Deep Learning Models for MRI Quality Control Results

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DS5220

Project Recap

- **Magnetic Resonance Imaging (MRI)** is non-invasive imaging technique utilizing strong **magnetic fields** and **radio waves** to produce images of bodily structures

- **PROBLEM**
  - Analysis of MRI require robust data quality control
- **SOLUTION**
  - Create a MRI quality control pipeline using deep learning for structural MRI images

Why?

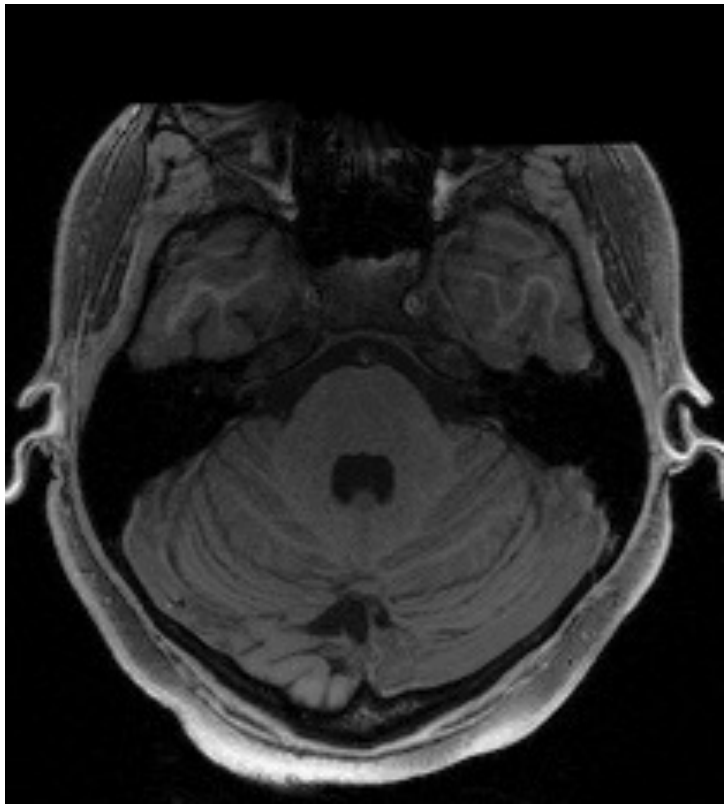
- MRI quality control is a **necessary** but **costly** and **time consuming** procedure
- Deep learning (e.g. CNN, autoencoder) has shown to be good at classifying images in MRI scans [1]
- Past work has shown some success in using ML for structural MRI, specifically for quality control [2, 3]

<u>If successful, these models could drastically improve MRI workflows for researchers, radiologists, and clinicians</u>

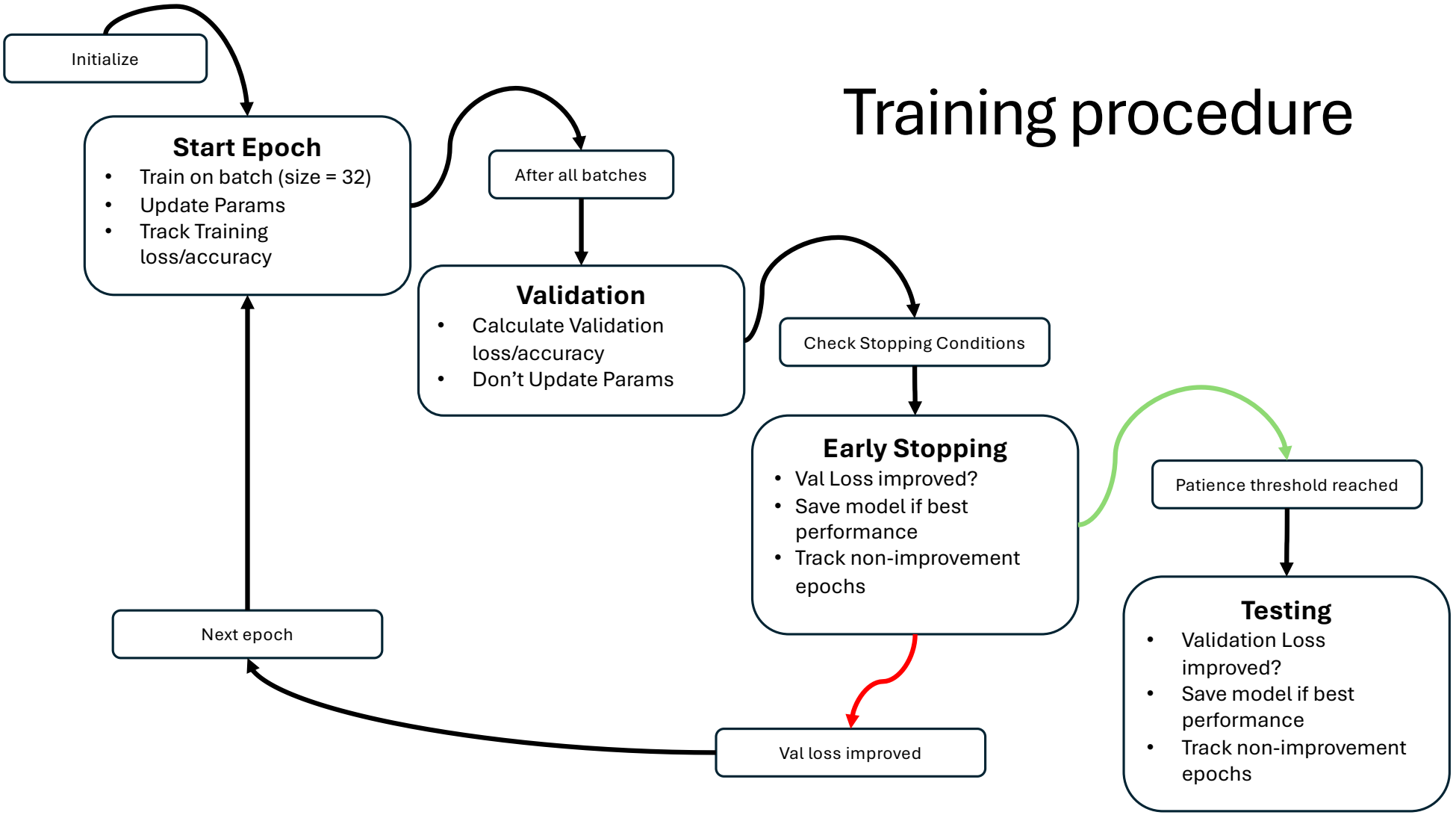
1) Mazurowski, M. A., Buda, M., Saha, A., & Bashir, M. R. (2019). Deep learning in radiology: An overview of the concepts and a survey of the state of the art with focus on MRI. *Journal of magnetic resonance imaging*, *49*(4), 939-954.
2) Sujit, S. J., Coronado, I., Kamali, A., Narayana, P. A., & Gabr, R. E. (2019). Automated image quality evaluation of structural brain MRI using an ensemble of deep learning networks. *Journal of Magnetic Resonance Imaging*, *50*(4), 1260-1267.
3) Garcia, M., Dosenbach, N., & Kelly, C. (2022). BrainQCNet: a Deep Learning attention-based model for the automated detection of artifacts in brain structural MRI scans. *bioRxiv*, 2022-03.

Models

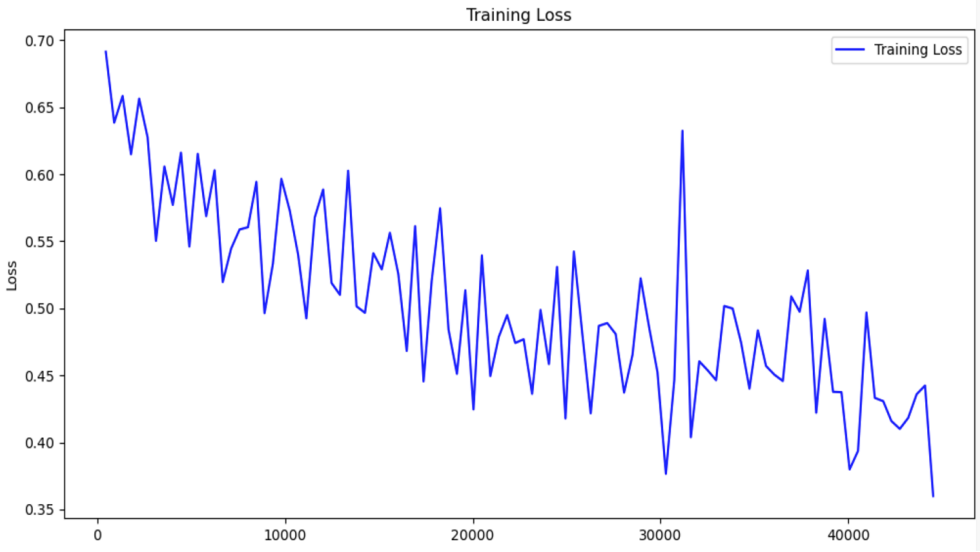
- Simple 2-layer CNN
- VGG-16
  - Retrained only on my data
- Autoencoder
- ResNet18
  - Default weights used
- Imaging database from Dr. Jo Etzel & Dr. Todd Braver (University of Washington)
    - Original study looking at neural correlates of cognitive control
  - Already classified as ‘accepted’ & ‘rejected’
  - 24 individuals, 115 axial slices each
    - 1380 unique PNG ‘accepted’
    - 1380 unique PNG ‘rejected’

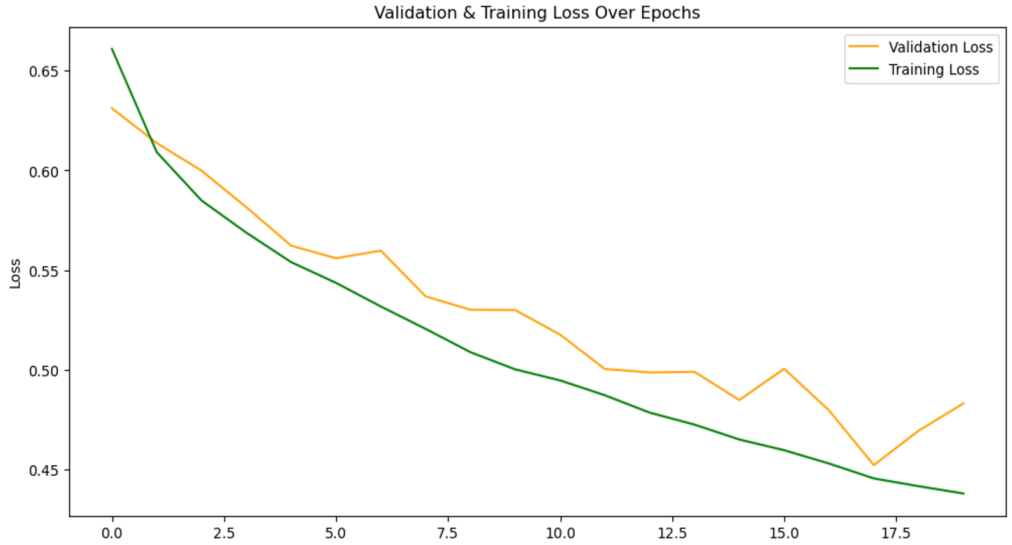


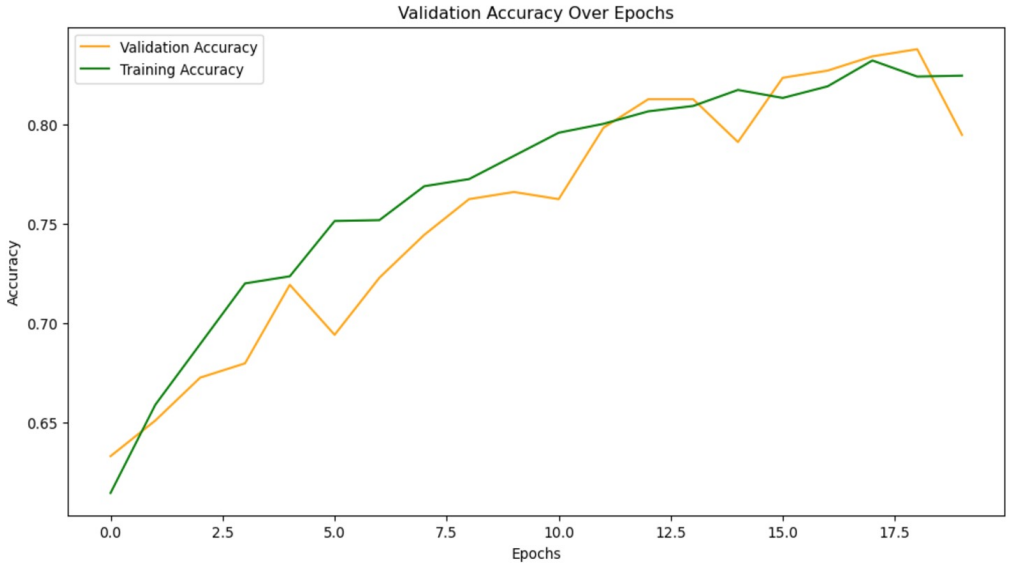
Training procedure



Simple CNN







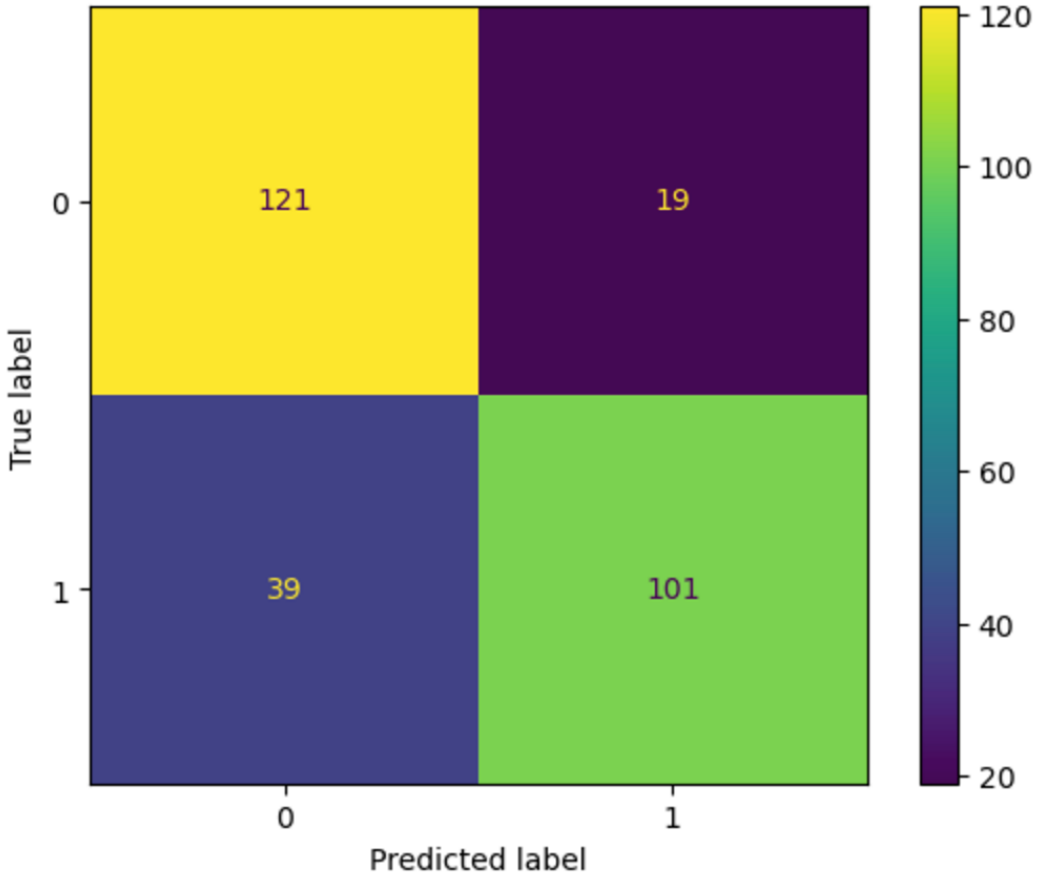
Test loss: 0.4728

Test Accuracy: 0.7929

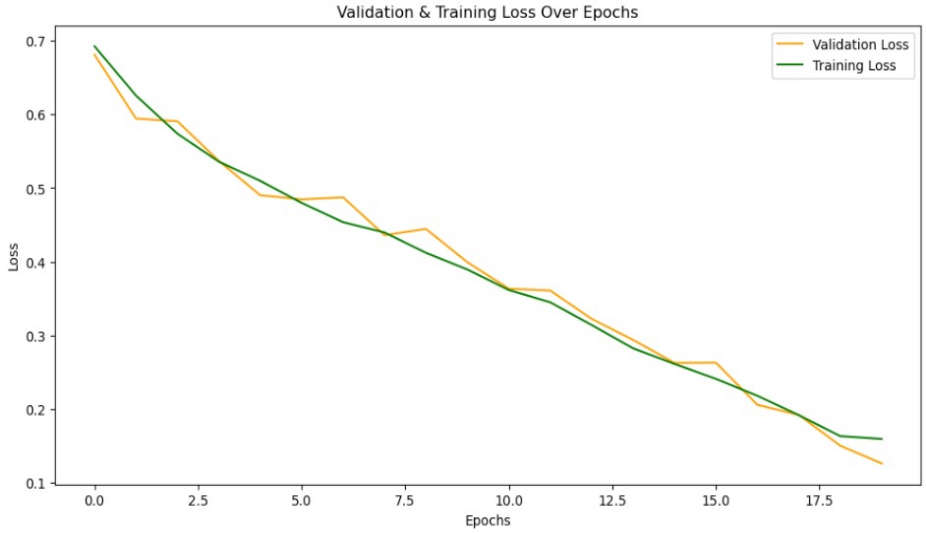
Simple CNN – epochs = 20 (patience =2)

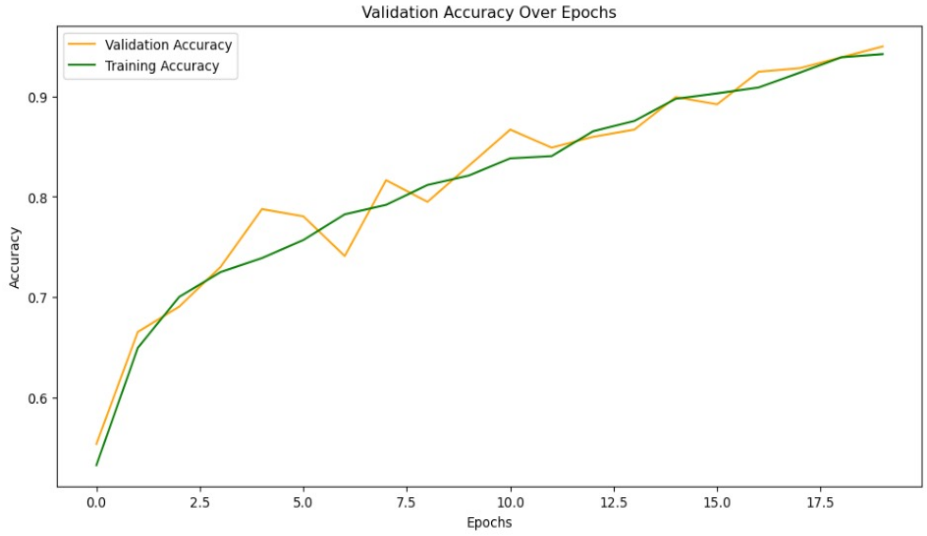
Epochs trained: 19

Runtime: 00:29:48



Vgg16 – fully retrained



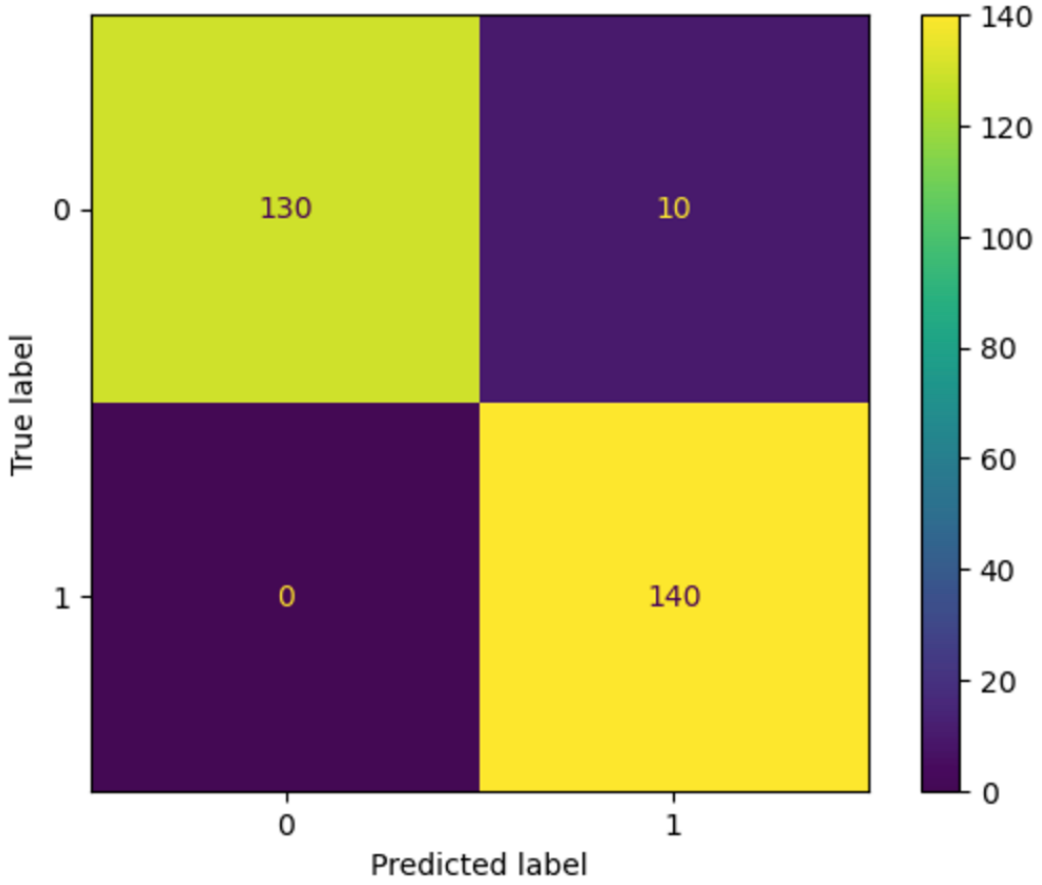


Test loss: 0.0937

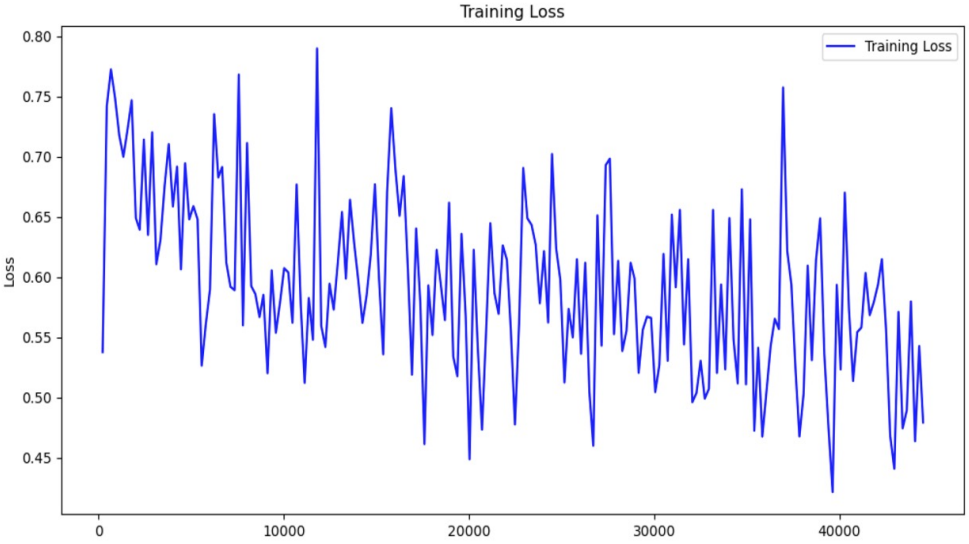
Test Accuracy: 0.9643

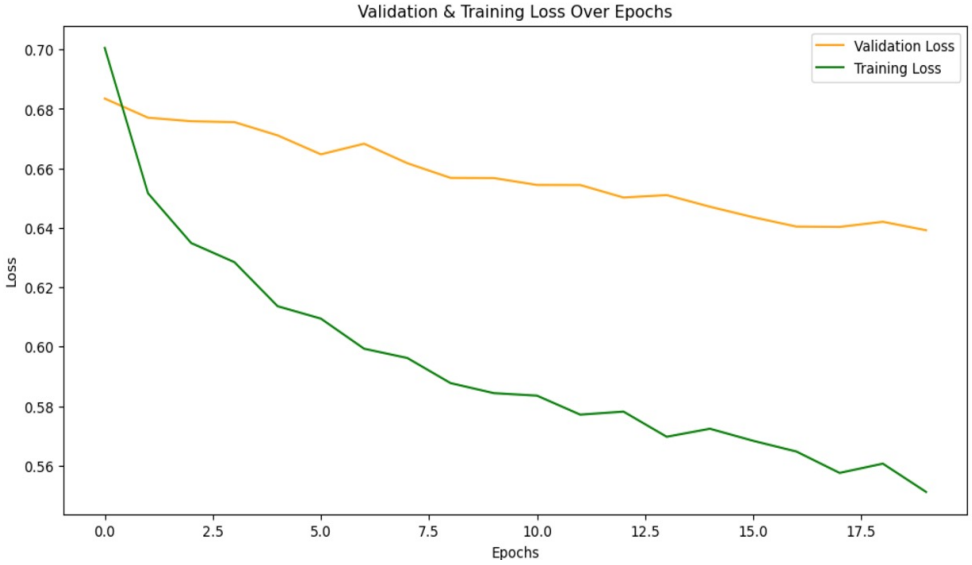
VGG-16: fully retrained; 20 epochs (patience = 2);

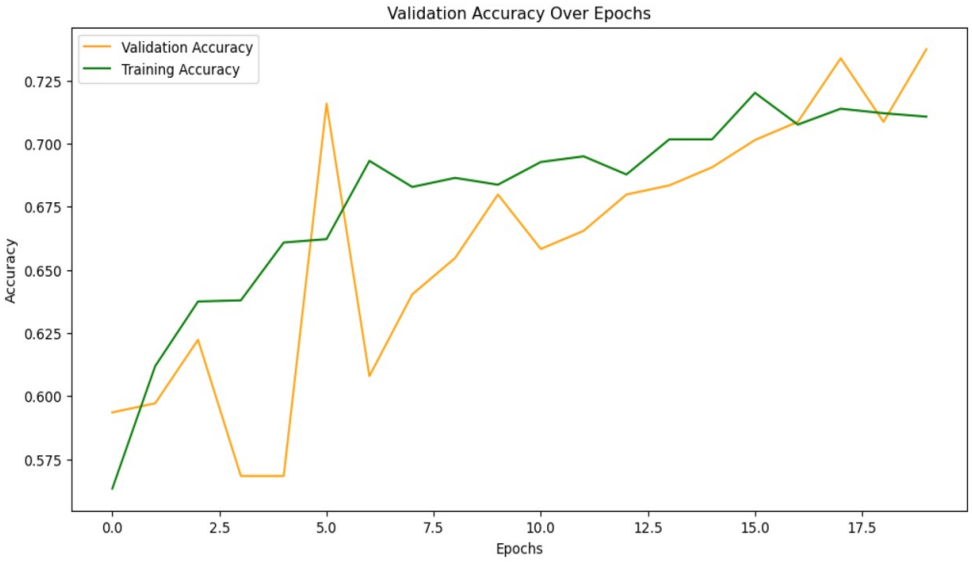
Epochs trained: 20
Runtime: 07:12:22



Autoencoder







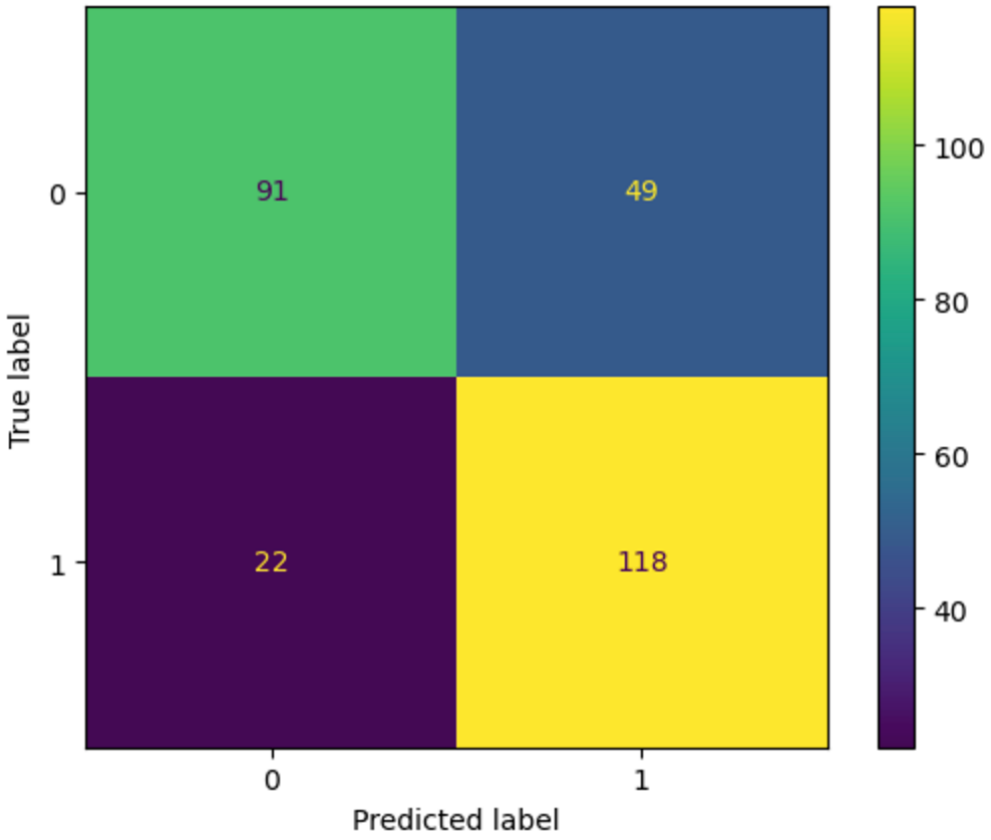
Test loss: 0.6326

Test Accuracy: 0.7464

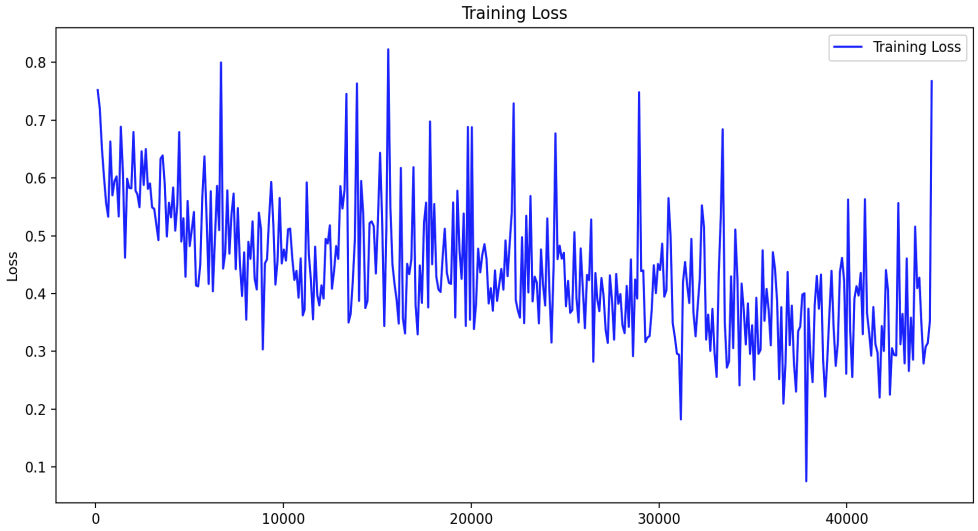
Autoencoder; 20 epochs (patience = 2)

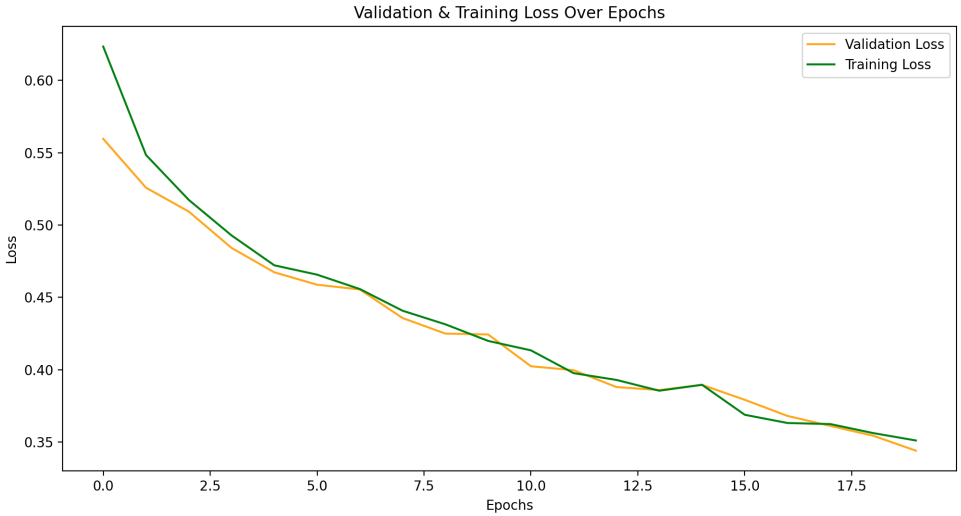
Epochs trained: 20

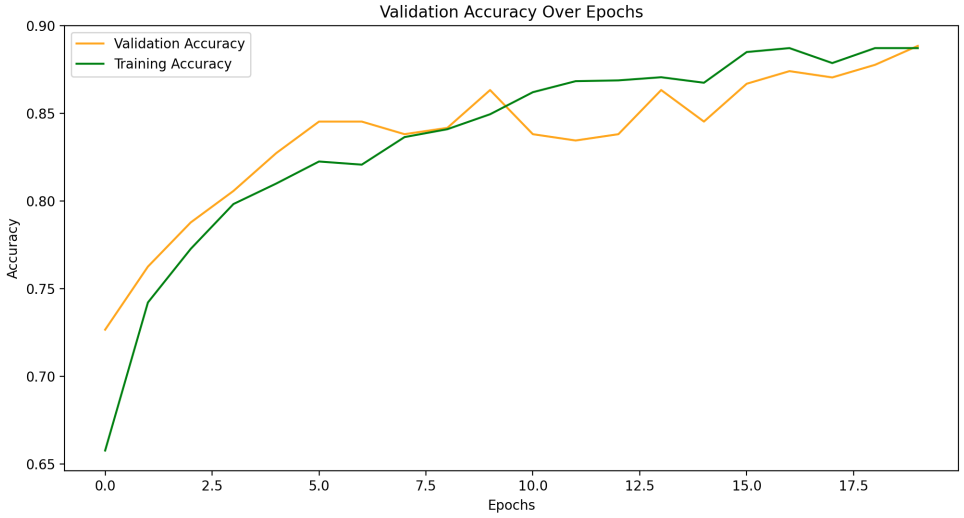
Runtime: 01:03:15



ResNet18 - default







Test loss: 0.3441

Test Accuracy: 0.8885

ResNet18; 20 epochs (patience = 2)

Epochs trained: 20

Runtime: 01:35:38