Junaid Ali

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Education

Max Planck Institute for Software Systems and Saarland University 2018- 2024
PhD. In Computer Science (Thesis submitted)

Saarland University 2013 - 2017
Masters in Visual Computing: **Top 5% out of 50** *GPA 1.2*

Selected Courses: Differential Equations in Image Processing and Computer vision, Partial Differential Equations and Boundary value problems, Machine learning, Calculus of Variations, Statistical Natural Language Processing, Vision for Graphics, Geometric Modeling.

Lahore University of Management Sciences 2007- 2011
Bachelor of Science (Honors) Computer Science: **Top 10% out of 400** *CGPA 3.5, Subject-GPA 3.6*

Selected Courses: Discrete Mathematics, Probability, Ordinary differential equations, Computer Vision, Algorithms and Advanced Programming in Java.

Self-directed Study:
Transformers architecture (from scratch), LLM Fine-tuning with optimization methods such as LORA, QLORA and adapters, RLHF/RLAIF and Efficient training of LLMs (Data/Model parallelism).

Projects: My Contributions

Amazon web services November 2022 – May 2023
Applied Scientist Intern

Evaluating the fairness of discriminative foundation models in computer vision (Accepted at AIES '23)

- **Ideation**:
  - Collaboratively, developed the concept of evaluating bias in discriminative foundation models.
  - Collaboratively, proposed a novel taxonomy for evaluating fairness in models, focusing on CLIP and OpenCLIP.
- **Implementation**:
  - Developed comprehensive evaluation framework for foundation models' behavior across multiple tasks.
  - Implemented evaluation metrics to assess bias in zero-shot classification, image retrieval, and image captioning.
  - Introduced new bias mitigation baselines: fair-PCA, gender-neutral captioning, and explicit gender inclusion in image retrieval.
  - Developed pipelines for zero-shot image classification and image retrieval using CLIP and OpenCLIP.
  - Fine-tuned image captioning systems based on CLIP and GPT-2 leveraging existing code.
  - Implemented existing bias mitigation methods where code was unavailable.
- **Analysis:**
  - Conducted bias and performance evaluation of CLIP and OpenCLIP, analyzing accuracy, precision, recall, and fairness.
  - Performed statistical analysis to assess bias mitigation effectiveness.
  - Evaluated the impact of mitigation techniques across binary (gender) and multi-valued (race) attributes using 10 diverse datasets.
- **Results:**
  - Demonstrated that both CLIP and OpenCLIP exhibit biases, with OpenCLIP showing higher bias levels.
  - Found that the effectiveness of mitigation methods depends on the application scenario and fairness definition. FairPCA performed best in most cases.
- **Communication:**
  - Authored the majority of the paper and presented the work at AIES'23.

Max Planck Institute for Software Systems June 2018-May 2024
PhD student with ***Krishna P. Gummadi***

During my PhD I worked on fairness, consistency and interpretability in machine learning.

Moderating inconsistency between human decision-maker (Accepted at NeurIPS'23 Workshop and CSCW'24)

- **Ideation:**
  - Collaboratively proposed evaluating the efficacy of algorithmic assistance in enhancing human decision consistency.
  - Explored the possibility of designing decision aids that do not rely on ground truth.
- **Key Insight:**
  - Social psychology literature suggests that comparative decision-making is more intuitive for humans than absolute judgments.
- **Approach:**
  - Designed decision aids to elicit comparative judgments and developed tools leveraging this data without relying on ground truth.
  - Evaluated several machine advice strategies through large-scale human-subject experiments.
- **Implementation:**
  - Contributed to survey design, experimental ideation, and machine advice strategy proposals.
  - Implemented decision aids for different machine advice strategies and implemented two surveys:
    - Data collection for decision aid development.
    - Evaluation of strategies to improve decision consistency.
- **Analysis and Impact:**
  - Conducted exploratory experiments examining decision-update propensity, consistency, and accuracy definitions.
  - Demonstrated that comparative strategies enhance decision consistency without ground truth, improving subjective decision-making processes.
- **Communication**: Co-authored the paper and personally presented findings at NeurIPS '23 Workshop and CSCW'24.

Accounting for model uncertainty in algorithmic discrimination (Accepted at AIES'21)

- **Ideation:** Proposed to investigate fairness issues arising under model uncertainty (epistemic uncertainty).
- **Key Insight:** Focus on errors due to model uncertainty while ignoring errors caused by inherent noise, leading to a novel group fairness approach.
- **Approach:** Developed methods to identify and equalize epistemic errors in binary classification by leveraging predictive multiplicity techniques.
- **Formulations and Implementation:**
  - Introduced two convex formulations for margin-based classifiers (e.g., SVM and logistic regression) to improve scalability of predictive multiplicity methods for larger datasets and extend applicability to nonlinear classification problems.
  - Introduced a convex formulation to equalize epistemic error rates across sensitive groups, incorporating a stochastic selection mechanism to pick classifiers and achieve fairness.
  - Designed an experimental pipeline using CVXPy to identify and equalize epistemic errors across different sensitive groups.
  - Adapted and extended existing predictive multiplicity codebases for experimentation.
- **Analysis & Results:**
  - Demonstrated, on synthetic data, that the proposed methods identify epistemic errors as effectively as existing approaches while being up to four orders of magnitude faster.
  - Showed, on synthetic and real-world datasets, that the methods effectively equalize epistemic errors while preserving aleatoric errors.
- **Communication:** Wrote the majority of the paper and presented findings at AIES'21.

Loss-aversively fair classification (Accepted at AIES'19)

- **Ideation**: Motivated by behavioral economics, collaboratively developed a novel fairness concept, loss-aversive fairness, to address fairness concerns in updates to decision-making systems.
- **Key idea**: Fairness updates should account for the endowment effect, where individuals and groups feel entitled to the benefits provided by the current system. This requires balancing absolute fairness with relative changes to mitigate perceived losses and ensure equitable outcomes.
- **Approach:**
    - Operationalized loss-aversive fairness for binary classification, incorporating it into machine learning models.
    - Addressed the computational challenge posed by the non-convex nature of the problem by proposing convex proxies for the fairness notion.
    - Integrated these proxies with existing fairness criteria, such as group fairness, for margin-based classifiers (e.g., SVM, logistic regression).
- **Implementation:**
    - Developed and implemented the approach using CVXpy, enabling classifiers to incorporate loss-aversive fairness constraints while ensuring non-discrimination (e.g., disparate impact and disparate mistreatment).
    - Extended applicability to both linear and non-linear classifiers.
- **Analysis/Results:** Conducted experiments on two synthetic and two real-world datasets, demonstrating that the proposed approach:
    - Improves outcomes for all sensitive groups compared to status-quo classifiers.
    - Effectively balances fairness updates without small trade-offs in overall performance.
- **Communication**: Drafted the majority of the paper and presented our findings at AIES'19

Fairness of time-critical influence maximization in social networks (Accepted at NeurIPS'19 Workshop, ICDE'22 (extended abstract), TKDE'21

- **Ideation:** Collaboratively developed the idea of incorporating fairness into time-critical influence maximization (TCIM) with my advisor, focusing on budget (TCIM-B) and coverage (TCIM-C) constraints, and addressing gaps in existing work.
- **Formulations:** Proposed fairness-aware formulations for TCIM problems, incorporating fairness notions into time-critical objectives.
- **Algorithm Design:** Developed submodular heuristics to tackle the non-submodular structure of fairness-constrained TCIM problems, ensuring computational efficiency.
- **Theoretical Guarantees:** Proved bounds for the proposed formulations under my advisor's guidance, demonstrating bounded fairness cost and efficient solutions.
- **Implementation:** Built an end-to-end pipeline for fairness-aware TCIM using the NetworkX library, integrating both traditional influence maximization and fairness constraints.
- **Exploratory Analysis:** Conducted extensive experiments on synthetic networks to study fairness impacts under varying algorithmic (e.g., time deadlines, seed set size) and graph properties (e.g., group sizes, connectivity).
- **Evaluation:** Demonstrated the effectiveness of proposed approaches on synthetic and four real-world social networks with multi-sensitive groups, achieving reduced disparity across groups with minimal fairness cost.
- **Communication**: Wrote the majority of the paper and personally presented findings at NeurIPS'19 Workshop and ICDE'22.

Unifying model explainability and accuracy through reasoning labels (NeuRIPS '19 Workshop)

- **Ideation:** Collaboratively conceptualized the use of reasoning labels as a bridge between explainability and robustness in deep neural networks, introducing the novel notion of prediction consistency to enhance model performance.
- **Experimental Design:** Provided detailed feedback on the experimental methodology, including the design of consistency-based evaluation metrics and analysis of intermediate results, which demonstrated improved accuracy on consistent samples and increased robustness to adversarial perturbations.
- **Results**: Demonstrated that integrating reasoning labels during training not only enhances classification accuracy for consistent predictions but also fortifies models against adversarial attacks, advancing state-of-the-art robustness in explainable AI.
- **Communication:** Contributed to drafting the paper and assisted in preparing the presentation for the SRDM Workshop at NeurIPS19.

Other side projects:

Counterfactual fairness
Implemented a GAN-based method (FlipTest) using PyTorch to assess counterfactual fairness, contributing to fairness analysis in machine learning models.

Fair feature acquisition:

- **Ideation:** Conceptualized the idea of fair feature acquisition, focusing on selectively gathering optional features only when they improve individual outcomes in expectation.
- **Proposed Solution:** Developed a **reinforcement learning-based** approach to optimize fair feature acquisition.
- **Implementation and Results**: Implemented the method using PyTorch and Gym, demonstrating its potential through experiments on synthetic datasets.

Max Planck Institute for Software Systems May 2017-May 2018
Research intern with ***Manuel G. Rodriguez***

Marked temporal point processes generation through VAEs

- **Ideation:** Collaboratively proposed leveraging Variational Autoencoders (VAEs) and Recurrent Neural Networks (RNNs) to model marked temporal point processes.
- **Implementation:** Developed a framework where VAEs were parameterized by recurrent marked point processes using TensorFlow. Implemented data generation for homogeneous and non-homogeneous Poisson processes as well as Hawkes processes to train and evaluate the setup.
- **Evaluation:** Conducted statistical tests (e.g., Kolmogorov-Smirnov test) to validate the model's success in generating diverse types of temporal point processes.
- **Impact:** Advanced beyond traditional parametric methods for generating point processes by proposing a non-parametric, data-driven approach capable of learning any time series without assuming a predefined functional form.

Max Planck Institute for Informatics March 2014-March 2017
Research Assistant with ***Karol Myszkowsk****i*

I helped conduct several experiments related to human-perception in computer graphics during this time and led the following two projects for my master's thesis:

Relationship between Frame-rates and Speed perception:

- **Ideation:** Investigated how frame rate influences speed perception through a literature review.
- **Approach:** Designed and conducted three psychophysical experiments using basic stimuli (Gabor patches), animated content, and real-world footage.
- **Experimental Design:** Developed a C++ experimental setup where participants compared the perceived speed of test and reference sequences at different frame rates.
- **Real-World Videos:** Used OpenCV to calculate optical flow and interpolate frames for test sequences. Implemented a 2AFC paradigm where participants indicated which sequence appeared faster.
- **Results:** Disproved the urban myth that frame-rates influence speed perception. Statistical analysis showed no significant difference.

Relationship between Frame-rates and Flicker perception:

- **Ideation:** Explored how variable frame-rate technology can mitigate the "soap-opera effect" of high-frame-rate videos while maintaining the "film look."
- **Key insight:** Identified flicker as a key differentiator between low and high frame rates, proposing to adjust flicker to retain HFR benefits without its drawbacks.
- **Approach:** Developed a pipeline to compute per-pixel flicker maps and derive corresponding frame-rate maps to achieve desired flicker levels.
- **Factors affecting flicker:** Conducted a literature review to identify key factors (contrast, spatial extent, and speed) that influence flicker perception.
- **Implementation:** Built the pipeline using OpenCV and C++, simulating retinal images, calculating contrast, and deriving flicker and frame-rate maps. Applied smoothing and variable frame-rate rendering.
- **Results:** Demonstrated that the system successfully achieved the "film look" by modulating flicker and frame rates in tests using basic stimuli and animated content.

Max Planck Institute for Informatics
Research Assistant with ***Christian Theobalt*** August 2015-January 2016

I worked on a project to improve the results of **3D face reconstruction** from monocular videos.

- I implemented the Hessian and its **Eigen functions** computation, of **flexural energy**. The motivation was to use these Eigen functions as bases for 3D face reconstruction in order to account for **bending** and **stretching** deformations in a triangular mesh, such that we can capture more nuanced feature in human face. The result provided a significant improvement compared to **Laplacian bases**.

Nosh Genie August 2012-June 2013
Co-Founder
Social Recommendation Engine for Food

- Conceived and developed the idea, including feature design and competitive analysis.
- Created marketing strategy and implemented cellphone applications for Android and Nokia platforms.

Anahata Solutions January 2011-June 2012
Developer

Besides developing android and Samsung TV application, I also mentored interns.

Lahore University of Management Science January 2011 -July 2012
Research Assistant

- Built 3D lung models from CT images and applied morphological filters to identify cancerous nodules.

Talks and presentations

CSCW 2024 November 2024
A premier conference in social computing
Presented our work on **moderating inconsistencies between human decision-makers**

Google research June 2023
Responsible AI group New York
Gave an hour-long research talk on **designing fair systems**.

NeurIPS 2023 December 2022
Human-centric AI Workshop
Gave a talk for our paper on **moderating inconsistency between human decision-makers**.

ICDE 2022 May 2022
A premiere conference on data engineering.
Presented a poster for our paper on **the fairness of time-critical influence maximization in social networks**.

AIES 2022 May 2021
A premiere conference on fairness and ethics in AI.
Gave a talk and presented a poster for our paper on **accounting for model uncertainty in algorithmic decision making**.

NeurIPS 2019 December 2019

Human-centric machine learning workshop

Gave a talk on our paper on **the fairness of time-critical influence maximization in social networks**.

Machine learning summer school (MLSS London) June 2019

Presented a poster for our paper on **loss aversive fairness**.

AIES 2019 January 2019

A premiere conference on fairness and ethics in AI.

Presented a poster for our paper on **loss aversive fairness**.

Max Planck Institute for intelligent systems January 2018

Gave a talk on our work on **marked point process generation through variational recurrent marked temporal point processes (RMTPP)**.

Honors and Awards

MLSS London: 11.6 % acceptance rate out of **1200** applicants. 2019

Machine learning summer school is a prestigious and very competitive summer school. It includes lectures by some of the world's leading experts.

Fulbright Scholarship (declined): **Less than 200 students** from a nationwide population of **200 million**. 2013

I was awarded Fulbright scholarship for masters in computer science at Stony Brook university, however I chose not to avail the opportunity. The scholarship includes full tuition waiver and living stipend for the duration of study.

Plan9 Tech Incubator: 14 teams were selected from a nationwide population of **200 million**. 2012- 2013

Our start-up Nosh Genie was selected in Plan9, a tech incubator. After rigorous testing and pitching sessions, 14 teams were selected. This incubation included free office space, stipend money, laptops, mentoring session and marketing support.

International Conference on Machine Vision Project Competition: 1st prize **out of 30 teams**. 2012-2013

We presented our bachelor's computer vision course project at ICMV. The project was a video editing. In this project we first performed color-based feature tracking in consecutive video frames. We then used the tracked points to place warped input images on those points generating effects like moving pictures in a newspaper, as in Harry Potter films.

National Outreach Undergraduate Scholarship: 50 students from a nationwide population of **200 million** 2007-2011

My undergraduate studies were funded during 4 years by the university, through the program named National Outreach Program (NOP). In this program few talented students in need of financial assistance are funded by the university as long as they maintain a certain GPA.

Academics Award: Top 5% out of 110 students 2005

Received award for academic performance in high school.

Teaching

Programming

Languages

Teaching Assistant (Bachelors): **Computational Biology** and **Distributed Software Systems**

Python, C++, Pytorch, OpenCv

English, Urdu and basic German

Teaching Assistant (Grad School):
Human Centered Machine Learning
http://courses.mpi-sws.org/hcml-ws18/

Publications

6) (De)Noise: Moderating the Inconsistency of Human Decisions,
Junaid Ali, Nina Grgić-Hlača, Krishna P. Gummadi and Jennifer Wortman Vaughan
in Human Centered AI (HCAI) workshop at **Neurips'19**, **Oral Presentation**

Also accepted at a premier conference in social computing

De)Noise: Moderating the Inconsistency of Human Decisions,
Nina Grgić-Hlača, **Junaid Ali**, Krishna P. Gummadi and Jennifer Wortman Vaughan
in Computer-Supported Cooperative Work in Social Computing (CSCW '24)

5) Evaluating the Fairness of Discriminative Foundation models in Computer Vision,
Junaid Ali, Matthäus Kleindessner, Florian Wenzel, Volkan Cevher, Kailash Budhathoki and Chris Russell
in AAAI/ACM Conference on AI, Ethics, and Society (**AIES '23**). Acceptance rate 29%

4) Accounting for Model Uncertainty in Algorithmic Discrimination,
Junaid Ali, Preethi Lahoti and Krishna P. Gummadi
in AAAI/ACM Conference on AI, Ethics, and Society (**AIES '21**). Acceptance rate 37%

3) Unifying Model Explanability and Accuracy Through Reasoning Labels,
Vedant Nanada, **Junaid Ali**, Krishna P. Gummadi and Muhammad Bilal Zafar
In Safety and Robustness in Decision Making (SRDM) Workshop at **NeurIPS'19**, 2019

2) On the Fairness of Time-Critical Influence Maximization in Social Networks,
Junaid Ali, Mahmoudreza Babaei, Abhijnan Chakraborty, Baharan Mirzasoleiman, Krishna P. Gummadi and Adish Singla
In Human-Centric Machine Learning (HCML) Workshop at **NeurIPS '19**, 2019, **Oral Presentation**
Also accepted at:
Journal: TKDE 21' (Transactions on Knowledge and Data Engineering, premier journal in data engineering**), Full paper Conference: ICDE22' (**International Conference on Data Engineering, premier conference in data engineering**), extended abstract**

1) Loss-Aversively Fair Classification
Junaid Ali, Muhammad Bilal Zafar, Adish Singla and Krishna P. Gummadi
in AAAI/ACM Conference on AI, Ethics, and Society (**AIES 19**). Acceptance rate 32%