Harman Singh

Pre-doctoral Researcher, Google DeepMind

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Education

Indian Institute of Technology Delhi (IIT D) **July 2018 - May 2022**
B.Tech in Electrical Engineering; GPA: **9.349/10.0**

Experience

Google DeepMind **Aug 2023 - Present**
Pre-doctoral Researcher | Advisors: Dr. Partha Talukdar, Dr. Sriram Ganapathy, Dr. Trevor Cohn
Projects: Gemini Core team member – multimodal data-curation and evaluation for low-resource languages, Measuring and improving long-context multimodal LLMs, IndicGenBench – for evaluating LLMs on 29 Indic Languages [C.1], Speech Tokenizer Assessment Benchmark (STAB) [S.1], a cost effective methodology for evaluation of speech-tokenizers.

FAIR, Meta AI **July 2022 - July 2023**
AI Resident | Advisors: Dr. Pengchuan Zhang, Dr. Hugo Chen, Dr. Wenhan Xiong, Dr. Qifan Wang
Project: Improving the compositionality of contrastively pre-trained vision-language models (MosaiCLIP [C.2]).

INKLab University of Southern Califronia **June 2021 - Jan 2022**
Undergraduate Researcher | Advisor: Prof. Xiang Ren
Project: Developed a model (FaiRR) [C.3] for deductive reasoning over natural language rulebases.

IBM Research AI and DAIR Lab, IIT Delhi **May 2022 - June 2022**
Research Intern | Advisor: Prof. Parag Singla, Dr. Dinesh Garg
Project: Neuro-Symbolic and object-centric models for multimodal reasoning, image editing [C.4] and generation [S.2].

LimeChat (YC'21) **May 2021 - Aug 2021**
NLP Engineering Intern, built chatbots for D2C brands

Mangul Lab USC **May 2020 - March 2021**
Undergraduate Bioinformatics Researcher, Advisor: Prof. Serghei Mangul
Project: Better algorithms for phylogenetic analysis of SARS-CoV-2.

Publications

S=In Submission, C=Conference, J=Journal, *=Equal Contribution

[C.1] IndicGenBench: A Multilingual Benchmark to Evaluate Generation Capabilities of LLMs on Indic Languages
Harman Singh, Nitish Gupta, Shikhar Bharadwaj, Dinesh Tewari, Partha Talukdar
Annual Conference of the Association for Computational Linguistics
Media: Indian Express | Google Blog | Presented by GDM Director **[ACL'24]**

[C.2] Coarse-to-Fine Contrastive Learning in Image-Text-Graph Space for Improved Vision-Language Compositionality
Harman Singh, Pengchuan Zhang, Qifan Wang, Mengjiao Wang, Wenhan Xiong, Jingfei Du, Yu Chen
Conference on Empirical Methods in Natural Language Processing
Oral at CLVL workshop, ICCV 2023; and Oral at SpLU-RoboNLP workshop, EMNLP 2023 **[EMNLP'23]**

[C.3] FaiRR: Faithful and Robust Deductive Reasoning over Natural Language
Soumya Sanyal, Harman Singh, Xiang Ren
Annual Conference of the Association for Computational Linguistics **[ACL'22]**

[C.4] Image Manipulation via Multi-Hop Instructions
Harman Singh, Poorva Garg, Mohit Gupta, Kevin Shah, Arnab Kumar Mondal, Dinesh Khandelwal, Parag Singla, Dinesh Garg
Conference on Empirical Methods in Natural Language Processing **[EMNLP'23]**

[C.5] Cross-Lingual Multi-Hop Knowledge Editing
Harman Singh*, Aditi Khandelwal*, Hengrui Gu, Tianlong Chen, Kaixiong Zhou
Conference on Empirical Methods in Natural Language Processing **[Findings of EMNLP'24]**

[S.1] Speech Tokenizer Assessment Benchmark (STAB)
Harman Singh*, Shikhar Vashishth*, Shikhar Bharadwaj*, Sriram Ganapathy, Chulayuth Asawaroengchai, Andrew Rosenberg, Kartik Audhkhasi, Ankur Bapna, Bhuvana Ramabhadran
Under Review **[Under Review at ICASSP'25]**

[S.2] **GraPE: A Generate-Plan-Edit Framework for Compositional T2I Synthesis**
Ashish Goswami, Satyam K. Modi, Santhosh R. Deshineni, Harman Singh, Prathosh A P, Parag Singla
Under Review [**Under Review at a Computer Vision Conference**]

[J.1] **Unlocking capacities of viral genomics for the COVID-19 pandemic response**
Sergey Knyazev, Karishma Chhugani, Harman Singh*, Varuni Sarwal*, Ram Ayyala*, Daniel Novikov, Prashant Emani, Jennifer Tsang, Ozgur Batuman, Jeffrey A. Rodriguez, Serghei Mangul
Nature Methods [**Nature Methods'22**]

[J.2] **A Novel Network Representation of SARS-CoV-2 Sequencing Data**
Sergey Knyazev, Daniel Novikov, Mark Grinshpon, Harman Singh, Ram Ayyala, Prashant Emani, Jennifer Tsang, Ozgur Batuman, Jeffrey A. Rodriguez, Serghei Mangul
International Symposium on Bioinformatics Research and Applications [**ISBRA'21**]

Selected Projects

Gemini (Core-team member) April 2024 – Sept 2024
Advisors: Dr. Partha Talukdar, Dr. Jason Riesa Google DeepMind

- Developed data-curation techniques for improving performance on low-resource languages.
- Built improved evaluations for measuring progress on low-resource language and speech understanding.

IndicGenBench: Generative Evaluation of LLMs on 29 Indic Languages Aug 2023 – May 2024
Advisors: Dr. Partha Talukdar, Dr. Nitish Gupta Google DeepMind

- Largest benchmark for Indic evaluation of LLMs in 29 of Indic languages, 13 scripts and 4 language families.
- 5 user-facing tasks including cross-lingual summarization, multilingual and cross-lingual QnA and Machine Translation.
- Studied transfer from high-resource languages, deficiencies in tokenization, improvements with in-context learning and quantifying when in-context learning is better than fine-tuning.

STAB: Speech Tokenizer Assessment Benchmark Dec 2023 – March 2024
Advisors: Dr. Partha Talukdar, Dr. Sriram Ganapathy, Dr. Bhuvana Ramabhadran Google DeepMind

- Developed a low-cost methodology for evaluating speech tokens without pre-training speech foundation models.
- STAB measures properties like compressibility of tokens, strongly correlated with downstream task performance.

Improving Compositionality of Vision Language Models (VLMs) Oct 2022 – July 2023
Advisors: Dr. Pengchuan Zhang, Dr. Hugo Chen, Dr. Wenhan Xiong, Dr. Qifan Wang FAIR, Meta AI

- Improved compositionality of VLMs, e.g., 16.5% improvements in relation understanding over strong baselines.
- Developed a scene-graph-based hierarchical contrastive learning method aligning sentences of varying semantic complexity to images using text-scene graphs for fine-grained and compositional alignment.
- Created hard-negative sub-graphs for data augmentation during contrastive learning to improve compositionality.
- Conducted large-scale pre-training and fine-tuning experiments of CLIP models on up to 100M image-text examples.

Faithful and Robust Deductive Reasoning over Natural Language June 2021 – Jan 2022
Advisors: Prof. Xiang Ren, Soumya Sanyal InkLab USC

- Designed a 3-step modular architecture for interpretable and robust deductive reasoning over natural language.
- Modeled rule selection, fact selection, and conclusion generation using individual RoBERTa and T5 transformer models.
- Improved robustness to linguistic perturbations by 2.2% and consistency of predictions by 3%.

Image Manipulation via Complex Instructions June 2021 – May 2022
Advisors: Prof. Parag Singla, Dr. Dinesh Garg DAIR, IIT Delhi and IBM Research

- Designed NeuroSIM, a weakly supervised, modular, neuro-symbolic architecture for text-guided image manipulation, trainable without output image supervision.
- The model is data efficient, interpretable by design, and can generalize to complex text instructions and scenes.

Generate-Plan-Edit Framework for Compositional T2I Synthesis Aug 2023 - Nov 2024
Advisors: Prof. Parag Singla, Prof. Prathosh A.P DAIR, IIT Delhi

- Proposed a Generate-Plan-Edit framework for improving T2I fidelity on complex compositional prompts.
- Developed PixEdit, a compositional image editor with enhanced word order understanding for complex spatial edits.
- Showed up to 3-point DSG score improvement across 10 T2I models (including SD3.5, DALLE-3) and 3 benchmarks.

Cross-Lingual Multi-hop Knowledge Editing in LLMs June 2023 - June 2024
Advisors: Dr. Tianlong Chen, Dr. Kaixiong Zhou Collab w/MIT, Mircorosft

- Proposed cross-lingual multi-hop knowledge editing and created a parallel benchmark for the task in 8 languages.
- Enhanced cross-lingual retrievers with novel contrastive losses improving retrieval-augmented knowledge editing.
- Achieved up to 30% accuracy gains over state-of-the-art methods on diverse LLMs, languages, and datasets.

Selected Honors and Awards

Oral acceptance at Closing the loop between vision and language workshop at ICCV 2023.

Oral acceptance at SpLU-RoboNLP workshop at EMNLP 2023.

Outstanding Reviewer Award, MLRC 2022 (Received GCP credits worth $5k USD).

Received 3 Peer Bonuses at Google DeepMind for productive collaborations, by colleagues and senior researchers.

One of 12, of 20k applicants to be selected for the Google Pre-doctoral program 2023-25.

One of 4 from India and 27 globally to be selected for the AI Residency position at Meta AI, 2022-23.

Selected for CIFAR Deep Learning Reinforcement Learning Summer School, 2022.

IIT-Delhi Semester Merit Award for being amongst **top 7%** students in 4 out of 8 semesters at IIT Delhi.

All India Rank 170 in IIT JEE Mains 2018 and **All India Rank 751** in IIT JEE Advanced amongst 10 million candidates.

KVPY Scholarship with All India Rank 160 in 2016-17 by Department of Science and Technology Govt. of India.

Recipient of **Professor S.K Saha award** for the **best robotics team** in IIT Delhi.

Placed in **top 0.1%** students in India by **securing 100%** in Mathematics and Computer Science in class 12.

Represented IIT Delhi National (India) **ABU Robocon 2019** as a first year undergraduate.

Teaching and Academic Service

Reviewing

- ICLR 2024, COLM 2024, ACL-ARR 2024 (Feb, April, June), NeurIPS 2023, EMNLP 2023, MLRC 2022 (Outstanding Reviewer).

TA for Machine Intelligence and Learning Aug - Dec 2021
Instructors: Prof Sumeet Agarwal and Prof Jayadeva IIT Delhi

- Responsible for conducting problem-solving and programming (Python and PyTorch) tutorials, grading assignments, taking vivas for projects and course assignments, and creating assignment questions.

TA for Introduction to Electrical Engineering Nov 2021 - Mar 2022
Instructor: Prof Anuj Dhawan IIT Delhi

- Responsible for conducting problem-solving tutorials, creating exam questions, and grading exam copies.

Co-organiser, NLP Reading Group, Google DeepMind India 2024 - Present

- Organized weekly presentations by researchers on topics like language modeling, inclusivity, and multimodality.

Demo Leader, NeurIPS Education Outreach Program 2022

- Gave a demo on compositional generalization in large ML models to 240+ high school students.

Volunteer, BiNDI Summit (Biases in NLP models and Data for the Indian Context) at Google Research 2023

Talks

"Multimodal In-context Learning for Cultural and Linguistic Adaptation"

- Gemini i18n Summit, Google DeepMind Dec 2024

"Coarse-to-fine Contrastive Learning for Vision-Language Compositionality"

- FAIR, Meta AI May 2023
- 5th Workshop on Closing the Loop Between Vision and Language, ICCV 2023 (Oral) Oct 2023
- 3rd SpLU-RoboNLP Workshop, EMNLP 2023 (Oral) Dec 2023

"IndicGenBench – Generative Evaluations of LLMs on Indic Languages"

- Multilinguality Research Forum, Gen AI, Google DeepMind May 2024

"Phylogenetic Analysis of SARS-CoV-2"

- ABACBS 2020 Nov 2020

Coursework

- Machine Learning, Deep Learning (Special Topics in Machine Learning), Meta Learning (Special Module in Machine Learning), Markov Decision Process and Reinforcement Learning, Probability and Stochastic Processes, Linguistics (Language Science), Natural Language Processing, NLP Seminar (Special Module in AI), Data Structures and Algorithms, Analysis and Design of Algorithms, Linear Algebra and Differential Equations, Calculus, Signals and Systems
- **Online**: Stanford CS229-Machine Learning, CS231-Convolution Neural Networks for Visual Recognition, Deep Learning and Neural Networks.

Skills

Languages	Python, Java, C, C++, MATLAB, LaTeX, Bash
Libraries	PyTorch (Adv), Tensorflow (Intermediate), HuggingFace (transformers), Scikit-Learn, NLTK, Spacy
Tools	Git, Autodesk Inventor, Quartus, Android Studio, Arduino, Raspberry Pi

References

- Dr. Partha Talukdar ..... *Senior Staff Research Scientist, Google DeepMind* [🌐]
- Prof. Parag Singla ..... *Professor at IIT Delhi* [🌐]
- Prof. Xiang Ren ..... *Professor at University of Southern California* [🌐]
- Prof. Sriram Ganapathy ..... *Professor at IISC (Indian Institute of Science)* [🌐]
- Dr. Pengchuan Zhang ..... *Senior Research Scientist, FAIR, Meta AI* [🌐]