Deep Learning

Michael Harrison

Submitted for the Degree of Master of Science in

Machine Learning

Department of Computer Science
Royal Holloway University of London
Egham, Surrey TW20 0EX, UK

August 5, 2018

Declaration

This report has been prepared on the basis of my own work. Where other published and unpublished source materials have been used, these have been acknowledged.

Word Count:

Student Name: Michael Harrison

Date of Submission:

Signature:

Acknowledgement

I would like to thank...

Abstract

ABSTRACT TBD

Contents

List of Figures

1 Introduction

The aim of this project is to explore the use of Deep Learning models in a practical situation. In particular, we have focused on using neural networks to classify x-ray images as normal or abnormal.

2 Background

This is the Background section!

2.1 Convolutional Neural Networks

Write about conv nets, their performance, history etc

2.2 Training

Write about training nets, loss functions, optimisers etc

2.3 Prediction

Write about generating predictions from the networks

2.4 Performance Measures

Write about performance measures - ROC curve, Cohen's Kappa etc Discuss train vs valid performance, overfitting etc.

2.5 State-of-the-Art

What is the current image processing SOTA - e.g. ILSVRC Anything done specifically for radiology?

2.6 Pretrained Models

Discuss the use of pre-trained models - can keep weights the same, replact the head. Describe the structure of the pre-trained models we'll use for comparison: [MAYBE PUT INTO APPENDIX?]

2.6.1 VGG16

Describe VGG16
An example of a reference: [1].

3 Data

Write about the MURA data, show some exmaple images (normal & abnormal), give data breakdowns

3.1 MURA

Discuss MURA - what it is, how it was produced

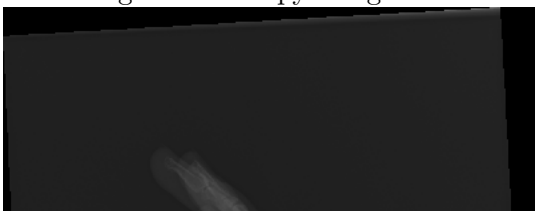
3.2 Image Examples

As can be seen in **Figure 1** below, the x-ray is of a hand. A side-profile of the hand from the same study can be seen in **Figure 2**. **Figure 3** is a copy of **Figure 2**.

Figure 1: Example X-Ray Image

Figure 2: Another example X-Ray Image

Figure 3: A copy of figure 2



3.3 Data Breakdowns

Here's another example of a reference [2] inline within the text

4 Model Development

4.1 Working Environment

Describe google cloud set-up, GPU, python packages used etc

4.2 Data Preprocessing

Describe the preprocessing work done on the data - resize images, normalise values, data augmentation etc

4.3 Model

Describe the final ab-initio model I end up with - structure, loss function, training params/hyperparams etc

4.4 Predictions

Discuss getting predictions and aggregating down to study-level predctions

5 Results

5.1 Baseline Performance

Give the performance of my chosen ab-initio model

5.2 Image Size

How do my results vary with size of image? Does increasing image size increase scope for

5.3 Regularisation

Perform some regularisation experiments, show results

5.4 Pre-Trained Models

How does my model compare vs a selection of pretrained models

6 Conclusions

Include introspective chapter Work here not comaparable to clinical setting, e.g. smaller, lower resoution images; radiologist may have a relationship with patient - know medical history, other symptoms etc What is "abnormal"? - type & severity of abnormality not known, MURA paper not clear.

7 Professional and Ethical Issues

Potential Impact on Radiology - Deep Learning tools used to help triage/prioritise radiologists' work, not replace them; Can we trust diagnosis to a computer program? Would you be happy to do so? Conversely - medical errors happen a lot (est. cost $X p.a.; any specifics for radiology?) but DL tools may at least help cut that down.

8 Extensions

Enquire further about what "abnormal" means Alternative data e.g. CheXNet, others(?) Alter NN to accept multiple images simultaneously and so predict based on several views at once (e.g. by weight-sharing, or appening all study images into a single 3D tensor)

References

[1] Trevor Hastie, Robert Tibshirani, and Jerome Friedman. *The Elements of Statistical Learning: Data Mining, Inference, and Prediction.* Springer, New York, second edition, 2009.

[2] P. Rajpurkar, J. Irvin, A. Bagul, D. Ding, T. Duan, H. Mehta, B. Yang, K. Zhu, D. Laird, R. L. Ball, C. Langlotz, K. Shpanskaya, M. P. Lungren, and A. Y. Ng. MURA: Large Dataset for Abnormality Detection in Musculoskeletal Radiographs. *ArXiv e-prints*, December 2017.

A Pretrained Model Architechtures

Below we describe the architechtures of the various pre-trained neural network models mentioned in the text.

A.1 VGG16

This is the VGG16 model.