Doctoral Course

## "Deep Learning for Medical Image Analysis"

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**Short Abstract:**

Medical imaging plays a crucial role in the entire spectrum of healthcare, encompassing wellness, screening, early diagnosis, treatment selection, and follow-up. This course will delve deeply into recent advancements in artificial intelligence for medical image analysis, with a specific focus on deep learning approaches for disease screening and detection using medical images. The topics covered in this course include the fundamentals of deep neural networks, the basics of medical imaging, and an exploration of state-of-the-art deep learning models within the context of various medical images. The objective of the course is to equip students from diverse backgrounds with both a conceptual understanding and practical grounding in cutting-edge research on deep learning and medical image analysis.

**Course Contents in brief:**

Day 1: Research Seminar Introduction. Introduction to AI.

    Basic Vision Models (classification, Segmentation).

    Tutorial 1 (Basic Implementation of MLP and CNN) and assigning paper lists to students

Day 2: Advanced 2D Medical Image Analysis Topic (Retinal Images, X-ray)

    Advanced 2D Medical Image Analysis Topic (Ultrasound Images)

    Advanced 2D Medical Image Analysis Topic (Pathology Images)

    Tutorial 2 (Implementation of neural networks for Skin Leision Classification)

Day 3: 3D Medical Image Analysis

    Advanced Medical Image Analysis Topic (Multi-modal Analysis)

    Tutorial 3 (Implementation of 3D U-Net for MR Image Segmentation)

Peer Paper Sharing Topic: Foundation Model for Medical Image Processing

Day 4: Special Topics (Transformer & Vision Foundation Models for MIA)

Special Topics (Medical Vision Language Foundation Model)

Tutorial 4 (Implementation of CLIP zero-shot transfer to MIA)

Peer Paper Sharing Topic: Medical Multi-Modal Diagnostic Foundation Model

Final test

**Total # of hours of lecture**: 16

**References:**

[1] Reference 1 – *"Deep learning for medical image analysis"* by S. Kevin Zhou, Hayit Greenspan, Dinggang Shen, 2017.

[2] Reference 2 – *"Introduction to deep learning for healthcare", Cao Xiao, Jimeng Sun, 2021*.

[3] Reference 3 – *"Handbook of medical imaging"*, 2000.

**CV of the Teacher**

Xiaomeng Li is an Assistant Professor of Electronic and Computer Engineering and Computer Science and Engineering at The Hong Kong University of Science and Technology. Her research lies in the interdisciplinary areas of artificial intelligence and medical image analysis, aiming at advancing healthcare with machine intelligence. Specifically, she works on making machine learning more reliable, human-compatible, and statistically rigorous, and is especially interested in applications in healthcare. She is an associate director of the Center for Medical Imaging and Analysis.

Dr. Li received her Ph.D. degree from the Chinese University of Hong Kong. Before joining HKUST, she was a postdoc research fellow at Stanford University, working with Prof Lei Xing. She is the author of more than 70 peer-reviewed publications such as IEEE Transactions on Medical Imaging, Medical Image Analysis, CVPR, ICCV, MICCAI, etc. She has been involved in several sponsored research projects in mainland China and Hong Kong SAR. Her Google Scholar has more than 4500+ citations with h-index 21.

**Final Exam: To be decided** (a final project during the last day).

**Room and Schedule**

Room:

*Aula Riunioni del Dip. di Ingegneria dell'Informazione, Via G. Caruso 16, Pisa – Ground Floor*

Schedule:

Day 1 – Monday, 21 July 2025, 9:00-13:00 - **Aula Magna Pacinotti, Largo Lucio Lazzarino**

Day 2 – Tuesday, 22 July 2025, 9:00-13:00 - **Aula Magna Pacinotti, Largo Lucio Lazzarino**

Day 3 – Thursday, 23 July 2025, 9:00-13:00 - **Aula Riunioni Piano Terra in via Caruso**

Day 4 – Monday, 28 July 2025, 9:00-13:00 - **Aula Riunioni Piano Terra in via Caruso**