

# RAO MUHAMMAD UMER



## Research Statement

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I develop next-generation foundation models in hematology and pathology by incorporating biomedical prior knowledge and knowledge distillation for efficient, robust, and explainable models for cancer research in low-resource constrained environment. I have skilled in AI leadership, project management, and model deployment for translational healthcare.

## Research Interests

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Computational Pathology, Computational Biology, AI in Biomedicine, Biomedical Multi-Modal Image Analysis, Computational Imaging

## Education

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- 11.2018 - 11.2021 **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](#)
- 09.2014 - 08.2016 **MS in Computer Science**, Pakistan Institute of Engineering and Applied Sciences, 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
- 09.2010 - 08.2014 **B.Sc. in Computer Systems Engineering**, The Islamia University of Bahawalpur, Bahawalpur, Pakistan
- Major Subjects: Artificial Intelligence, Parallel and Distributed Computing, Image Processing, Object Oriented Programmings, Data Structures and Algorithms
  - Thesis Title: [Spam Filtering System: Malicious Email Detection and Filtering System Using Bayesian Machine Learning Algorithm](#)
  - CGPA: 3.82/4.0

## Work Experience

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- 03.2022 -PRESENT **Postdoctoral Researcher**, Institute of AI for Health (AIH), Helmholtz Munich, Munich, Germany
- Supervisor: Prof. Dr. Carsten Marr
  - Worked on hierarchical representation learning, distilled pathology foundation model, diffusion models for image synthesis in hematology and cytomorphology, robust segmentation and classification of single white and red blood cells in whole slide images
  - Published papers in top conferences and journals in medical computer vision and AI, i.e., ICCV, ICLR, MIDL, IJMI
  - Contributed to 2 grant proposals for Helmholtz funding and European Research Council (ERC) grants
  - Mentoring in “Computational Pathology Reading Course”, offered to Master students of Technical University of Munich (TUM)
  - Mentoring in “Data Challenge: Help a Hematologist out” and “Introduction to interpretable Machine Learning course” in Helmholtz Incubator Summer Academy

- 09.2024 - 12.2024 **Visiting Researcher**, Biological Research Centre (BRC) of the Hungarian Academy of Sciences, Szeged, Hungary  
 • Collaboration with Dr. Peter Horvath on revealing trajectories from benign to malignant cell states from histopathology whole slide images
- 10.2018 - 12.2021 **Doctoral Researcher**, Machine Learning and Perception Lab, University of Udine, Italy  
 • Supervisor: Prof. Dr. Christian Micheloni  
 • Worked on deep learning based solutions for image restoration problems in computer vision, i.e., image denoising, deblurring, super-resolution  
 • Published papers in top conferences in computer vision and AI, i.e., CVPR, ECCV, ICPR, NeurIPS, ICPR, ICIAP
- 12.2017 - 09.2018 **Research Fellow**, Computational Imaging Group (CIG) at the Skolkovo Institute of Science and Technology, Moscow, Russia  
 • Worked on inverse problems in computational imaging, i.e., image denoising
- 09.2016 - 11.2017 **Lecturer**, Department of Computer Science and Information Technology, The University of Lahore, Lahore, Pakistan  
 • Taught courses ([link](#)): • Computer Vision, • Data Structures and Algorithms, • Digital Logic Design, • Programming Fundamentals (C++/OOP)

## Publications

\* denotes equal contribution.

## Conferences:

- MIDL 2026 Fatih Ibrahim Ozlugedik, Muhammed Furkan Dasdelen, **Rao Muhammad Umer**, Carsten Marr. “*MoA: Mixture of Aggregators Improves Slide-Level Diagnosis in Computational Pathology*”. In Medical Imaging with Deep Learning, 2026.
- ICCV 2025 Jan Carreras Boada\*, **Rao Muhammad Umer\***, and Carsten Marr. “*CytoDiff: AI-Driven Cytomorphology Image Synthesis for Medical Diagnostics*”. In International Conference on Computer Vision (ICCV) Workshops, 2025.
- ICIAP 2023 Asif Hussain Khan, **Rao Muhammad Umer**, Matteo Dunnhofer, Christian Micheloni, and Niki Martinel. “*LBKNet: Lightweight Blur Kernel Estimation Network for Blind Image Super-Resolution*”. In International Conference on Image Analysis and Processing (ICIAP), 2023.
- ICIAP 2023 Hussain Ahmad Madni, **Rao Muhammad Umer**, and Gian Luca Foresti. “*Federated Learning for Data and Model Heterogeneity in Medical Imaging*”. In International Conference on Image Analysis and Processing (ICIAP) Workshops, 2023.
- 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 International Conference on Learning Representations (ICLR) Workshops, 2023.
- 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 (HIC), 2022.
- AVSS 2022 **Rao Muhammad Umer**, and Christian Micheloni. “*Real Image Super-Resolution using GAN through modeling of LR and HR process*”. In International Conference on Advanced Video and Signal Based Surveillance (AVSS), 2022.

- NEURIPS 2021 **Rao Muhammad Umer**, and Christian Micheloni. “*RBSRICNN: Raw Burst Super-Resolution through Iterative Convolutional Neural Network*”. In Conference on Neural Information Processing Systems (NeurIPS) Workshops, 2021.
- SPLITECH 2021 **Rao Muhammad Umer**, Asad Munir, and Christian Micheloni. “*A Deep Residual Star Generative Adversarial Network for multi-domain Image Super-Resolution*”. In International Conference on Smart and Sustainable Technologies, 2021.
- CVPR 2021 Goutam Bhat, ..., **Rao Muhammad Umer**, ..., and others. “*NTIRE 2021 Challenge on Burst Super-Resolution: Methods and Results*”. In Conference on Computer Vision and Pattern Recognition (CVPR) Workshops, 2021.
- ICPR 2020 **Rao Muhammad Umer**, Gian Luca Foresti, and Christian Micheloni. “*Deep Iterative Residual Convolutional Network for Single Image Super-Resolution*”. In International Conference on Pattern Recognition (ICPR), 2021.
- ECCV 2020 **Rao Muhammad Umer**, and Christian Micheloni. “*Deep Cyclic Generative Adversarial Residual Convolutional Networks for Real Image Super-Resolution*”. In European Conference on Computer Vision (ECCV) Workshops, 2020.
- ECCV 2020 Pengxu Wei, ..., **Rao Muhammad Umer**, ..., and others. “*AIM 2020 Challenge on Real Image Super-Resolution: Methods and Results*”. In European Conference on Computer Vision (ECCV) Workshops, 2020.
- ECCV 2020 Kai Zhang, ..., **Rao Muhammad Umer**, ..., and others. “*AIM 2020 Challenge on Efficient Super-Resolution: Methods and Results*”. In European Conference on Computer Vision (ECCV) Workshops, 2020.
- CVPR 2020 **Rao Muhammad Umer**, Gian Luca Foresti, and Christian Micheloni. “*Deep Generative Adversarial Residual Convolutional Networks for Real-World Super-Resolution*”. In Conference on Computer Vision and Pattern Recognition (CVPR) Workshops, 2020.
- CVPR 2020 Andreas Lugmayr, ..., **Rao Muhammad Umer**, ..., and others. “*NTIRE 2020 Challenge on Real-World Image Super-Resolution: Methods and Results*”. In Conference on Computer Vision and Pattern Recognition (CVPR) Workshops, 2020.
- ICDSC 2019 **Rao Muhammad Umer**, Gian Luca Foresti, and Christian Micheloni. “*Deep Super-Resolution Network for Single Image Super-Resolution with Realistic Degradations*”. In International Conference on Distributed Smart Cameras (ICDSC), 2019.

## Preprints:

- ARXIV 2025 **Rao Muhammad Umer**, ..., Carsten Marr. “*A Multicenter Benchmark of Multiple Instance Learning Models for Lymphoma Subtyping from HE-stained Whole Slide Images*”. arXiv preprint, 2025.
- ARXIV 2025 Christian Grashei, Christian Brechenmacher, **Rao Muhammad Umer**, Jingsong Liu, Carsten Marr, Ewa Szczurek, Peter J. Schuffler. “*Pathryoshka: Compressing Pathology Foundation Models via Multi-Teacher Knowledge Distillation with Nested Embeddings*”. arXiv preprint, 2025.
- ARXIV 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, 2024.

## Journals:

IJMI 2025	Hussain Ahmad Madni*, <b>Rao Muhammad Umer*</b> , Silvia Zottin, Carsten Marr, and Gian Luca Foresti. <i>“FL-W3S: Cross-domain federated learning for weakly supervised semantic segmentation of white blood cells”</i> . In International Journal of Medical Informatics (IJMI), 2025.
MLST 2024	Hussain Ahmad Madni, <b>Rao Muhammad Umer</b> , and Gian Luca Foresti. <i>“Exploiting Data Diversity in Multi-Domain Federated Learning”</i> . In Machine Learning: Science and Technology (MLST), 2024.
IJNS 2024	Hussain Ahmad Madni, <b>Rao Muhammad Umer</b> , and Gian Luca Foresti. <i>“Robust Federated Learning for Heterogeneous Model and Data”</i> . In International Journal of Neural Systems (IJNS), 2024.
IJNS 2023	Hussain Ahmad Madni, <b>Rao Muhammad Umer</b> , and Gian Luca Foresti. <i>“Swarm-FHE: Fully Homomorphic Encryption based Swarm Learning for Malicious Clients”</i> . In International Journal of Neural Systems (IJNS), 2023.
IEEE 2023	ACCESS Hussain Ahmad Madni, <b>Rao Muhammad Umer</b> , and Gian Luca Foresti. <i>“Blockchain-Based Swarm Learning for the Mitigation of Gradient Leakage in Federated Learning”</i> . In IEEE Access, 2023.

## Reviewing Activities

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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

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DURING PHD & POSTDOC	Supervised 2 PhD, 1 Master, 3 Bachelor’s theses, 3 research interns <ul style="list-style-type: none"><li>• Supervising work in image restoration, biomedical AI, and computational pathology</li><li>• Visit the link for <a href="#">students projects page</a></li></ul>
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## Given Seminars

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09.2024	<a href="#">AI for Cytomorphology and Computational Pathology</a> , at the Biological Research Centre of the Hungarian Academy of Sciences, Szeged, Hungary
03.2022	<a href="#">Deep Convolutional Neural Networks for Image Super-Resolution</a> , at Helmholtz Munich, Germany
05.2020	<a href="#">Deep Neural Networks for Super-Resolution</a> , Deep Learning and more for Computer Vision Applications seminar, Universit Politecnica delle Marche (UNIVPM), Italy
08.2016	<a href="#">Deep Learning &amp; GPUs</a> , Introduction to DNNs workshop, Pakistan Institute of Engineering and Applied Sciences (PIEAS), Islamabad, Pakistan

02.2016 [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

## Honors and Awards

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03.2022 - 05.2026 **Postdoctoral Fellowship**, sponsored by Helmholtz Munich, Germany

11.2018 - 10.2021 **PhD Fellowship**, sponsored by Italian Government for PhD studies

10.2016 **Best MS Thesis Award**, from the Department of Computer and Information Sciences, Pakistan Institute of Engineering and Applied Sciences (PIEAS), Islamabad, Pakistan

11.2014 - 10.2016 **MS Fellowship**, sponsored by the Pakistan Higher Education Commission for Master studies

08.2010 - 10.2014 **Fully Funded National ICT Scholarship**, sponsored by the National ICT R & D Fund, Pakistan for Bachelor studies

06.2011 - 10.2014 **Position Scholarship**, by the University College of Engineering and Technology, The Islamia University of Bahawalpur, Pakistan for excellent academic performance throughout undergraduate degree

08.2010 - 10.2014 **Merit Scholarship**, by Punjab Educational Endowment Fund (PEEF), Pakistan for excellent academic performance in higher secondary school examination

09.2008 - 07.2010 **Merit Scholarship**, by Multan Board of Intermediate and Secondary Education, Pakistan for excellent academic performance in secondary school examination

03.2006 - 08.2008 **Merit Scholarship**, by Multan Board of Intermediate and Secondary Education, Pakistan for excellent academic performance in District level school examination

## Skills

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Languages	<ul style="list-style-type: none"> <li>• Native: Urdu, Punjabi</li> <li>• English: Fluent</li> </ul>
Hobbies	<ul style="list-style-type: none"> <li>• Cricket, Running</li> </ul>
Programming	Python, C/C++, Java, MATLAB
Scientific Software	Pytorch, QuPath, OpenSlide, Numpy, Scikit-learn, Version control system (Git / GitHub), Scientific writing (Latex), AI assistant (ChatGPT, Claude)
Computer Skills	Experienced in managing Linux, MAC, and Windows systems