University of Messina, Italy
Department of Mathematical and Computer Sciences,
Physical Sciences and Earth Sciences

Subject: Internship Proposal

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Project Supervisor

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Project details

Title	Generative AI for New Diseases Imaging Biomarker Discovery

Detailed description: The outbreak of COVID-19 has underscored the need for rapid development of diagnostic and prognostic tools in medical imaging. Generative models, such as GANs and latent diffusion models, can simulate and analyze complex disease phenotypes, creating synthetic datasets for rare or emerging conditions where limited data exists. Leveraging deep generative approaches allows the exploration of disease progression scenarios, virtual clinical trial simulation, and in silico testing of diagnostic criteria, providing valuable insight for pandemics or novel disease outbreaks.

Objectives
The key objectives of this internship include:

Literature review of state-of-the-art generative models in medical imaging, with a focus on COVID-19 lung/brain manifestations.

Preparation, preprocessing, and curation of relevant datasets (e.g., public COVID-19 CT, MRI collections, possibly multimodal sources).

Design, training, and validation of generative models (GANs, Diffusion Models), conditional on clinical variables (age, disease severity, comorbidities).

Synthetic data generation to support data augmentation and virtual patient cohorts.

Evaluation of generated images using quantitative metrics (SSIM, PSNR, biological plausibility), and comparison against real clinical progression in COVID-19 patients.

Exploratory analysis of generated disease phenotypes to discover new imaging biomarkers of COVID-19.

Methods
Development and implementation of generative models in Python using PyTorch or TensorFlow.

Application of state-of-the-art similarity and plausibility measures for image validation and comparison.

Data augmentation and multi-task training strategies for improving model robustness against small sample sizes typical of new diseases.

Visualization of synthetic image sequences, and interpretation of clinically-relevant features.

Skills and Technologies
Advanced Python programming, experience with machine learning and deep learning libraries (PyTorch/TensorFlow).

Familiarity with medical imaging formats (DICOM, NIfTI).

Knowledge of image quality metrics and evaluation, data management, and basic statistical analysis.

Interest in biomedical AI and translational research.

Expected Outcomes
Trained generative model for COVID-19-related imaging modalities.

Synthetic dataset and demo scripts for disease progression simulation.

Quantitative and qualitative assessment report of synthetic image realism and clinical plausibility.

Identification and description of new imaging biomarkers for COVID-19, with visualization and interpretability tools

Duration (month – max 12)	6

Duration (hours)	undefined
Open positions	2

Internship Skills

Technical requirements: PyTorch/TensorFlow/GitHub/, NIfTI files/ Machine Learning/ Deep Learning	
Other skills	