|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| S.No. | Kernel | Penalty Parameter  ( C ) | Kernel Coefficient (gamma) | Training Time  (in seconds) | Accuracy  (% age) |
| 1.1 | Radial Basis Function (rbf) | 1 | 0.0 | 14.717918573825267 | 53.51637764932563 |
| 1.2 | Radial Basis Function (rbf) | 1 | 5.0 | 20.259658244591563 | 88.294797687861271 |
| 1.3 | Radial Basis Function (rbf) | 1 | 10.0 | 49.77984757556541 | 86.801541425818884 |
| 2.1 | Radial Basis Function (rbf) | 10 | 0.0 | 10.91928373088761 | 80.973025048169556 |
| 2.2 | Radial Basis Function (rbf) | 10 | 5.0 | 19.581059889092217 | 88.969171483622356 |
| 2.3 | Radial Basis Function (rbf) | 10 | 10.0 | 50.659539527844345 | 87.235067437379576 |
| 3.1 | Radial Basis Function (rbf) | 100 | 0.0 | 7.2436635577647195 | 86.705202312138729 |
| 3.2 | Radial Basis Function (rbf) | 100 | 5.0 | 19.243339823695365 | 88.294797687861271 |
| 3.3 | Radial Basis Function (rbf) | 100 | 10.0 | 50.66085798509113 | 87.186897880539505 |
| 4.1 | Radial Basis Function (rbf) | 1000 | 0.0 | 6.068772320865371 | 88.150289017341044 |
| 4.2 | Radial Basis Function (rbf) | 1000 | 5.0 | 19.179974332207593 | 88.294797687861271 |
| 4.3 | Radial Basis Function (rbf) | 1000 | 10.0 | 50.54288278987775 | 87.186897880539505 |
| 5.1 | Radial Basis Function (rbf) | 10000 | 0.0 | 6.277793767285239 | 87.668593448940269 |
| 5.2 | Radial Basis Function (rbf) | 10000 | 5.0 | 19.17688324917816 | 88.294797687861271 |
| 5.3 | Radial Basis Function (rbf) | 10000 | 10.0 | 50.95072527978192 | 87.186897880539505 |
| 6.1 | Radial Basis Function (rbf) | 100000 | 0.0 | 7.173925166539156 | 87.572254335260113 |
| 6.2 | Radial Basis Function (rbf) | 100000 | 5.0 | 19.18787737791652 | 88.294797687861271 |
| 6.3 | Radial Basis Function (rbf) | 100000 | 10.0 | 50.592198137224784 | 87.186897880539505 |
| 7.1 | Radial Basis Function (rbf) | 1000000 | 0.0 | 9.732850540490489 | 87.186897880539505 |
| 7.2 | Radial Basis Function (rbf) | 1000000 | 5.0 | 19.2118927152992 | 88.294797687861271 |
| 7.3 | Radial Basis Function (rbf) | 1000000 | 10.0 | 50.54131843158757 | 87.186897880539505 |

Fig. Change in **Accuracy** and **Training time** with change in SVC parameters **C** and **gamma** [for ‘**rbf’** kernel]

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| S.No. | Kernel | Penalty Parameter ( C ) | Training Time (in seconds) | Accuracy (% age) |
| 1 | Linear | 1 | 5.744766691228165 | 85.597302504816952 |
| 2 | Linear | 10 | 4.48024516547855 | 88.439306358381498 |
| 3 | Linear | 100 | 4.467598581728339 | 87.909441233140651 |
| 4 | Linear | 1000 | 5.394875593316442 | 87.475915221579958 |
| 5 | Linear | 10000 | 10.462791323242755 | 87.186897880539505 |
| 6 | Linear | 100000 | 101.26224597887654 | 87.090558766859349 |

Fig. Change in **Accuracy** and **Training time** with change in SVC parameter **C** [for ‘**linear’** kernel]

**OBSERVATIONS:**

Using different values for the **Penalty Parameter ( C )** and **Kernel coefficient ( gamma )**, we found that:

For ‘rbf’ kernel:

* For a fixed **gamma** value, with the increase in the value of **C,** the accuracy of our predictions increased gradually,

reached a certain maximum value and then decreased gradually or remained constant.

This observation can be justified because as we increase the value of **C,** the generality of the classification model

is also decreased and is somewhat lost with very large value of **C** as the model tries to include every outlier inside

the correct decision boundary and results in overfitting the training data.

For ‘linear’ kernel:

* Training time increased with increasing value of **C**, and increasesby a high amount after C = 10000.
* gamma parameter have NO significance for the ‘linear’ kernel function.

**BEST RESULTS:**

The following are the best results we found from our experiments:

For ‘rbf’ kernel:

* C = 10.0
* gamma = 5.0
* Training Time taken = 19.581059889092217 seconds
* Accuracy on test dataset = 88.969171483622356 %

For ‘linear’ kernel:

* C = 10.0
* Training Time taken = 4.48024516547855 seconds
* Accuracy on test dataset = 88.439306358381498 %

After taking these observations, we then took the values of the svc parameters **C** and **gamma** of the 5 most accurate observations.

We then used these 5 most accurate observations to computed the **Average Accuracy** and **Average Training time** with different

random splits of training and test, for both the ‘**rbf’** and the ‘**linear’** kernel.

Use of random training and test dataset:

|  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- |
| S.No. | Kernel | Penalty Parameter  ( C ) | Kernel Coefficient (gamma) | Average Training Time  (in seconds) | Average Accuracy  (% age) | Minimum Accuracy  (% age) | Maximum Accuracy  (% age) |
| 1. | Radial Basis Function (rbf) | 10 | 5.0 | 19.59759051189758 | 87.591522157996149 | 86.849710982658956 | 88.198458574181116 |
| 2. | Radial Basis Function (rbf) | 1 | 5.0 | 19.828029212188813 | 88.236994219653186 | 88.053949903660889 | 88.342967244701354 |
| 3. | Radial Basis Function (rbf) | 100 | 5.0 | 19.10364374027886 | 86.531791907514455 | 85.9344894026975 | 86.705202312138729 |
| 4. | Radial Basis Function (rbf) | 1000 | 5.0 | 18.75711862138014 | 87.976878612716758 | 87.186897880539505 | 88.198458574181116 |
| 5. | Radial Basis Function (rbf) | 10000 | 5.0 | 20.28234682823986 | 88.737957610789986 | 87.861271676300579 | 89.25818882466281 |

Fig. Computation of **Average Accuracy** and **Average Training time** with different random splits of training and test datasets for fixed value of SVC parameters **C** and **gamma** [for ‘**rbf’** kernel]

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
| S.No. | Kernel | Penalty Parameter  ( C ) | Average Training Time  (in seconds) | Average Accuracy  (% age) | Minimum Accuracy  (% age) | Maximum Accuracy  (% age) |
| 1. | Linear | 10 | 26.454119013539277 | 86.310211946050097 | 85.308285163776498 | 87.668593448940269 |
| 2. | Linear | 100 | 19.094978187508424 | 87.360308285163779 | 86.657032755298646 | 88.872832369942201 |
| 3. | Linear | 1000 | 26.599559003206924 | 85.462427745664737 | 84.489402697495186 | 86.897880539499039 |
| 4. | Linear | 10000 | 19.12901739225981 | 87.283236994219648 | 86.416184971098264 | 88.535645472061653 |
| 5. | Linear | 100000 | 22.862347076279367 | 88.169556840077068 | 87.475915221579958 | 89.0655105973025 |

Fig. Computation of **Average Accuracy** and **Average Training time** with different random splits of training and test datasets for fixed value of SVC parameter **C** [for ‘**linear** kernel]

**OBSERVATIONS:**

Using different random splits of training and test datasets for fixed value of svc parameters, we found that:

For ‘rbf’ kernel:

* All the top 5 most accurate observations were found having gamma = 5.0 .
* We found that the best result found on average basis is having different **C** parameter from the best result found previously.

This is the result of the change in training and test dataset, which shows that the accuracy depends heavily on the training data,

as well as the test data on which the model is to be tested of the same dataset. So, we cannot fix the value of the parameters **C** and **gamma**

and say that these are the perfect parameter values for this dataset. The parameter values which are best for a specific split of training and test data may not be the best for any other split.

* So, we cannot find the perfect parameter values for the dataset if the training and test datasets are applicable to changes but we can find the perfect parameter values for a dataset with fixed training and test dataset.
* We even reached 89.25 % accuracy for some random splitting of out dataset in our last observation, which also turned out to be the best observation.

For ‘linear’ kernel:

* In this case also we have different best results for the same reason as above.
* Here also we reached 89.06 % accuracy for some random splitting of out dataset in our last observation, which also turned out to be the best observation.

**BEST RESULTS:**

The following are the best results we found from our experiments:

For ‘rbf’ kernel:

* C = 10000.0
* gamma = 5.0
* Average Training Time taken = 20.28234682823986 seconds
* Average Accuracy on test dataset = 88.737957610789986 %

For ‘linear’ kernel:

* C = 100000.0
* Average Training Time taken = 22.862347076279367 seconds
* Average Accuracy on test dataset = 88.169556840077068 %