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From chest to hand X-rays: Transfer learning for skeletal age prediction

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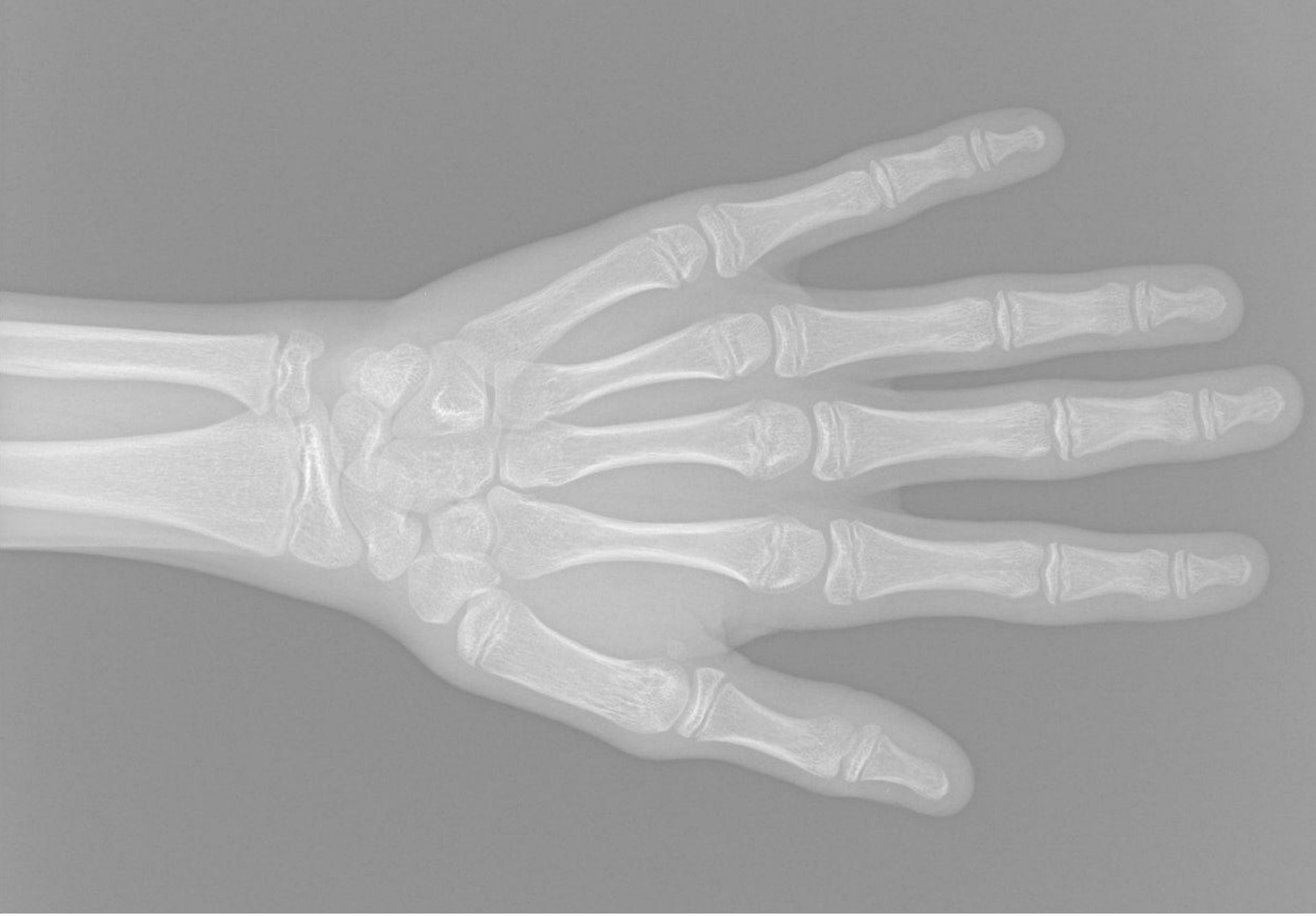
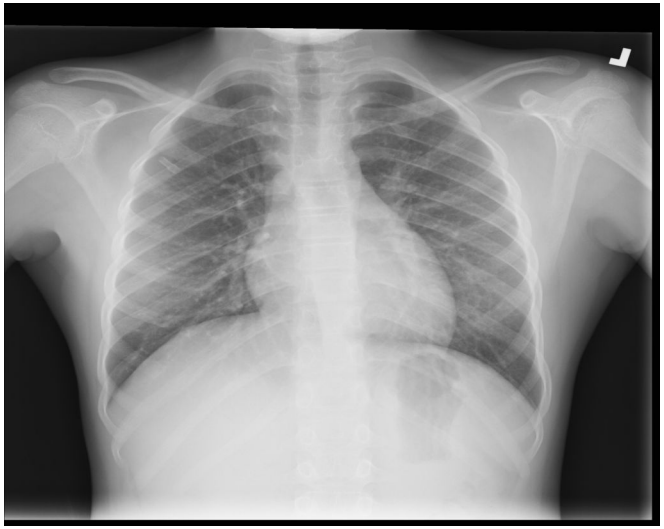
https://www.flickr.com/photos/jfawcette/7006682435
https://hype.my/2016/108000/leechongwei-malaysian-shuttler-records-fastest-smash-in-badminton-history/

https://www.fluege.de/Katalog/Rom/Flug-445
https://paris.ticketbar.eu/de/home/



https://www.16bit.ai/blog/ml-and-future-of-radiology

From chest to hand X-rays?



?

112’120x

14’236x

Challenge

- **Skeletal age prediction based on pediatric hand X-rays**
  2017 RSNA global ML competition to develop best model
  winner: 16BitNet with mean absolute error (MAE) of 4.265 months
  Radiologist performance: MAE of 7.32 months

- Our idea: apply transfer learning

Transfer Learning Recap

Transfer learning and domain adaptation refer to the situation where what has been learned in one setting … is exploited to improve generalization in another setting

— Page 526, Deep Learning, 2016

Transfer Learning Recap

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Example from ImageNet dataset (for MURA)

"The weights of the network were initialized with weights from a model pretrained on ImageNet."

1'300'000x

40'561x

MURA: Large Dataset for Abnormality Detection in Musculoskeletal Radiographs (Pranav Rajpurkar et al, Dec 2017)

Method

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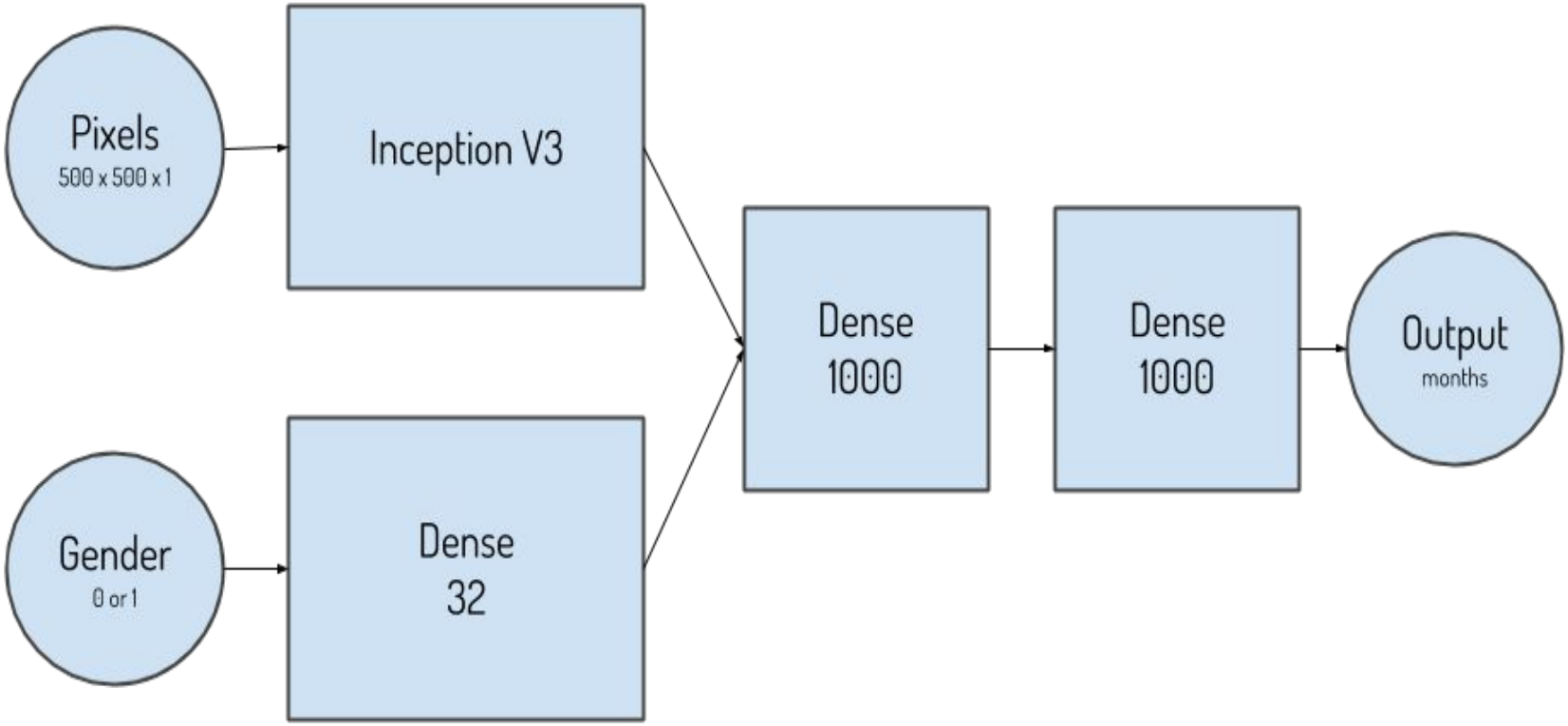
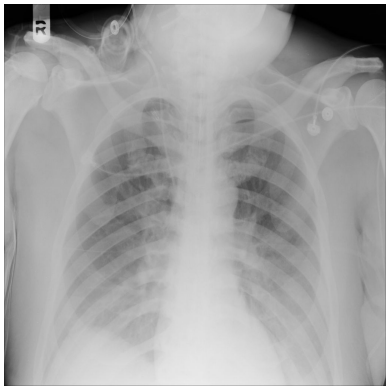
Architecture (by 16BitNet)

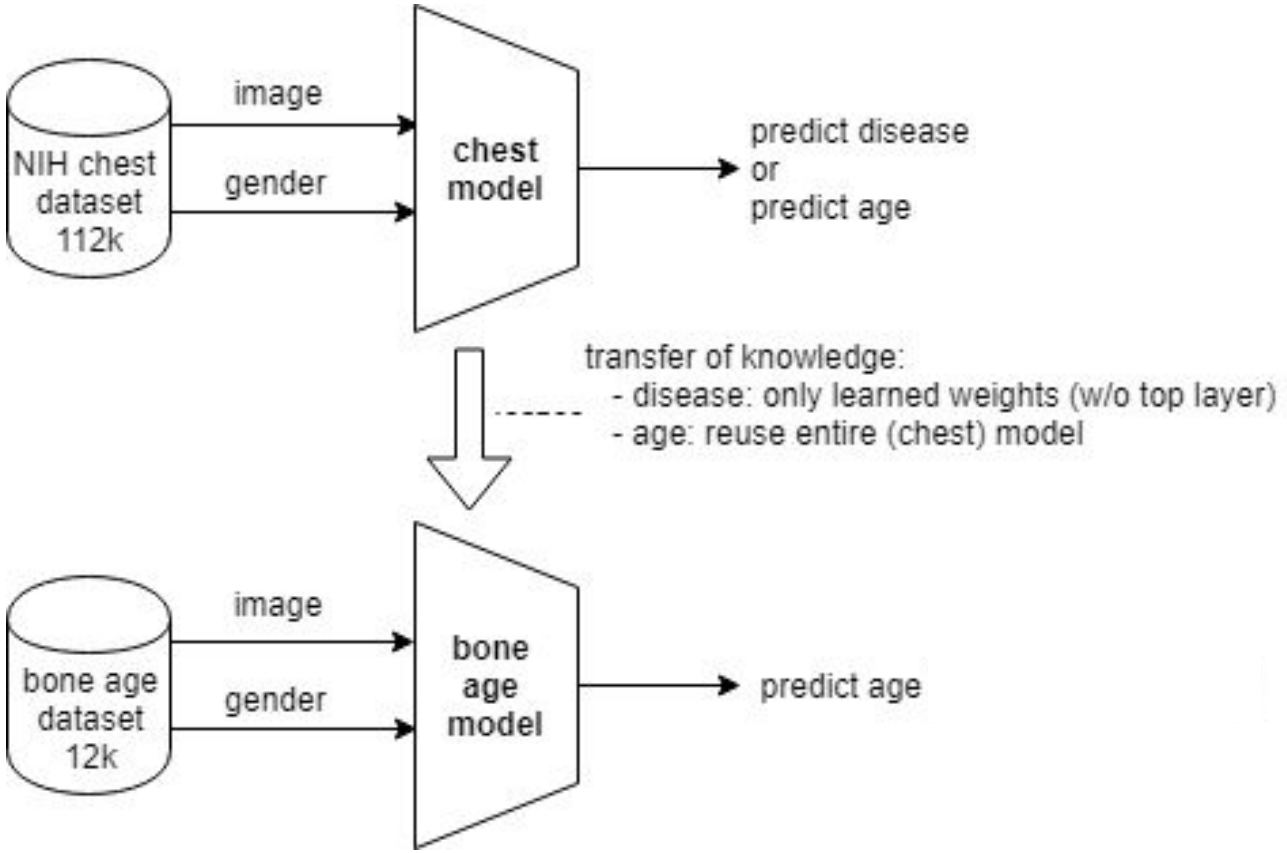


https://www.16bit.ai/blog/ml-and-future-of-radiology

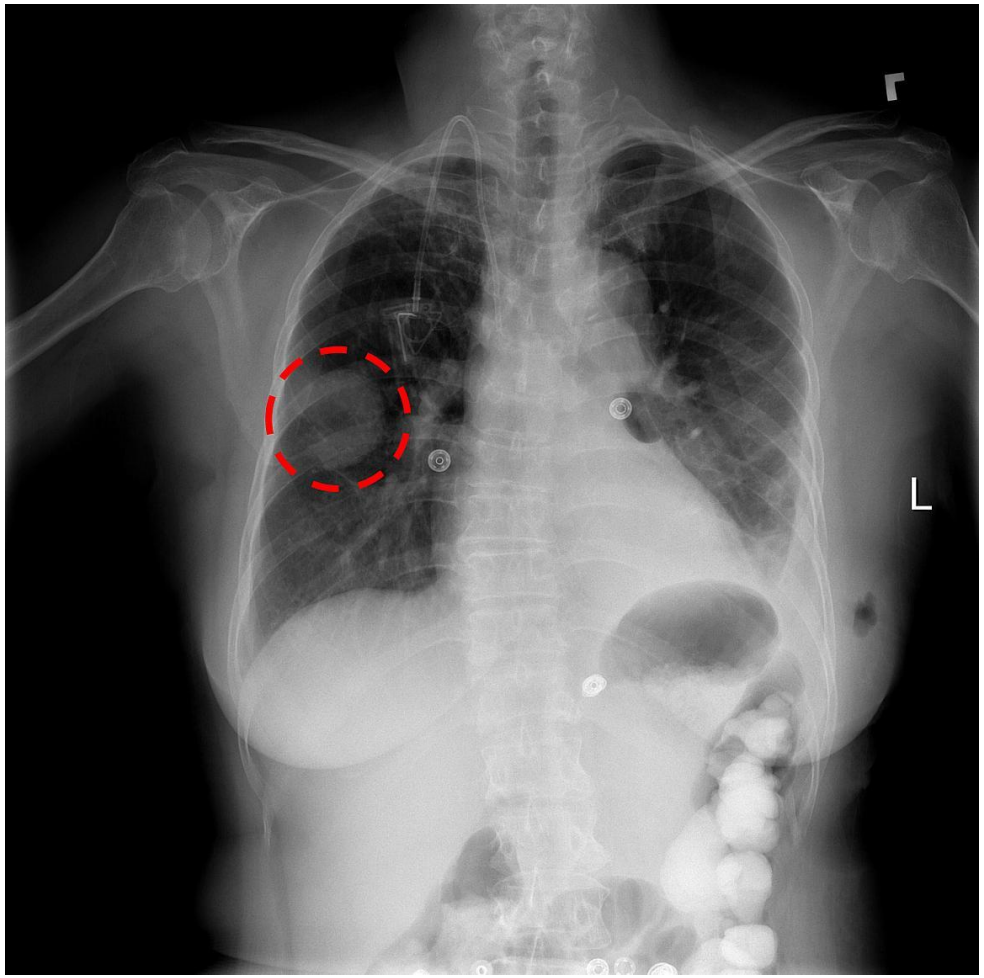
Method

Transfer learning from NIH chest dataset





NIH chest X-Ray: 112’120 images



https://www.nih.gov/news-events/news-releases/nih-clinical-center-provides-one-largest-publicly-available-chest-x-ray-datasets-scientific-community

RSNA hand X-Ray: 14’236

http://rsnachallenges.cloudapp.net/competitions/4

MURA arm X-Ray: 40’561 images

https://stanfordmlgroup.github.io/competitions/mura/

Experiments

Setup

1. Keras on Tensorflow
2. Dataset split training <-> validation 4:1
3. Data augmentation: left-right flip, random shift (20%), random rotation (20 degree), zoom (0.2)
4. Batch size 16
5. Adam optimizer with initial learning rate 1e-3
6. SGD optimizer with learning rate 1e-4 for finetuning
7. Learning rate decays to 0.01 of original learning rate
8. MAE (mean absolute error) loss function

Experiments

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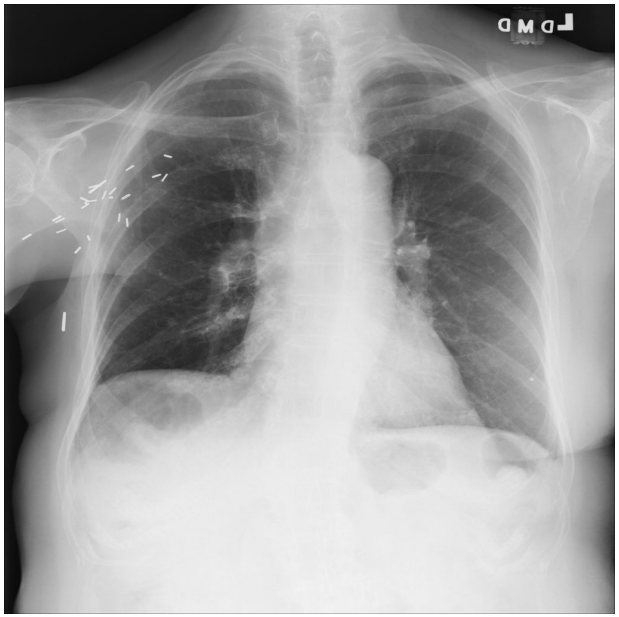
Pretraining on ImageNet vs. random initialization

Experiment	Epochs	MAE
Imagenet	50	76.8
Imagenet	250	8.8
No Transfer Learning, random initialization	250	10.8

Experiments

Predict chest within hand X-Ray age range only (0-20 years)

87 years, female



12 years, female

Experiments

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Chest 0-20 years (train: 1560 images), Finetuning

Experiment	Epochs	MAE
Chest 0-20yrs., **30** layers finetuning	50	33.9
Chest 0-20yrs., **100** layers finetuning	50	37
Chest 0-20yrs., **100** layers finetuning	250	41.8
Chest 0-20yrs., **50** layers finetuning	250	34.5
Chest 0-20yrs., **20** layers finetuning	250	36.7
Chest 0-20yrs., **30** layers finetuning	250	35.8

Experiments

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Chest 0-100 years (train: 89696 images), Finetuning

Experiment	Epochs	MAE
Chest 0-100yrs, **3** layers finetuning	250	running...
Chest 0-100yrs, **all** layers finetuning	250	running...

Conclusions, Future Work

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- Pretraining with Imagenet confirmed
- chest X-Rays vs. ImageNet pending
- Code available:
  https://github.com/lukaszbinden/pediatric-bone-age-prediction
  → simple framework to run experiments
- Use more recent deep models
- hyperparameter tuning
- experiment with MURA Dataset

Questions || Comments