RAO MUHAMMAD UMER

Research Statement

I design robust deep learning algorithms to classify and segment single cell by exploiting a large biomedical datasets for diagnostics in rare blood diseases, i.e., lymphoma and leukemia cancer subtyping. I like to train large foundation models in digital pathology.

Research Interests

Computational Biology, Computational Pathology (CPath), Computational Imaging, Foundation Models for Digital Pathology, Deep Learning in Biomedicine, Biomedical Image Analysis.

Professional Experience

MAR 2022 - CONT.	**PostDoc Researcher**, Institute of AI for Health (AIH), Helmholtz Munich, Munich, Germany. Working on training / finetuning CPath foundation model on whole slide images, Diffusion model for generating single cell data, unsupervised segmentation and classification of single white and red blood cells.
SEP 2024 - DEC 2024	**Visiting Researcher**, Biological Research Centre (BRC) of the Hungarian Academy of Sciences, Szeged, Hungary.
2022-2023	**Mentor** in "Computational Pathology Reading Course", offered to Master students of Technical University of Munich, Munich, Germany.
2022	**Mentor** in "Data Challenge: Help a Hematologist out" and "Introduction to interpretable Machine Learning course" in Incubator Summer Academy - From Zero to Hero, Munich, Germany.
DEC 2017 - SEP 2018	**Research Fellow**, Computational Imaging Group (CIG) at the Skolkovo Institute of Science and Technology, Moscow, Russia.
NOV 2016 - 2017	**Lecturer**, Department of CS & IT, The University of Lahore, Lahore, Pakistan. Taught courses (link): • Computer Vision, • Data Structures and Algorithms, • Digital Logic Design, • Business Computing, • Programming Fundamentals - I, • Introduction to Information and Communication Technologies.

Education

NOV 2018 - 2021	**PhD in Industrial and Information Engineering**, University of Udine, Udine, Italy. Research Area: Computer Vision and Deep Learning Thesis Title: Deep Convolutional Neural Networks for Image Super-Resolution
NOV 2014 - 2016	**MS in Computer Science**, Pakistan Institute of Engineering and Applied Sciences, Nilore, Islamabad, Pakistan. Research Area: Computational Intelligence and Machine Learning Thesis Title: Deep Web Extractor (DWX): Content Discovery From Deep Web Using Large Scale Data Analytics Paradigm CGPA: 3.45/4.0, Best Thesis Award.
SEP 2010 - 2014	**BSc. in Computer Systems Engineering**, The Islamia University of Bahawalpur, Bahawalpur, Pakistan.

Major Subjects: AI, Parallel and Distributed Computing, Image Processing
Thesis Title: Spam Filtering System: Malicious Email Detection and Filtering System Using Bayesian Machine Learning Algorithm
Cgpa: 3.82/4.0, ranked in top 5% of the class.

Research Publications

Conference Publications:

arXiv preprint 2024	Xudong Sun, Carla Feistner, Alexej Gossmann, George Schwarz, **Rao Muhammad Umer**, Lisa Beer, Patrick Rockenschaub, Rahul Babu Shrestha, Armin Gruber, Nutan Chen, Sayedali Shetab Boushehri, Florian Buettner, and Carsten Marr. *"DomainLab: A modular Python package for domain generalization in deep learning"*. arXiv preprint arXiv:2403.14356, 2024.
ICIAP 2023	Asif Hussain Khan, **Rao Muhammad Umer**, Matteo Dunnhofer, Christian Micheloni, and Niki Martinel. *"LBKENet: Lightweight Blur Kernel Estimation Network for Blind Image Super-Resolution"*. In proceedings of the 22nd International Conference on Image Analysis and Processing (ICIAP), September 11–15, 2023, Udine, Italy.
ICIAP 2023	Hussain Ahmad Madni, **Rao Muhammad Umer**, and Gian Luca Foresti. *"Federated Learning for Data and Model Heterogeneity in Medical Imaging"*. In proceedings of the 22nd International Conference on Image Analysis and Processing (ICIAP) Workshops, September 11–15, 2023, Udine, Italy.
ICLR 2023	**Rao Muhammad Umer**, Armin Gruber, Sayedali Shetab Boushehri, Christian Metak, and Carsten Marr. *"Imbalanced Domain Generalization for Robust Single Cell Classification in Hematological Cytomorphology"*. In proceedings of the 11th International Conference on Learning Representations (ICLR) Workshops, May 01–05, 2023, Rwanda.
HIC 2022	**Rao Muhammad Umer**, Christian Metak, and Carsten Marr. *"Raw image space improves single-cell classification in Acute Myeloid Leukemia"* (poster presentation). In Helmholtz Imaging Conference, June, 2022, Germany.
AVSS 2022	**Rao Muhammad Umer**, and Christian Micheloni. *"Real Image Super-Resolution using GAN through modeling of LR and HR process"*. In proceedings of the 18th IEEE International Conference on Advanced Video and Signal Based Surveillance (AVSS), November 29–December 02, 2022, Madrid, Spain.
NeurIPS 2021	**Rao Muhammad Umer**, and Christian Micheloni. *"RBSRICNN: Raw Burst Super-Resolution through Iterative Convolutional Neural Network"*. In proceedings of the 35th Conference on Neural Information Processing Systems (NeurIPS) Workshops, December 06–14, 2021, Australia.
Splitech 2021	**Rao Muhammad Umer**, Asad Munir, and Christian Micheloni. *"A Deep Residual Star Generative Adversarial Network for multi-domain Image Super-Resolution"*. In proceedings of the 6th International Conference on Smart and Sustainable Technologies, Sept. 08–11, 2021, Croatia.
CVPR 2021	Goutam Bhat, ..., **Rao Muhammad Umer**, ..., and others. *"NTIRE 2021 Challenge on Burst Super-Resolution: Methods and Results"*. In proceedings of the IEEE/CVF Conference on Computer Vision and Pattern Recognition (CVPR) Workshops, June 19–25, 2021, USA.

ICPR 2020	**Rao Muhammad Umer**, Gian Luca Foresti, and Christian Micheloni. *"Deep Iterative Residual Convolutional Network for Single Image Super-Resolution"*. In proceedings of the IEEE International Conference on Pattern Recognition (ICPR), Jan 10–15, 2021, Italy.
ECCV 2020	**Rao Muhammad Umer**, and Christian Micheloni. *"Deep Cyclic Generative Adversarial Residual Convolutional Networks for Real Image Super-Resolution"*. In proceedings of European Conference on Computer Vision (ECCV) Workshops, August 24–28, 2020, UK.
ECCV 2020	Pengxu Wei, ..., **Rao Muhammad Umer**, ..., and others. *"AIM 2020 Challenge on Real Image Super-Resolution: Methods and Results"*. In proceedings of European Conference on Computer Vision (ECCV) Workshops, August 24–28, 2020, UK.
ECCV 2020	Kai Zhang, ..., **Rao Muhammad Umer**, ..., and others. *"AIM 2020 Challenge on Efficient Super-Resolution: Methods and Results"*. In proceedings of European Conference on Computer Vision (ECCV) Workshops, August 24–28, 2020, UK.
CVPR 2020	**Rao Muhammad Umer**, Gian Luca Foresti, and Christian Micheloni. *"Deep Generative Adversarial Residual Convolutional Networks for Real-World Super-Resolution"*. In proceedings of the IEEE/CVF Conference on Computer Vision and Pattern Recognition (CVPR) Workshops, June 14–19, 2020, USA.
CVPR 2020	Andreas Lugmayr, ..., **Rao Muhammad Umer**, ..., and others. *"NTIRE 2020 Challenge on Real-World Image Super-Resolution: Methods and Results"*. In proceedings of the IEEE/CVF Conference on Computer Vision and Pattern Recognition (CVPR) Workshops, June 14–19, 2020, USA.
ICDSC 2019	**Rao Muhammad Umer**, Gian Luca Foresti, and Christian Micheloni. *"Deep Super-Resolution Network for Single Image Super-Resolution with Realistic Degradations"*. In 13th International Conference on Distributed Smart Cameras (ICDSC), Sept. 9-11, 2019, Trento, Italy.

Journal Publications:

MLST 2024	Hussain Ahmad Madni, **Rao Muhammad Umer**, and Gian Luca Foresti. *"Exploiting Data Diversity in Multi-Domain Federated Learning"*. In Machine Learning: Science and Technology (MLST), 2024.
IJNS 2024	Hussain Ahmad Madni, **Rao Muhammad Umer**, and Gian Luca Foresti. *"Robust Federated Learning for Heterogeneous Model and Data"*. In International Journal of Neural Systems (IJNS), 2024.
IJNS 2023	Hussain Ahmad Madni, **Rao Muhammad Umer**, and Gian Luca Foresti. *"Swarm-FHE: Fully Homomorphic Encryption based Swarm Learning for Malicious Clients"*. In International Journal of Neural Systems (IJNS), 2023.
IEEE ACCESS 2023	Hussain Ahmad Madni, **Rao Muhammad Umer**, and Gian Luca Foresti. *"Blockchain-Based Swarm Learning for the Mitigation of Gradient Leakage in Federated Learning"*. In IEEE Access, 2023.

Theses and Dissertation:

UNIUD 2021   **Rao Muhammad Umer**. *"Deep Convolutional Neural Networks for Image Super-Resolution"*. Ph.D. dissertation, Department of Industrial and Information Engineering, University of Udine (UNIUD), Udine, Italy.

PIEAS 2016   **Rao Muhammad Umer**. *"Deep Web Extractor (DWX): Content Discovery From Deep Web Using Large Scale Data Analytics Paradigm"*. MS Thesis, Pakistan Institute of Engineering and Applied Sciences (PIEAS), Islamabad, Pakistan.

IUB 2014   **Rao Muhammad Umer**. *"Spam Filtering System: Malicious Email Detection and Filtering System Using Bayesian Machine Learning Algorithm"*. Technical Report, The Islamia University of Bahawalpur (IUB), Bahawalpur, Pakistan.

Reviewing Activities

JOURNAL REVIEWER	Transaction on Pattern Analysis and Machine Intelligence (TPAMI), Pattern Recognition Letters (PRL), Computer Methods and Programs in Biomedicine (CMPB), Computerized Medical Imaging and Graphics (CMIG).
CONFERENCE REVIEWER	International Conference of Pattern Recognition (ICPR), International Conference on Neural Information Processing Systems (NeurIPS), International Conference on Machine Learning (ICML), International Conference on Image Analysis and Processing (ICIAP).

Students Supervision Activities

DURING POSTDOC	Supervised one MD (medical) student Thesis, Supervised two PhD students and one Bachelor student thesis. Supervising work in image restoration, biomedical AI, and computational pathology.
DURING PHD	Supervised one Master student Thesis. Supervising work in image super-resolution.

Given Seminars

SEP 2024	AI for Cytomorphology and Computational Pathology, at the Biological Research Centre of the Hungarian Academy of Sciences, Szeged, Hungary.
MAR 2022	Deep Convolutional Neural Networks for Image Super-Resolution, at Helmholtz Munich, Germany.
MAY 2020	Deep Neural Networks for Super-Resolution, Deep Learning and more for Computer Vision Applications seminar, Universit Politecnica delle Marche (UNIVPM), Italy.
AUG 2016	Deep Learning & GPUs, Introduction to DNNs workshop, Pakistan Institute of Engineering and Applied Sciences (PIEAS), Islamabad, Pakistan.
FEB 2016	Implementation of Linear Regression and Multi-variate Regression on GPU using Cuda C/C++, GPU Computing workshop, Pakistan Institute of Engineering and Applied Sciences (PIEAS), Islamabad, Pakistan.

AI Summer Schools

AUG 2021	Oxford Machine Learning Summer School, (Virtual) in August 9–20, 2021, at University of Oxford, UK.
JUN 2019	AI-DLDA 2019 International Summer School on Artificial Intelligence, in June 3–7, 2019, at University of Udine, Italy.

Honors and Awards

MAR 2022 - 2025	**PostDoc Fellowship**, sponsored by Helmholtz Munich, Germany.
NOV 2018 - 2021	**PhD Fellowship**, sponsored by Italian Govt. for PhD studies.
OCT 2016	**Best MS Thesis Award**, from the Department of Computer and Information Sciences, Pakistan Institute of Engineering and Applied Sciences (PIEAS), Islamabad, Pakistan.
NOV 2014 - 2016	**MS Fellowship**, sponsored by the Pakistan Higher Education Commission for Master studies.
SEP 2010 - 2014	**Fully Funded National ICT Scholarship**, sponsored by the National ICT R & D Fund, Pakistan for Bachelor studies.
JUN 2011 - 2014	**Position Scholarship**, by the University College of Engineering and Technology, The Islamia University of Bahawalpur, Pakistan for excellent academic performance throughout undergraduate degree.
SEP 2010 - 2014	**Merit Scholarship**, by Punjab Educational Endowment Fund (PEEF), Pakistan for excellent academic performance in higher secondary school examination.
SEP 2008 - 2010	**Merit Scholarship**, by Multan Board of Intermediate and Secondary Education, Pakistan for excellent academic performance in secondary school examination.
MAR 2006 - 2008	**Merit Scholarship**, by Multan Board of Intermediate and Secondary Education, Pakistan for excellent academic performance in District level school examination.

Skills

Languages	• Native: Urdu, Punjabi • English: Fluent
Hobbies	• Cricket, Walking and Running
Programming	Python, C/C++, Java, MATLAB.
Scientific Software	Pytorch, QuPath, OpenSlide, Numpy, Scikit-learn, Version control system (Git / GitHub), Scientific writing (Latex), ChatGPT.
Computer Skills	Experienced in managing Linux and Windows systems.