] **Shirly Stephen**, Torsten Hahmann. "An Ontological Framework for Characterizing Hydrological Flow Processes". In: *Proceedings of the 13th International Conference on Spatial Information Theory (COSIT 2017)*. Schloss-Dagstuhl-Leibniz Zentrum für Informatik. Mar. 2017.

[5] **Shirly Stephen**, Torsten Hahmann. "Model-finding for Externally Verifying FOL Ontologies: A Study of Spatial Ontologies". In: IOS Press: *Proceedings of the 10th Internation Conference on Formal (FOIS 2020).* Bolzano, Italy, Sept. 2020.

[6] Rui Zhu, Ling Cai, Gengchen Mai, Cogan Shimizu, Colby K. Fisher, Krzysztof Janowicz, Anna Lopez-Carr, Andrew Schroeder, Mark Schildhauer, Yuanyuan Tian, **Shirly Stephen**, Zilong Liu. "Providing Humanitarian Relief Support through Knowledge Graphs". In: *Proceedings of the 11th Knowledge Capture Conference (K-Cap'21)*. (pp 285-288). Dec. 2021.

[7] Torsten Hahmann, **Shirly Stephen**, Boyan Brodaric. "Semantically Refining the Groundwater Markup Language (GWML2) with the help of a Reference Ontology". In: *Proceedings of the 9th International Conference on Geographic Information Science (GIScience'16),* Montreal, Canada, Sept 27-30, 2016.

[8] Zilong Liu, Zhining Gu, Thomas Thelen, **Shirly Stephen**, Seila Gonzalez Estrecha, Rui Zhu, Colby K Fisher, Anthony D'Onofrio, Cogan Shimizu, Krzysztof Janowicz, Mark Schildhauer, Dean Rehberger, Wenwen Li, Pascal Hitzler. "Knowledge Explorer: Exploring the 12-Billion-Statement KnowWhereGraph using Faceted Search". In: *Proceedings of the 30th International Conference on Advances in Geographic Information Systems (SIGSPATIAL'22)*, Seattle, USA. (pp. 1-4). Nov. 2022.

(Best Paper Award)

[9] Cogan Shimizu, **Shirly Stephen**, Rui Zhu, Gengchen Mai, Colby Fisher, Ling Cai, Mark Schildhauer, Krzysztof Janowicz, Pascal Hitzler, Lu Zhou. "A Pattern for Features on a Hierarchical Spatial Grid". In: *Proceedings of the 10th International Joint Conference on Knowledge Graphs*. (pp 108-114) 2021.

[10] Rui Zhu, Cogan Shimizu, **Shirly Stephen**, Lu Zhou, Ling Cai, Gengchen Mai, Krzysztof Janowicz, Mark Schildhauer, Pascal Hitzler. "SOSA-SHACL: Shapes Constraint for the Sensor, Observation, Sample, and Actuator Ontology". In: *Proceedings of the 10th International Joint Conference on Knowledge Graphs (IJCKG'21)*. (pp 99-107). 2021.

[11] Cogan Shimizu, **Shirly Stephen**, Antrea Christou, Kitty Currier, Mohammad Saeid Mahdavinejad, Sanaz Saki Norouzi, Abhilekha Dalal, Adrita Barua, Colby K Fisher, Anthony D'Onofrio, Thomas Thelen, Krzysztof Janowicz, Dean Rehberger, Mark Schildhauer, Pascal Hitzler. "KnowWhereGraph-Lite: A Perspective of the KnowWhereGraph". In: *Proceedings of the Iberoamerican Knowledge Graphs and Semantic Web Conference (KGSWC'23)*. Zaragoza, Spain (pp 199-212), Nov 13-15, 2023.

[12] **Shirly Stephen**, Torsten Hahmann. "Identifying Bottlenecks in Practical SAT-Based Model Finding for First-Order Logic Ontologies with Datasets". In: *Proceedings of the AAAI Conference on Artificial Intelligence*. Vol. 33. No. 01. Honolulu, USA, (pp 10039-10040). Feb. 2019.

Refereed workshop papers:

[13] **Shirly Stephen**, Cogan Shimizu, Mark Schildhauer, Rui Zhu, Krzysztof Janowicz, Pascal Hitzler. "A Pattern for Representing Scientific Taxonomies". In: *Proceedings of the 22nd International Semantic Web Conference (ISWC): 14th Workshop on Ontology Design Patterns*. Athens, Greece. Nov 6-10, 2022.

[14] **Shirly Stephen**, Wenwen Li, and Torsten Hahmann. "Geo-Situation for Modeling Causality of Geo-Events in Knowledge Graphs". In: *Proceedings of the 11th International Conference on Geographic Information Science (GIScience;21): 1st International Workshop on Methods, Models, and Resources for Geospatial Knowledge Graphs and Geo-AI.* Poznan, Poland, Sept. 2021.

[15] **Shirly Stephen**, Mark Schildhauer, Ling Cai, Yuanyuan Tian, Kitty Currier, Cogan Shimizu, Krzysztof Janowicz, Pascal Hitzler, Anna Lopez-Carr, Andrew Schroeder, Zilong Liu, Rui Zhu, Colby K Fisher, Gengchen Mai. "The Expertise Ontology: Modeling Expertise in the Context of Emergency Management.". In: *Proceedings of the 9th Joint Ontology Workshops (JOWO 2023), co-located with 13th International Conference in Formal Ontologies in Information Systems*. Sherbrooke, Canada. July 2023.

[16] Cogan Shimizu, Shirly Stephen, Rui Zhu, Kitty Currier, Mark Schildhauer, Dean Rehberger, Pascal Hitzler, Krzysztof Janowicz, Colby K Fisher, Mohammad Saeid Mahdavinejad, Antrea Christou, Adrita Barua, Abhilekha Dalal, Sanaz Saki Norouzi, Zilong Liu, Meilin Shi, Ling Cai, Gengchen Mai, Zhangyu Wang, Yuanyuan Tian. "The KnowWhereGraph Ontology: A Showcase". In: *Proceedings of the 9th Joint Ontology Workshops (JOWO 2023),*

co-located with 13th International Conference in Formal Ontologies in Information Systems. Sherbrooke, Canada. July 2023.

[17] **Shirly Stephen**, Mark Schildhauer, Kitty Currier, Pascal Hitzler, Cogan Shimizu, Krzysztof Janowicz, Dean Rehberger. "Formal Framework for Disaster Risk Properties.". In: *Proceedings of the 9th Joint Ontology Workshops (JOWO 2023), co-located with 13th International Conference in Formal Ontologies in Information Systems*. Sherbrooke, Canada. July 2023.

[18] Rui Zhu, **Shirly Stephen**, Lu Zhou, Cogan Shimizu, Ling Cai, Gengchen Mai, Krzysztof Janowicz, Pascal Hitzler, Mark Schildhauer. "Environmental Observations in Knowledge Graphs". In: *4th Workshop on Metadata and Research (objects) Management for Linked Open Science (DaMaLOS 2021), Extended Semantic Web Conference (ESWC), Hersonissos, Greece* (pp. 1-11). May. 2021.

Journals and magazines:

[19] **Shirly Stephen**. "Improving Model-Finding for Integrated Qualittative-Quantitative Spatial Reasoning with First-Order Logic Ontologies". In: *DigitalCommons@UMaine*. Ph.D. Dissertation (Sep. 2021).

[20] Krzysztof Janowicz, Pascal Hitzler, Wenwen Li, Dean Rehberger, Mark Schildhauer, Rui Zhu, Cogan Shimizu, Colby Fisher, Ling Cai, Gengchen Mai, Joseph Zalewski, Lu Zhou, **Shirly Stephen**, Seila Gonzalez, Bryce Mecum, Anna Carr, Andrew Schroeder, Dave Smith, Dawn Wright, Sizhe Wang, Yuanyuan Tian, Zilong Liu, Meilin Shi, Anthony D'onofrio, Zhining Gu, Kitty Currier. "Know, Know Where, KnowWhereGraph: A densely connected, cross-domain knowledge graph and geo-enrichment service stack for applications in environmental intelligence". In: *AI Magazine* 43(1) (2022), pages 30–39.

[21] Torsten Hahmann, **Shirly Stephen**. "Moving from Information to Insight by Linking Urban and Hydrologic Systems through the Urban Flooding Open Knowledge Network". In: *Water Resources IMPACT* 22.3. Issue: *Geospatial Water Technology: Complex Systems* (Mar. 2020).

[22] Torsten Hahmann, **Shirly Stephen**. "Using a hydro-reference ontology to provide improved computer-interpretable semantics for the groundwater markup language (GWML2)". In: *International Journal of Geographic Information Science* 32(6) (Mar. 2018), pages 1138-1171.

[23] Krzysztof Janowicz, Cogan Shimizu, Pascal Hitzler, Gengchen Mai, **Shirly Stephen**, Rui Zhu, Ling Cai, Lu Zhou, Mark Schildhauer, Zilong Liu, Zhangyu Wang, Meilin Shi. "Diverse data! Diverse schemata?". In: *International Journal of Semantic Web* 0 (2021) 1-0. IOS Press, 2022.

[24] Torsten Hahmann, **Shirly Stephen**, Boyan Brodaric. "Domain Reference Ontologies vs. Domain Ontologies: What's the difference". In: *Lessons from the Water Domain*, 2016.

[25] Krzysztof Janowicz, Kitty Currier, **Shirly Stephen**, Cogan Shimizu, Rui Zhu, Meilin Shi, Colby K Fisher, Dean Rehberger, Pascal Hitzler, Zilong Liu. "Fast Forward from Data to Insight: (Geographic) Knowledge Graphs and Their Applications". In: *Handbook of Geospatial Artificial Intelligence*. CRC Press (pp 411-426). 2023.

In submission (Journal articles with online pre-published copies):

[26] **Shirly Stephen**, Mitchell Faulk, Krzysztof Janowicz, Colby Fisher, Thomas Thelen, Rui Zhu, Cogan Shimizu, Pascal Hitzler, Kitty Currier, Mark Schildhauer. "Utilizing S2 Geometry as a Nexus for Cross-Graph Integration". Submitted to: *Transactions in GIS (Aug 2024)*, (pending publication).

[27] Cogan Shimizu, **Shirly Stephen**, Adrita Barua, Ling Cai, Antrea Christou, Abhilekha Dalal, Pascal Hitzler, Mark Schildhauer, et. al. "The KnowWhereGraph Ontology". Submitted to: *Journal of Web Semantics (March 2024)*, (accepted, pending publication).

[28] Rui Zhu, **Shirly Stephen**, Cogan Shimizu, Krzysztof Janowicz, Pascal Hitzler, Mark Schildhauer, Colby Fisher, Kitty Currier, et. al. "KnowWhereGraph: A Geo-Knowledge Graph to Support Cross-Disciplinary Knowledge Discovery". Submitted to: *International Journal of Geographic Information Science (July 2024)*, (pending publication).

REFERENCES

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Dr. Hari Prasath Palani
Northeastern University
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