

# GUNJAN SINGH

Knowledgeable Computing and Reasoning Lab, IIIT-Delhi, India

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## Research Interests

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

## Education

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- 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

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- 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

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**Tools and Technologies:** OWL, RDF, SPARQL, SHACL, Protege, GraphDB, Stardog

**Programming Languages:** Python, Java, C

## Projects

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- **Benchmarking OWL 2 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 three OWL reasoning communities: conventional reasoning, stream reasoning, and neuro-symbolic reasoning.

1. ***OWL2Bench (Conventional Reasoner Benchmarking)***

The conventional OWL reasoning community primarily deals with static ontologies and focuses on tasks such as consistency checking, classification, and realization. The performance of these reasoners is usually evaluated in terms of reasoning time taken or memory consumed, and in order to do that, it is crucial to have benchmarking tools that can generate ontologies with various characteristics, such as varying size TBox and ABox axioms

2. ***OWL2StreamBench (Stream Reasoner Benchmarking)***

The OWL-based stream reasoning community addresses the challenges posed by streaming data. The key performance indicators for these reasoners typically include latency, throughput, memory usage, completeness, and correctness. To evaluate their performance, these reasoners require a benchmark that includes characteristics in addition to those mentioned for conventional static reasoning benchmarks, such as realistic domain, stream data generator, and continuous queries.

3. ***NeSyBench (Neuro-symbolic Reasoner Benchmarking)***

Neuro-symbolic reasoning systems can vary in terms of their support for different OWL 2 profiles, subsets of Description Logics, and reasoning tasks. Although significant developments have taken place in the field of neuro-symbolic reasoning space and advancements are ongoing, there is a need for a common infrastructure and experiment design that will enable developers to evaluate the performance of their systems and compare them with existing systems using standardized performance metrics.

- **Neuro-Symbolic Techniques for Description Logic Reasoning**

Project Description: Motivated by the need for reasoning approaches that can scale well even on the most expressive and large ontologies, neuro-symbolic approaches have received major attention recently. The idea is to combine the robustness and learning capabilities of artificial neural networks and the precise reasoning abilities of logic-based approaches. In relation to this theme, our endeavor is to propose a reinforcement learning-based solution to deal with the non-determinism involved at each step of the tableau expansion procedure and reduce the overall time complexity of the conventional tableau algorithm.

- **Towards a Concurrent Approximate Description Logic Reasoner**

Project Description: Automated Reasoning is notoriously inefficient and is undecidable in the case of more expressive reasoning profiles. Approximation techniques offer an attractive alternative in such cases by sacrificing either soundness or completeness in favor of reasoning runtime. Another alternative to reduce the reasoning runtime is to better utilize the computing resources by using concurrent computation techniques. We are developing a system to perform approximate reasoning using concurrent programming methods to achieve highly efficient reasoners. The work involves developing novel data structures and algorithms with performance guarantees.

## Publications

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- Gunjan Singh, Riccardo Tommasini, Pieter Bonte, Sumit Bhatia, Raghava Mutharaju, *GenACT: An Ontology-based Temporal Web Data Generator*, 43<sup>rd</sup> International Conference on Conceptual Modeling (**ER**), 2024 (Under review).
- 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).
- Gunjan Singh: *Benchmarking Symbolic and Neuro-Symbolic Description Logic Reasoners*. Doctoral Consortium, 22<sup>nd</sup> International Semantic Web Conference (**ISWC**), 2023 ([link](#))
- 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](#))
- 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](#))
- Gunjan Singh, Sumit Bhatia, Raghava Mutharaju, *OWL2Bench: A Benchmark for OWL 2 Reasoners*, Resources Track, 19<sup>th</sup> International Semantic Web Conference (**ISWC**), Virtual Conference, 2020 ([link](#))
- Gunjan Singh, Ashwat Kumar, Kanav Bhagat, Sumit Bhatia, Raghava Mutharaju, *OWL2Bench: Towards a Customizable Benchmark for OWL 2 Reasoners*, Posters Track, 19<sup>th</sup> International Semantic Web Conference (**ISWC**), Virtual Conference, 2020 ([link](#))
- Gunjan Singh, Sumit Bhatia, Raghava Mutharaju, *A Benchmark for OWL 2 DL Reasoners*. Young Researchers' Symposium, **CODS-COMAD**, Hyderabad, 2020 ([link](#))
- Raj Kamal Yadav, Gunjan Singh, Raghava Mutharaju, Sumit Bhatia. *Towards a Concurrent Approximate Description Logic Reasoner*, Posters & Demonstrations Track, Proceedings of the 18<sup>th</sup> International Semantic Web Conference (**ISWC**), 2019. (Best Poster Nominee) ([link](#))

## Proceedings

- 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
- 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
- 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

- 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

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- 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.