Periodic learning in edge-fog-cloud computing, with a focus on diagnosing lung diseases with deep learning algorithms.

From Development to Deployment

Team 1

NATIONAL UNIVERSITY OF SINGAPORE | HEWLETT-PACKARD | GAIP

Meet the Team

Rugved Chavan

Autoencoder model architect and web deployment

Ishanay Sharma

Data processing and security

Swapnika

Security personnel

Vineet

UNet model architect

Rishab Agarwal

CNN model architect

Nithish Reddy

Business Analyst

Vinay Kumar

Deployment officer

NATIONAL UNIVERSITY OF SINGAPORE | HEWLETT-PACKARD | GAIP

Problem Statement

- Although the adoption rate of AI in the healthcare sector has been slower than in other industries, there has been an increase in interest from stakeholders.
- There are Multiple Challenges to deploy AI in Healthcare.
    a. Privacy, Confidentiality & Transparency
    b. Mitigation of bias
    c. Data Storage
    d. Accuracy and Liability

Solution

- Adoption of AI in Singapore's existing E-healthcare system:
  - This project proposes an E-healthcare solution based on edge fog cloud computing to enable periodic learning, which would indirectly contribute to the dynamic improvement of the accuracy of Deep Learning (DL) models.
- This project focuses on using deep learning models to diagnose lung diseases as an application of AI in healthcare.
- We have also highlighted key insights regarding technology design and adoption, data security and privacy rules, and system effectiveness and safety.

Understanding the Dataset

Citations of all verified dataset used

NIH Clinical Center provides one of the largest publicly available

The dataset of scans is from more than 30,000 patients, including many with advanced lung disease.

National Institutes of Health (NIH) / Sep 27, 2017

X-ray Bone Shadow Supression

Chest X-ray for the project
https://github.com/hmchuong/ML-BoneSuppression

NIH National Library of Medicine
National Center for Biotechnology Information
Log in

PMC PubMed Central® | Search PMC Full-Text Archive | Search | Advanced Search | User Guide

Journal List > Quant Imaging Med Surg > v.4(6): 2014 Dec > PMC4256233

Quantitative Imaging in Medicine and Surgery
Print ISSN 2223-4292; Online ISSN 2223-4306

Quant Imaging Med Surg. 2014 Dec; 4(6): 475–477.
doi: 10.3978/j.issn.2223-4292.2014.11.20

PMCID: PMC4256233
PMID: 25525580

Two public chest X-ray datasets for computer-aided screening of pulmonary diseases

Stefan Jaeger,[1] Sema Candemir,[1] Sameer Antani,[1] Yi-Xiang J. Wang,[2] Pu-Xuan Lu,[3] and George Thoma[1]

Author information • Article notes • Copyright and License information Disclaimer

OTHER FORMATS
PubReader | PDF (95K)

ACTIONS
Cite
Favorites

SHARE

RESOURCES

UNet - Image segmentation for extracting ROI

Why did we use UNet in our project?

- UNet is used in Bio-Medical Imaging for segmentation of the area of interest.
- We wanted our model to focus only on the area of interest which are the lungs.
- UNet helps us segment the lungs from the image leading into a higher accuracy for the model.

Results for Image Segmentation

State of the art accuracy - 96.8

Custom Filter

We introduce our custom Filter to mitigate any possible data loss cussed by UNet Segmentation

Input Mask

10	5	10
5	7.5	5
10	5	10

Kernel

Output Mask

Autoencoders - Bone Shadow Separation & Image quality Enhancement

Auto Encoders are Networks that work somewhat like GANs (Generative Adversarial Networks) here there are two phases

1. Encoder
2. Decoder

Results of Autoencoder

Got lowest Mean Square Error after comparing latest research paper MSE = 0.0010

ChestNet- Diseases classification

Classified pneumonia with 96% accuracy

ChestNet- Diseases classification

accuracy: 0.9830
precision: 0.9961
recall: 0.9809
val_loss: 0.0830
val_accuracy: 0.9692
val_precision: 0.9790
val_recall: 0.9790
lr: 2.2387e-04

Pipe-Lining Boost

```
In 97  1  loss, acc, prec, rec = model.evaluate(val_ds)

66/66 [==============================] - 3s 32ms/step - loss: 2.5741 - accuracy: 0.9828 - precision: 0.9844 - recall:
0.9921
```

Pneumonia Classification boosted to 98.28% accuracy

Multi Diseases Classification

98%

Pneumonia

No Finding

Confidence

93%

Ededma

No Finding

Confidence

87%

Cardiomegaly

No Finding

Confidence

90%

Aclectis

No Finding

Confidence

Vote 1

Vote 2

Vote 3

Vote 4

Results with High votes

Model Optimization

Quantization and Pruning

This technique brings improvements via model compression. In the future, framework support for this technique will provide latency improvements. We've compressed model to 1/3rd its initial size with minimal loss of accuracy.

INPUT

Model - 41 MB

OUTPUT

Model - 13 MB

Architecture

Cloud Layer:

- Initial Model Training
- Periodic training of data

Fog Layer

- Software Hosting
- Live Prediction
- Periodic Backups
- Data security
- Traffic management

Edge Device

- User Interface
- Feedbacks

Web Interface

Security and Compliance

- Restriction of data and application access ensures that only authorized users can access sensitive data.
- Encryption of data at rest and in transit makes it harder for attackers to decode any information even if they have access to it.
- Frequent off-site data backups of the trained model are recommended while maintaining the stringent restrictions for data encryption, and access to ensure data backup security.
- After the patient's images have been used for periodic learning, they will all be shredded.
- To ensure high standards of privacy and confidentiality, none of the utilized images will be annotated with patients' personal information.
- Data discovery and categorization play a key supporting role in implementing data usage rules by ensuring that sensitive data can be recognized and labeled to receive the appropriate level of protection.

Business Scope

- Microsoft Azure will host the Periodic Learning applications and databases.
- **Depending on the computational utilization** of the deployed models, Azure services will be billed.
- We will sell fog devices to manage **software hosting, live prediction, periodic backups, data protection, and traffic management**.
- Our business will provide for the configuration, installation, and maintenance of these fog machines.
- Once implemented, every authorized hospital staff with an edge device will be able to connect to the fog servers and upload their x-ray scans for evaluation.

Cost of end-to-end deployment and updates

- Any **updates** to our models will be propagated from our cloud to the relevant fog servers, making them accessible to users.
- Our primary expenditures will be for the **cloud server operation on Azure**, which will scale according to the website's demand.

Model Architecture

Unet - Image segmentation for extracting ROI

Presentations are communication tools

Autoencoders - Image quality Enhancement

Presentations are communication tools that can be uce.

CNN - Image classification

Presentations are communication tools that can be used as

Classified Disease Name

Abstract-Overview

1 Data Cleaning of NIH Dataset - 1

2 CNN Model evaluation

3 Data cleaning for Image segmentation Dataset - 2

4 UNet Model Evaluation

5 Data Cleaning for for Bone Shadow Sepration - Dataset -3

6 Model Pipeline

7 Web Interface on Flask

8 Deployment of web app on Azure

Microsoft Azure

9 Edge-Fog-Cloud Architecture Deployment

Timeline

An ongoing journey

START HERE

Week 1

- Research U-Net, Auto Encoders and CNNs
- Explore Flask and Azure

Week 2

- Auto Encoder Model development
- UNet Model development
- CNN development
- Creation of Pipeline

week 3

- Web app Development
- Azure deployment
- Presentation preparation

End of Week 1

Teem Meeting
Model Evaluation
Brain Storming sessions

End of week 2

- Web app Development
- Azure deployment
- Presentation preparation

NATIONAL UNIVERSITY OF SINGAPORE | HEWLETT-PACKARD | GAIP

Objectives Achived

1. Cleaning the dataset for model training.
2. Use the Autoencoders model for biomedical image quality enhancement.
3. Use the image segmentation model (UNet) for extracting the Region Of Interest (ROI).
4. Architect state of an art model of CNN for image classification (ChestNet).
5. Creating a pipeline of UNet-Autoencoder-ChestNet model.
6. Design of a Flask-based web application for model deployment.
7. Deploy complete software on edge-cloud-fog architecture.
8. Analyse the results and prepare the research paper.

Thank You
Xiè xiè