Analysis of Diabetic Retinopathy Fundus Imagery using Convolutional Neural Networks

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Objectives

- Learn more about the Data Analytics process
- Learn more about the development of convolutional neural networks
- Develop a CNN model that correctly classifies the presence of diabetic retinopathy in fundus images as either being present or not present

Implemented Models

Constants

- All models share the following components:
  - Constructed using Keras’ built-in Sequential structure
  - Compiled with the Adam optimizer
  - Utilize the binary cross entropy loss function
  - Contain a Flatten layer and a Dense layer

Base Model

The Base Model’s layer architecture is as follows:

1. 2D Convolution Layer
    a. 64 nodes
    b. Kernel Size = 3x3
    c. ReLU activation function
2. 2D Convolution Layer
    a. 32 nodes
    b. Kernel Size = 3x3
    c. ReLU activation function
3. Flatten Layer
4. Dense Layer
    a. Sigmoid activation function

1 Convolution Layer

The 1 Convolution Layer’s architecture is as follows:

1. 2D Convolution Layer
    a. 64 nodes
    b. Kernel Size = 3x3
    c. ReLU activation function
2. Flatten Layer
3. Dense
    a. Sigmoid activation function

Max Pooling and Kernel Adjustments

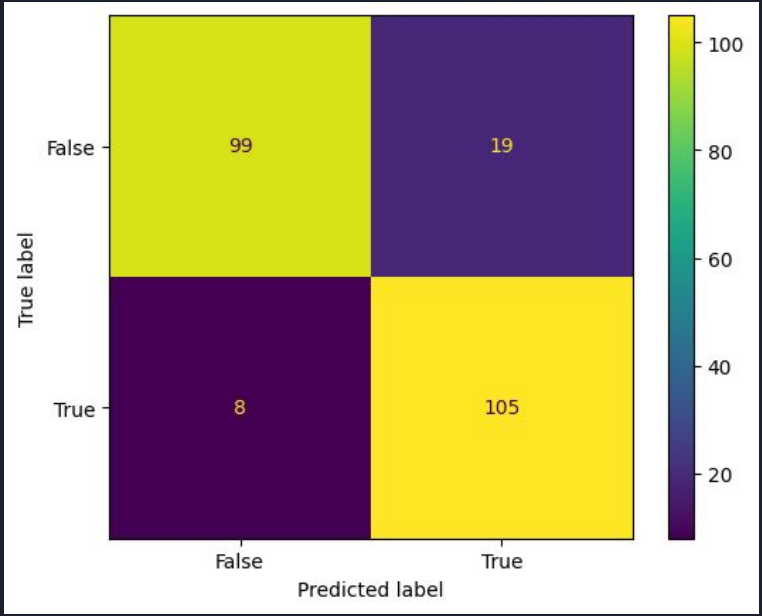
The Max Pooling Model's architecture is as follows:

1. 2D Convolution Layer
   a. 64 nodes
   b. Kernel Size = 5x5
   c. ReLU activation function
2. Max Pooling 2D Layer
   a. Pool Size = 3x3
   b. Padding = "same"
3. 2D Convolution Layer
   a. 32 nodes
   b. Kernel Size = 3x3
   c. ReLU activation function
4. Flatten Layer
5. Dense Layer
   a. Sigmoid activation function

Results and Analysis

Results and Analysis

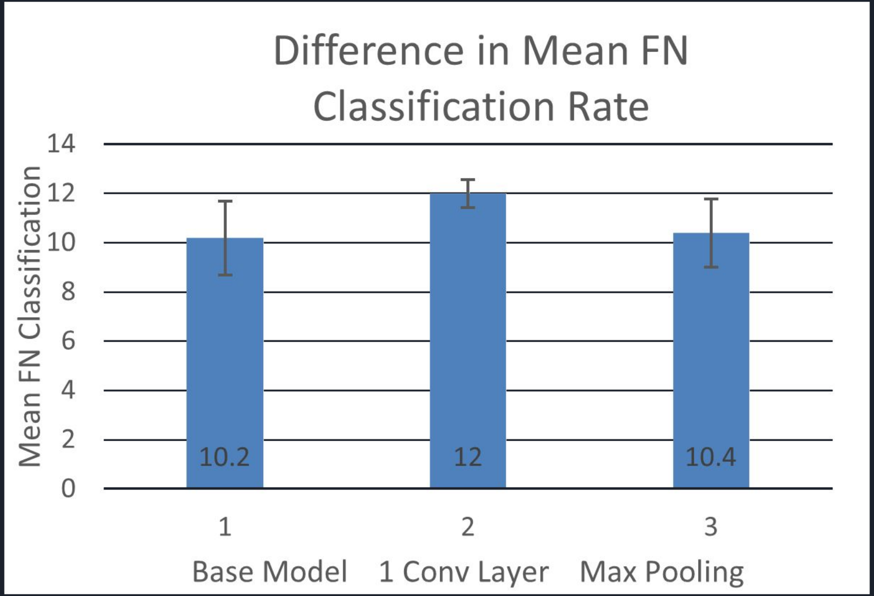
- Success Criteria = Minimal False Negatives (FN)
- Difference of Means T-Test
- Comparison of Other Relevant Metrics
    - Precision
    - Recall
    - F1 Score



Difference of Means T-Test

- Conducted comparing the two models achieving the lowest average FN counts across five runs: Base Model (10.2), and Max Pooling Model (10.4)
- P-value of 0.815 = insignificant statistical difference

- *A t-test was also conducted comparing the Base Model to the 1 Convolution Layer Model, which indicated a statistically significant difference in performance



Further Comparisons

The following are averages achieved by each model in the corresponding metrics

	Base Model	Max Pooling Model
Testing Accuracy	88.75%	89.78%
Precision	86.77%	88.64%
Recall	90.97%	90.80%
F1 Score	88.79%	89.69%

Future Scope

Future Scope

- Further examination of hyperparameters
  - Learning Rate
- Experimentation with model architecture
  - Node counts
  - Activation and loss functions
  - Additional layers; deeper network
- Additional image preprocessing
  - Data augmentation
    - Rotation
    - Skew
    - Shear
    - Flipping

Reflections and Conclusion

Reflections and Conclusion

- False negative classification rate (~4.50%) at present is still higher than what's required for practical implementation
- Gained a greater appreciation for the Data Analytics Process
- Obtained exposure to the development of CNNs
- Better accuracy likely could've been achieved with adjustments to learning rate, amongst other parameters

Thank you!