Research theme title:

Digital Driven Diagnostics, prognostics and therapeutics for sustainable Health care

Description:

The aim of the digital driven approach for diagnostics, prognostics, and therapeutics for sustainable health care is to devise digital twins, by exploiting a data mining methodology. The twins will be attained by analyzing healthcare data with Artificial Intelligence (AI) algorithms on a multi-layer platform, and from emerging technologies and biomedical images . Biomarkers will be extracted to diagnose, monitor, and provide treatment suggestions by means of data driven approach for diseases among the following five: metastatic colon cancer, liver and bile duct cancer, central nervous system cancer, diabetes type I and multiple sclerosis. Radiomics methodologies will be employed to characterize pathologies and predict evolution of diseases. This methodology will enable the application of optimized precision medicine techniques resulting in improved outcomes for patients.
Based on this premise, **the purpose of this research project consists in the study, design, development and validation of innovative digital twins to characterize specific diseases and hence improve the current medical practice, allowing the benefits of precision medicine for patients and citizens**.

This challenging aim can be accomplished by following the methodology outlined in the subsequent steps:

1. Perform a literature analysis of state-of-the-art approaches regarding digital twins for the specific diseases under investigation. Indeed, the first task of the Ph.D. student will involve realizing a comprehensive literature survey.
2. Design and development of innovative digital twins. The Ph.D. student will apply computational modeling and simulation methods to develop virtual replicas that capture the disease dynamics (e.g., tumor growth) and response to various interventions and therapies. To properly initialize the computational models, parameters will be estimated from available bioimaging and bioinformatics sources. Particularly, an important role will be given to Radiomics methodologies to characterize the phenotype of chronic pathologies to forecast the progression of the tumor growth and the response to various treatments. Subsequently, a multi-scale analysis will be conducted to characterize all aspects of disease evolution.
3. Validation of the developed twins. The Ph.D. student will conduct comprehensive validation studies to assess the fidelity and reliability of the developed digital twins, involving comparisons with clinical data and expert evaluations. Auxiliary components of the digital twins, i.e., AI-based systems for bioimaging and bioinformatics analyses, will be also thoroughly examined and validated. Radiomics methodologies will be assessed for both segmentation and characterization tasks.
4. Publication and dissemination of the research results. The Ph.D. student will share the main technical and scientific achievements by submitting research findings to prestigious international conferences (e.g., MICCAI, IEEE ISBI, IPMI, BMVC) and high-profile international journals (e.g., IEEE TMI, Elsevier Computers in Biology and Medicine, Elsevier Computer Methods and Programs in Biomedicine, Elsevier Artificial Intelligence in Medicine, Elsevier Journal of Biomedical Informatics, Neurocoputing and Bioengineering). Open Access publication or sharing pre-print versions through academic websites will be considered to increase the availability of the research results. The produced datasets will follow the Findable, Accessible, Interoperable, Reusable (FAIR) principles and will be shared through platforms like Zenodo and IEEE dataport.

Research activities of the Ph.D. student will produce *several contributions* alongside the following items.

1. Scientific contribution. In line with the expectations on that topic, at both EU and National (for example, those identified with the definition of NRRP Complementary Investments initiatives) levels, the Ph.D. student will develop innovative methodologies, tools, and software in the context of digital twins for disease characterization and assessment of therapy response, aiming to exceed the current state of the art.
2. Technological and economic contributions: The achieved outcomes will be shared with both national and international stakeholders, thereby generating a greater interest in investing in tangible development initiatives and accelerating the time required to bring products to market.

3. Societal contribution. Scientific, technological, and economic impacts will guarantee an enhancement in the quality of care of patients, thanks to the biological and digital twins made available by this research work. Improving the quality of care through personalized diagnosis, prognosis and treatment will play a vital role in establishing a sustainable healthcare.

Contacts:

Prof. Vitoantonio Bevilacqua, vitoantonio.bevilacqua@poliba.it

Hosting University

Polytechnic of Bari, Italy

Type of scholarship:

Complementary PNRR (Italy's Recovery and Resilience Plan) – Project D3 4 Health