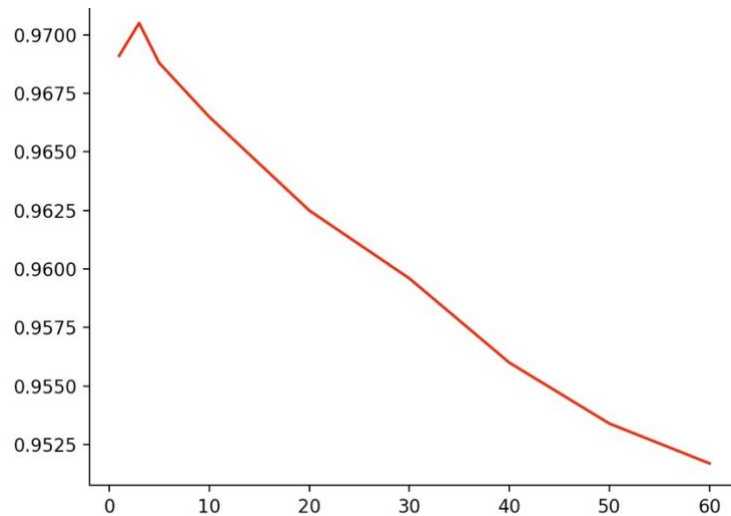


## Q1: Handwritten Digits Recognition with k-NN

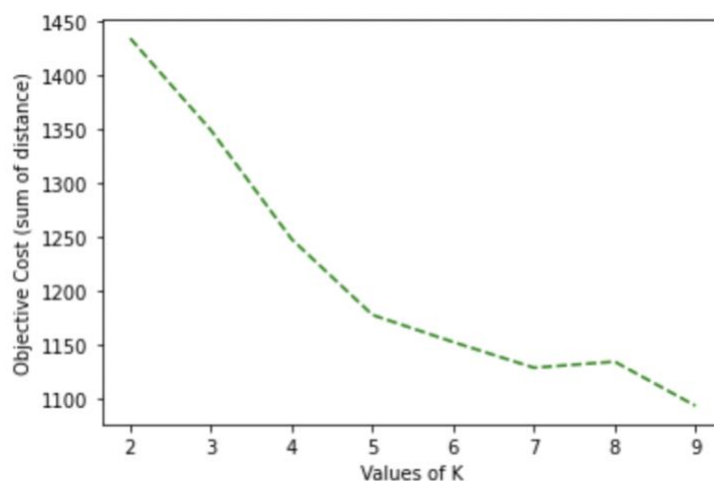
- Plot of accuracy vs the value of  $k$



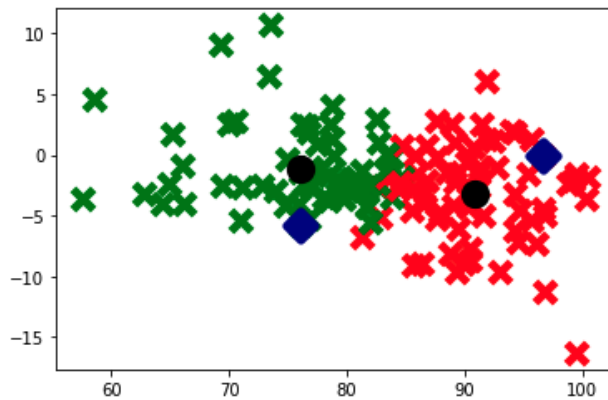
- Observations
  - In the plot above, we can see that max accuracy of KNN is at  $k = 3$ .
  - After  $k = 3$ , the accuracy of the model decreases as the value of  $k$  increases. Reason for this behavior can be attributed to overfitting of the data which causes lower accuracy.

## Q2: K-Means Clustering

- Plot the objective function as a function of  $k$



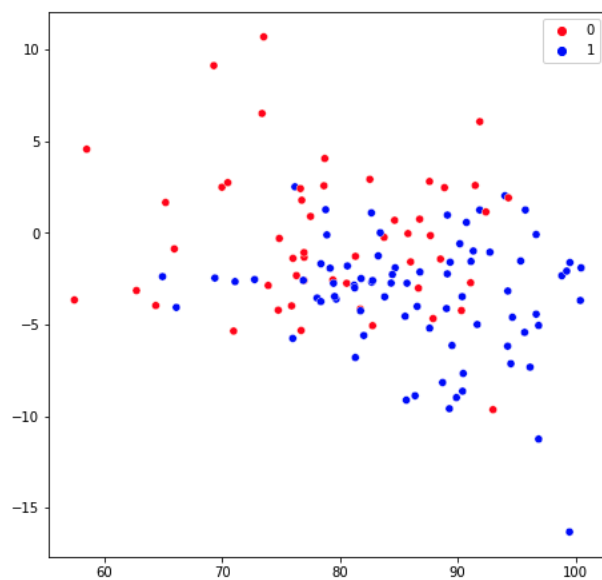
- For  $K = 2$ , plot the points using its first two features



- Observations
  - In the first plot, objective function is decreasing with the increase in value of  $k$ .
  - This is observed because, with more center points the loss value gets less.
  - Elbow point for the above plot is at  $k = 4$

Q3: Gaussian Mixture Model

- Plot



- Observations

- In GMM, data points form an elliptical/ellipsoidal clusters, whereas in k-means data points form a circular/spherical cluster.
- In GMM, we use gaussian distributions and degree of freedom of clusters can be controlled whereas in k-means we use distance from centroids.