Madhur Panwar

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Education

- **Birla Institute of Technology and Science, Pilani (BITS Pilani)** — Pilani, India
  B.E. Computer Science and M.Sc. Mathematics (Dual Degree) — *2016 – 2021*
  - CGPA: 9.32/10.00 **(Distinction division)**
  - Recepient of Pratibhashali Award (Department of Mathematics)

Experience

- **Microsoft Research** — Bangalore, India
  Research Fellow – Advisor: Dr. Navin Goyal — *Aug 2022 - Present*
  - Understanding the emergent abilities of large language models and how they represent natural language via mechanistic interpretability. Our work on In-Context Learning and Bayesian Inference has been **accepted at ICLR 2024** and **various NeurIPS 2023 Workshops**.

- **Adobe** — Noida, India
  Software Development Engineer – Manager: Ganesh R — *Jul 2021 - Jul 2022*
  - Developed the Landing Pages feature in Adobe Journey Optimizer (AJO), allowing marketers to design and serve landing pages to millions of end users. Received Spot Award for fixing a Customer Service Outage and won the New Hire Coding Bootcamp. Mentored summer internship projects for three students across Machine Learning and Software Engineering domains.

- **Nanyang Technological University** — Singapore
  Undergraduate Thesis – Advisors: Prof. Chng Eng Siong, Prof. Poonam Goyal — *Jan 2021 - Jun 2021*
  - Developed a fully Pythonic pipeline for speaker diarization using the x-vector representations and LSTM-based spectral clustering. [thesis]

- **Amazon** — Hyderabad, India
  Software Development Engineer Intern – Manager: Pankaj Jain — *Aug 2020 - Dec 2020*
  - Developed a new module end-to-end for generating the node launch configuration of a major Amazon carrier. The developed features were deployed to production.

- **Adobe** — Noida, India
  Research Intern – Advisors: Balaji Krishnamurthy, Milan Aggarwal — *May 2020 - Jul 2020*
  - Worked at the Media and Data Science Research (MDSR) Lab and developed novel approaches to topic modeling. This research has been published as **a long paper at ACL 2021 (Oral)**.

- **University of Victoria** — British Columbia, Canada
  Mitacs Globalink Research Intern – Advisor: Prof. Ralph Evins — *May 2019 - Aug 2019*
  - Worked on the development of an open-source project, BESOS, that has been published in The Journal of Open Source Software (JOSS). Formulated and solved building energy optimization problems.

- **Indian Institute of Remote Sensing, Indian Space Research Organisation** — Dehradun, India
  Research Intern – Advisor: Dr. Shashi Kumar — *May 2018 - Jul 2018*
  - Developed a system to calibrate Synthetic Aperture Radar (SAR) satellite imagery and a plugin to detect oil spills in SAR images.

Publications

(* = Equal Contribution)

[1] In-Context Learning through the Bayesian Prism [pdf]
Madhur Panwar*, Kabir Ahuja*, Navin Goyal
The Twelfth International Conference on Learning Representations [ICLR'24]

[2] In-Context Learning and Bayesian Inference [pdf]
Madhur Panwar*, Kabir Ahuja*, Navin Goyal
NeurIPS 2023 Workshop - Robustness of Few-shot and Zero-shot Learning in Large Foundation Models (R0-FoMo)

[3] Surprising Deviations from Bayesian View in In-Context Learning [pdf]
Madhur Panwar, Kabir Ahuja, Navin Goyal
NeurIPS 2023 Workshop - I Can't Believe It's Not Better (ICBINB): Failure Modes in the Age of Foundation Models

[4] Transformers Can Learn To Solve Linear-Inverse Problems In-Context [pdf]
Kabir Ahuja*, Madhur Panwar*, Navin Goyal
NeurIPS 2023 Workshop - Deep Learning and Inverse Problems

[5] TAN-NTM: Topic Attention Networks for Neural Topic Modeling [pdf]
Madhur Panwar*, Shashank Shailabh*, Milan Aggarwal*, Balaji Krishnamurthy
In Proceedings of the 59th Annual Meeting of the Association for Computational Linguistics [ACL'21 (Oral)]

[6] [Re] AdaBelief Optimizer: Adapting Stepsizes by the Belief in Observed Gradients [pdf]
Anirudh Buvanesh*, Madhur Panwar*
ReScience C, vol. 8, no. 2, 2022 (accepted under ML Reproducibility Challenge 2021) [ReScience C'22]
Presented at NeurIPS 2022 Journal Track (Spotlight)

Patents

[1] System and Methods for Neural Topic Modeling using Topic Attention Networks [pdf]
Shashank Shailabh, Madhur Panwar, Milan Aggarwal, Pinkesh Badjatiya, Simra Shahid, Nikaash Puri, S Sejal Naidu, Sharat Chandra Racha, Balaji Krishnamurthy, Ganesh Palwe
US Patent Application No. 17/644,856 | Adobe Inc.

Selected Research Projects

- **ICL and Emergent Abilities**
  Advisor: Dr. Navin Goyal *Apr 2023 - Present*
  - Working on uncovering the cause of emergent abilities, such as in-context learning, in transformer language models.
  - Found that in-context learning can be viewed from a Bayesian perspective. In our paper, we discuss various problems where transformers simulate the Bayesian predictor and where they deviate from it.
  - This work has been **accepted at ICLR 2024** and **NeurIPS 2023 Workshops: R0-FoMo, ICBINB, Deep Inverse**.
- **Interpretation of World Models**
  Advisor: Dr. Navin Goyal *Aug 2023 - Present*
  - Constructing specialized worlds with specific linguistic elements to train and interpret language models.
  - Found that small (2-layer) LMs are capable of answering questions about the final state in a synthetic world where people transact objects among each other.
- **Speaker Diarization**
  Advisors: Prof. Chng Eng Siong, Prof. Poonam Goyal *Jan 2021 - Jun 2021*
  - Traditional diarization systems were modular with different components trained independently. I developed a fully Pythonic end-to-end pipeline for speaker diarization by jointly training the x-vector representation network and LSTM-based spectral clustering component. [thesis]
  - Analysed the x-vectors' ability to recognize an audio input across various data augmentations.
  - Discovered a limitation of x-vector representations: *the learned speaker discriminative characteristics are dependent on the sampling rate of training data.*
  - Contributed to the open source project - Kaldi Speech Recognition Toolkit. [pull request]
- **Topic Modeling**
  Advisors: Balaji Krishnamurthy, Milan Aggarwal *May 2020 - Feb 2021*
  - Developed a novel topic-aware attention mechanism for better document encodings in topic modeling.
  - Designed a query recommendation system for Adobe Support Communities using topic modeling and deployed it to production.
  - Applied topic models for downstream tasks like document classification and supervised keyphrase generation.
  - This research has been published as **a long paper at ACL 2021 (Oral)**.
- **Process Sequence Extraction**
  Advisor: Prof. Poonam Goyal *Jan 2020 - May 2020*
  - Built a finite-state machine to process the transcript of an instructional video and output a captioned sequence of frames that defines the task in the video.

Achievements, Honours and Awards

- **Research Week with Google, 2023** | Selected by Google Research India among nationwide applicants to attend the "Research Week with Google" event. [certificate]
- **Institute Merit Scholarship, 2016 - 2021** | Received scholarship at BITS Pilani for being in the top 4% of students across all academic departments for all 10 semesters.
- **Hacktoberfest [🌍], 2021** | Contributed to open source projects like microsoft/ML-For-Beginners, pytorch-ignite, kedro & TheAlgorithms/Java, and was one among the first 50,000 participants to complete the Hacktoberfest challenge.
- **Pratibhashali Award, 2020** | Conferred by the Department of Mathematics, BITS Pilani, for notable achievements in research and academics. [certificate]
- **Mitacs Globalink Research Internship (GRI) [🌍], 2019** | I was one among the 64 Indian applicants selected for this program by Mitacs in consultation with AICTE [AICTE report, page 47]. Under GRI, Mitacs provides funding to conduct research in Canada. This competitive program involves international undergraduate applicants from 15 countries.
- **INSPIRE Scholarship [🌍], 2015** | Awarded by DST, Government of India, for securing a place among the **top 1% students** in the Indian School Certificate Examination conducted by CISCE.
- **Putani Vignana International Science Talent Examination, 2010 | Ranked third nationwide**. [certificate]

Services and Teaching Assistantships

- **Reviewer for NeurIPS 2023 R0-FoMo Workshop**
- **NeurIPS Volunteer, 2022** | Helped attendees with their queries at the helpdesk and with the execution of certain virtual events at the NeurIPS 2022 conference.
- **ACL Volunteer, 2021** | Served as a Helpdesk Volunteer at ACL 2021 virtual conference.
- **Logic in Computer Science (CS F214) - Teaching Assistant, 2019** | Responsibilities included helping students with the coursework and assignments.
- **Student Faculty Council (SFC) - Member, 2018 - 2019** | Responsibilities included highlighting the academic concerns of students to faculty members and the HoD, Department of Mathematics.

Relevant Coursework

- **Computer Science:** Data Structures & Algorithms, Object Oriented Programming, Image Processing, Cryptography
- **Mathematics:** Mathematics I (Multivariate Calculus), Mathematics II (Linear Algebra, Complex Variables and Calculus), Mathematics III (Differential Equations), Probability & Statistics, Discrete Mathematics, Algebra I (Abstract Algebra), Non-Linear Optimization, Numerical Analysis, Number Theory