activation function is utilized for all hidden layers. Then, the first 2 fully connected layers with 4096 channels each are uitilized followed by the last layer of 1000 channels to represent the different 1000 classes of the ImageNet with soft-max activation function[15].

EfficientNetB0 model

Google research group designed a family of models, called EfficientNets using a scaling method and achieved better efficiency and accuracy than previous ConvNets. EfficientNet is based on scaling CNNs and reaching better performance by balancing network width, depth, and resolution. Therefore, the focus is to present a scaling method to uniformly scale the 3 dimensions with a simple highly effective compound coefficient. Thus, it can be considered as an optimization problem to find the best coefficients for depth, width, and resolution that maximizes the accuracy of the network given the constraints of the available resources. The primary building block of the EfficientNet models is MBConv. The network's dimension equation was used to get the family of neural networks EfficientNet-B0 to B7[16]. In this research, EfficientNetB0 was used for the classification of the chest X-ray images. Figure 4 sums up the framework of the adopted methodology in this research.

Ethical approval

This article does not contain any studies with human participants or animals performed by the author.

Experimental results

This section presents the experimental results of the proposed framework to evaluate its performance and study the effect of different enhancements applied to the X-ray images on the performance of the CNN classification model.

Experimental setup

Keras Python deep learning library on top of TensorFlow was utilized for implementing CNN models on a machine with the following specification; an Intel® Core™ i7 CPU@ 3.6 GHz with 32 GB RAM and a Titan × Pascal Graphics Processing Unit (GPU). Extensive experiments were carried out to obtain the best settings of the CNN models that achieve the best possible results. It is worth noting that the pre-processing for enhancing the images has been carried out using MATLAB®18 software.

Both the full and segmented datasets with their enhanced versions have been used to train VGG19 and EfficientNetB0 CNN pre-trained models. The training was carried on with Adam optimizer, learning rate of 0.001, batch size of 32, and the number of epochs (10–30) epochs, SoftMax classifier. The fine-tuned pre-trained models were used for feature extraction; therefore, the weights of the pre-trained models were frozen, and they were not updated during the training to maintain ImageNet's initial weights. The top layers were fine-tuned to adjust the

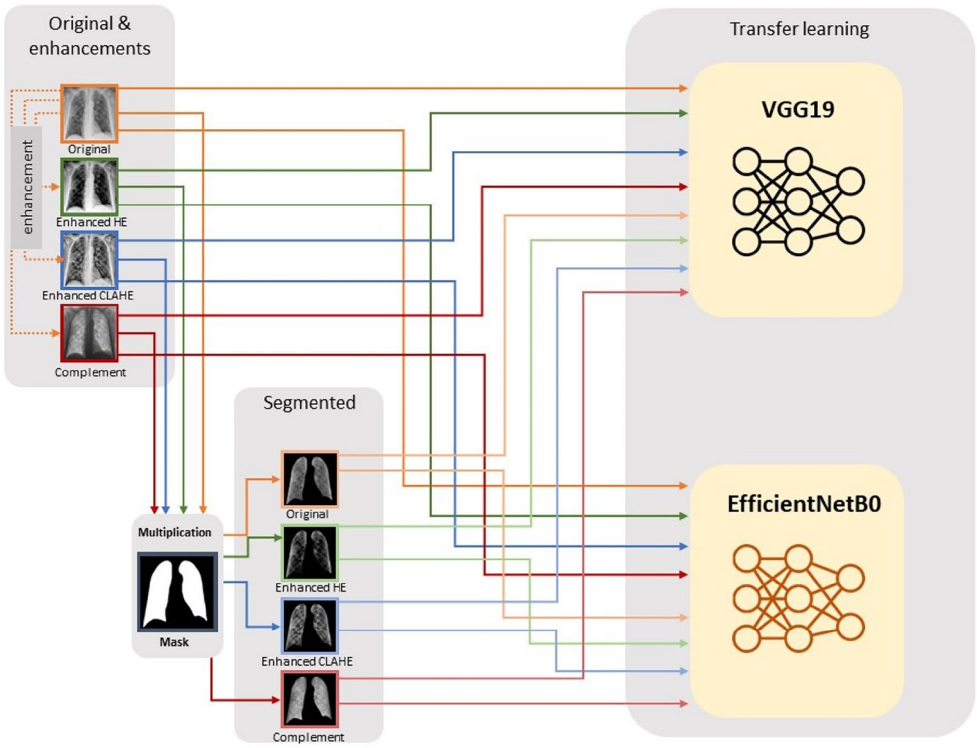

Figure 4. The framework of the used methodology for Chest X-ray images classification.