1.

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| **Data size** | **Configuration** | **Training error** | **Validation error** | **Time of execution** |
| 1000 | 1 hidden layer 4 nodes | 0.061406 | 0.043239 | 17.5122 |
| 10000 | 1 hidden layer 4 nodes | 0.008779 | 0.011313 | 54.55 |
| 100000 | 1 hidden layer 4 nodes | 0.003282 | 0.003973 | 427.56 |
| 1000 | 2 hidden layers of 4 nodes each | 0.027271 | 0.028756 | 14.16 |
| 10000 | 2 hidden layers of 4 nodes each | 0.004131 | 0.008034 | 56.26 |
| 100000 | 2 hidden layers of 4 nodes each | 0.003221 | 0.003501 | 454.29 |

2.

The model with 2 hidden layers of 4 nodes each trained on 100,000 data points demonstrates the best performance based on training and validation error assessments. The selected model configuration reaches the lowest validation error rate of 0.003501 among all tested setups thus demonstrating superior performance on new data points. The model demonstrates excellent fit with minimal overfitting because its training error stands at 0.003221. The model takes 454.29 seconds to execute but delivers improved prediction results that validate the longer processing time. The deeper architecture successfully detects complex patterns within the larger dataset because its increased computational complexity offers significant benefits for this modeling task.

3.

|  |  |  |  |
| --- | --- | --- | --- |
| Method Used | Dataset Size | Testing-set predictive performance (Test Accuracy) | Time taken for the model to be fit |
| XGBoost in Python via scikit-learn and 5-fold CV | 100 | 1.000 | 0.180s |
|  | 1000 | 0.975 | 0.898s |
|  | 10000 | 0.9815 | 0.539s |
|  | 100000 | 0.9881 | 2.6393s |

XGBoost proves to be the superior model when compared to deep learning models through its superior performance across all evaluation metrics. XGBoost reaches test accuracy levels from 0.975 to 0.9881 while running significantly faster than deep learning models which needed 14-454 seconds for completion. The deep learning model with 2 hidden layers and 100000 data points attained a validation error of 0.003501 translating to around 0.9965 accuracy that came close to XGBoost's exact accuracy rate of 0.9881 on the similar dataset size. The execution time for XGBoost outpaced other models by 172 times because it needed 2.64 seconds instead of 454.29 seconds. XGBoost proves itself to be the superior model selection for this problem by delivering both exceptionally fast processing along with satisfactory accuracy levels and superior performance on smaller data sets.