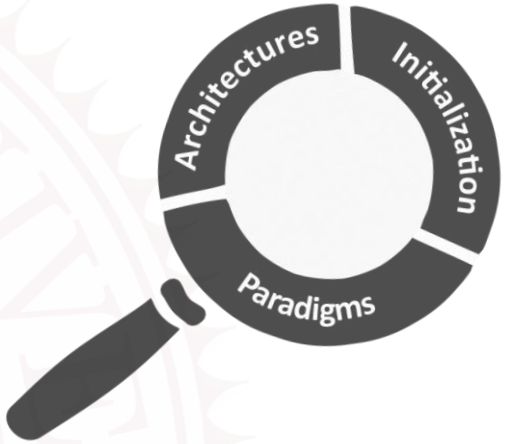

Seeking an Optimal Approach for Computer-aided Pulmonary Embolism Detection

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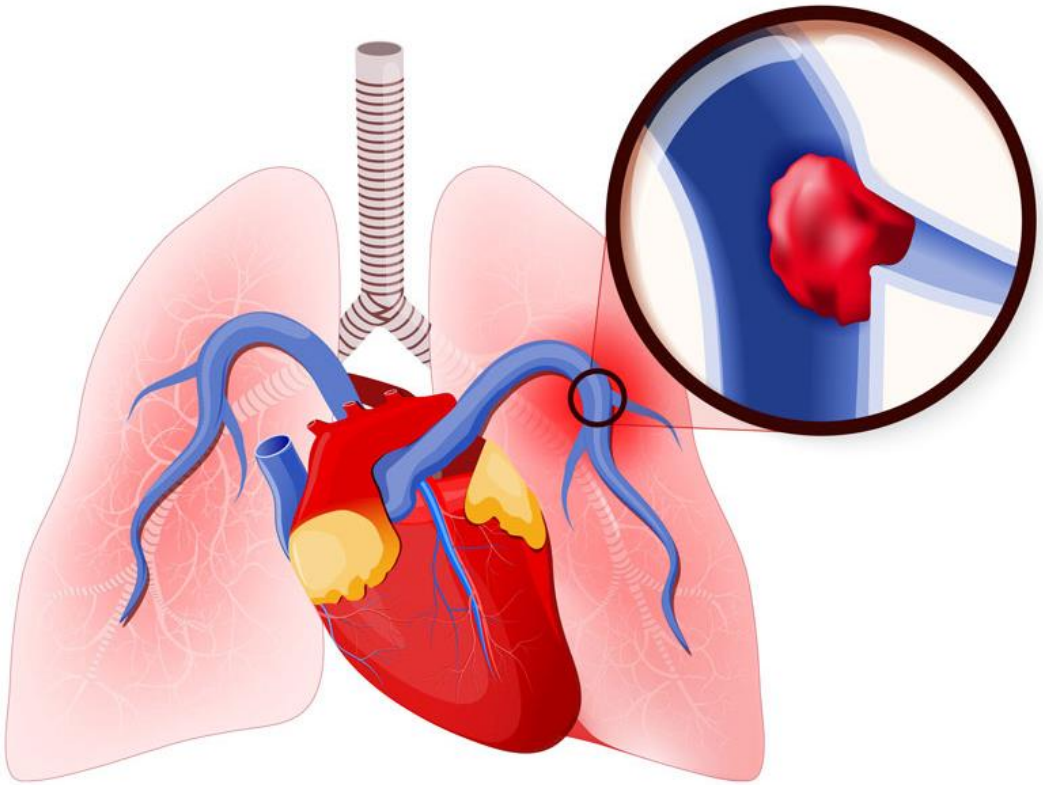
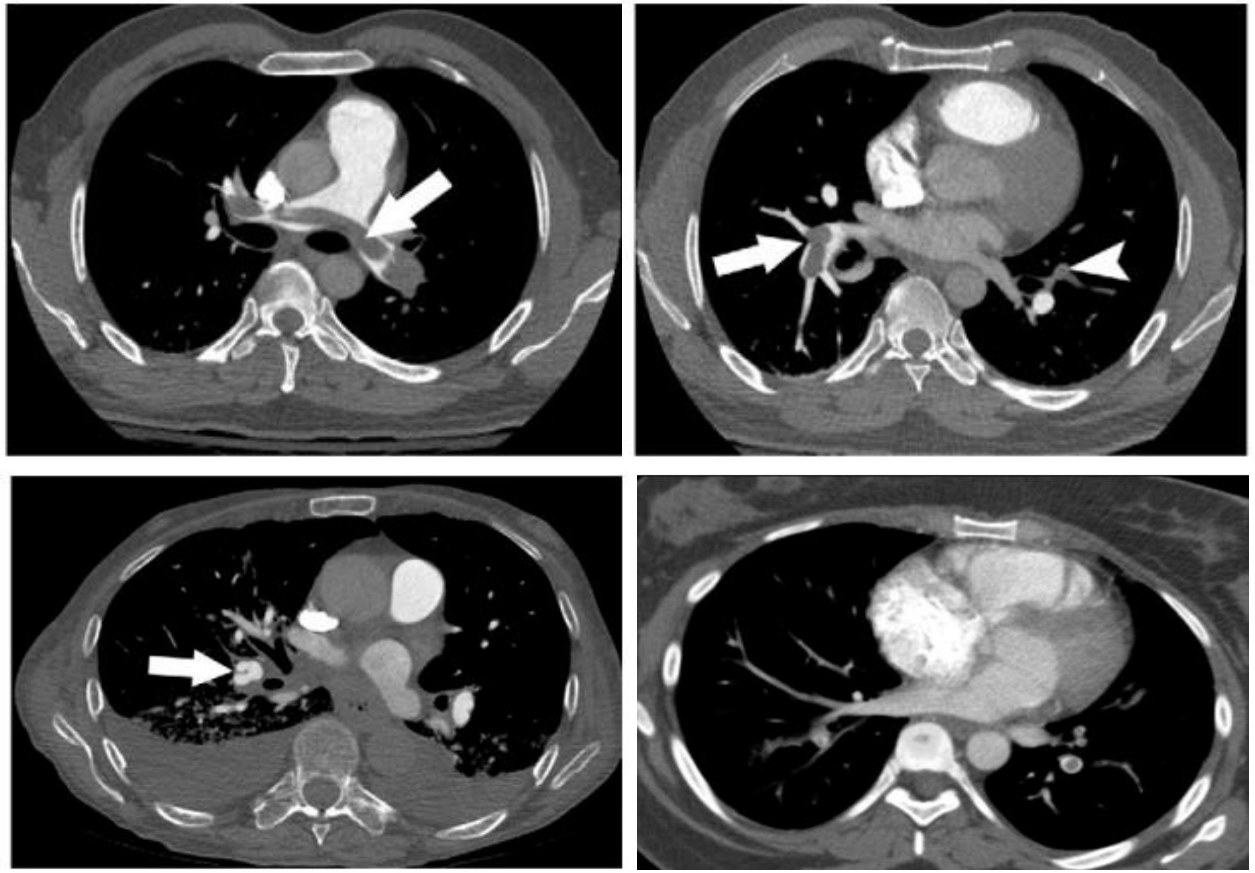
Michael B Gotway[2], and Jianming Liang[1]

[1]Arizona State University **[2]Mayo Clinic**

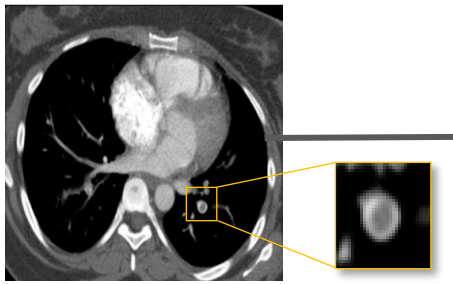
Pulmonary Embolism





RSNA Pulmonary Embolism Dataset

Exams: 7,279 (with 1,790,624 slices)



Input image

1

Slice-level Classification

Ground Truth

1. PE present or not

Feature vector

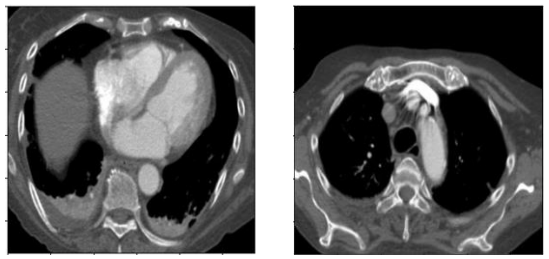
Organize for each exam

2

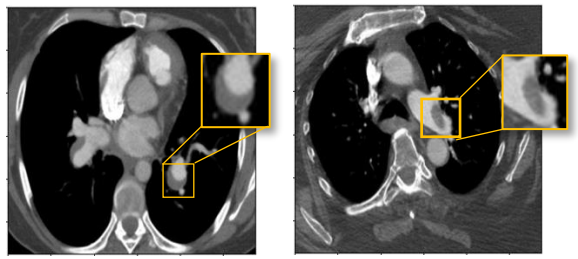
Exam-level Classification

Ground Truth

1. Negative Exam for PE
2. Indeterminate
3. Chronic PE
4. Acute & Chronic PE
5. Central PE
6. Left PE
7. Right PE
8. RV LV Ratio > 1
9. RV LV Ratio < 1



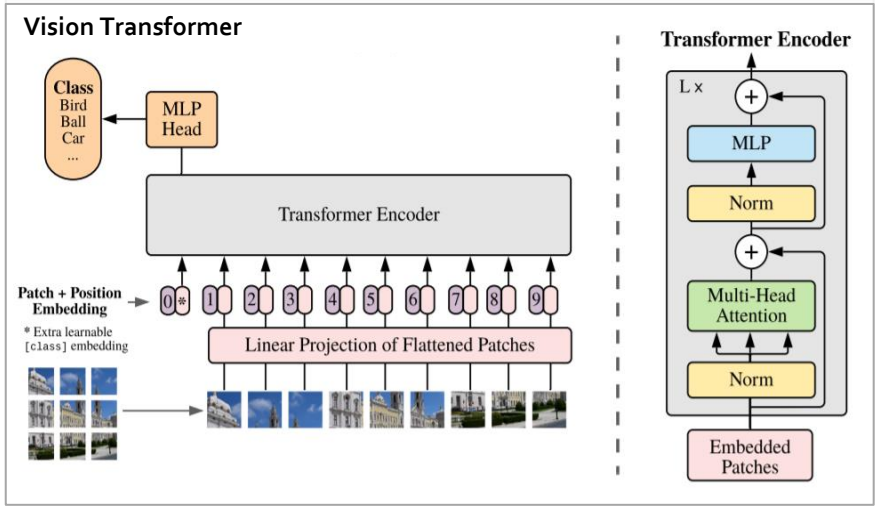
PE absent



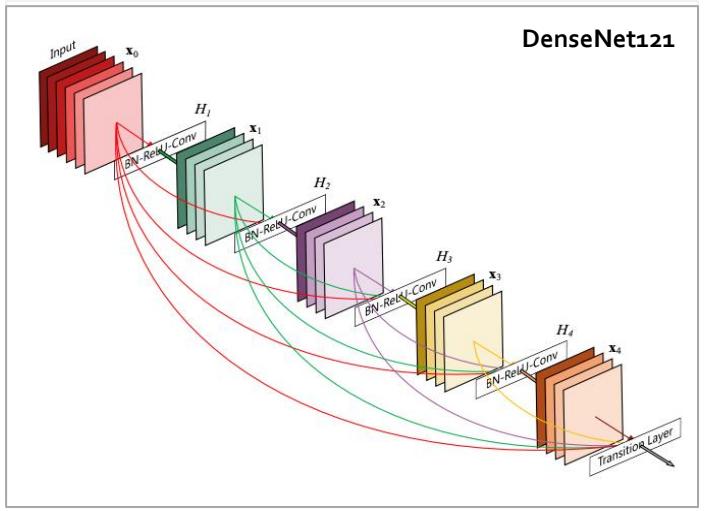
PE present

Colak, E., Kitamura, F. C., Hobbs, S. B., Wu, C. C., Lungren, M. P., Prevedello, L. M., Kalpathy-Cramer, J., Ball, R. L., Shih, G., Stein, A., Halabi, S. S., Altinmakas, E., Law, M., Kumar, P., Manzalawi, K. A., Nelson Rubio, D. C., Sechrist, J. W., Germaine, P., Lopez, E. C., Amerio, T., ... RSNA-STR Annotators and Dataset Curation Contributors (2021). The RSNA Pulmonary Embolism CT Dataset. *Radiology. Artificial intelligence*, *3*(2), e200254. https://doi.org/10.1148/ryai.2021200254

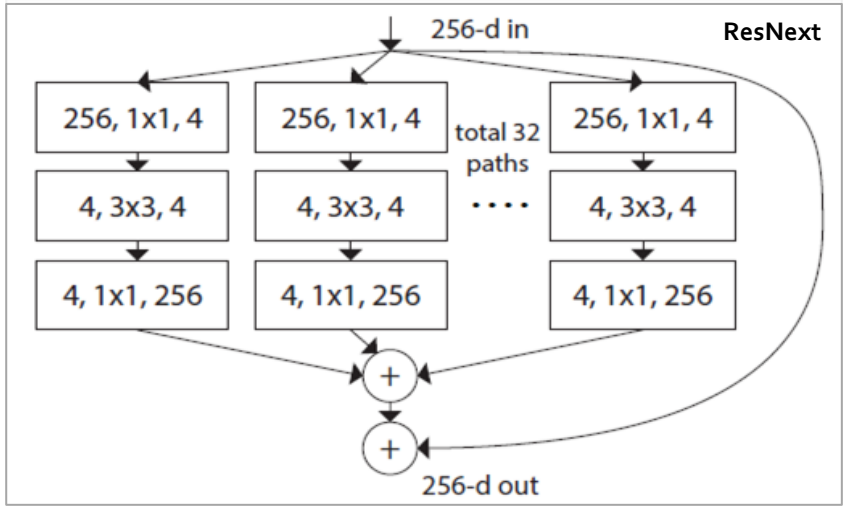
Vision Transformer



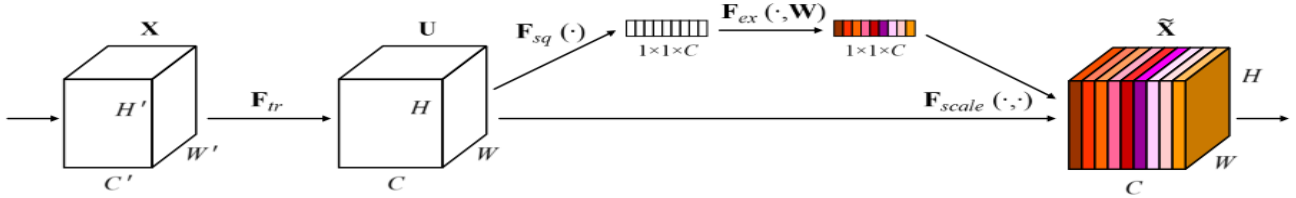
DenseNet121



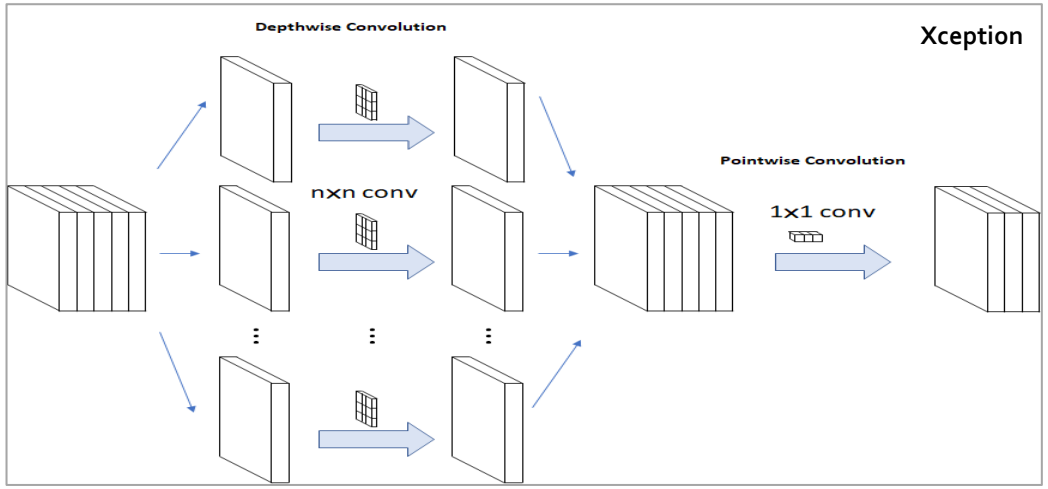
ResNext



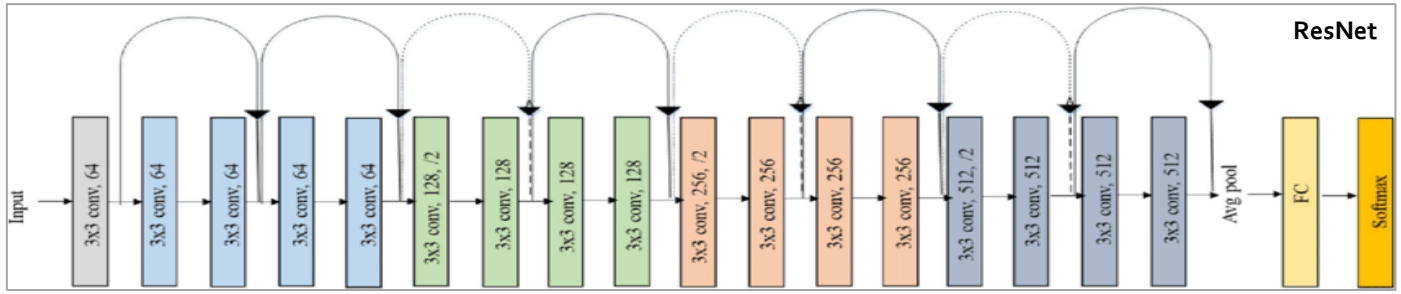
Squeeze & Excitation Block



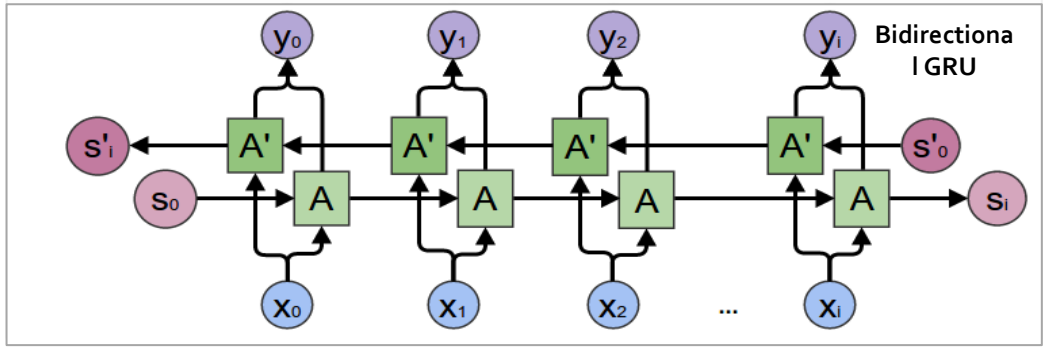
Xception



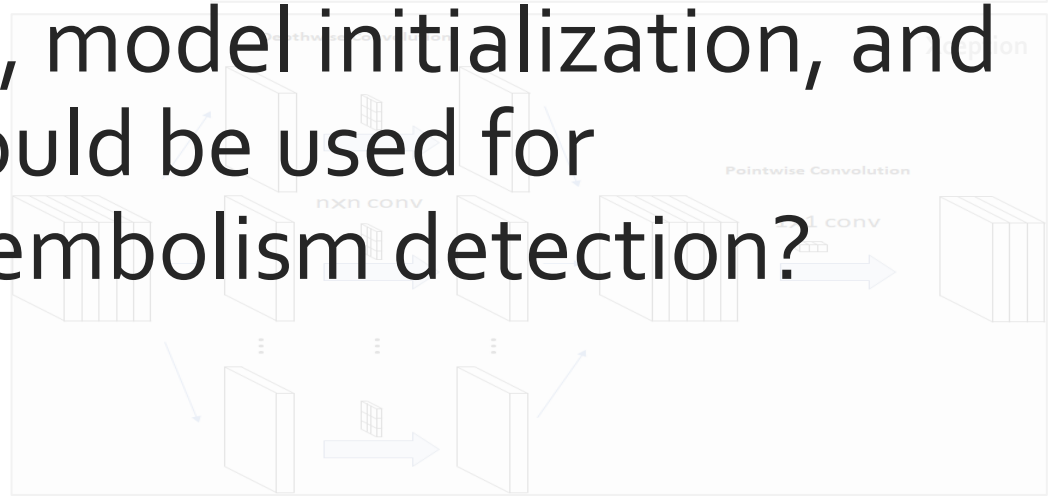
ResNet



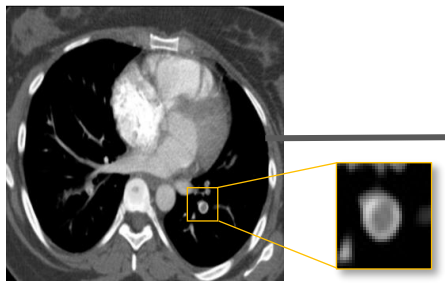
Bidirectional GRU



What deep learning architectures, model initialization, and learning paradigms should be used for computer-aided pulmonary embolism detection?

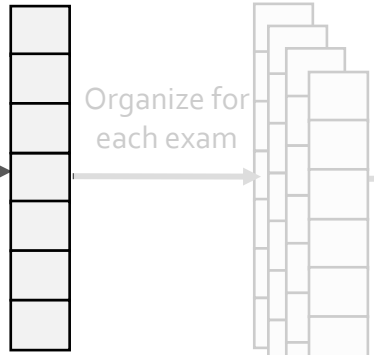


Fist Stage



Input image

Slice-level Classification



Feature vector

Organize for each exam

Exam-level Classification

Convolutional Neural Networks

1. ResNet18
2. ResNet50
3. ResNext50
4. SeResNet50
5. SeResNext50
6. DRN-A-50
7. Xception
8. SeXception
9. DenseNet121
10. SeNet154

Vision Transformer

1. ViT-B_16
2. ViT-B_32

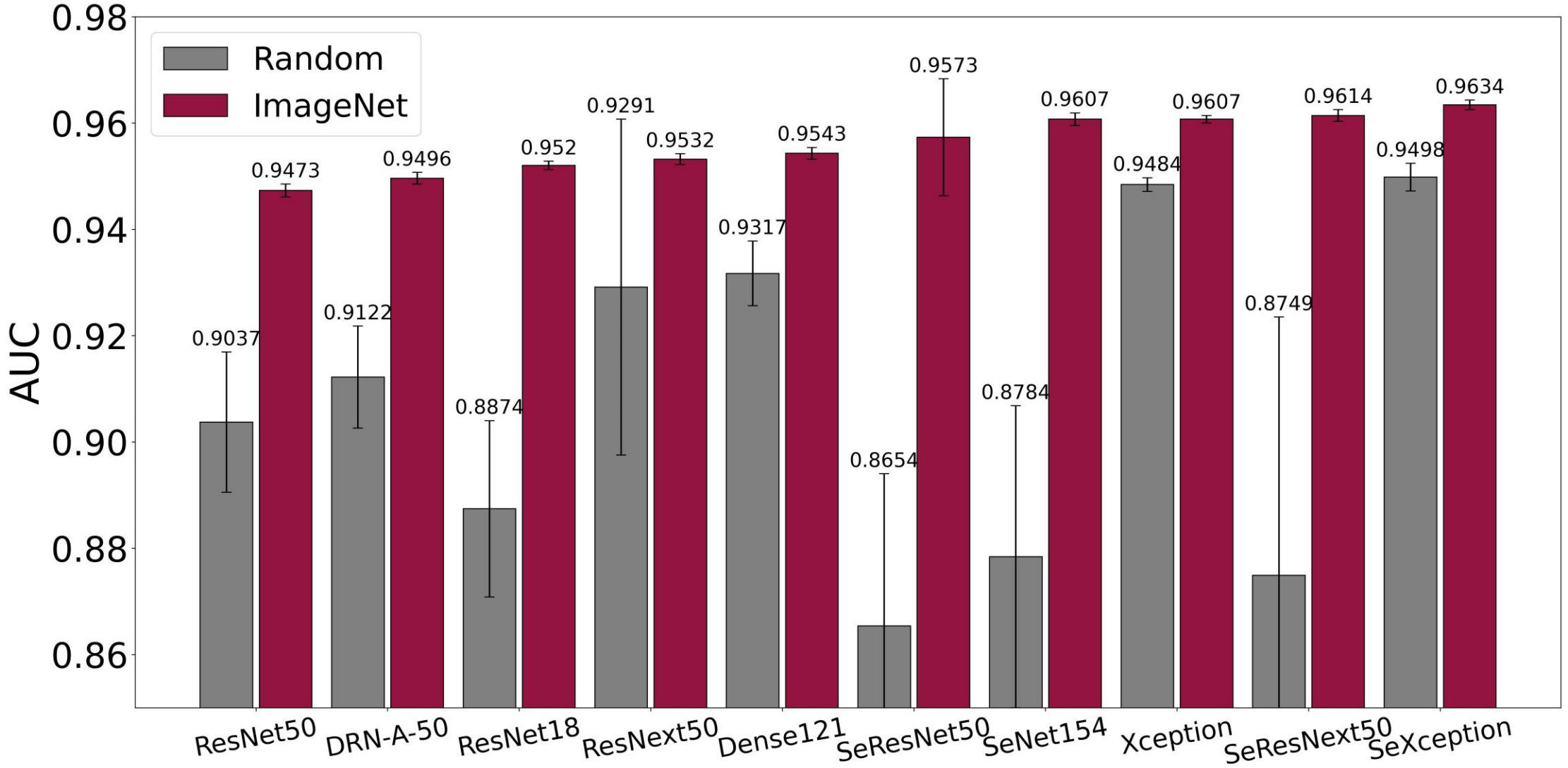
- Training from scratch
- Fine-tuning
  - Supervised pretrained models
  - Self-supervised pretrained models

Self-supervised Methods

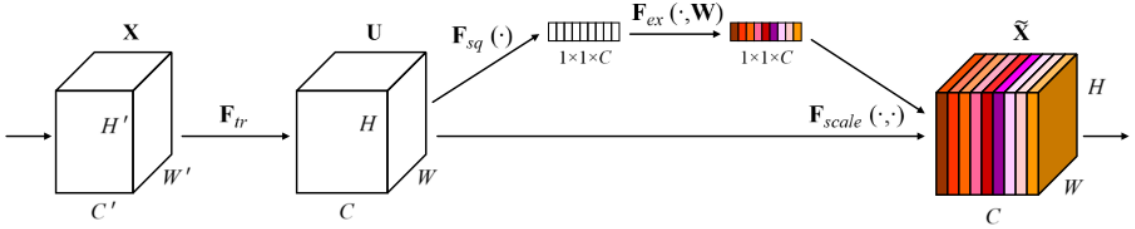
1. InsDis
2. InfoMin
3. MoCo-v1
4. BYOL
5. MoCo-v2
6. DeepCluster-v2
7. PCL-v1
8. SwAV
9. PCL-v2
10. SimCLR-v1
11. PIRL
12. SimCLR-v2
13. SeLa-v2
14. Barlow Twins

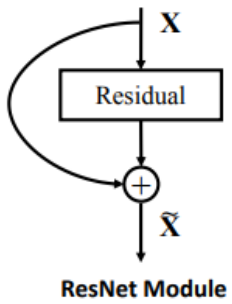
https://www.kaggle.com/c/rsna-str-pulmonary-embolism-detection/discussion/194145

Transfer learning significantly improves slice-level classification

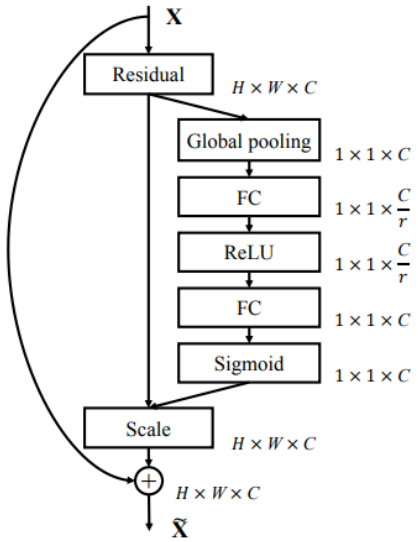


Squeeze and excitation (SE) blocks enhance CNN performance

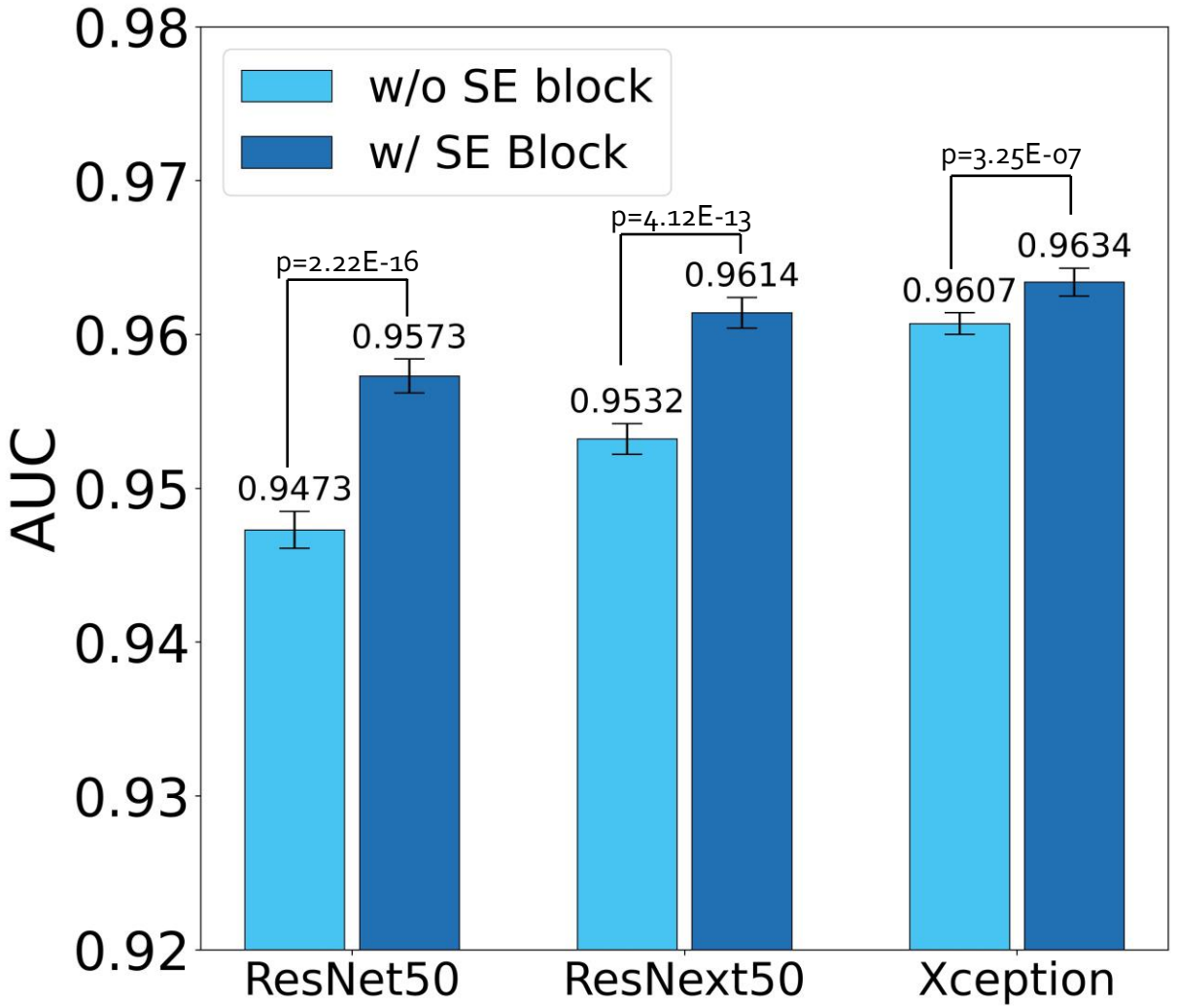




ResNet Module

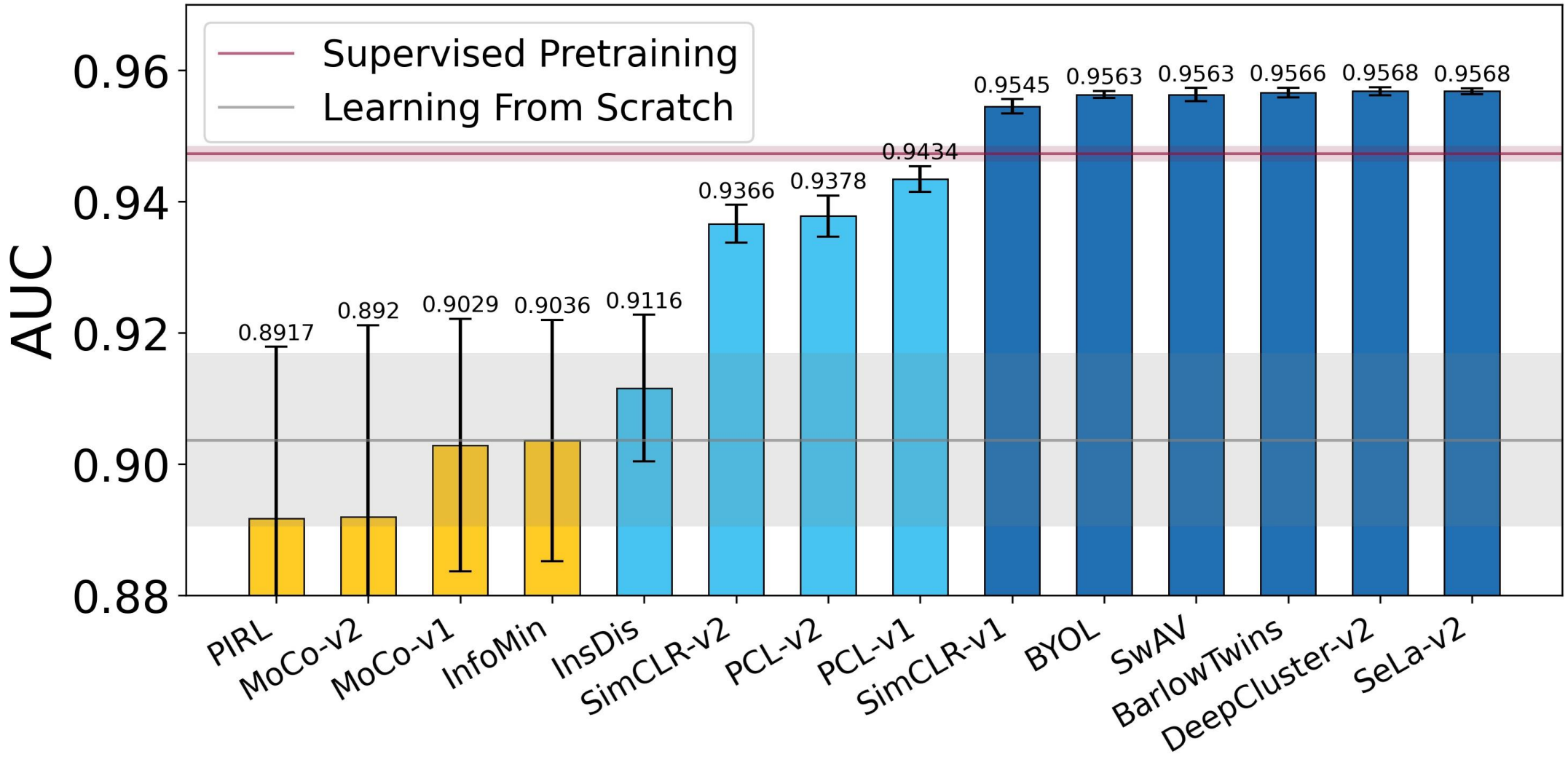


SE-ResNet Module



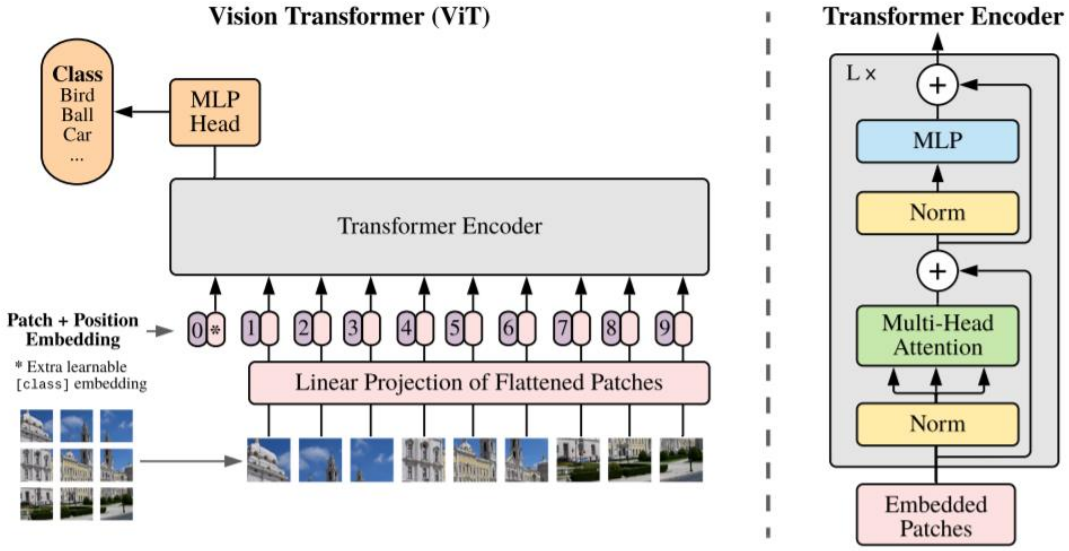
Hu, J., Shen, L., & Sun, G. (2018). Squeeze-and-excitation networks. In *Proceedings of the IEEE conference on computer vision and pattern recognition* (pp. 7132-7141).

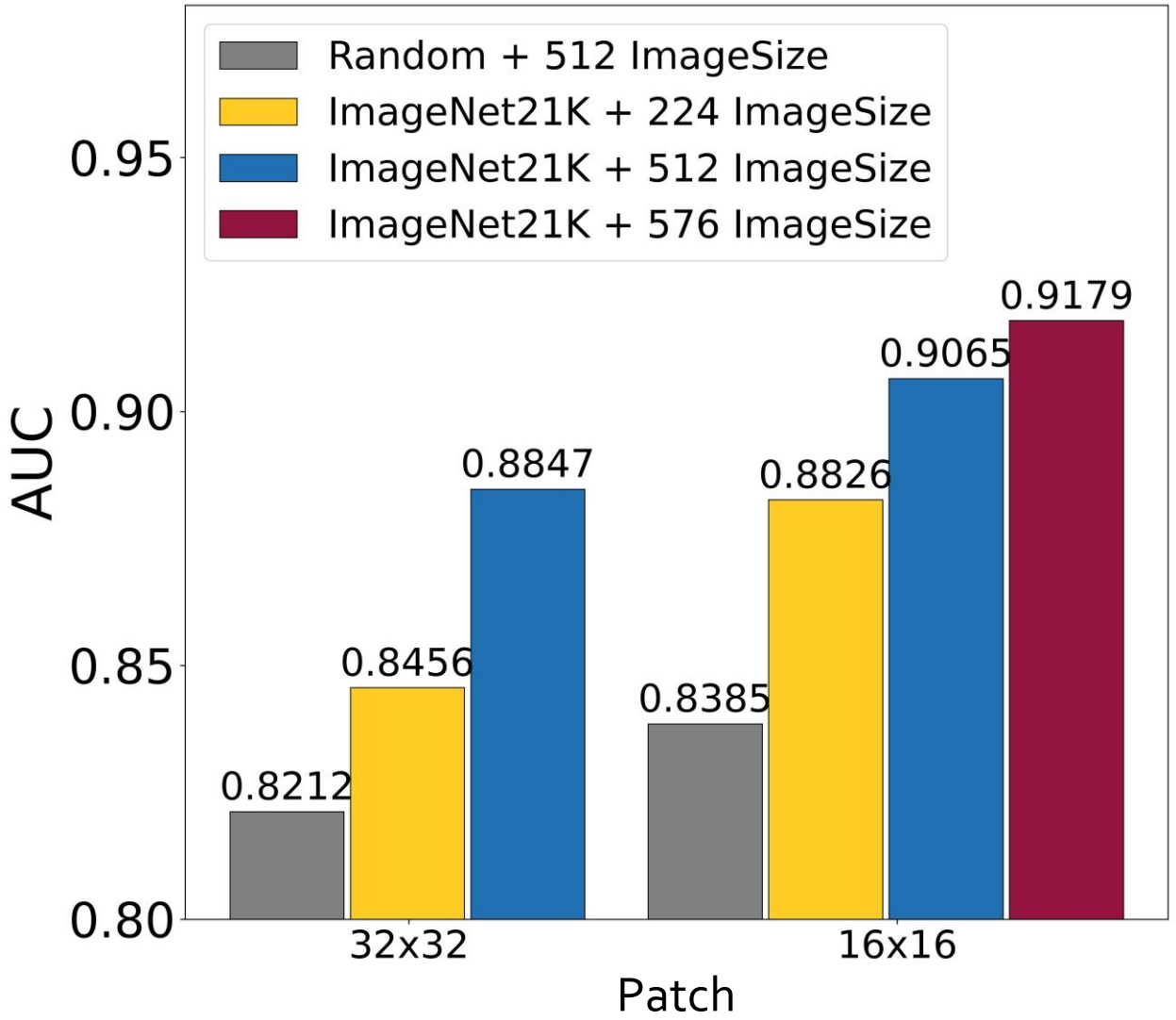
Self-supervised pre-training overtakes (fully) supervised pre-training



Ericsson, L., Gouk, H., & Hospedales, T. M. (2021). How Well Do Self-Supervised Models Transfer?. In *Proceedings of the IEEE/CVF Conference on Computer Vision and Pattern Recognition* (pp. 5414-5423).

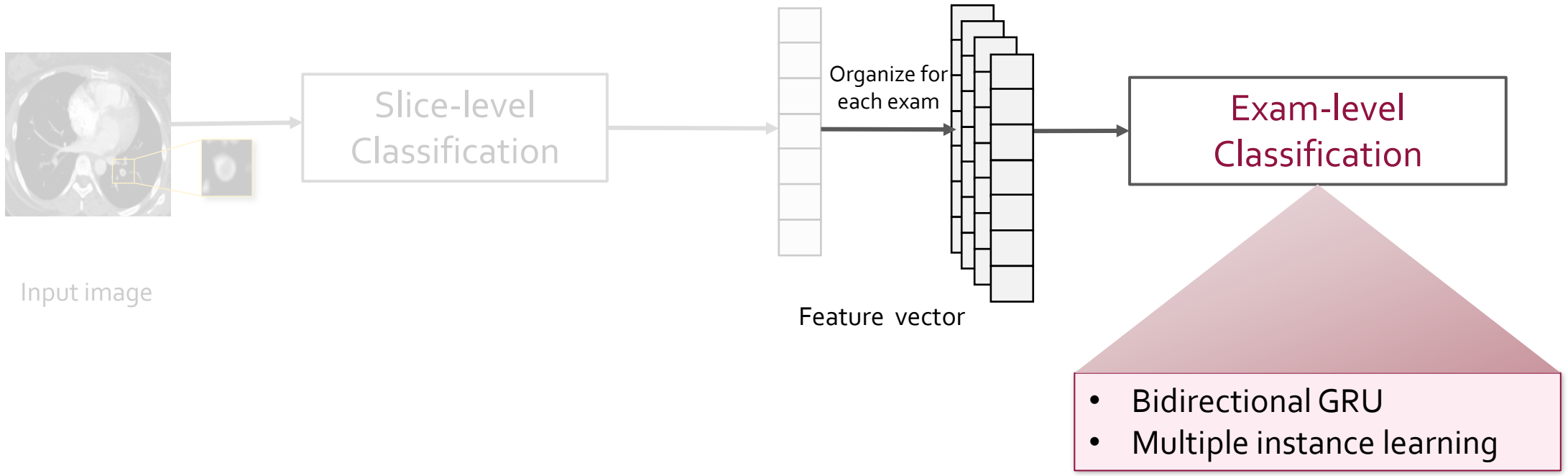
Vision transformer (ViT) performs inferiorly compared with CNN





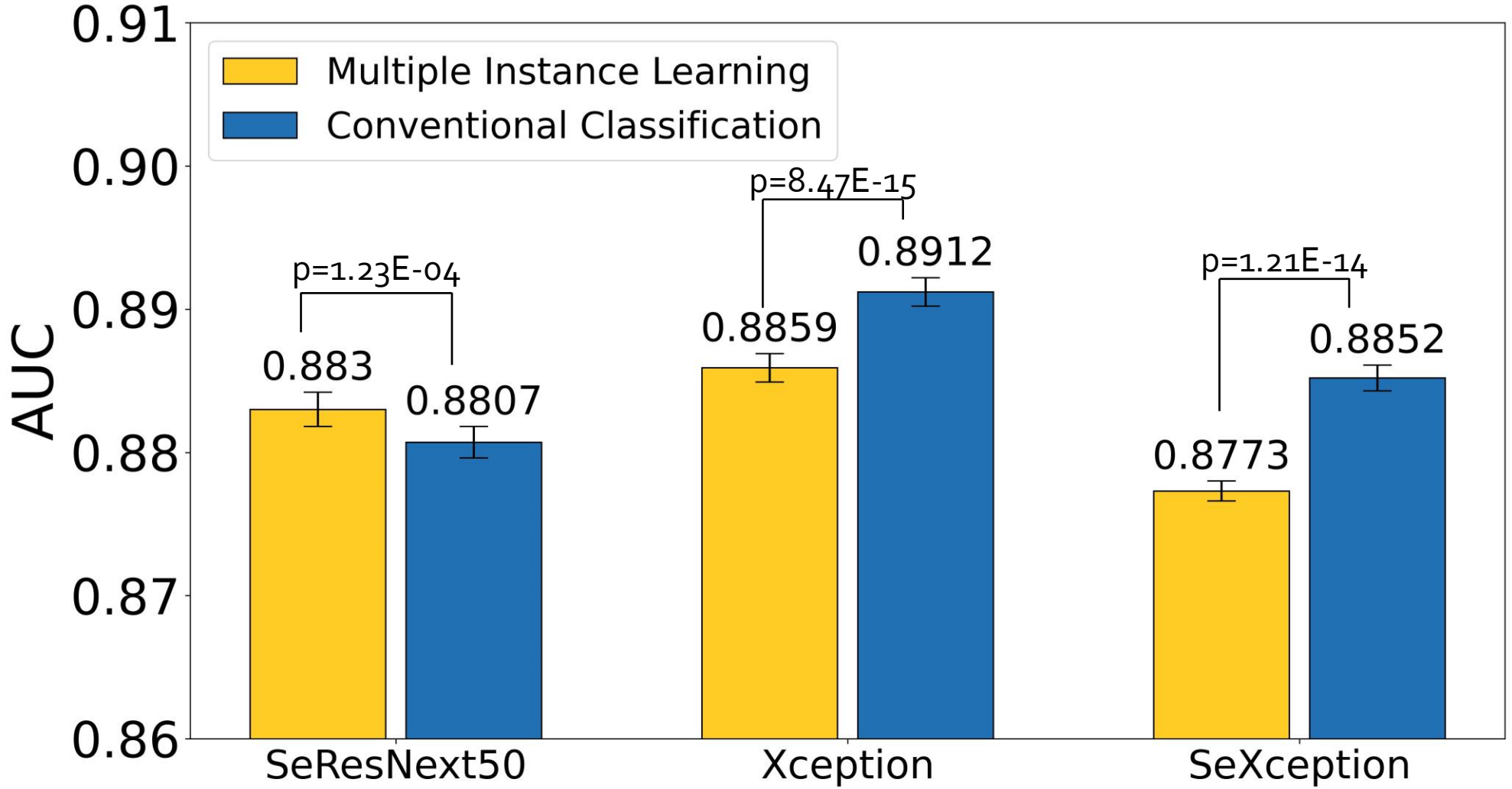
Dosovitskiy, A., Beyer, L., Kolesnikov, A., Weissenborn, D., Zhai, X., Unterthiner, T., ... & Houlsby, N. (2020). An image is worth 16x16 words: Transformers for image recognition at scale. *arXiv preprint arXiv:2010.11929*.

Second Stage



https://www.kaggle.com/c/rsna-str-pulmonary-embolism-detection/discussion/194145

Conventional classification (CC) marginally outperforms Multiple instance learning (MIL)



Ilse, M., Tomczak, J., & Welling, M. (2018, July). Attention-based deep multiple instance learning. In *International conference on machine learning* (pp. 2127-2136). PMLR.

Conclusion

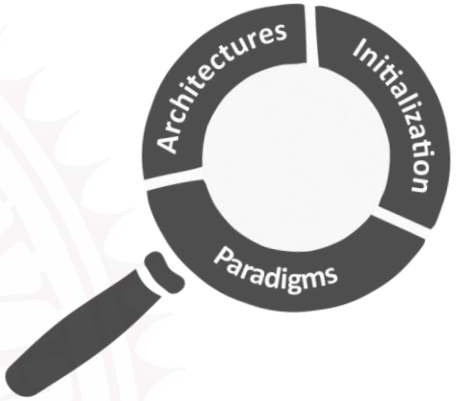
Compared with the state-of-the-art, our optimal approach provides an AUC gain of 0.2% and 1.05% for slice-level and examination-level, respectively.

We have analyzed

- Deep learning architectures
- Model initialization
- Learning paradigms

We have benchmarked:

- Supervised learning
- Self-supervised learning
- Vision transformers
- Bidirectional GRU
- Multiple instance learning



Seeking an Optimal Approach for Computer-aided Pulmonary Embolism Detection

Poster Session, MLMI2021-P-46

Monday, 27th September 2021, 15:50 - 16:40

https://github.com/Nahid1992/CAD_PE