Foundations of Intelligent Systems
Project 2: The Metal Part Sort-R
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Algorithms:

Multi-layer perceptron is a group of interconnected nodes which resembles the structure of neurons of present in human brain. A decision tree is a group of nodes arranged in tree-like structure which uses a top-down approach for classifying. Both of them infer a function from the given training dataset and hence be called supervised learning.The multi-layer perceptron takes a longer time for training and classifying the training dataset; it is bit slower. On the other hand, decision tree will work relatively faster for the same given set. A multi-layer perceptron can model nonlinear functions and so it will be more accurate. Nevertheless, a decision tree can only model functions that are parallel to the axis split of the data. In multi-layer perceptron, if the data arrives in a stream then we can do an incremental update with stochastic gradient descent. However, it cannot be performed in a decision tree because it uses batch-learning algorithm. Multi-layer perceptron can handle binary data better than a decision tree but it cannot handle categorical values.

We expect the Multi-layer perceptron (MLP) to perform better than the decision trees because of the nonlinear regions that MLP can model when compared with only linear function model produced by decision trees.

Data:

In the given training dataset, we have four classes. Class 1 is a representation for Bolt, class 2 for nut, class 3 for ring, class 4 for scrap. As represented in Figure 1, the class 1 is in red dots, class 2 is green stars, class 3 is blue squares, class 4 is black triangles. It can be seen that some

of class 4 triangles are placed in blue square region as well as in green star region. To explain in detail, class 1 occurs mostly when eccentricity is more than 0.8. Class 2 occurs when rotational symmetry is more than 0.3 and eccentricity is less than 0.2. Class 3 occurs when rotational symmetry is less than 0.3 and eccentricity is less than 0.2. Class 4 occurs when eccentricity is between 0.2 and 0.8.

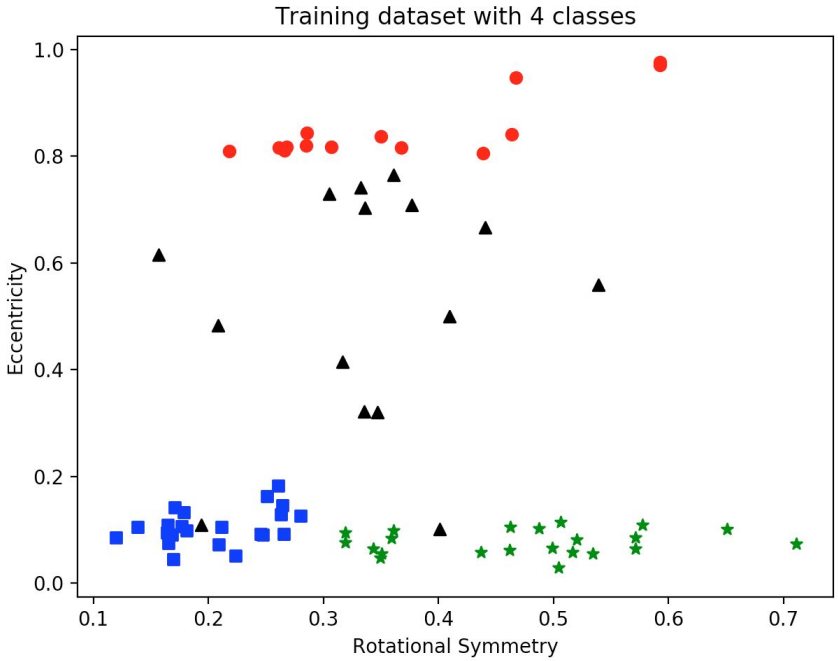

Figure 1: Plot of training dataset

The training dataset has three attributes: symmetry, eccentricity and class. The values of both symmetry and eccentricity varies from 0 to 1. The class values varies from 1 to 4. In the given training dataset, there are 15 data points in class 1, 22 in class 2, 22 in class 3 and 15 in class 4.

Results:

Multi-Layer Perceptron:

For training the MLP, we used 3 layers with 5 nodes in the hidden layers. The following figures shows the classification regions produced by different number of training epochs like 0, 10, 100, 1000, 10000.

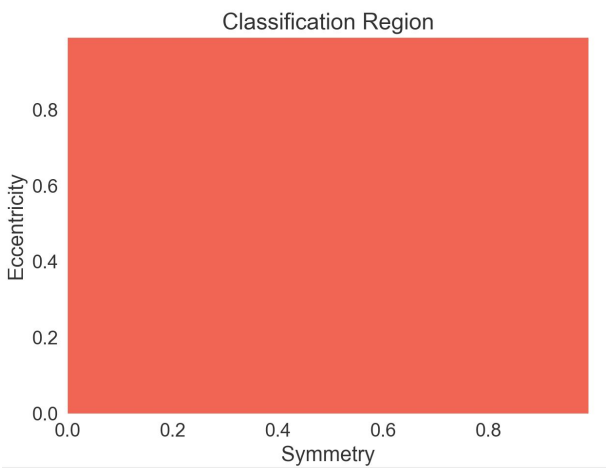

Figure 2: Classification region for 0 epoch

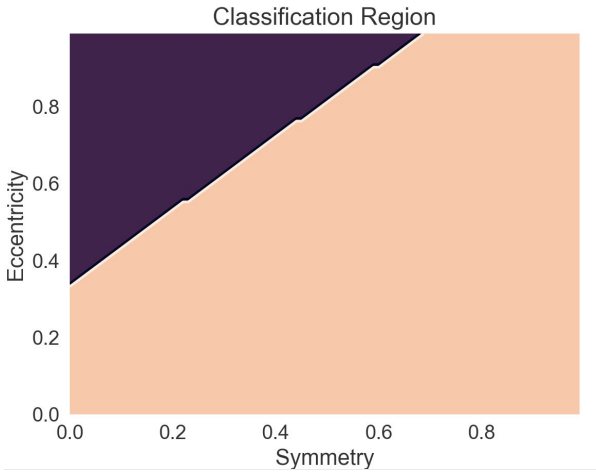

Figure 3: Classification region for 10 epoch

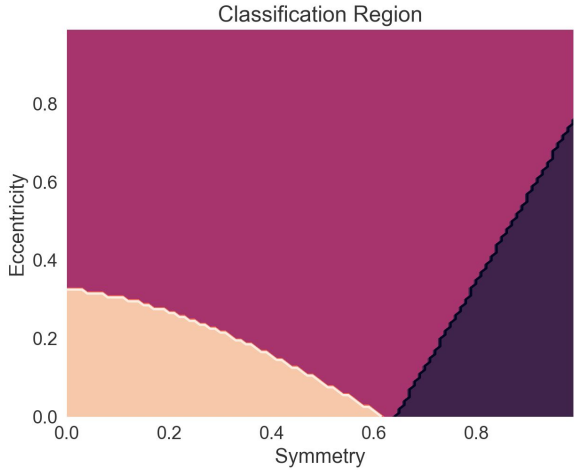

Figure 4: Classification region for 100 epoch

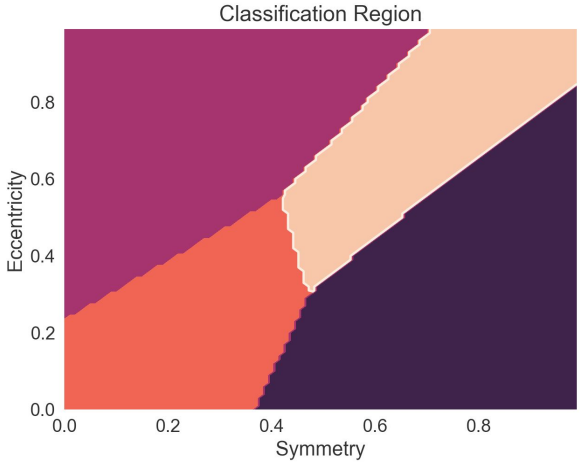

Figure 5: Classification region for 1000 epoch

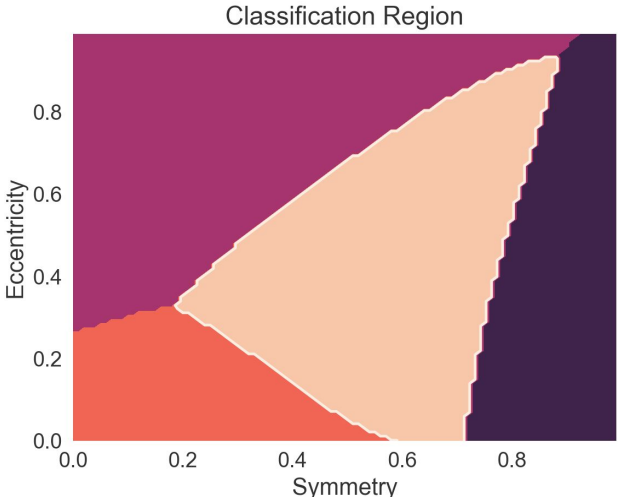

Figure 6: Classification region for 10000 epoch

The following figure shows the learning curve (SSE vs Epoch) for the trained MLP from 0 to 10000 epochs. It can be seen that the SSE gradually decreases as the number of epochs increases.

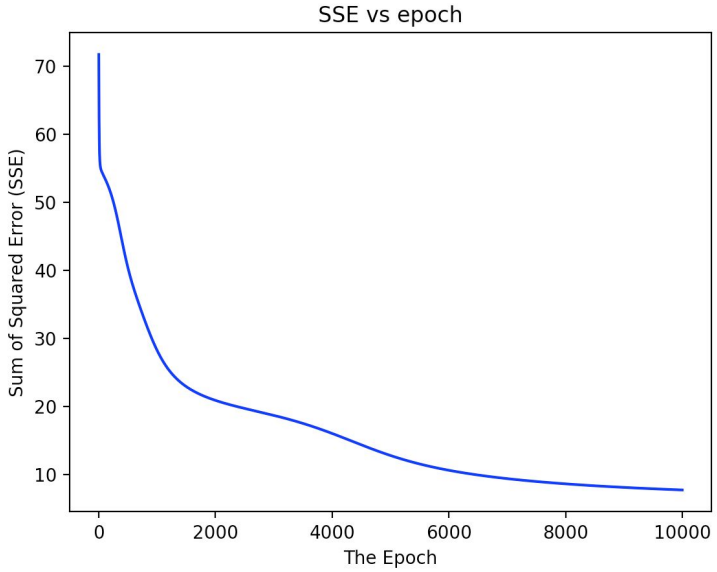

Figure 7: SSE vs Epoch plot

The following table shows the recognition rate and the profit for each epoch.

Table 1: Table showing recognition rate and profit for each epoch

Epochs	Recognition Rate (%)	Profit (in cents)*
0	25	-5
10	30	-8
100	55	71
1000	80	187
10000	95	199

* Negative profit indicates a loss