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DenseNet and Autoencoder Architecture for COVID-19 Chest X-Ray Image Classification and Improved U-Net Lung X-Ray Segmentation

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Abstract : Purpose AI-driven solutions are at the forefront of many pathology and medical imaging methods. Using algorithms designed to better the experience of medical professionals within their respective fields, the efficiency and accuracy of diagnosis can improve. In particular, X-rays are a fast and relatively inexpensive test that can diagnose diseases. In recent years, X-rays have not been widely used to detect and diagnose COVID-19. The under use of Xrays is mainly due to the low diagnostic accuracy and confounding with pneumonia, another respiratory disease. However, research in this field has expressed a possibility that artificial neural networks can successfully diagnose COVID-19 with high accuracy. Models and Data The dataset used is the COVID-19 Radiography Database. This dataset includes images and masks of chest X-rays under the labels of COVID-19, normal, and pneumonia. The classification model developed uses an autoencoder and a pre-trained convolutional neural network (DenseNet201) to provide transfer learning to the model. The model then uses a deep neural network to finalize the feature extraction and predict the diagnosis for the input image. This model was trained on 4035 images and validated on 807 separate images from the ones used for training. The images used to train the classification model include an important feature: the pictures are cropped beforehand to eliminate distractions when training the model. The image segmentation model uses an improved U-Net architecture. This model is used to extract the lung mask from the chest X-ray image. The model is trained on 8577 images and validated on a validation split of 20%. These models are calculated using the external dataset for validation. The models' accuracy, precision, recall, f1-score, IOU, and loss are calculated. Results The classification model achieved an accuracy of 97.65% and a loss of 0.1234 when differentiating COVID19-infected, pneumonia-infected, and normal lung X-rays. The segmentation model achieved an accuracy of 97.31% and an IOU of 0.928. Conclusion The models proposed can detect COVID-19, pneumonia, and normal lungs with high accuracy and derive the lung mask from a chest X-ray with similarly high accuracy. The hope is for these models to elevate the experience of medical professionals and provide insight into the future of the methods used.

Keywords : artificial intelligence, convolutional neural networks, deep learning, image processing, machine learning
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