Mudit **Dhawan**

Research Fellow, Microsoft Research

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Education

Jun 2022 | **IIIT Delhi** | B.Tech. Electronics and Communication Engineering **(ECE)** **Delhi, India**
Aug 2018 | **CGPA:** 8.94/10
Thesis Title: Multimodal Fake News Analysis and Detection [thesis]
Advisors: *Prof. Ponnurangam Kumaraguru* and *Prof. Rajiv Ratn Shah*

May 2018 | **Delhi Public School, Rohini** | Senior Secondary | CBSE **Delhi, India**
Aug 2018 | **Percentage:** 95% | Awarded a **Silver Medal** for being on the academic merit list for 5 years.

Experience

Present | **Microsoft Research | Extreme Classification (XC) Group** [🌐] **Bangalore, India**
Jul 2022 | *Pre-Doctoral Research Fellow | Advisor: Dr. Manik Varma*
Work on Extreme Multi-Label Learning for large-scale recommendation systems and AutoSuggest for Bing. Algorithms created for Bing, and Text Ads Platforms have been deployed in production for English and Multilingual Markets which have led to an increase in key performance metrics.

Jun 2022 | **Nanyang Technological University (NTU) | SenticNet Lab** [🌐]
Jan 2022 | *Research Intern | Advisor: Prof. Erik Cambria, PhD student Jinjie Ni*
Worked on Conversational Agents in task-oriented dialogue systems and retrieval-based dialogue systems. With the main focus on emotion-controlled response generation using a conversation vector embedded in sentiment space.

Jun 2022 | **IIIT Hyderabad | Precog Research Group** [🌐]
Aug 2019 | *Research Assistant | Advisor: Prof. Ponnurangam Kumaraguru*
Worked on problems related to Misinformation, NLP, Multi-modal systems, Legal AI, and Heterogeneous Graph-based systems. Projects have led to publications at conferences and also deployed in real-world systems.

Jul 2021 | **Oracle NetSuite** [🌐]
May 2021 | *Summer Software Development Intern | Manager: Divender Kumar*
Rewrote legacy **PL/SQL code** in refactored **Java** to make the system to improve scalability along with **UML** diagrams for the implemented **Façade design pattern**. Also, created a suite of Unit test cases using Mockito and PowerMockito for automated testing with **94% code coverage**.

Publications

S=In Submission, C=Conference

[S.3] **CROSS-JEM: Cross-encoder Joint Efficient Modeling for ranking in sponsored search**
Bhawna Paliwal*, Deepak Saini*, Mudit Dhawan*, Jian Jiao, Manik Varma
ACM The Web Conference 2024 [Under Submission]

[S.2] **Enhancing Tail Performance in Extreme Classifiers by Label Variance Reduction** [🔗]
Anirudh Buvanesh, Rahul Chand, Jatin Prakash, Bhawna Paliwal, Mudit Dhawan, Neelabh Madan, Deepesh Hada, Vidit Jain, Sonu Mehta, Yashoteja Prabhu, Manish Gupta, Ramachandran Ramjee, Manik Varma
International Conference on Learning Representations 2024 (ICLR) [Under reiew]

[S.1] **GAME-ON: Graph Attention Network based Multimodal Fusion for Fake News Detection** [🔗] [code]
Mudit Dhawan*, Shakshi Sharma*, Aditya Kadam, Rajesh Sharma, Ponnurangam Kumaraguru
Multimodal Fusion Technologies to Counter Disinformation, Information Fusion Journal
[Under review]

[C.2] **HLDC: Hindi Legal Documents Corpus** [🔗] [code]
Arnav Kapoor, Mudit Dhawan, Anmol Goel, Arjun T H, Akshala Bhatnagar, Vibhu Agrawal, Amul Agrawal, Arnab Bhattacharya, Ponnurangam Kumaraguru, Ashutosh Modi
Annual Conference of the Association for Computational Linguistics (Virtual) [**Findings of ACL'22**]

[C.1] **Inter-modality Discordance for Multimodal Fake News Detection** [🔗] [code]
Shivangi Singhal, Mudit Dhawan, Rajiv R Shah and Ponnurangam Kumaraguru
ACM Multimedia Asia (Virtual) [**MMAsia '21**]

Select Research Projects

Multi-Intent Combination In Session-Based Recommendation Systems using LLMs Sep'23 - Present

Advisors: Dr. Yashoteja Prabhu,Dr. Amit Sharma, Dr. Manik Varma

- Identified three properties of GPT-4 based models in session-based recommendations settings: (i) find diverse relevant intents in session history, (ii) combine intents to find sequential recommendations, and (iii) world knowledge.
- Performed task-specific distillation using Low-Rank Adaptation of desired properties to increase inference speedup by $\sim$ **100** $times$ by using smaller LLMs (1-7 billion parameters).
- High alignment between GPT-4 and task-specific distilled model on relevance, and diversity indicated by high cosine similarity between recommendations.

Efficient Modelling For Cross-Encoder based Ranking Systems Aug'23 - Oct'23

Advisors: Dr. Manik Varma

- Highlighted the inconsistency in current research of pair-wise query-item ranking systems and the real-world need to rank thousands of items for a given query.
- Proposed a novel and efficient paradigm of jointly scoring multiple items per query in one shot.
- Proposed algorithm led to **10**$\times$**faster** scoring than pairwise, with negligible drop in performance (within 1% of pair-wise cross-encoders). Under review at the ACM Web Conference 2024, and would be submitted for a US patent.

Denoising Hard Negatives using LLMs For Robust Representation Learning in Dense Retrieval Jun'23 - Sep'23

Advisors: Dr. Manik Varma

- Identified the problem of high probability of hard negatives being false negatives in large-scale dense retrieval datasets.
- Proposed a novel scoring method to use Large Language Models like GPT-4 as a large-scale oracle to denoise hard negatives, which led to 30$\times$increase in the throughput and significantly reduced API costs.
- Led to $\sim$**0.6% absolute gain in clicks** and other system-specific metrics on a large scale search engine during **online A-B tests** in English markets.

Query Auto-Complete (QAC) using Extreme Classification and Statistical Language Models Jan'23 - Jun23

Advisors: Dr. Yashoteja Prabhu, Dr. Manish Gupta, Dr. Manik Varma

- Proposed an imporvement over XC based QAC solutions by replacing suffix classifiers with small localized statistical language models to improve performance on head and torso queries.
- Utilized Kneser-Ney smoothing and a weighted finite state transducer (FST) to represent the n-gram language model over queries containing a cluster of suffixes to better memorize frequency based patterns in the data.
- This framework led to a **6 point increase in Success Rate @ 10** and **5 point increase in Mean Reciprocal Rank @ 10** on publicly available dataset over XC baseline.

Query Auto-Complete (QAC) using Extreme Classification Jul'22 - Jun23

Advisors: Dr. Yashoteja Prabhu, Dr. Manish Gupta, Dr. Manik Varma

- Proposed a novel reformulation of QAC as an XC task, which led to significant improvement over NLG based solutions.
- To overcome the sparsity of training data based on clicks, added popularity weighted augmentation to vanilla XC loss to improve performance on tail and torso prefixes.
- Our framework achieved SOTA performance while compared to NLG models with an improvement of $\sim$**10% on Mean Reciprocal Rank@10** and $\sim$**15% on Success rate@10** on publicly available dataset.
- When deployed in en-markets, our method led to **1% gain in CTR** (Click Through Rate) and a **4% gain in the average number of suggestions** in **production**. In non-en multilingual markets, it gave a relative increase of **0.8%** increase in CTR and a **3% gain in suggestion density** in **production**.
- On Bing AI Chat Platform let an 8% increase in KSPQ (keystrokes saved per query), and 6% increase in acceptance rate for long queries

Graph Based Multimodal Fake News Detection [code] Aug'21 - Jul'22

Advisors: Prof. Ponnurangam Kumaraguru, Prof. Rajesh Sharma

- Proposed a novel graph framework that allows for granular interactions across (inter)- and within (intra)- modalities to fuse them early in the framework, decreasing information loss.
- Our Graph-based approach using scenic graph for images and transformer representations for text nodes outperform by $\sim$**11%** sota models on publicly available dataset, with $\sim$**91%** fewer parameters than the best comparable baseline.

Hate-Speech Based User Characterization Jun'21 - Apr'22

Advisors: Prof. Ponnurangam Kumaraguru, Prof. Srijan Kumar

- Analyzed sentimentally charged tweets to study the effect of the network on the user's posting activity.
- Studying the influence and susceptibility of a user based on their online neighborhood and how this network can be leveraged to determine the magnitude (or impact) of potential spreaders of hate or counter-hate on online social media platforms.

Legal AI [code] Mar'21 - Dec'21

Advisors: Prof. Ponnurangam Kumaraguru, Prof. Ashutosh Modi, Prof. Arnab Bhattacharya

- Helped release a corpus of ∼**900K** legal documents in Hindi.
- Proposed Bail prediction as a Multi-Task Learning Framework which used an auxiliary extractive summarization task to improve the main task's performance.
- In training a model for predicting bail for a new district (previously unseen district during training), a Multi-Task end-to-end trained model achieved **78%** Accuracy and **77%** F1 score, which was around 2% more than our other competitive baselines.

Multimodal Fake News Detection [code] [thesis] Jul'20 - Jan'22

Advisors: Prof. Ponnurangam Kumaraguru, Prof. Rajiv Ratn Shah

- We proposed an inter-modality discordance based fake news detection framework based on the hypothesis that fabrication of either modality will lead to dissonance between the modalities.
- First ones to leverage information from different components of the news article (i.e., headline, body, and multiple images) for multimodal fake news detection.
- Conducted extensive experiments on the real-world datasets to show that our approach outperforms the state-of-the-art by an average F1-score of **6.3%**.
- Released code to previous Multimodal Fake News detection frameworks to make previous state-of-the-art approaches in the field more accessible [code]

Language Model for Code-Mix Data [code] Feb'21 - Apr'21

Advisors: Prof. Ponnurangam Kumaraguru

- Proposed changes in the **sampling strategy** and the **Masked Language Modelling** (MLM) Task and trained a modified **XLM (Cross-Lingual Language Model)** from scratch on English-Hindi code-mixed data collected from social media.
- Weighted sampling strategy led to **15 point decrease in perplexity** score on an online social media Hindi-English code mix data, and **2% increase in F1-score** on the downstream POS-Tagging task on LINCE Dataset

Honours and Achievements

Poster Presentation at ARCS 2022, ACM India [🌐] Our work on Inter-modality Discordance for Multimodal Fake News Detection which was accepted at ACM Multimedia Asia'21 was selected to be presented as a poster at ARCS 2022, ACM India

Selected for Visiting Student Research Programme at India Connect@NTU [🌐] Was selected for a research internship in the SenticNet Lab at NTU and worked under supervision of Prof. Erik Cambria, PhD student Jinjie Ni

Open Source Projects

- **Digital Image Processing Concepts From Scratch**: Code for Geometric Transformation, Bi-Linear Interpolation, Histogram matching and equalization, Constrained Least Squares Filtering. [code]
- **Computer Vision Concepts From Scratch**: Code for 2D Convolution for Edge detection, Spatial Pyramid Pooling, Semantic segmentation, Circular Bounding Boxes, Super-pixel saliency, Interactive saliency, Otsu-Algorithm, Background subtraction from video. [code]
- **Machine Learning Concepts From Scratch**: Code for N-layer Neural Network, Grid Search, Bootstrapping, Gaussian Naive Bayes, Linear Regression and Logistic Regression. [code]
- **Anomaly detection in building energy consumption**: Code for a deep-learning based building load-line prediction/ anomaly detection model. Used data from Smart Buildings equipped with meters and sensors which are periodically collecting time-series data (ASHRAE Dataset – Kaggle). [code]

References

- Dr. Manik Varma ..... *Partner Researcher, Microsoft Research, India* [🌐]
- Prof. Ponnurangam Kumaraguru ..... *Professor, IIIT Hyderabad, India* [🌐]
- Dr. Manish Gupta ..... *Principal Applied Scientist, Microsoft India R&D Private Limited* [🌐]
- Dr. Yashoteja Prabhu ..... *Senior Researcher, Microsoft Research, India* [🌐]
- Prof. Rajesh Sharma ..... *Associate Professor, University of Tartu, Estonia* [🌐]