# Convolutional Neural Networks for Skin Cancer Lesion Classification

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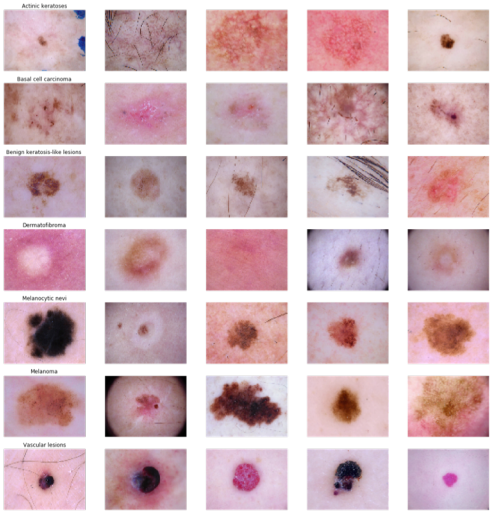
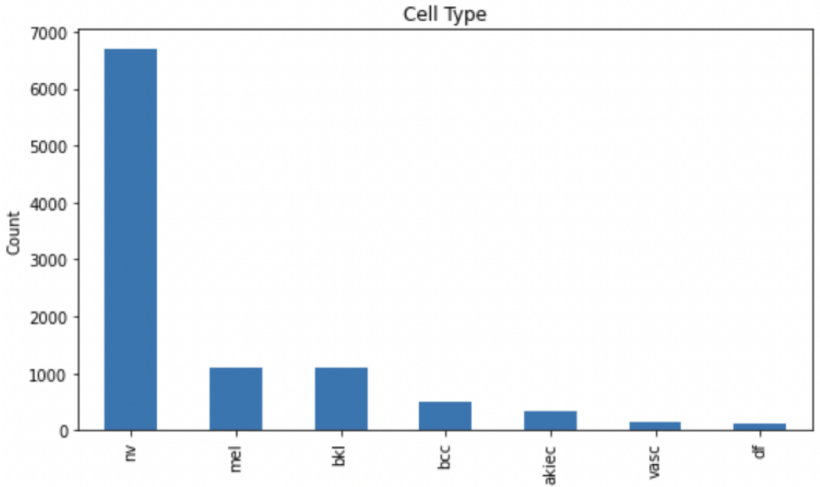
# HAM10000 is a Dataset of 10,000 Skin Cancer Lesions

- Motivation: use a simple image of a lesion to identify skin cancer
- More complicated / higher resolution version of MNIST problem
- 7 classes, highly skewed class distribution--unique challenge



# Approaching the Problem

- CNN is obvious architecture choice -- VGG19 network transfer learning
- Started with architecture with fewer layers, increase number of layers later
- Tried replacing dense layers with classifier layers like xgboost and decision tree
- Experimented with common models like VGG and ResNet - around 40% accuracy
- Ended up sticking with a “simpler” custom CNN, and experimenting with hyperparameters

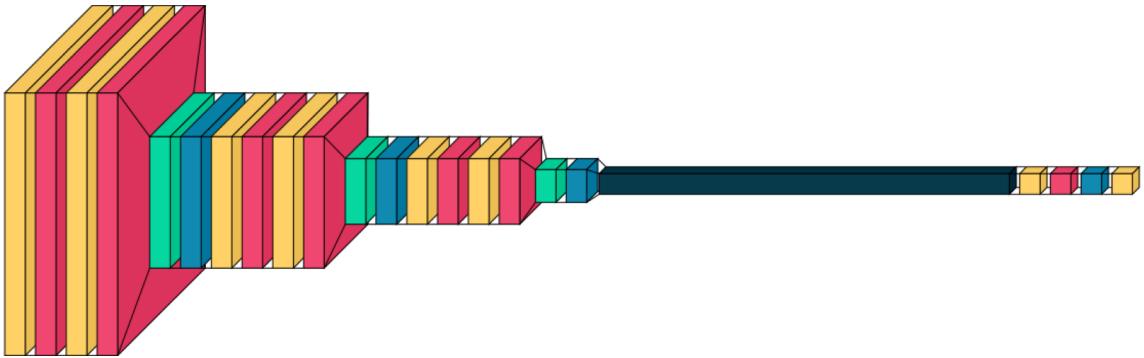
# Addressing imbalanced class distributions - three steps

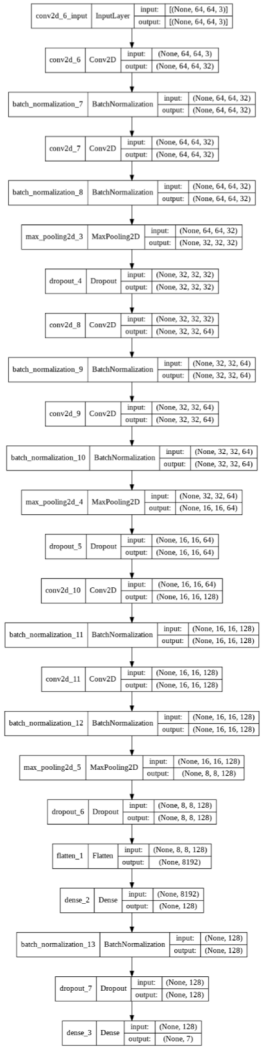
- Data Augmentation: image data generator to apply rotations, flips, shifts, rescales, etc.
  - Essentially increases diversity of dataset
- Class weights: weight classes with fewer examples more heavily than those with more samples
  - Input to model has more evenly distributed classes
  - Have a higher penalty for misclassification of malignant class labels
- Dropouts to address network overfitting

# Architecture 1 (Custom CNN)

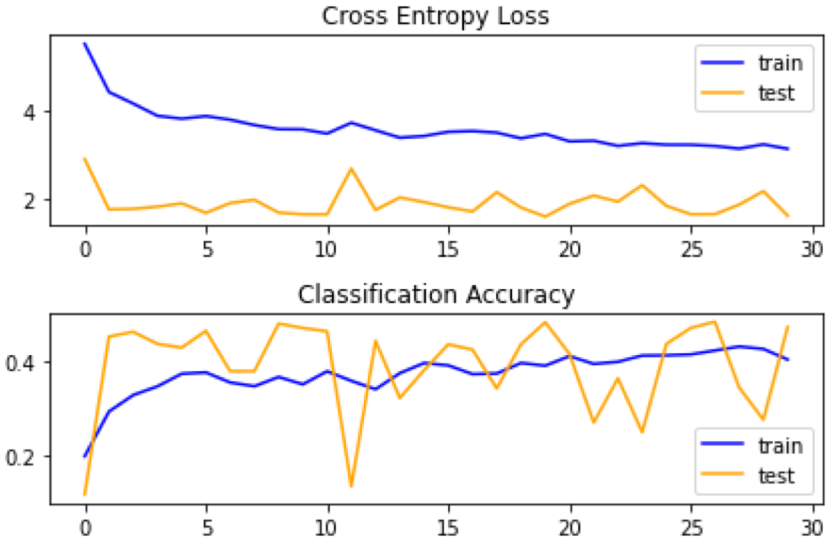
Color legend:

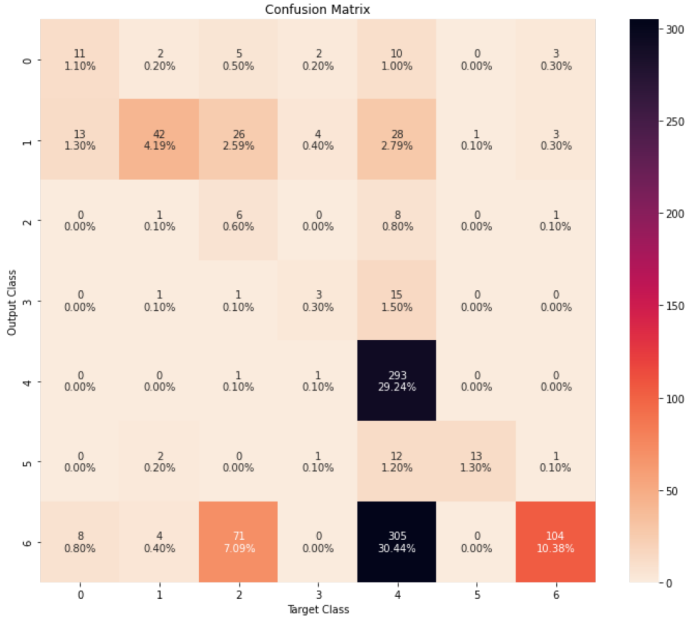
- Yellow: Conv2D
- Red: Batch normalization
- Green: MaxPooling2D
- Blue: Dropout
- Dark Green: Flatten



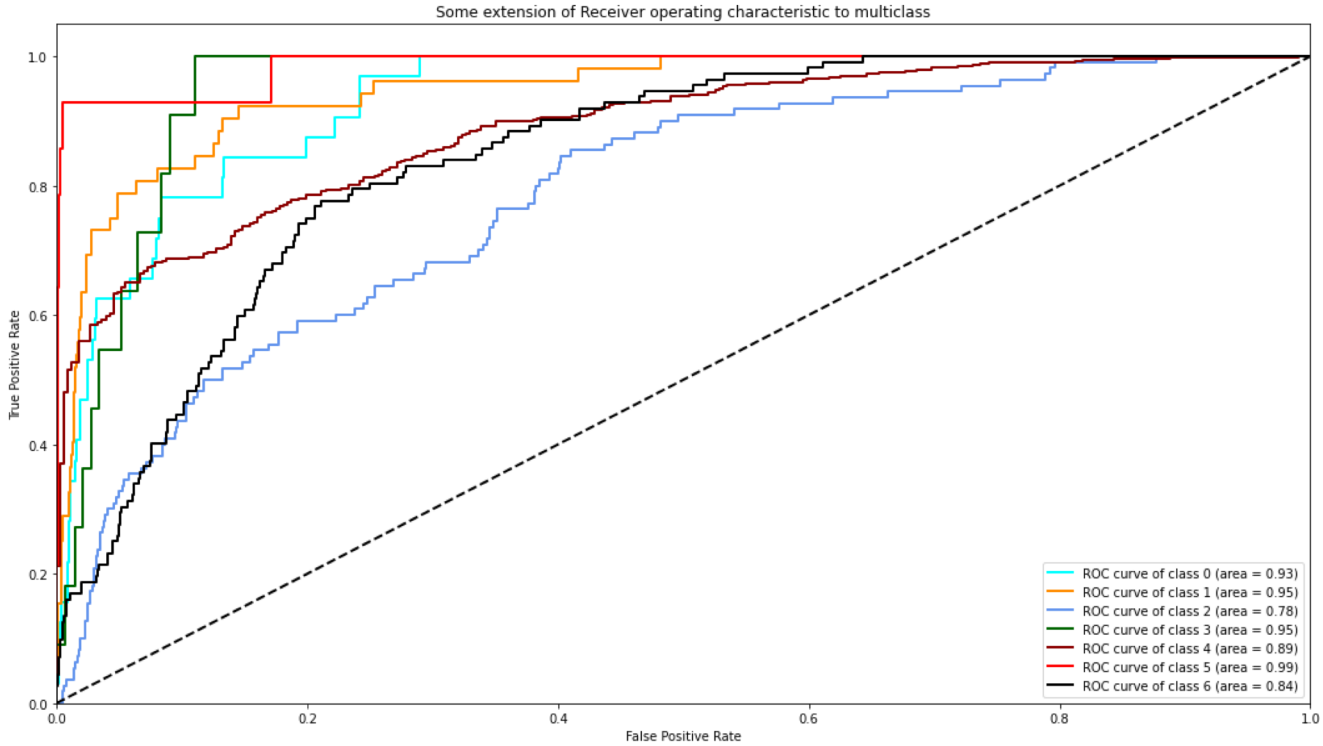


# Architecture 1 (Custom CNN) - Exemplary Loss, Accuracy, Confusion Matrix



# Architecture 1 (Custom CNN) - Exemplary Receiver Operating Curve



# Architecture 1 (Custom CNN) - Recall

$$\text{Recall} = \frac{True\ Positives}{True\ Positives + False\ Negatives}$$

- Recall for malignant classes is used as a key metric over accuracy, loss or auc-roc

# Hyperparameter Adjustment - Performance Comparison

- Changing data augmentation & class weights

| Data Aug | Size | weights | dropout | weights | Acc | Recall | Loss | cancer | recall for cancer |
|---|---|---|---|---|---|---|---|---|---|
| y | y | y | 0.2 | 3,8,8 | 0.5 | 0.4376884472 | 1.632410765 | 148 | 0.758974359 |
| y | y | n | 0.2 | | 0.767465055 | 0.60998854 | 0.6540125608 | 71 | 0.3641025641 |
| n | y | n | 0.2 | | 0.7864271402 | 0.6411499175 | 0.7860460877 | 93 | 0.4769230769 |
| n | y | y | 0.2 | 3,8,8 | 0.4381237626 | 0.3519971084 | 2.137435436 | 127 | 0.6512820513 |

# Hyperparameter Adjustment - Performance Comparison

- Changing dropout rate

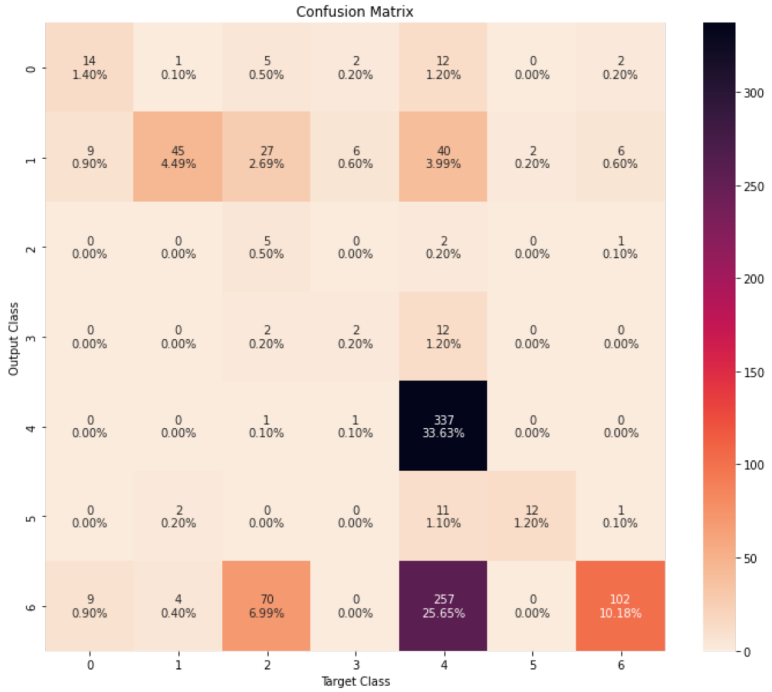
| Data Aug | Size | weights | dropout | weights | Acc | Recall | Loss | cancer | recall for cancer |
|---|---|---|---|---|---|---|---|---|---|
| y | y | y | 0.2 | 3,8,8 | 0.5 | 0.4376884472 | 1.632410765 | 148 | 0.758974359 |
| y | y | y | 0.25 | 3,8,8 | 0.5159680843 | 0.4512328871 | 1.458364964 | 161 | 0.8256410256 |
| y | y | y | 0.3 | 3,8,8 | 0.2874251604 | 0.389135138 | 1.991754651 | 146 | 0.7487179487 |
| y | y | y | 0.4 | 3,8,8 | 0.382235527 | 0.3020589518 | 1.93186903 | 152 | 0.7794871795 |
| y | y | y | linear inc | 3,8,8 | 0.4810379148 | 0.4509781951 | 1.584651947 | 150 | 0.7692307692 |

# Hyperparameter Adjustment - Performance Comparison

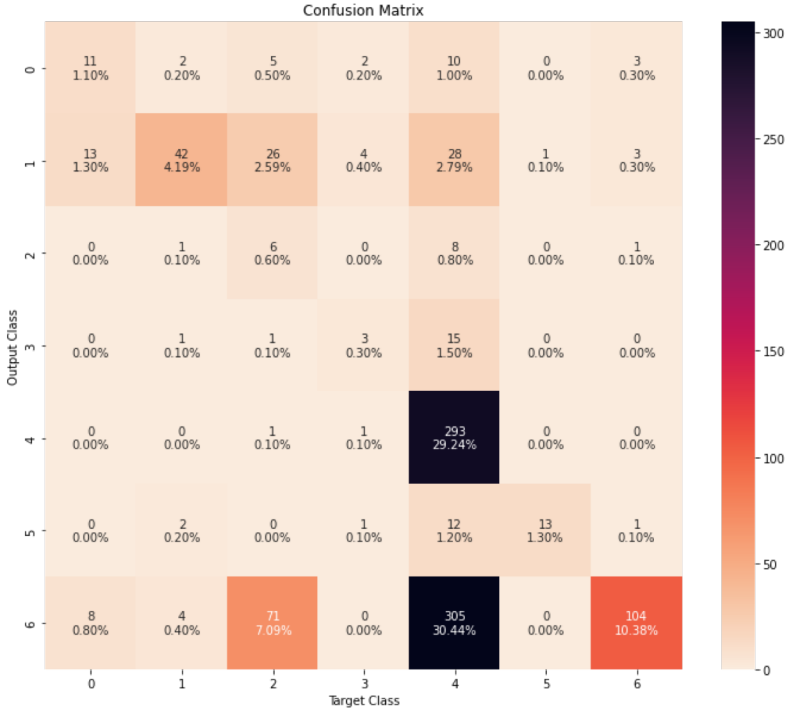
- Further experimentation with cancerous class weight multiplier

| Data Aug | Size | weights | dropout | weights | Acc | Recall | Loss | cancer | recall for cancer |
|---|---|---|---|---|---|---|---|---|---|
| y | y | y | 0.25 | 8,4,2 | 0.5049900413 | 0.4138706765 | 1.310278535 | 106 | 0.5435897436 |
| y | y | y | 0.25 | 6,6,6 | 0.4790419042 | 0.4739038394 | 1.498404026 | 152 | 0.7794871795 |
| y | y | y | 0.25 | 3.75,5.4,11.7 | 0.4710578918 | 0.4100265725 | 1.533285499 | 157 | 0.8051282051 |

# Final comparison: class 0,1,6 weight multiplier




Weight multiplier = 3, 8, 8




Weight multiplier = 3.75, 5.4, 11.7

# Potential Improvements

- Longer training times -- due to Google Colab restrictions, limited to ~30 epochs
  - Image classification tasks typically require longer training periods
  - Sometimes running out of memory just loading the images
- Combining different network architectures with hyperparameter tuning
  - Was difficult in this project due to Colab limitations

# Questions?