Milestone 4 – Final Comparison

Additional task accomplished

1. Decision Tree trained with CART algorithm without pruning. (10 fold cross validation)
2. Support Vector Machine trained with Gaussian Kernel. (10 fold cross validation)

Comparison (Decision Tree, Support Vector Machine, Gaussian Process and Linear Regression)

For two labels in the dataset, the performance is consistent:

Our of fold loss (MSE):

GP (Squared Exponential Kernel) ~ GP (Matern 3/2 Kernel) < SVM < Linear Regression < Decision Tree

Training time:

Linear Regression < Decision Tree < SVM < GP (Squared Exponential Kernel) ~ GP (Matern 3/2 Kernel)

The results for training with PCA is similar except that all MSE loss increase slightly compared to the model trained with full dataset.

Because this is a regression problem/dataset (mapping the voice measurements to the unified score), we are particularly interested in understanding/assessing how well the model fits the training data. Even though overfitting can really hurt the prediction performance, we are using cross validation to help reduce overfitting while still aim to fit the training data as much as possible. Therefore we used to measure how well the model fits the training data and GP has the best performance compared to other models.

The time for GP is much worse compared to other models, but for this particular dataset/training, it is okay because thirty seconds is not writable. In any cases where the training data is significantly larger, GP may not be the best option in terms of the time cost.

The detailed data is represented in the tables below:

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| Loss w/ M label | GP w/ Sqaured Exponential Kernel | GP w/ Matern 3/2 Kernel | Linear Regression | SVM | Tree |
| Trial 1 | 47.69661129 | 37.937923 | 57.15221749 | 54.11742058 | 79.35755284 |
| Trial 2 | 39.32462598 | 40.47016312 | 58.13904129 | 55.21840582 | 76.80713033 |
| Trial 3 | 44.56767741 | 43.31933254 | 65.08094938 | 51.60456771 | 74.47098075 |
| Trial 4 | 42.86944459 | 41.95604508 | 60.59913909 | 52.54441636 | 75.35458443 |
| Trial 5 | 38.72965416 | 37.97635988 | 58.5480321 | 54.13477613 | 67.51066367 |
| Trial 6 | 41.68365579 | 39.62072736 | 62.93905963 | 54.52823908 | 76.54447887 |
| Trial 7 | 39.53462029 | 41.2420908 | 59.21276744 | 54.43315283 | 73.52275196 |
| Trial 8 | 42.67138221 | 44.06760763 | 62.4439867 | 50.09593282 | 79.6002797 |
| Trial 9 | 42.51385735 | 40.63825756 | 60.84722064 | 54.36112278 | 71.24434943 |
| Trial 10 | 39.0447405 | 41.52144738 | 66.54929684 | 52.93532489 | 84.76729385 |
| **Average** | **41.86362696** | **40.87499544** | **61.15117106** | **53.3973359** | **75.91800658** |
|  |  |  |  |  |  |
|  |  |  |  |  |  |
| Loss w/ T label | GP w/ Sqaured Exponential Kernel | GP w/ Matern 3/2 Kernel | Linear Regression | SVM | Tree |
| Trial 1 | 64.31165358 | 70.70019911 | 96.32940585 | 98.82156641 | 113.3479289 |
| Trial 2 | 73.59946174 | 63.54830686 | 92.72126563 | 96.19183906 | 126.2778462 |
| Trial 3 | 64.42268926 | 71.90963291 | 107.8671364 | 88.90009354 | 140.6179852 |
| Trial 4 | 62.1070148 | 64.2740245 | 99.35574789 | 104.723799 | 133.4390898 |
| Trial 5 | 72.86799023 | 79.96841165 | 102.0181749 | 95.39640419 | 150.4355627 |
| Trial 6 | 76.67276319 | 71.61560832 | 112.7847753 | 102.5389806 | 116.5823097 |
| Trial 7 | 71.59139487 | 72.88587731 | 102.6488336 | 101.7098959 | 119.2572442 |
| Trial 8 | 65.61913488 | 78.75419607 | 97.86260705 | 93.2752645 | 132.1542909 |
| Trial 9 | 71.00100486 | 69.21137462 | 98.16659803 | 97.3418311 | 116.467682 |
| Trial 10 | 68.0843772 | 64.67747559 | 109.6629991 | 98.5805465 | 147.6288078 |
| **Average** | **69.02774846** | **70.7545107** | **101.9417544** | **97.74802207** | **129.6208747** |
| **R-squared** | **0.39** | **0.39** | **0.15** | **0.37** | **-0.07** |
|  |  |  |  |  |  |
| Time w/ M Label | GP w/ Sqaured Exponential Kernel | GP w/ Matern 3/2 Kernel | Linear Regression | SVM | Tree |
| Trial 1 | 28.907 | 31.701 | 0.36 | 1.09 | 0.597 |
| Trial 2 | 23.315 | 31.265 | 0.045 | 1.005 | 0.45 |
| Trial 3 | 28.862 | 27.289 | 0.032 | 0.965 | 0.465 |
| Trial 4 | 23.771 | 30.076 | 0.027 | 0.967 | 0.495 |
| Trial 5 | 25.724 | 33.397 | 0.032 | 0.975 | 0.498 |
| Trial 6 | 25.606 | 34.772 | 0.028 | 0.99 | 0.197 |
| Trial 7 | 28.355 | 31.499 | 0.028 | 0.958 | 0.17 |
| Trial 8 | 31.633 | 33.806 | 0.028 | 1.91 | 0.18 |
| Trial 9 | 31.791 | 42.222 | 0.028 | 1.962 | 0.18 |
| Trial 10 | 33.711 | 36.012 | 0.027 | 0.97 | 0.165 |
| **Average** | **28.1675** | **33.2039** | **0.0635** | **1.1792** | **0.3397** |
|  |  |  |  |  |  |
| Time w/ T Label | GP w/ Sqaured Exponential Kernel | GP w/ Matern 3/2 Kernel | Linear Regression | SVM | Tree |
| Trial 1 | 30.453 | 47.432 | 0.025 | 0.932 | 0.168 |
| Trial 2 | 28.704 | 38.076 | 0.028 | 0.976 | 0.185 |
| Trial 3 | 32.264 | 33.442 | 0.028 | 0.995 | 0.167 |
| Trial 4 | 30.061 | 33.727 | 0.027 | 0.972 | 0.162 |
| Trial 5 | 31.401 | 35.505 | 0.028 | 0.975 | 0.157 |
| Trial 6 | 26.503 | 35.544 | 0.032 | 1.265 | 0.163 |
| Trial 7 | 29.921 | 37.554 | 0.03 | 2.613 | 0.17 |
| Trial 8 | 30.934 | 34.609 | 0.027 | 0.957 | 0.17 |
| Trial 9 | 33.031 | 35.536 | 0.025 | 0.982 | 0.181 |
| Trial 10 | 32.705 | 30.205 | 0.025 | 0.971 | 0.167 |
| **Average** | **30.5977** | **36.163** | **0.0275** | **1.1638** | **0.169** |