Gunjan Singh

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Research Interests

Knowledge Graphs, Ontology Reasoning and Benchmarking, Neuro-symbolic Reasoning, Reinforcement Learning

Education

Jan 2019 – Dec 2024	**Ph. D. in Computer Science and Engineering** Indraprastha Institute of Information Technology (IIIT), New Delhi, India Advisors: Dr. Raghava Mutharaju (IIIT, Delhi, India), Dr. Sumit Bhatia (Adobe Inc., India) Thesis title: *Benchmarking Static and Stream-based Description Logic Reasoners.*
Jul 2014 – Jun 2016	**M. Tech in Computer Science and Engineering** *(Gold Medalist)* Aligarh Muslim University (AMU), Aligarh, India Advisor: Dr. Saiful Islam (AMU, India) Thesis title: *Content Prioritization Based Self-Embedding for Image Restoration*
Jul 2010 – Jun 2014	**B. Tech in Computer Engineering** Aligarh Muslim University (AMU), Aligarh, India

Work Experience

Sep 2023 – Feb 2024	**Research Intern** INSA, Lyon, France Mentor: Dr. Riccardo Tommasini
May 2019 – Jul 2019	**Research Intern** IBM Research Lab, New Delhi, India Mentor: Dr. Sumit Bhatia
Aug 2016 – Dec 2018	**Assistant Professor** Galgotias College of Engineering and Technology, India

Technical Skills

Programming Languages	Java, Python, C
Tools and Technologies	OWL, RDF, SPARQL, SHACL, Protege, GraphDB, Stardog

Projects

Benchmarking Static and Stream-based Description Logic Reasoners

Despite efforts to optimize reasoning methods, current approaches face challenges in handling large and expressive ontologies effectively. Therefore, there is a need for more advanced and efficient reasoning techniques. One of the ways to advance the field of ontological reasoning is to have standardized benchmarks that can help developers find performance bottlenecks. We address this need by introducing synthetic benchmarks for static and steaming Description Logic reasoners.

1. OWL2Bench (Conventional Reasoner Benchmarking)
OWL2Bench generates static ontologies with varying sizes of TBox and ABox axioms to benchmark conventional OWL reasoners. It helps evaluate performance in terms of reasoning time and memory usage.

2. OWL2StreamBench (Stream Reasoner Benchmarking)
OWL2StreamBench benchmarks OWL-based stream reasoners by simulating streaming data. It measures performance indicators like latency, throughput, memory usage, completeness, and correctness using realistic domain data and continuous queries.

3. OntoGen (Configurable Ontology Generator for Reasoner Benchmarking)
OntoGen creates customizable ontologies for benchmarking reasoners, allowing selection of OWL 2 constructs and specifying their count. It aids in evaluating different reasoning systems across various OWL 2 profiles and Description Logics.

4. NeSyBench (Neuro-symbolic Reasoner Benchmarking)
NeSyBench benchmarks neuro-symbolic reasoners, supporting different OWL 2 profiles and reasoning tasks. It provides a standardized framework for performance evaluation and comparison using common metrics, addressing the unique needs of neuro-symbolic reasoning systems.

Exploring Non-Conventional Techniques for Description Logic Reasoning

In recent years, there has been significant interest in exploring innovative approaches for description logic reasoning to improve scalability and efficiency. This includes leveraging neuro-symbolic methods and approximation techniques to enhance reasoning performance, especially for large and expressive ontologies.

1. TLDR (Deep Reinforcement Learning for Optimizing Description Logic Tableau Expansion)
This project proposes using deep reinforcement learning to optimize the tableau expansion procedure in description logic reasoning. By addressing the non-determinism at each step, the approach aims to reduce the overall time complexity of the conventional tableau algorithm.

2. ARC (Towards a Concurrent Approximate Description Logic Reasoner)
ARC focuses on developing a concurrent system for approximate reasoning in description logics. By utilizing concurrent programming methods and creating novel data structures and algorithms, this project aims to achieve highly efficient reasoners, even for more expressive reasoning profiles.

Publications

Papers

1   G. Singh, U. Arora, S. Kumar, *et al.*, "GenACT: An ontology-based temporal web data generator," 43rd International Conference on Conceptual Modeling (ER 2024), Pittsburgh, Pennsylvania, October 28-31, 2024, 2024. 🔗 URL: To_Appear.

2   G. Singh, A. Kumar, S. Bhatia, and R. Mutharaju, "OWL2Gen: Towards a configurable ontology generator for benchmarking," 43rd International Conference on Conceptual Modeling (ER 2024), Posters and Demos, Pittsburgh, Pennsylvania, October 28-31, 2024, 2024. 🔗 URL: To_Appear.

3   G. Singh, R. Tommasini, S. Bhatia, and R. Mutharaju, "Benchmarking neuro-symbolic description logic reasoners: Existing challenges and a way forward," Neurosymbolic Artificial Intelligence, 2024. 🔗 URL: `To_Appear`.

4   G. Singh, "Benchmarking symbolic and neuro-symbolic description logic reasoners," CEUR Workshop Proceedings, vol. 3678, 2023. 🔗 URL: `https://ceur-ws.org/Vol-3678/paper11.pdf`.

5   G. Singh, S. Bhatia, and R. Mutharaju, "Neuro-symbolic RDF and description logic reasoners: The state-of-the-art and challenges," Frontiers in Artificial Intelligence and Applications, vol. 369, pp. 29–63, 2023. 🔗 URL: `https://doi.org/10.3233/FAIA230134`.

6   G. Singh, S. Mondal, S. Bhatia, and R. Mutharaju, "Neuro-symbolic techniques for description logic reasoning (student abstract)," pp. 15 891–15 892, 2021. 🔗 DOI: `10.1609/AAAI.V35I18.17942`.

7   G. Singh, S. Bhatia, and R. Mutharaju, "A benchmark for OWL 2 DL reasoners," p. 353, 2020. 🔗 DOI: `10.1145/3371158.3371222`.

8   G. Singh, S. Bhatia, and R. Mutharaju, "Owl2bench: A benchmark for OWL 2 reasoners," Lecture Notes in Computer Science, vol. 12507, pp. 81–96, 2020. 🔗 DOI: `10.1007/978-3-030-62466-8\_6`.

9   G. Singh, A. Kumar, K. Bhagat, S. Bhatia, and R. Mutharaju, "OWL2Bench: Towards a customizable benchmark for OWL 2 reasoners," CEUR Workshop Proceedings, vol. 2721, pp. 344–349, 2020. 🔗 URL: `https://ceur-ws.org/Vol-2721/paper587.pdf`.

10 R. K. Yadav, G. Singh, R. Mutharaju, and S. Bhatia, "Towards a concurrent approximate description logic reasoner," CEUR Workshop Proceedings, vol. 2456, pp. 145–148, 2019. 🔗 URL: `https://ceur-ws.org/Vol-2456/paper38.pdf`.

Proceedings

1   R. Mutharaju, A. Lawrynowicz, P. Bhattacharyya, E. Blomqvist, L. Asprino, and G. Singh, "Proceedings of the 14th workshop on ontology design and patterns (WOP 2023) co-located with the 22nd international semantic web conference (ISWC 2023), athens, greece, november 06, 2023," ser. CEUR Workshop Proceedings, vol. 3636, CEUR-WS.org, 2024. 🔗 URL: `https://ceur-ws.org/Vol-3636`.

2   D. Banerjee, R. Usbeck, N. Mihindukulasooriya, G. Singh, R. Mutharaju, and P. Kapanipathi, "Joint proceedings of scholarly QALD 2023 and semrec 2023 co-located with 22nd international semantic web conference ISWC 2023, athens, greece, november 6-10, 2023," ser. CEUR Workshop Proceedings, vol. 3592, CEUR-WS.org, 2023. 🔗 URL: `https://ceur-ws.org/Vol-3592`.

3   G. Singh, R. Mutharaju, P. Kapanipathi, *et al.*, "Joint proceedings of semrec 2022 and SMART 2022 co-located with 21st international semantic web conference (ISWC 2022), hybrid event, hangzhou, china, october 24-27, 2022," ser. CEUR Workshop Proceedings, vol. 3337, CEUR-WS.org, 2023. 🔗 URL: `https://ceur-ws.org/Vol-3337`.

4   G. Singh, R. Mutharaju, and P. Kapanipathi, "Proceedings of the semantic reasoning evaluation challenge (semrec 2021) co-located with the 20th international semantic web conference (ISWC 2021), virtual event, october 27th, 2021," ser. CEUR Workshop Proceedings, vol. 3123, CEUR-WS.org, 2022. 🔗 URL: `https://ceur-ws.org/Vol-3123`.

Achievements and Activities

- Received the prestigious two-year 2020 **IBM Ph.D. Fellowship**.
- Organizing a tutorial titled **A Deep Dive Into Benchmarking Ontology Reasoners: Techniques, Tools, and Insights** at the 43rd International Conference on Conceptual Modeling (ER), 2024, to be held in Pittsburgh, Pennsylvania from October 28th, 2024 to October 31st, 2024.

Achievements and Activities (continued)

- Organized **Semantic Reasoning Evaluation Challenge** (SemREC) for three years consecutively at the **International Semantic Web Conference** (ISWC). SemREC provides a platform for researchers to showcase their ontologies and reasoning systems, promoting advancements in the field.

- Organizing Committee member for the **14th Workshop on Ontology Design and Patterns** (WOP) 2023 at ISWC 2023. This workshop brings together experts in the field of ontology design to discuss and exchange ideas on best practices and emerging trends.

- Acted as a Sub reviewer for prestigious conferences and workshops, including ESWC 2023, ACL 2023, ISWC 2022, ICKG 2022, AAAI 2023, TheWebConf 2023 and NeSy2024.

- Served as a Program Committee (PC) member for CIKM 2022, a leading conference in the field of information and knowledge management

- Held the position of Head Teaching Assistant for the Semantic Web Course and Information Retrieval during the Winter Semesters of 2020-2021, 2021-2022 and 2023-24. Responsibilities included evaluating assignments and exams, designing questions, and assisting students in mastering course material.