**Uncertainty-Aware Deep Learning for Robust Chest X-ray Interpretation**

# **1. Project Overview**

This work aims to examine, using the CheXpert dataset, the efficiency of pre-trained deep learning models such ResNet50 and DenseNet121 versus models created from scratch in the identification of chest diseases. Using the large collection of 224,316 chest radiographs, I will investigate how transfer learning affects performance—especially in relation to subsets of the data.

**Research Question**

How does the performance of pre-trained models (e.g., ResNet50, DenseNet121) compare to models trained from scratch in detecting chest pathologies?

* Alternate Hypothesis (H1): Pre-trained models will outperform models trained from scratch in detecting chest pathologies, especially when using smaller datasets, due to the transfer of learned features from large, diverse datasets.
* Null Hypothesis (H0): No significant difference exists in the performance of pre-trained models and models trained from scratch in detecting chest pathologies, regardless of the dataset size.

**Project Objectives**

1. Utilize a sample from the CheXpert dataset to ensure feasibility while maintaining relevance in results.
2. Analyse the models depending on important performance criteria.
3. Especially in cases of low training data, find how transfer learning affects model performance.
4. Examine the models' sensitivity to identify certain chest diseases.
5. By means of better model performance in chest X-ray interpretation, provide results that can assist clinical decision-making in radiology.

# **2. Project Plan**

**Task List:**

Project Planning: Define project objectives, research questions, and methodologies to create a structured approach for the project.

Literature Review: Conduct a comprehensive review of existing studies on deep learning in chest X-ray interpretation, focusing on pre-trained models.

Dataset Familiarization: Explore the CheXpert dataset, understand its structure, and analyse the distribution of pathologies and patient demographics.

Data Preprocessing: Prepare the dataset for training by cleaning and augmenting images, ensuring high-quality input for the models.

Model Selection: Finalize the choice of pre-trained models and establish the baseline for training from scratch.

Model Training Phase 1: Begin training the selected models on the dataset, focusing on parameter tuning and initial performance evaluation.

Model Training Phase 2: Continue training and refine the models based on initial results, optimizing for accuracy and other metrics.

Model Evaluation: Assess the performance of the trained models using validation metrics and compare their effectiveness in detecting pathologies.

Results Analysis: Analyse the evaluation results, drawing conclusions on the performance differences between pre-trained and scratch-trained models.

Report Writing: Compile the project report, including methodology, results, and discussion, ensuring all aspects of the research are documented.

Submission: Submit the completed project, ensuring all components are thoroughly reviewed and meet submission criteria.

**Project Timeline:**

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|  | **Sept 25 - Oct 15** | **Oct 16 - Nov 5** | **Nov 6 - Nov 26** | **Nov 27 - Dec 17** | **Dec 18 - Jan 6** |
| **Project Planning** |  |  |  |  |  |
| **Literature Review** |  |  |  |  |  |
| **Dataset Familiarization** |  |  |  |  |  |
| **Data Preprocessing** |  |  |  |  |  |
| **Model Selection** |  |  |  |  |  |
| **Model Training Phase 1** |  |  |  |  |  |
| **Model Training Phase 2** |  |  |  |  |  |
| **Model Evaluation** |  |  |  |  |  |
| **Results Analysis** |  |  |  |  |  |
| **Report Writing** |  |  |  |  |  |
| **Submission** |  |  |  |  |  |

# **3. Data Management Plan**

This project's data management plan presents the methodical approach to manage the dataset utilised for chest X-ray interpretation. Originally gathered by the Stanford ML Group, the CheXpert collection consists of 224,316 chest radiographs from 65,240 individuals used to further medical imaging and machine learning research. Data will be obtained from the official CheXpert website (<https://stanfordmlgroup.github.io/competitions/chexpert/>), with files in standard picture formats (JPEG/PNG) and a total projected to surpass several terabytes. GitHub will be used for code tracking under strong version control using weekly commits and a clear file naming pattern to support teamwork. Additionally included in the GitHub repository will be a ReadMe file covering project goals, installation procedures, and use policies for next developers. Weekly regular backups will be carried out from files kept on OneDrive and GitHub for redundancy. While keeping confidentiality and ethical standards followed, data exchange will be maintained securely providing access to project colleagues and markers. This strategy guarantees a methodical approach to data management, therefore preventing loss and allowing effective project advancement.

**Ethical Requirements:**

Since the CheXpert dataset comprises anonymised chest radiographs, which guarantees that personal data cannot be linked back to specific patients, it satisfies GDPR criteria. The initiative follows ethical guidelines set by the University of Hertfordshire as it makes use of publicly accessible data for study without violating patient confidentiality. As stated on the CheXpert website, permission to use the dataset is provided for scholarly and scientific interests. Moreover, the Stanford ML Group gathered the data properly, guaranteeing adherence to ethical guidelines and research criteria and thereby verifying the integrity of the dataset for this study.

# **References**

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Gour, M. and Jain, S. (2022) ‘Uncertainty-aware convolutional neural network for COVID-19 X-ray Images classification’, Computers in Biology and Medicine, 140, p. 105047. doi:10.1016/j.compbiomed.2021.105047.

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