Abnormality Detection of Upper Extremity X-Rays

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10cm

Musculoskeletal Radiographs

“The AAMC (Association of American Medical Colleges) predicts there will be a shortage of 17,000 - 42,000 radiologists in the next decade”

Motivation

- Radiologist shortage
- 1.7 billion people worldwide are affected by musculoskeletal conditions
- X-Rays are the most common diagnostic technique
- Radiology imaging delays were an independent predictor of the length of a patient’s hospital stay

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Data

Image Info

patient No.
study No.
label
image No.

Abnormality Label

Each image is labeled as either:
0: *Normal*
1: *Abnormal*

Body part

Elbow
Finger
Forearm
Hand
Humerus
Shoulder
Wrist

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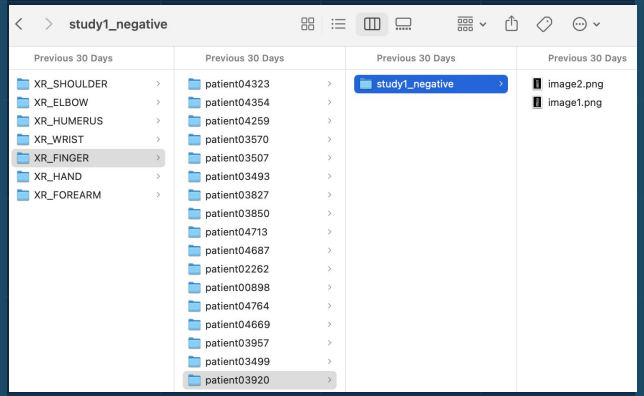
Data Preprocessing

Cleaning

- Nested folders
- Labels located in image file name



Transformations

- Resized: 256x256
- Random Horizontal Flip
- Normalized : $(\mu,\sigma) = (0.5, 0.5)$

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Train

29,583 images *(74%)*

Validation

3,197 images *(8%)*

Test

7,395 images *(18%)*

	path	label	body_part
patient11511_study1_positive_image2.png	1	hand
patient11511_study1_positive_image1.png	1	hand
patient11371_study1_negative_image3.png	0	hand
patient11371_study1_negative_image2.png	0	hand
patient11371_study1_negative_image1.png	0	hand
...	...	...
patient11359_study1_positive_image3.png	1	forearm
patient11359_study1_positive_image1.png	1	forearm
patient11392_study1_positive_image3.png	1	forearm
patient11392_study1_positive_image2.png	1	forearm
patient11392_study1_positive_image1.png	1	forearm

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Model Pipeline

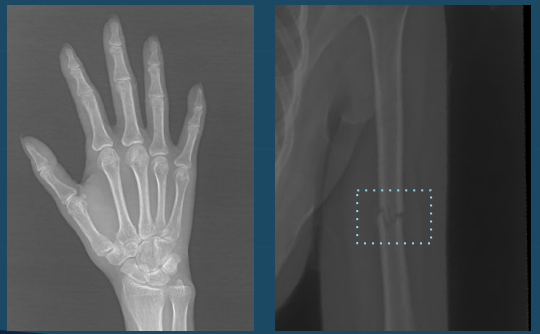
Stage 1

Body Part Classification

HUMERUS HAND SHOULDER

Stage 2

Normal/Abnormal Classification



0: NORMAL 1: ABNORMAL

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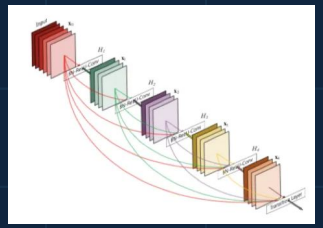
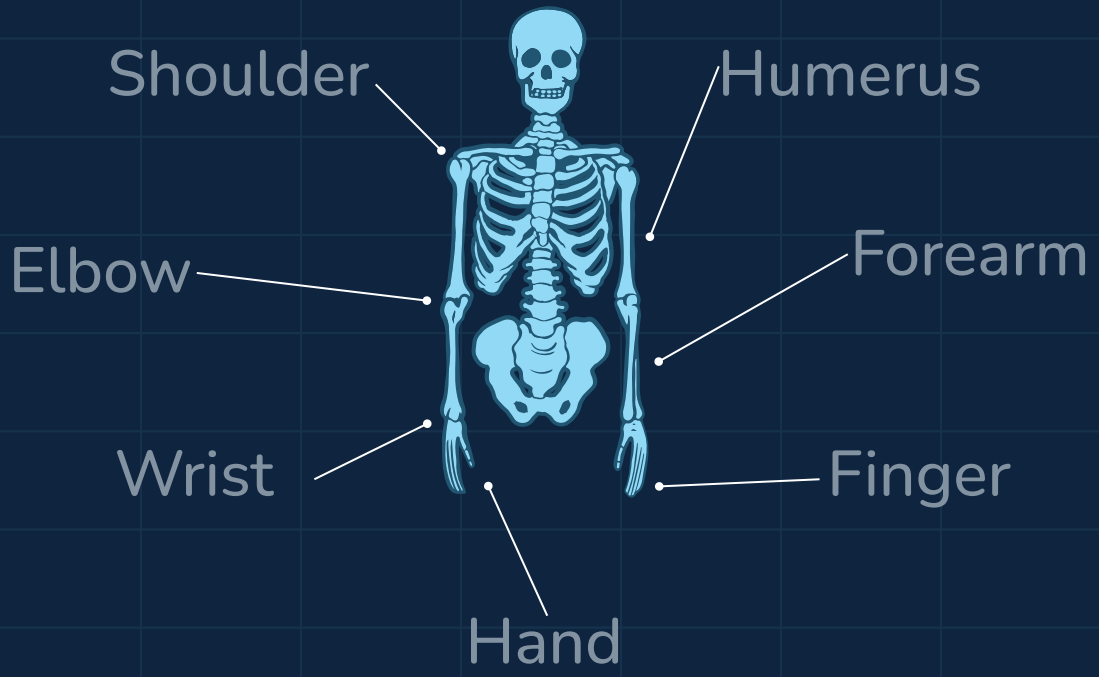
Stage 1

- Pretrained: DenseNet121
- Linear Layer input: 2048
- *No.* of predicted classes: 7
- Optimizer: Adam
- Loss Function: Cross Entropy
- Learning Rate: 0.001
- 15 Epochs





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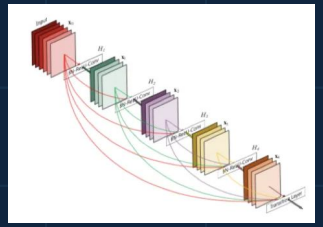
Stage 2

- Pretrained: DenseNet121
- Linear Layer input: 2048
- *No.* of predicted classes: **2**
- Optimizer: Adam
- Loss Function: Cross Entropy
- Learning Rate: 0.001
- 15 Epochs



0: NORMAL

1: ABNORMAL

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Previous Results

Agreement Measured using Cohen's Kappa Statistic

	Radiologist 1	Radiologist 2	Radiologist 3	Model
Elbow	0.850 (0.830, 0.871)	0.710 (0.674, 0.745)	0.719 (0.685, 0.752)	0.710 (0.674, 0.745)
Finger	0.304 (0.249, 0.358)	0.403 (0.339, 0.467)	0.410 (0.358, 0.463)	0.389 (0.332, 0.446)
Forearm	0.796 (0.772, 0.821)	0.802 (0.779, 0.825)	0.798 (0.774, 0.822)	0.737 (0.707, 0.766)
Hand	0.661 (0.623, 0.698)	0.927 (0.917, 0.937)	0.789 (0.762, 0.815)	0.851 (0.830, 0.871)
Humerus	0.867 (0.850, 0.883)	0.733 (0.703, 0.764)	0.933 (0.925, 0.942)	0.600 (0.558, 0.642)
Shoulder	0.864 (0.847, 0.881)	0.791 (0.765, 0.816)	0.864 (0.847, 0.881)	0.729 (0.697, 0.760)
Wrist	0.791 (0.766, 0.817)	0.931 (0.922, 0.940)	0.931 (0.922, 0.940)	0.931 (0.922, 0.940)
Overall	0.731 (0.726, 0.735)	0.763 (0.759, 0.767)	0.778 (0.774, 0.782)	0.705 (0.700, 0.710)

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Results

Stage 1 Accuracy:

97.8%

Stage 2 Accuracy:

Body Part	Elbow	Finger	Forearm	Hand	Humerus	Shoulder	Wrist
Accuracy	81.5%	76.6%	72.1%	79.9%	73.4%	76.6%	83.1%

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Conclusion

Compare Performances:

	Their Model:	Our Model:
Best Performance:	*Finger, Hand, Wrist*	*Wrist, Elbow*
Worst Performance:	*Forearm, Humerus, Elbow*	*Forearm, Humerus*

Future Steps:

- Get more data for body parts
- Further customize models for each bodypart

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Thanks!

Do you have any questions?

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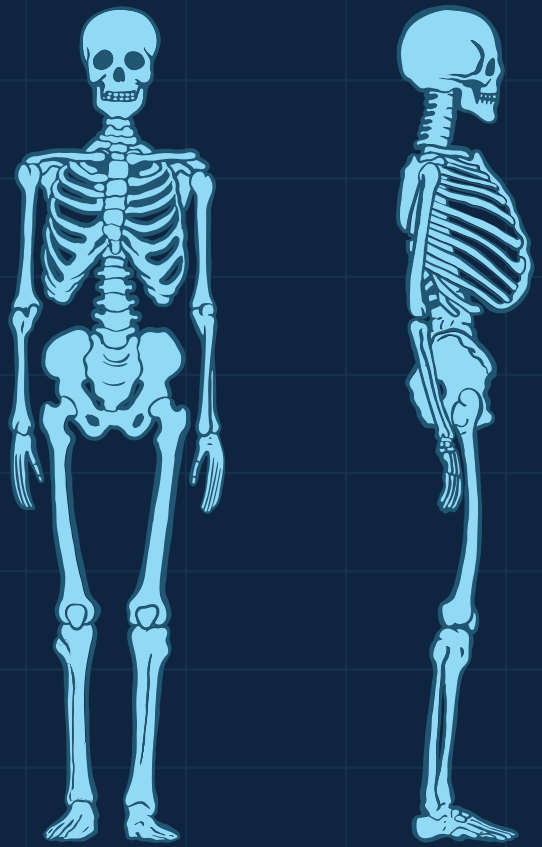

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