Classification and Localisation of Abnormality in Musculoskeletal Radiograph

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Introduction

Radiological imaging is of increasing importance in patient care. Technological advancements in radiologic imaging equipment have also fueled the utilization of imaging. The increasing number and complexity of the images threaten to overwhelm radiologists' capacities to interpret them. Machine learning algorithms underpin the algorithms and software that make computer-aided diagnosis/prognosis/treatment possible. Musculoskeletal conditions affect more than 1.7 billion people worldwide, and are the most common cause of severe, long-term pain and disability, with 30 million emergency department visits annually and increasing. Deep learning models like ResNet, MobileNet, Inception-v3, NASnet can be used for the classification of these radiographs as normal or abnormal images. Our project also focuses on detection of abnormality in Musculoskeletal Radiographs.

Problem Formulation

Determining whether a radiographic study is normal or abnormal is a critical radiological task: a study interpreted as normal, rules out disease and can eliminate the need for patients to undergo further diagnostic procedures or interventions. Machine and Deep learning frameworks can be used for the classification of these radiographs as normal or abnormal images. Our project focuses on **classification and localisation of abnormalities in Musculoskeletal Radiographs using machine and deep learning frameworks**.

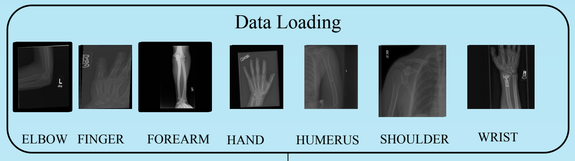
Dataset

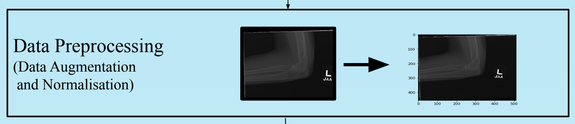
- 40,005 images (36,808 - train , 3197 - valid , 7362 - test)
- Seven standard upper extremity radiographic study types.
- Each study was labeled normal or abnormal by certified radiologists from Stanford Hospital.

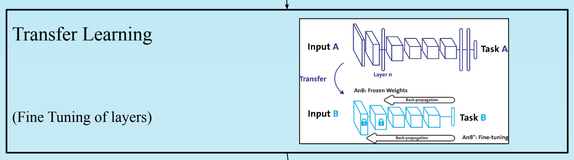
Study	Train		Valid		Total
	Normal	Abnormal	Normal	Abnormal	
Elbow	1094	660	92	66	1912
Finger	1280	655	92	83	2110
Hand	1497	521	101	66	2185
Humerus	321	271	68	67	727
Forearm	590	287	69	64	1010
Shoulder	1364	1457	99	95	3015
Wrist	2134	1326	140	97	3697
Total No. of Studies	8280	5177	661	538	14656

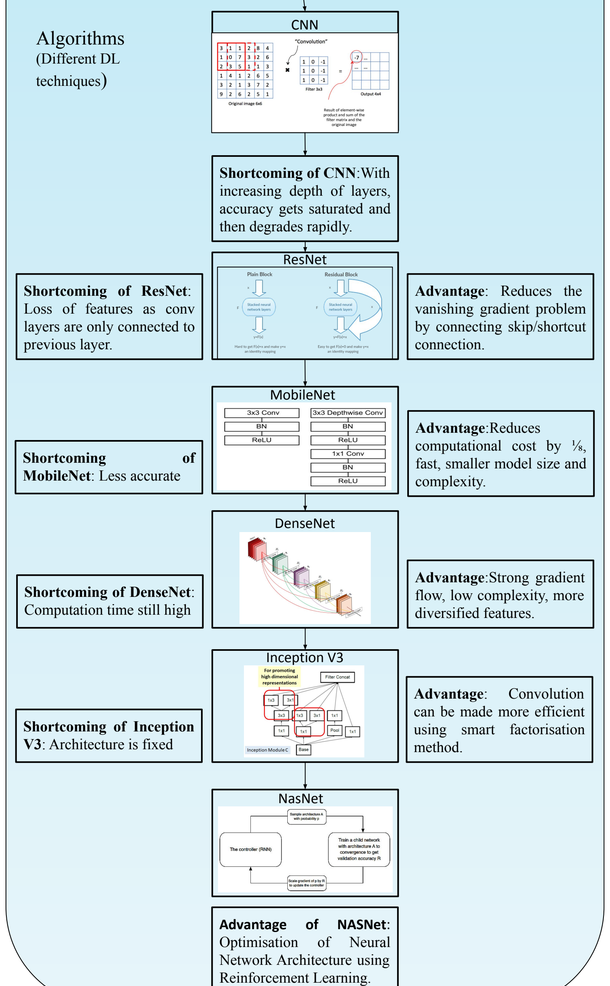
Table I
Distribution of images in MURA dataset

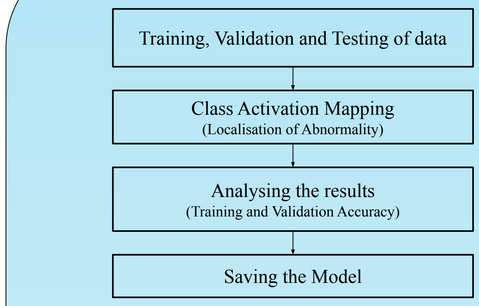
Proposed Methodology









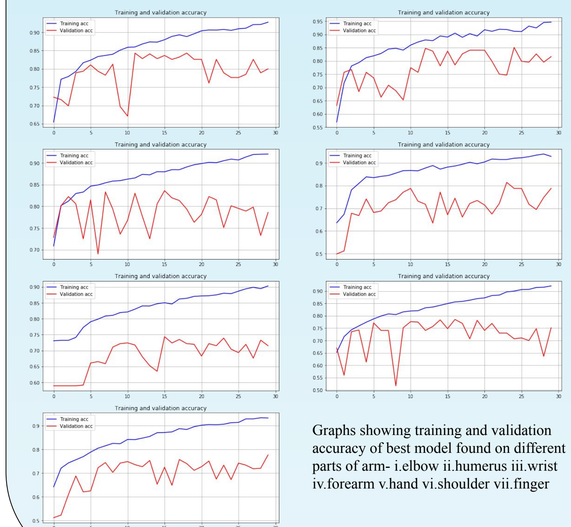


Classification:
Classification in machine learning is the problem of identifying to which of a set of categories a new observation belongs , on basis of training set of data containing observation whose category membership is known.

Results

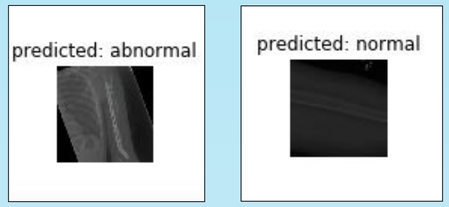
Body Parts	ResNet-18	MobileNet	DenseNet	Inception V3	NASNet
Wrist	75%	62%	77%	81%	87%
Shoulder	69%	56%	71%	73%	72%
Forearm	73%	57%	72%	75%	71%
Elbow	78%	64%	79%	82%	81%
Finger	71%	55%	71%	74%	75%
Humerus	78%	64%	81%	82%	80%
Hand	68%	57%	71%	69%	67%

Table II
Comparison of accuracy between different DL techniques

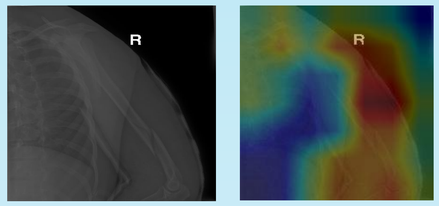


Graphs showing training and validation accuracy of best model found on different parts of arm- i.elbow ii.humerus iii.wrist iv.forearm v.hand vi.shoulder vii.finger

Classification of Musculoskeletal Radiographs :



Localisation of Abnormality in Radiograph using CAM:



- It was found that CNN gives very low accuracy i.e. 60%. Thus, higher/deep ConvNets were used for achieving better results.
- From the observations, we conclude that Inception V3 gives the best results for majority of body parts. The highest accuracy achieved is for elbow i.e. 82%. MobileNet gives faster results but gives lesser accuracy.
- Localisation of Abnormality highlighted the region of interest (ROI) locating the presence of abnormality

Conclusion

- Classification of radiographs into abnormal and normal with significant accuracy comparable to that of radiologists is achieved.
- Performance of different deep learning models on MURA dataset was observed and analysed.
- Abnormality was detected and localised using Class Activation Mapping.
- This would thus help radiologists for faster and reliable diagnosis of patients.

References

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[2] Berlin, Leonard. Liability of interpreting too many radiographs. American Journal of Roentgenology, 175(1):17–22, 2000.

[3] Zhou, Bolei, Khosla, Aditya, Lapedriza, Agata, Oliva, Aude, and Torralba, Antonio. Learning deep features for discriminative localization. In Proceedings of the IEEE Conference on Computer Vision and Pattern Recognition, pp. 2921–2929, 2016.