Water Quality Classification

CIND820:
Big Data Analytics Project

Project by: Ann Sam
ann.sam@ryerson.ca
Student #501160843

Supervisor: Dr. Ceni Baboglu

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Why classify water?

- Basic necessity for all human life
- Process of water testing is time consuming: water collection and laboratory testing
- Costly

Can machine learning improve the process of water classification?

Predicting Water Potability

- Can we predict water potability?
- Which machine learning algorithms can yield the most efficient and accurate results?
- Can the parameters within the ML algorithms be tuned to yield the best results?
- Are the parameters within the dataset affective in water quality prediction?
- Should there be other parameters to consider?
- How confident are we in our findings?

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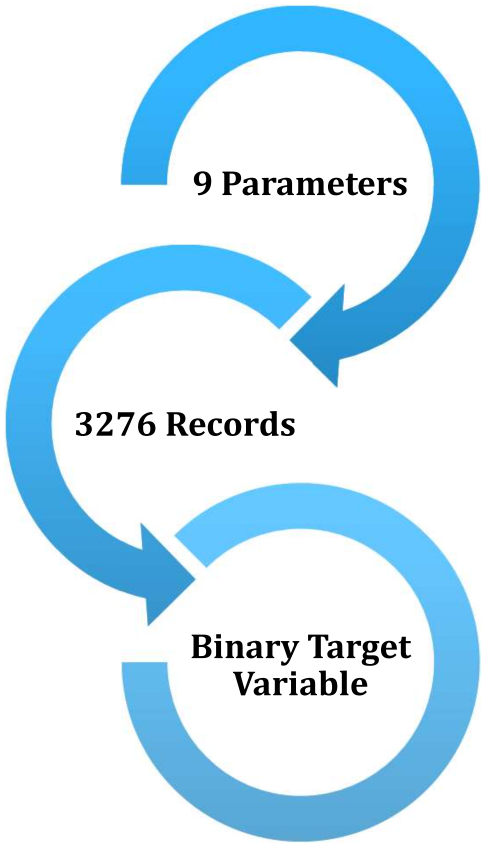
The Dataset

https://www.kaggle.com/datasets/adityakadiwal/water-potability/



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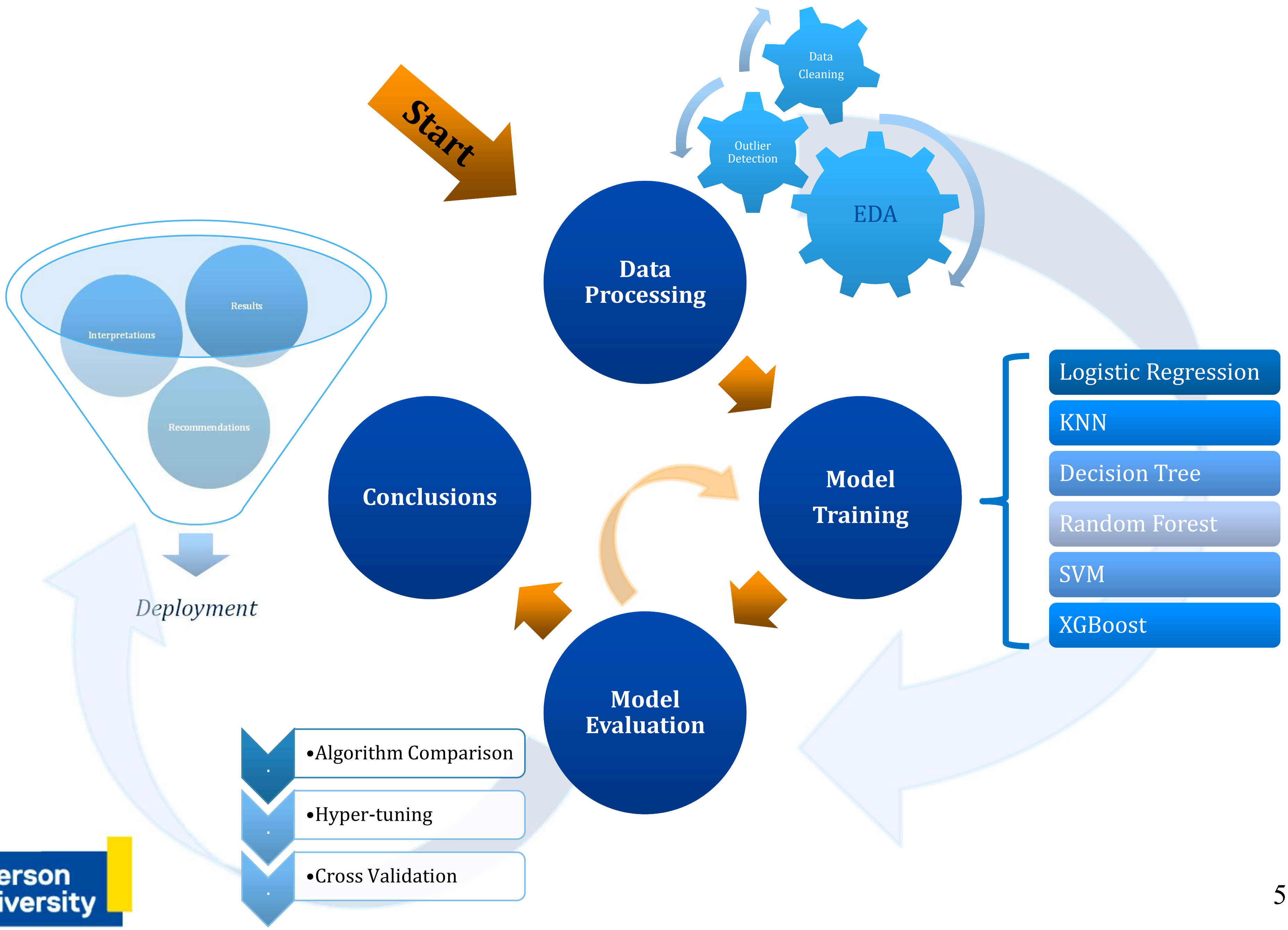
Approach Process



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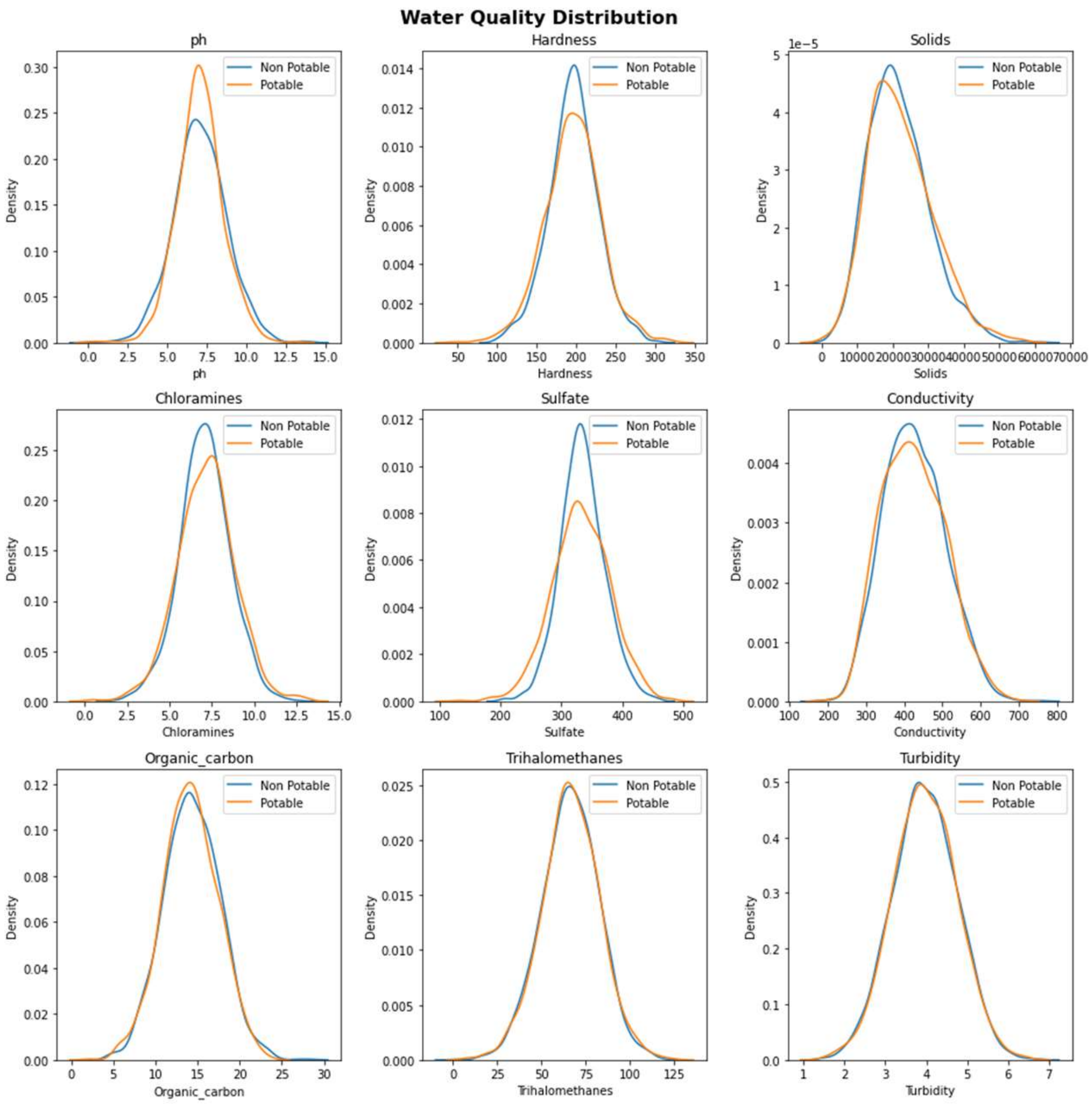
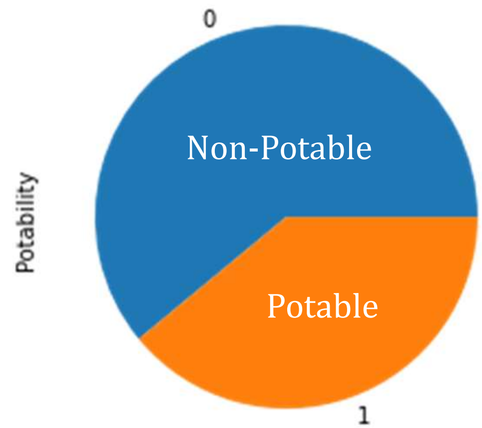
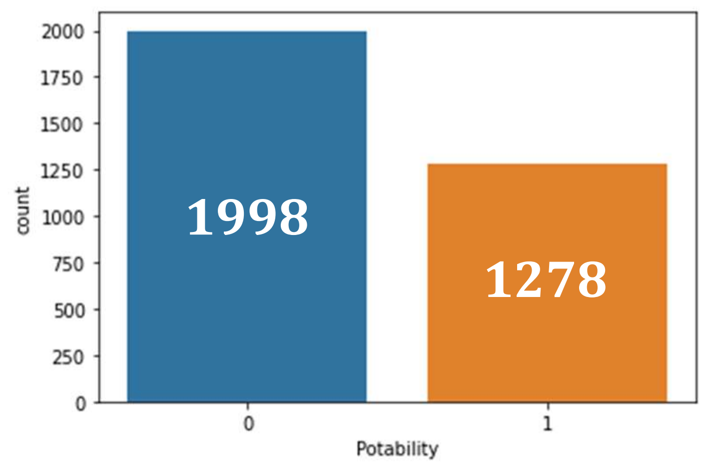
EDA: Visual Analyses







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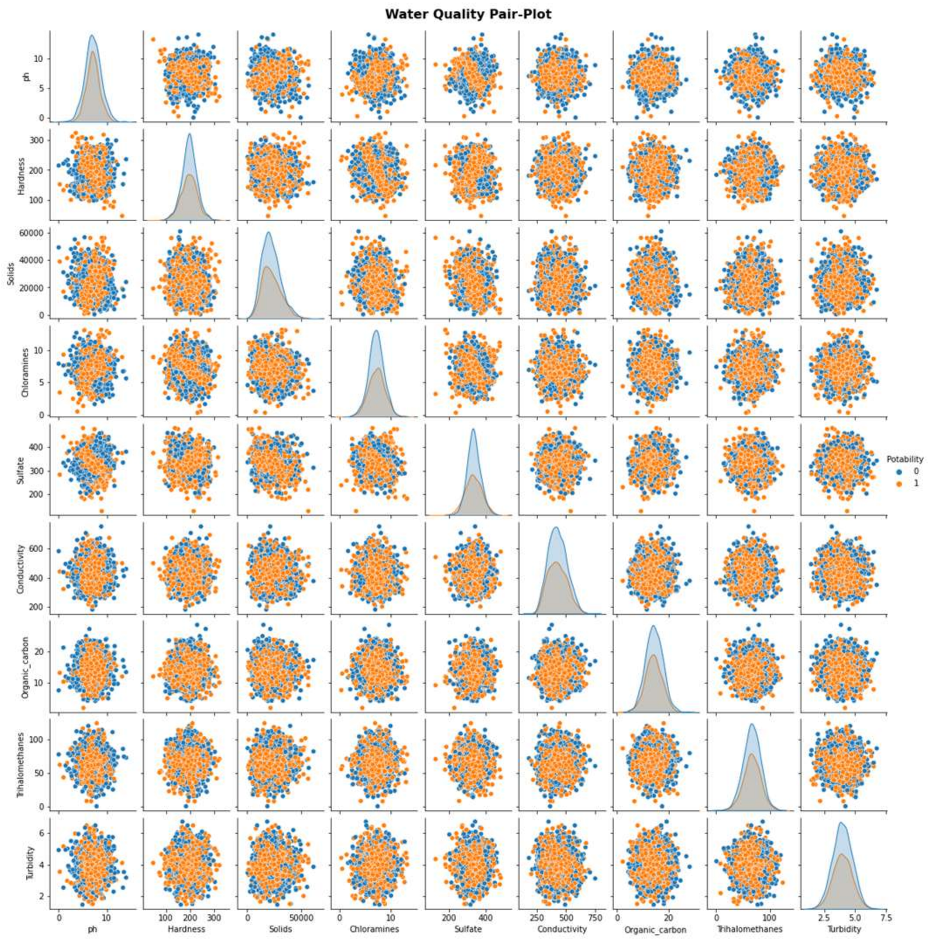

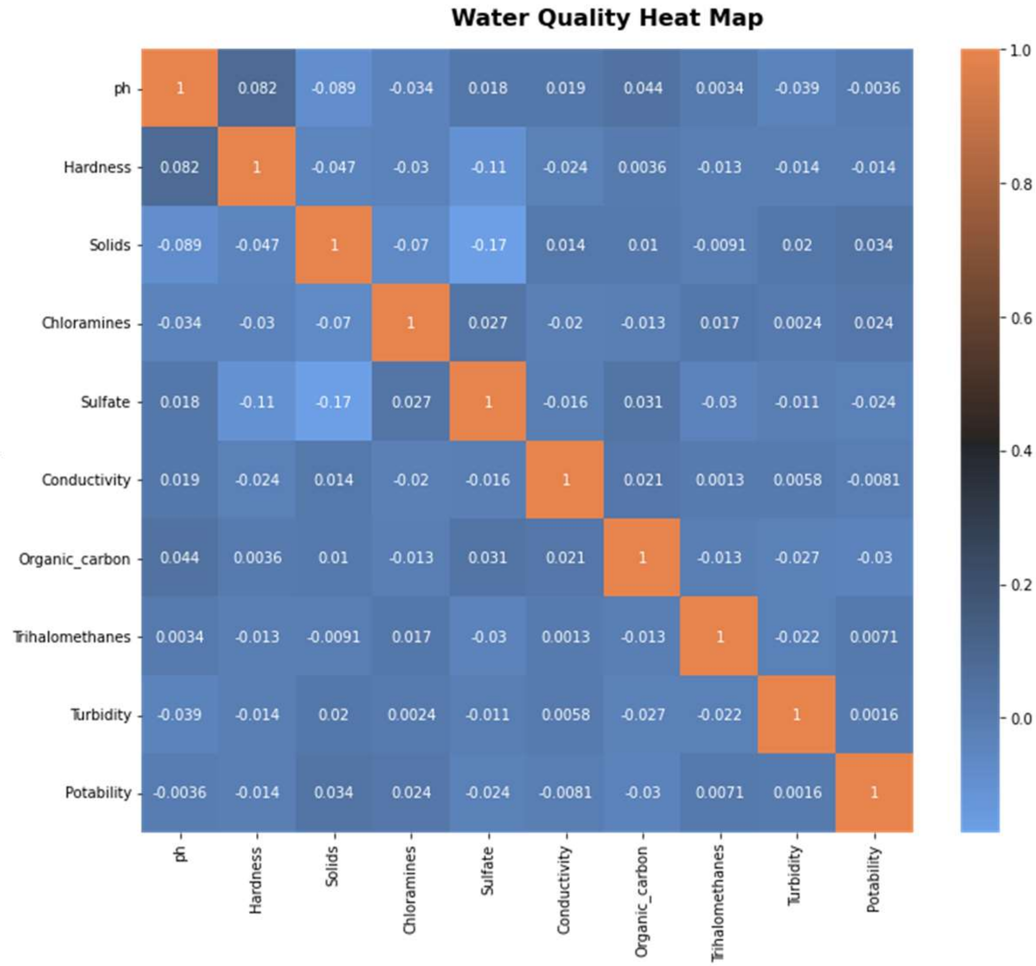

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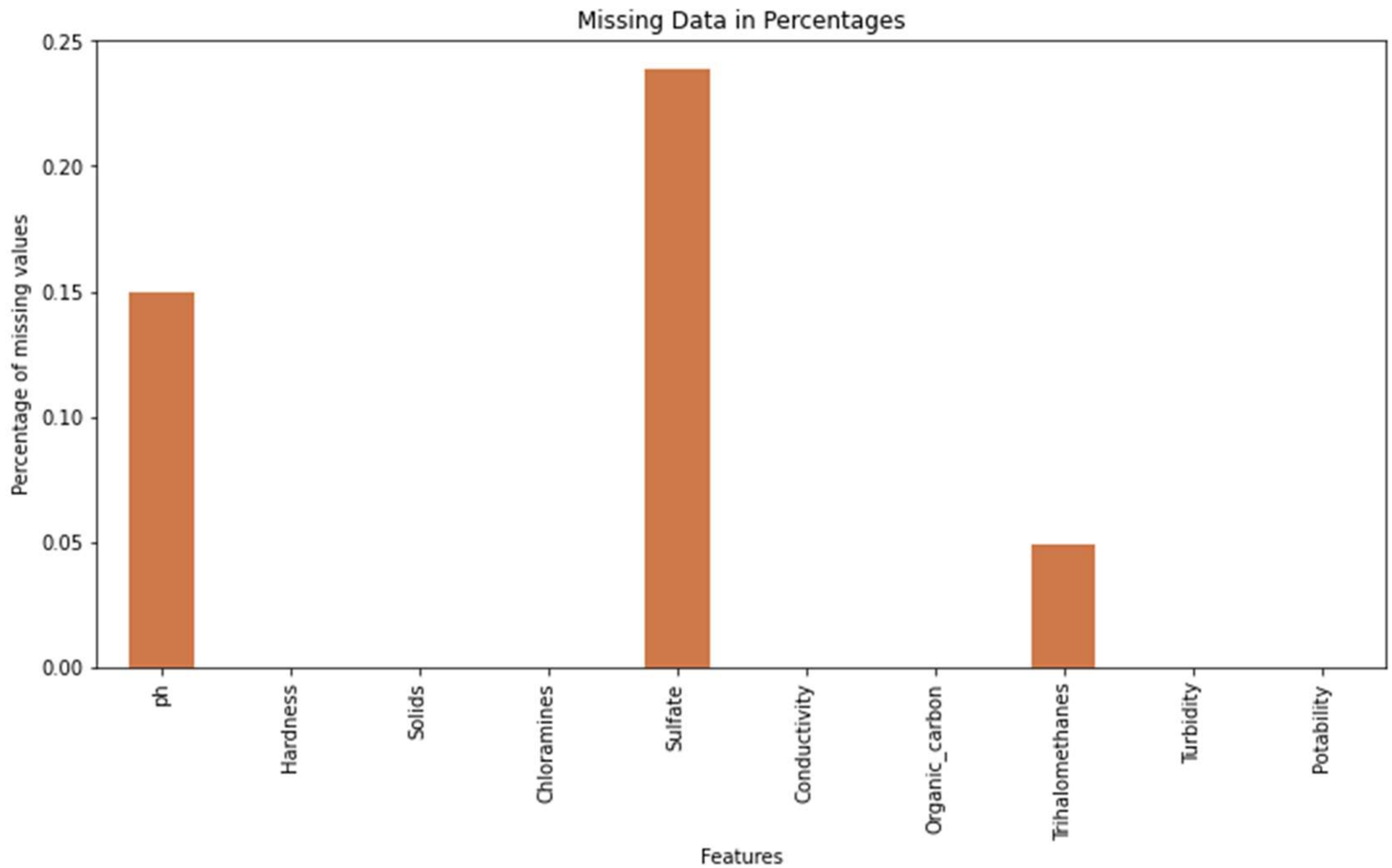
Missing Values



- The majority of the parameters have a Gaussian distribution therefore it was safe to replace missing values with the mean value

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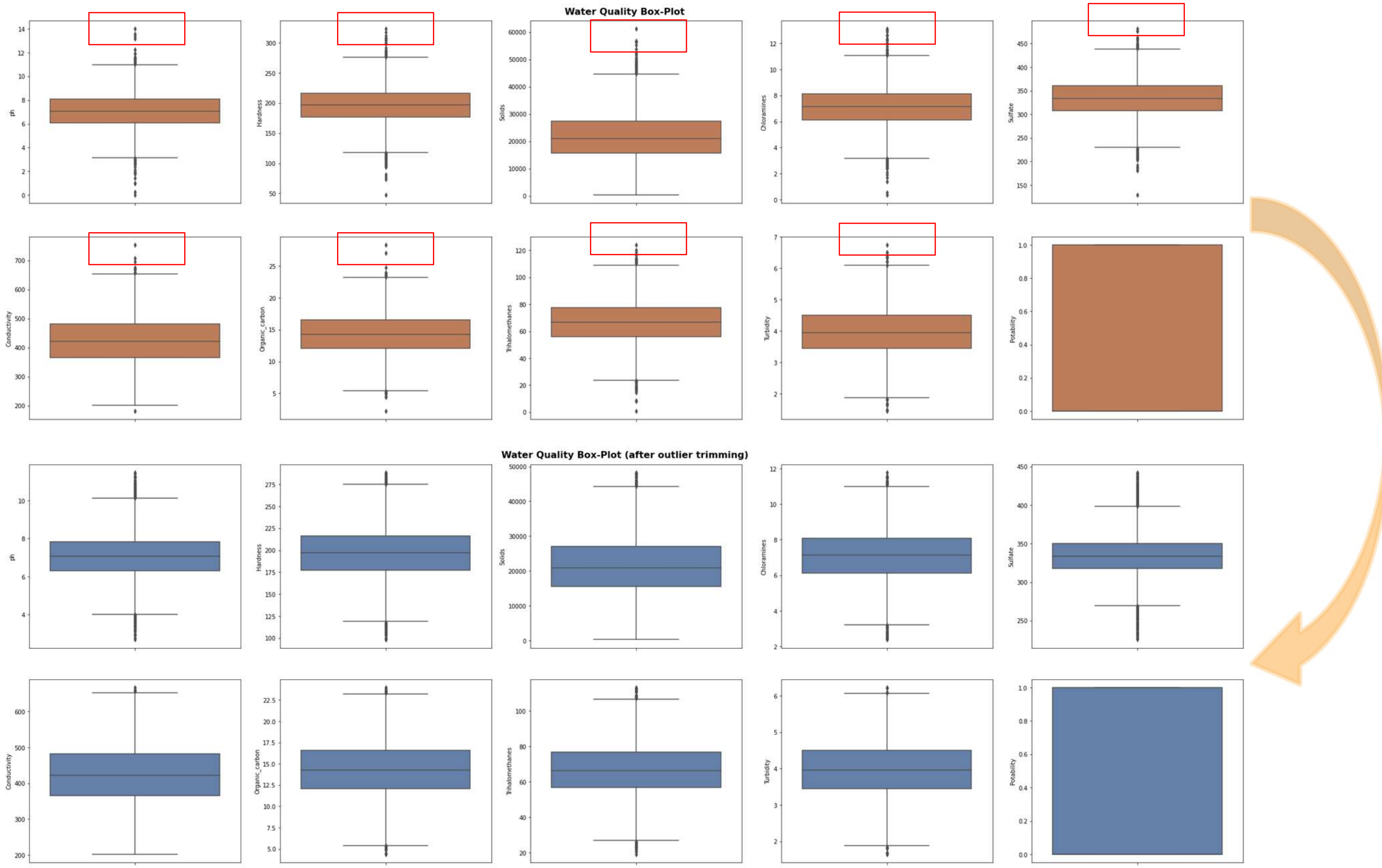
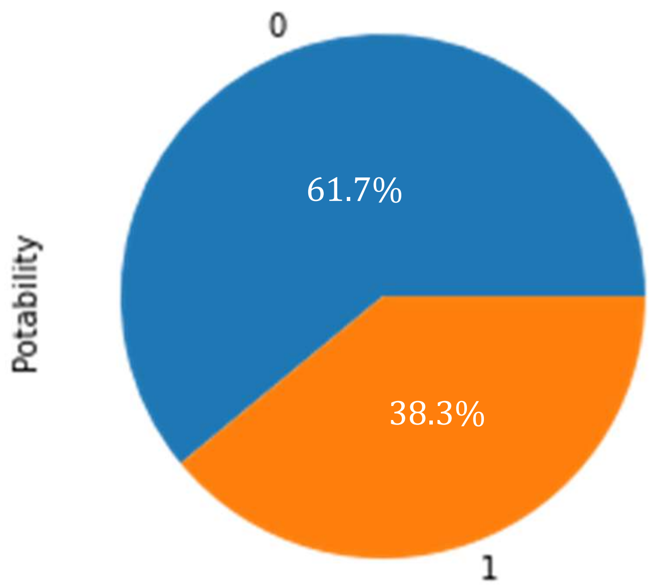
Outlier Detection



Class Imbalance



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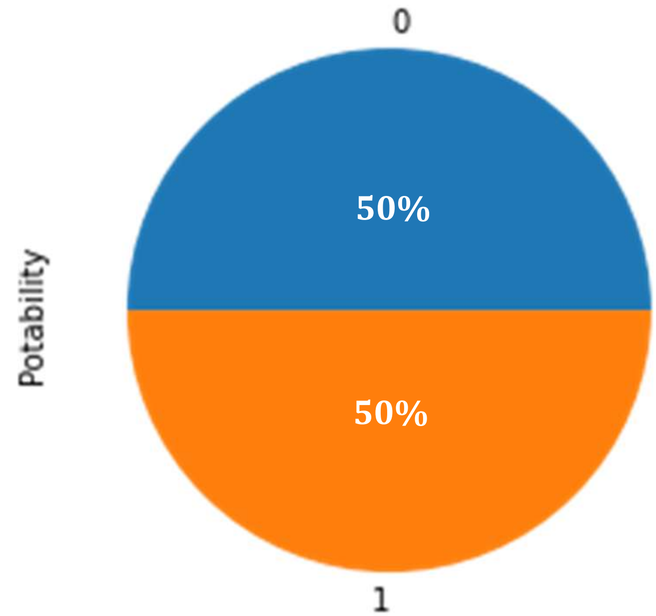

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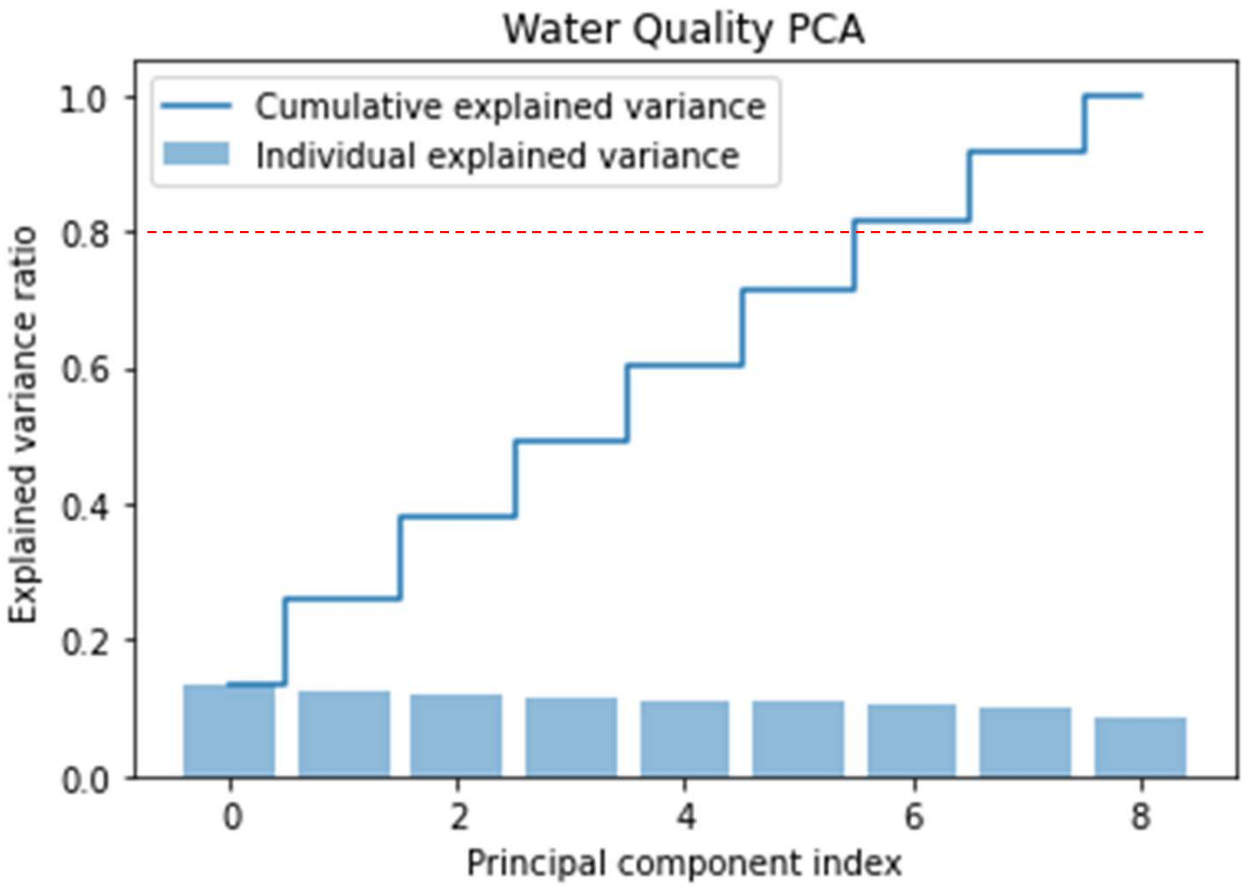
- Up-sampling the minority class to balance the data for training to prevent bias to the majority class

Principle Component Analysis

- Exploring dimensionality reduction using **PCA** tells us that all the variables are independent from each other and further confirms our previous observations from the heatmap.



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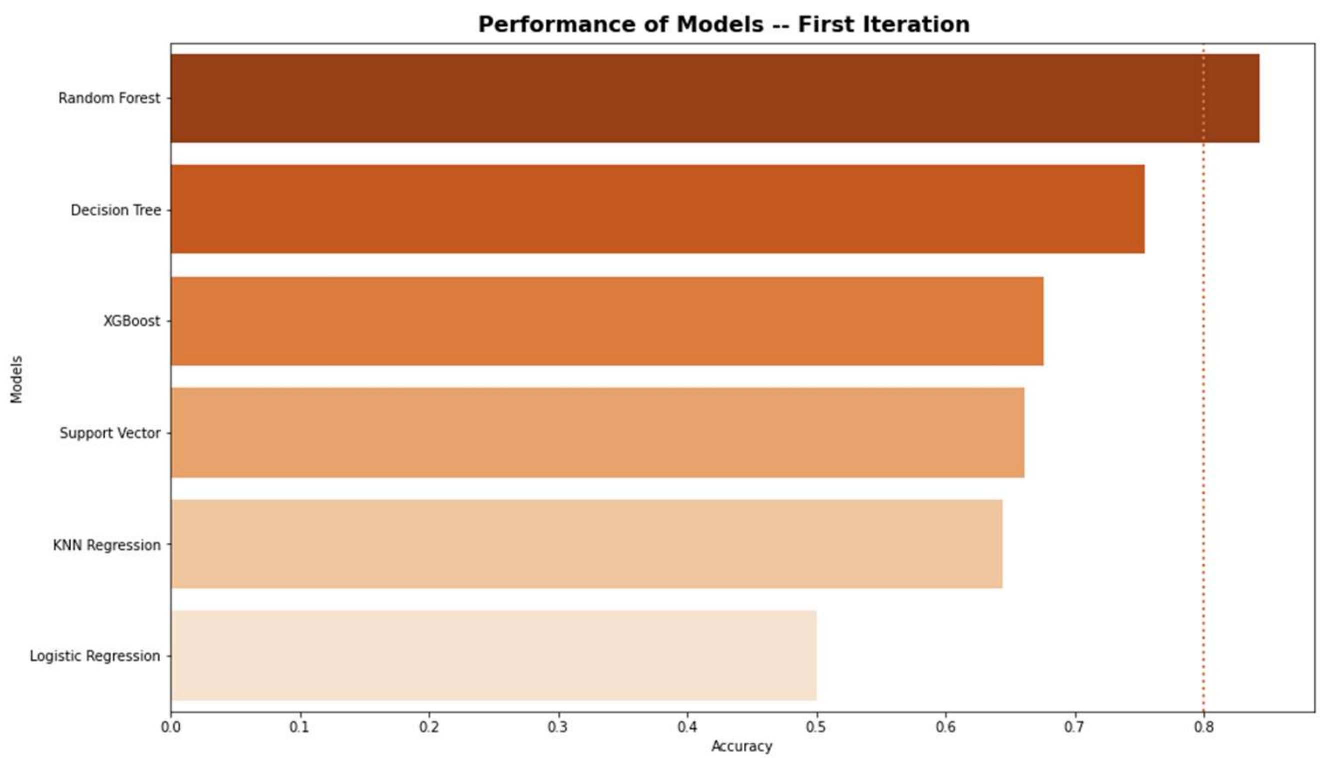
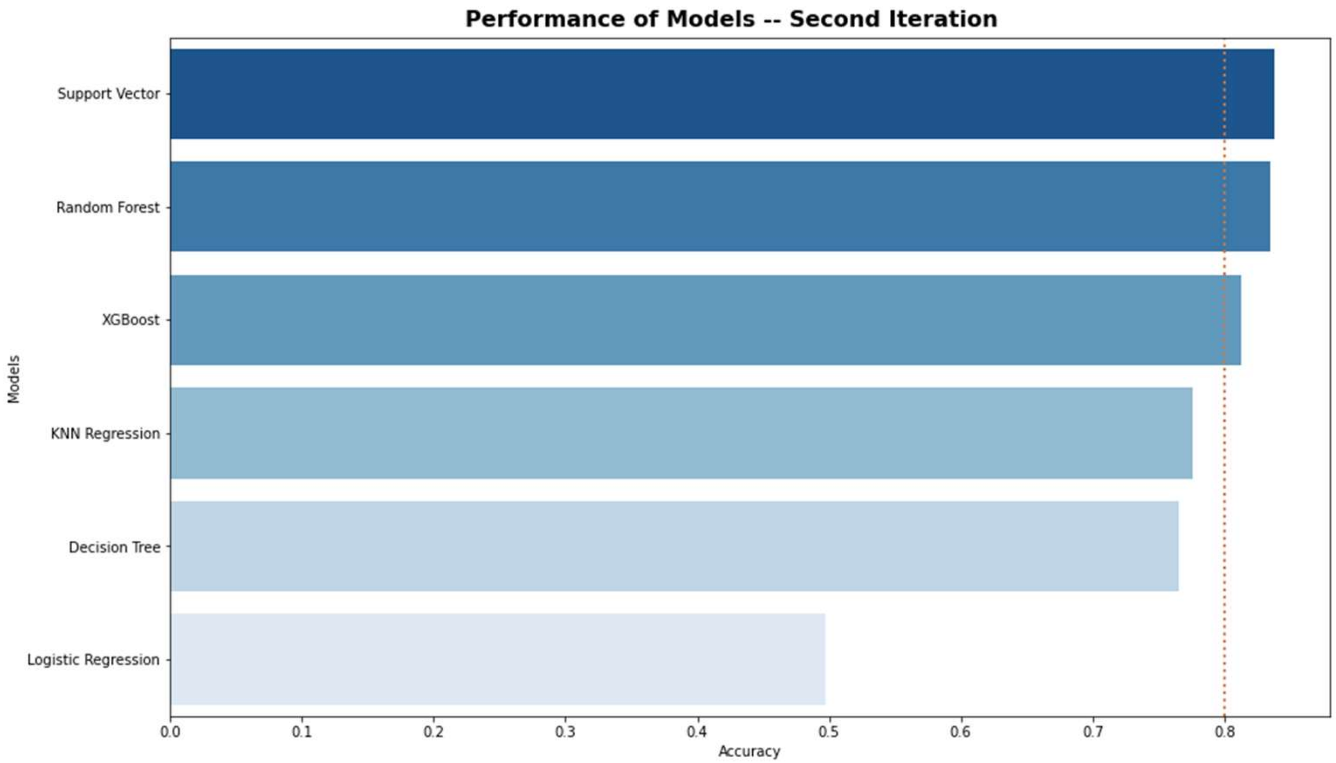
Algorithm Comparison 1st Iteration

	Model	Accuracy	Precision	Recall	F1 Score
3	Random Forest	0.843264	0.827676	0.852151	0.839735
2	Decision Tree	0.753886	0.698690	0.860215	0.771084
5	XGBoost	0.676166	0.654822	0.693548	0.673629
4	Support Vector	0.660622	0.632212	0.706989	0.667513
1	KNN Regression	0.643782	0.620347	0.672043	0.645161
0	Logistic Regression	0.500000	0.483645	0.556452	0.517500



Algorithm Comparison 2nd Iteration

	Model	Accuracy	Precision	Recall	F1 Score
4	Support Vector	0.838083	0.853868	0.801075	0.826630
3	Random Forest	0.834197	0.808081	0.860215	0.833333
5	XGBoost	0.812176	0.763341	0.884409	0.819427
1	KNN Regression	0.775907	0.722595	0.868280	0.788767
2	Decision Tree	0.765544	0.714607	0.854839	0.778458
0	Logistic Regression	0.497409	0.481132	0.548387	0.512563



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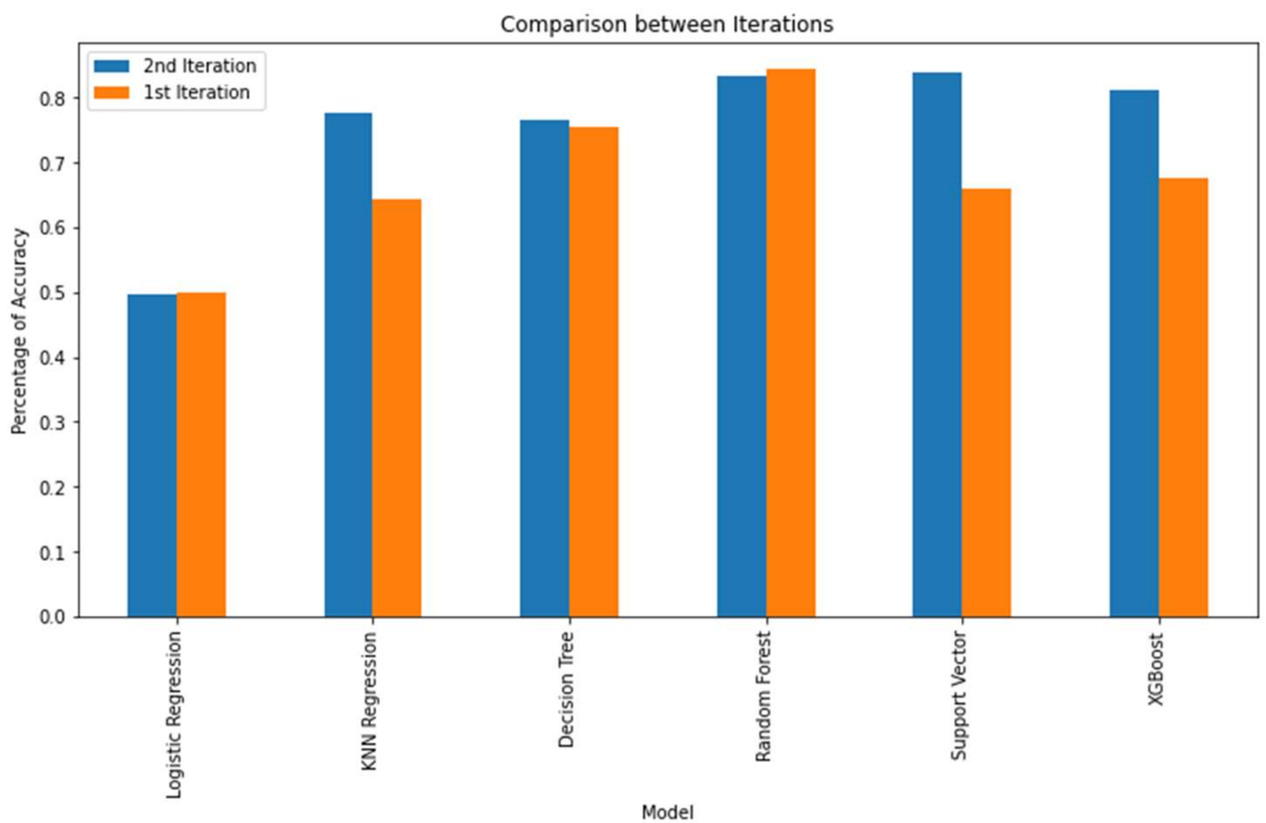
Model Evaluation

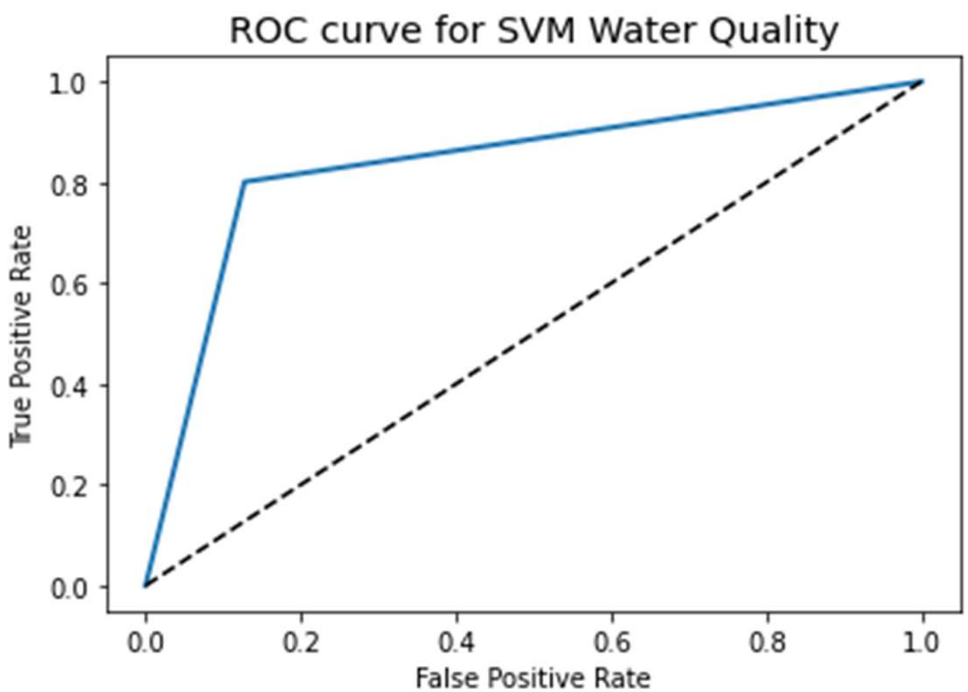
	Model	2nd Iteration	1st Iteration	Difference in Accuracy
0	Logistic Regression	49.74%	50.00%	-0.26%
1	KNN Regression	77.59%	64.38%	13.21%
2	Decision Tree	76.55%	75.39%	1.17%
3	**Random Forest**	**83.42%**	**84.33%**	**-0.91%**
4	**Support Vector**	**83.81%**	**66.06%**	**17.75%**
5	XGBoost	81.22%	67.62%	13.60%



Cross Validation

K-Fold CV

Algorithm	Mean Accuracy Score	Standard Deviation
Random Forest	85.28 %	1.84 %
SVM	**87.98 %**	**1.91 %**
XGBoost	80.73 %	1.77%



ROC AUC: **0.8368**
CV ROC AUC: **0.8674**

Interpretation & Recommendations

- After 2nd iteration and hyper-tunning parameters, SVM performed with the greatest accuracy 84.33%
- After k-Fold cross validation, SVM's accuracy increased to 87.98%

- Increasing parameters: coliforms and heavy metals
- Explore deeper machine learning such as ANN (artificial neural network)

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Conclusions

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✓ **Using ML it is possible to predict water potability**

✓ **Support Vector Machine Classifier best performance 87.98% accuracy**

✓ **Hyper-tunning did increased accuracy in modeling for most of the algorithms**

✓ **The parameters within the dataset were affective in prediction although had low correlation**

✓ **Through research from other studies, additional attributes such as coliform and heavy metals should be included**

✓ **Confident in our findings but room for improvement**

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