Università degli Studi di Messina

From Scratch to Large Pre-Trained Models.
A Comparative Study for Medical Image Classification

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ITADATA 2024 - Scientific HPC in the pre-Exascale era

Introduction

- The use of AI in healthcare fields is constantly increasing.

- Diagnostic technologies such as x-ray, Magnetic Resonance Imaging (MRI) and computerized tomography (CT) use images to represent information.

- 90% of data in healthcare are images.

- **Image classification** is a key task in healthcare, with applications in a variety of areas, including:
  - Diagnosis
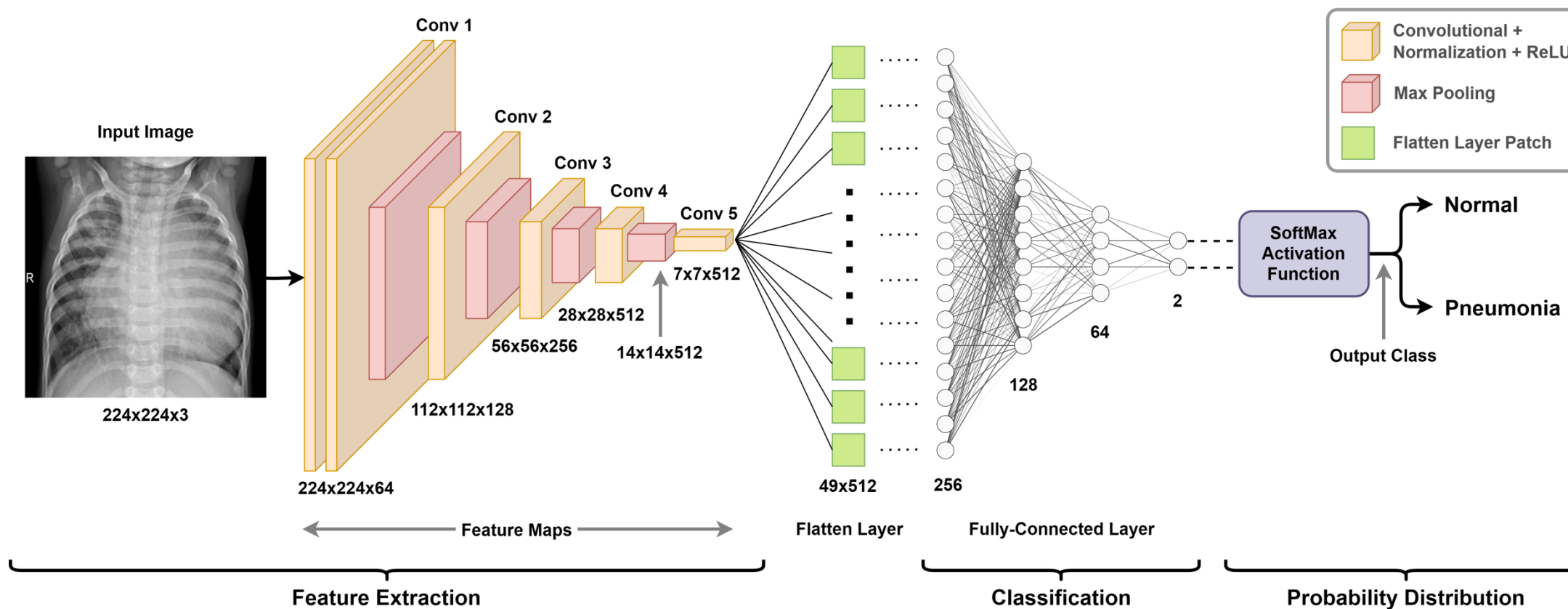 - Treatment planning
  - Research

Workflow

Study of Convolutional Neural Network (CNN) and Vision Transformer (ViT) architectures
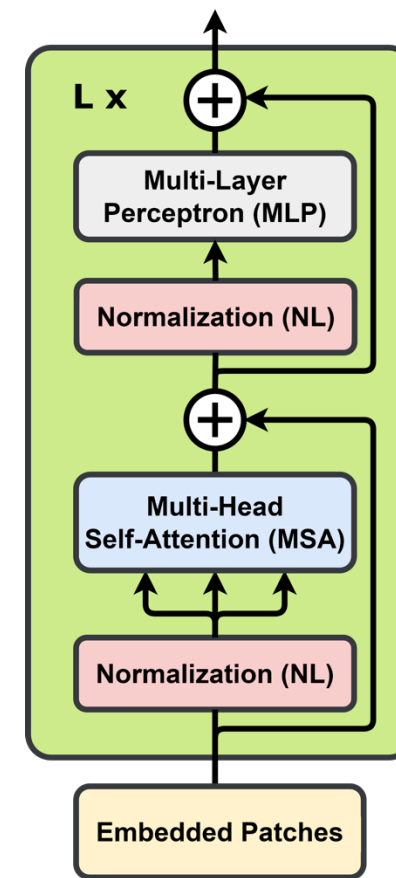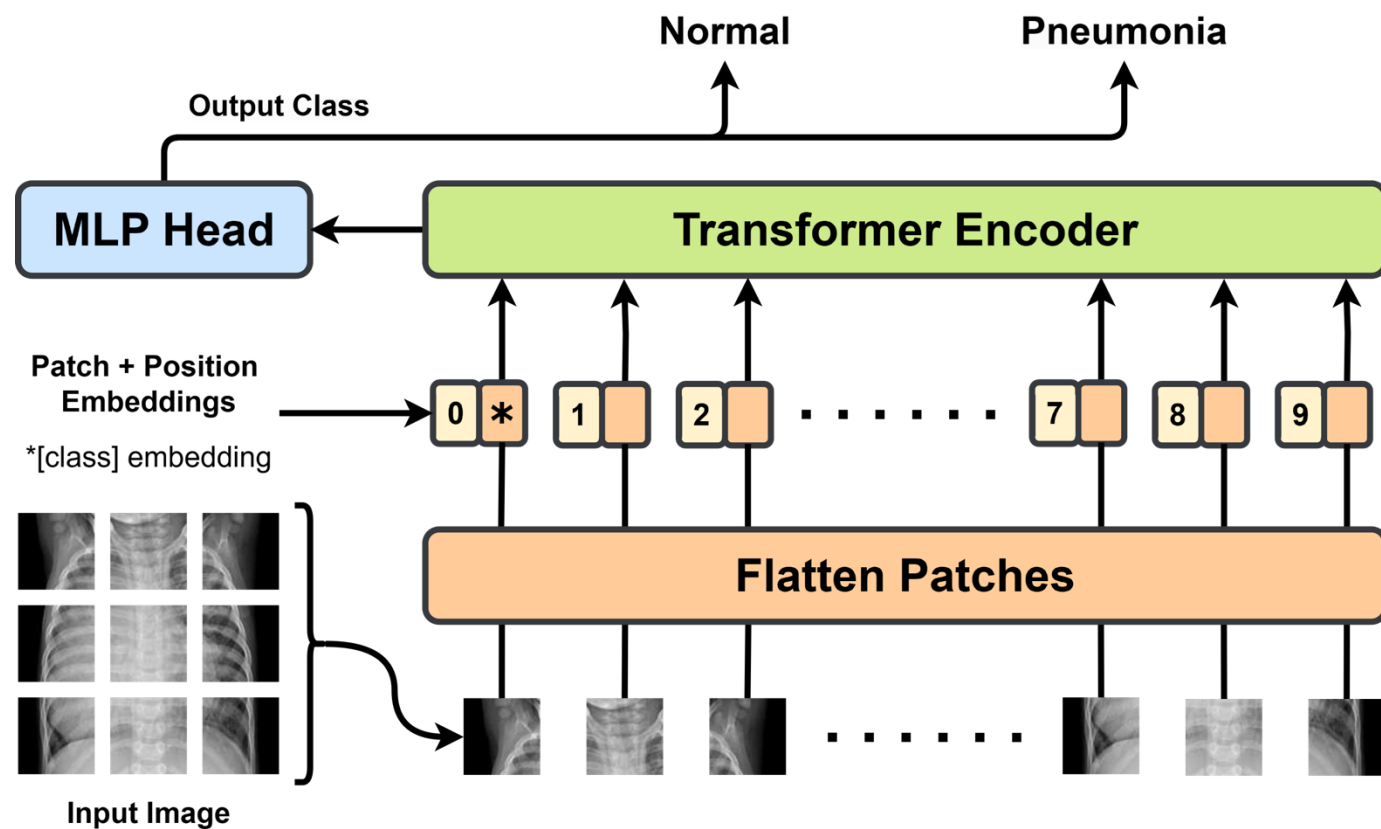
From scratch implementation

Comparison with Pre-Trained approach

Performance evaluation comparison between consumer laptop and a Cloud HPC Infrastructure as a Service (IaaS)

Convolutional Neural Network (CNN)

Vision Transformer (ViT)

CNNs vs ViTs

| Feature	CNNs	ViTs
Learning patterns	Local patterns	Global patterns
Image processing	Sequential	Parallel
Accuracy	Typically lower	Can be higher
Inference times	Typically faster	Can be slower
Memory usage	Lower	Higher
Training complexity	Lower	Higher

Dataset

The dataset selected for this study is the Chest X-Ray Images (Pneumonia)
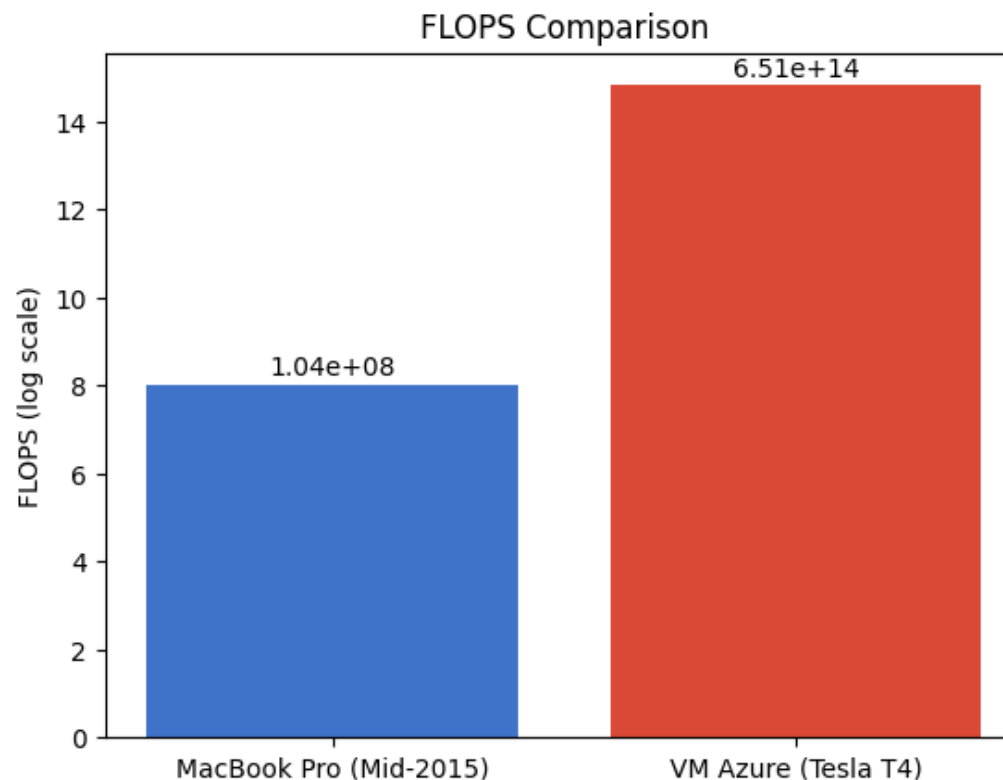
Content: 5863 JPEG-formatted X-ray pictures

Classes:

• Normal

• Pneumonia
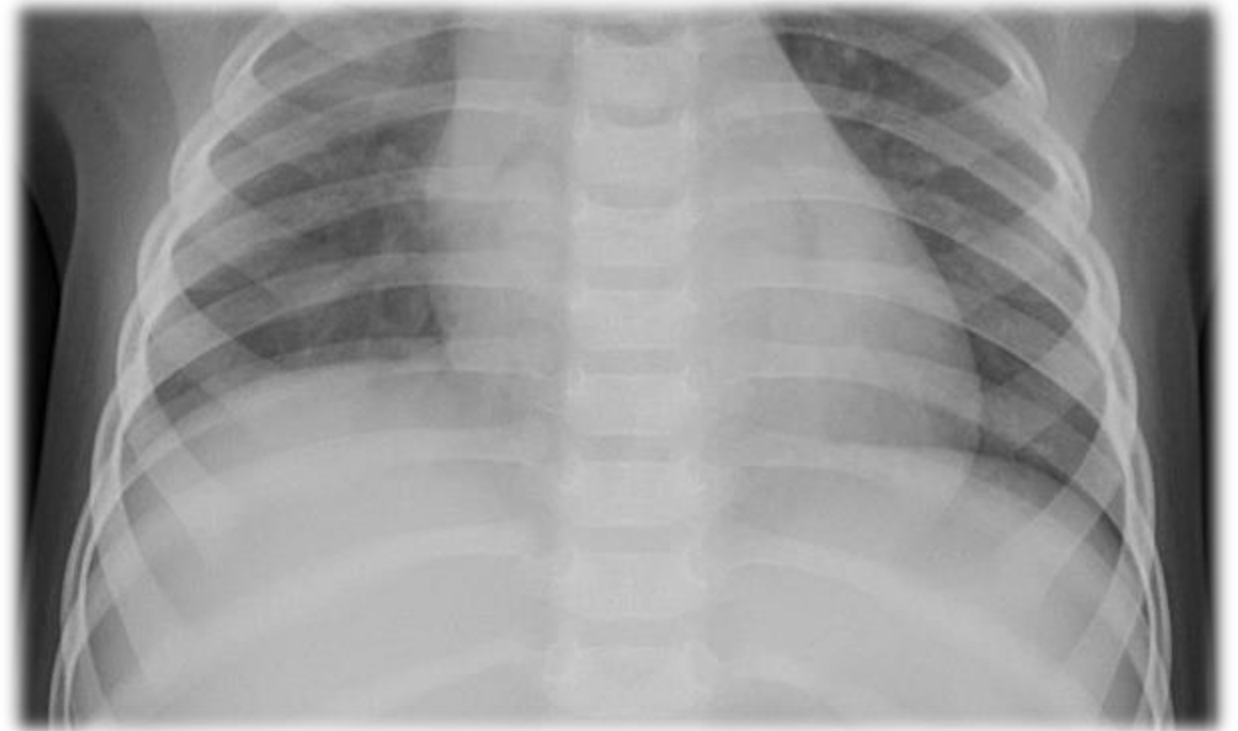
Test beds

	Macbook Pro (Mid-2015)	Azure VM
CPU	i7-4770HQ, 4 cores, 2.2Ghz	8 cores, 2.5GHz
RAM	16Gb, DDR3	56 GB, DDR4
GPU	Not used	Nvidia Tesla T4, 16Gb DDR6
FLOPS	10.38M	65.13T

FLOPS Comparison

Models Parameters

Model	Layers	Hidden size D	MLP size	Heads	Params
ViT_scratch	4	56	224	4	155.7K
ViT-Tiny	12	192	768	3	5.5M
ViT-Base	12	768	3072	12	86M
ViT-Large	24	1024	4096	16	307M
ViT-Huge	32	1280	5120	16	632M

Model	Parameters
CNN_scratch	17,6M
ViT_scratch	155K
ResNet50	23,5M
ViT_Base	86M

Model Sizes

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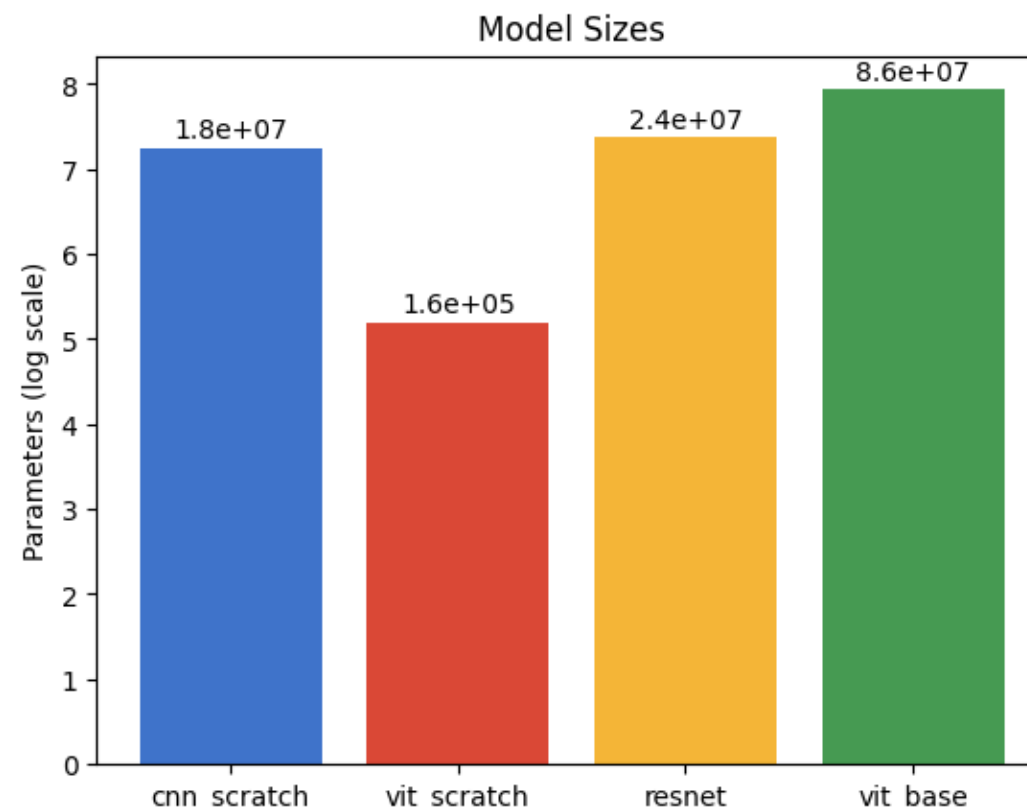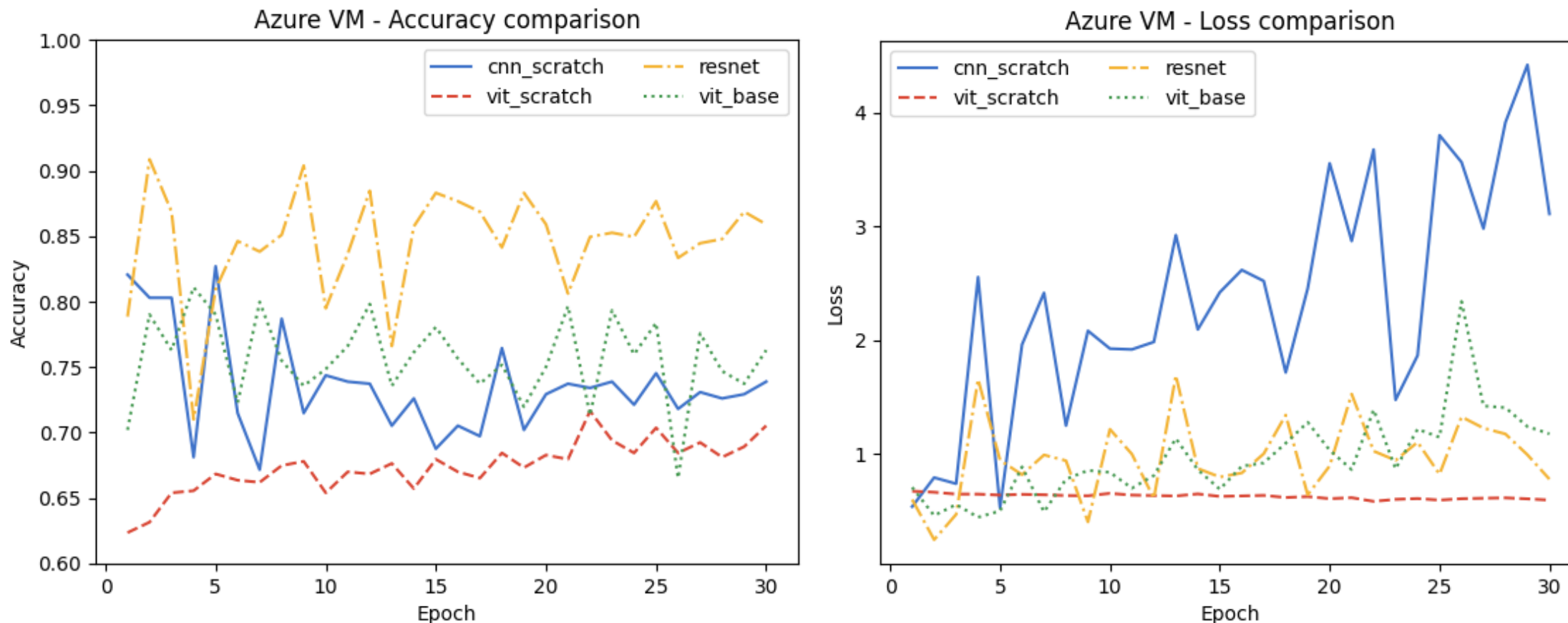
Results

Results
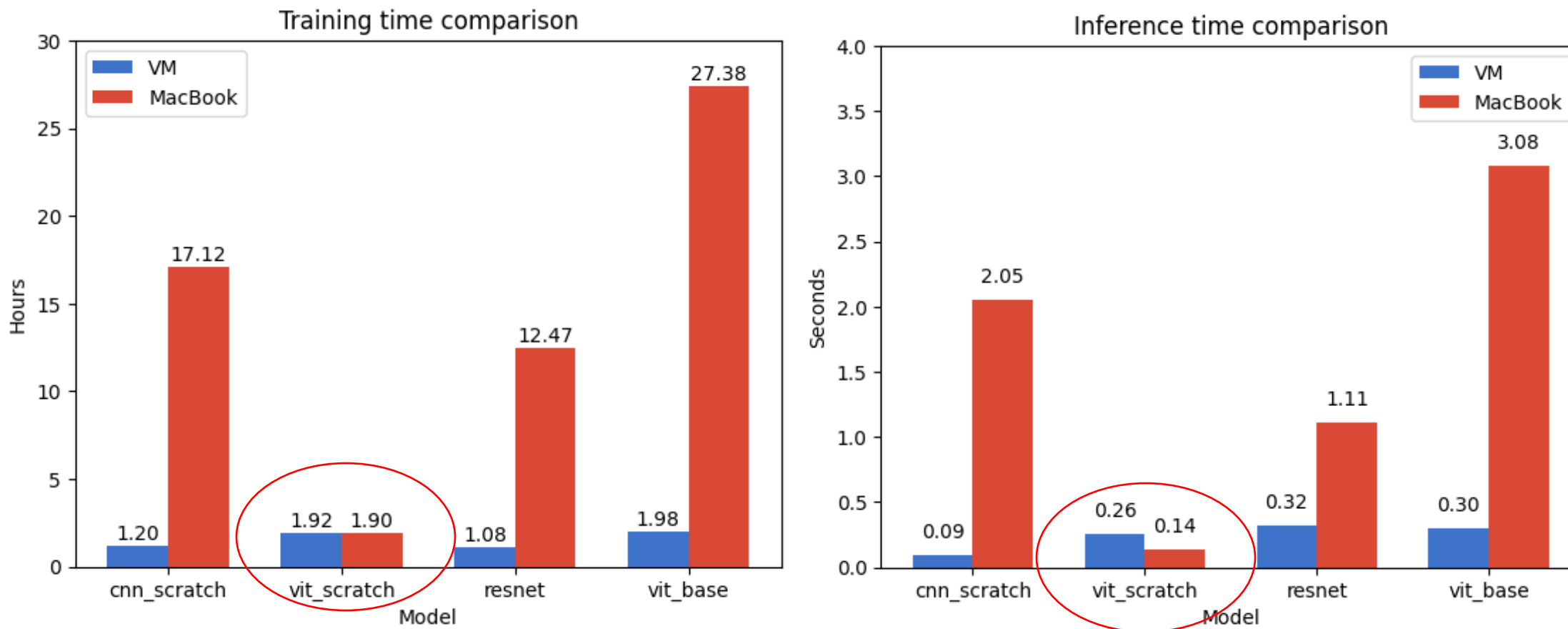
Conclusion

- **Transfer Learning** is particularly useful in domains where data availability is scarce

- **HPC environment** significantly accelerates the development process of **large deep** learning models

Future Works

- Compare other CNN and ViT models.

- Explore alternative approaches such as **Federated Learning** to ensure clinical data privacy and parallel process-ing towards the perspective of classifying Big Medical Data in a collaborative federated healthcare scenario using HPC services.

Thank you

Any Question?

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