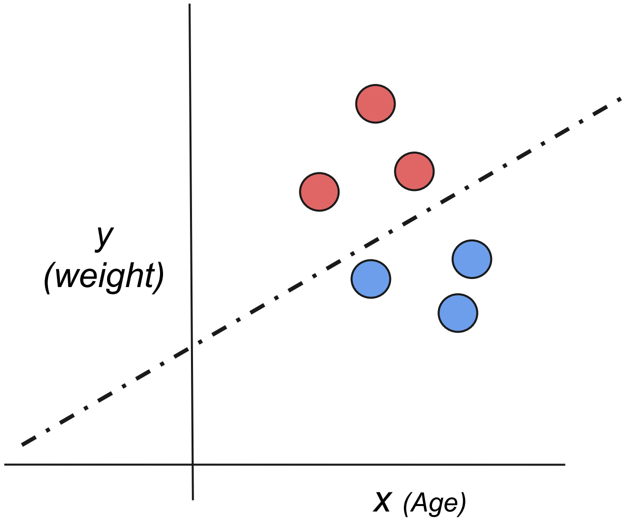
CIS 678 - Machine Learning

Classification Models: Logistic Regression

Classification Models

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

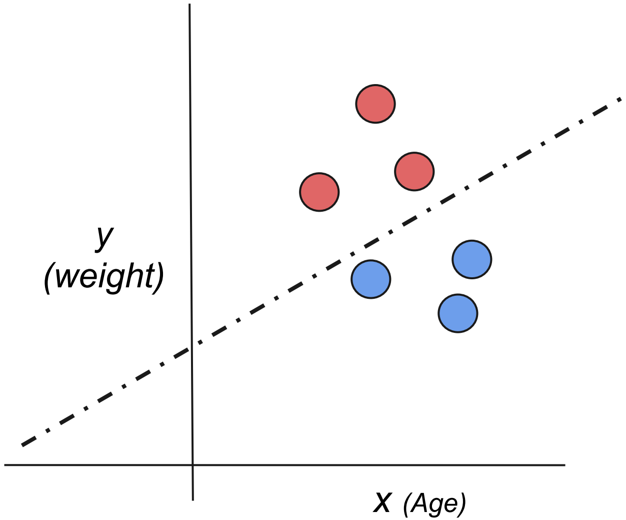
Linear Line as a Threshold



Straight Line as the Separator

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

Linear Line as a Threshold



Straight Line as the Separator

$$\boxed{y = \beta_0 + \beta_1 x}$$

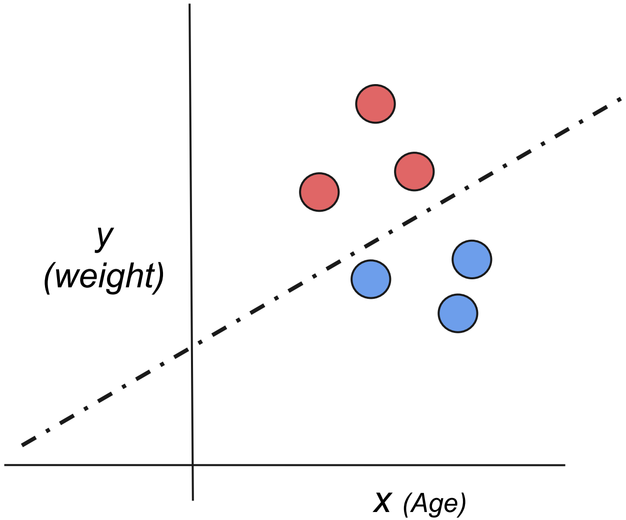
$$\boxed{y - (\beta_0 + \beta_1 x) = 0}$$

Classification Rule

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

Logistic Regression

From Regression to Classification



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

Logistic Regression

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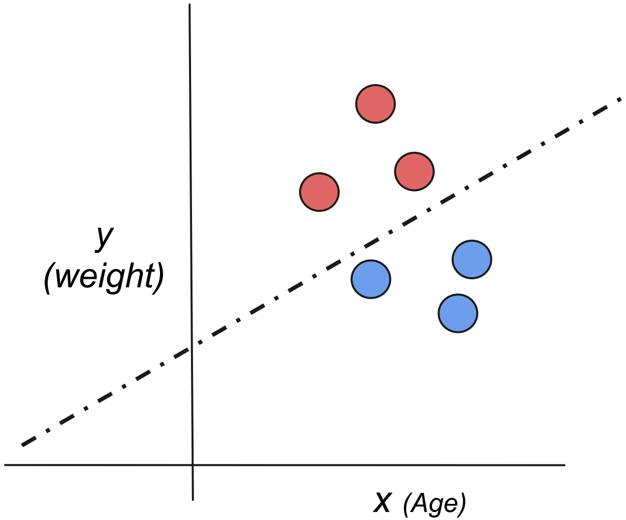

- Relationship to Decision Boundary (The dotted line in this case)

Logistic Regression

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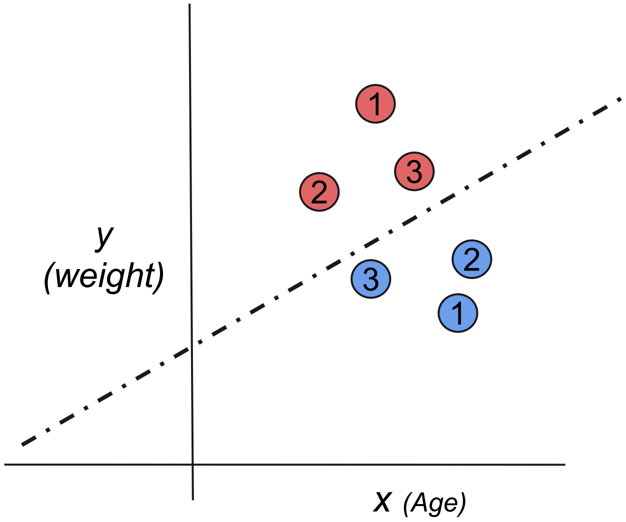

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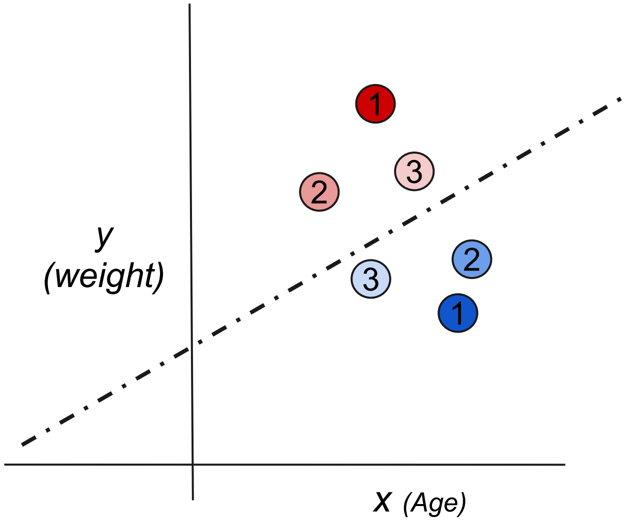
- We index based on their distance

Logistic Regression

From Regression to Classification



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- Also add color code for better understanding

Logistic Regression

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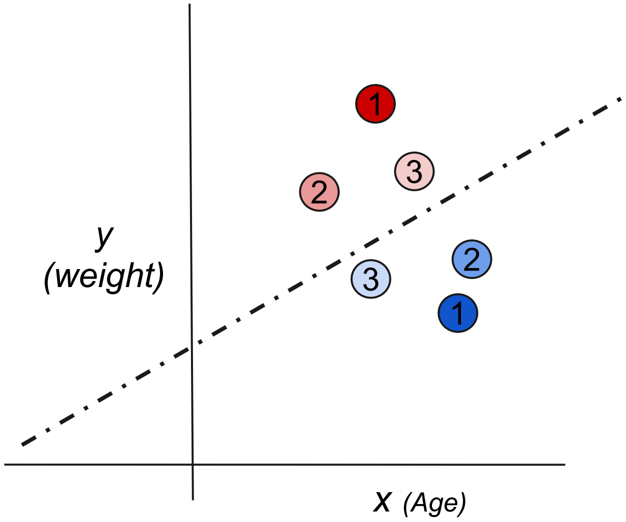

- Relationship to Decision Boundary (The dotted line in this case)
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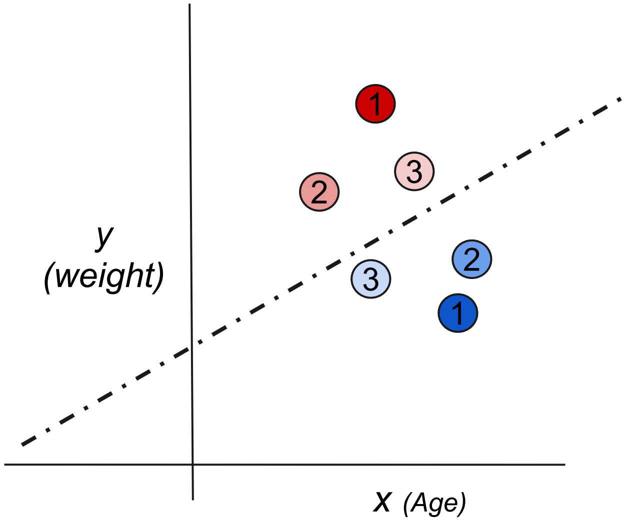
- Let's do feature encoding

Logistic Regression

From Regression to Classification



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Logistic Regression

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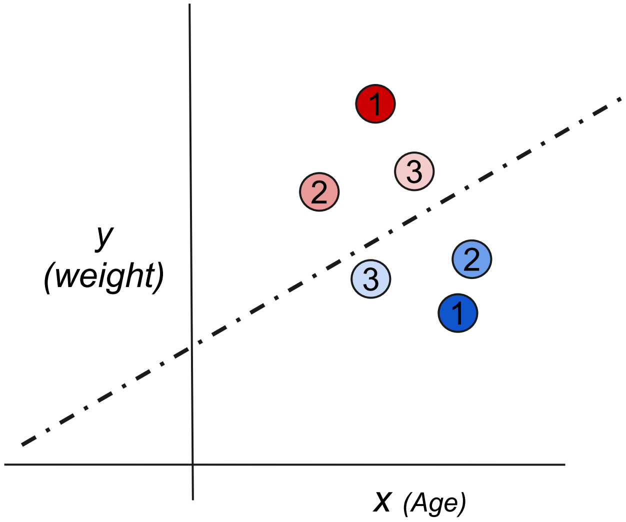

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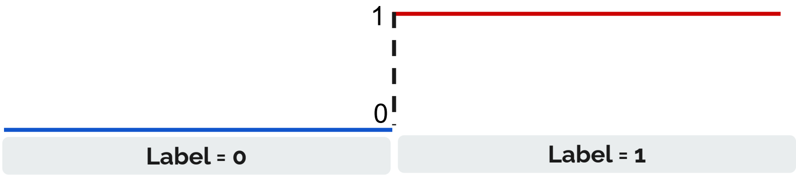

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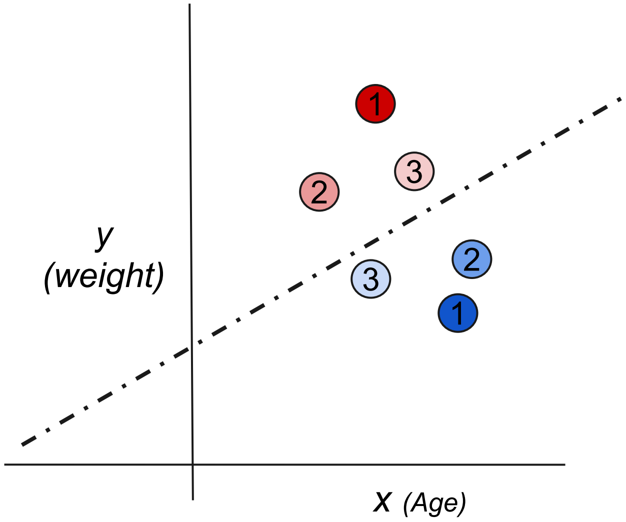

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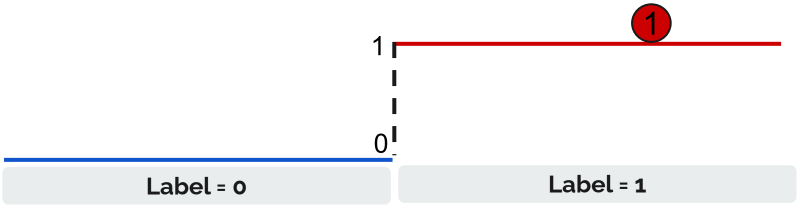

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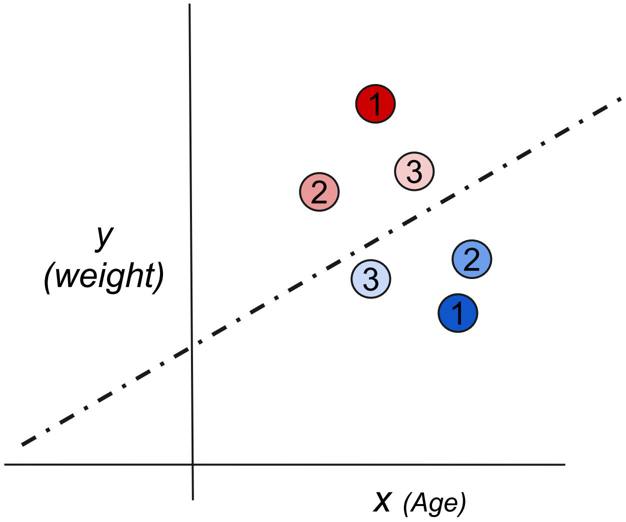

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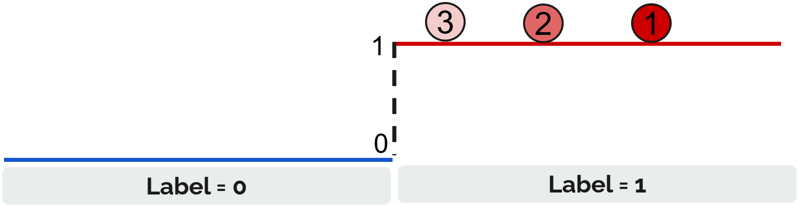

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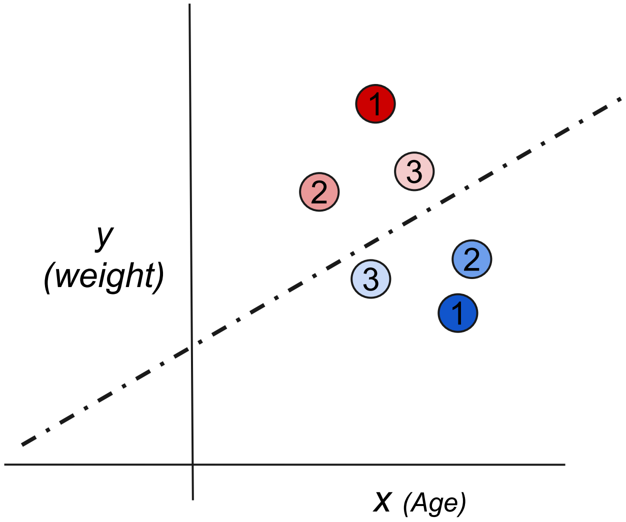

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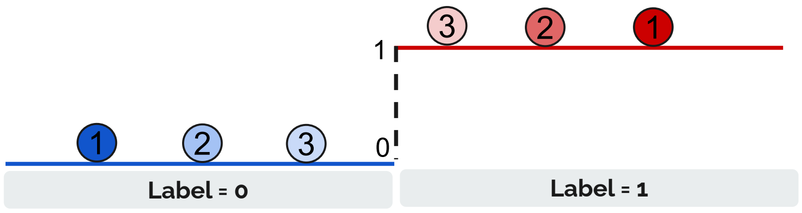

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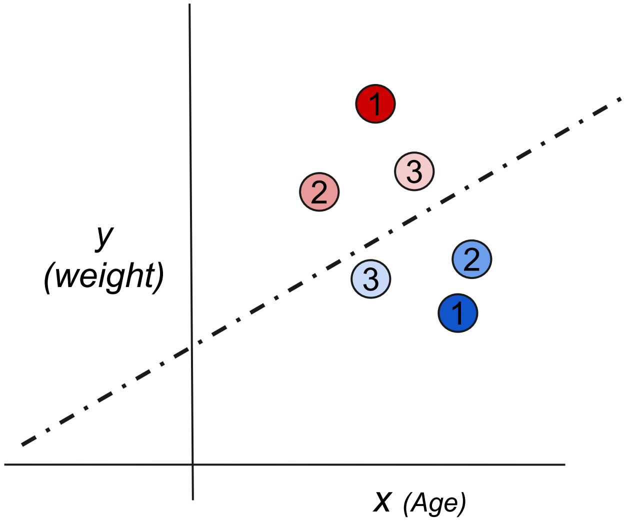

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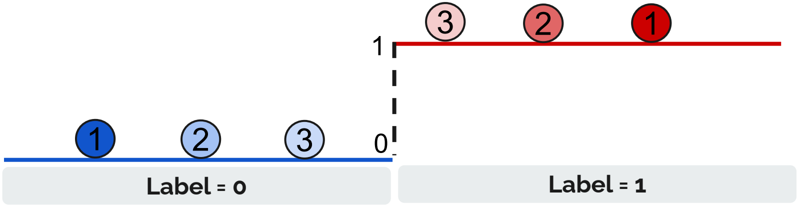

Logistic Regression

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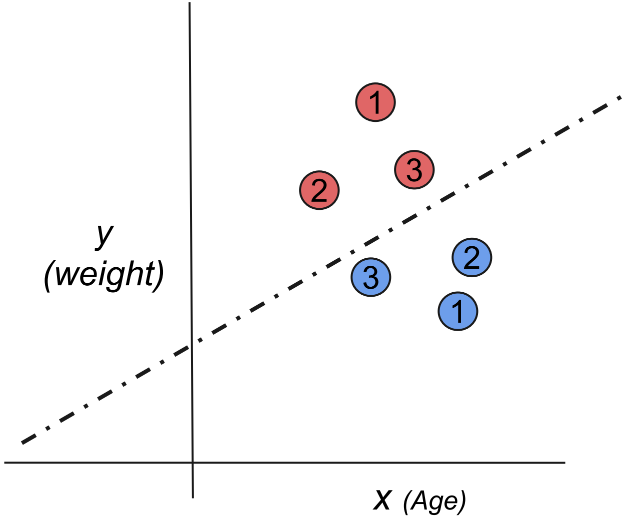

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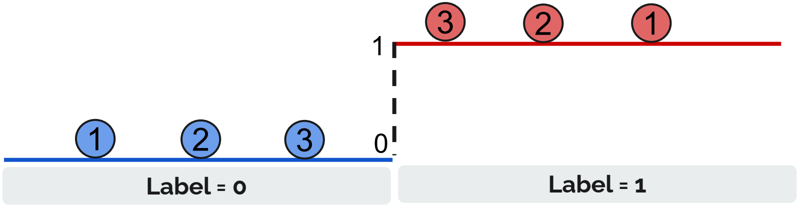

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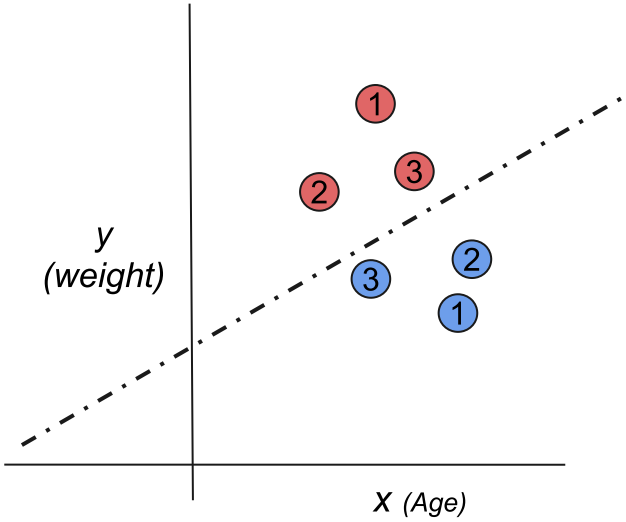

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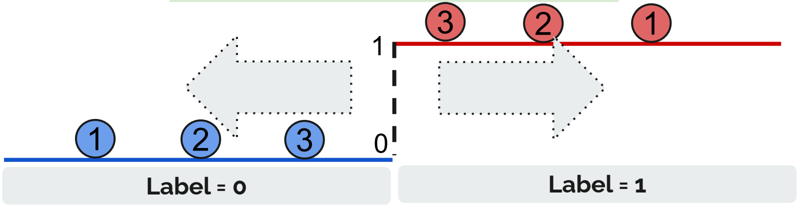
- We capture the indexing relationship with the distance from the 0-axis.



Logistic Regression

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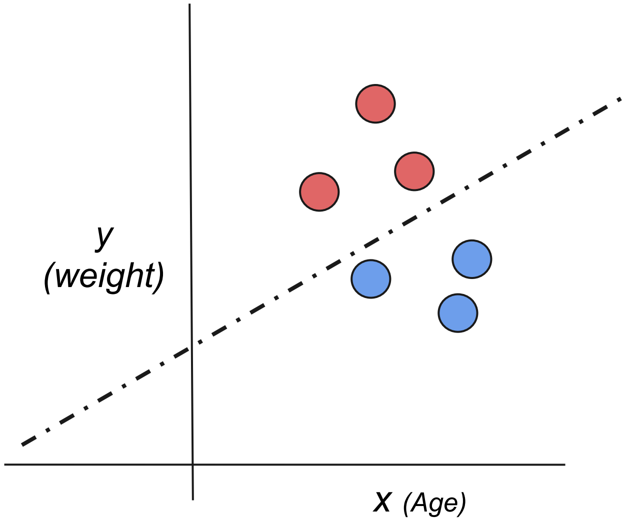
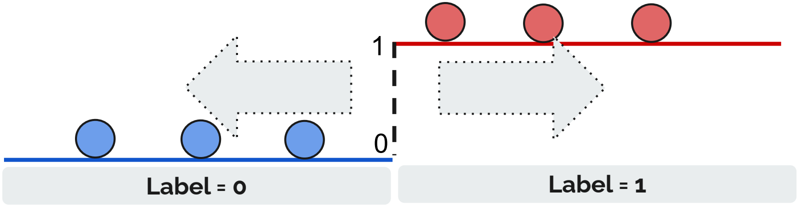


$$p(x) = \frac{1}{1 + e^{-(\beta_0 + \beta_1 x)}}$$

- *All we have discussed so far are captured through the above function; how?*



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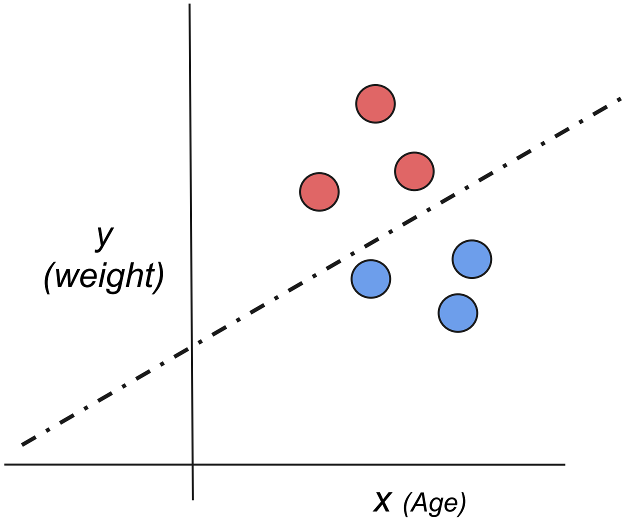

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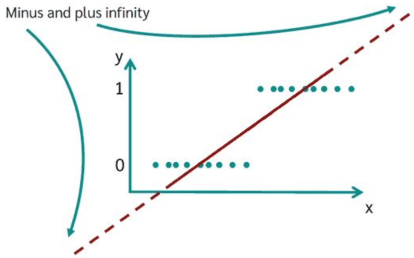

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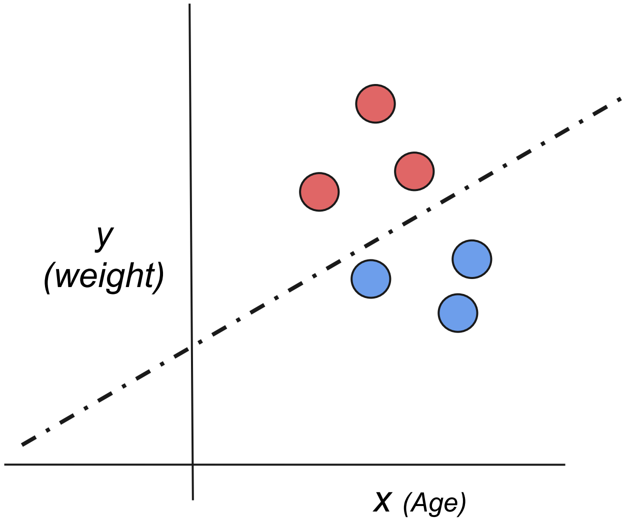

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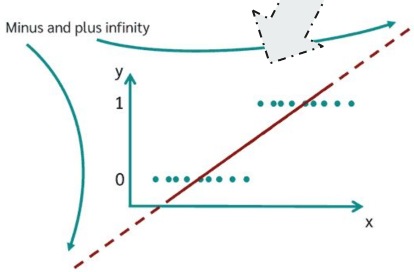

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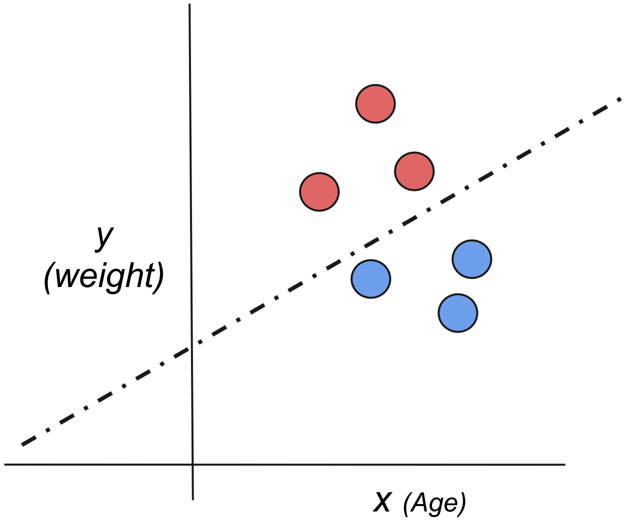

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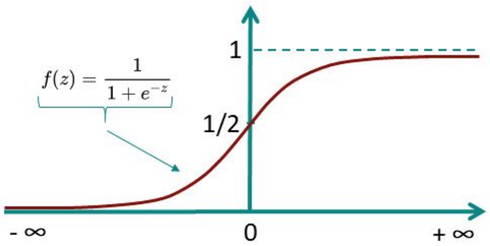


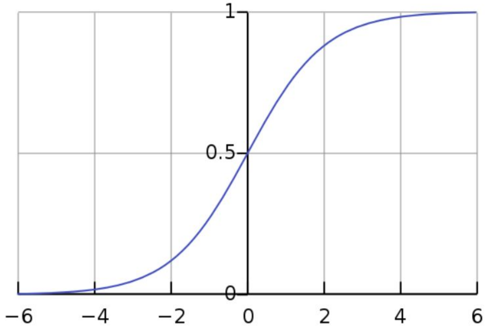
Logistic Regression

- Probabilistic classifier

  Sigmoid function characteristic

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

- Sigmoid function



Logistic Regression

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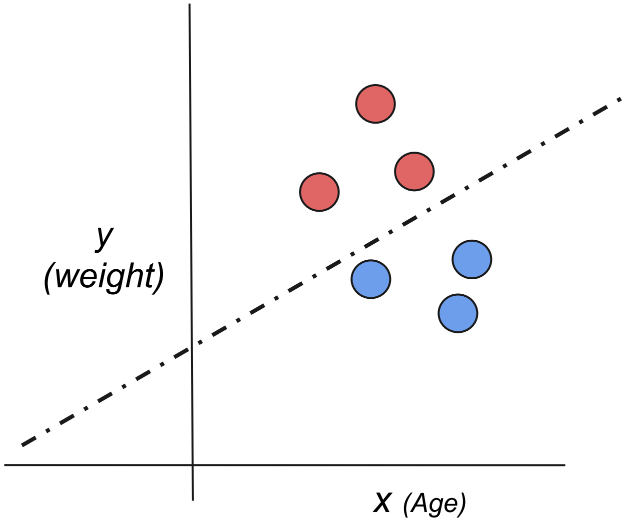

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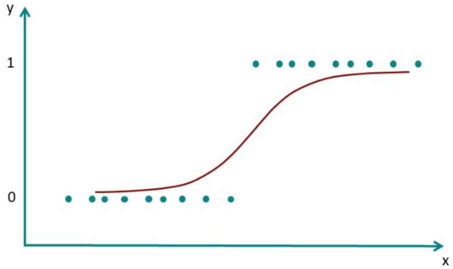
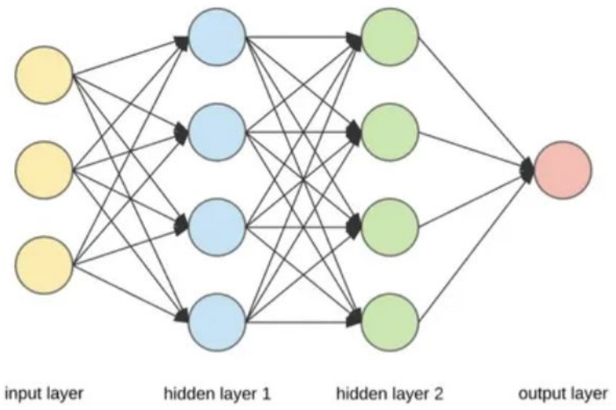


What's its connection to Neural Networks

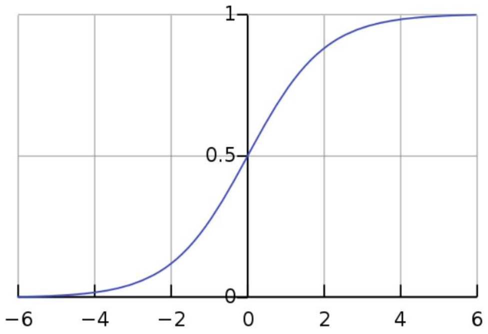


Logistic Regression

- Probabilistic classifier

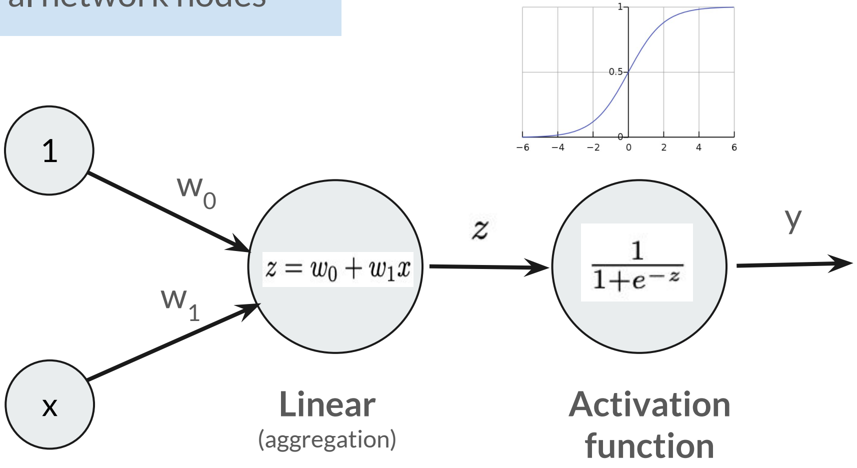
$$p(x) = \frac{1}{1+e^{-(w_0+w_1 x)}}$$

- Sigmoid function



Logistic Regression to Neural Networks (NNs)

Concept of neural network nodes

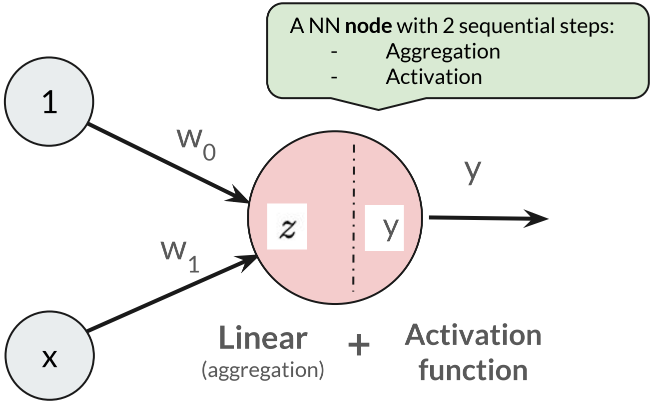


$y \in \{0, 1\}$

Logistic Regression

Neural Networks (Node)

Concept of neural network nodes



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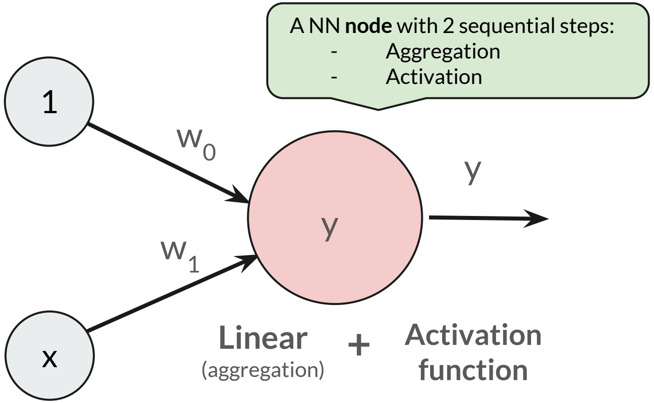

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