Farwa Abbas
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Research Interests

Biomedical signal processing, machine learning, inverse problems, dictionary learning, graph signal processing, reinforcement learning, statistical signal processing, deep learning based image reconstruction, and convex optimization methods for learning low rank and sparse representations

Education

- **Imperial College London** — London, England
  Doctor of Philosophy in Electrical Engineering — Apr. 2021 – Present
- **Lahore University of Management Sciences (LUMS)** — Lahore, Pakistan
  Masters of Science in Electrical Engineering; (Distinction) — Sep. 2017 – May. 2019
- **University of Engineering and Technology (UET)** — Lahore, Pakistan
  Bachelor of Science in Electrical Engineering; (Dean's Honour Roll) — Sep. 2013 – Jun. 2017

Professional Experience

- **Graduate Teaching Assistant** — October 2021 - Present
  Imperial College London, England
  * Served as a Graduate Teaching Assistant for several courses taught at the Department of Electrical and Electronic Engineering, Imperial College London. My responsibilities include developing course material, marking assignments, lab demonstrations, and providing tutorial support to students.
- **Lecturer** — August 2022, August 2023
  Princess Nourah Bint Abdulrehman University, Riyadh, Saudi Arabia
  * Served as an lecturer for a three-week summer school of Computer Science for a Digital Future offered by the Universal Enrichment Program co-led by Oxmedica and Mawhiba for two years in 2022 and 2023.
- **Research Associate** — January 2018 - December 2020
  Information Technology University, Lahore, Pakistan
  * Gathered practical experience working on various industrial and research projects on machine learning and image processing. Worked on machine learning techniques and deep learning models such as Generative Adversarial Networks (GANs), Autoencoders such as (VAEs) and other models using tools from convex optimization. Worked on mathematical problems such as inverse problems; Blind Deconvolution, Sparse Reconstruction, and Low Rank matrix recovery.

Publications

- **F. Abbas**, V. McClelland, Z. Cvetkovic, W. Dai, "SS-ADMM: Stationary and Sparse Granger Causal Discovery For Corticomuscular Coupling", *International Conference on Acoustics, Speech, and Signal Processing*, 2023.
- F. Shamshad, **F. Abbas**, A. Ahmed, "Deep Ptych: Subsampled Fourier Ptychography Using Generative Priors", *International Conference on Acoustics, Speech, and Signal Processing (ICASSP)*, 2019.
- F. Shamshad, A. Hanif, **F. Abbas**, M. Awais, A. Ahmed, "Image Adaptive Generative Priors for Subsampled Fourier Ptychography",*International Conference on Computer Vision (ICCV)*, 2019.
- **F. Abbas**, V. McClelland, Z. Cvetkovic, W. Dai, "DLGC: Dictionary Learning based Granger Causal Discovery for Cortico-muscular Coupling", *Under review*
- **F. Abbas**, V. McClelland, Z. Cvetkovic, W. Dai, "Stationary and Sparse Denoising Approach for Corticomuscular Causality Estimation", *Under review*
- **F. Abbas**, V. McClelland, Z. Cvetkovic, W. Dai, "Exploring Corticomuscular Causality: Methods, Applications, and Significance", *Under review*

Technical Expertise

- **Languages & Tools :** C, R, Python, Tensorflow, Pytorch, VHDL, Java, MATLAB, Assembly language, SQL

Achievements

- **International Scholarship** 2021-2024
  - Awarded prestigious EEE scholarship from Department of Electrical and Electronic Engineering, Imperial College London

- **National Scholarships** 2019-2020
  - Selected among top four students within the country for Chief Minister Merit Scholarship for doctoral studies
  - Selected for merit based Higher Education Overseas scholarship for doctoral studies abroad

Selected Graduate Courses

- Advanced Digital Signal Processing
- Linear Algebra
- Stochastic Systems
- Convex Optimization
- Information Theory, Learning and Inference
- Computer Vision
- Machine Learning

Selected Research Projects

- **Identifying Corticomuscular Coupling in Real Physiological Signals**
  We considered the problem of identifying brain-muscle causal interactions from simultaneously recorded EEG and sEMG signals in the presence of noise and background activity. This type of causal information is fruitful in identifying biomarkers and treatment of people suffering from movement disorders.
- **Deep Distributed Compression Using a Learned Prior**
  We considered the problem of distributed compression in which two correlated image sources need to be compressed with no communication links between the encoders. We focused on distributed compression with a deep-learning based joint reconstruction algorithm. After learning the underlying correlation in the set of statistically correlated images using a Convolutional Neural Network (CNN). We then developed a deep learning framework by incorporating the knowledge from a prior learned network.
- **Fourier Ptychograhy Using Generative Prior**
  We proposed a novel framework to regularize the highly ill-posed and non-linear Fourier Ptychography problem using Generative Adversarial Network (GAN). We demonstrated the effectiveness of integrating deep generative priors with Fourier Ptychography problem to improve quality of reconstruction and robustness against noise, using far fewer samples. We also refined the proposed algorithm to allow the generative model to explore solutions outside the range, leading to improved performance.
- **Robust Partial Least Squares**
  We developed a novel framework for simultaneous dimensionality reduction and regression in the presence of outliers in data by applying low-rank and sparse matrix decomposition. For multivariate data corrupted with outliers, it is generally hard to estimate the true low dimensional manifold from corrupted data. The objective of the proposed framework is to find a robust estimate of the low dimensional space of data to reliably perform regression. The effectiveness of the proposed algorithm is verified experimentally for simultaneous regression and dimensionality reduction in the presence of outliers in data.

- **Predicting Remaining Useful Life of a Bearing using Vibration Data**
  Bearings are one of the most common cause of failures in rotary industrial equipment leading to down-times, and loss of revenue. Any method that can reliably predict the remaining useful life, and the chance of failure of different bearing is helpful in setting up timely and planned maintenance to reduce the down time and save capital. Predicting the remaining useful life of a bearing from raw vibration signals is a challenging problem as it is hard to pin down a signature in the vibration signal that leads to failure. We preprocessed the time series signals and learned a neural network model that estimated a health indicator to predict remaining useful life of bearing components based on convolutional networks, Long Short-Term Memory (LSTM) networks and Gaussian Processes (GPs).
- **Root Cause of Yield Loss in Semi-Conductor Manufacturing**
  Semiconductor manufacturing is very complicated that consists of hundreds of process steps, in which big data including process features, lot history and tool profiles are automatically generated and collected as the wafers move from step to step in a wafer fabrication facility. In yield analysis for semiconductor manufacturing it is observed that the primary source that results in loss of yield happens during the wafer fabrication stage. This project aimed to develop an effective approach for analysing production data for INTECH Process Automation industry to identify possible root causes of yield loss. The root cause analysis points to the process steps and equipment involved that are responsible for yield loss reducing the scope for troubleshooting.
- **Bayesian Network for Root Cause Identification**
  Bayesian network is a powerful tool to represent statistical relationship between different components working in a combined architecture in an industry. To identify root causes of fault in industrial units we have successfully employed Bayesian network for diagnostic purposes for INTECH Process Automation.

Undergraduate Projects

- WiFi based Home Automation
- Implementation of single phase and three phase inverter with PWM waveform
- Autonomous traffic signal control based on traffic density using Tiva C Launchpad
- Digital fan dimmer control using STM32F discovery board
- Design of a CMOS operational amplifier
- Verilog implementation of 32-bit single and multicycle MIPS processor on Spartan-3 FPGA
- Design and implementation of a variable gain audio amplifier
- 4-bit Arithmetic Logic Unit on programmable FPGA

Work Ethics and Interpersonal Skills

- Demonstrated strong problem-solving skills through various challenging scenarios
- Proven ability to adapt and learn quickly in dynamic environments by working on various industrial projects
- Excelled in team environments, fostering collaboration and achieving shared objectives.
- Exhibited leadership qualities by heading a cross-functional research projects by masters students

References

- Dr. Zohaib Akhtar. Senior Teaching Fellow. Department of Electrical and Electronic Engineering, Imperial College London. Email: z.akhtar@imperial.ac.uk
- Dr. Wei Dai. Senior Lecturer. Department of Electrical and Electronic Engineering, Imperial College London. Email: wei.dai1@imperial.ac.uk
- Dr. Zoran Cvetkovic. Professor of Digital Signal Processing. Department of Engineering. King's College London. Email: zoran.cvetkovic@kcl.ac.uk