Deep Learning For Condition Detection In Chest Radiographs: A Performance Comparison Of Different Radiograph Views And Handling Of Uncertain Labels

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- MSc in Artificial Intelligence with Robotics (2017-2019)
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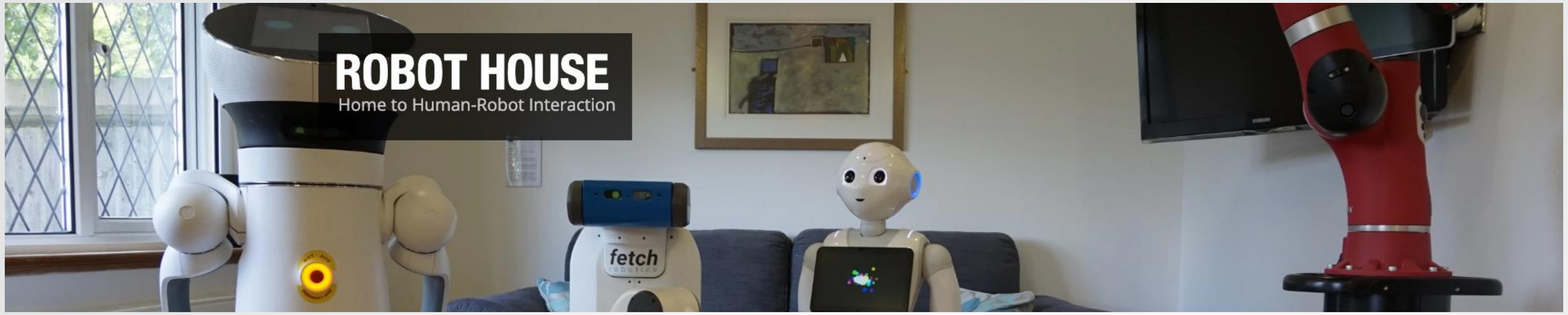
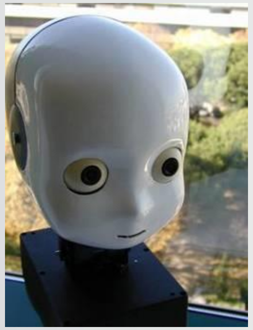
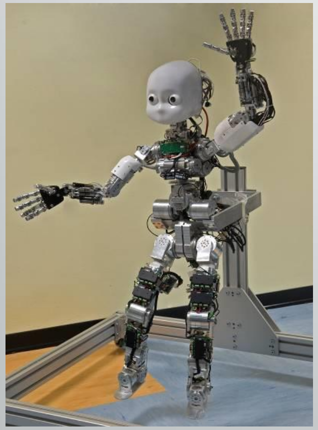
Interests

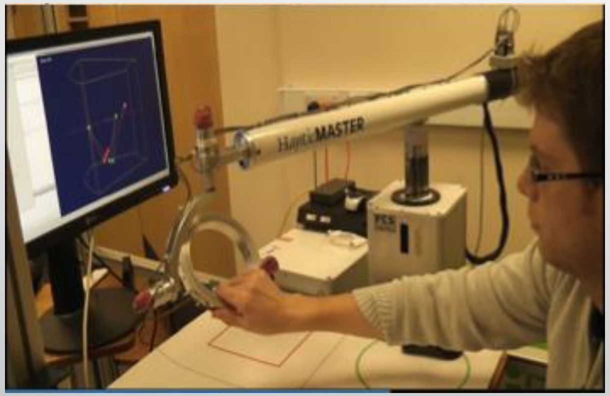
- Artificial Intelligence, Deep learning, Medical Imaging





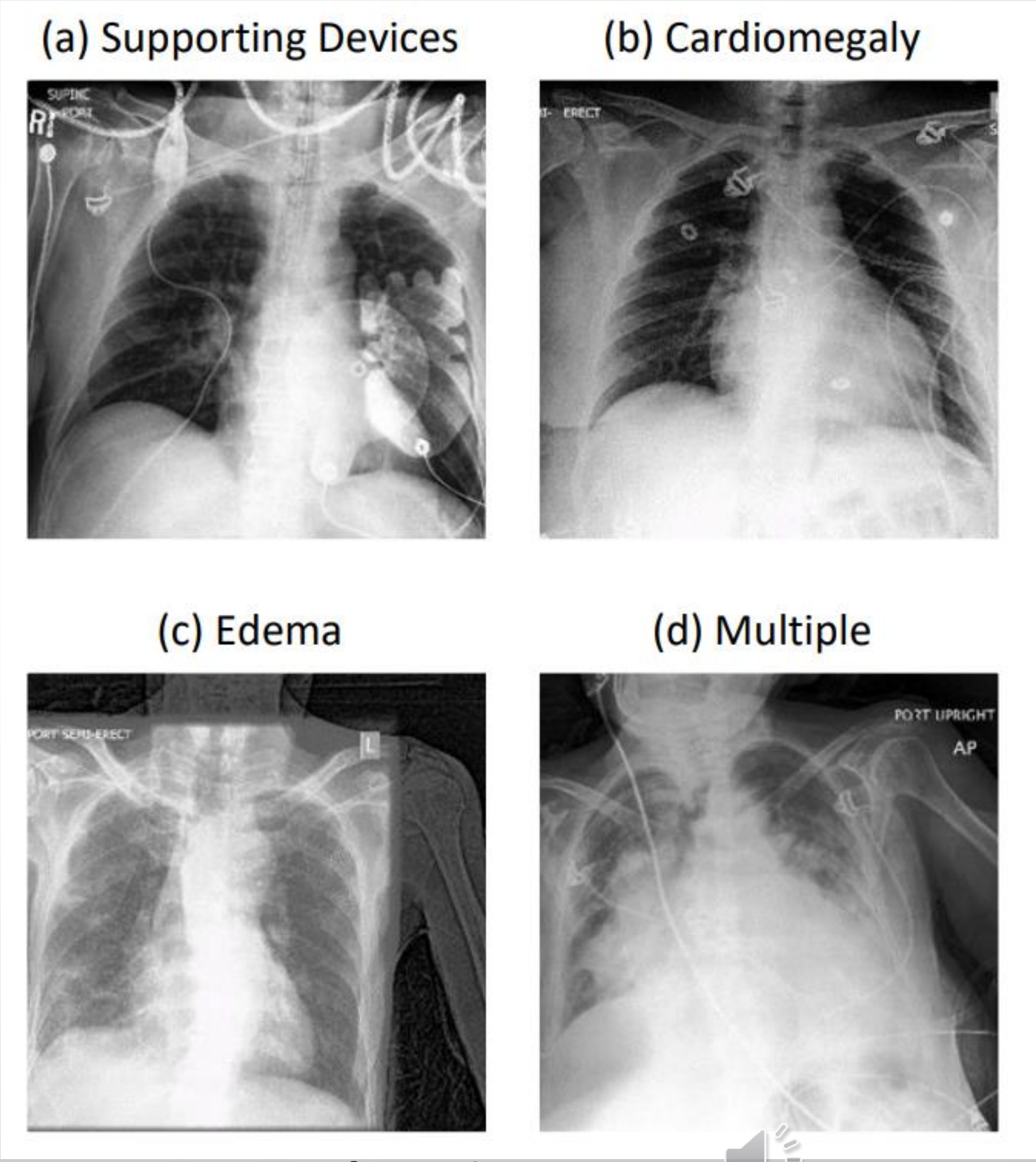
Robots in UH **Robot House** and Robotics Research Group





Introduction

- Chest Radiograph Interpretation
- Chexpert Dataset
- AP, PA and Lateral Projections
- Multilabel Classification
- Deep Learning for Image Classification
- Five Clinically Significant Conditions
  - Cardiomegaly
  - Consolidation
  - Atelectasis
  - Pleural Effusion
  - Oedema

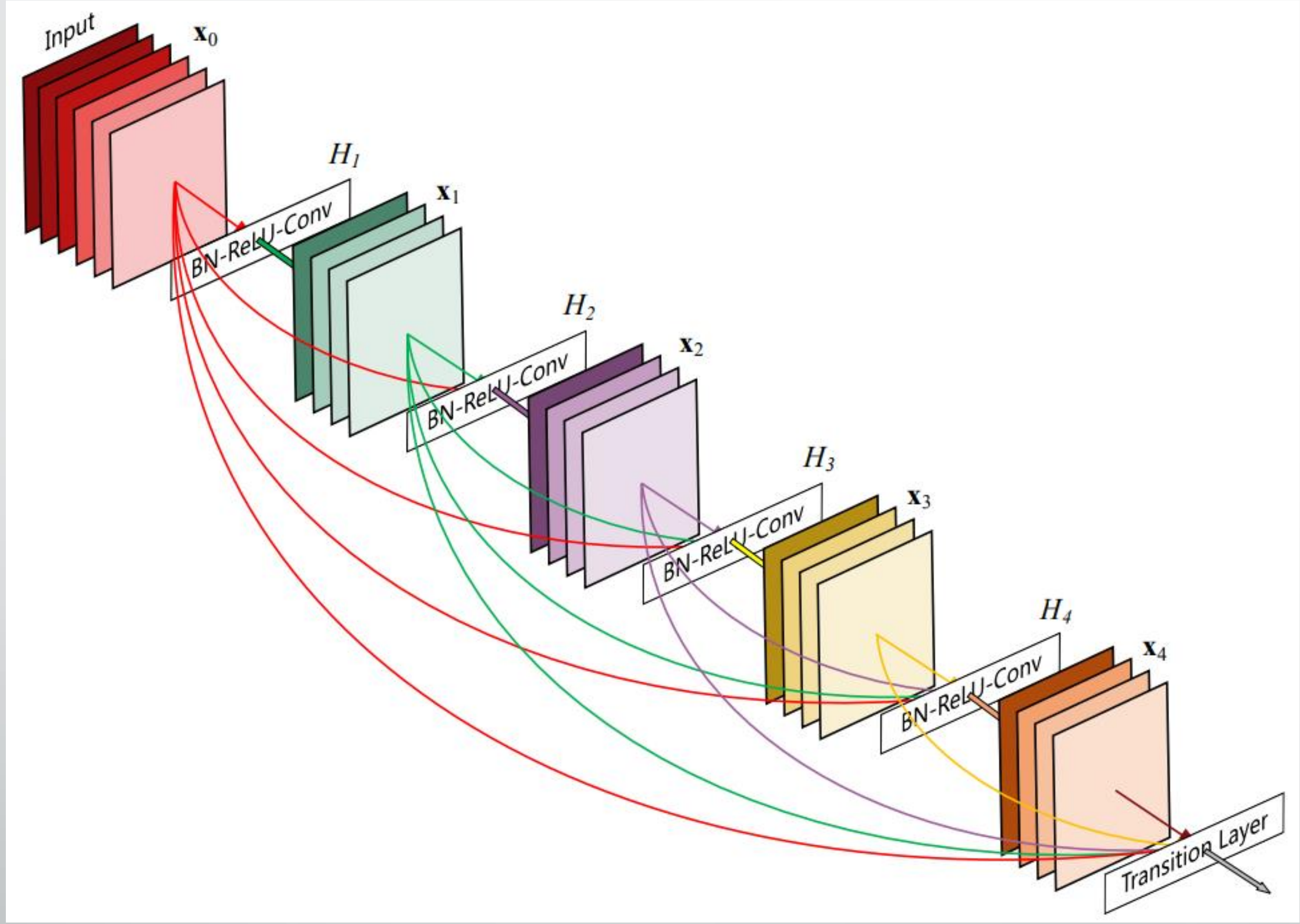


Images from CheXpert Dataset [1]

Methodology

- DenseNet121
- Each Projection Separately Considered
- Transfer Learning
- Multiscale Template Matching
- Data Augmentation
- Labelling Uncertain Samples

Methodology – DenseNet121



Five Layer Dense Block From DenseNet121 [2]

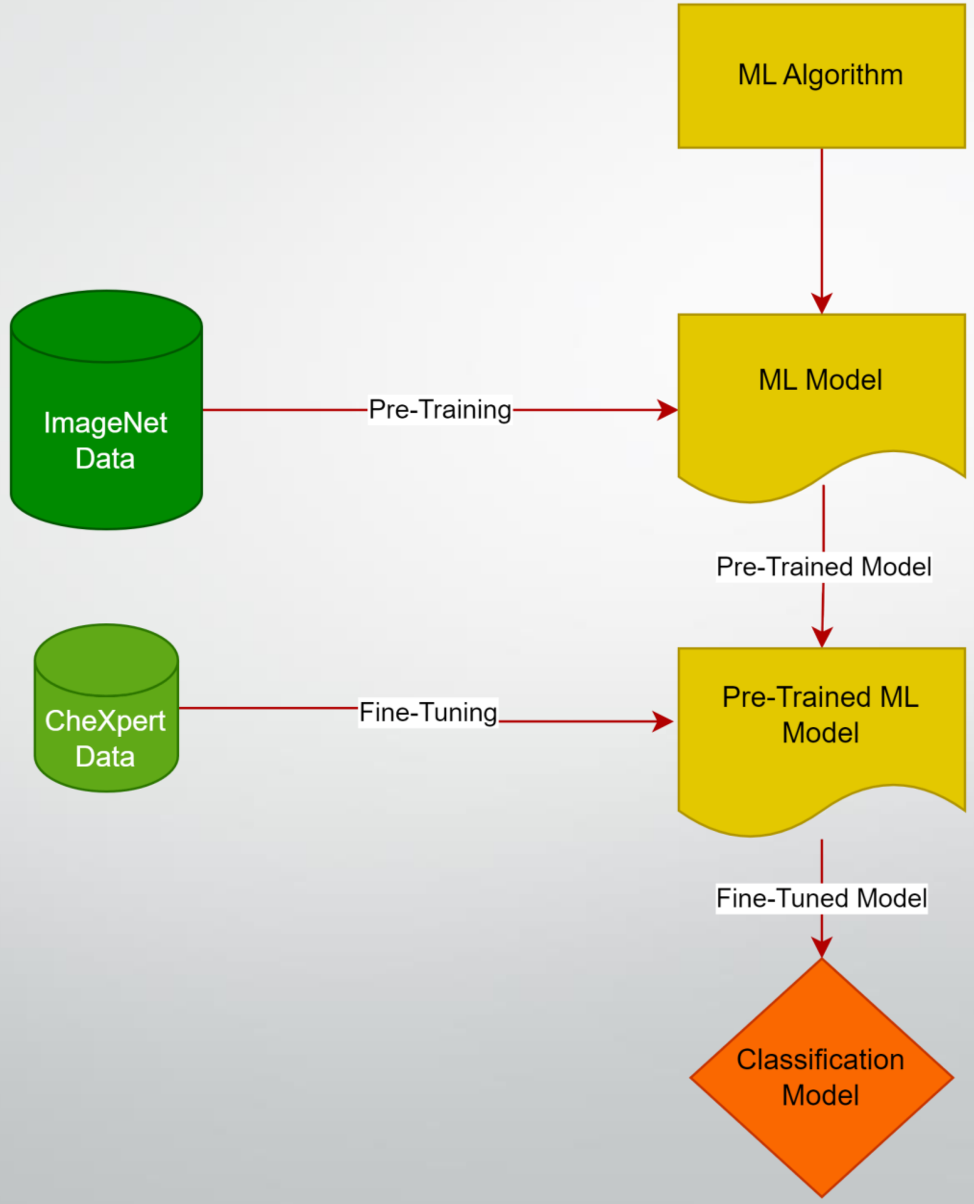
Methodology – ALL Views

AP PA Lateral

Different projections of radiographs of same patient from CheXpert data Set [1]

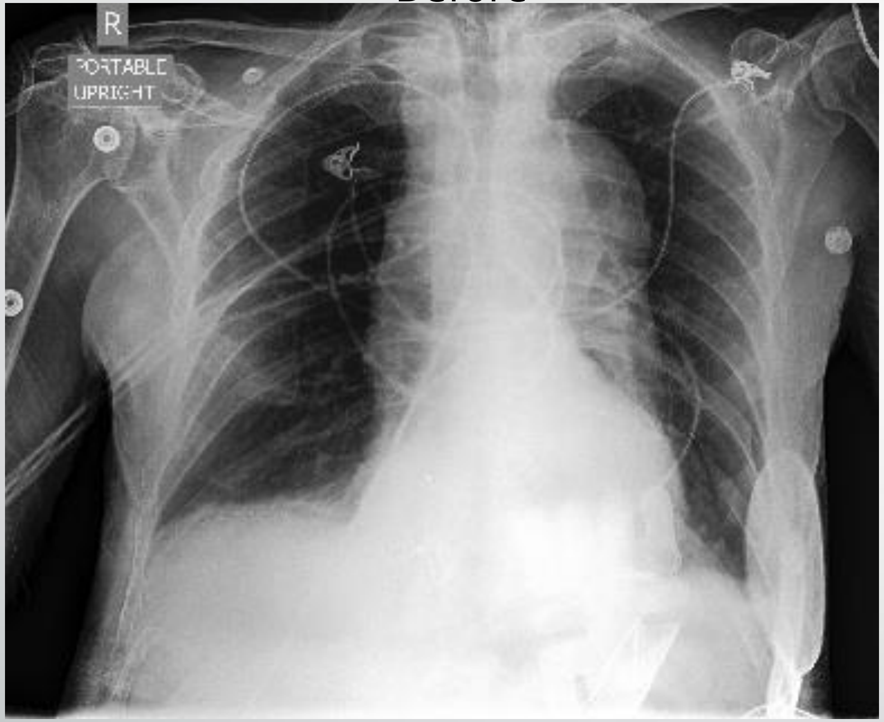
- Different orientation of Discriminative Features
- Heart size in AP and PA

Methodology – Transfer Learning



Methodology – Template Matching

Before

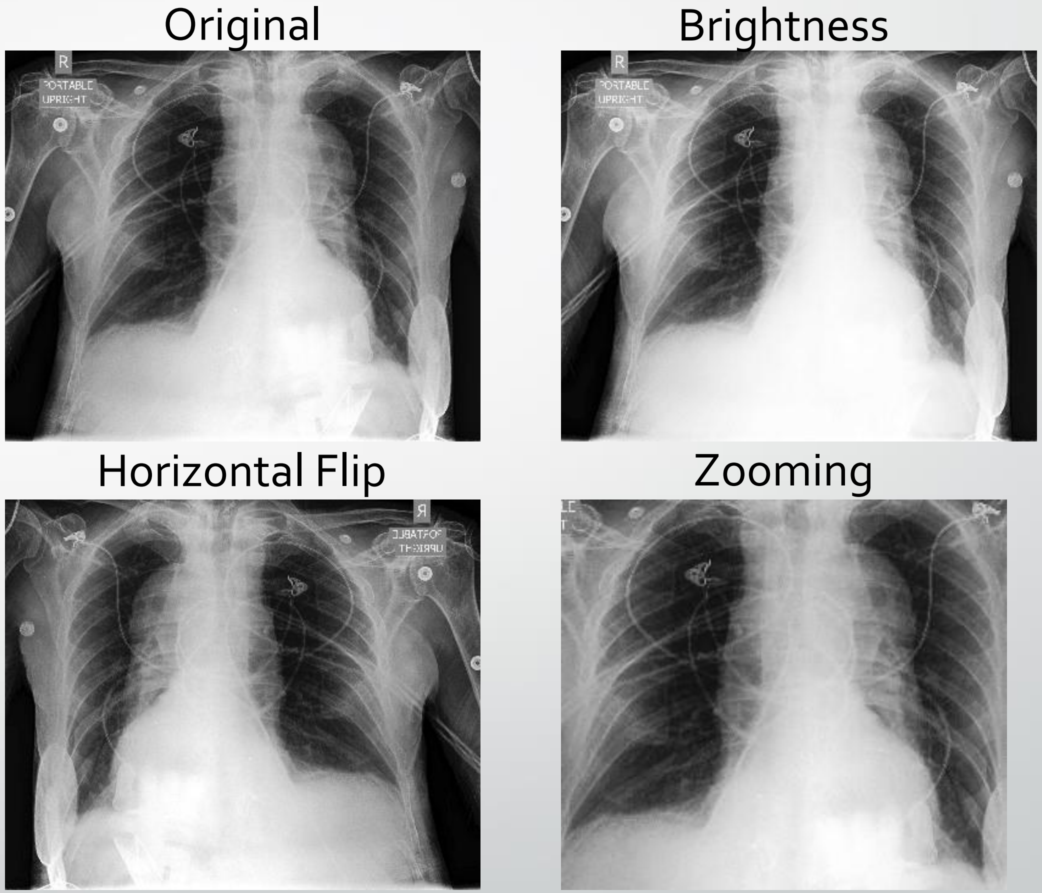


After

Same radiograph before and after applying template Matching [1]

Methodology – Augmentation

- Enhance data
- Increase data diversity
- Multiple Techniques (Zooming, Brightness, Flipping, etc.)



Methodology – Label Uncertain with GMM

- Trained GMM for each condition and view separately
- Classify uncertain samples
- Included them in the training set

Results – Best Model

Anteroposterior					
Exp	**DN121**	**DN121_TM**	**DN121_TL**	**DN121_AUG**	**DN121_TM_TL_AUG**
1	**0.85**	0.79	0.76	**0.87**	0.84
2	0.79	0.74	0.81	0.76	0.85
3	0.76	0.75	0.86	0.79	0.82
4	0.78	0.81	0.8	0.8	0.83
5	0.76	**0.81**	0.84	0.84	0.83
6	0.76	0.72	**0.9**	0.86	0.83
7	0.8	0.79	0.67	0.8	0.88
8	0.82	0.63	0.8	0.84	0.85
9	0.81	0.79	0.82	0.82	0.86
10	0.74	0.78	0.81	0.8	**0.88**
Avg	0.79	0.76	0.81	0.82	0.85
Std	0.03	0.05	0.06	0.03	0.02

- Analysis of Variance (ANOVA)

  [$F(4, 45) = 5.504$, $p = 0.001$]

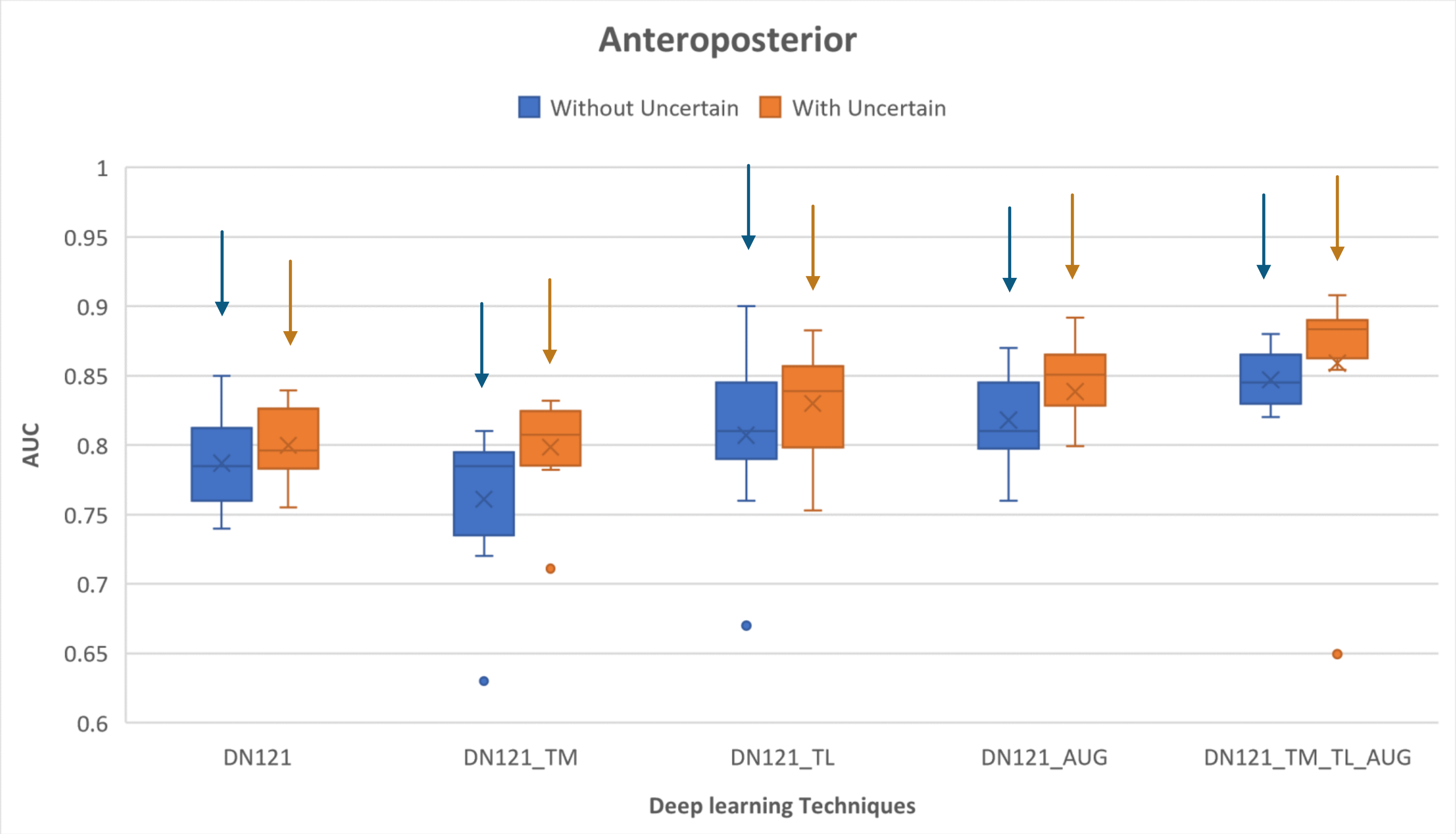
Results – Comparison Between Views

Exp	Anteroposterior(AP)	Posteroanterior(PA)	Lateral
1	0.84	0.69	0.79
2	0.85	0.73	**0.9**
3	0.82	0.74	0.84
4	0.83	0.74	0.78
5	0.83	**0.74**	0.87
6	0.83	0.73	0.82
7	0.88	0.73	0.84
8	0.85	0.69	0.86
9	0.86	0.7	0.82
10	**0.88**	0.72	0.81
Avg	0.85	0.72	0.83
Std	0.02	0.02	0.04

- Analysis of Variance (ANOVA)

  $[F(2, 27) = 64.677, p < 0.001]$

Results – After Removing Uncertainty



Limitations and Future Work

Limitations:

- Insufficient data for each projection
- Same hospital data

Future Work:

- Other deep learning techniques such as transformers
- Co-design studies with radiologists
- Integrate in clinical work flow

Conclusion

- AP out performs PA and Lateral views
- Added techniques improve the model performance
- Relabelling the uncertain with GMM works
- These models can assist radiologist

References

1) Irvin, J., Rajpurkar, P., Ko, M., Yu, Y., Ciurea-Ilcus, S., Chute, C., ... & Ng, A. Y. (2019, July). Chexpert: A large chest radiograph dataset with uncertainty labels and expert comparison. In *Proceedings of the AAAI conference on artificial intelligence* (Vol. 33, No. 01, pp. 590-597).

2) Huang, G., Liu, Z., Van Der Maaten, L., & Weinberger, K. Q. (2017). Densely connected convolutional networks. In *Proceedings of the IEEE conference on computer vision and pattern recognition* (pp. 4700-4708)

THANK YOU