Shubhabrata Mukherjee
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Website
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Primary focus area:
Computer Vision; Optimization; Biometric Privacy

Machine learning and data analytics:

Applied deep learning frameworks like TensorFlow, PyTorch, and math-based libraries like NumPy, Pandas, SciPy, scikit-learn, and matplotlib for tuning pre-trained models and building models from scratch.
Developed end-to-end Raspberry Pi based event notification system with AWS IoT core, and SNS.
Deployed and productionized classical and neural-network models, including YOLO and CNN.
Multi GPU / CPU parallel computing and benchmarking for various deep learning tasks and models.
Multi-objective optimization of CPU power, frequency, and throughput using Bayesian optimization.
Experienced in using R, Snowflake (SQL), and Matlab for machine learning applications.
Applied OpenCV with Azure and offline settings for object detection and biometric privacy research.
Developed various unsupervised learning methods, such as PCA, clustering, and autoencoders.
Performed energy benchmarking of LLM-based transformers for research in semantic communication.

Related Coursework:

Deep learning using Python; Computer Vision; Pattern recognition; Introduction to statistical learning and R; Principal of big data management; Neural and adaptive Networks; Digital Signal Processing

Education:

University of Missouri-Kansas City, USA: Ph.D., Computer network & comm. systems, **exp. Dec 2023.**
University of Missouri-Kansas City, USA: Master of Science, Electrical Engineering, May 2017.
West Bengal University of Technology, India: Bachelor's, Electronics & Communication Eng., 2009.

Professional Experience:

1. **SPAN (Sept '22 – Dec'22), Machine learning intern**
   Successfully implemented an anomaly notification system using Python, Docker, and Airflow.
   Conducted comprehensive literature analysis, to validate research findings, and designed machine learning models.
   Collected, cleaned, and analyzed electrical consumption data to create various models for predictive analytics.
   Demonstrated research skills by breaking down requirements for the development of new products and features.
   Actively implemented, tested, and evaluated new features and products, leveraging field data.

2. **T-Mobile (May '21 – Dec'21), Technology Strategy intern: 5G and AI**

   UAV-Aided Infrared Imaging-Based Object Detection and Localization:
   Developed a UAV-based streaming infrastructure with Azure VM, enabling live object detection and localization.
   Implemented an infrared-based object detection model using the latest YOLOV7-official model.
   Presented a paper at the IEEE HST conference, 2022 (UNIMODAL) based on the research.

   Autonomous Fault Management for Next-Generation Networks:
   Designed an AI-based multi-phase framework for end-to-end autonomous fault management in 5G and beyond.
   Successfully implemented an optimal combination of classical machine learning and deep learning techniques.
   Published a paper in IEEE Wireless Communications Journal, special issue, 2022 (openFM) based on the research.

3. **Intel Corp. (May '20 – Jan'21), Graduate Intern for Network AI**

   Dynamic and static Closed-loop NFV optimization:
   - Multi-objective Bayesian optimization experiments of NFV workload.
   - Performance comparison of various optimization like Genetic algorithm, TuRBO, etc.
   - Automation environment development to support optimization tests and benchmarking.
   - End-to-end Kubernetes-based NFV architecture implementation.
   - Reinforcement-learning-based DAaaS (Data analytics as a service) framework implementation.

University of Missouri Kansas City (Aug '19 – Current), Graduate Assistant

Worked as a graduate research assistant for computer vision at CBIT lab. (Spring 2022)
Instructed lab for "Electronic circuit lab (ECE 331)" (Spring 2021)
Assisted teacher for the graduate class of "Wireless Communication". (Spring 2020)
Assisted teacher with the class "Intro to wireless networking". (Spring 2020)
Assisted teacher with the class "Internet of Things". (Fall 2019)
Assisted teacher for the class of "Foundation of Software Engineering" (Fall 2019)

Google Inc, (Contract), June '17 – June'19, Test & Automation Engineer

Project: ©Loon by Google X Lab
Developed analytics platform for temporospatial analysis of critical metrics like latency, throughput, CQI, etc.
Created performance prediction frameworks using data from Google Cloud for data-driven decision-making.

Sprint Corp., (Contract), Aug '16 – May'17, Implementation Engineer

Developed models to predict signal parameters like RSSI, RSRP, SNR, etc.
Was responsible for the development and performance analysis of various Nokia & Airspan products.

Past work experiences in India:

- Bharti Airtel Ltd., SME – RF planning and optimization (Full-time, India, Dec 2013 – July 2015)
- Ericsson Global Services Ltd., Assurance Engineer (Full-time, India, Nov 2011 – Dec 2013)
- Nokia Siemens Networks, Transmission Engineer (Full-time, India, May 2010 - Nov 2011)

Academic Research Projects:

1. **Energy-efficient semantic communication using transformers**
   We are using various transformer models to develop an energy-optimized semantic communication system. We have shown how our proposed novel loss function can help the selection of an energy-efficient model that can deliver superior semantic efficiency. We are benchmarking detailed resource consumption during inference. A paper based on this research has been submitted to IEEE ICC 2024. Link-to-preprint Link-to-project

2. **Privacy-preserving biometrics using deep neural networks**
   In our **CBIT** (Computational Intelligence and Bio-Identification Technologies) lab, we used deep neural networks to preserve biometric privacy. This project is funded by TrippleBlind©. This project is also a part of the NSF CBL initiative. A journal is waiting to be submitted on biometric privacy preservation at IEEE Transactions. Link-to-preprint

3. **On-device computer-vision experiments with IoT**
   Various neural network approaches are being experimented with and implemented with CPU-only IoT hardware like Raspberry Pi for diverse tasks like low light object detection, face detection, segmentation, etc. Models are tested against low-energy and limited computation environments. Also, developed cloud and IoT-based person detection and notification systems using AWS IoT core and Simple Notification Service. Link-to-project

4. **Development of ultra-reliable communication techniques for MCPTT (Master's thesis project):**
   The thesis discusses possible strategies to achieve reliability in a mission-critical network. Based on this, a reliable mission-critical system framework has also been proposed. A simulation study of the effects of different pivotal factors that affect communication channels is described. This study provides a better understanding of the requirements for improving the reliability of a practical communication system. Link-to-thesis

Publications:

Published:

[1] S. Mukherjee, O. Coudert and C. Beard, "UNIMODAL: UAV-Aided Infrared Imaging Based Object Detection and Localization for Search and Disaster Recovery," 2022 IEEE International Symposium on Technologies for Homeland Security (HST), Boston, MA, USA, 2022, pp. 1-6, doi: 10.1109/HST56032.2022.10025436.

[2] S. Mukherjee, O. Coudert and C. Beard, "An Open Approach to Autonomous Ran Fault Management," in IEEE Wireless Communications, vol. 30, no. 1, pp. 96-102, February 2023, doi: 10.1109/MWC.004.2200244.

[3] Mukherjee, S., Choi, T., Islam, M.T., Choi, B.-Y., Beard, C., Ho Won, S. and Song, S. (2020), A supervised-learning-based spatial performance prediction framework for heterogeneous communication networks. ETRI Journal, 42: 686-699. https://doi.org/10.4218/etrij.2020-0188

[4] S. Mukherjee and C. Beard, "A framework for ultra-reliable low latency mission-critical communication," 2017 Wireless Telecommunications Symposium (WTS), Chicago, IL, USA, 2017, pp. 1-5, doi: 10.1109/WTS.2017.7943546.

[5] Master's thesis on "A framework for ultra-reliable low latency Mission critical communication." https://mospace.umsystem.edu/xmlui/bitstream/handle/10355/60660/Thesis_2017_Mukherjee.pdf?sequence=1&isAllowed=y

Submitted and under review:

[6] "Transformers for Green Semantic Communication: Less Energy, More Semantics", IEEE ICC 2024.

Under internal review:

[7] "Secure and private ensemble matchers using multi-vault obfuscated templates"

Under preparation:

[8] YOLO-fusion: Low light surveillance using Fusion-based multimodal object detection and localization.

Conference presentation:

1. Presented the paper "UNIMODAL: UAV-Aided Infrared Imaging Based Object Detection and Localization for Search and Disaster Recovery" at the 2022 IEEE Symposium on Technologies for Homeland Security.
2. Presented the work on "Secure inner product for privacy-preserving pattern matching" in NSF, CBL (2022)
3. Presented the work on "Load balancing heterogeneous network using deep learning" in NSF, CBL seminar (2019)
4. Presented the paper "A framework for ultra-reliable low latency mission-critical communication" at the 2017 IEEE Wireless Telecommunications Symposium.

Peer review activities:

1. Current reviewer for The Journal of Supercomputing, Springer.
2. Volunteered as a judge in T-Mobile Artificial Intelligence Ops HacksGiving. (2021 Fall) HacksGiving
3. Reviewed two papers for the IEEE Symposium on Technologies for Homeland Security, 2022.
4. A member of O-RAN ALLIANCE. (May 2021 – Dec 2021)
5. A member of the Ran Intelligence and Automation sub-group, Telecom Infra Project (May 2021 – Dec 2021)

Awards, Grants, and Other Research Activities:

1. Developed a novel multi-objective loss function for LLM-based semantic transformation and energy consumption for end-to-end semantic communication.
2. Developed an ML-based end-to-end anomaly notification up to the final product at SPAN.
3. Contributed to multiple grant writing initiatives for NSF, DOE, and NTIA, leading to their successful conversion into active research projects.
4. The Autonomous fault management project done at T-Mobile got featured on WayUp. https://www.wayup.com/guide/community/t-mobile-tech-internships/
5. UMKC graduate student travel grant (FY2022-2023) for a conference presentation.
6. Submitted internal invention applications based on the research done at Intel Internship.
7. Submitted internal invention applications for the research work at the T-Mobile internship.
8. Doctoral NR Award from UMKC SCE.
9. Dean's International Scholar Award from UMKC Dean's office.
10. "Kudos! For Being Alive" award from MS Head, Bharti Airtel India, LTE Operations.