# Kumar Tanmay

Research Fellow
Microsoft Research India

kmr.tanmay147@gmail.com | t-ktanmay@microsoft.com
 | Google Scholar | Website
+91-9572127367


## Education

**Indian Institute of Technology, Kharagpur, India** 2018 - 2022
Bachelor of Technology (Hons.) in Instrumentation Engineering
Department: Electrical Engineering | Minor: Computer Science
CGPA: 8.97/10.0, **Department Rank 3**

**Rajendra Vidyalaya, Jamshedpur, India** 2018
Indian School Certificate (ISC) - 12th Grade - English, Science, Maths, and Computer Science
Percentage score: 95.6%, **Ranked 1st in school**

**Rajendra Vidyalaya, Jamshedpur, India** 2016
Indian Certificate of Secondary Education (ICSE) - 10th Grade
Percentage score: 96.5%, **Ranked 1st in school**

## Talks/Presentations

**DUBLIN: Visual Document Understanding By Language-Image Network** [Slides, Video] Dec 2023
EMNLP 2023

**A Case and Framework for In-Context Ethical Policies in LLMs** [Slides] Dec 2023
EMNLP 2023

## Publications (Google Scholar)

* = equal contribution

**Kumar Tanmay***, Aditi Khandelwal*, Utkarsh Agarwal*, Monojit Choudhury. "Probing the Moral Development of Large Language Models through Defining Issues Test". *ICML/COLM*. 2024. (To be submitted, pdf)

Utkarsh Agarwal*, **Kumar Tanmay***, Aditi Khandelwal*, Monojit Choudhury. "Ethical Reasoning and Moral Value Alignment of LLMs Depend on the Language we Prompt them in". *LREC-COLING*. 2024. (Under Review, pdf)

Aditi Khandelwal*, Utkarsh Agarwal*, **Kumar Tanmay***, Monojit Choudhury. "Do Moral Judgment and Reasoning Capability of LLMs Change with Language? A Study using the Multilingual Defining Issues Test". *EACL*. 2024. (Under Review, pdf)

**Kumar Tanmay***, Aditi Khandelwal*, Utkarsh Agarwal*, Monojit Choudhury. "Probing the Moral Development of Large Language Models through Defining Issues Test". *Workshop on AI meets Moral Philosophy and Moral Psychology (MP$^2$) - Neurips*. 2023. (Accepted, Workshop, pdf)

Abhinav Rao*, Aditi Khandelwal*, **Kumar Tanmay***, Utkarsh Agarwal*, Monojit Choudhury. "Ethical Reasoning over Moral Alignment: A Case and Framework for In-Context Ethical Policies in LLMs". *Findings of EMNLP*. 2023. (Accepted, Poster, pdf)

Kriti Aggarwal*, Aditi Khandelwal*, **Kumar Tanmay***, Owais Mohammed Khan, Qiang Liu, Monojit Choudhury, Hardik Hansrajbhai Chauhan, Subhojit Som, Vishrav Chaudhary, Saurabh Tiwary. "DUBLIN: Visual Document Understanding By Language-Image Network". *EMNLP Industry Track*. 2023.(Accepted, Poster, pdf)

**Kumar Tanmay***, Kumar Ayush*. "Augmented Reality Based Recommendations based on Perceptual Shape Style Compatibility with Objects in the Viewpoint and Color Compatibility with the Background". *Advances in Image Manipulation Workshop (AIM) - ICCV*. 2019. (Accepted, Workshop, pdf)

Kumar Ayush*, Burak Uzkent*, **Kumar Tanmay**, Marshall Burke, David Lobell, Stefano Ermon. "Efficient Poverty Mapping from High Resolution Remote Sensing Images". *AAAI*. 2021. (Accepted, Oral, pdf)

Shuvam Chakraborty, Kumar Ayush*, Burak Uzkent*, **Kumar Tanmay**, Evan Sheehan, Stefano Ermon. "Efficient Conditional Pre-training for Transfer Learning". *Workshop on Learning with Limited Labelled Data for Image and Video Understanding (L3D-IVU) - CVPR*. 2022. (Accepted, Workshop, pdf)

Kumar Ayush*, Burak Uzkent*, Chenlin Meng*, **Kumar Tanmay**, Marshall Burke, David Lobell, Stefano Ermon. "Geography-Aware Self-Supervised Learning". *ICCV*. 2021. (Accepted, Poster, Webpage, pdf, )

## Patents

**Kumar Tanmay**, Monojit Choudhury, Subhojit Som, Vishrav Chaudhary, Saurabh Tiwary. "An Efficient Variable Input Resolution Training Method for Vision Transformer Models". 2023. (Filed)

**Kumar Tanmay**, Monojit Choudhury, Subhojit Som, Vishrav Chaudhary, Saurabh Tiwary. "A Template-based Multimodal Instruction Tuning Method to Enhance Visual Document Understanding". 2023. (Filed)

## Work Experience

***Research Fellow, Turing Team , Microsoft Research, India***
**Visual Document Understanding, Image QA, Table QA** Jul 2022 - Aug 2023
Advisors: Dr. Subhojit Som, Vishrav Chaudhary and Dr. Monojit Choudhury

- Co-led the development of DUBLIN (*accepted in EMNLP Industry Track 2023*), a large-scale transformer-based encoder-decoder model for visual document understanding (VDU) that can analyze both text and visual elements in document images (including infographics, webpages, tables, forms, and natural images) achieving state-of-the-art-performance on diverse downstream tasks such as QA, information extraction, bounding box prediction, summarization, image captioning, and classification.
- Standardized 20 multimodal datasets into a unified benchmark format, implementing metrics such as CIDEr, ANLS, Relaxed Accuracy, EM, and F1 score for comprehensive model evaluation.
- Developed a novel and efficient method to handle variable input resolution images, enabling DUBLIN to process documents with varying aspect ratios resulting in significant performance gains for long documents.
- Incorporated synthetic table data derived from private logs and introduced a novel training strategy as part of curriculum learning to enhance the model's ability to understand tables.
- Developed a template-based multimodal instruction tuning method to handle a wide range of diverse tasks by creating templates for various tasks thus eliminating the need for external task-specific layers.
- Achieved significant performance improvements, with an average 5% enhancement across 20 benchmarking datasets. Notable gains were observed in AI2D (21%), InfographicsVQA (7.5%), and DocVQA (5.6%) compared to existing pixel-only and specialized pipeline based state-of-the-art models.
- Curated multimodal datasets for TableQA and ImageQA to train DUBLIN to support real-world production scenarios in Microsoft Bing.

**Ethical Generalisation and Value Pluralism in Large Language Models (LLMs)** Dec 2022 - Oct 2023
Advisor: Dr. Monojit Choudhury

- Developed a psychometric assessment tool inspired by the Kohlbergian Moral Development and Defining Issues Test frameworks to evaluate the moral judgment and reasoning capabilities of LLMs, including GPT-4, LLaMA, PaLM, and GPT3.x series. *Accepted in MP$^2$ Neurips 2023.*
- Established a comprehensive framework designed to facilitate the infusion of ethical policies for moral alignment in LLMs levraging in-context learning to address complex social dilemmas characterized by conflicting values. *Accepted in Findings of EMNLP 2023.*
- Conducted an in-depth examination of the "Foreign Language Effect" in LLMs, with a specific focus on understanding the moral reasoning abilities of these models within multilingual contexts. *Two papers under review in EACL 2024 and LREC-COLING 2024.*

**Cryptographically Secure Large Language Models** Oct 2023 - Present
Advisor: Dr. Nishant Chandra

- Engaged in instruction training the Turing Language Model to differentiate instructions from data, employing cryptographic delimiters to prevent man-in-the-middle threats. Focus is on bolstering model security against jailbreak attacks, addressing challenges unaddressed by prompt engineering or post-processing.

**Multilingual Instruction Finetuning** Sep 2023 - Present
Advisors: Vishrav Chaudhary and Dr. Monojit Choudhury

- Engaged in improving the reasoning capabilities of Turing Language Generation Models in multilingual settings, focusing on transformer architectures with 6.7B and 13.6B parameters.
- Established a robust 2.2M multilingual instruction dataset using GPT-4 and GPT-3.5 Turbo, employing systematic prompt engineering methods.
- Analyzed tokenizer fertility across 100+ languages to address tokenization impact, and implemented a systematic pipeline for filtering undesirable samples from the multilingual dataset.
- Conducted extensive instruction tuning experiments, resulting in a remarkable 25% average performance improvement over non-instruction-finetuned models.

**Methods for Faster Inference with Large Language Models** Oct 2023 - Present
Advisor: Dr. Tejas Indulal Dhamecha

- Exploring methods from matrix compression, quantization, early-exit decoding and uncertainty quantification to make LLMs amenable to single GPU deployment and faster inference.

## Internship Experience

***qure.ai, Mumbai***
**Classification and Localization of Tubes and Catheters in Chest X-Ray Images** Summer 2021
Advisors: Tarun Raj and Dr. Pooja Rao [qXR-BT]

- Developed an end-to-end pipeline for classification and segmentation of medical entities (tubes & catheters) in Chest X-Rays, addressing class imbalance through a weighted-binary cross-entropy loss function.
- Developed a two-step strategy for precise tube tip localization using deep learning-based segmentation and advanced image processing techniques.
- Conducted extensive experiments with various CNN architectures, surpassing baseline methods and contributing to the successful integration of models into qure.ai's deep learning stack for the qXR-BT product.

***Sustainability and AI Lab, Stanford University, CA***
**Machine Learning for Socioeconomic, Sustainability and Computer Vision Tasks** Fall 2020
Advisor: Prof. Stefano Ermon *Remote Collaborator*

- **Geography-Aware Self-Supervised Learning (ICCV 2021)**: Helped develop and validate a novel contrastive learning method for remote sensing data, leveraging spatio-temporal structures and geo-location showing improvements in image classification, object detection, and semantic segmentation.
- **Efficient Poverty Mapping from High Resolution Remote Sensing Images (AAAI 2021)**: Helped develop and validate a novel reinforcement learning method to optimize acquisition of high-resolution satellite images based on analysis of free low-resolution imagery, enhancing poverty prediction in Uganda.
- **Efficient Conditional Pre-training for Transfer Learning (CVPRW 2022)**: Helped develop and validated efficient and adaptable methods for pre-training dataset filtering to reduce high training costs, emphasizing performance, adaptability, and flexibility.

## Undergraduate Research Projects

**Medical Tube Abnormality Detection in Chest-X Rays using Deep Learning** Spring 2022
Advisor: Prof. Pabitra Mitra [Bachelor's Thesis]

Developed DL algorithms for abnormal tube position detection in Chest X-Rays, achieving a 24% improvement via knowledge distillation. Created a proprietary dataset, incorporating segmentation masks for anatomical regions and ideal tip positions, leading to a 35% avg. improvement in abnormalities detection across tube types. Developed CNN-based segmentation models and applied image processing techniques for optimal detection.

**Typologically Diverse QA - Zero-Shot and Few Shot Language Jackknifing** Fall 2021
Self-Project [PDF]

Investigated cross-lingual generalization of multilingual BERT (mBERT) using TYDI QA dataset, exploring its performance on QA tasks across various languages. Identified linguistic feature impacts on zero-shot transfer, finding that fine-tuning mBERT as a language model on QA questions significantly improved zero-shot cross-lingual understanding, addressing question interpretation challenges.

**Effect of Negative Labels on Conditional Generative Adversarial Networks** Spring 2021
Self-Project [PDF]

Proposed a novel data augmentation technique for stabilizing the training of class-conditional Generative Adversarial Networks (CGANs), addressing issues such as non-convergence and mode-collapse. Additionally, introduced a new evaluation metric based on the classification ability of the Discriminator, demonstrating its positive correlation with visual inspection, surpassing traditional metrics like Inception score and FID.

**Augmented Reality Based Context Aware Recommendations** Summer 2019
Self-Project [PDF]

Developed a novel consumer targeting system by modeling AR-based data. Created persuasive recommendations by using statistical modeling, an exemplar part-based 2D-3D alignment method to find the best matching 3D models of furniture present in the user's preferred purchase viewpoint in the AR app and a combination of 3D style compatibility and color compatibility algorithms. *Work published in ICCV Workshop 2019.*

## Other Selected Projects

**MusicAnalyst**, OpenAnalytics (intra-collegiate tech competition), IIT Kharagpur Spring 2022

Led a hostel team, developing a neural network based model to predict popularity (highest possible revenue) of music tracks based on features associated with the music. Incorporated a meticulously designed loss function to address class imbalance challenges. *Received Second Prize.*

**EthPhoto**, OpenSoft (inter-hostel tech competition), IIT Kharagpur Spring 2022

Co-led the hostel team, developing a decentralized location & tag based photo-sharing app using Ethereum blockchain technology and IPFS storage. *Received Third Prize.*

**Pet Projects**
implemented the following deep learning algorithms in Python/PyTorch

(a) Knowledge Distillation, (b) Deep Convolutional Generative Adversarial Networks (DCGAN), (c) Global Wheat Detection: Detection of Wheat Heads using Faster-RCNN algorithm; confidence scores calculated using weighted boxes fusion (better than Non-Maximum Suppression), (d) Sentimal Analysis using Naive Bayes and Logistic Regression, (e) Character-based model (using LSTM) for Sonnet Generation.

## Awards and Achievements

**OpenAnalytics Intra-collegiate Tech Competition (Captain) - Second Prize - IIT Kharagpur** 2022
Led a team, developing a neural network based model to predict popularity of music tracks based on the features associated with the music. Competition featured 50 teams.

**OpenSoft Inter-hostel Tech Competition (Captain) - Third Prize - IIT Kharagpur** 2022
Co-led the hostel team, developing a decentralized photo-sharing application (EthPhoto) using Ethereum blockchain technology and IPFS storage. Competition featured 14 teams.

**Honda Young Engineer & Scientist's (Y-E-S) Fellowship Finalist** 2021
Amongst 20 finalists from all over India.

**Kamalavati Syngal and Goralal Syngal Memorial Scholarship** 2019
Awarded for academic excellence at IIT Kharagpur.

**Kishore Vaigyanik Protsahan Yojana (KVPY) Scholarship** 2017
Awarded to 1323 students from around 100,000 applicants by Dept. of Science and Technology, Govt. of India for exceptional aptitude in basic sciences.

**Abhay Seva Sansthan Gold Medal (Class XII)** 2018
Awarded for scoring 100% in Computer Science in ISC (12th grade) board examination.

**C. D. Sinha Award** 2018
Awarded for outstanding performance (95.6%) in ISC (12th grade) board examination.

**Abhay Seva Sansthan Gold Medal (Class X)** 2016
Awarded for scoring 100% in Computer Science in ICSE (10th grade) board examination.

**S. P. Sinha Scholarship** 2016
Awarded full scholarship for 11th & 12th grade due to outstanding performance (96.5%) in ICSE (10th grade) board examination.

## Technical Skills

**Languages:** Python, C, C++, R, MATLAB, Octave
**Libraries:** PyTorch, Pytorch Lightning, Tensorflow, Keras, NumPy, Scikit-learn, Selenium, Pandas, OpenCV, Beautiful Soup, Scipy, NLTK, Flask, Tesseract, EasyOCR

## Relevant Coursework

Programming & Data Structures (+Lab)
Mathematics I & II
Algorithms I (+Lab)
Marketing & Market Research
Transform Calculus
Signals & Networks (+Lab)
Theory and App. of Blockchain
Probability and Stochastic Processes
Big Data Processing
Foundation of Educational Technology
Data Analytics
Digital Signal Processing
Social Computing
Artificial Intelligence

## Online MOOCs | Coursera

Machine Learning - Certificate
Neural Networks and Deep Learning - Certificate
Structuring Machine Learning Projects - Certificate
Improving Deep Neural Networks: Hyperparameter tuning, Regularization and Optimization - Certificate
Convolutional Neural Networks - Certificate
Sequence Models - Certificate
Natural Language Processing with Classification and Vector Spaces - Certificate
Natural Language Processing with Probabilistic Models - Certificate
Natural Language Processing with Sequence Models - Certificate

## Extra Curricular Activities

**Sub-reviewer** for ACL 2023 and AACL-IJCNLP 2023.

**Teaching Assistant** (2023) for a workshop course in Practical NLP and Large Language Models (LLMs) for bachelor's students at the Indian Institute of Science (IISc) as part of Kotak-IISc AI-ML Centre.

**Volunteer Teacher at eVidyaloka** (2023): Taught Maths and Science to underprivileged children in remote areas of Jharkhand via Skype.

**Technovation Mentor for Youth Coding Initiative** (2022): Mentored 5 high-school girls to build a business plan and mobile app for autistic children that we piloted with 10 families.

**Captain** (2022) of the OpenAnalytics (intra-collegiate tech competition) team of my hall of residence, IIT Kharagpur.

**Co-Captain** (2022) of the OpenSoft (inter-hostel tech competition) team of my hall of residence, IIT Kharagpur.

**Student Academic Mentor, Student Welfare Group, IIT Kharagpur** (2020 - 2022): Looked after the orientation and guidance of 5 new students to ease their transition into college life.

**National Sports Organization** (2018 - 2020): Involved in Health & Fitness/Athletics as part of NSO, IIT Kharagpur.