Info 251: Applied Machine Learning
Lab 11
4/15/2020

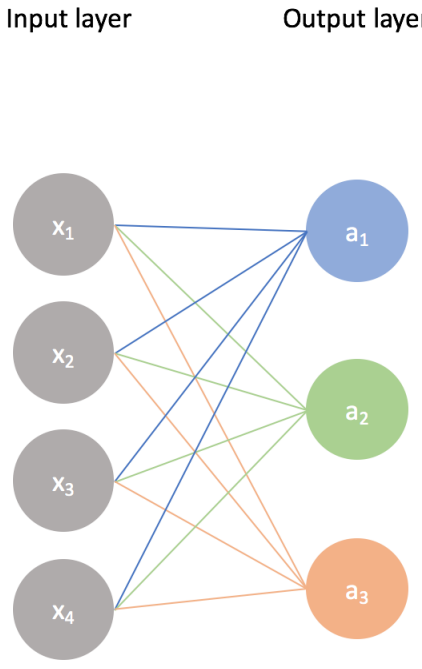
Topics

- Feature Importance
- Neural networks
- Tensorflow

Feature Importance

- In Sklearn
- Gini imputiry: $G = \sum_{i=1}^{C} f_i(1 - f_i)$
- f_i is the frequency of the label at that node
- Nodes importance: $ni_j = w_j G_j - w_{left_j} G_{left_j} - w_{right_j} G_{right_j}$
- $left, right$ denote the children of the binary tree
- w_j: weighted number of samples reaching node j
- Feature importance: $fi_i = \frac{\sum_{j:node\ j\ splits\ on\ feature\ i} ni_j}{\sum_{k:all\ nodes} ni_k}$

Neural Networks



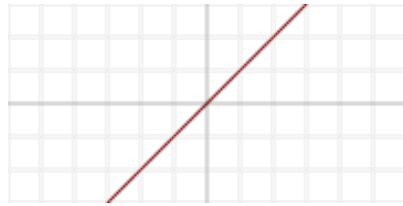
A simple neural network

$$\begin{bmatrix} w_1 & w_2 & w_3 & w_4 \\ w_1 & w_2 & w_3 & w_4 \\ w_1 & w_2 & w_3 & w_4 \end{bmatrix} \begin{bmatrix} x_1 \\ x_2 \\ x_3 \\ x_4 \end{bmatrix} + \begin{bmatrix} b \\ b \\ b \end{bmatrix} = \begin{bmatrix} w_1x_1 + w_2x_2 + w_3x_3 + w_4x_4 + b \\ w_1x_1 + w_2x_2 + w_3x_3 + w_4x_4 + b \\ w_1x_1 + w_2x_2 + w_3x_3 + w_4x_4 + b \end{bmatrix} \xrightarrow{activation} \begin{bmatrix} a_1 \\ a_2 \\ a_3 \end{bmatrix}$$

- layer 1$\rightarrow$ input:x, output
  $a = g(W_1x + b_1),\ W \in \mathbb{R}^{3\times4}, b \in \mathbb{R}^3$
- layer 2$\rightarrow$ input:$g(W_1x + b_1)$, output $g(W_2g(W_1x + b_1) + b_2)$
- ...

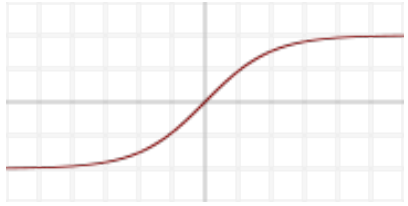
Neural Networks (Regression)

- Objective function
- Commonly, MSE $\frac{1}{n}\sum_{i=1}^{n}(y_i - \tilde{y}_i)^2$
- Last layer of the network has linear activation



Neural Networks (Classification)

- Objective function
- Commonly, Cross-Entropy $\sum_{i=1}^{n} -y_i log\tilde{y}_i - (1-y_i)log(1-\tilde{y}_i)$
- Last layer should output "probabilities"
- Sigmoid function $\tilde{y}_i = \frac{e_i^x}{1+e^{x_i}}$



Multiclass?

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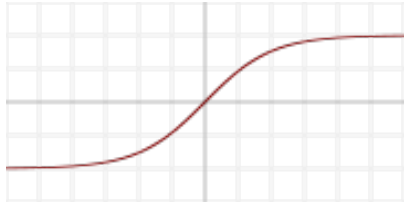
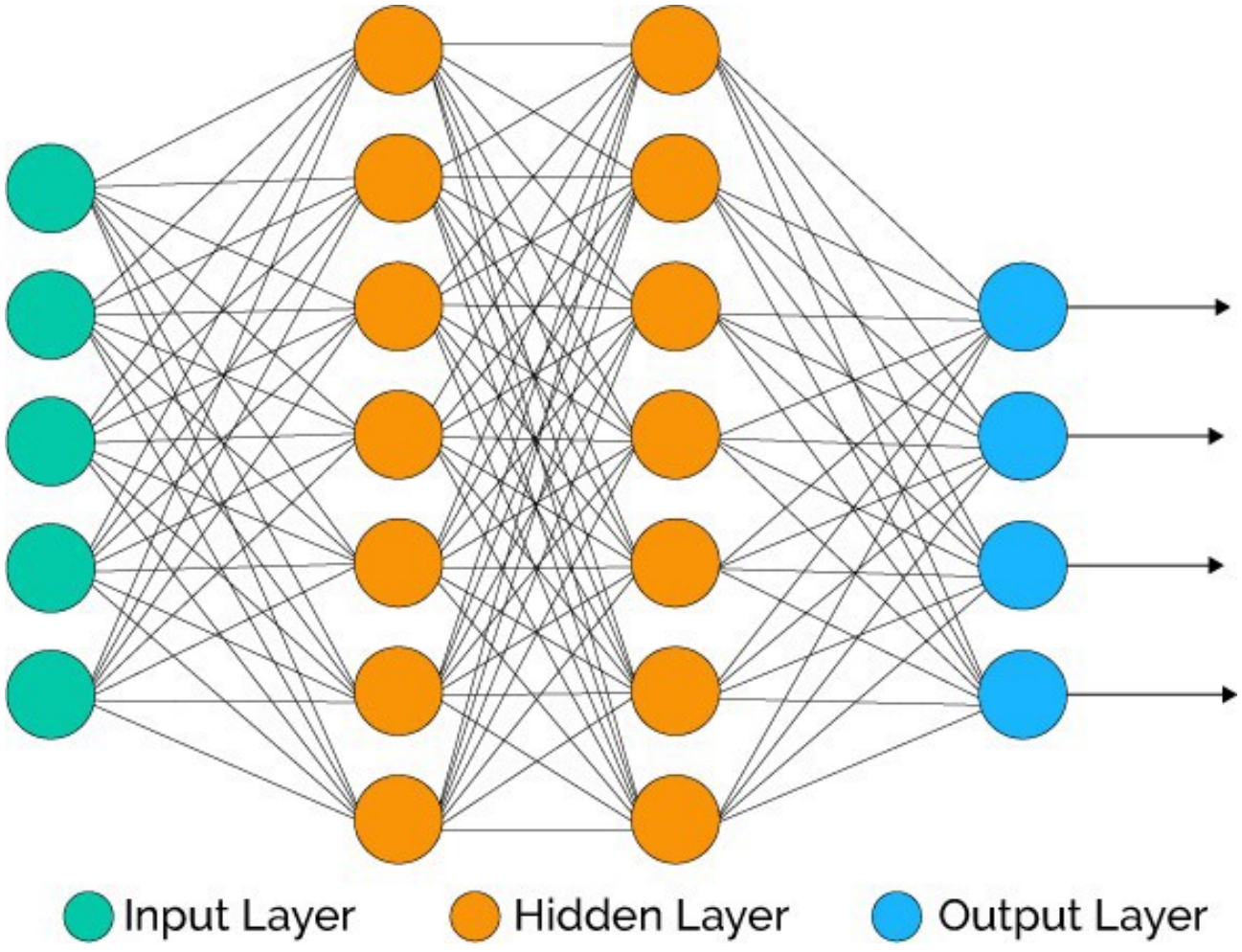


Multiclass?

Cross-Entropy $\sum_{i=1}^{n} \sum_k -y_{i,k} log\tilde{y}_{i,k}$

Neural Network Architecture



- Notebook