DATA698 - Analytics Master's Research Project

Project Proposal

Title: Integrate Image Recognition technology in Radiology Practice

Dr. Paul J. Bailo

CUNY -SPS

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By: Anjal Hussan

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Introduction

Various clinical diagnosis requires medical imaging, such as early detection, monitoring, diagnosis, and treatment evaluation of various health conditions. In the health care system, there has been a significant increase in demand for medical image services, e.g., Radiography, endoscopy, Computed Tomography (CT), Mammography Images (MG), Ultrasound images, Magnetic Resonance Imaging (MRI), Magnetic Resonance Angiography (MRA), Nuclear medicine imaging, Positron Emission Tomography (PET) and pathological tests. Due to a shortage of radiologists, medical images can often be challenging to analyse and time-consuming. Machine Learning (ML) applications can help the Radiologist to detect anomalies as well as other abnormalities. ML applications can function without being specifically programmed, which learn from data and make predictions or decisions based on past data.

Background and Context

The term machine learning refers to a wide range of statistical techniques to analyse algorithms that iteratively improve in response to training data to build models for autonomous predictions. In other words, computer programs become more efficient as they learn from data. The objective of a machine learning algorithm is to develop a mathematical model that fits the data. Once this model fits known data, it can be used to predict the labels of new data. The field of radiology involves inherently interpreting data—extracting features from images and analysing them with the help of a wide knowledge base that includes these features—which provides an excellent opportunity for implementing ML tools in practice.

Relevant Research and Paper Summaries

[1] M. Kohli, L.M. Prevedello, R.W. Filice, J.R. Geis, Implementing machine learning in radiology practice and research, Am. J. Roentgenol. 208 (4) (2017) 754–760.

Summary: The purposes of this article are to describe concepts that radiologists should understand to evaluate machine learning projects, including common algorithms, supervised as opposed to unsupervised techniques, statistical pitfalls, and data considerations for training and evaluation, and to briefly describe ethical dilemmas and legal risk.

[2] A. Saha, S. Tso, J. Rabski, A. Sadeghian, M.D. Cusimano, Machine learning applications in imaging analysis for patients with pituitary tumors: a review of the current literature and future directions, Pituitary. 23 (3) (2020) 273–293. surgery, Neuroendocrinology 83 (3-4) (2006) 240–248.

Summary: This article gives an overview of fundamental concepts in machine learning (ML), review the literature on ML applications in imaging analysis of pituitary tumours for

the last 10 years, and highlight the future directions on potential applications of ML for pituitary tumour patients.

[3] Z. Obermeyer, E.J. Emanuel, Predicting the future—big data, machine learning,

and clinical medicine, New England J. Med. 375 (13) (2016) 1216–1219.

Summary: This article emphasis on developing statistical tools from the field of machine learning that will be critical for anyone practicing medicine in the 21st century.

[4] Geis, J.R., Brady, A., Wu, C.C. et al. Ethics of artificial intelligence in radiology: summary of the joint European and North American multisociety statement. Insights Imaging 10, 101 (2019). https://doi.org/10.1186/s13244-019-0785-8

Summary: This article focuses on ethical use of AI in radiology and states that it should promote well-being, minimize harm, and ensure that the benefits and harms are distributed among the possible stakeholders in a just manner. The article also highlights that the AI in radiology should be appropriately transparent and highly dependable, curtail bias in decision making, and ensure that responsibility and accountability remains with human designers or operators. The radiology community should start now to develop codes of ethics and practice for AI. Radiologists will remain ultimately responsible for patient care and will need to acquire new skills to do their best for patients in the new AI ecosystem.

Research Question
The Main focus of this research is to answer the following questions:

- Can we apply machine learning techniques to read medical images?
- What ML algorithms produce best results to predict?
- What data should be used for training and evaluation?
- Is it ethically ok to use ML for image recognition and detection?
- What is the legal risk?

Methodology

A few exploratory analyses will be done to identify the dataset with images. Using python and a helper library, I will attempt to read the images and apply machine learning techniques to predict some of the outcomes and evaluate anomalies.

After the initial exploration, the work focused on radiology images and image recognition, optimization, and prediction.