IIT ROORKEE

NPTEL ONLINE CERTIFICATION COURSE

ARTIFICIAL NEURAL NETWORKS

LECTURE 53

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ARTIFICIAL NEURAL NETWORKS

- Based on
  - Human learning and memory properties
  - Capacity to generalize from particulars
  - Biological activity of brain, where interconnected neurons learn from experience
- Can model complex relationships between outcome variable and set of predictors
  - Applications in Finance (credit card fraud) and engineering disciplines (autonomous vehicle movement)

ARTIFICIAL NEURAL NETWORKS

- Can model complex relationships between outcome variable and set of predictors
  - Flexible data driven model
    - Not required to specify the form of relationship
    - Useful technique, when functional form of relationship is complicated or unknown
    - Linear and logistic regressions can be conceptualized as special cases
- Neural Network Architectures
  - Multilayer feedforward networks

ARTIFICIAL NEURAL NETWORKS

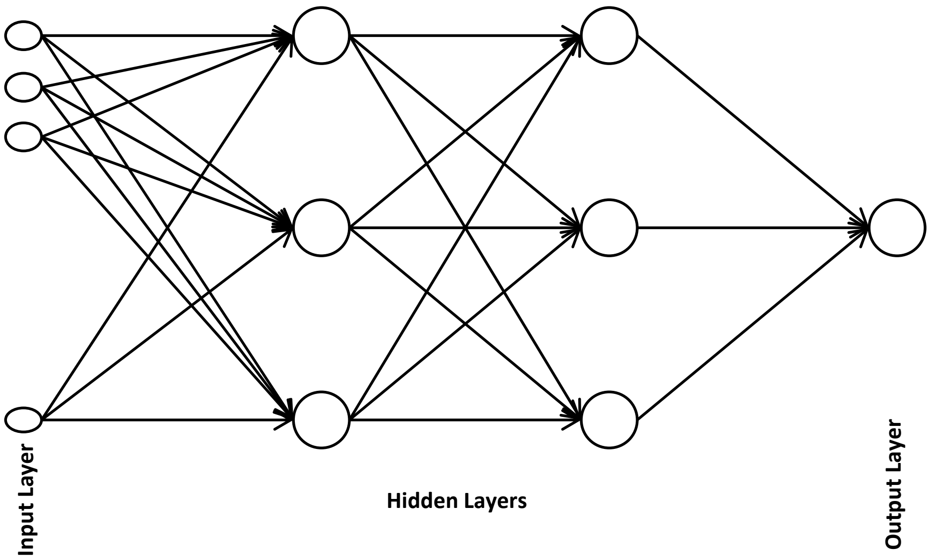
- Multilayer feedforward networks
  - Fully connected networks
    - Comprising of multiple layers of nodes
    - With one-way flow and no cycles
  - Input layer
    - First layer of the network
  - Hidden layers
    - Layers between input and output layer

ARTIFICIAL NEURAL NETWORKS

- Multilayer feedforward networks
  - Output layer
    - Last layer of the network
  - Nodes receive feed from previous layer and forward it to next layer after applying a particular function
  - Function used to map input values (received feed) to output values (forwarded feed) at a node is typically different for each type of layers

ARTIFICIAL NEURAL NETWORKS

- Multilayer feedforward networks



ARTIFICIAL NEURAL NETWORKS

- Multilayer feedforward networks
  - Each arrow from node i to node j has a value w_{ij} indicating weight of the connection
  - Each node in the hidden and output layers also has a bias value, θ_j (equivalent to intercept term)
- Computing output values at nodes of each layer type
  - Input layer nodes
    - No. of nodes are typically equal to no. of predictors, p
    - Each node will receive input values from its corresponding predictor
    - Output is same as input, that is, predictor's value

ARTIFICIAL NEURAL NETWORKS

- Computing output values at nodes of each layer type
  - Hidden layer nodes
    - Sum of bias value and weighted sum of input values received from previous layer is computed

$$\theta_j + \sum_{i=1}^{p} w_{ij} x_i$$

    - Function g (referred as transfer function) is applied on this sum to produce the output values
    - Transfer function could be a monotone function, for example:
      - Linear function: $g(x) = bx$
      - Exponential function: $g(x) = e^{bx}$
      - Logistic or sigmoidal function: $g(x) = 1/1+e^{-bx}$

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- Computing output values at nodes of each layer type
  - Hidden layer nodes
    - θ_j and w_{ij} are typically initialized to small random values in the range 0.0±0.05
    - Network updates these values after learning from data during each iteration or round of training
  - Output layer nodes
    - Steps are same as for hidden layer nodes, except the fact that input values are received from last hidden layer
    - Output values produced by nodes are used as
      - Predictions in a prediction task
      - Scores to be used to classify a record in a classification task

Key References

- Data Science and Big Data Analytics: Discovering, Analyzing, Visualizing and Presenting Data by EMC Education Services (2015)
- Data Mining for Business Intelligence: Concepts, Techniques, and Applications in Microsoft Office Excel with XLMiner by Shmueli, G., Patel, N. R., & Bruce, P. C. (2010)

Thanks...