# MACHINE LEARNING

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**Q1.**
Absolute Classification accuracy and mean class accuracy of the model for iterations varying number of trees from 5 to 105:

1. Absolute Classification Accuracy of the model is : 99.5238
   Mean Class-Wise Accuracy of the model is : 99.5238
2. Absolute Classification Accuracy of the model is : 100
   Mean Class-Wise Accuracy of the model is : 100
3. Absolute Classification Accuracy of the model is : 100
   Mean Class-Wise Accuracy of the model is : 100
4. Absolute Classification Accuracy of the model is : 100
   Mean Class-Wise Accuracy of the model is : 100
5. Absolute Classification Accuracy of the model is : 100
   Mean Class-Wise Accuracy of the model is : 100
6. Absolute Classification Accuracy of the model is : 100
   Mean Class-Wise Accuracy of the model is : 100
7. Absolute Classification Accuracy of the model is : 100
   Mean Class-Wise Accuracy of the model is : 100
8. Absolute Classification Accuracy of the model is : 100
   Mean Class-Wise Accuracy of the model is : 100
9. Absolute Classification Accuracy of the model is : 100
   Mean Class-Wise Accuracy of the model is : 100
10. Absolute Classification Accuracy of the model is : 100
    Mean Class-Wise Accuracy of the model is : 100
11. Absolute Classification Accuracy of the model is : 100
    Mean Class-Wise Accuracy of the model is : 100
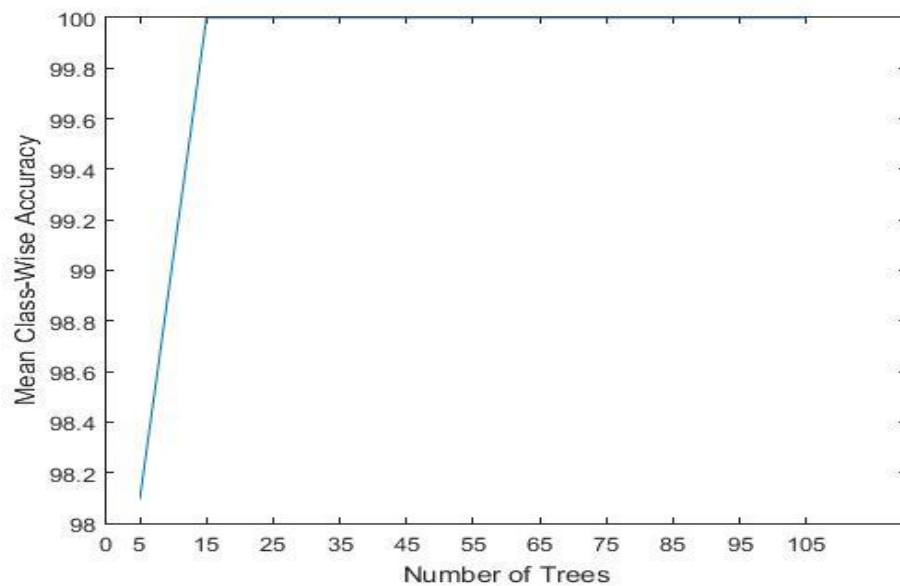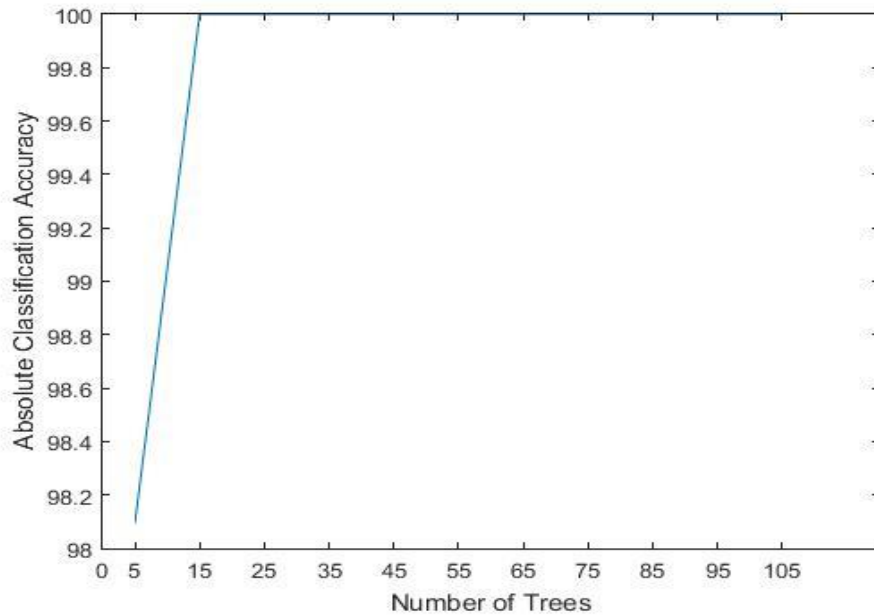
Pattern observed – the accuracy grew with increase in the number of trees. It was close to 98-99% for 5 trees and shot to 100% as we increased the number of trees. This is true because as we increase the number of trees, the bias and variance reduce.

**Q2.**
**A.**
Confusion matrix for perceptron that performs a 2-class classification with the given features

## Confusion matrix for Perceptron

| Output Class | Target Class 1 | Target Class 2 | |
|---|---|---|---|
| **1** | 30<br>50.0% | 0<br>0.0% | 100%<br>0.0% |
| **2** | 0<br>0.0% | 30<br>50.0% | 100%<br>0.0% |
| | 100%<br>0.0% | 100%<br>0.0% | 100%<br>0.0% |

**B.** Using perceptron trained above, to create a double hidden layer network with four nodes each.

## Confusion matrix for double hidden layer network with 4 nodes ea

| Output Class | Target Class 1 | Target Class 2 | |
|---|---|---|---|
| **1** | 30<br>50.0% | 0<br>0.0% | 100%<br>0.0% |
| **2** | 0<br>0.0% | 30<br>50.0% | 100%<br>0.0% |
| | 100%<br>0.0% | 100%<br>0.0% | 100%<br>0.0% |

There is no change in the result when we use a Multi Layer Neural Network. Both perceptron and neural network report TP=30, FP=0, TN=20, FN=0

**C.** Using the entire dataset to train a two hidden layer neural network of 4 hidden nodes each for the complete seven-class problem.

Confusion matrix for Complete classification problem using double hidden layer network with 4 nodes each

| | 1 | 2 | 3 | 4 | 5 | 6 | 7 | |
|---|---|---|---|---|---|---|---|---|
| **1** | 29<br>13.8% | 0<br>0.0% | 0<br>0.0% | 0<br>0.0% | 0<br>0.0% | 0<br>0.0% | 0<br>0.0% | 100%<br>0.0% |
| **2** | 0<br>0.0% | 30<br>14.3% | 0<br>0.0% | 0<br>0.0% | 0<br>0.0% | 0<br>0.0% | 0<br>0.0% | 100%<br>0.0% |
| **3** | 0<br>0.0% | 0<br>0.0% | 27<br>12.9% | 0<br>0.0% | 9<br>4.3% | 0<br>0.0% | 0<br>0.0% | 75.0%<br>25.0% |
| **4** | 0<br>0.0% | 0<br>0.0% | 1<br>0.5% | 28<br>13.3% | 2<br>1.0% | 0<br>0.0% | 0<br>0.0% | 90.3%<br>9.7% |
| **5** | 1<br>0.5% | 0<br>0.0% | 2<br>1.0% | 2<br>1.0% | 19<br>9.0% | 0<br>0.0% | 0<br>0.0% | 79.2%<br>20.8% |
| **6** | 0<br>0.0% | 0<br>0.0% | 0<br>0.0% | 0<br>0.0% | 0<br>0.0% | 30<br>14.3% | 0<br>0.0% | 100%<br>0.0% |
| **7** | 0<br>0.0% | 0<br>0.0% | 0<br>0.0% | 0<br>0.0% | 0<br>0.0% | 0<br>0.0% | 30<br>14.3% | 100%<br>0.0% |
| | 96.7%<br>3.3% | 100%<br>0.0% | 90.0%<br>10.0% | 93.3%<br>6.7% | 63.3%<br>36.7% | 100%<br>0.0% | 100%<br>0.0% | 91.9%<br>8.1% |

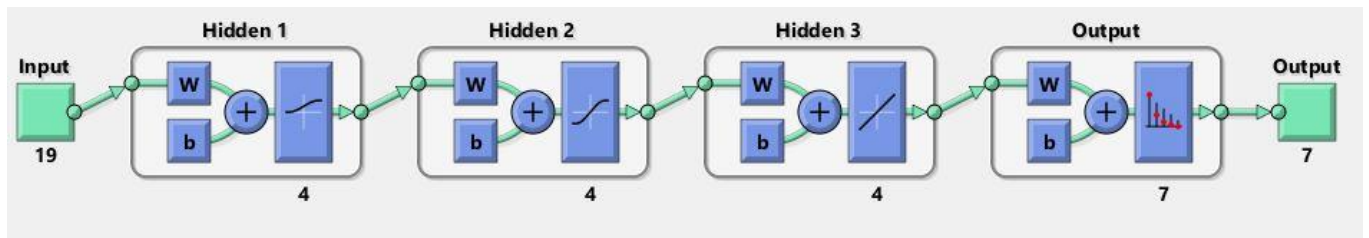*Output Class (vertical axis) — Target Class (horizontal axis)*

Mean class accuracy of the trained network is 91.9048%

**D.** Increase the hidden layers to three and change the activation function on all layers.
Layer 1 – logsig
Layer 2 – tansig
Layer 3 – purelin

Confusion matrix for Complete classification problem using double hidden layer network with 4 nodes each

| Output Class | 1 | 2 | 3 | 4 | 5 | 6 | 7 | |
|---|---|---|---|---|---|---|---|---|
| 1 | 30 / 14.3% | 11 / 5.2% | 26 / 12.4% | 3 / 1.4% | 25 / 11.9% | 0 / 0.0% | 1 / 0.5% | 31.3% / 68.8% |
| 2 | 0 / 0.0% | 19 / 9.0% | 0 / 0.0% | 0 / 0.0% | 0 / 0.0% | 0 / 0.0% | 0 / 0.0% | 100% / 0.0% |
| 3 | 0 / 0.0% | 0 / 0.0% | 0 / 0.0% | 0 / 0.0% | 0 / 0.0% | 0 / 0.0% | 0 / 0.0% | NaN% / NaN% |
| 4 | 0 / 0.0% | 0 / 0.0% | 4 / 1.9% | 27 / 12.9% | 5 / 2.4% | 30 / 14.3% | 0 / 0.0% | 40.9% / 59.1% |
| 5 | 0 / 0.0% | 0 / 0.0% | 0 / 0.0% | 0 / 0.0% | 0 / 0.0% | 0 / 0.0% | 0 / 0.0% | NaN% / NaN% |
| 6 | 0 / 0.0% | 0 / 0.0% | 0 / 0.0% | 0 / 0.0% | 0 / 0.0% | 0 / 0.0% | 0 / 0.0% | NaN% / NaN% |
| 7 | 0 / 0.0% | 0 / 0.0% | 0 / 0.0% | 0 / 0.0% | 0 / 0.0% | 0 / 0.0% | 29 / 13.8% | 100% / 0.0% |
| | 100% / 0.0% | 63.3% / 36.7% | 0.0% / 100% | 90.0% / 10.0% | 0.0% / 100% | 0.0% / 100% | 96.7% / 3.3% | 50.0% / 50.0% |
| | 1 | 2 | 3 | 4 | 5 | 6 | 7 | |

Target Class

Mean Class-Wise Accuracy of the model is : 49.5238% . The performance of the network has dropped because of using different activation functions on each layer instead of the default which has resulted in loss in information, added noise in the data.

**Q3.** Using the dataset provided, train the ID3 algorithm and use it for classification on the test set.

Absolute Classification Accuracy of the model is : 71.9048
Mean Class-Wise Accuracy of the model is : 71.9048