Radial Basis Function [RBF] ANN

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1 Introduction

In the field of mathematical modeling, a radial basis function network is an artificial neural network that uses radial basis functions as activation functions. The output of the network is a linear combination of radial basis functions of the inputs and neuron parameters. Radial basis function networks have many uses, including function approximation, time series prediction, classification, and system control

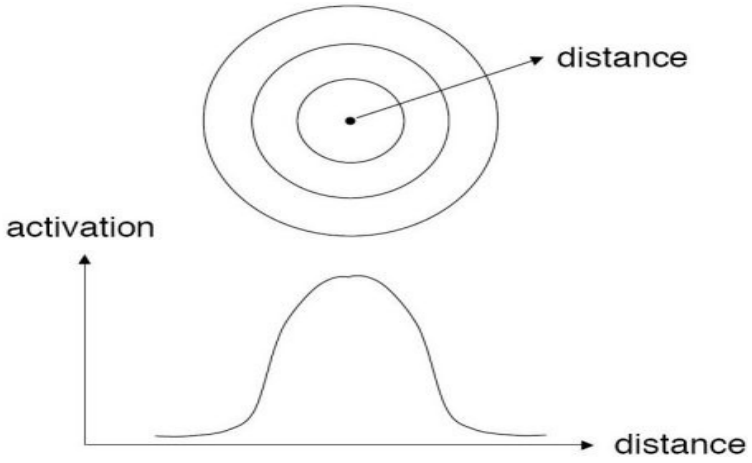

Figure 1: Radial Basis Function Mapping

2 Comparison With a Standard ANN

What sets the RBF-ANN apart is the fact that the data points are not directly fed to the network , based on domain knowledge one would intuitively expect how many many features the data set would comprise and accordingly each input vector is converted into a representation where in it is represented using its belongingness to each of the feature models which are made up by the gaussian mixtues or other such Radial Functions. If a set of gaussian mixtures are used then the set of posterior probabilities would form the feature vector and incase of the clusterring algorithms the membership to each cluster will be the feature vector

3 Training Procedure

3.1 Feature Vector Generation

- Input data vector is fed to a K-Means clustering function which produces a feature vector
- For the rainfall data set k is assumed to be 52 which is the number of weeks in a year. Since K-Means uses $||x||_2$ the region of interest of each cluster would be a circle and the membership is assigned depending on the distance from each cluster centre
- After forming a 52 dimensional feature vector for each data point , it is fed to a ANN
- Algorithm

1. Initialize **cluster centroids** $\mu_1, \mu_2, \ldots, \mu_k \in \mathbb{R}^n$ randomly.
2. Repeat until convergence: {

   For every i, set
   $$c^{(i)} := \arg\min_j ||x^{(i)} - \mu_j||^2.$$

   For each j, set
   $$\mu_j := \frac{\sum_{i=1}^{m} 1\{c^{(i)} = j\} x^{(i)}}{\sum_{i=1}^{m} 1\{c^{(i)} = j\}}.$$

   }

3.2 ANN Training

- The size of the first hidden layer would be [52 x N] where N is the no of perceptrons in the First layer
- The number of hidden layers chosen based on the evaluation result accuracy and for initialization the elements of the weight matrix are randomly generated between 0 and 1
- The final layer of the Neural network is chosen to be 52 dimensional so that it outputs the prediction of which cluster a certain input point would belong
- And after each epoch the weight matrix is updated using the Back Propagation Algorithm

4 Advantages

- Training in RBNN is faster than in Multi-layer Perceptron (MLP) $->$ takes many interactions in MLP
- We can easily interpret what is the meaning / function of the each node in hidden layer of the RBNN. This is difficult in MLP

5 Results

- A trend of the data was formed by joining the cluster centres for data visualization and it was evident that the distribution of rainfall seems to follow a sinusoidal trend
- For the rainfall dataset used , with 52 number of clusters the Accuracy score of RBF network is 0.82

6 References

- https://en.wikipedia.org/wiki/Radial-basis-function-network
- https://www.hackerearth.com/blog/developers/radial-basis-function-network