

# Predicting Alzheimer's at UK Hospitals

# Our Team



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# Background

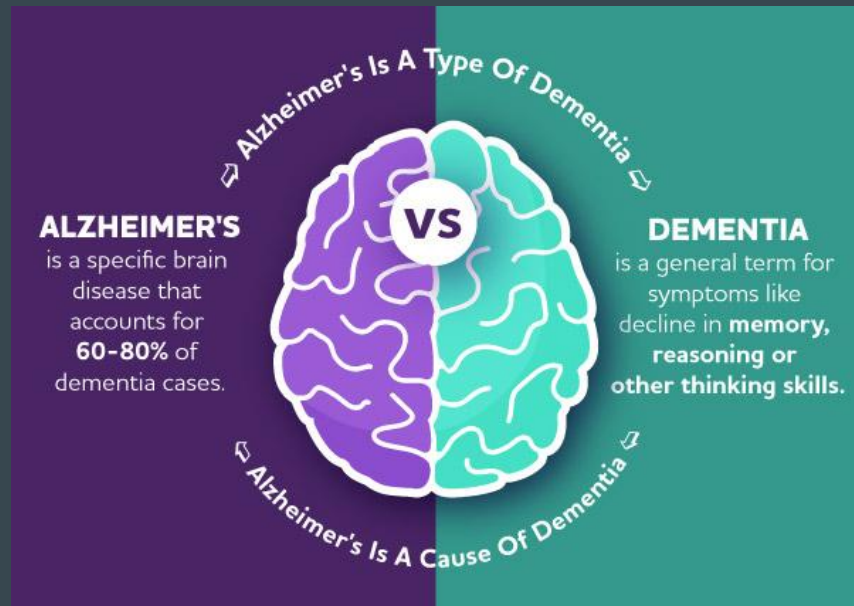
## UK NHS 2017:

- *67% diagnosis rate of dementia*

## UCL Health Study (2016)

People who went to UK hospitals within one year of dementia diagnosis:

- *61% of hospitals recognized prior dementia diagnosis*



# Problem Statement

## Our Problem:

- We are looking to develop a solution for UK hospitals that can predict and identify the presence and severity of dementia via Alzheimer's predictions. The solution and models, if accurate and accepted, are to be used in hospitals moving forward as a means of improving outcomes on diagnostic testing of patients admitted with/without prior diagnoses.

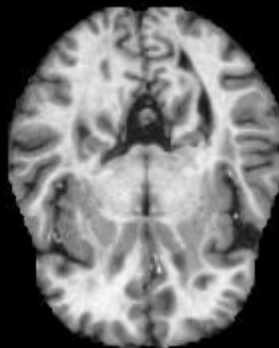
# Our Approach

- We developed several predictive machine learning models (Neural Net)
- Diagnostic metrics are to exceed 50% accuracy and a recall of 64%
  - Determine whether person has Alzheimer's
- Class Classification metrics are to exceed 50% accuracy
  - Determine severity of dementia in Alzheimer's diagnosis

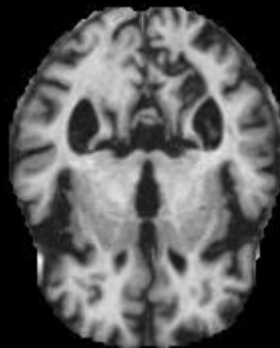
# Our Modeling Data

- 6,400 brain scan images
  - 4 classes of severity
    - Non-Demented
    - Very-Mild Demented
    - Mild Demented
    - Moderate Demented

## Brain Scan Examples



Non-Demented



Moderate

# Our Models and Results

# Diagnosis Model - Predicting Alzheimer's

## Description and Process

- Used Min-Max Standardization
- 2 Dropout layers, with .10 dropout, 25 epochs
- 8000 neurons - > 1 layer
- Loss Function: Binary Cross Entropy

## Scoring

- AVG Accuracy, Precision, Recall: 85%, 87%, 85%

## Conclusion

- Operates higher than baseline model



# Diagnosis Model

## Model Structure

- Highlights:
  - Simple
- Future Work:
  - Experiment with more complex models

Model: "sequential"

| Layer (type)        | Output Shape  | Param #   |
|---------------------|---------------|-----------|
| =====               |               |           |
| flatten (Flatten)   | (None, 36608) | 0         |
| -----               |               |           |
| dropout (Dropout)   | (None, 36608) | 0         |
| -----               |               |           |
| dense (Dense)       | (None, 8000)  | 292872000 |
| -----               |               |           |
| dropout_1 (Dropout) | (None, 8000)  | 0         |
| -----               |               |           |
| dense_1 (Dense)     | (None, 1)     | 8001      |
| =====               |               |           |

Total params: 292,880,001

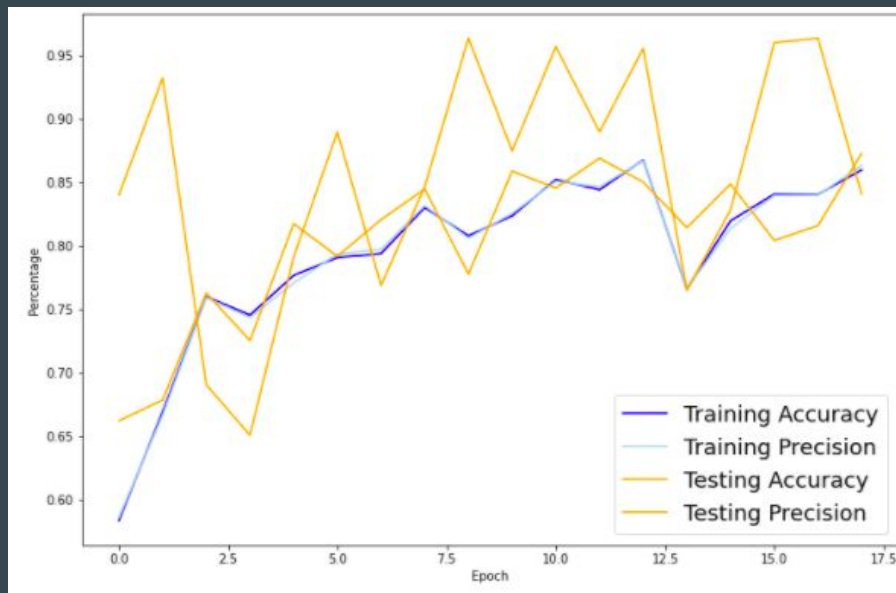
Trainable params: 292,880,001

Non-trainable params: 0

# Diagnosis Model

## Model Performance

- Highlights:
  - Best Accuracy: 85%
  - Highest Precision: 87%
  - Little overfitting
- Future Work:
  - Stabilize testing performance metric
  - Improve recall
  - Increasing overall performance



|              | precision | recall | f1-score | support |
|--------------|-----------|--------|----------|---------|
| 0            | 0.78      | 0.97   | 0.87     | 640     |
| 1            | 0.96      | 0.73   | 0.83     | 641     |
| accuracy     |           |        | 0.85     | 1281    |
| macro avg    | 0.87      | 0.85   | 0.85     | 1281    |
| weighted avg | 0.87      | 0.85   | 0.85     | 1281    |

# Model #2 - Predicting Stages of Alzheimer's

## Description and Process

- 6 Conv2D layers, with 4 max pooling layers, 1 flatten, drop out (0.5), dense layer, 1 output layer, 60 epochs
- Tested against pretrained InceptionV3 and MobileNetV3 models
- Loss Function: Categorical Cross Entropy

## Scoring

- Accuracy, Precision, Recall: 72%

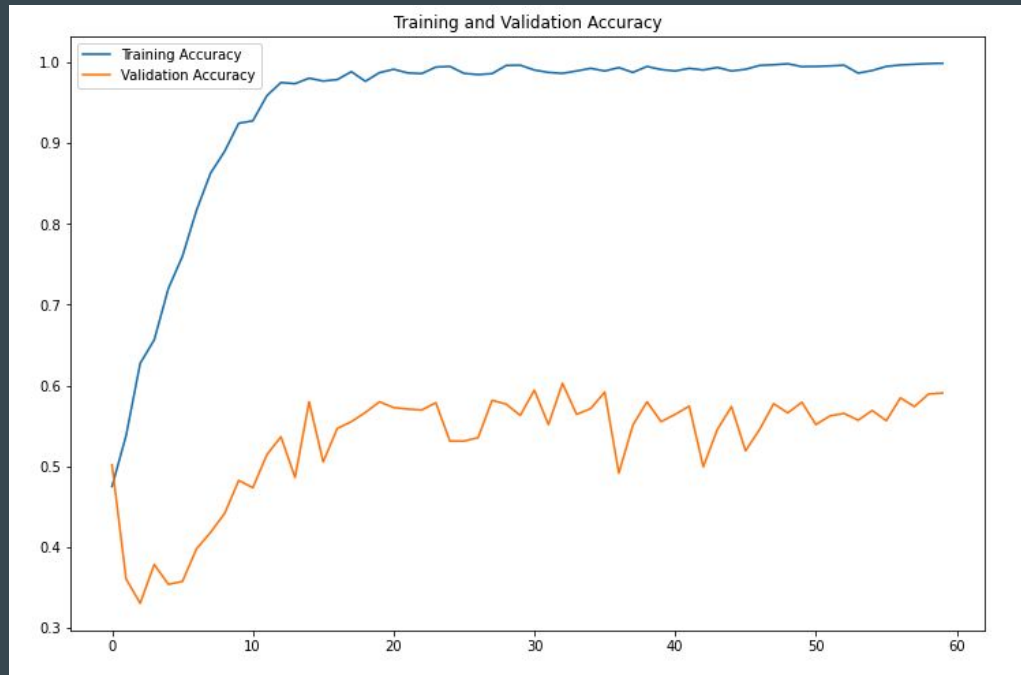
## Conclusion

- Performs significantly better than baseline

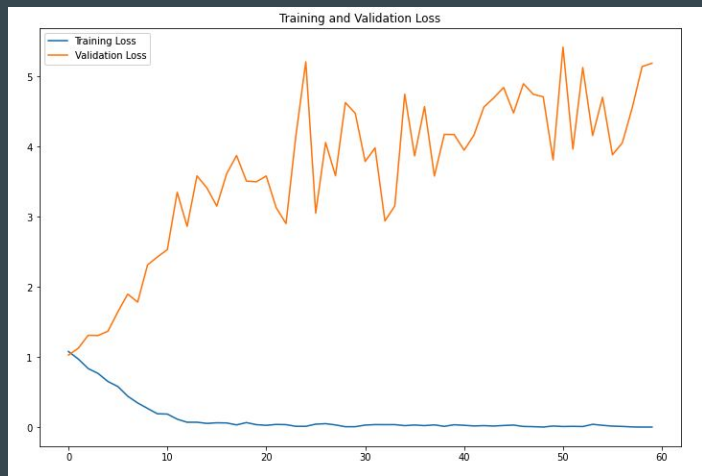
# Basic CNN Model #1

## Basic Fine Tuned Model

- Best Accuracy, Recall, and Precision 60%
- Tested a model with Data Augmentation although less overfit, performed worse than non-augmented data.



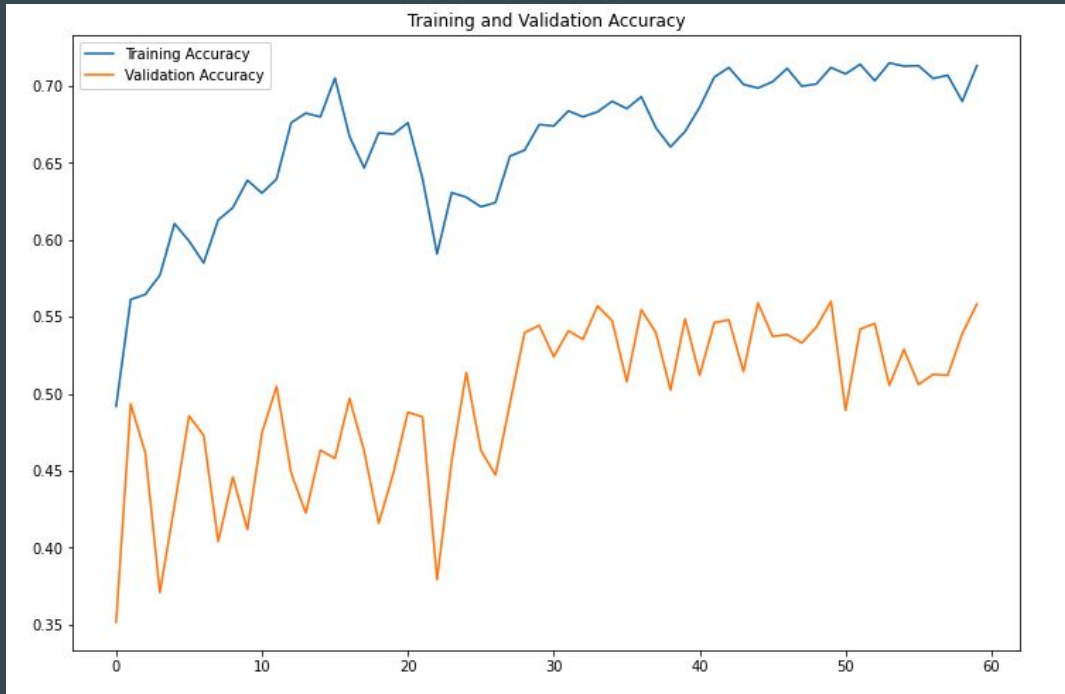
# Metrics



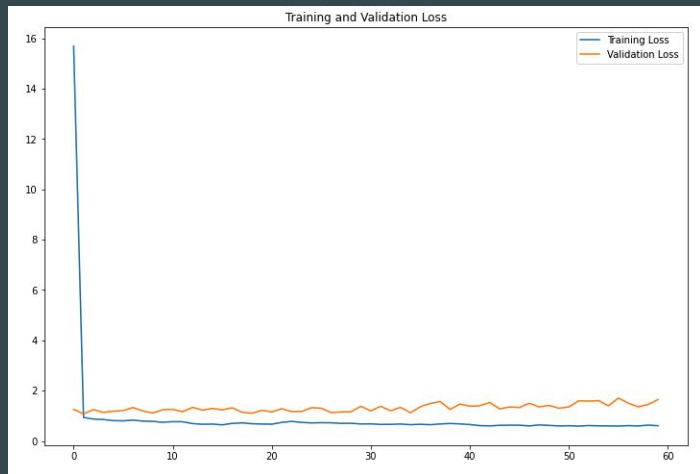
# Pre-trained Model #2

## InceptionV3 Model

- Best Accuracy - 56%, Recall - 40%, and Precision 60%
- Tested a model with Data Augmentation although less overfit, performed worse than non-augmented data.



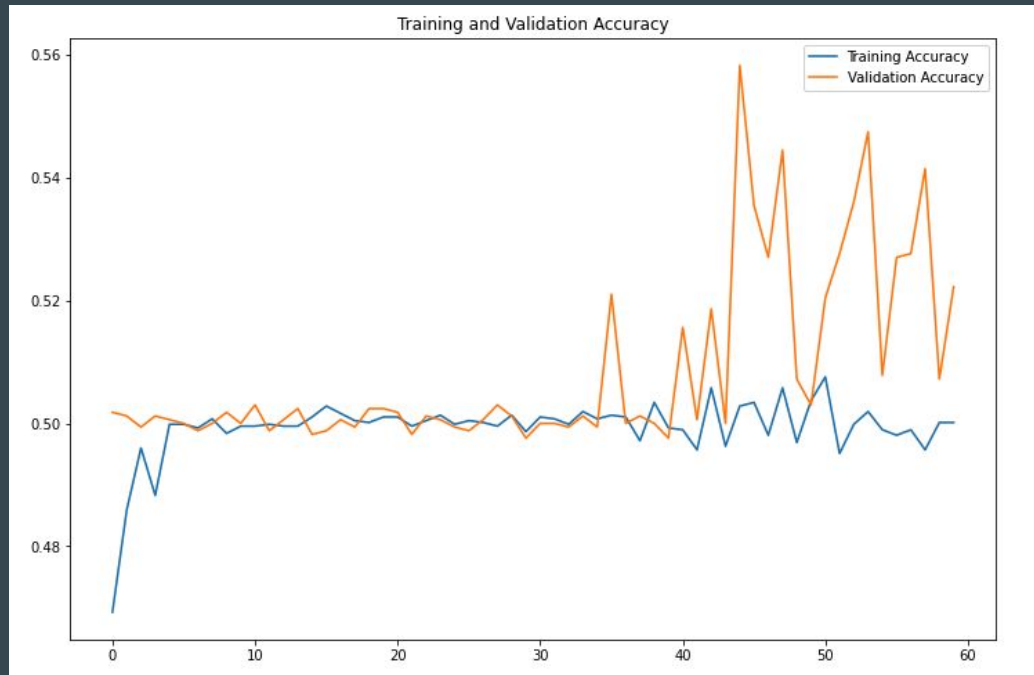
# Metrics



# Pre-trained Model #3

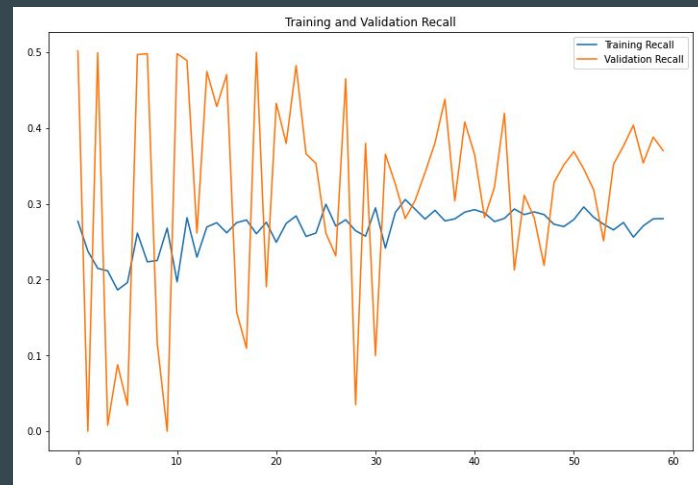
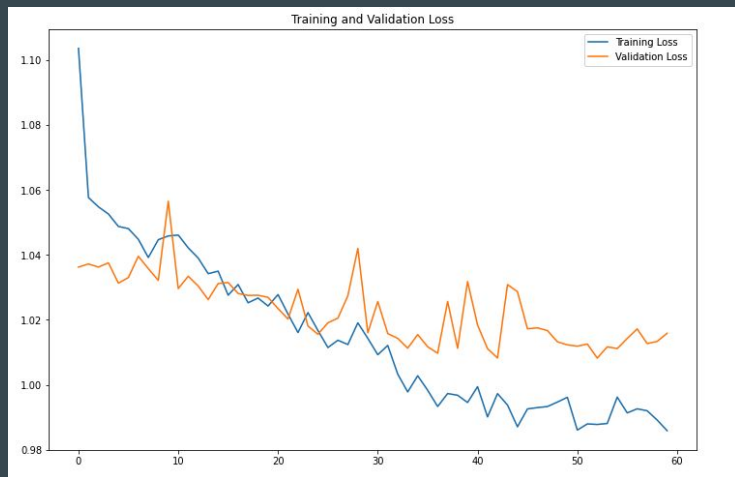
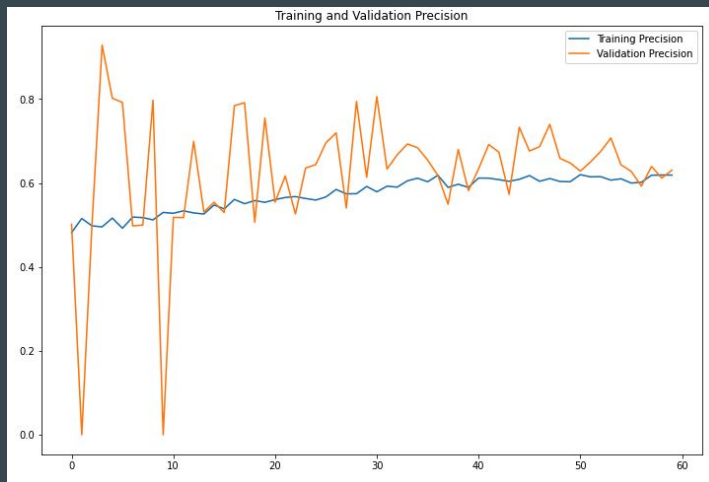
## MobileNetV3 Model

- Best Accuracy - 56%, Recall - 21%, and Precision 73%
- Tested a model with Data Augmentation although less overfit, performed worse than non-augmented data.

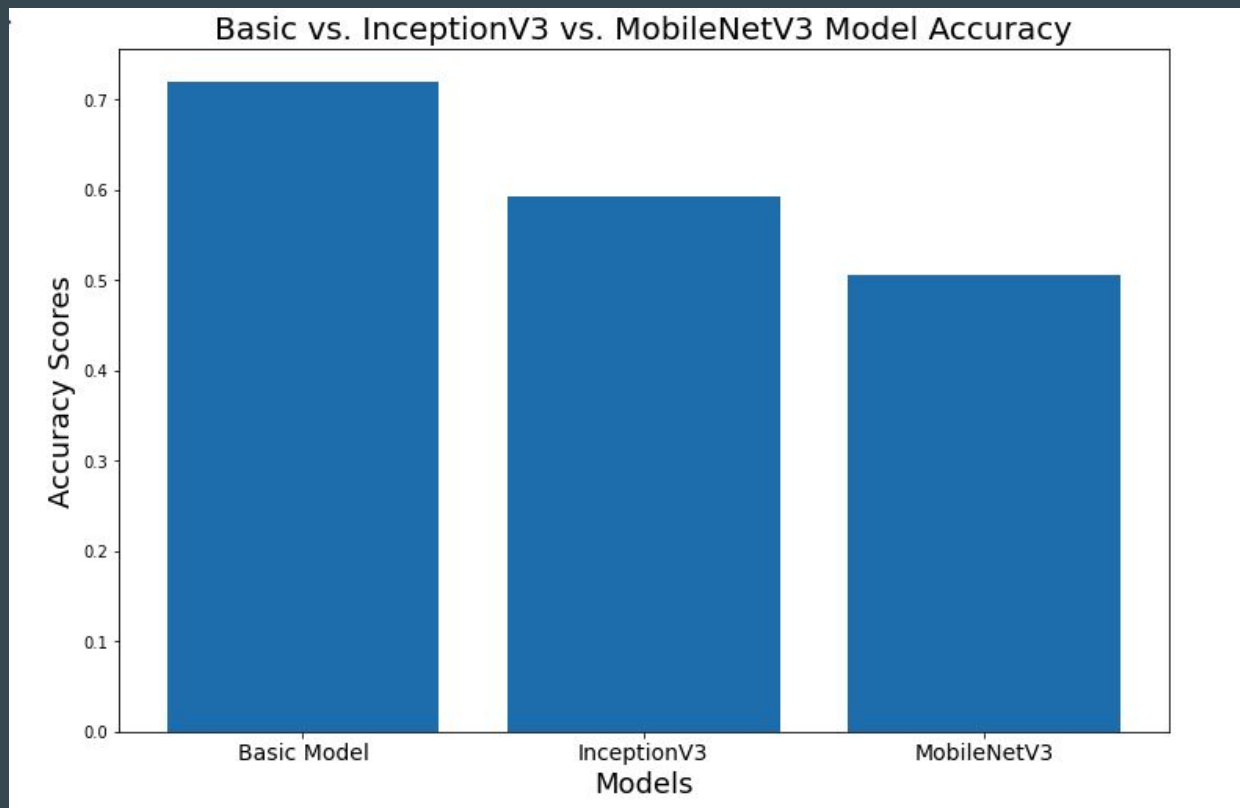




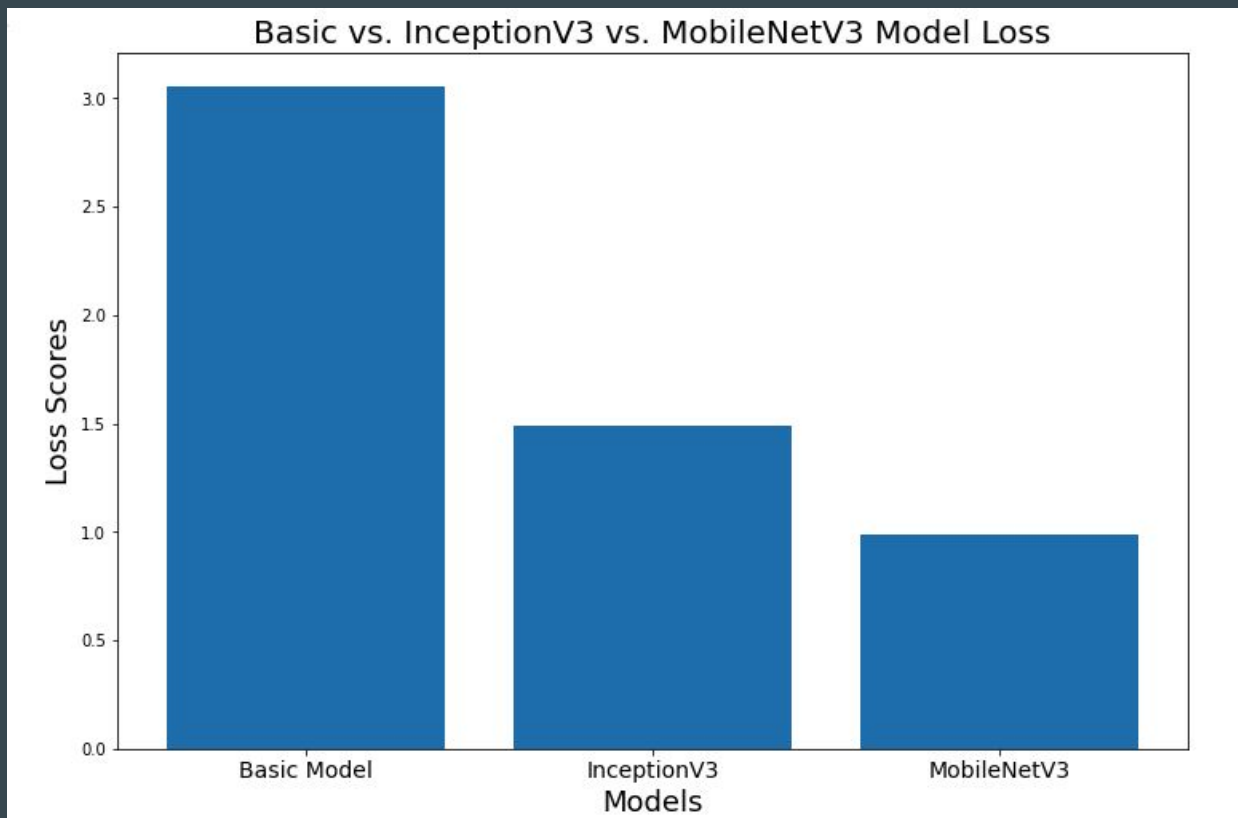
# Metrics



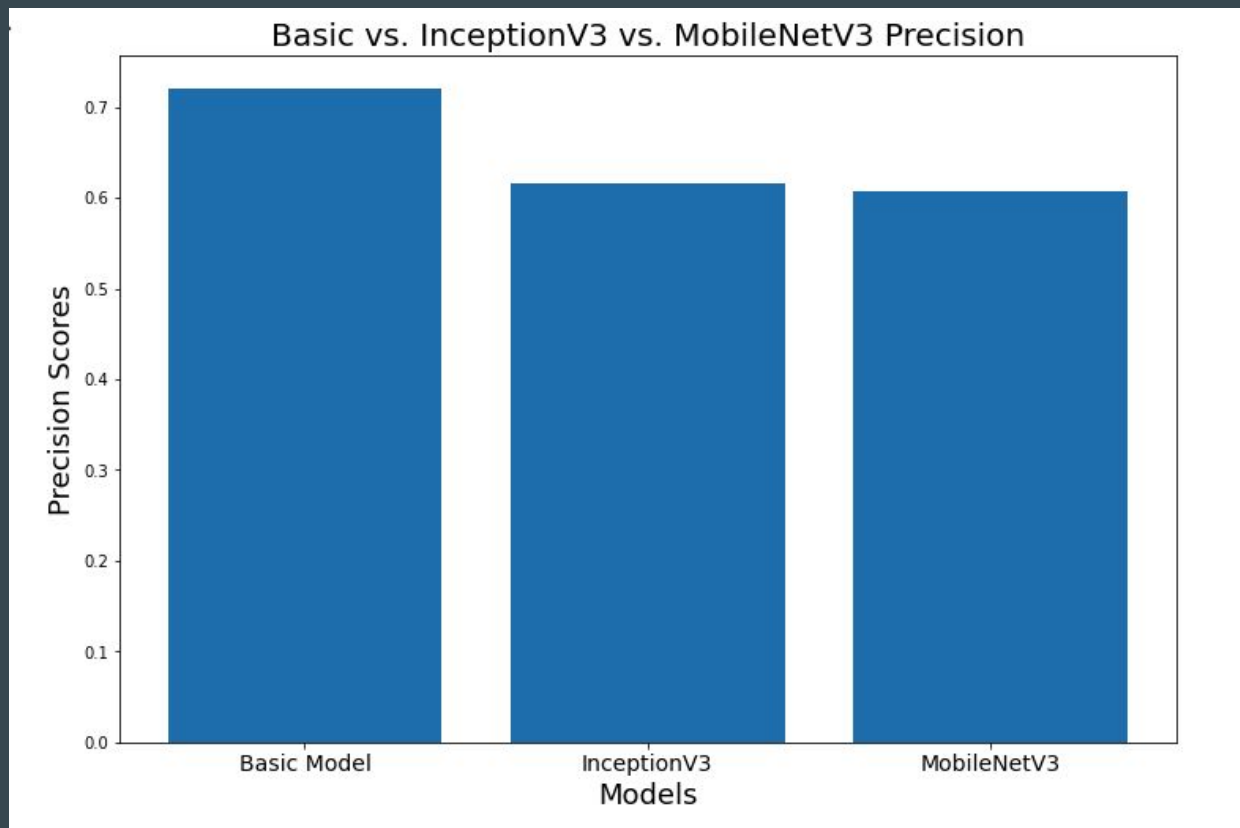
# Model Accuracy Comparison



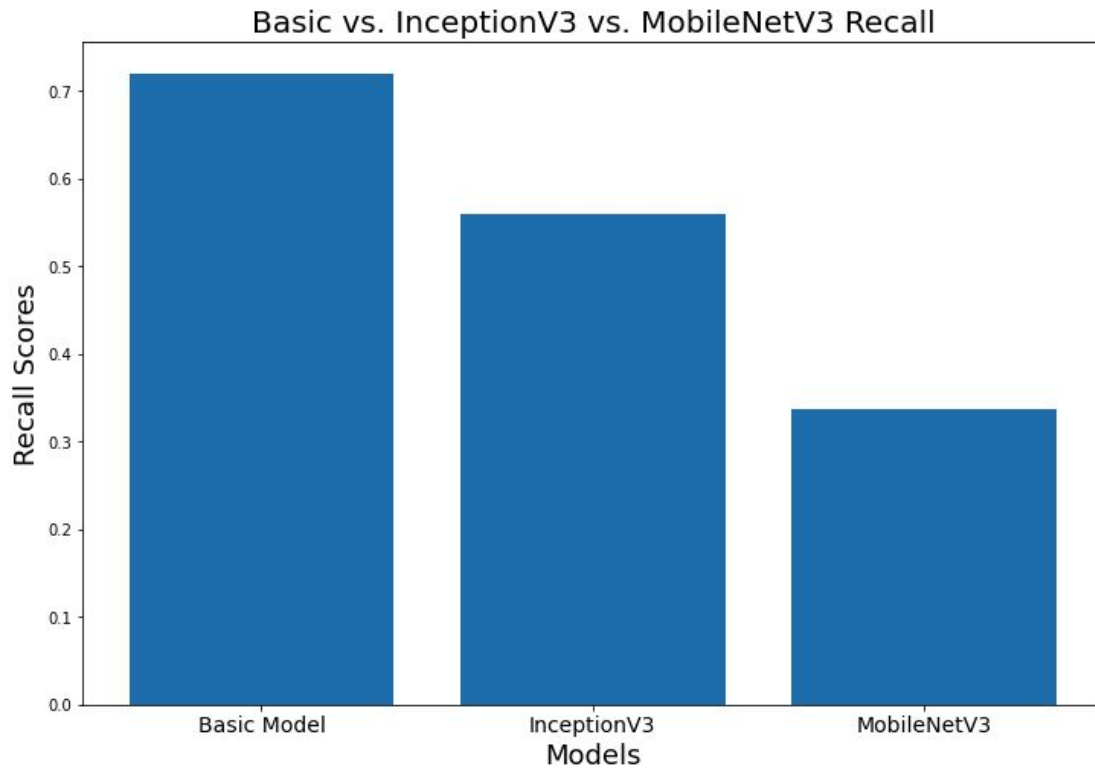
# Loss Comparison



# Precision Comparison



# Recall Comparison



# Demonstration

# Conclusions and Recommendations

# Summary Of Results

## Baseline Models

### Detection:

Baseline prediction  
accuracy of 50%

Recall score of 64%

### Predict Class:

Accuracy of 50%

## Model #1 - Detection

### Chosen Model:

Sequential (With Dropout)

**Accuracy:** 86%

**Precision:** 87%

**Recall:** 85%

## Model #2 - Predict Class

### Chosen Pre-Trained Model:

Basic Fine Tuned Model

**Accuracy:** 72%

**Precision:** 72%

**Recall:** 72%



# Conclusions

- Our general prediction model is scoring well above baseline and UK averages at 85%
- For the severity classification we chose the Basic Fine Tuned Model, as our recall scoring is slightly higher than UK hospital averages
- Our two models, with additional improvement and feature development before deployment, will improve the detection rate of dementia in UK hospitals and help determine the severity of patient's dementia

# Recommendations

- Fine-tune InceptionV3 and MobileNetV3 models to update weights to be specific to the MRI Images. Potential to improve scores more.
- Augment the data differently and see how that impacts the models (minimize shear and distortions, sharpening, changing contrast)
- Integrate within existing image record data at select hospitals to begin testing over larger sets of image data.

# Recommendations

- We could use higher resolution images with more detail for our models to train with
- Develop the program to be hosted on a local machine
- Try to use other patient data to try and predict dementia
  - General Wellness Survey

Questions?