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Open challenges of Artificial Intelligence applied to medical imaging

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The two big challenges of Artificial Intelligence applied to medical imaging are: (1) improving the robustness and generalization ability of AI models even with limited data availability and (2) developing explainable AI methods. The next_AIM (Artificial Intelligence in Medicine: next steps) experiment of INFN-CSN5 aims to address these two challenges in the development of techniques based on Artificial Intelligence approaches, including Machine Learning and Deep Learning (DL), to automatically analyze medical images obtained from medical imaging modalities (MRI, CT, RX, PET, etc.). In particular, different applications focused on the COVID-19 use case were developed, trying to tackle these two challenges. A fully automatic Deep Learning (DL) pipeline has been developed to predict the degree of severity of patients from chest X-rays and associated clinical data, exploring the possibility of explaining the prediction using a visualization technique. A DL-based quantification software for the characterization of COVID-19 infection visible in Computed Tomography (CT) images was set up to produce quantitative indices representing qualitative characteristics immediately understandable to radiologists. It was validated in a multicenter study. Finally, a Machine Learning pipeline was developed to predict the patient's severity grade from the radiomic features extracted from CT images, with particular attention to the feature importance.
Moreover, an overview of other activities within the project, focused on different use cases and imaging modalities, will be presented.
Considerable computing resources are necessary to develop these AI-based solutions. Especially when dealing with volumetric data and large models (e.g., 3D U-Net for semantic segmentation), computational capability, also in terms of memory, represents a bottleneck in training the models and finding the best possible model design, forcing researchers to use downsized and lower resolved images, small batches or shallow neural networks. Moreover, in dealing with medical data acquired on patients, secure storage is needed, meaning storage services based on certified security standards (e.g. the information security standard ISO 27001) and GDPR compliant.

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