Evaluating Convolutional Neural Networks for Multi-Label Chest X-ray Diagnosis: Model Complexity, Hardware Efficiency, and Radiologist Comparison

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Radiology, an important branch of medicine, relies on imaging techniques such as X-rays to diagnose diseases and injuries, yet a shortage of radiologists in underserved areas causes delays in diagnosis and treatment. Deep learning, especially convolutional neural networks, may serve as a valuable tool in diagnostic radiology. This study examined whether the more complex convolutional neural network model, EfficientNetB4, improves diagnostic performance on chest X-ray images compared to the simpler EfficientNetB1, and if it could run effectively on lower-end hardware. Furthermore, it investigated whether EfficientNetB4 maintained feasible inference speed and diagnostic performance, and if its diagnostic accuracy and speed compared favorably with a radiologist's evaluations. EfficientNetB1 was trained with images that were 240×240 pixels, while EfficientNetB4 used images that were 380×380. Inference speed was measured on an Intel i5-10210U laptop with 8GB DDR4 RAM and no dedicated GPU versus a computer with a Ryzen 7800x3d, RTX 4080, and 32GB of DDR5 RAM. EfficientNetB4 and a radiologist assessed 18 images as a benchmark. Results showed that EfficientNetB4 outperformed EfficientNetB1 in diagnostic accuracy and could be run with rapid processing, even on hardware lacking GPUs. Compared to the radiologist, EfficientNetB4 delivered 18 out of 18 images correct and faster image processing. Using GradCAM heatmaps, localizaiton was precise, with the exception of a single pneumothorax case. These findings indicate that CNNs may be a potentially fast and reliable tool for chest X-ray diagnosis in clinical settings, enhancing healthcare in resource-limited environments.

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