GUNJAN SINGH

Knowledgeable Computing and Reasoning Lab, IIIT-Delhi, India
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Research Interests

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

Education

- Indraprastha Institute of Information Technology (IIIT) — New Delhi, India
  Ph. D. in Computer Science and Engineering — *Jan 2019-Dec 2024 (expected)*
  Advisors: Dr. Raghava Mutharaju (IIIT, Delhi, India), Dr. Sumit Bhatia (Adobe Inc., India)
- Aligarh Muslim University (AMU) — Aligarh, India
  M. Tech in Computer Science and Engineering (Gold Medalist) — *July 2014-June 2016*
  Advisor: Dr. Saiful Islam (AMU, India)
- Aligarh Muslim University (AMU) — Aligarh, India
  B. Tech in Computer Engineering — *July 2010-June 2014*

Work Experience

- LIRIS Lab, INSA — Lyon, France
  Research Intern — *Sept 2023,-Feb 2024*
  Mentor: Dr. Riccardo Tommasini
- IBM Research Lab — New Delhi, India
  Research Intern — *May 2019-July 2019*
  Mentor: Dr. Sumit Bhatia
- Galgotias College of Engineering and Technology — Greater Noida, India
  Assistant Professor — *Aug 2016-Dec 2018*

Technical Skills

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

Projects

- **Benchmarking Static and Streaming Description Logic Reasoners**
  Project Description: 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. Below are two projects focused on such non-conventional techniques.
  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

1. Gunjan Singh, Riccardo Tommasini, Pieter Bonte, Sumit Bhatia, Raghava Mutharaju, *GenACT: An Ontology-based Temporal Web Data Generator*, 43rd International Conference on Conceptual Modeling (**ER**), 2024 (To appear).

2. Gunjan Singh, Riccardo Tommasini, Sumit Bhatia, Raghava Mutharaju, *Benchmarking Neuro-Symbolic Description Logic Reasoners: Existing Challenges and A Way Forward*, Neurosymbolic Artificial Intelligence (**NAI**) Journal. (To appear).
3. Gunjan Singh: *Benchmarking Symbolic and Neuro-Symbolic Description Logic Reasoners*. Doctoral Consortium, 22nd International Semantic Web Conference (**ISWC**), 2023 (link)
4. Gunjan Singh, Sumit Bhatia, Raghava Mutharaju, *Neuro-Symbolic RDF and Description Logic Reasoners: State-Of-The-Art and Challenges*, Neuro-Symbolic Artificial Intelligence: The State of the Art, IOS Press, 2022 (Book Chapter) (link)
5. Gunjan Singh, Sutapa Mondal, Sumit Bhatia, Raghava Mutharaju, *Neuro-Symbolic Techniques for Description Logic Reasoning*, Student Abstract, Association for the Advancement of Artificial Intelligence (**AAAI**), 2020 (link)
6. Gunjan Singh, Sumit Bhatia, Raghava Mutharaju, *OWL2Bench: A Benchmark for OWL 2 Reasoners*, Resources Track, 19th International Semantic Web Conference (**ISWC**), Virtual Conference, 2020 (link)
7. Gunjan Singh, Ashwat Kumar, Kanav Bhagat, Sumit Bhatia, Raghava Mutharaju, *OWL2Bench: Towards a Customizable Benchmark for OWL 2 Reasoners*, Posters Track, 19th International Semantic Web Conference (**ISWC**), Virtual Conference, 2020 (link)
8. Gunjan Singh, Sumit Bhatia, Raghava Mutharaju, *A Benchmark for OWL 2 DL Reasoners*. Young Researchers' Symposium, **CODS-COMAD**, Hyderabad, 2020 (link)
9. Raj Kamal Yadav, Gunjan Singh, Raghava Mutharaju, Sumit Bhatia. *Towards a Concurrent Approximate Description Logic Reasoner*, Posters & Demonstrations Track, Proceedings of the 18th International Semantic Web Conference (**ISWC**), 2019. (Best Poster Nominee) (link)

Proceedings

1. Raghava Mutharaju, Agnieszka Lawrynowicz, Pramit Bhattacharyya, Eva Blomqvist, Luigi Asprino, Gunjan 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. CEUR Workshop Proceedings 3636, CEUR-WS.org 2024
2. Debayan Banerjee, Ricardo Usbeck, Nandana Mihindukulasooriya, Gunjan Singh, Raghava Mutharaju, Pavan Kapanipathi: *Joint Proceedings of Scholarly QALD 2023 and SemREC 2023* co-located with 22nd International Semantic Web Conference (ISWC), Athens, Greece, November 6-10, 2023. CEUR Workshop Proceedings 3592, CEUR-WS.org 2023
3. Gunjan Singh, Raghava Mutharaju, Pavan Kapanipathi, Nandana Mihindukulasooriya, Mohnish Dubey, Ricardo Usbeck, Debayan Banerjee: *Joint Proceedings of SemREC 2022 and SMART 2022* co-located with 21st International Semantic Web Conference (ISWC), Hybrid event, Hangzhou, China, October 24-27, 2022. CEUR Workshop Proceedings 3337, CEUR-WS.org 2023
4. Gunjan Singh, Raghava Mutharaju, Pavan Kapanipathi: *Proceedings of the Semantic Reasoning Evaluation Challenge (SemREC 2021)* co-located with the 20th International Semantic Web Conference (**ISWC**), Virtual Event, October 27th, 2021. CEUR Workshop Proceedings 3123, CEUR-WS.org 2022

Achievements and Activities

- Received the prestigious two-year 2020 IBM Ph.D. Fellowship.
- 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.