Classification Trees

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Bullets

When you click the **Render** button a document will be generated that includes:

- Content authored with markdown
- Output from executable code

Code

When you click the **Render** button a presentation will be generated that includes both content and the output of embedded code. You can embed code like this:

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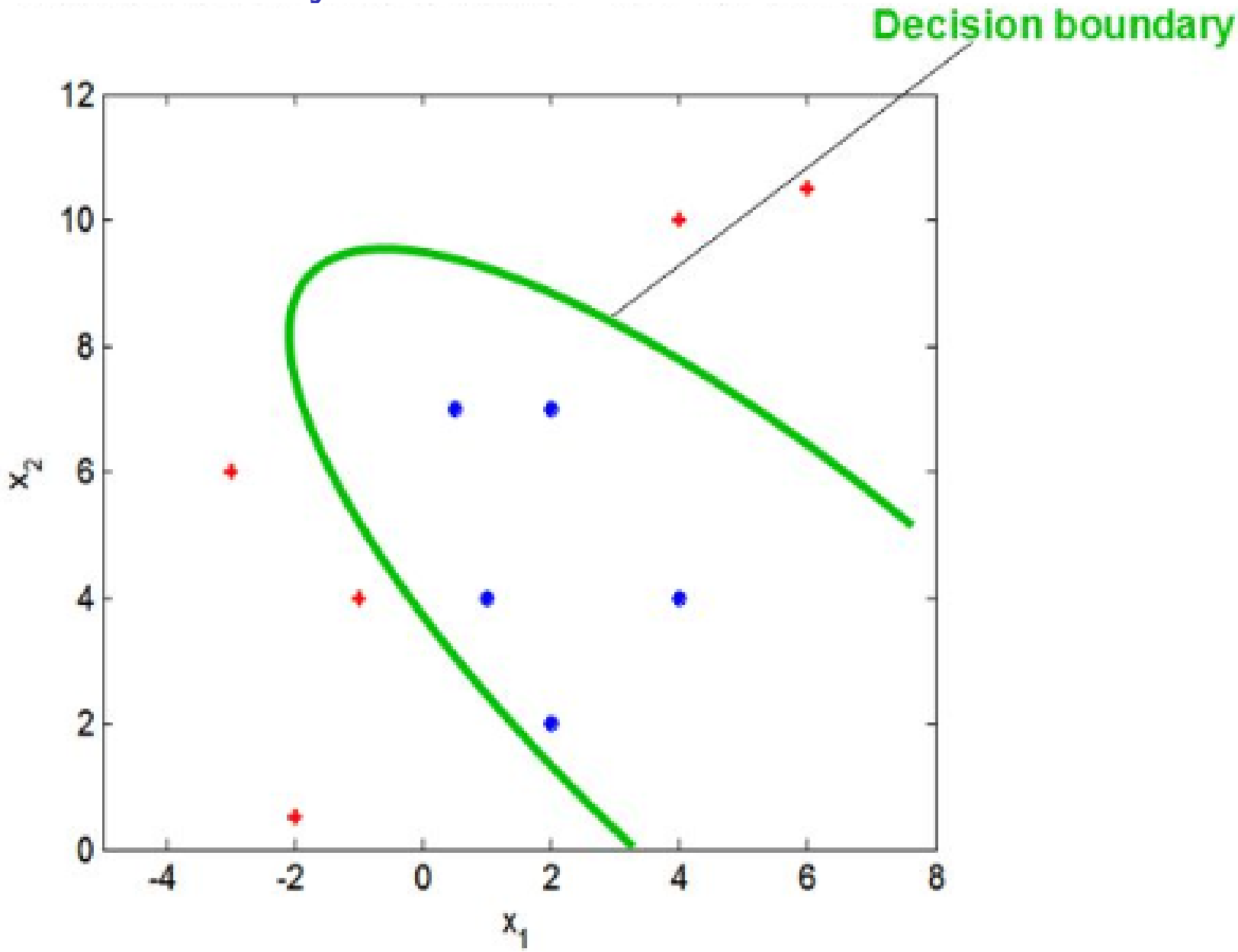
[1] 2
```

Reading Materials

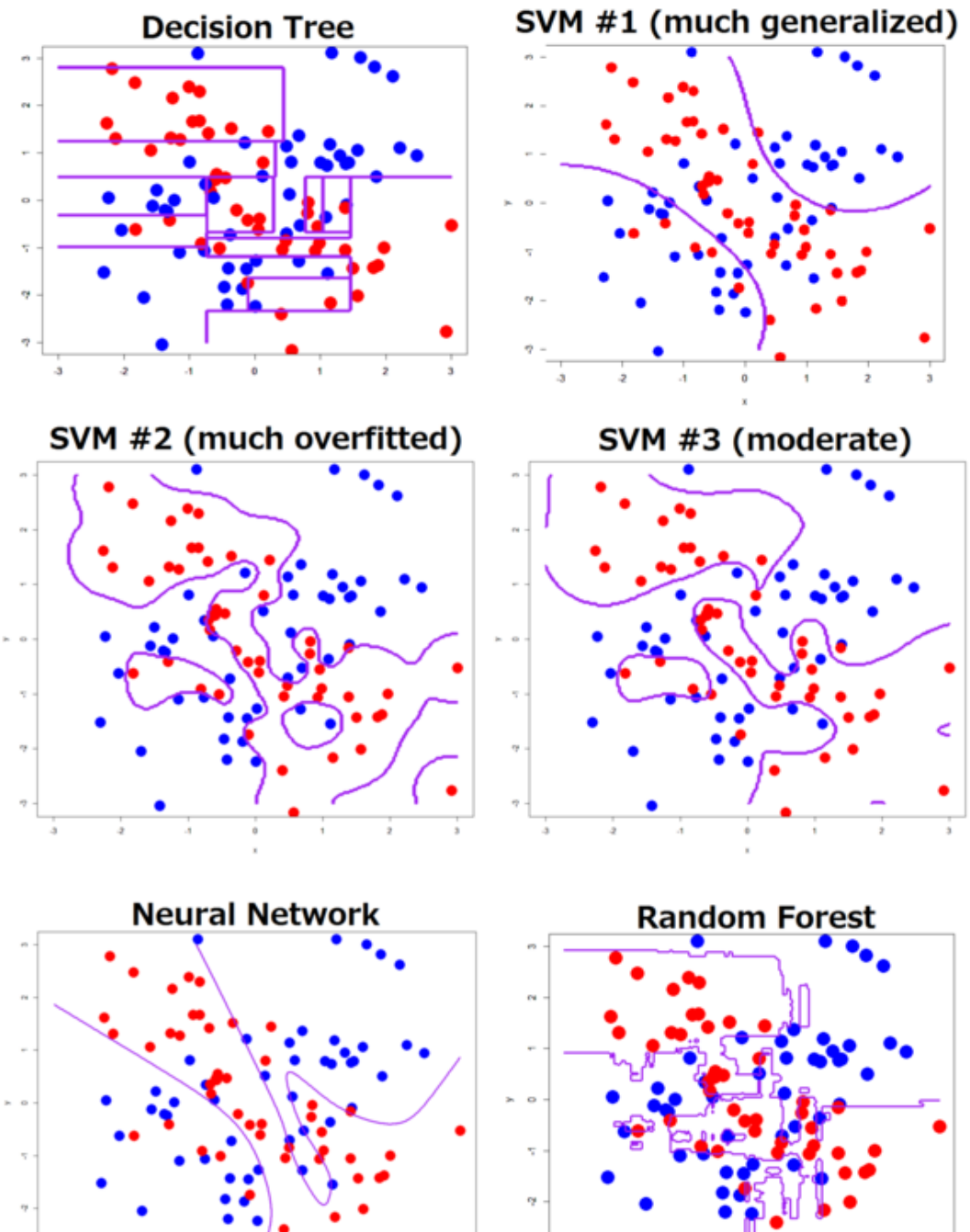
- Max Kuhn. Chapter 14. Section 14.1

Decision Boundary in Classification



Classification is a process of finding the **decision boundary** that

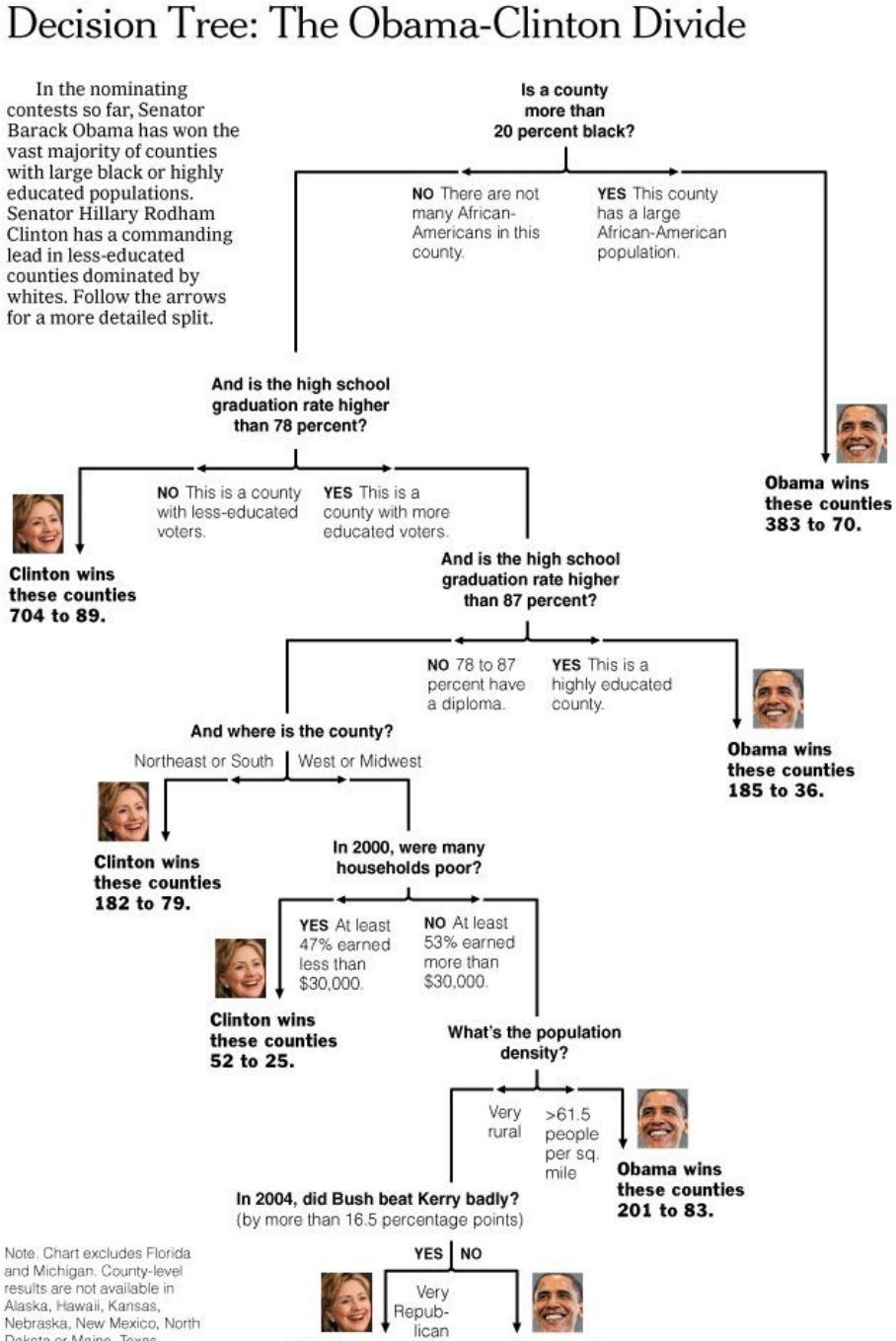
Decision Boundary in Classification



Decision Tree

- Decision Tree for classification is **Classification Tree**
- Decision Tree for Regression is **Regression Tree**

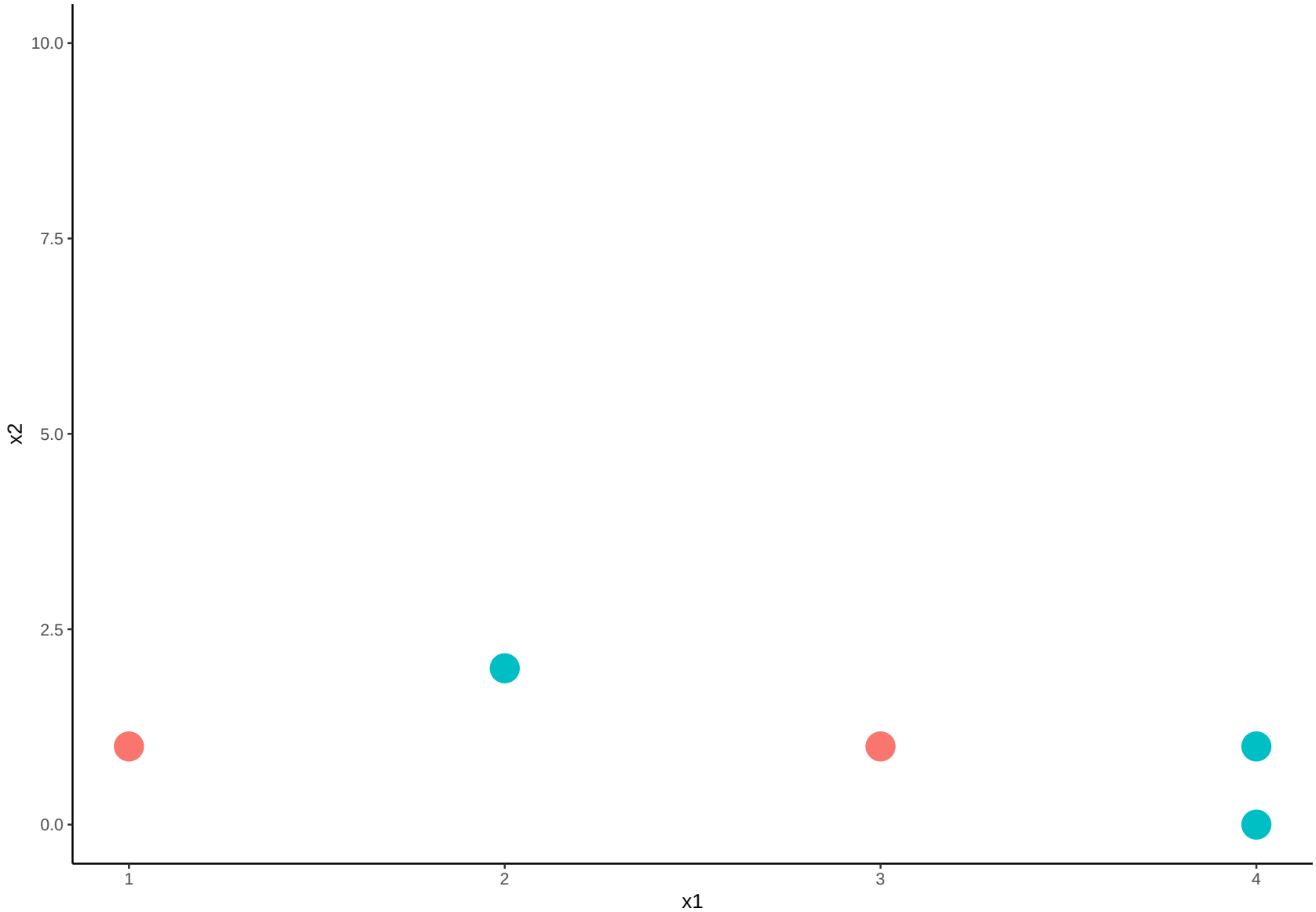
Example of Classification Tree



Classification Tree

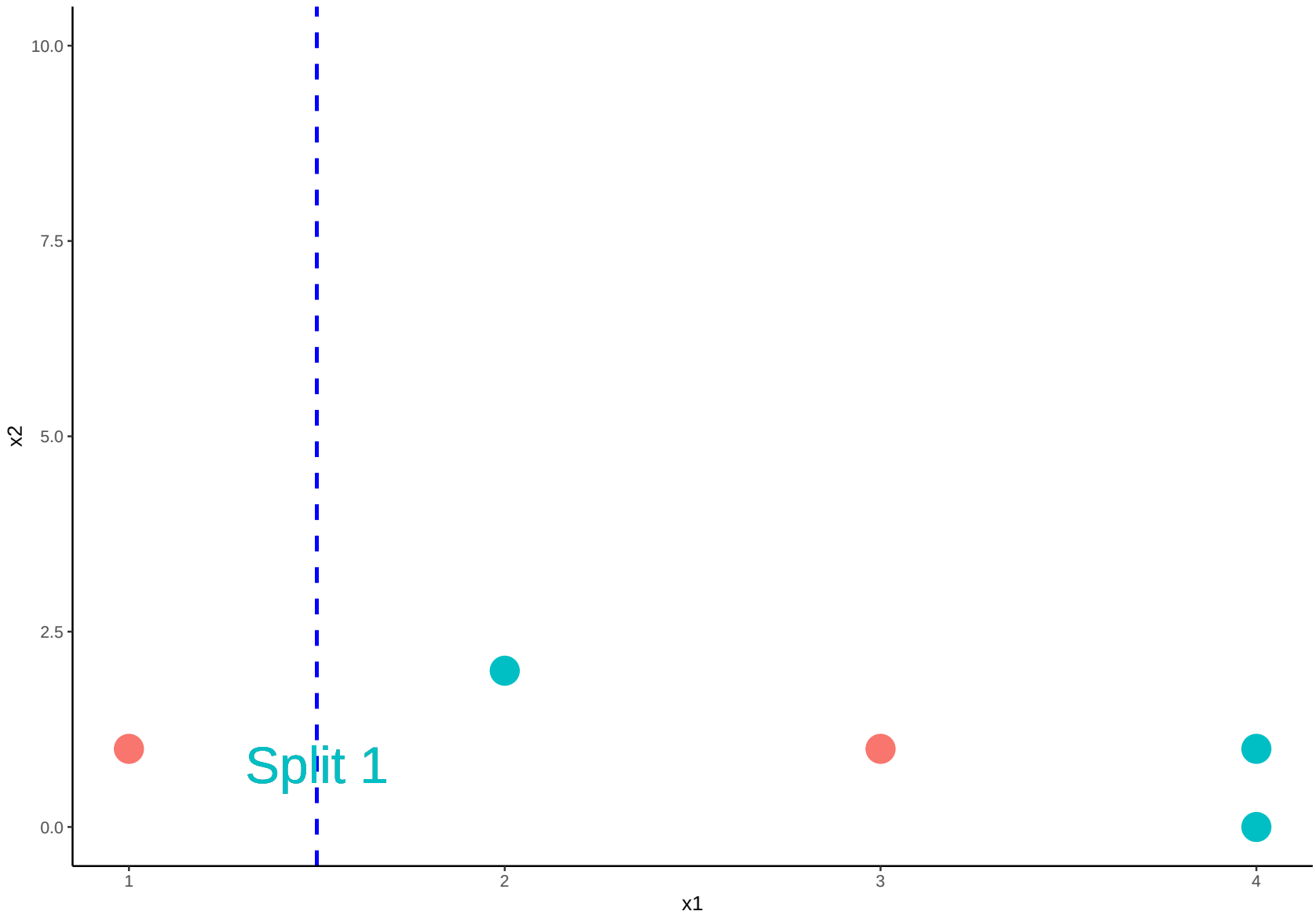
- In two dimension, classification Tree's decision boundary is a collection of horizontal and vertical line

Data

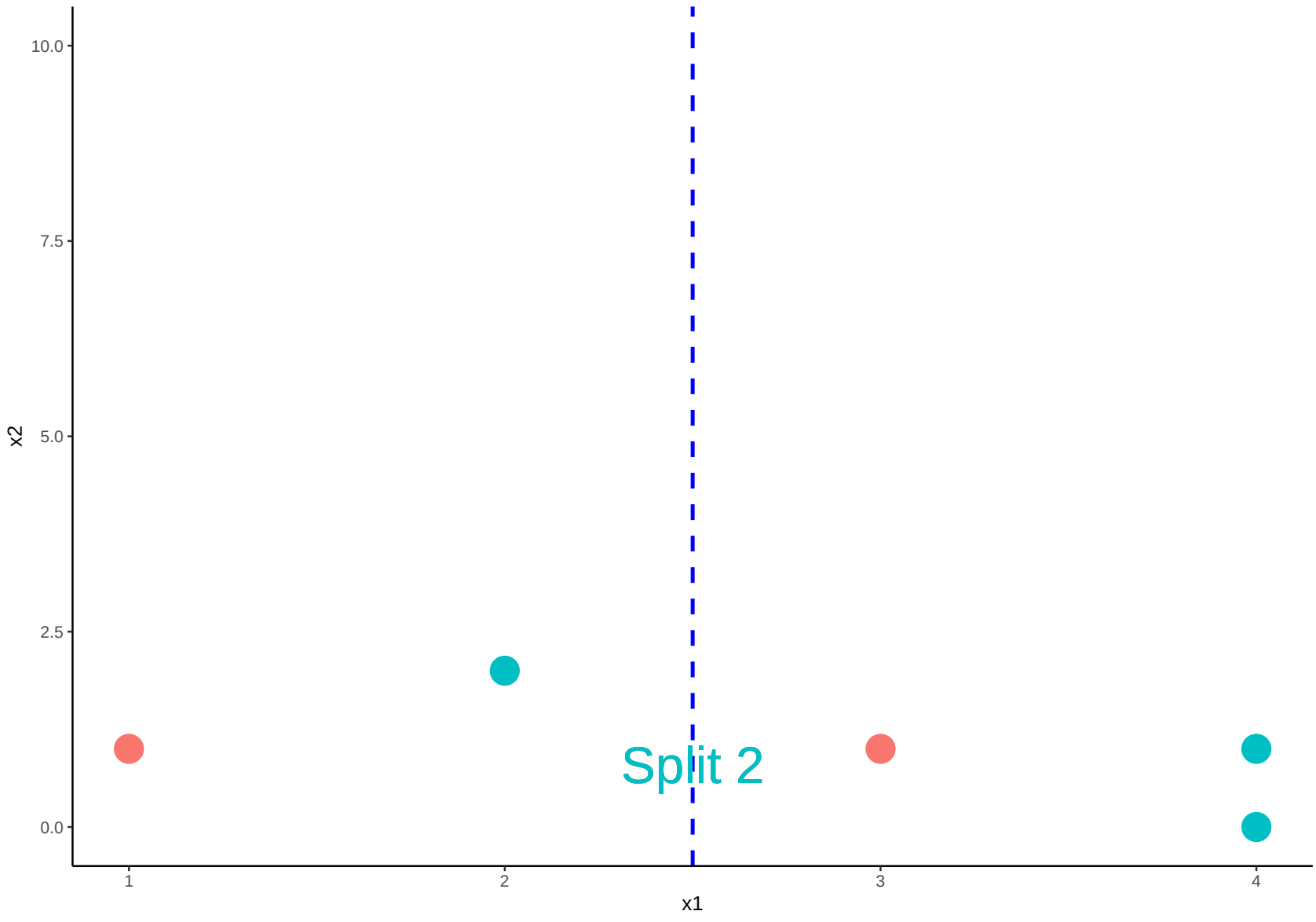


- The tree starts by a vertical or horizontal line that **best** seperate the data

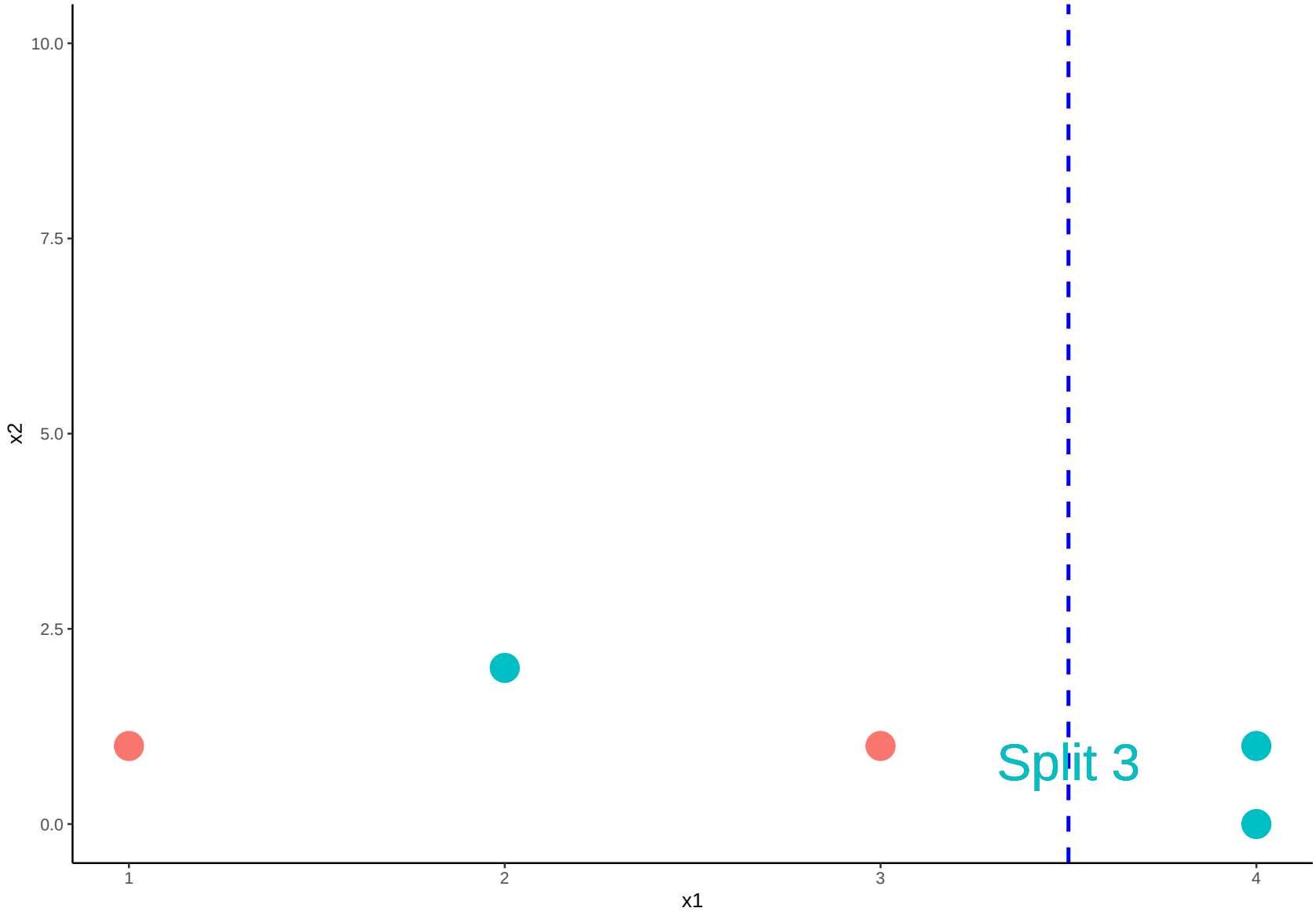
One way to seperate the reds and greens



One way to seperate the reds and greens



One way to seperate the reds and greens



Question

- **Question**: Which is the best split?

Partial Answer

- It looks like Split 1 and 3 are better than Split 2 since it misclassifies less
- Which is the better split between Split 1 and Split 3?
- We need to find a way to measure *how good a split is*

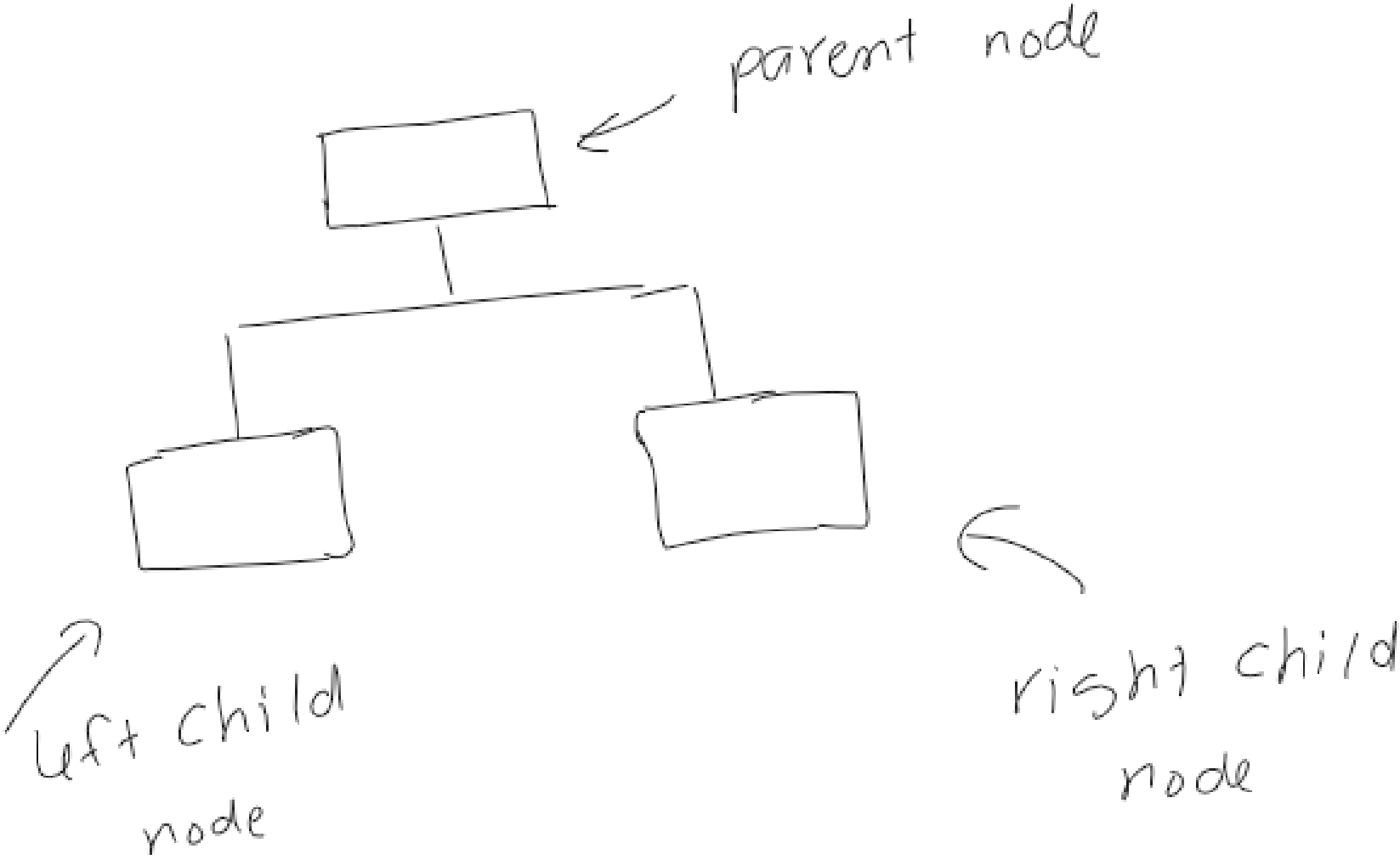
Impurity Measure

- The impurity of a node (**a node = a subset of the data or the original data**) measure how uncertain the node is.
- For example, node A with 50% reds and 50% greens would be more uncertained than node B with 90% reds and 10% greens. Thus, node A has greater impurity than node B.
- More uncertained = Greater impurity

Impurity Measure

- A split that *gains* more impurity is the **better split**!

Impurity Gain



$$IG = I_{parent} - \frac{N_{left}}{N} I_{left} - \frac{N_{right}}{N} I_{right}$$

- IG is Impurity Gain of the split

Impurity Measure

- Impurity can be measured by: classification error, Gini Index, and Entropy.

Impurity Measure

- Let p_0 and p_1 be the proportion of class 0 and class 1 in a node.

$$\text{By Classification Error: } I = min\{p_0, p_1\}$$
$$\text{By Gini Index: } I = 1 - p_0^2 - p_1^2$$
$$\text{By Entropy: } I = -p_0 \log_2(p_0) - p_1 \log_2(p_1)$$