MediMint: Medical Imaging and Multimodal Intelligence Laboratory

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Abstract

The MediMint (Medical Imaging and Multimodal Intelligence) laboratory at the University of Brescia focuses on developing AI-based solutions in healthcare, particularly for diagnostic imaging and multimodal clinical data analysis. Current research lines include the analysis of chest X-rays, brain MRI processing, AI for digital microbiology, and ECG signal interpretation. This paper provides an overview of these activities, with a focus on ongoing projects, collaborations with industrial and clinical partners, and the potential clinical impact of the developed technologies.

Keywords

Artificial Intelligence, Deep Learning, Medical Imaging, Multimodal Intelligence, Healthcare AI, Digital Medicine

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1. Introduction

MediMint is a research laboratory within the Department of Medical and Surgical Specialties, Radiological Sciences, and Public Health (DSMC) at the University of Brescia (https://medimint.unibs.it). The lab is dedicated to the development of Artificial Intelligence methods and tools for healthcare, with a special focus on medical imaging and the integration of heterogeneous clinical data (signals, reports, digital lab data).

The lab is coordinated by AS and MS and includes several faculty members and affiliates, PhD students and research fellows. Our research spans from algorithmic innovation, especially in deep learning and multimodal learning, to the design of applied solutions in clinical settings. MediMint aims to address real-world challenges in several medical specialties, such as radiology, neurology, cardiology, oncology, pathology, dentistry, orthopedics, ophthalmology, epidemiology, surgery, and clinical microbiology, through close collaboration with clinical departments, industry partners, and international research centers.

In line with national and international priorities in digital health, MediMint's mission is to accelerate the development and the deployment of trustworthy, explainable, and clinically effective AI systems. This document provides an overview of the lab's main research lines, ongoing projects, and collaborative initiatives, illustrating how AI can translate into tangible benefits for clinical workflows.

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2. Chest X-ray Analysis

One of our main research lines focuses on the multifunctional applications of deep learning in chest radiograph analysis. For example, the BS-Net method [1] was developed to assess COVID-19 pneumonia severity on large-scale datasets. Other studies address the identification of significant coronary artery disease using plain X-rays [2], and the development of measures to quantify cardiac and pulmonary involvement in predicting long-term mortality [3]. These methods aim to support radiologists with reliable, quantitative tools for diagnosis and disease monitoring in respiratory and cardiovascular conditions.

We also explore the integration of AI into clinical practice and medical training. In one study [4], we assessed the impact of an AI tool assisting radiology residents in scoring COVID-19 lung severity across 150 chest X-rays under three conditions: no AI, on-demand AI, and fully integrated AI. The AI system, embedded in the RIS/PACS, outperformed average radiologist scores, reduced errors, and improved inter-rater agreement by 22%. Residents chose to use the AI in 70% of cases and remained resilient to its errors within acceptable thresholds. Feedback highlighted strong preferences for collaborative AI, citing usefulness, reliability, and explainability.

Another study investigated the concept of "trustworthy AI" during the COVID-19 pandemic [5], applying the EU High-Level Expert Group's guidelines in a real-world healthcare context. Using the Z-Inspection® methodology [6], we performed a post-hoc assessment of an AI system for predicting multiregional lung severity scores. Deployed in the ASST Spedali Civili hospital in Brescia since December 2020, the system was developed by an interdisciplinary team spanning academia, hospitals, and industry. This work identified ethical, technical, and domain-specific issues, offering practical insights into the responsible deployment of AI in clinical settings.

3. Brain MRI Processing

The lab develops end-to-end CNN architectures for the segmentation and morphometric analysis of brain MRI volumes. A key goal is to mitigate the "scanner effect" variability introduced by different MRI systems by enhancing model robustness through multi-site datasets. Recent studies propose progressive networks trained on multi-center data [7, 8] to ensure consistent segmentation across different acquisition protocols. These solutions have applications in neuroscience and clinical practice, enabling volumetric brain measurements and the detection of anomalies in support of neurological disease diagnosis.

4. Artificial Intelligence for Digital Microbiology

The new full automation of microbiology labs generates massive image streams. In this context, MediMint developed AI-based decision support tools for the automatic interpretation of these images [9, 10, 11, 12]. Computer vision and deep learning algorithms are used to count bacterial colonies, detect morphological features, and classify pathogens with high accuracy. These solutions aim to accelerate microbiological analyses, reduce human error, and enhance lab efficiency.

5. ECG and PTG Signal Analysis

Our lab develops advanced AI methods for the analysis of electrocardiographic (ECG) and phonocardiographic (PCG) signals, with a focus on early detection of cardiovascular diseases. We explore transformer-based models for their ability to capture complex temporal patterns in ECG data, aiming to improve diagnostic accuracy and enable scalable tools for clinical use.

We recently introduced HuBERT-ECG [13], a foundation model pre-trained on over 9 million ECGs, capable of adapting to a wide range of tasks such as disease classification and survival prediction. This marks a shift from narrow, task-specific models to general-purpose ECG analysis tools.

Additionally, we investigate bimodal approaches combining ECG and PCG signals [14]. This integration enhances detection of both electrical and mechanical heart abnormalities, showing significant performance gains over single-modality models and offering a cost-effective solution for CVD screening in preventive care.

6. Research Projects and Collaborations

Among the most significant funded initiatives are the FISR 2020 project *ResponsiX*, which aims to develop AI solutions for COVID-19 severity assessment on chest radiographs (coordinated by A.S.), and the PRIN 2022 project *QT-Seed*, which investigates the technological and social uses of diagnostic ECGs (with A.S. as deputy PI). These projects reflect the lab's commitment to clinically relevant AI applications.

Scientific collaborations include partnerships with leading neuroscience centres such as the University of Glasgow, Sagol Brain Institute (Tel Aviv), and UMC Leiden, among others. On the industrial side, MediMint collaborates with several companies, among which Copan Italia S.p.A. (automation in clinical microbiology), Antares Vision S.p.A. (industrial vision and traceability technologies), and Gexcel S.r.l. (a UniBS spin-off specialised in data analytics). These synergies enable the real-world validation of AI solutions and foster effective technology transfer into clinical practice.

7. Potential Clinical Impact

Although the MediMint laboratory does not develop medical devices intended for direct clinical use, its research operates at a level of technological maturity that brings it into close dialogue with the realities of healthcare practice. This proximity enables the lab to move beyond purely academic experimentation and begin addressing the broader ecosystem in which AI technologies might one day operate, including the clinical, ethical, and organisational contexts that shape their adoption.

Working in close collaboration with hospitals and clinical departments, the lab develops AI models that are tested on real-world data and embedded within realistic workflows. This practical orientation allows us to engage with the needs and expectations of healthcare professionals early in the development process, identifying issues such as usability, interpretability, and integration that are often overlooked in more abstract research settings.

Importantly, this position also allows the lab to contribute to the ongoing discourse around trustworthy and responsible AI in medicine, also through a close research relationship with the interdepartmental Trustworthy AI Lab (https://trail.unibs.it/) at University of Brescia. MediMint's work does not stop at algorithmic performance; it actively considers how AI tools might be used, misused, or misunderstood in practice. Studies exploring human-AI interaction, ethical evaluation methodologies, and the potential for bias or over-reliance provide valuable insights for the safe and equitable integration of AI into clinical decision-making.

In this way, the lab's research not only advances the technical frontier but also hopes to help in shaping a thoughtful and grounded vision of AI's role in healthcare, one that respects clinical complexity, promotes collaboration, and anticipates the responsibilities that come with technological innovation.

Declaration on Generative AI

During the preparation of this work, the authors used Gemini 2.5 and Grammarly to check grammar and spelling. After using these tool the authors reviewed and edited the content as needed and take full responsibility for the publication's content.

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