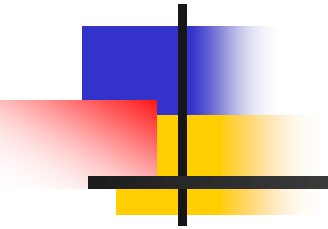

RBF Neural Net

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Outline

- Discuss how to improve default Neural Network model performance
- Describe RBF (Radial Basis Function) Neural model
- Demonstrate RBF

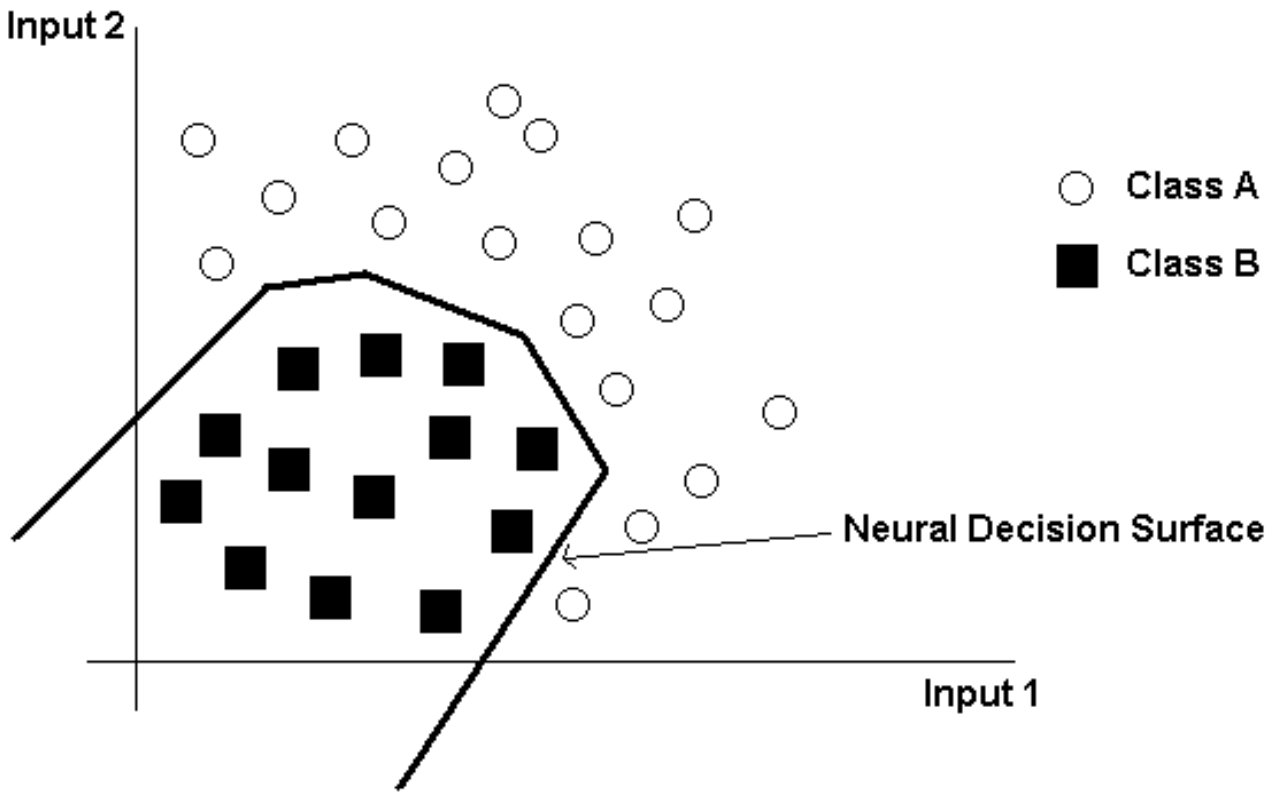
How to Improve the Default Neural Net (NN) model?

- A default NN model can be improved in multiple ways:
  - Changing the architecture of the network: number of neurons in a hidden layer, changing the number of hidden layers, changing type of NN from MLP to RBF
  - Changing input variables
    - Perhaps we are putting in too many redundant variables – may be we should use variable selection before NN (based on either statistical reasoning or data/business understanding or both)
    - Perhaps we should create combinations of existing variables or create indices
    - Perhaps, recode/combine categories of class variables
    - If for input numeric fields, the data distribution are **very skewed** then some modelers will apply a transformation that will make the skewed distribution appear more flat (uniform) or normal-like.
- Remember, "the proof of the pudding is in the eating" – that is, it is only worth doing all these if the performance of the model improves in the validation data

Types of Neural Networks

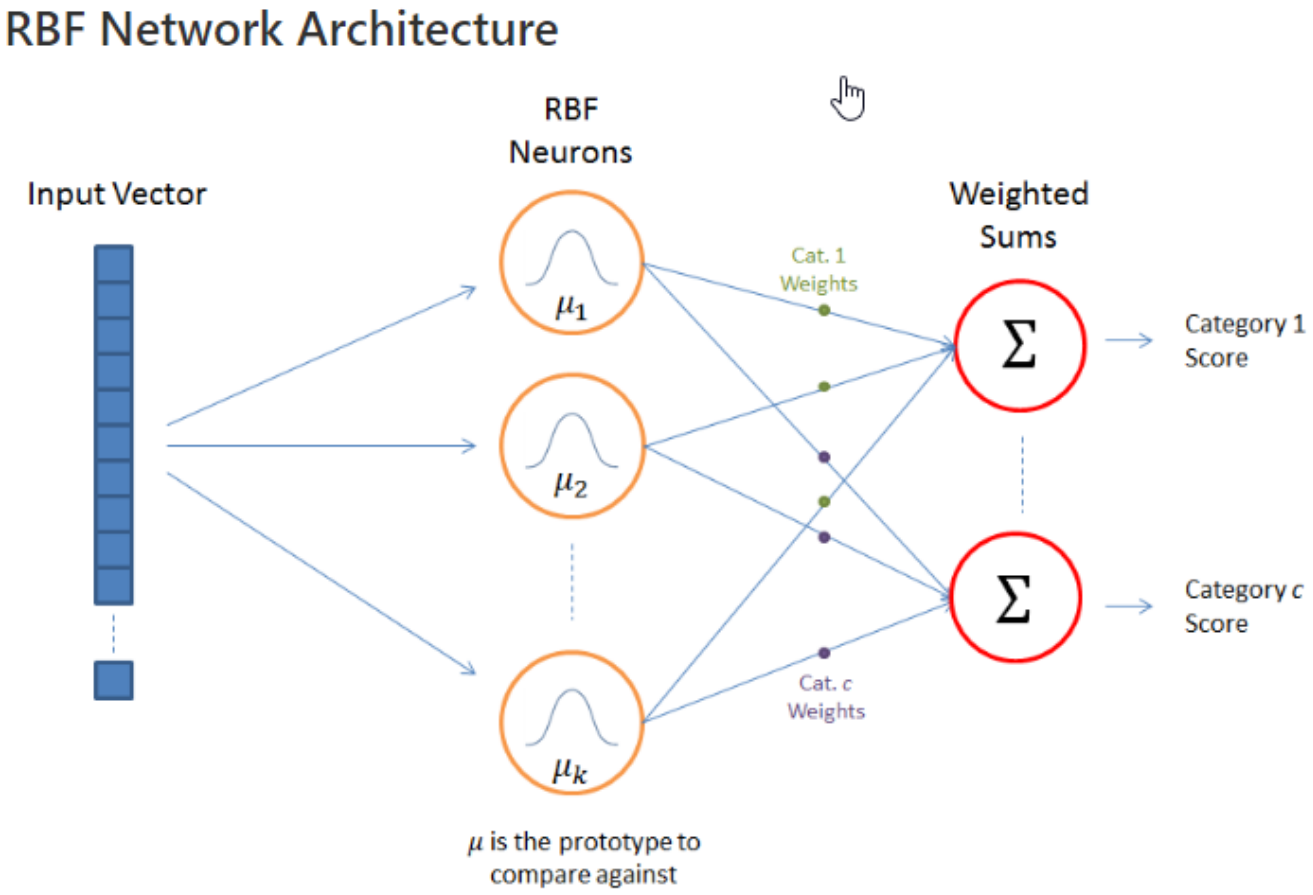
- MLP (Multi-layered Perceptron)
- RBF (Radial Basis Function)
- So far, we have dealt with MLP only
- Let’s understand the difference between the two – we will consider a prediction problem (outcome variable: Flag type – class A or B and only two input variables – Input1 and Input 2)

Decision Surface in MLP

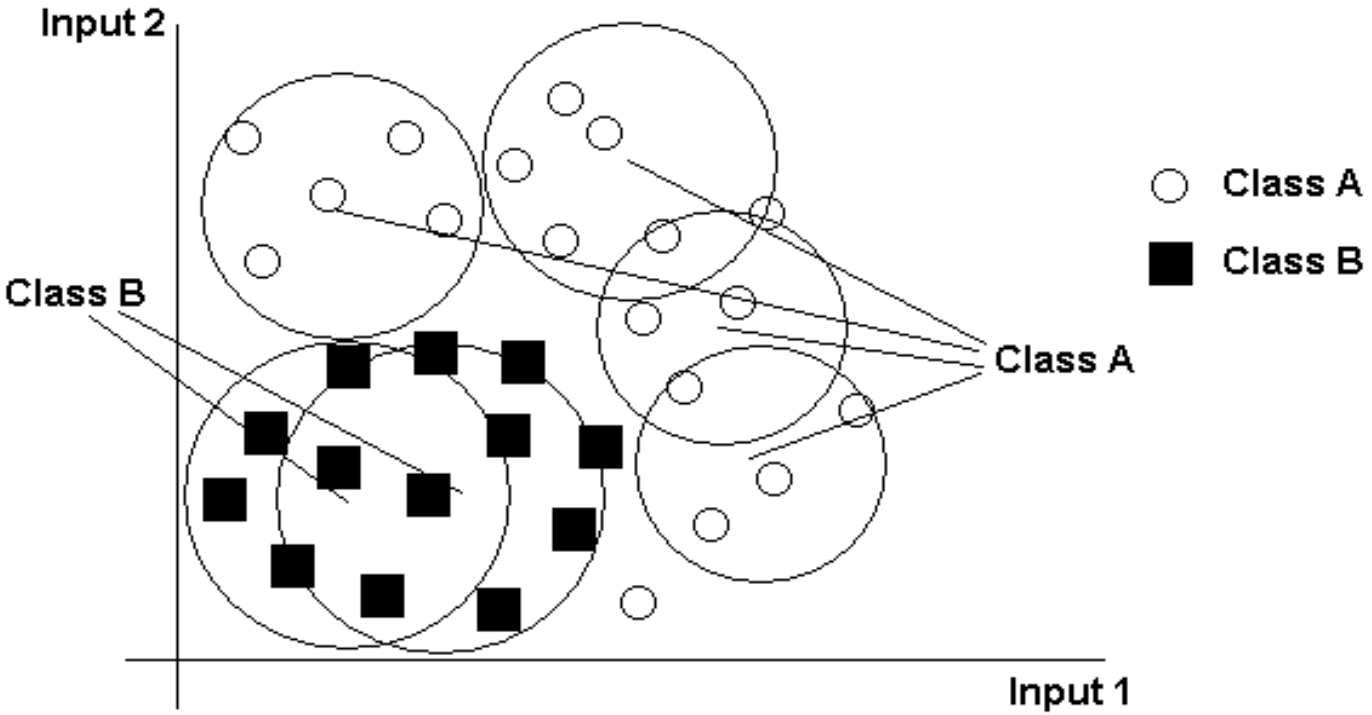


Using a non-linear combination of the inputs, the MLP fits an open curve between the two classes.

RBF Network Architecture



Operation of a RBF



RBF models place radial basis (circles) functions at different locations in the data space

RBF (Radial Basis Functions)

- Instead of Combination and Transfer function of MLPs, RBF nodes contain a distance function and a transfer function.
- The nodes output is a non-linear function of how close the input is to the target.
- Radial means all inputs that are the same distance from the node's position produce the same output.
  - These points form a circle in 2D, sphere in 3D
- Transfer function in RBF is typically Gaussian (bell-shaped)
  - Generalizations of familiar Normal curve
- Unlike MLP, there are usually no weights between input and hidden layer. Instead this layer has RBF node's position, width and height.

RBF (Radial Basis Functions)

- As with MLP, the connections between hidden layers and the output layer has weights that are optimized during the training process.
- As more nodes or inputs are added, the response surface can get very complicated and approximate any shape.
- Since the output of RBF node is a function of how close it is to an input record, placement of nodes is important.
  - One strategy is to choose locations evenly making no assumptions about patterns in the data.
  - Another strategy is to first run a clusters and then place the RBF nodes at the center of those clusters.
    - This may produce uneven coverage of the input space

RBF in SAS EM

- You get seven different choices of RBF depending on whether you want equal/unequal width/heights etc.
- Add another Neural Network node and connect to regression(optimal) node.
  - Click on Network ellipsis button and then use Architecture drop-down. Select RBF with unequal Width – run and take a look at the model fit statistics.
  - You should try running each of these RBFs (perhaps change number of nodes etc.) on your own in this data and see for yourself how they perform
- Read the help file in SAS EM about RBF for more details

Performance of Neural Network

- All Variables (No selection):
  - Number of Parameters = 253, ASE (V) = 0.2429, Misclassification (V) = 0.4301
- With variable Selection:
  - Number of Parameters = **19**, ASE (V) = 0.2404, Misclassification (V) = 0.4216
- With variable Selection and 6 neurons:
  - Number of Parameters = 37, ASE (V) = **0.2398**, Misclassification (V) = 0.4228
- AutoNeural:
  - Number of Parameters = **7**, ASE (V) = 0.2411, Misclassification (V) = **0.4175**
- RBF
  - Number of Parameters = 19, ASE (V) = 0.2409, Misclassification (V) = 0.4253