Pneumonia Detection on Chest X-rays Using Transfer Learning
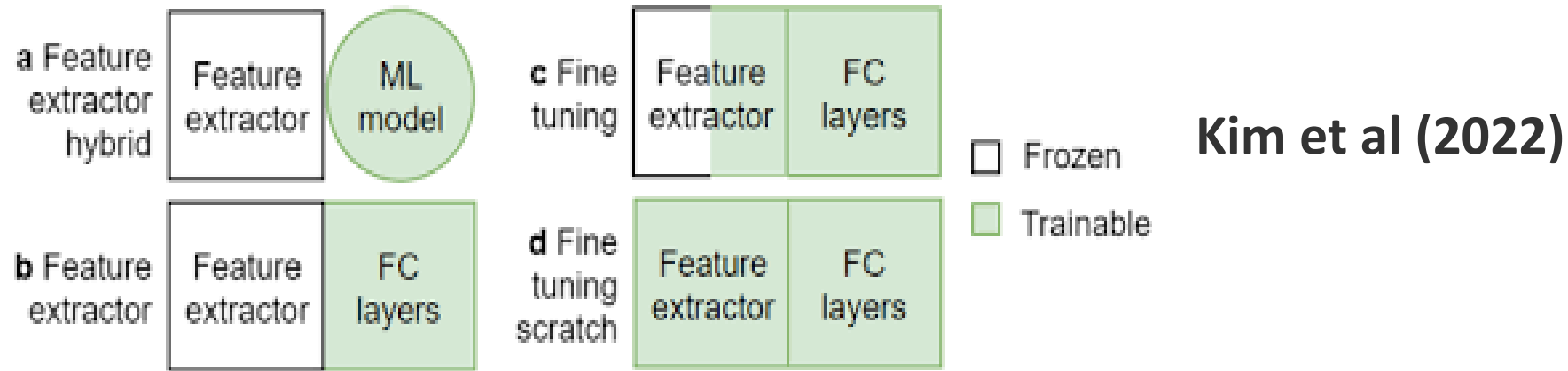
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PNEMONIA

- Pneumonia is an infection of the lungs

- One of the leading causes of death worldwide

- Chest x-ray is the best method for diagnosis

Why is diagnosis hard?

- Limited expert radiologists

- Appearance of pneumonia can overlap with other diagnosis

- Diagnosis can be inaccessible in developing countries

Transfer Learning

- Knowledge can be transferred at the parametric level

- Improve by leveraging the generic image features

- Saves the amount of samples, hardware, and time used to train the model

a Feature extractor hybrid: Feature extractor | ML model

b Feature extractor: Feature extractor | FC layers

c Fine tuning: Feature extractor | FC layers

d Fine tuning scratch: Feature extractor | FC layers

☐ Frozen
☐ Trainable

Kim et al (2022)

Feature Extractor Hybrid:
  Frozen pretrained feature extractor plus trainable machine learning model

Feature Extractor:
  Frozen pretrained feature extractor plus fully connected (FC) layer

Fine Tuning:
  The feature extractor is partially trainable (unfrozen) plus FC layers

Fine-Tuning from Scratch:
  All layers in the feature extractor and FC layers are trainable

Radiologist-Level Pneumonia Detection on Chest X-Rays (Pranav et al)

- The researchers used DenseNet with slight modifications

- The output layer was replaced with a single output with a sigmoid function

- The weights were initialized from a model pretrained on ImageNet

- Downscale the images to 224 X 224 and normalize based on ImageNet training set

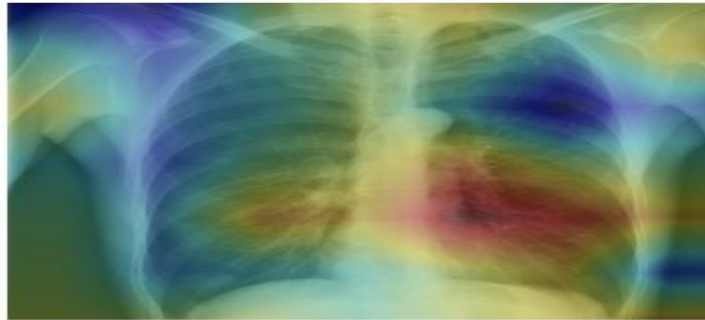- The model outperformed radiologist on F1 metric

Input
Chest X-Ray Image

CheXNet
121-layer CNN

Output
Pneumonia Positive (85%)

Objective - Build a binary classification model for detecting pneumonia

Methodology:

Preprocessing:

- Resize images, normalize, and augment (flip, rotate).

Model Architecture:

- Fine-tune a pre-trained CNN that was trained on the ImageNet dataset.

- Fully connected with two neurons at the output layer

- SoftMax loss function

Evaluation:

- Use a confusion matrix, a classification report

- (Optional) Apply class activation mappings (CAMs) to visualize areas indicative of disease.

REFERENCES

- Kim, H. E., Cosa-Linan, A., Santhanam, N., Jannesari, M., Maros, M. E., & Ganslandt, T. (2022). Transfer learning for medical image classification: a literature review. BMC medical imaging, 22(1), 69. https://doi.org/10.1186/s12880-022-00793-7

- Rajpurkar, P., Irvin, J., Zhu, K., Yang, B., Mehta, H., Duan, T., ... & Ng, A. Y. (2017). Chexnet: Radiologist-level pneumonia detection on chest x-rays with deep learning. arXiv preprint arXiv:1711.05225.