DD2424 - Project proposal

15 April 2020

Selected topic: *Exploration of deep learning techniques for classifying and visualizing COVID-19 X-ray images*

Supervised by: *Josephine Sullivan*

Group members: GROUP 4

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Description of the project:

In this project we aim to classify X-ray images from the National Institute of Health Clinical Center (NIHCC) as COVID-19 infected or not. We aim to achieve this by designing and implementing our own deep layered convolutional network using Python with Tensorflow. Since the available open source datasets have few COVID-19 positive images we will also consider methods of expanding and balancing the dataset using different data augmentation techniques. We also aim to implement Grad-CAM in order to increase the explainability of our model. If time allows we will also implement the Automated Concept based Explanation (ACE) algorithm and compare the two visualization techniques.

We will initially run our network on the data available and measure the performance. We will then progressively tweak and fine-tune the network using various deep learning techniques such as drop-out, learning rate scheduling, data augmentation etc. When the implementation is complete we will apply Grad-CAM to the resulting feature map to improve the explainability of the network.

Scope of the project:

- Learning how to use **Tensorflow** to implement our own deep neural network.
- Determining a **good network architecture** using relevant literature and **improving performance** of the model by implementing techniques from lectures.
- Comparative performance analysis with/without **data augmentation** and use **class balancing techniques** to compensate for the small sample size.
- Apply **Grad-CAM** [4] on the final network. If time allows: apply ACE on the final network and compare to Grad-CAM.
- Experimentally **compare** our own method **with state of the art**/modern methods implemented in some of the reference papers [1] and [5].

- Present the results visually and produce a detailed **comparison** and **analysis** of the results.

Datasets:

1. NIH Chest X-rays
2. COVIDx
3. Additional COVID datasets once they become available.
4. Using suggestions from https://github.com/lindawangg/COVID-Net#covidx-dataset

Intended learning outcomes:

Magnus: Learn and practice how to use Tensorflow, choose a network architecture, and work with real life data. Also to learn the theory and applicability of Grad-CAM as well as pre- and postprocessing data.

Resa: To practice the workflow to solve an interesting problem with Deep learning. Being familiar with AI tool chain, Preprocessing, processing and post processing, teamwork, discussions and reporting.

Anirudh: To account for the technical background ,practical application of advanced neural architectures and compensating for scarcity of training data by exploring data augmentation and other alternatives. To implement and compare our methods with recently published research papers.

The success of our project will be based on the quality of our implemented network, not necessarily as measured in performance, but rather in correctness, clarity ,structure, and detailed analysis, showing that we have understood and learned how to build a network of this depth . Being able to explain the steps we have taken and why, is another factor proving that we have reached the intended learning outcomes.

Division of workload:

Student name	*Scope of responsibilities, tasks in the project*
Magnus Pierrau	Implement Grad-CAM and ACE, discussion, reporting, analysis and report formatting.
Anirudh Seth	Data preprocessing, data augmentation, class balancing techniques, comparative analysis and performance evaluation, discussion and reporting.
Reza Dadfar	Model architecture implementation, discussion and reporting, data visualization

Aiming for grade: *A*

References:

[1] Comparison of Deep Learning Approaches for Multi-Label Chest X-Ray Classification By Ivo M. Baltruschat and Hannes Nickisch and Michael Grass and Tobias Knopp and Axel Saalbach
[2] Deep Learning on Chest X-ray Images to Detect and Evaluate Pneumonia Cases at the Era of COVID-19
[3] Selvaraju, Ramprasaath R. et al. “Grad-CAM: Visual Explanations from Deep Networks via Gradient-Based Localization.” International Journal of Computer Vision 128.2 (2019): 336–359. Crossref. Web.
[4] Ghorbani, Amirata, et al. "Towards automatic concept-based explanations." Advances in Neural Information Processing Systems. 2019.
[5] Wang, L., Wong, A. “COVID-Net: A Tailored Deep Convolutional Neural Network Design for Detection of COVID-19 Cases from Chest Radiography Images.” 2020