Hemorrhage Detection

Lilian De Rivera / Swetha Kalla

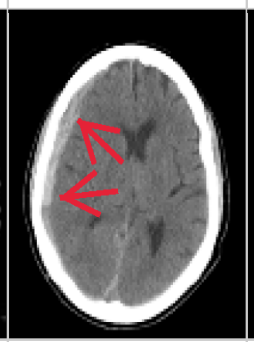
4/27/2020

Introduction

Machine Learning in Medicine

- Tele - Medicine
- Image Recognition
  - Diagnostics on Cancer Cells
  - Diagnostics on MRI Images
    - **Pulmonary deseases**
    - **Cerebral Tumors**

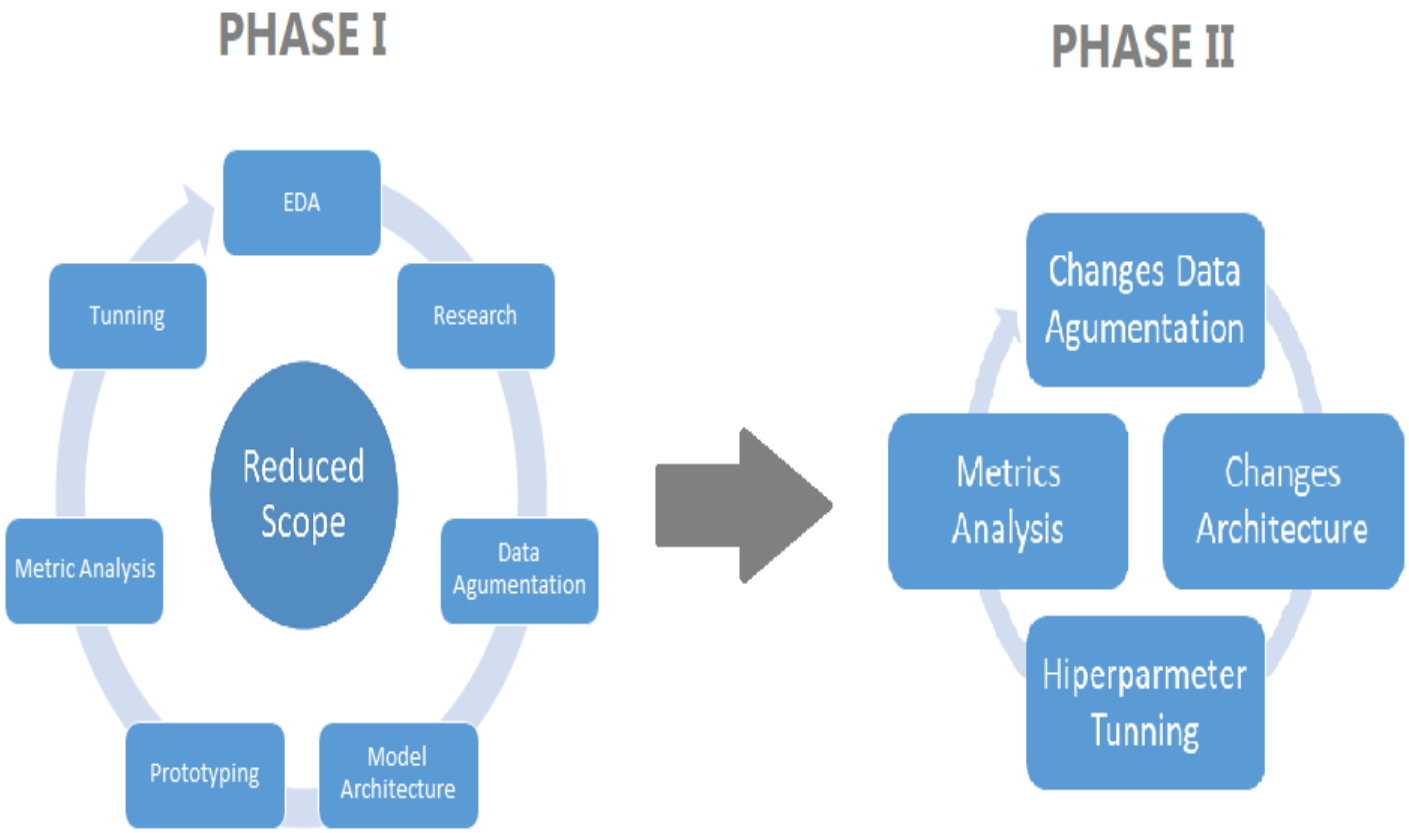
Hemorrhage Detection and Subtypes

	Intraparenchymal	Intraventricular	Subarachnoid	Subdural	Epidural
Location	Inside of the brain	Inside of the ventricle	Between the arachnoid and the pia mater	Between the Dura and the arachnoid	Between the dura and the skull
Imaging					
Mechanism	High blood pressure, trauma, arteriovenous malformation, tumor, etc	Can be associated with both intraparenchymal and subarachnoid hemorrhages	Rupture of aneurysms or arteriovenous malformations or trauma	Trauma	Trauma or after surgery
Source	Arterial or venous	Arterial or venous	Predominantly arterial	Venous (bridging veins)	Arterial
Shape	Typically rounded	Conforms to ventricular shape	Tracks along the sulci and fissures	Crescent	Lentiform
Presentation	Acute (sudden onset of headache, nausea, vomiting)	Acute (sudden onset of headache, nausea, vomiting)	Acute (worst headache of life)	May be insidious (worsening headache)	Acute (skull fracture and altered mental status)

Problem Definition

Classify the type of tumor in a MRI Image base on the images presented in the trainning set

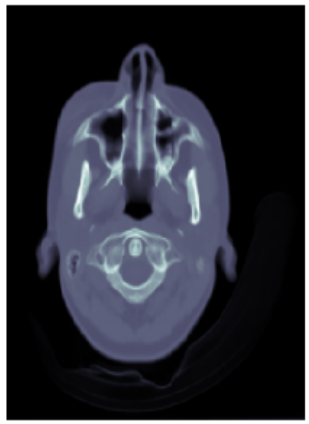
Project Planning



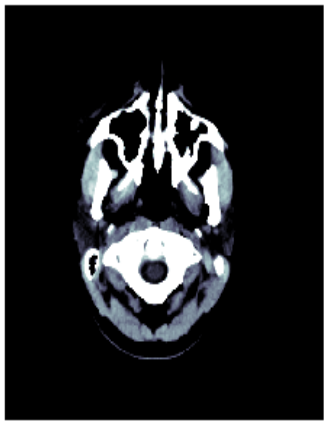
EDA IMAGES

Original	Modified to fit models	Hounsfield Scale
• Dcom Files • Monocrome • One Chanel	• Change to include Hounsfield Scale • Resize to 224 • Convert to three channel (color)	• Brain Matter : W:30 L:40 • Blood Subdural : W: 130-300 L:50-100 • Soft Tissue : W:350-400 L:20-30 • Bone : W:2800 L: 600

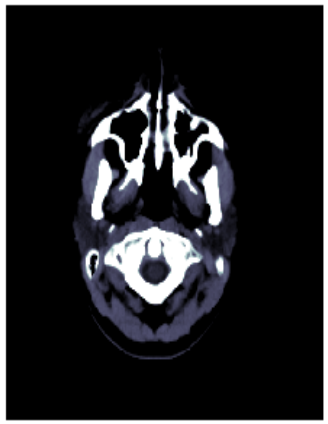
Default window



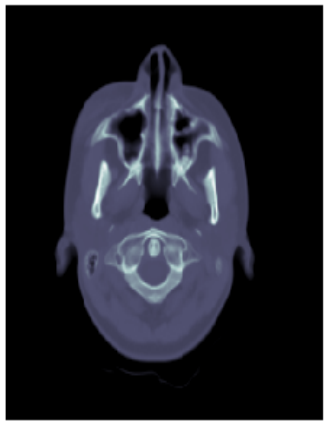
Brain window



Subdural window



Bone window



Research

- **A CNN trainned on a finer disease classes perform better than done trained ddirectly on several classess.**

Dermatologist- level classification of skin cancer with deep neural networks. by A. Esteva, B. Kuprel, and others.(2017) doi:10.1039/nature2106 (doi:10.1039/nature2106). page 116.

- **Networks that include Spatial Transformation Networks can transform regions to a canonical, expected pose to simplify recognition in the following layer.**

Spatial Trannsformed Networks by M.Jadergerg, K. Simonyan, and others. Google DeepMind UK.(2016)

Prototype Data Augmentation (Scope)

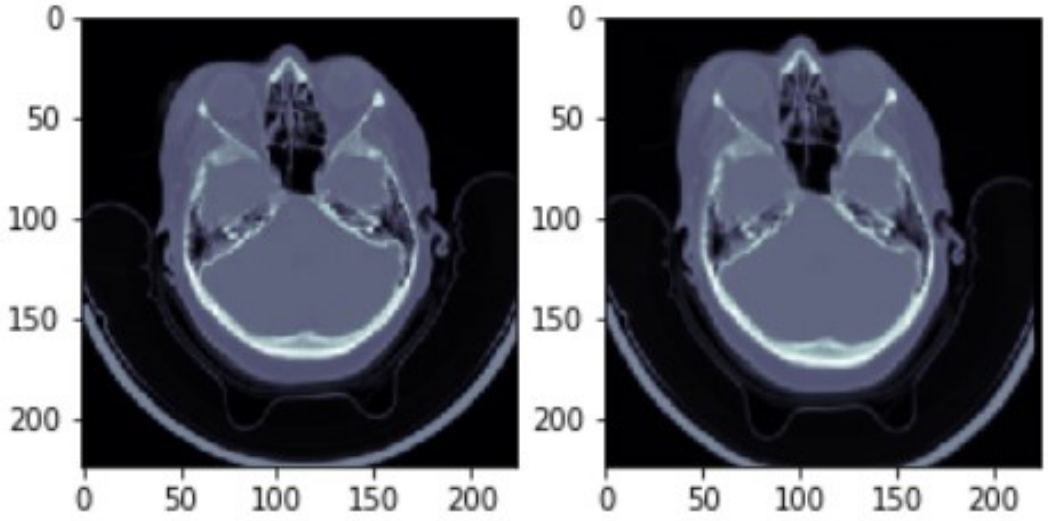
- Only a subset of images will be used for the prototype
  - 500 Images per class
  - 1000 Images annotated as with tumor
  - balanced dataset for training
  - 75% training 25% por validation
- A subset of balance dataset will be used for testing
  - 100 images per class
  - 200 images annotated with tumor and no tumor

Model Architecture

Ensemble_1 | Ensemble_2 | STN | STN-Transformation

```
tensor([[ 1.0147, -0.0230,  0.0308],
        [-0.0334,  0.9481, -0.0070]], grad_fn=<SelectBackward>)
```

Horizontally stacked subplots

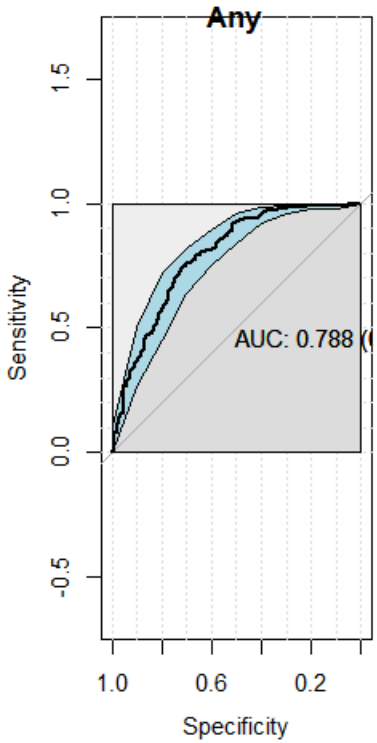


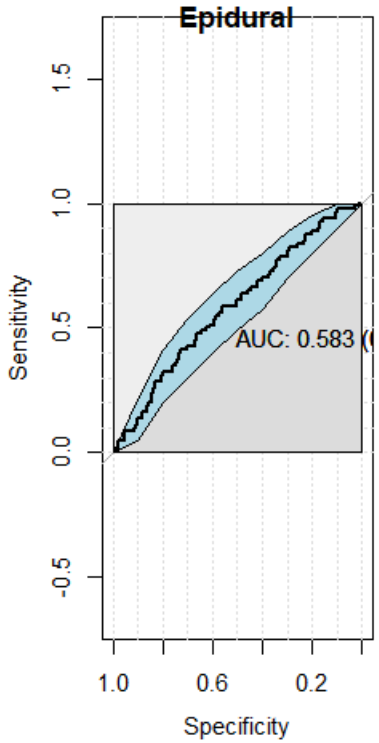
Prototype

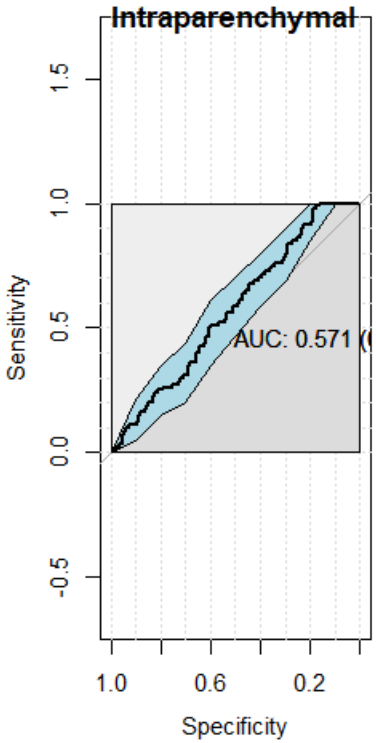
- **pyTorch** is used the models and deliver the metrics
  - Convenience due to recent use
- **AWS** is used as a GPU and python providers
  - Avalilability
- **Data Loader** that reads into memory a batch of images
- **Shiny** is used to process the metrics and visualizations
  - Easy to feed and faster to generate results
- **Pycharm** is used as a python editor
- **vGG16** model for transfer learning, only 16 layers
  - If the model works as expected then it will be changed to *inceptionv3* for phase II

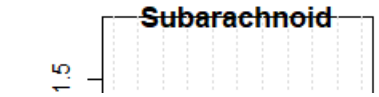
Model-1 Metrics (Single Label)

Loss Function | Loss by Epoch | Accuracy | Test Results



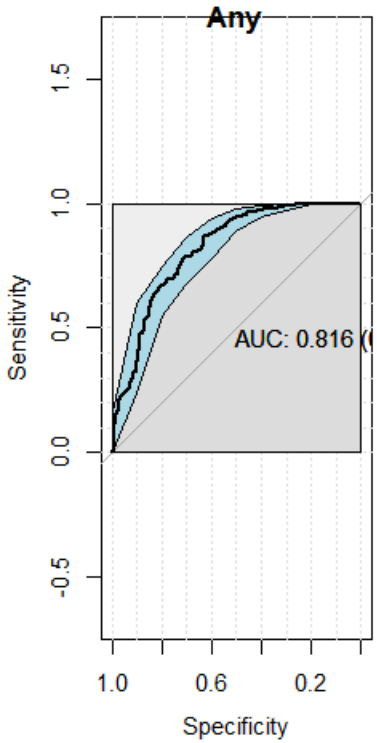


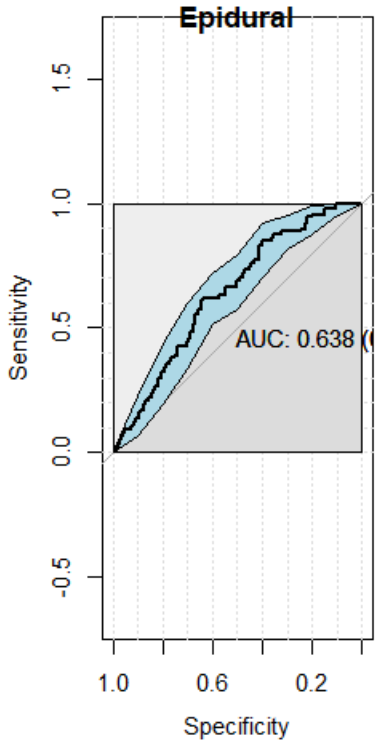


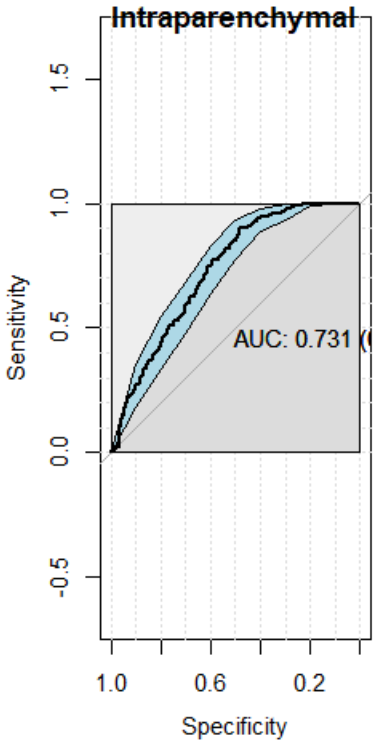


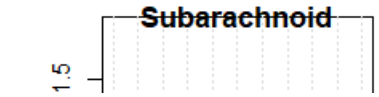
Model-2 Metrics (Multilabel)

Loss Function | Loss by Epoch | Accuracy | Test Results









Results and Conclusions

- Batches of 15 or 10 images gave better results
- The prototype shows that two models are a good approach
- The use of the function loss in the validation phase is not a good option
- The accuracy and other metrics are necessary to evaluate the model
- The number of images use in “Any” category shows a good metric for sampling the other clases
- It is important to include feature enhancing on the model
- The prototype is ready to go into second phase
  - Modification Data Augmentation and Sampling
  - Fine tunning
  - Including InceptionV3

Leasons Learned

- Good resarch can help avoid mistakes and learn new techniques to include in our models
- Good presentation of metrics helps in the decision process
- Pytorch is very helpful to include controls in the model
- Learn about memory usage of GPUs is important to design Network architectures