Report

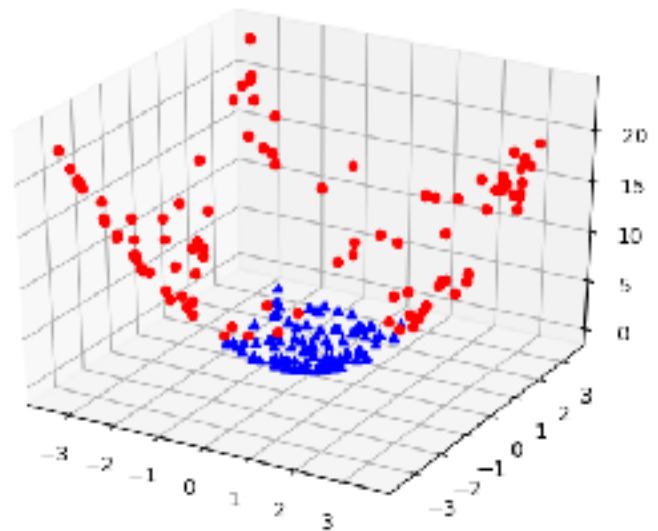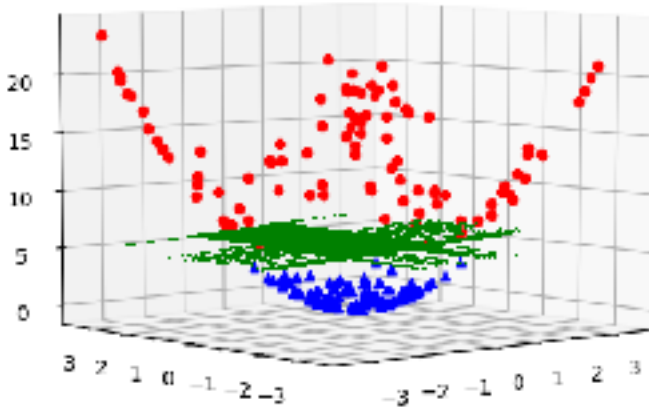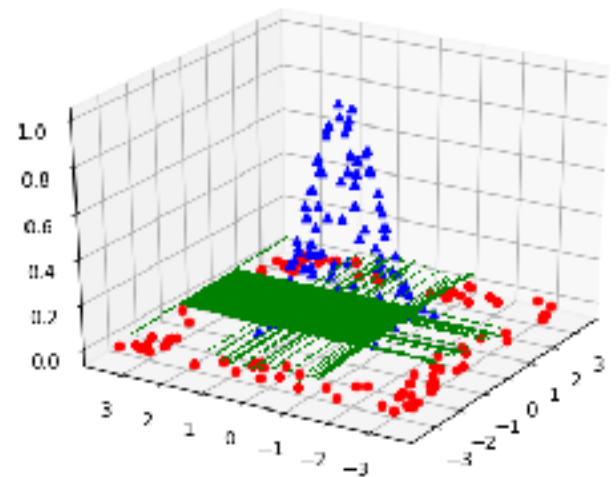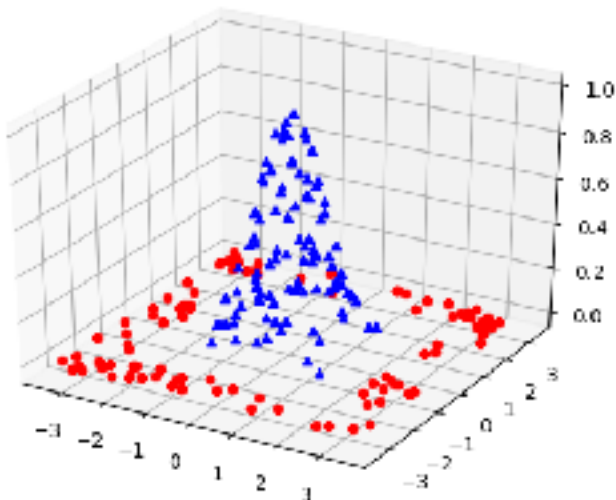## Question-1

A. Inseparable data using perceptron
• **Kernel used:-** (x, y) -> (x, y, x^2+y^2)

Training Accuracy : 100%

Explanation : On using this kernel, one set of the data lies inside the other, and thus the a separating hyperplane can now be generated such that both the sets are now separated.
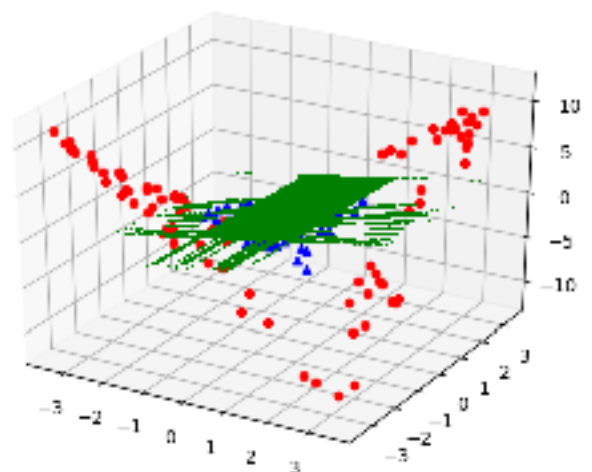
- **<u>Kernel used:-</u>** (x, y) -> (x ,y , e^(-(x^2+y^2)))

Training Accuracy: 98 %

Explanation : We observe that on kernelization, the set of data points(blue) are projected out of the 2D plane, while the rest still lie on the same plane. These data sets still lie one inside another. They are not completely linearly separable, however, the separating hyperplane almost splits the entire set of data into 2 categories.

- **<u>Kernel used:-</u>** (x, y) -> (x, y, x*y)
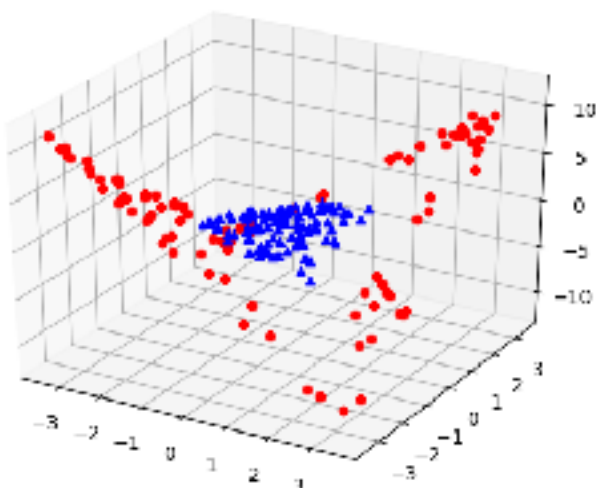
Training Accuracy: 43%

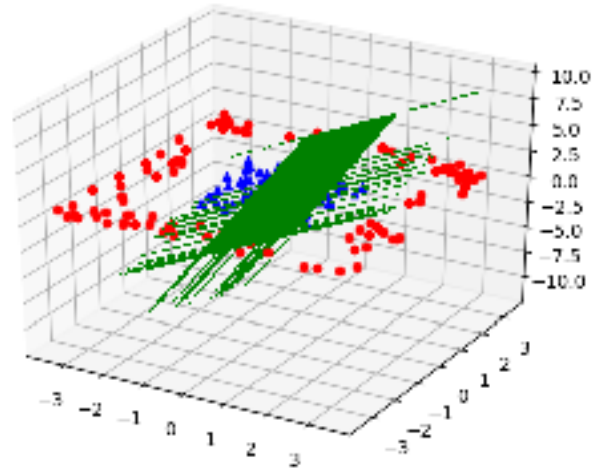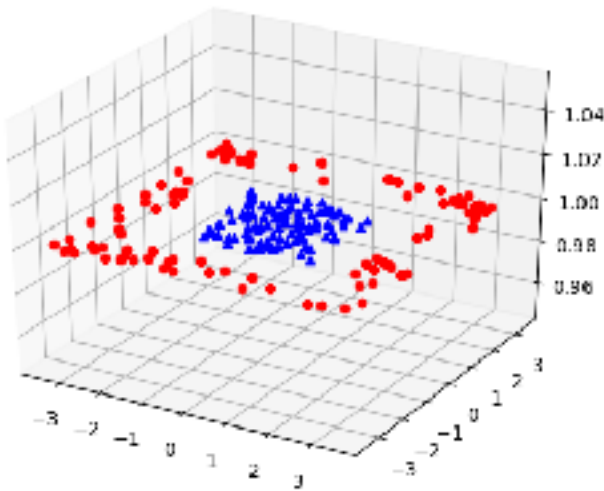- **Kernel used:-** (x, y) -> (x, y, 1)

Training Accuracy: 34.50%

The initial perceptron was trained with the following hyper-parameters:
- **n_iter** = 100 (The no. of iterations before which to stop iterating)
- **verbose**=0 (So that no verbose output comes up on the terminal)
- **random_state**=None (The seed of the pseudo random number generator to use when shuffling the data)
- **eta0** : 0.01 This is the alpha i.e the learning rate.

B. Letter classification using SVM's

1. RBF
$$K(X,Y) = \exp(\|X-Y\|^2/2\sigma2)$$

Choice of hyper-parameters and their respective metrics:
- C = 1000.0 (Penalty parameter C of the error term)
  Gamma = 0.1 (Kernel coefficient for the respective kernel)
    Metrics:
    Accuracy: 95.24%
    Precision: 95.29%
    Recall: 95.23%
    F-1 Value: 97.236%

- C=100.0
  Gamma = 0.1
    Metrics:
    Accuracy: 95.68%
    Precision: 95.73%
    Recall: 95.65%
    F-1 Value: 95.66%

- C=0.1
  Gamma=1.0
    Metrics:
    Accuracy: 84.50%
    Precision: 85.72%
    Recall: 84.364%
    F-1 Value: 84.61%

2. Sigmoid
$$K(X,Y)=\tanh(\gamma \cdot XTY+r)$$

Choice of hyper-parameters and their respective metrics:
- C = 1000.0 (Penalty parameter C of the error term)
  Gamma = 0.1 (Kernel coefficient for the respective kernel)
    Metrics:
    Accuracy: 65.28%
    Precision: 67.24%
    Recall: 65.06%
    F-1 Value: 65.29%

- C=100.0
  Gamma = 0.1
    Metrics:
    Accuracy: 66.07%

Precision: 67.59%
Recall: 65.83%
F-1 Value: 65.92%

- C=0.1
  Gamma=1.0
    Metrics:
    Accuracy: 19.11%
    Precision: 25.00%
    Recall: 19.07%
    F-1 Value: 19.73%

3. Linear
K(X,Y)=X(transpose)*Y

Choice of hyper-parameters and their respective metrics:
- C = 1000.0 (Penalty parameter C of the error term)
  Gamma = 0.1 (Kernel coefficient for the respective kernel)
    Metrics:
    Accuracy: 84.94%
    Precision: 85.15%
    Recall: 84.82%
    F-1 Value: 84.86%

- C=100.0
  Gamma = 0.1
    Metrics:
    Accuracy: 85.24%
    Precision: 85.31%
    Recall: 85.11%
    F-1 Value: 85.12%

- C=0.1
  Gamma=1.0
    Metrics:
    Accuracy: 81.41%
    Precision: 82.13%
    Recall: 81.25%
    F-1 Value: 81.41%