MUSCULOSKELETAL ABNORMALITY DETECTION USING DEEP LEARNING

Capstone Project Phase 1

2 Credits

Team Composition

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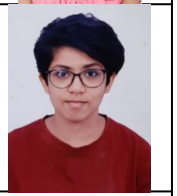
NIHARIKA GOWRI RAGHUNATH	PES1UG19EC184	
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Introduction

- Musculoskeletal disorders are conditions that affects joints, bones, muscles, and the spine.

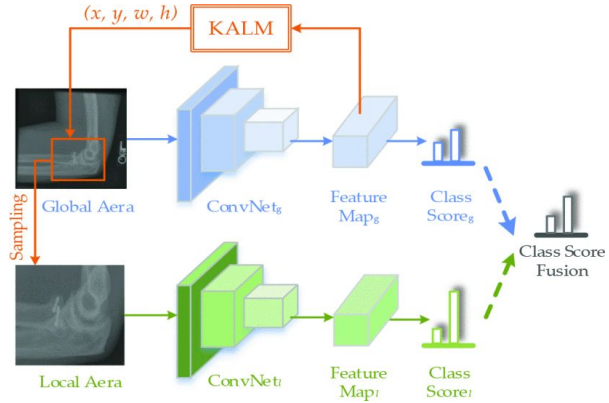
- Increasing radiologist workloads and increasing primary care, radiology services make it relevant to explore the use of artificial intelligence (AI) and particularly deep learning to provide diagnostic assistance to radiologists.

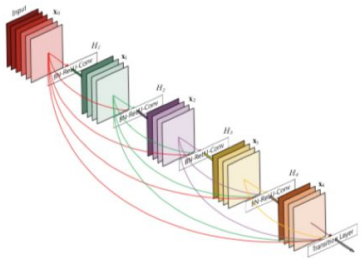
Problem Statement

- To investigate new model architectures to improve the performance in detecting abnormalities of upper extremities (specifically, shoulders) in limited data environments and allow them to serve as initial analysis tools to prioritize studies for expedited review.

Proposed methodologies

- Efficient Nets
- CADx model using Ensemble learning
- Key Area Localization Mechanism(KALM)
- DenseNet-169,DenseNet-201
- Capsule Network
- AlexNet,ResNet,GoogLeNet





DenseNet with 5 layers with expansion of 4

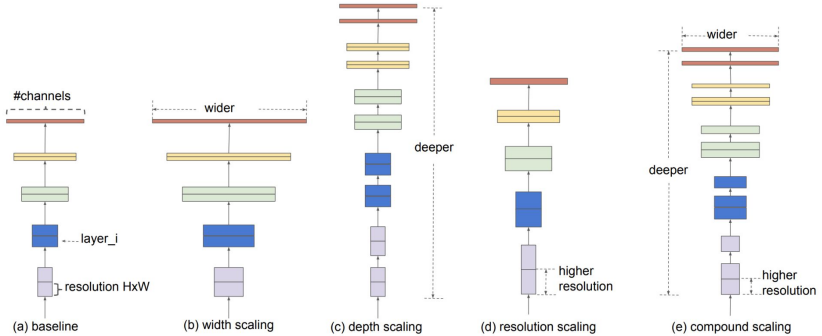


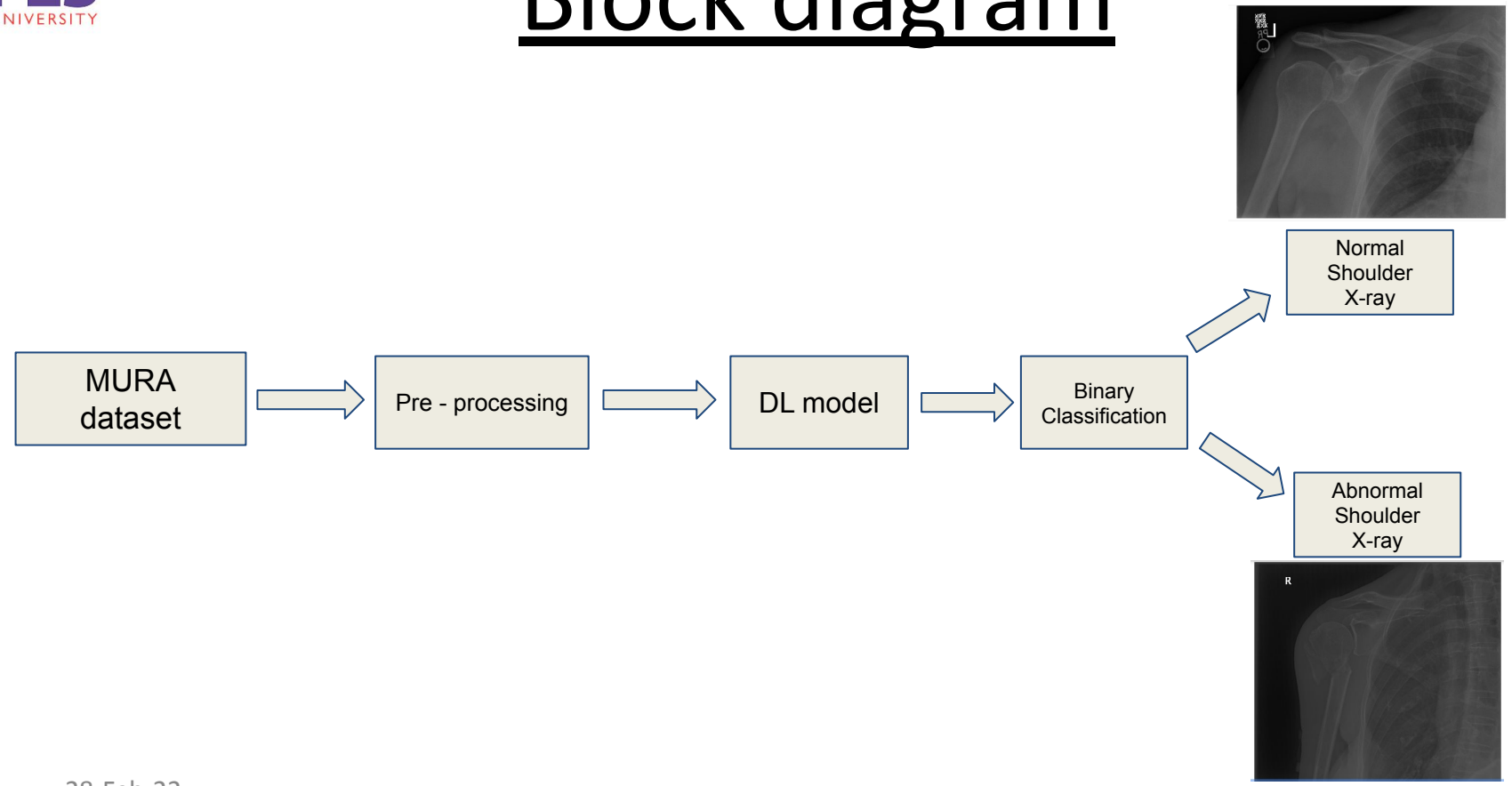
Figure 2. **Model Scaling.** (a) is a baseline network example; (b)-(d) are conventional scaling that only increases one dimension of network width, depth, or resolution. (e) is our proposed compound scaling method that uniformly scales all three dimensions with a fixed ratio.

Motivation

- Global Burden of Disease (GBD) conducted a study in 2016, found that musculoskeletal abnormalities were the second highest exploiter to global disability.

- Around 20%-30% people worldwide live with tormenting musculoskeletal abnormalities.

Block diagram



Brief Working Principle

- Using the publicly available MURA dataset, we test the performance of existing models specifically for shoulder radiographs.

- Upon analysing the performance, we will conclude on how to improve the operation of the model.

Deliverables

- A more efficient model for classification of abnormality in Shoulder radiographs by comparing different models using different parameters (such as accuracy and reliability).

References

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[3] O. Pelka, F. Nensa and C. M. Friedrich, "Branding - Fusion of Meta Data and Musculoskeletal Radiographs for Multi-Modal Diagnostic Recognition," 2019 IEEE/CVF International Conference on Computer Vision Workshop (ICCVW), 2019..

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[4] S. Madan, S. Kesharwani, K. V. S. Akhil, B. S, B. K P and R. K. M, "Abnormality Detection in Humerus Bone Radiographs Using DenseNet," 2021 Innovations in Power and Advanced Computing Technologies (i-PACT), 2021.

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[8] W. Huang, Z. Xiong, Q. Wang and X. Li, "KALM: Key Area Localization Mechanism for Abnormality Detection in Musculoskeletal Radiographs," ICASSP 2020 - 2020 IEEE International Conference on Acoustics, Speech and Signal Processing (ICASSP), 2020.

[9] T. C. Mondol, H. Iqbal and M. Hashem, "Deep CNN-Based Ensemble CADx Model for Musculoskeletal Abnormality Detection from Radiographs," 2019 5th International Conference on Advances in Electrical Engineering (ICAEE), 2019.

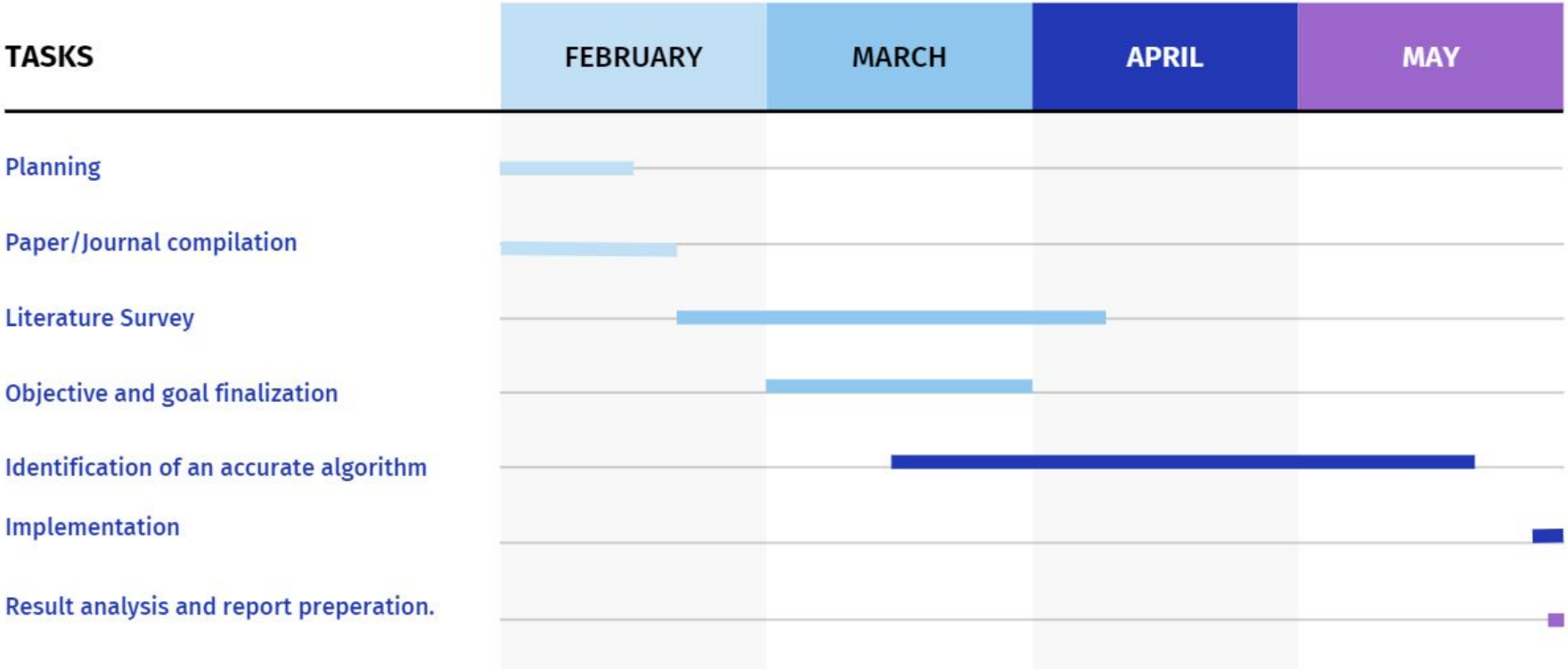
Literature Survey

Title	Author	Published on	Work	Method	Dataset	Result	Limitation
Abnormality Detection in Humerus Bone Radiographs using DenseNet	Saksham Madan,Sudhansh Kersharwani,K Venkata Sai Akhil,Balaji S,Bharath K P,Rajesh Kumar M	27-29 Nov.2021	Identify the large data as abnormal or normal using the DenseNet-169 architecture after pre-processing .	169-layer DenseNet	MURA	On testing the proposed model ,Cohens Kappa score was about 0.680 and accuracy is around 84.028%	Other sections of the dataset such as wrist,elbow etc can also be included for the proposed model
Deep Learning for Musculoskeletal Image Analysis	Ismail Irmarkci,Syed Muhammad Anwar,Drew A.Torigian,Ulas Bagci	3-6 Nov.2019	Using CNN based architectures, comparatively evaluated the knee abnormality classification performances of different neural network architectures	AlextNet, ResNet-18, and GoogLeNet	MRI images from MRNet	On an average (for all three classes), the AUC was 0.8787, 0.8579, and 0.8596 for AlexNet, ResNet18, and GoogLeNet, respectively. The highest accuracy for abnormality was 85.83% using AlexNet, 86.67% for ACL using ResNet-18, and 75.83% using both AlexNet and ResNet18 architectures. In general, ResNet-18 out-performed AlexNet and GoogLeNet in all performance parameters except in specificity (0.6908).	Other architectures can be included for analysis.

Abnormality Detection in Musculoskeletal Radiographs Using Capsule Network	A. F. M. Saif, Celia Shahnaz, Wei-Ping Zhu and M. O. Ahmad	June 14, 2019	Finding abnormality in musculoskeletal radiographs is a very difficult task and if automatic detection of abnormality can be introduced, it would be very helpful for further diagnosis and Treatment. In this paper, a capsule network is designed to classify normal and abnormal condition and compared the result with densenet architecture	Capsule network,blind image spatial quality evaluator (BRISQUE) and naturalness image quality evaluator (NIQE)	MURA	The proposed capsnet architecture provides almost 10% better kappa score than the 169 layers of densenet while using 50% less training data.	As capsule network is a very recent idea, it has been used in very limited areas like classification problem.
KALM: Key Area Localization Mechanism for Abnormality Detection in Musculoskeletal Radiographs	Wei Huang, Zhitong Xiong, Qi Wang and Xuelong Li	8 May 2020	Proposed a key area localization mechanism (KALM) for abnormality detection.	Key area Localization Mechanism (KALM)	MURA	**Table 2**. Comparison with other literature. *Accuracy* / *AUROC* / *Kappa* MobileNet [20]: 77.3% / 0.67 / 0.34 Ensemble200 [20]: 79.7% / 0.82 / 0.66 DNN [21]: 82.7% / – / – DenseNet-169 [22]: – / **0.91** / – $VGG16_{KALM}$: **84.2%** / 0.901 / **0.678**	KALM was first time proposed in this paper further improvements can be done using this method

Deep CNN-Based Ensemble CADx Model for Musculoskeletal Abnormality Detection from Radiographs	Tusher Chandra Mondol,Hasib Iqbal,MMA Hashem	26-28 Sept.2019	Develop a novel Computer-Aided Diagnosis(CADx) system based on Deep Convolutional Neural Network (Deep CNN) that will help the doctors to identify musculoskeletal abnormalities through radiographs	VGG-19,ResNet architecture to build a model for four types of study (Elbow, Wrist, Finger, and Humerus). 5-fold cross-validation method is also applied to evaluate our models and ensemble techniques to improve the model's performance.	MURA	Elbow, Finger, Humerus, Wrist study, model performance was consecutively 86.45%, 82.13%, 87.15%, and 87.86%.	1.Contrast Limited Adaptive Histogram Equalization (CLAHE) can be used instead of Histogram Equalization (HE) to enhance the radiographs. .
Branding - Fusion of Meta Data and Musculoskeletal Radiographs for Multi-Modal Diagnostic Recognition	Obioma Pelka,Felix Nensa,Christoph M.Friedrich	27-28 Oct.2019	The objective of this paper is to fuse automatically generated image keywords with radiographs, enabling multi-modal image representations for body part and abnormality recognition.	A fusion method by branding radiographs with automatically generated keywords. Transfer Learning and LSTM-RNN is utilized for creating textual features for datasets lacking text information. 3 deep learning based classifiers are trained with the branded radiographs for abnormality recognition and body part classification and labeling.	MURA,Radiology Objects in COntext (ROCO) dataset	Prediction accuracy was higher for all classification schemes using the proposed approach with 95.93 % for anatomic regions and 81.5 % for abnormality classification, respectively.	The proposed work can be further enhanced by exploiting other word embedding methods, as well as other branding methods, and precedes the way of combining several features of different heterogeneous modalities.

Project timeline



Q & A

Thank You