



CIS 678 - Machine Learning

Predictive modeling: Classification



Regression vs Classification

- Essentially, we are learning some relationship among variables.

$$f(y|X)$$

Regression vs Classification

- Essentially, we are learning some relationship among variables.

$$f(y=\text{diabetes-score} | X=\text{'bmi'})$$

BMI vs. Target Value





Regression vs Classification

- Essentially, we are learning some relationship among variables.

$$f(y|X)$$

*The difference is with the variable, **y***



Regression problems

$$y \in R$$

- *Insurance cost* : $y \in R$
- *House price*: $y \in R$
- *Weather prediction*: $\mathbf{Y} \in \mathbf{R}$
- *Energy consumption*: $y \in R$
- *Sales forecasting*: $y \in R$

We have learned about regression
(not complete; will continue ..)



Regression vs Classification

$$y \in R$$

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$$y \in \{....\}$$

- Cat vs dog: $y \in \{\text{cat}, \text{dog}\}$
- Spam filter: $y \in \{\text{spam}, \text{not-spam}\}$
- Digit classification: $y \in \{0, 1, ..., 9\}$
- Sentiment classification: $y \in \{\text{happy}, \text{sad}, \text{confused}, \text{angry} \dots\}$

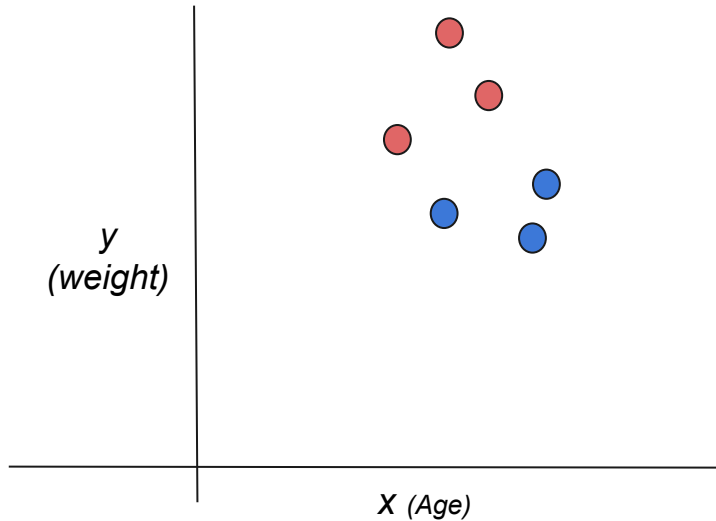
note: has to be from a closed set

We are starting today



Classification Modeling

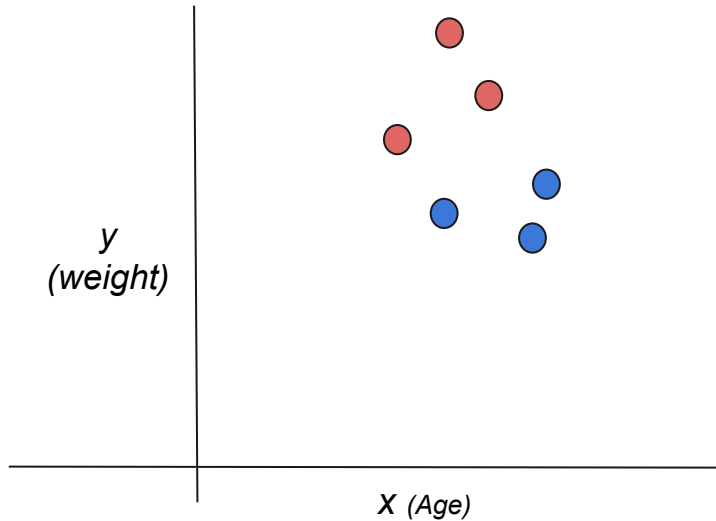
Linear Line as a Threshold



- We have some overweight and underweight people

$$y \in \{\text{underweight}(0), \text{overweight}(1)\}$$

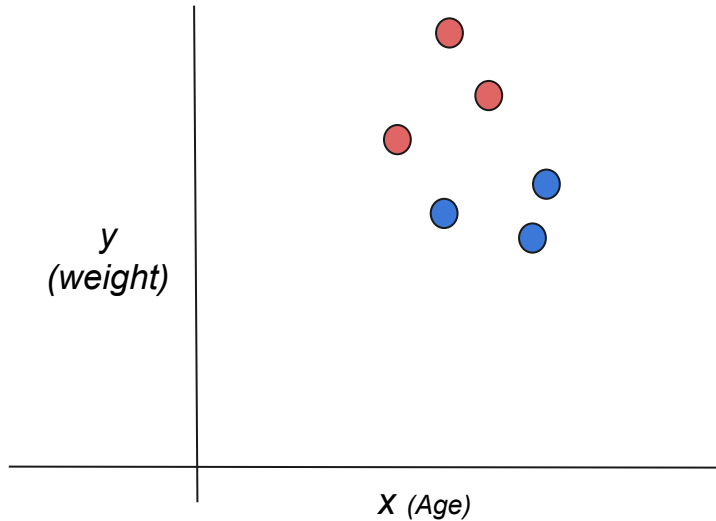
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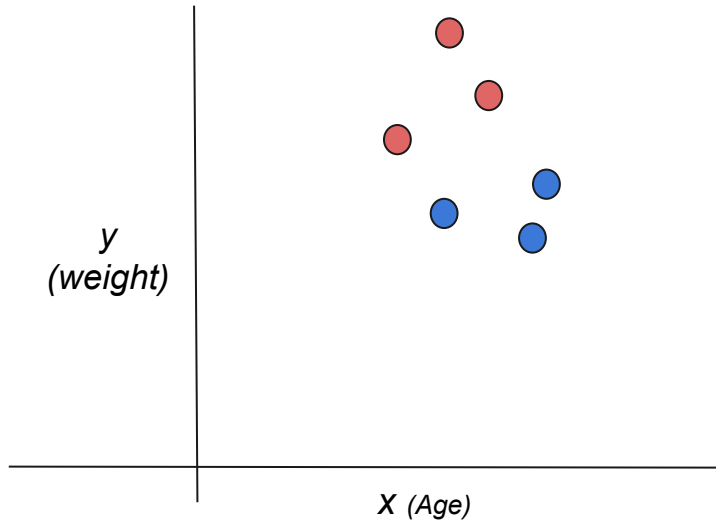
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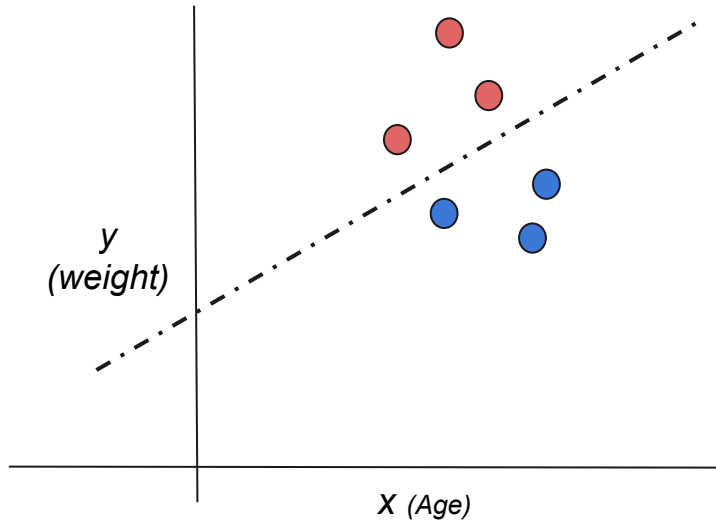
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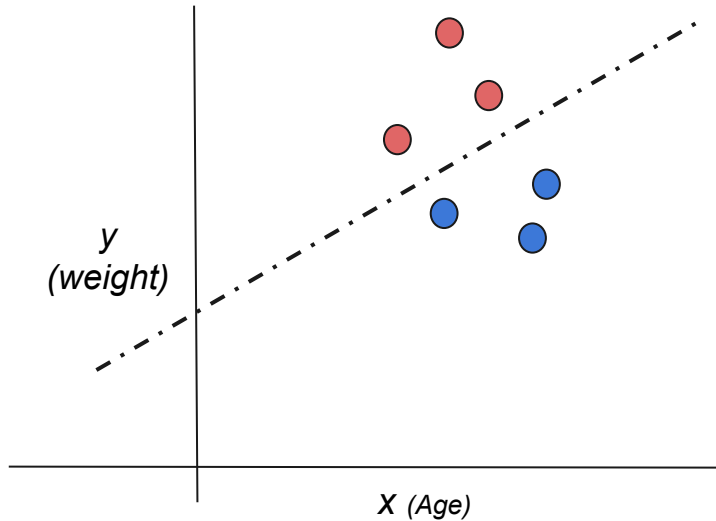
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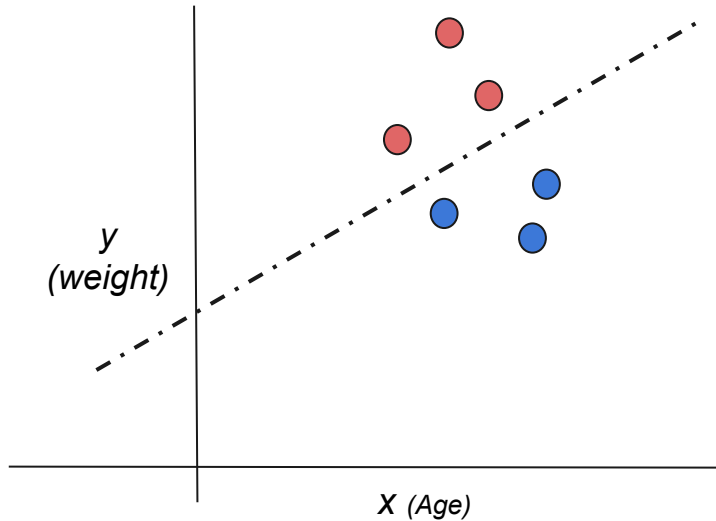


Straight Line as the Separator

$$y = \beta_0 + \beta_1 x$$

$$y \in \{\text{underweight}(\text{0}), \text{overweight}(\text{1})\}$$

Linear Line as a Threshold

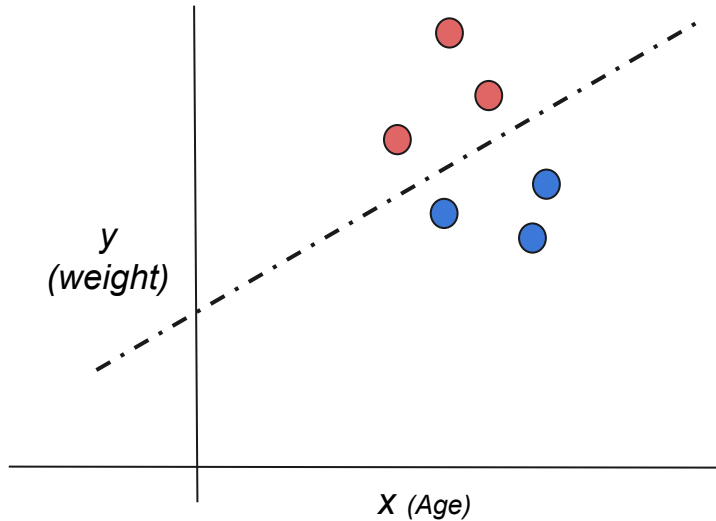


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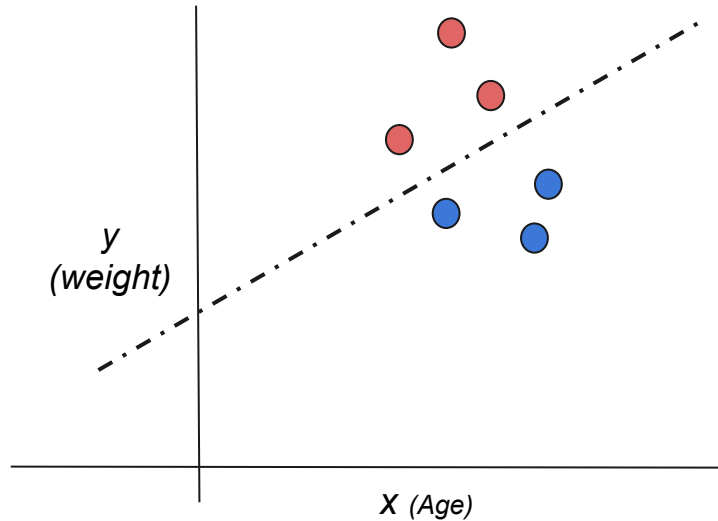
Straight Line as the Separator

$$y = \beta_0 + \beta_1 x$$

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Linear Line as a Threshold



Straight Line as the Separator

$$y = \beta_0 + \beta_1 x$$

$$y - (\beta_0 + \beta_1 x) = 0$$

Classification Rule

$$\hat{y} = \begin{cases} 1, & \text{if } y - (\beta_0 + \beta_1 x) > 0 \\ 0, & \text{otherwise} \end{cases}$$



Classification Models

- Logistic Regression
- k-NN
- Decision Tree
- Random Forest Classifier
- Support Vector Machines (SVMs)
- Boosting Classifiers
- Naive Bayes



Decision Tree

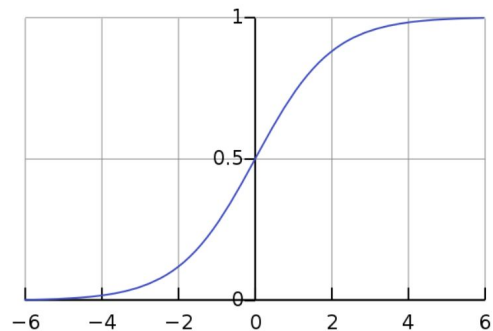
Logistic Regression

- Probabilistic classifier

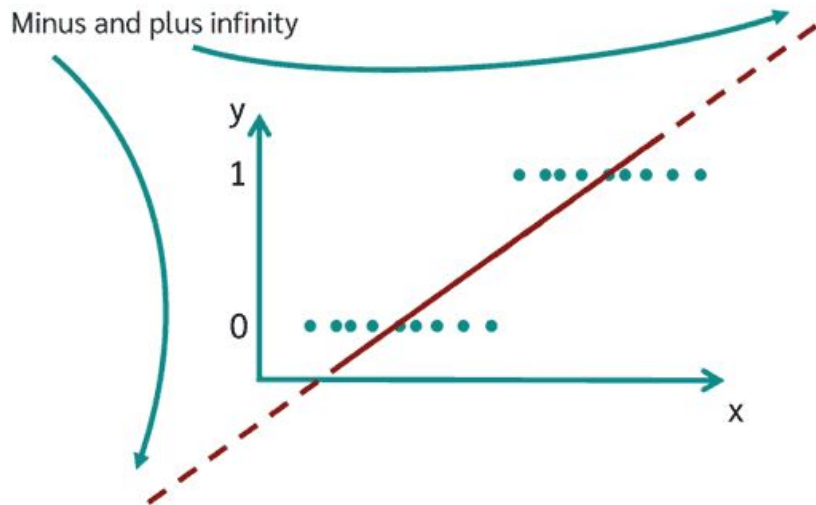
Sigmoid function characteristic

$$p(x) = \frac{1}{1 + e^{-(\beta_0 + \beta_1 x)}}$$

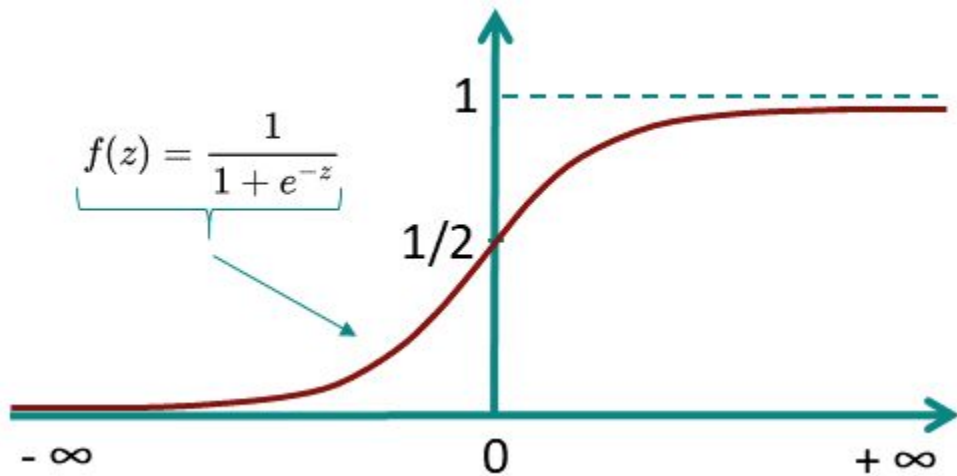
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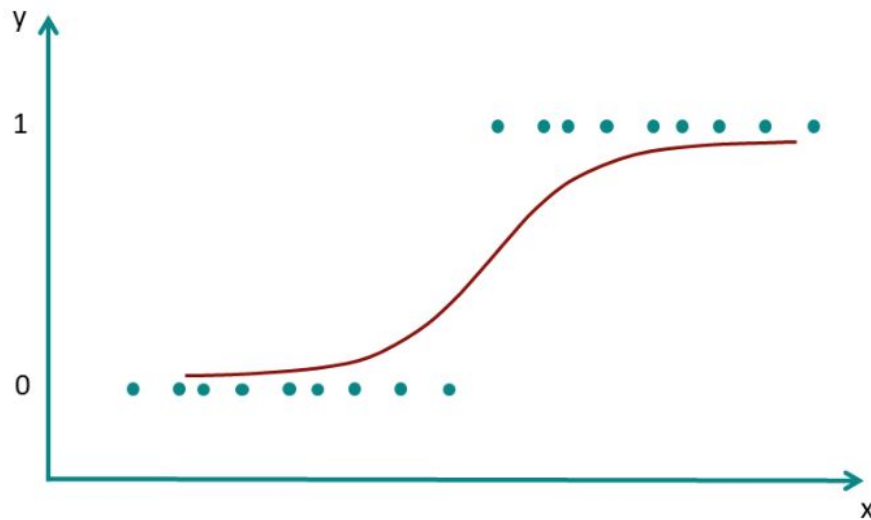
Logistic Regression



Logistic Regression



Logistic Regression

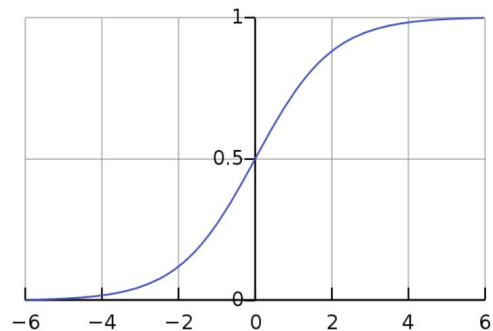


Logistic Regression

- Probabilistic classifier

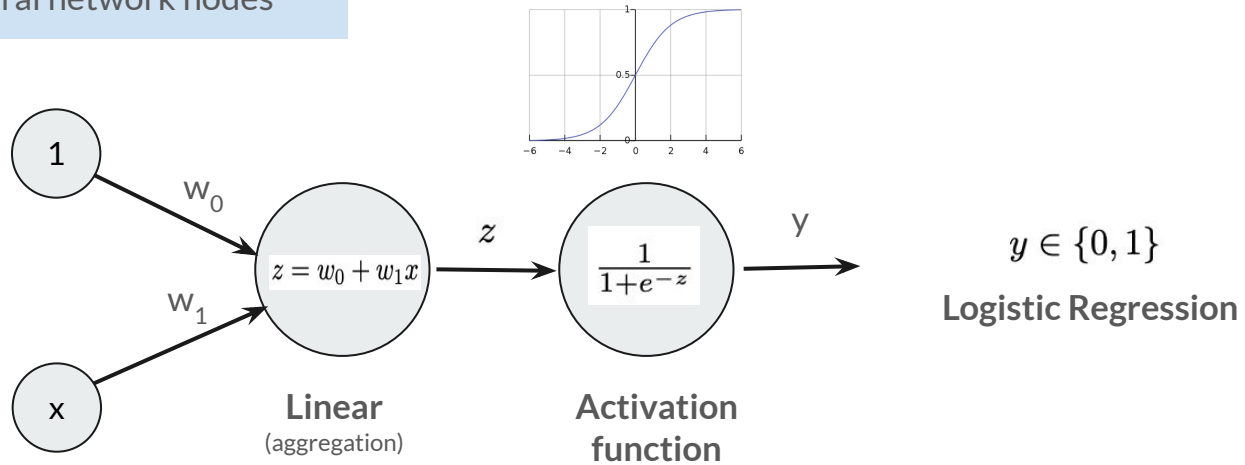
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- Sigmoid function



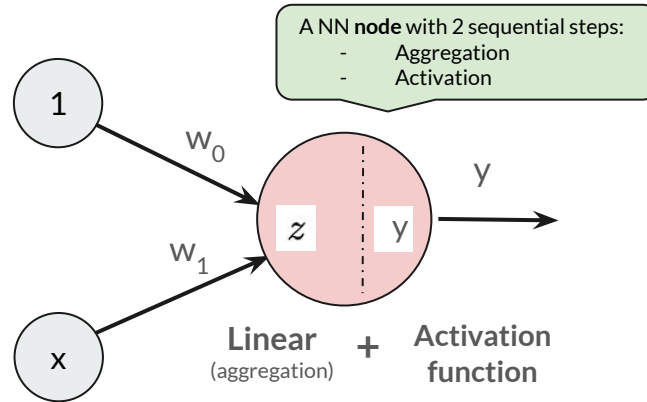
Logistic Regression to Neural Networks (NNs)

Concept of neural network nodes



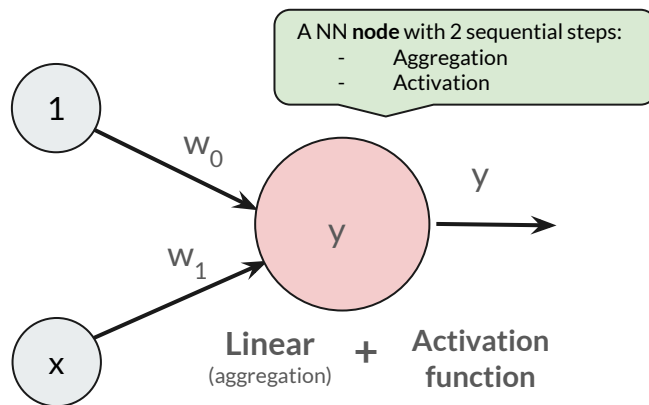
Neural Networks (Node)

Concept of neural network nodes



Neural Networks (Node)

Concept of neural network nodes





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