Project 1: Dimension Reduction, Predictive Modeling, and Mislabeling

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MVE441 Statistical Learning for Big Data

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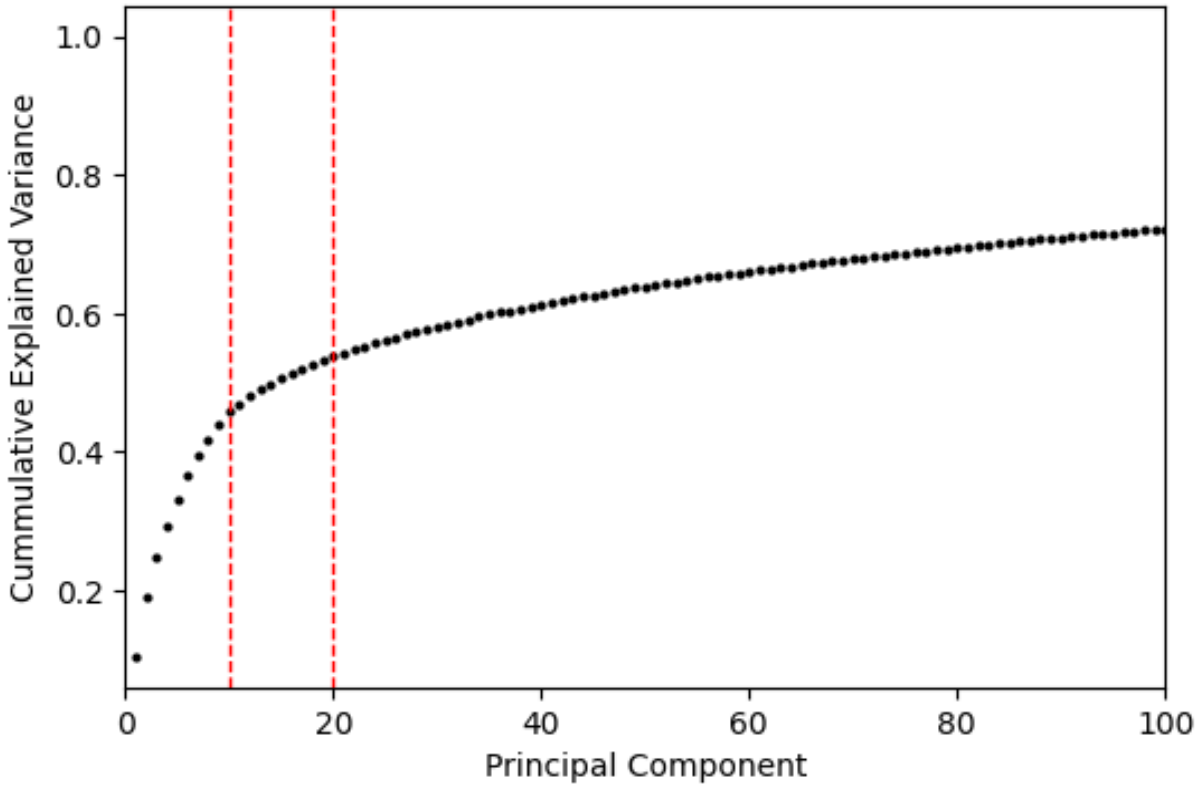
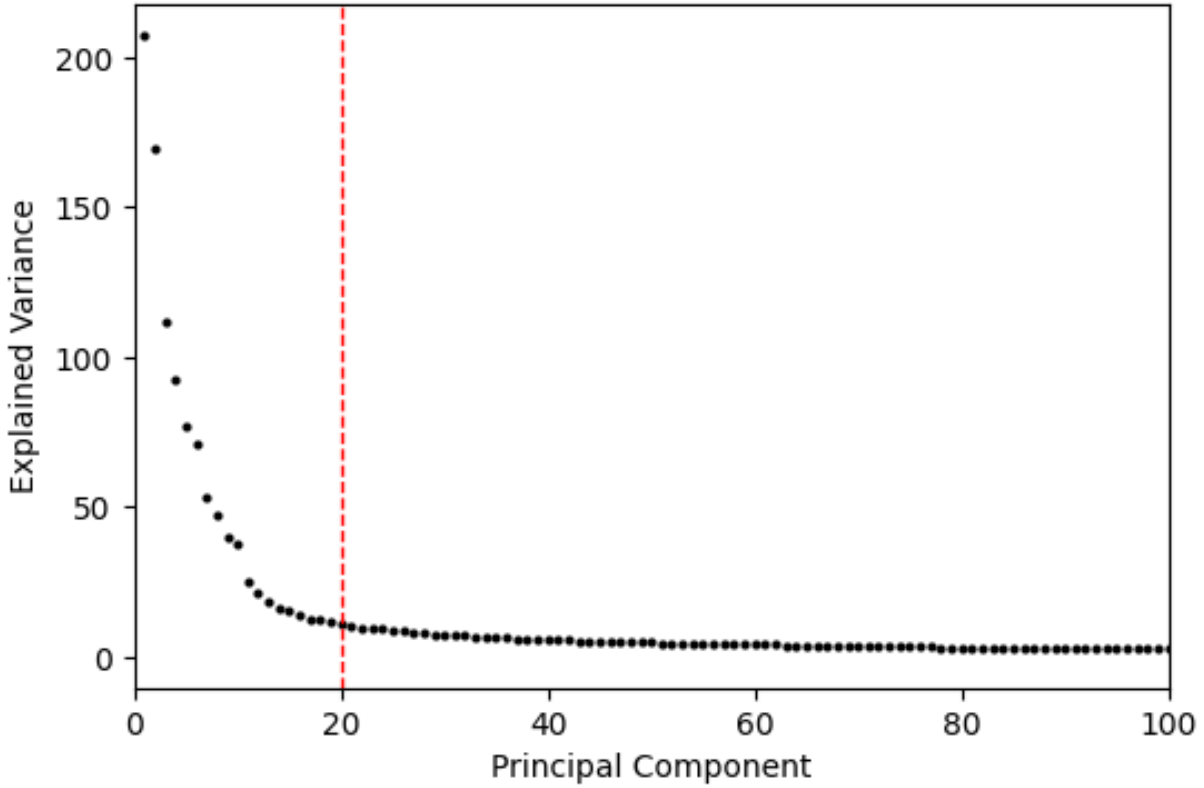
Scale data and explore PCA

Ratio of explained variance



Elbow method



Both methods suggest the number of principle components around >20

3 different classifiers of different character

kNN, small k

- the closer 2 points the more similar they are

QDA

- p(x|i) ~ Normal (should be tested)
- QDA assumes that each class has its own covariance matrix

Logistic Regression

- Binary classification (extended to multiclass using softmax)
- No multicollinearity (reduced with PCA)
- Large sample (sample of 2000)
- Linear relationship of variables to log odds
- No outliers
- Independent observations

Flexible

Moderate

Rigid

Setup

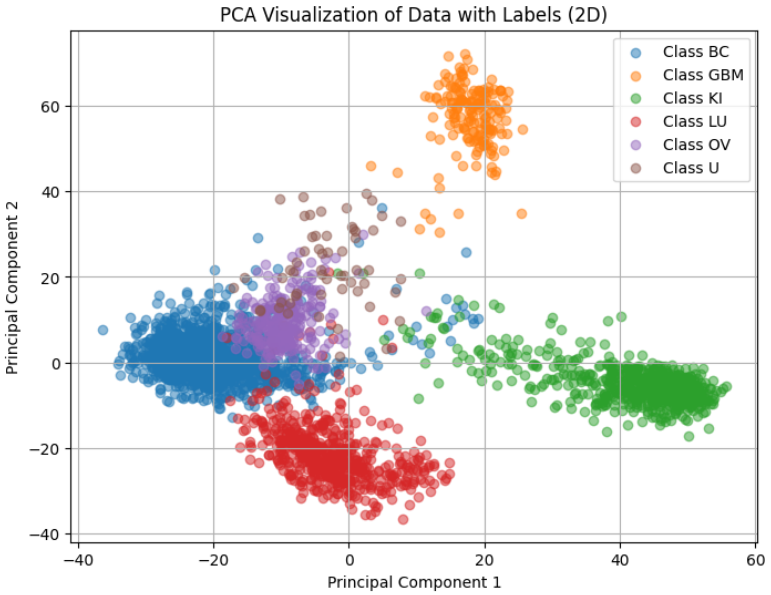
- **Training data sizes:** 50%, 65%, 80%
- **Mislabeling in training data:** 0%, 5%, 30%, 70%
- **Optimization method:** *GridSearchCV* for parameters (k in kNN, # of PCs)
- **Evaluation metric:** Recall or Sensitivity
  - Recall = TP/(TP + FN)
  - Ideal for ensuring detection of positive cases

Limitations

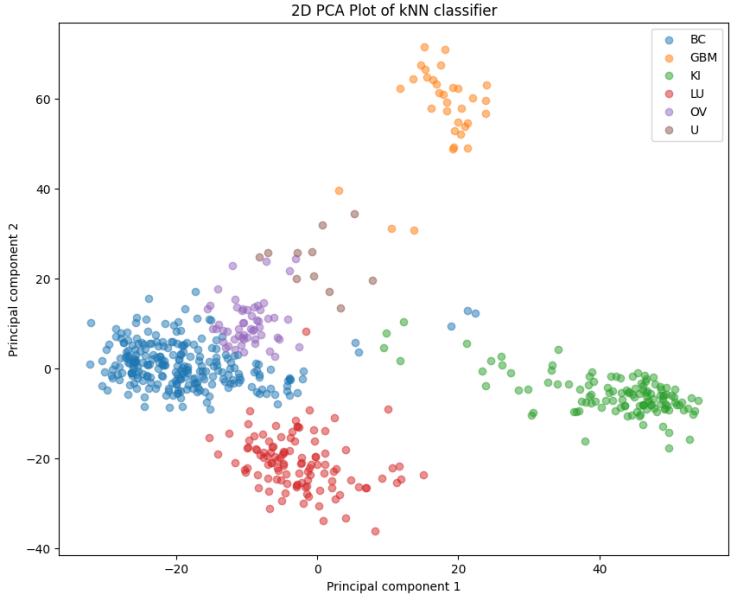
(Due to limited time and compute resources)

- Only 3 mislabeling levels
- Only 3 iterations per test to minimze randomness
- Few parameters given to *GridSearchCV*

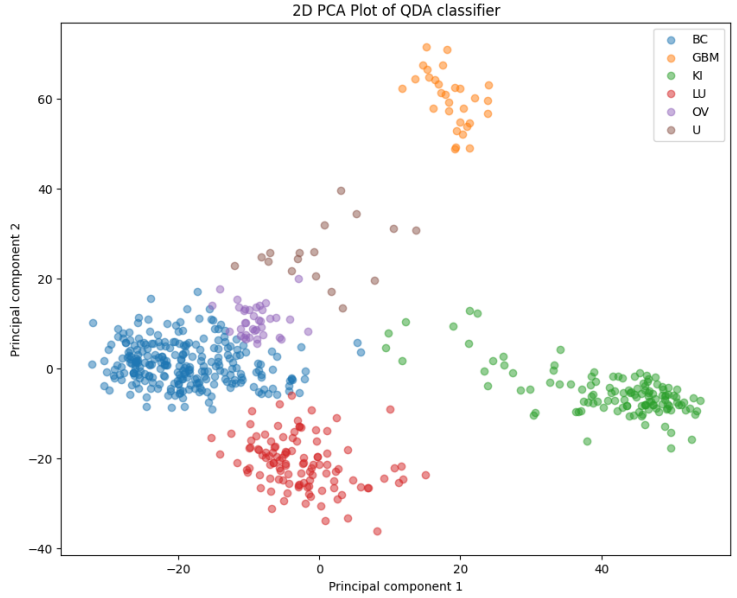
Data Visualization



Original Data

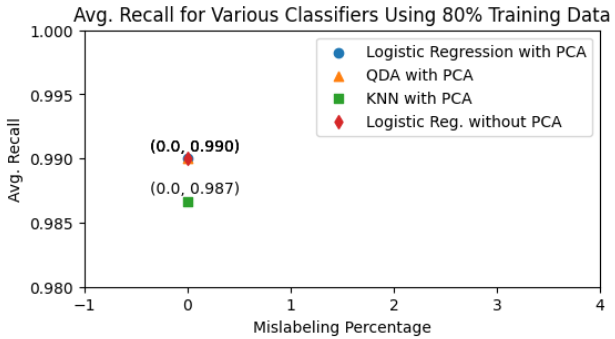


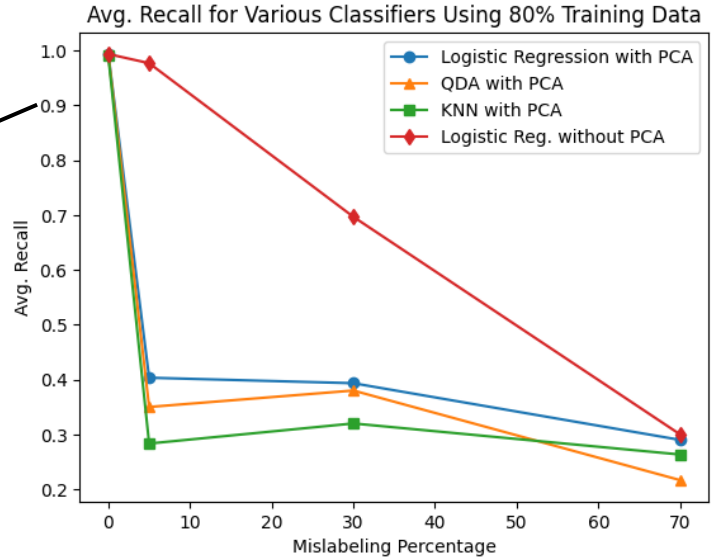
KNN

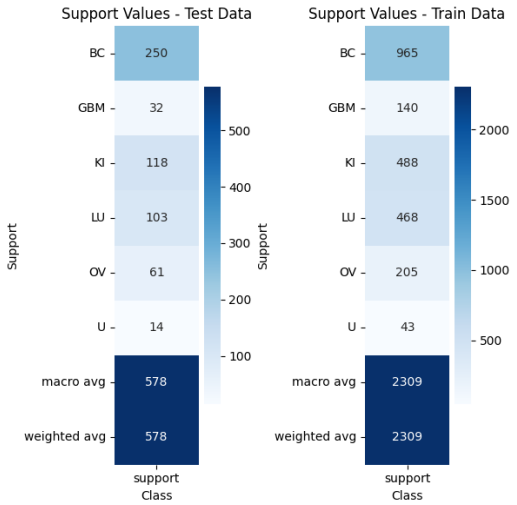


QDA

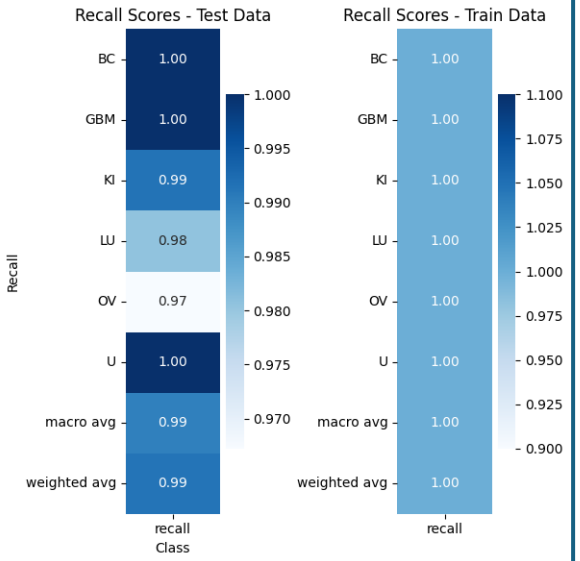
Recall Evaluation on 80% Training Data





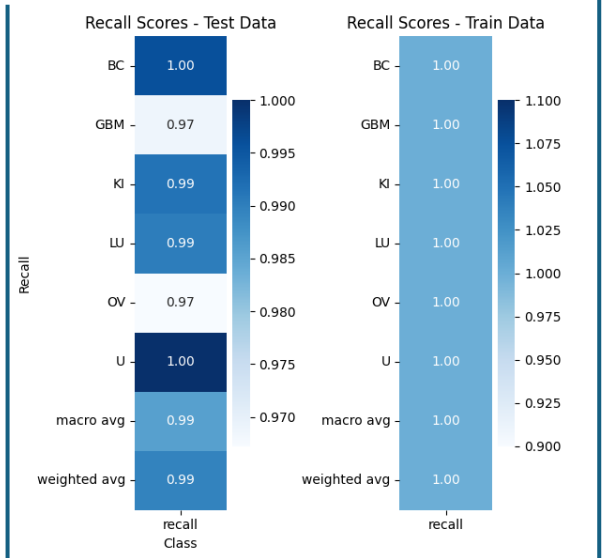


Wtih, Logistic regression performed better than QDA and KNN



Raw Logistic regression

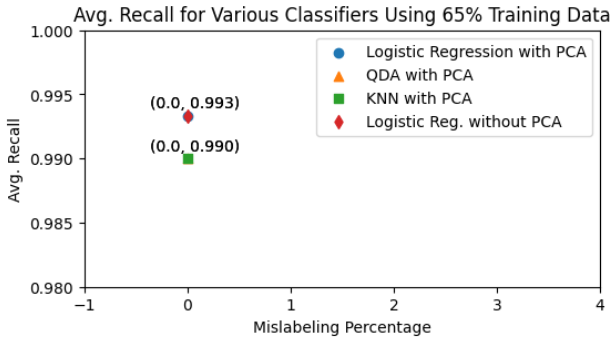
KNN with 40 PCA with 7 neighbours

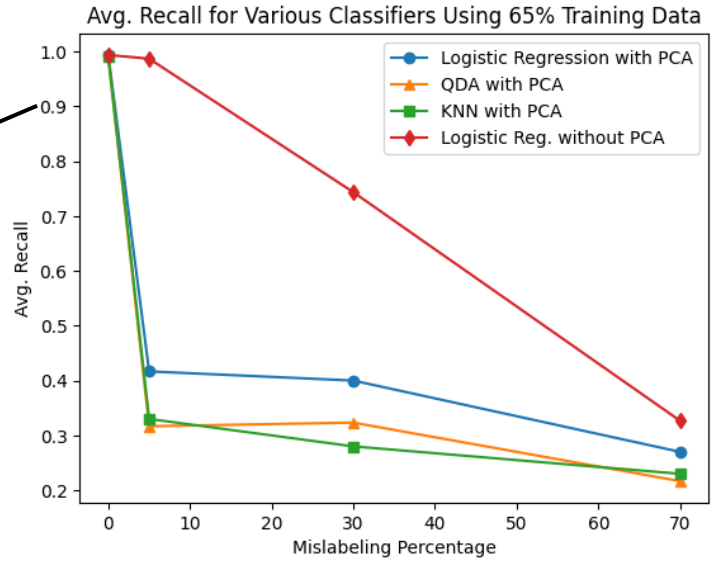


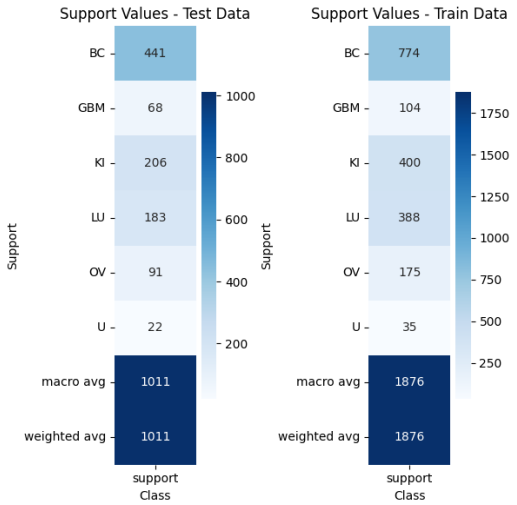
Logistic regression with PCA 40

QDA with 20 PCA

Recall Evaluation on 65% Training Data

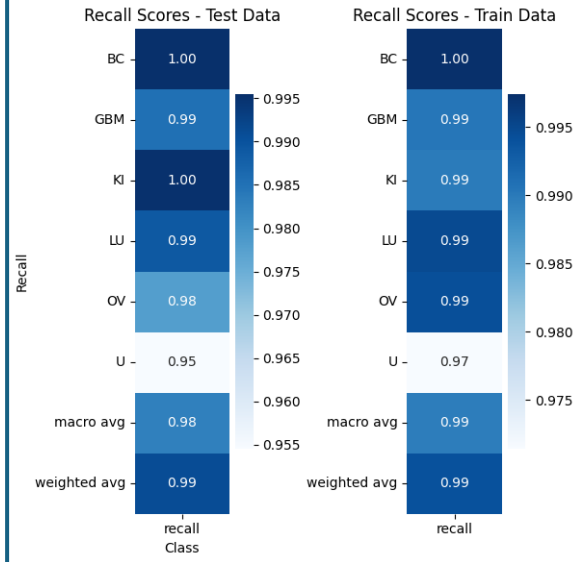




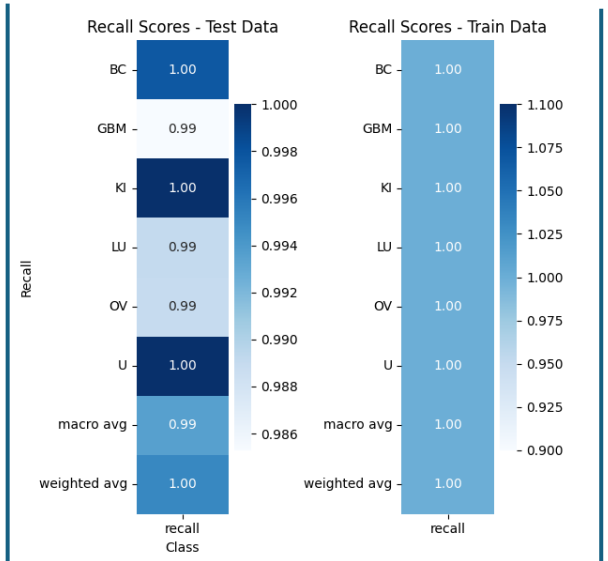


With PCA, Logistic regression performed better than QDA and KNN

Raw Logistic regression



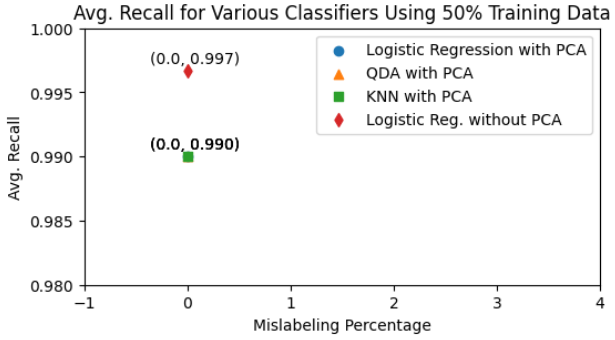
KNN with 30 PCA with 5 neighbours

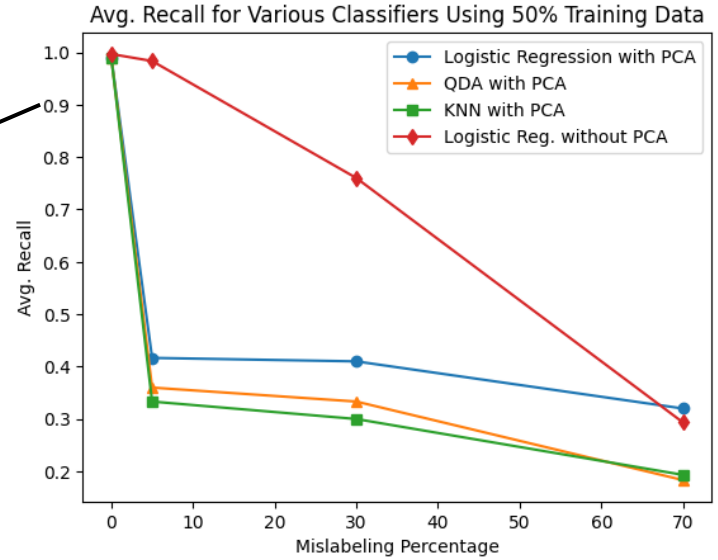


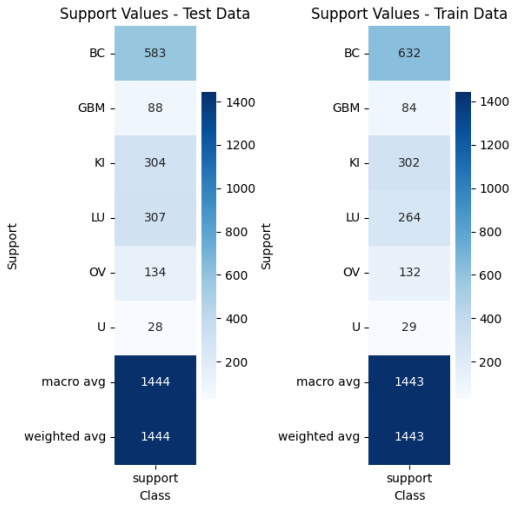
Logistic regression with PCA 40

QDA with 20 PCA

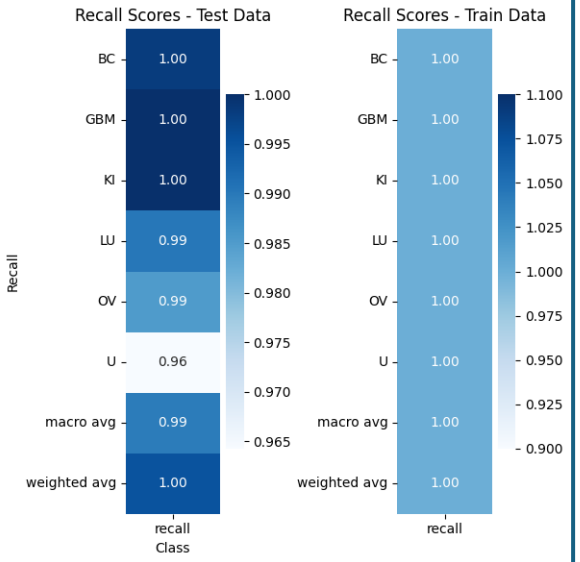
Recall Evaluation on 50% Training Data



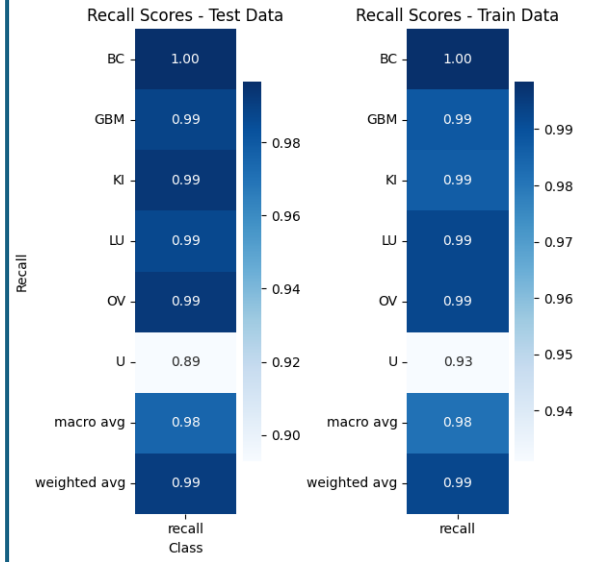




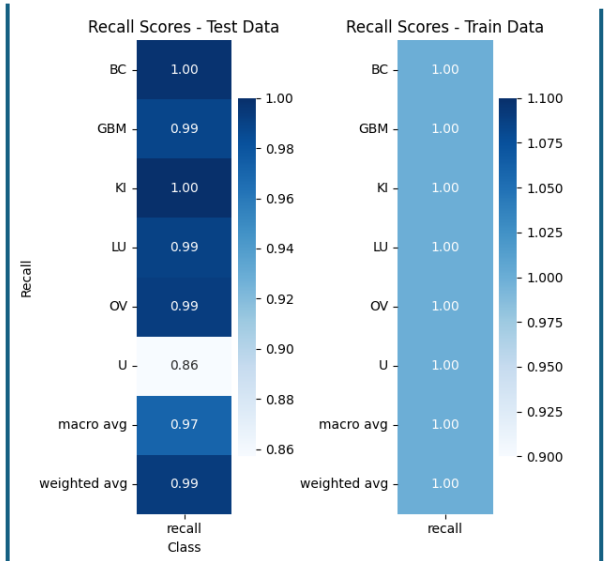
With PCA, Logistic regression performed better than QDA and KNN



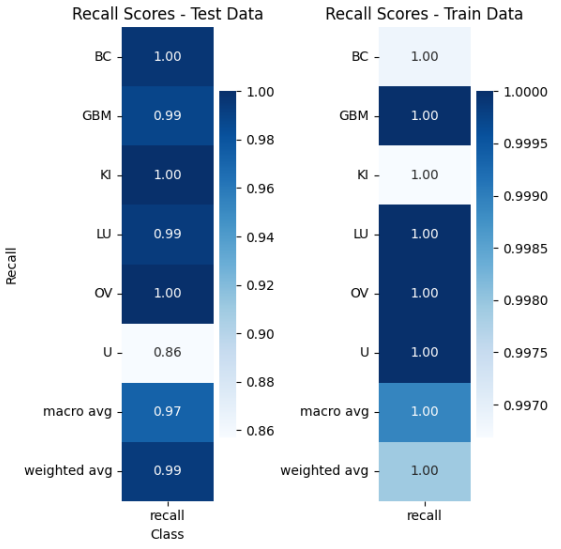
Raw Logistic Regression



KNN with 30 PCA with 5 neighbours



Logistic Regression with PCA 20



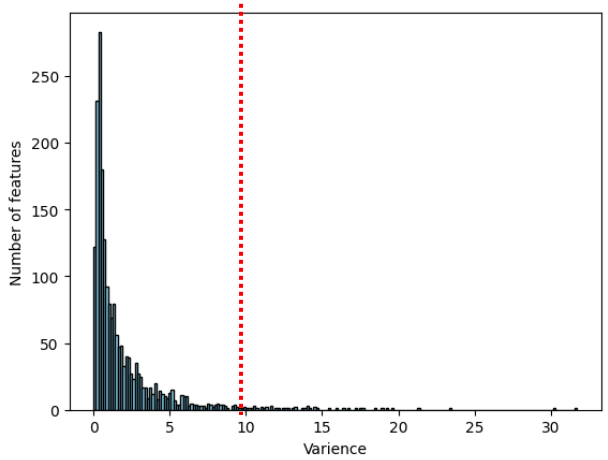
QDA with 20 PCA

Feature Selection

Keeping features with maximum variance

Training data size (% of dataset)	% of Mislabeling data			
	0%	5%	30%	70%
80%	**0**	**0**	**10**	**10**
65%	**0**	**0**	**10**	**10**
50%	**0**	**0**	**10**	**10**

The table shows the maximum variance threshold for feature selection that optimizes predictive performance in each condition

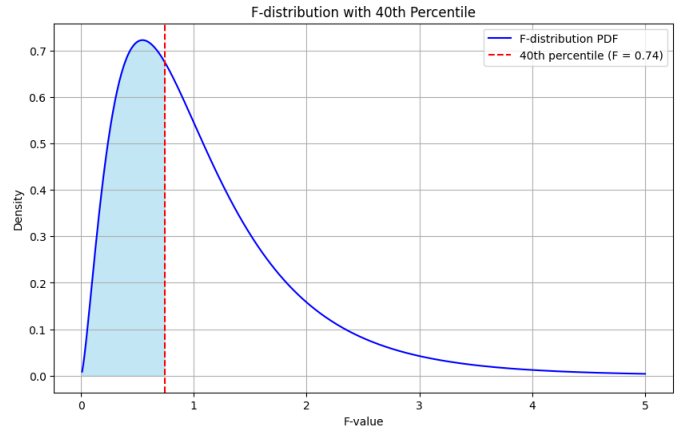


Keeping feature with ANOVA F-test

- the score is obtained by comparing the variances of each feature to the target variable.

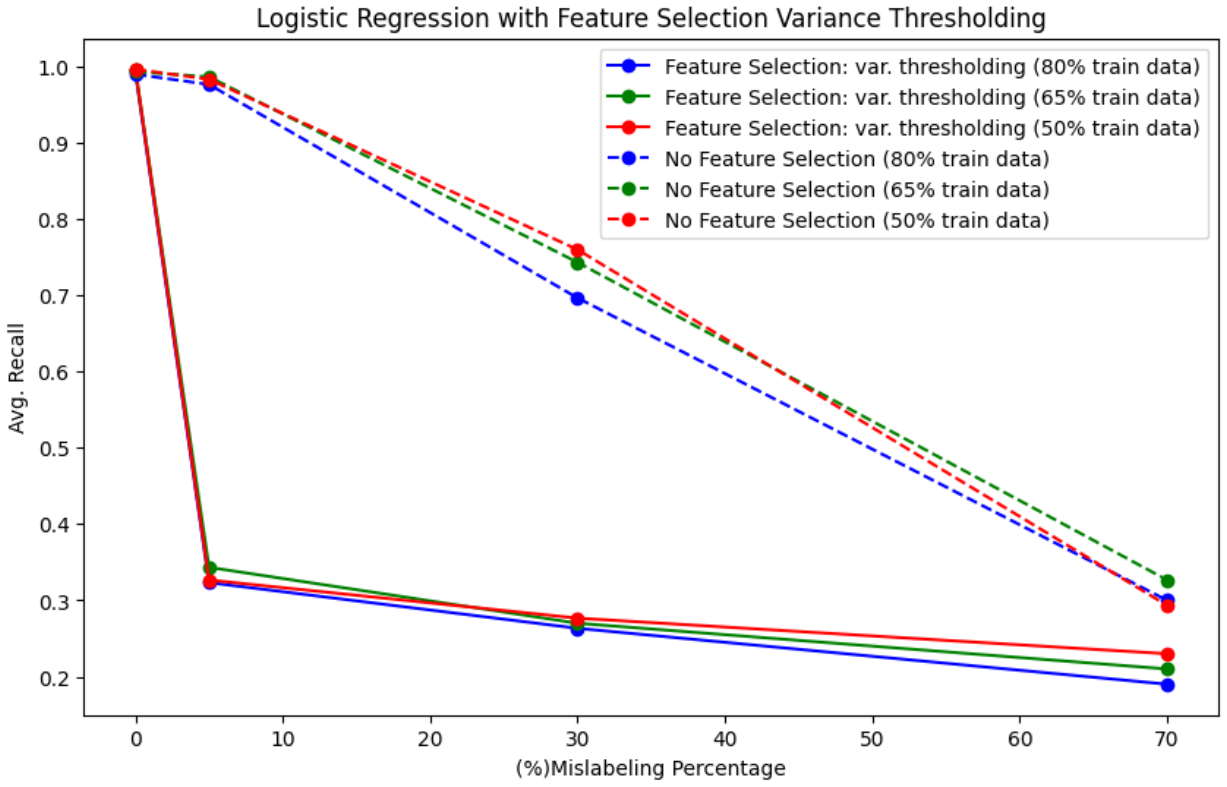
Training data size (% of dataset)	% of Mislabeling data			
	0%	5%	30%	70%
80%	**40th**	**90th**	**5th**	**5th**
65%	**40th**	**80th**	**5th**	**5th**
50%	**60th**	**60th**	**5th**	**5th**

The table show the percentile for features selection that optimize predictive performance in each condition



Recall Evaluation on Feature Selection with Maximum Variance and F test

Keeping features with maximum variance



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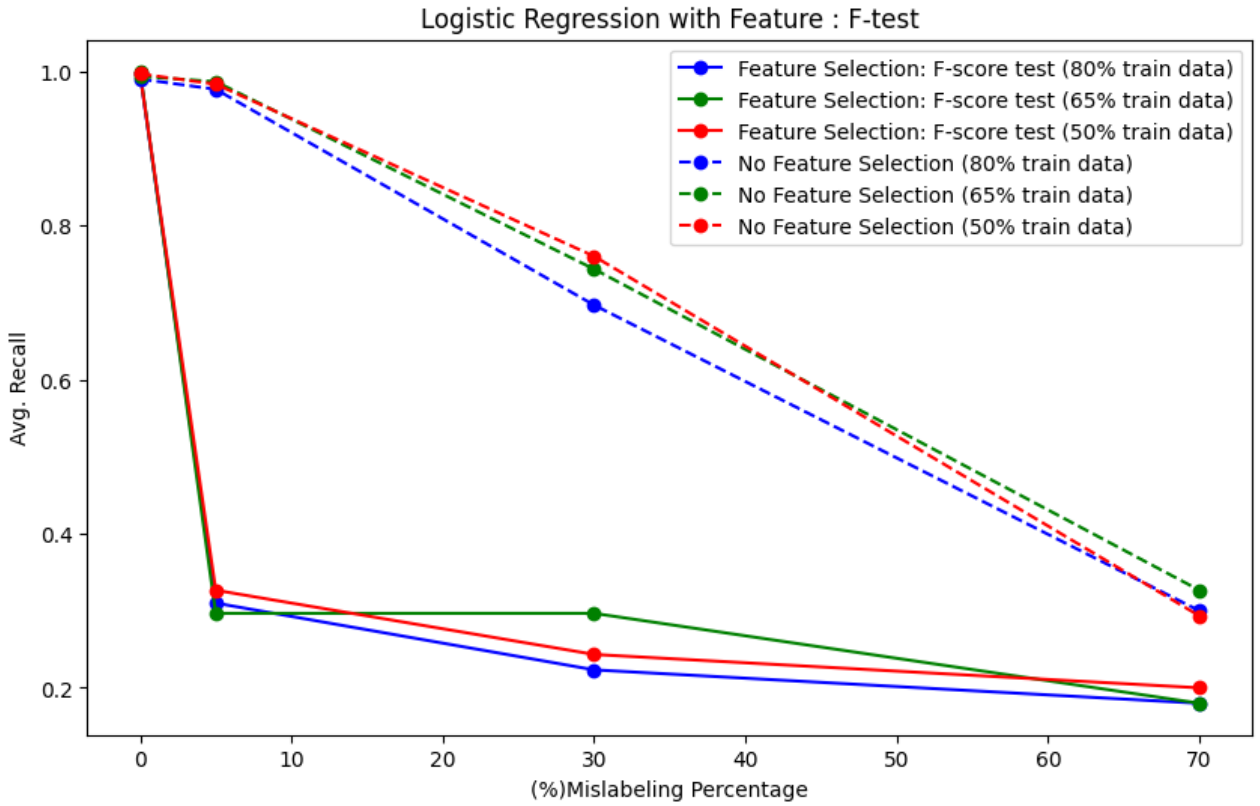

Conclusion and Key Findings

Top performer: Logistic Regression

- Indicates (a likely) linear relationship between the variables.

Stability against mislabeling (noise):

- Logistic regression without feature selection shows the highest robustness to mislabeling.
- Regularization techniques help to prevent overfitting.

Impact of mislabeling:

- Even a small percentage of mislabeling significantly impacts performance.
- This effect is amplified when feature selection is applied.