# Shoe Brand Image Classification with Deep Neural Networks

## Log Report

- ## Members:

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- ## Dataset Information:

Dataset link:
https://publiclyhosteddata.s3.amazonaws.com/nike-adidas-dataset.zip

- ## Dataset Characteristics:

This dataset contains images of shoes belonging to different shoe brands. The images were pulled from bing using bing_image_search from pypi, 400 images of each class were downloaded and then the dataset was trimmed to 300(some unrelated images were removed in the process of compiling the dataset).

- ## Summary Statistics:

There are total 576 images present in the dataset.

- ## Class Information:

There are 2 categories of shoes: Nike, Adidas

The data distribution of images into different scenes is tabularized below

| Categories | Training Data | Validation Data | Testing Data |
|---|---|---|---|
| Nike | 230 | 28 | 30 |
| Adidas | 230 | 27 | 30 |

- Libraries Used -
  - matplotlib
  - numpy
  - pyspark
  - scikit-learn (for visualisation)
  - tensorflow (only for pre-processing)
  - sparkdl (for comparing performance with standard transfer learning models)

- Log Table

Output using different hyperparameters:

1. Learning Rate = 0.1

| Epochs | Rate | Hidden Layers | Train Loss | Train Accuracy | Test Loss | Test Accuracy |
|---|---|---|---|---|---|---|
| 10 | 0.1 | 32 | 0.2675142490405710 | 0.6613043478260870 | 0.5833333333333330 | 0.5906814370359430 |
| 20 | 0.1 | 32 | 0.2438302085704720 | 0.7460869565217390 | 0.6875 | 0.5795862789419990 |
| 30 | 0.1 | 32 | 0.2520712150630560 | 0.7178260869565220 | 0.5625 | 0.614425026166268 |
| 10 | 0.1 | 64 | 0.2536264132063600 | 0.6569565217391300 | 0.3333333333333330 | 0.6729405834844200 |
| 20 | 0.1 | 64 | 0.2597202484237670 | 0.6526086956521740 | 0.5416666666666670 | 0.6087084502148340 |
| 30 | 0.1 | 64 | 0.2492558551313660 | 0.7178260869565220 | 0.4583333333333330 | 0.6291574386802720 |
| 10 | 0.1 | 128 | 0.2638157695393380 | 0.7113043478260870 | 0.4166666666666670 | 0.6452426047558790 |
| 20 | 0.1 | 128 | 0.2473344333045890 | 0.7460869565217390 | 0.6041666666666670 | 0.6198558753738790 |
| 30 | 0.1 | 128 | 0.2455597506340300 | 0.7482608695652170 | 0.6458333333333330 | 0.5884241558346610 |

Learning Rate = 0.2

| Epochs | Rate | Hidden Layers | Train Loss | Train Accuracy | Test Loss | Test Accuracy |
|---|---|---|---|---|---|---|
| 10 | 0.2 | 32 | 0.3152707448225930 | 0.6178260869565220 | 0.5 | 0.6579690752796750 |
| 20 | 0.2 | 32 | 0.2392294107228500 | 0.7395652173913040 | 0.5625 | 0.5913166330188850 |

| | | | | | | |
|---|---|---|---|---|---|---|
| 30 | 0.2 | 32 | 0.23230200659833200 | 0.7960869565217390 | 0.5208333333333330 | 0.6156901312298430 |
| 10 | 0.2 | 64 | 0.24627612976367900 | 0.7134782608695650 | 0.5833333333333330 | 0.5880257440115710 |
| 20 | 0.2 | 64 | 0.2535033130708600 | 0.6852173913043480 | 0.4583333333333330 | 0.6301317470279260 |
| 30 | 0.2 | 64 | 0.22971782650045500 | 0.7634782608695650 | 0.625 | 0.5944487756724880 |
| 10 | 0.2 | 128 | 0.24623739077808800 | 0.7526086956521740 | 0.5625 | 0.6210861539635760 |
| 20 | 0.2 | 128 | 0.22720191615018400 | 0.7830434782608700 | 0.5208333333333330 | 0.6134079049770070 |
| 30 | 0.2 | 128 | 0.2219577704849890 | 0.8221739130434780 | 0.5416666666666670 | 0.6035687583253820 |

Learning Rate = 0.3

| **Epochs** | **Rate** | **Hidden Layers** | **Train Loss** | **Train Accuracy** | **Test Loss** | **Test Accuracy** |
|---|---|---|---|---|---|---|
| 10 | 0.3 | 32 | 0.25433885242712200 | 0.6873913043478260 | 0.6041666666666670 | 0.585873896460828 |
| 20 | 0.3 | 32 | 0.24526839751877100 | 0.7330434782608700 | 0.4375 | 0.6141131773345660 |
| 30 | 0.3 | 32 | 0.24908317983968500 | 0.7113043478260870 | 0.6875 | 0.5854242738030310 |
| 10 | 0.3 | 64 | 0.2608126521520700 | 0.6678260869565220 | 0.4375 | 0.6325282653478170 |
| 20 | 0.3 | 64 | 0.23379250737033100 | 0.7721739130434780 | 0.7291666666666670 | 0.588403922721852 |
| 30 | 0.3 | 64 | 0.22849949100935100 | 0.7895652173913040 | 0.5208333333333330 | 0.5996544713191160 |
| 10 | 0.3 | 128 | 0.24451328072397700 | 0.7591304347826090 | 0.5416666666666670 | 0.6205496334588060 |
| 20 | 0.3 | 128 | 0.23149074459534700 | 0.7786956521739130 | 0.6041666666666670 | 0.6126546226116000 |
| 30 | 0.3 | 128 | 0.22594945304866300 | 0.7960869565217390 | 0.375 | 0.6383159948352940 |

2. Hidden Layers = 32

| Epochs | Rate | Hidden Layers | Train Loss | Train Accuracy | Test Loss | Test Accuracy |
|---|---|---|---|---|---|---|
| 10 | 0.1 | 32 | 0.26751424904057100 | 0.6613043478260870 | 0.5833333333333330 | 0.5906814370359430 |
| 20 | 0.1 | 32 | 0.2438302085704720 | 0.7460869565217390 | 0.6875 | 0.5795862789419990 |
| 30 | 0.1 | 32 | 0.2520712150630560 | 0.7178260869565220 | 0.5625 | 0.614425026166268 |
| 10 | 0.2 | 32 | 0.31527074482259300 | 0.6178260869565220 | 0.5 | 0.6579690752796750 |
| 20 | 0.2 | 32 | 0.2392294107228500 | 0.7395652173913040 | 0.5625 | 0.5913166330188850 |
| 30 | 0.2 | 32 | 0.2323020065983200 | 0.7960869565217390 | 0.5208333333333330 | 0.6156901312298430 |
| 10 | 0.3 | 32 | 0.2543388524271200 | 0.6873913043478260 | 0.6041666666666670 | 0.585873896460828 |
| 20 | 0.3 | 32 | 0.2452683975187700 | 0.7330434782608700 | 0.4375 | 0.6141131773345660 |
| 30 | 0.3 | 32 | 0.2490831798396850 | 0.7113043478260870 | 0.6875 | 0.5854242738030310 |

Hidden Layers = 64

| Epochs | Rate | Hidden Layers | Train Loss | Train Accuracy | Test Loss | Test Accuracy |
|---|---|---|---|---|---|---|
| 10 | 0.1 | 64 | 0.2536264132063600 | 0.6569565217391300 | 0.3333333333333330 | 0.6729405834844200 |
| 20 | 0.1 | 64 | 0.2597202484237670 | 0.6526086956521740 | 0.5416666666666670 | 0.6087084502148340 |
| 30 | 0.1 | 64 | 0.2492558551313660 | 0.7178260869565220 | 0.4583333333333330 | 0.6291574386802720 |
| 10 | 0.2 | 64 | 0.2462761297636790 | 0.7134782608695650 | 0.5833333333333330 | 0.5880257440115710 |
| 20 | 0.2 | 64 | 0.2535033130708600 | 0.6852173913043480 | 0.4583333333333330 | 0.6301317470279260 |
| 30 | 0.2 | 64 | 0.2297178265004550 | 0.7634782608695650 | 0.625 | 0.5944487756724880 |
| 10 | 0.3 | 64 | 0.2608126521520700 | 0.6678260869565220 | 0.4375 | 0.6325282653478170 |
| 20 | 0.3 | 64 | 0.2337925073703310 | 0.7721739130434780 | 0.7291666666666670 | 0.5884039227218520 |
| 30 | 0.3 | 64 | 0.2284994910093510 | 0.7895652173913040 | 0.5208333333333330 | 0.5996544713191160 |

Hidden Layers = 128

| Epochs | Rate | Hidden Layers | Train Loss | Train Accuracy | Test Loss | Test Accuracy |
|---|---|---|---|---|---|---|
| 10 | 0.1 | 128 | 0.2638157695393380 | 0.711304347826087 | 0.4166666666666670 | 0.6452426047558790 |
| 20 | 0.1 | 128 | 0.2473344333045890 | 0.746086956521390 | 0.6041666666666670 | 0.6198558753738790 |
| 30 | 0.1 | 128 | 0.2455597506340300 | 0.748260869565217 | 0.6458333333333330 | 0.5884241558346610 |
| 10 | 0.2 | 128 | 0.2462373907780800 | 0.752608695652174 | 0.5625 | 0.6210861539635760 |
| 20 | 0.2 | 128 | 0.2272019161501840 | 0.783043478260870 | 0.5208333333333330 | 0.6134079049770070 |
| 30 | 0.2 | 128 | 0.2219577704849890 | 0.822173913043478 | 0.5416666666666670 | 0.6035687583253820 |
| 10 | 0.3 | 128 | 0.2445132807239700 | 0.759130434782609 | 0.5416666666666670 | 0.6205496334588060 |
| 20 | 0.3 | 128 | 0.2314907445953470 | 0.778695652173913 | 0.6041666666666670 | 0.6126546226116000 |
| 30 | 0.3 | 128 | 0.2259494530486630 | 0.796086956521739 | 0.375 | 0.6383159948352940 |

3. Number of epochs = 10

| Epochs | Rate | Hidden Layers | Train Loss | Train Accuracy | Test Loss | Test Accuracy |
|---|---|---|---|---|---|---|
| 10 | 0.1 | 32 | 0.2675142490405710 | 0.661304347826870 | 0.5833333333333330 | 0.5906814370359430 |
| 10 | 0.2 | 32 | 0.3152707448225930 | 0.617826086956520 | 0.5 | 0.6579690752796750 |
| 10 | 0.3 | 32 | 0.2543388524271220 | 0.687391304347826 | 0.6041666666666670 | 0.585873896460828 |
| 10 | 0.1 | 64 | 0.2536264132063600 | 0.656956521739130 | 0.3333333333333330 | 0.6729405834844200 |
| 10 | 0.2 | 64 | 0.2462761297636790 | 0.713478260869565 | 0.5833333333333330 | 0.5880257440115710 |
| 10 | 0.3 | 64 | 0.2608126521520700 | 0.667826086956520 | 0.4375 | 0.6325282653478170 |
| 10 | 0.1 | 128 | 0.2638157695393380 | 0.711304347826087 | 0.4166666666666670 | 0.6452426047558790 |
| 10 | 0.2 | 128 | 0.2462373907780800 | 0.752608695652174 | 0.5625 | 0.6210861539635760 |
| 10 | 0.3 | 128 | 0.2445132807239700 | 0.759130434782609 | 0.5416666666666670 | 0.6205496334588060 |

Number of epochs = 20

| Epochs | Rate | Hidden Layers | Train Loss | Train Accuracy | Test Loss | Test Accuracy |
|---|---|---|---|---|---|---|
| 20 | 0.1 | 32 | 0.2438302085704720 | 0.7460869565217390 | 0.6875 | 0.5795862789419990 |
| 20 | 0.2 | 32 | 0.2392294107228500 | 0.7395652173913040 | 0.5625 | 0.5913166330188850 |
| 20 | 0.3 | 32 | 0.2452683975187710 | 0.7330434782608700 | 0.4375 | 0.6141131773345660 |
| 20 | 0.1 | 64 | 0.2597202484237670 | 0.6526086956521740 | 0.5416666666666670 | 0.6087084502148340 |
| 20 | 0.2 | 64 | 0.2535033130708600 | 0.6852173913043480 | 0.4583333333333330 | 0.6301317470279260 |
| 20 | 0.3 | 64 | 0.2337925073703310 | 0.7721739130434780 | 0.7291666666666670 | 0.5884039227218520 |
| 20 | 0.1 | 128 | 0.2473344333045890 | 0.7460869565217390 | 0.6041666666666670 | 0.6198558753738790 |
| 20 | 0.2 | 128 | 0.2272019161501840 | 0.7830434782608700 | 0.5208333333333330 | 0.6134079049770070 |
| 20 | 0.3 | 128 | 0.2314907445953470 | 0.7786956521739130 | 0.6041666666666670 | 0.6126546226116000 |

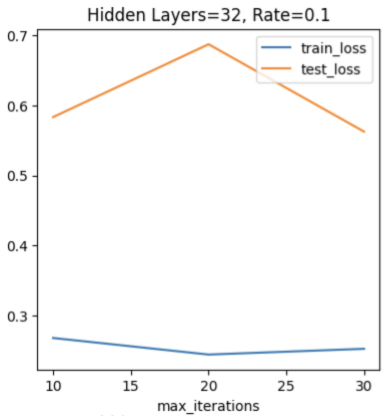
Number of epochs = 30

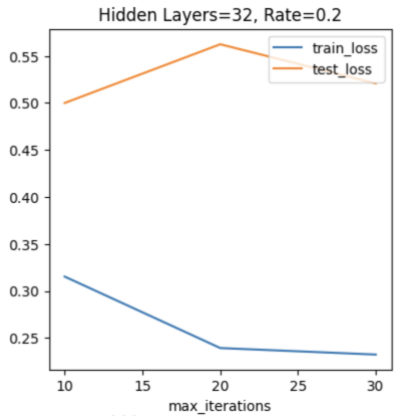
| Epochs | Rate | Hidden Layers | Train Loss | Train Accuracy | Test Loss | Test Accuracy |
|---|---|---|---|---|---|---|
| 30 | 0.1 | 32 | 0.2520712150630560 | 0.7178260869565220 | 0.5625 | 0.6144250261662680 |
| 30 | 0.2 | 32 | 0.2323020065983320 | 0.7960869565217390 | 0.5208333333333330 | 0.6156901312298430 |
| 30 | 0.3 | 32 | 0.2490831798396850 | 0.7113043478260870 | 0.6875 | 0.5854242738030310 |
| 30 | 0.1 | 64 | 0.2492558551313660 | 0.7178260869565220 | 0.4583333333333330 | 0.6291574386802720 |
| 30 | 0.2 | 64 | 0.2297178265004550 | 0.7634782608695650 | 0.625 | 0.5944487756724880 |
| 30 | 0.3 | 64 | 0.2284994910093510 | 0.7895652173913040 | 0.5208333333333330 | 0.5996544713191160 |
| 30 | 0.1 | 128 | 0.2455597506340300 | 0.7482608695652170 | 0.6458333333333330 | 0.5884241558346610 |
| 30 | 0.2 | 128 | 0.2219577704849890 | 0.8221739130434780 | 0.5416666666666670 | 0.6035687583253820 |
| 30 | 0.3 | 128 | 0.2259494530486630 | 0.7960869565217390 | 0.375 | 0.6383159948352940 |

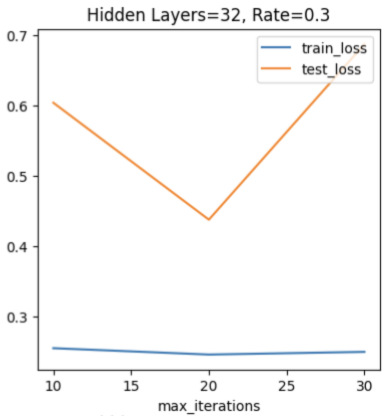
- Model Plots

Loss curve for models tuned with different hyperparameter combinations:

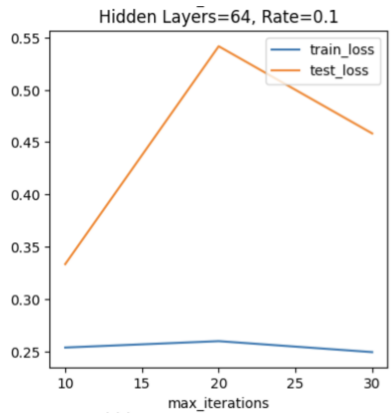
(i) Hidden Layers = 32

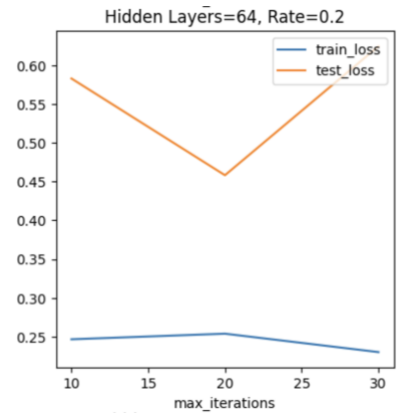


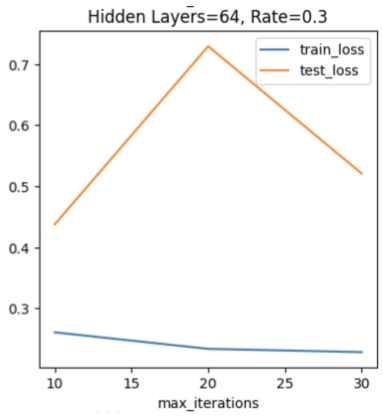



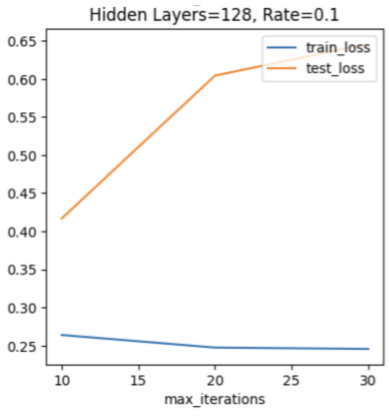

(ii) Hidden Layers = 64

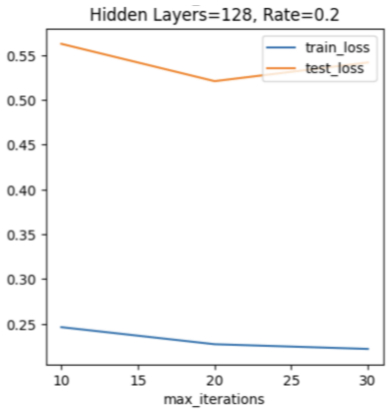


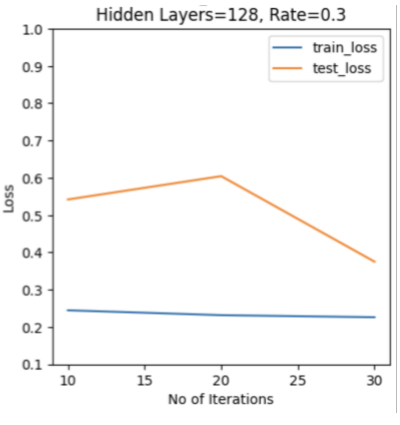




(iii) Hidden Layers = 128

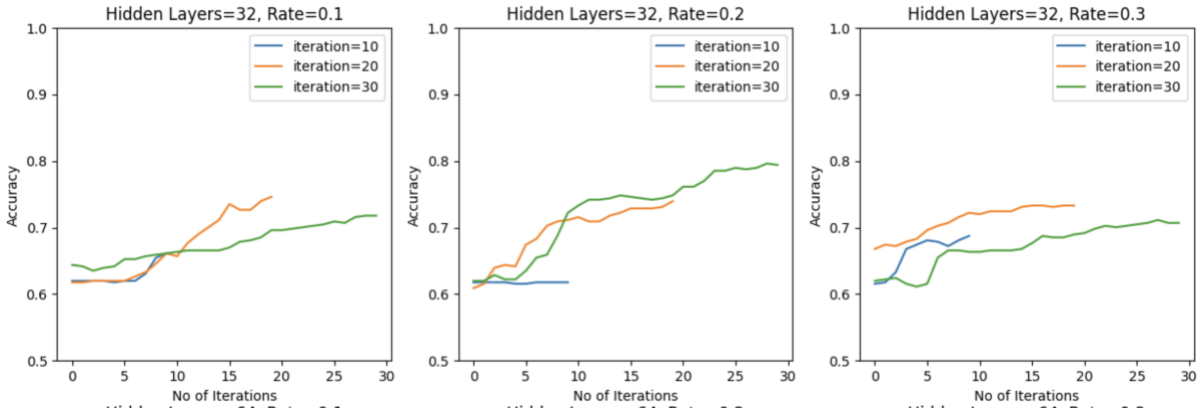


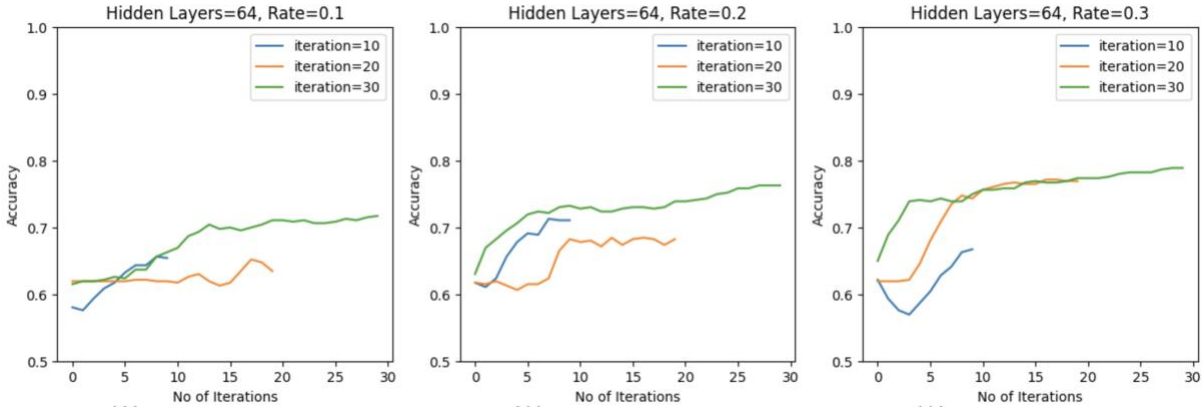



Accuracy curve for models tuned with different hyperparameter combinations:

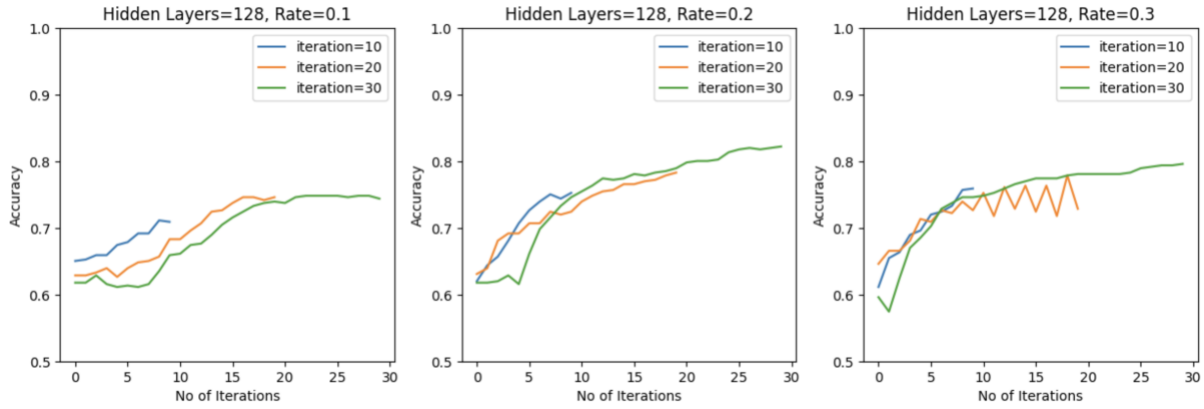
(i) Hidden Layers = 32




(ii) Hidden Layers = 64




(iii) Hidden Layers = 128



- ## Summary

As observed by us, for the dataset used, we obtained the best output/result for the following parameters:

1. Hyperparameters:

Max Number of Iterations: 30
Learning Rate: 0.2
Hidden Layers: 128

2. Result:

Training Accuracy: 0.822174
Test Accuracy: 0.803569
Training Loss: 0.221958
Testing Loss: 0.541667

We reached this conclusion after having a detailed comparison between a combination of parameters, which are logged into a tabular format.