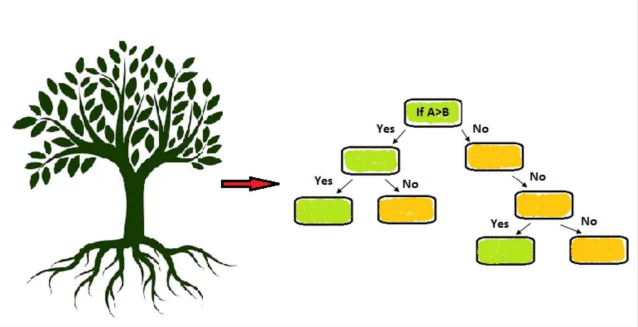
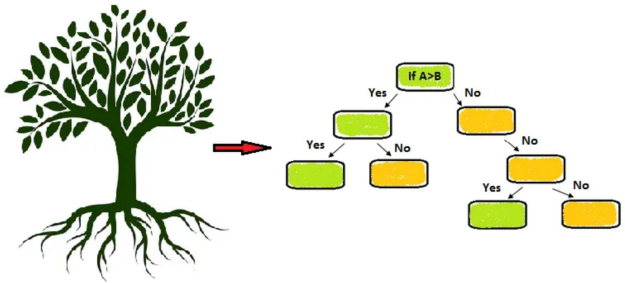
CIS 678 - Machine Learning

ML Models: Decision Tree



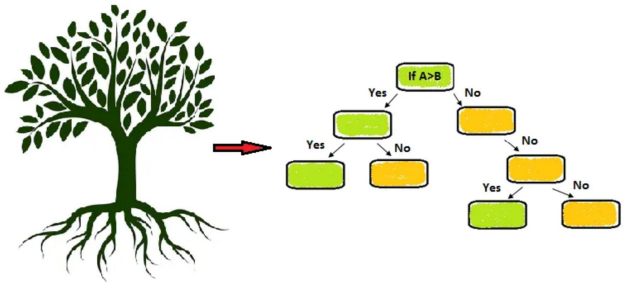
Decision Tree

- Another non-parametric model
  - Recall k-NN, its an in memory model; right?



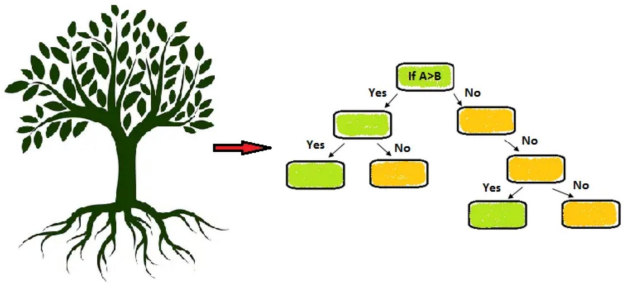
Decision Tree

- Another non-parametric model
  - Recall k-NN, its an in memory model; right?
- Decision Tree is our second example



Decision Tree

- *Concepts and Principles*
- *Let's learn through an example*

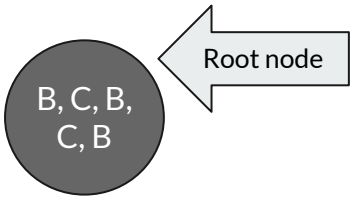


Decision Tree

- Data records for two animal classes:
  - **Bunny** and **Cat**

nb of legs	weight (lb)	animal
4	2.1	Bunny
4	7	Cat
4	1.7	Bunny
4	9	Cat
4	2.75	Bunny

Decision Tree



- What feature should we use to split records?

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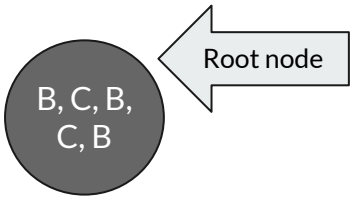

- What feature should we use to split records?
- nb of legs is useless as there is no variation.

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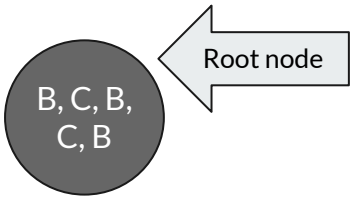

- *What feature should we use to split records?*
- *nb of legs is useless as there is no variation.*
- *We can use the '**weight(lb)**' feature.*

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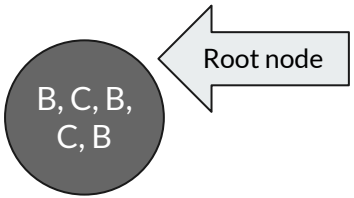

- *Let's plot the data points*

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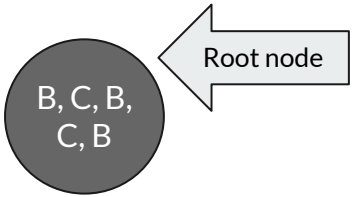

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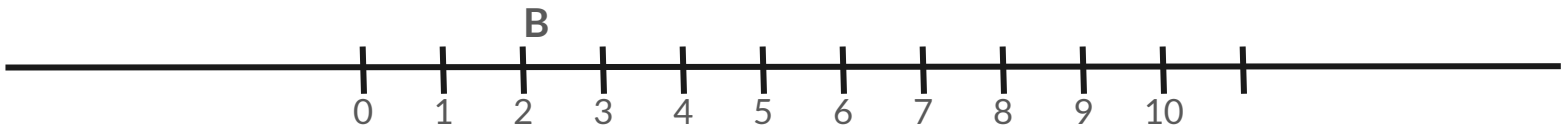

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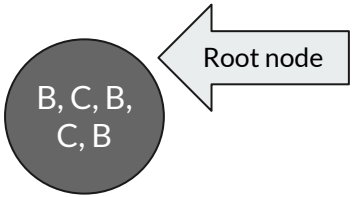

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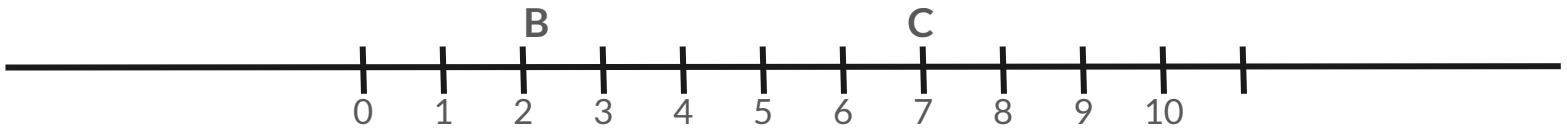

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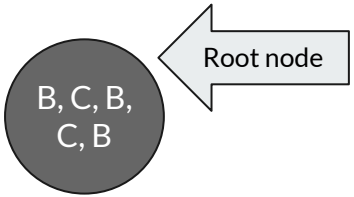

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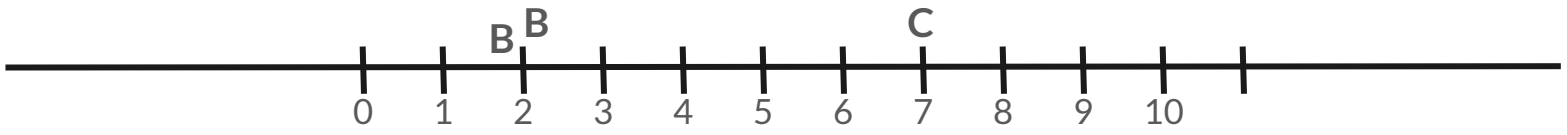

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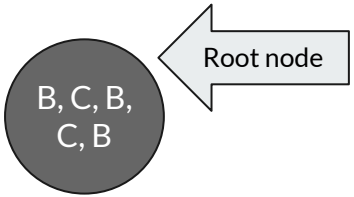

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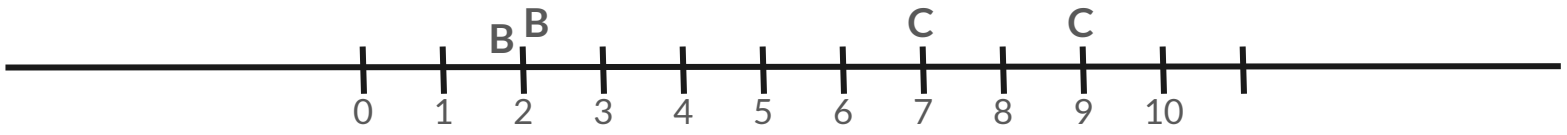

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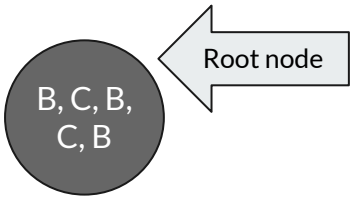

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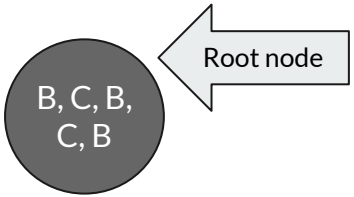

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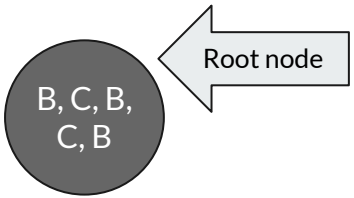
- *Can we identify groups?*

Decision Tree



- *Let's find a split point.*

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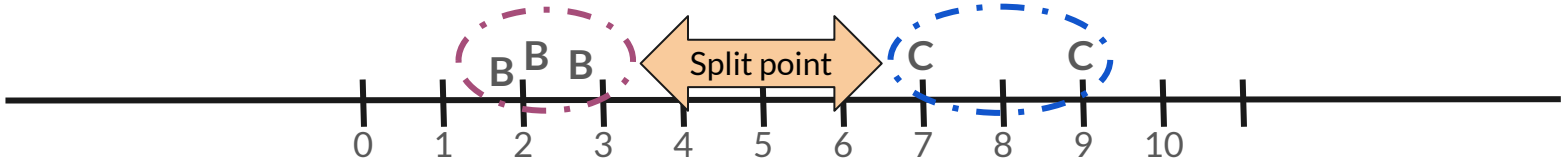

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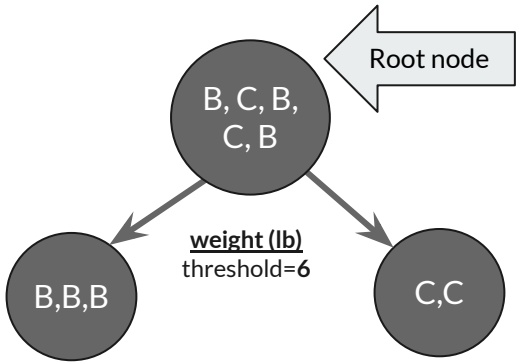

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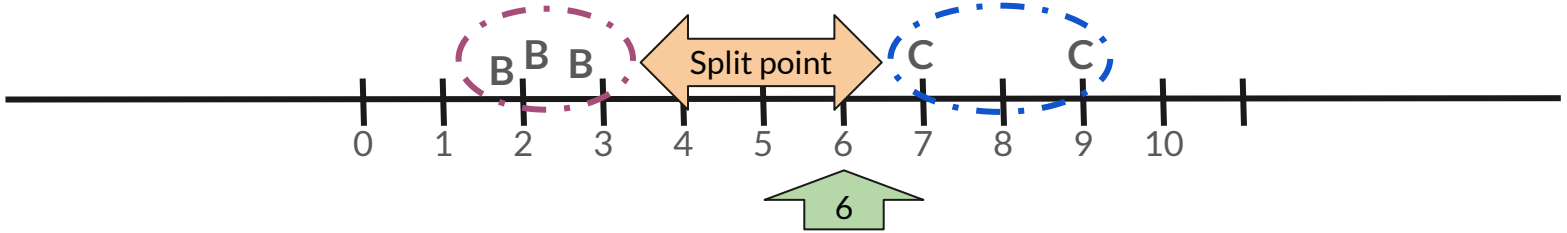
- *Create branches*



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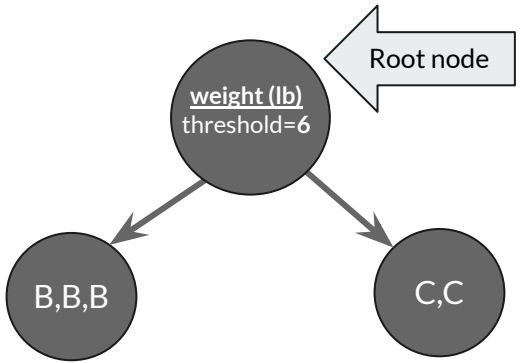

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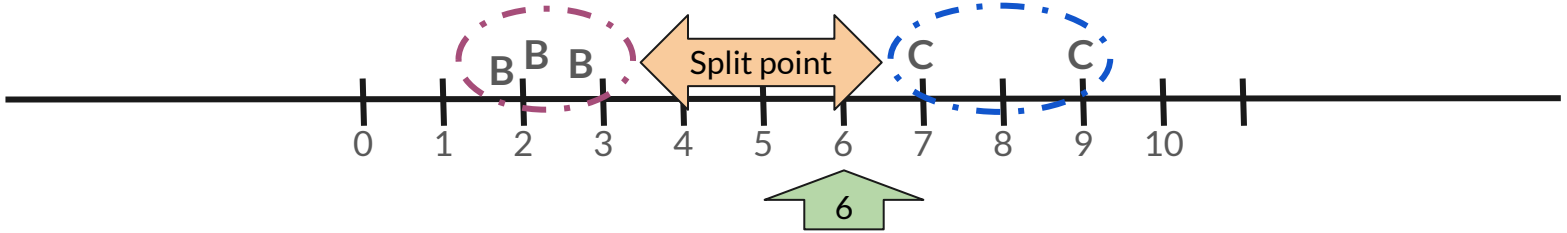

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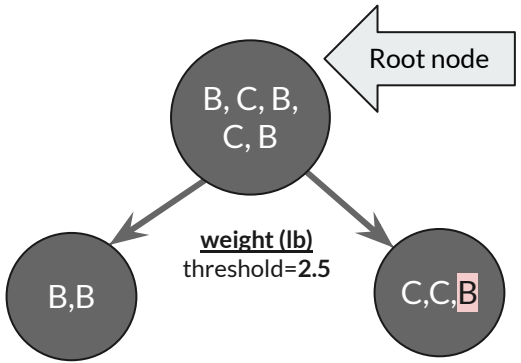

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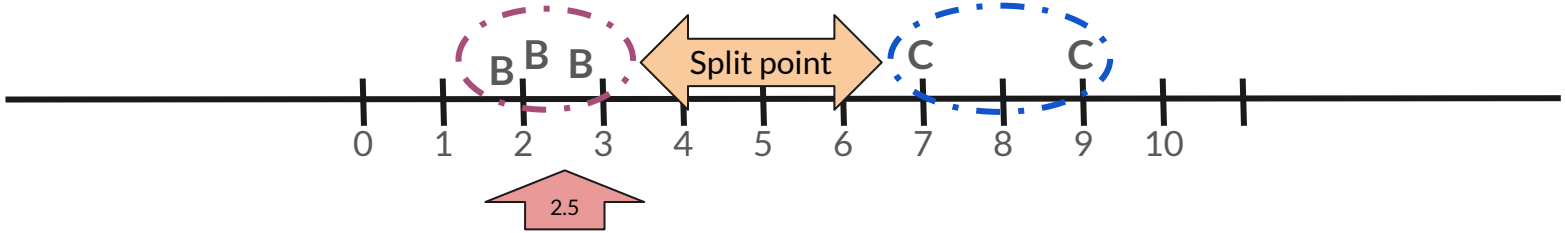
- *What if we used a threshold=2.5?*



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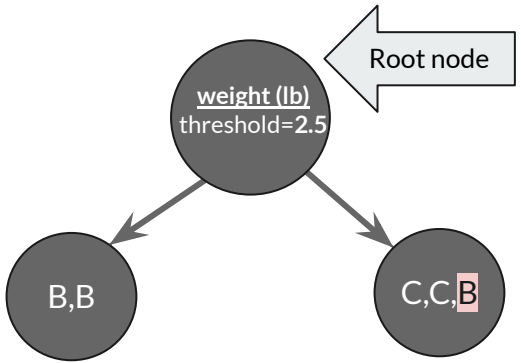

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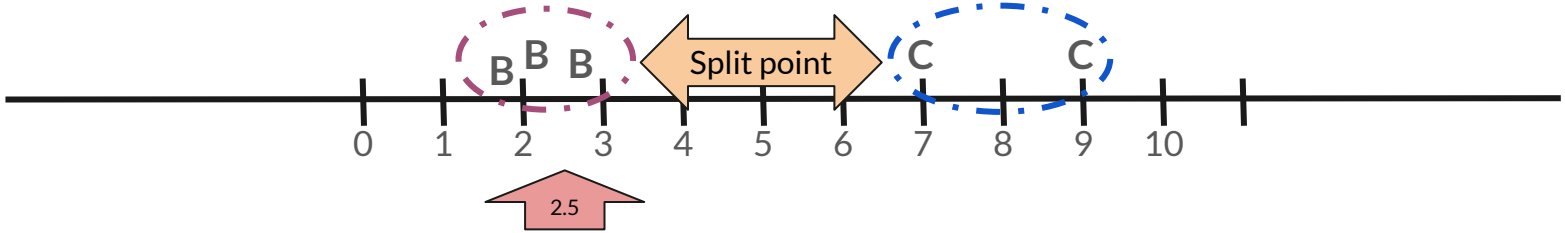

Decision Tree

- What metrics are used for split point determination?

Decision Tree

- What metrics are used for split point determination?

Entropy

Gini Impurity

Information Gain

The idea is quite simple, choose the one that make classes more separable.

Decision Tree

- How about this configuration?
- We have data points for an additional animal class “**Chicken**”

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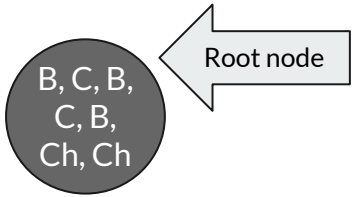
Decision Tree



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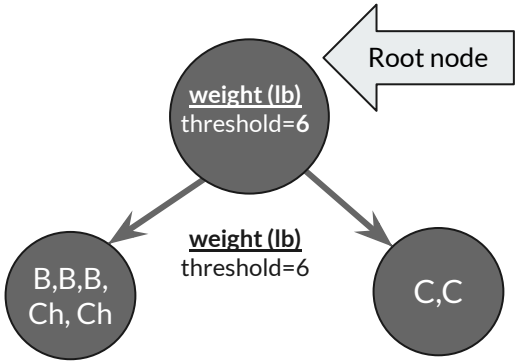

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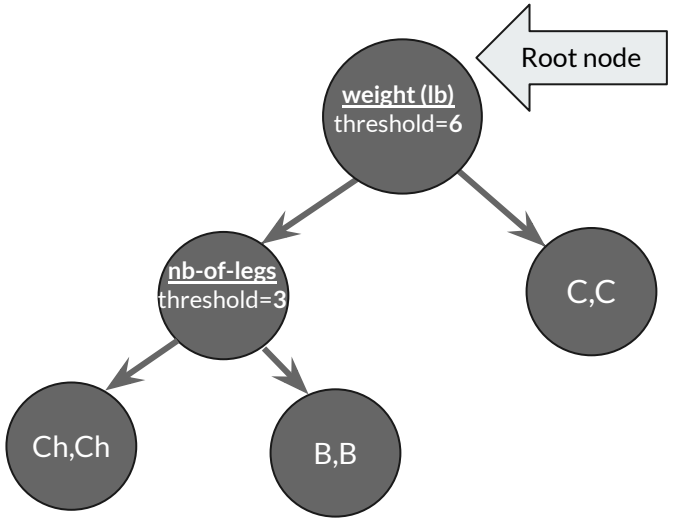

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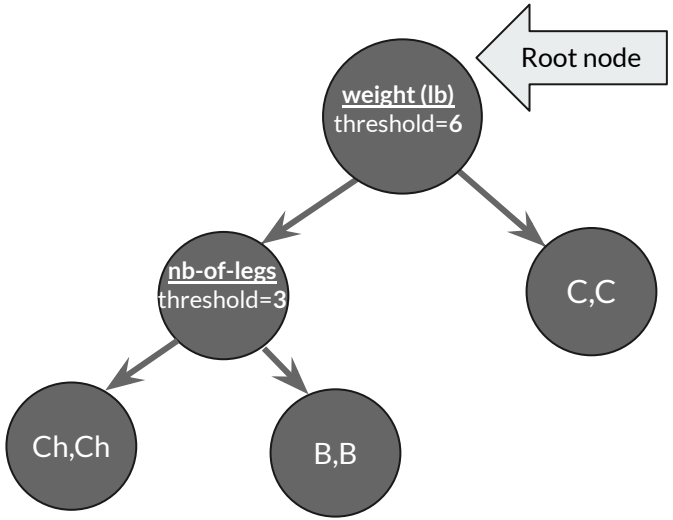
Decision Tree

- Prediction Time

Decision Tree



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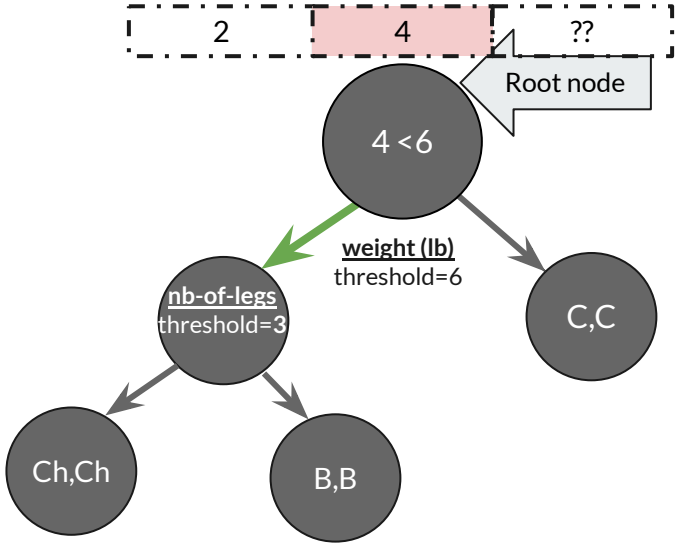
Test case

2	4	??

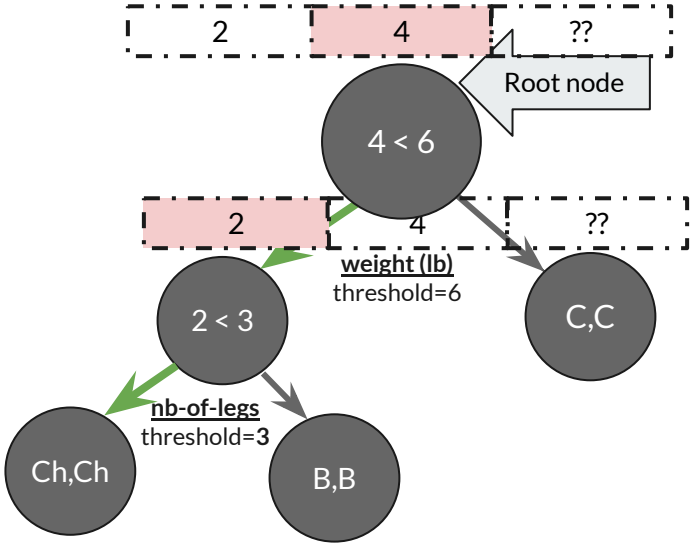
Decision Tree



Test case

2	4	??

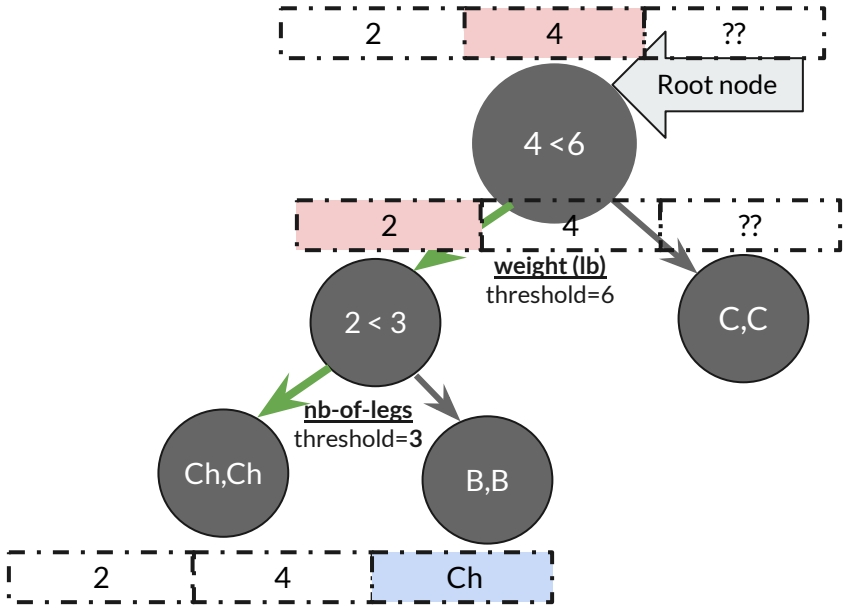
Decision Tree



Test case

2	4	??

Decision Tree



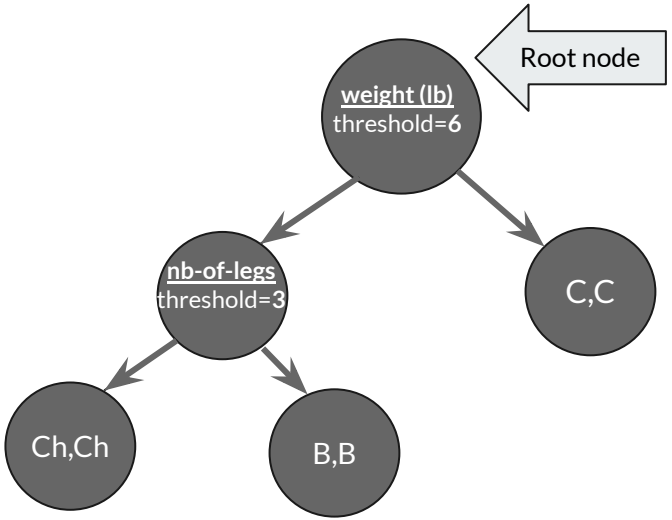
Test case

2	4	??

Decision Tree

You may have multiple trees

Decision Tree



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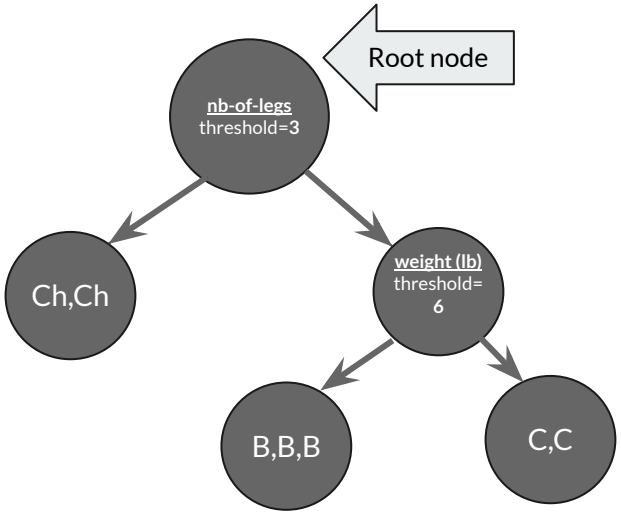

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Decision Tree

Entropy and Information Gain

Decision Tree

Entropy

- What metrics are used for split point determination?

Entropy (discrete variable) :

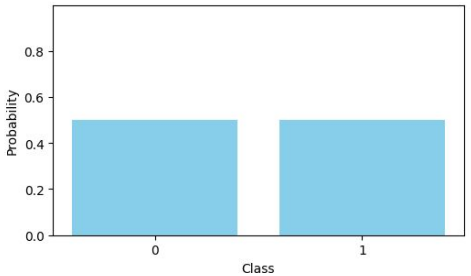
$$H(X) = -\sum_{i=1}^{n} p(x_i) \log_b p(x_i)$$

Decision Tree

- What metrics are used for split point determination?

Entropy

H=1



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Decision Tree

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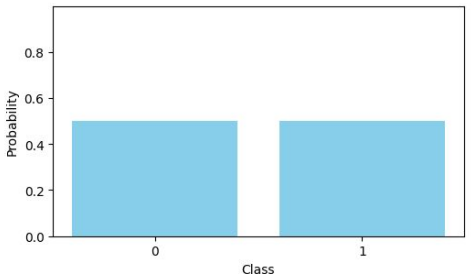
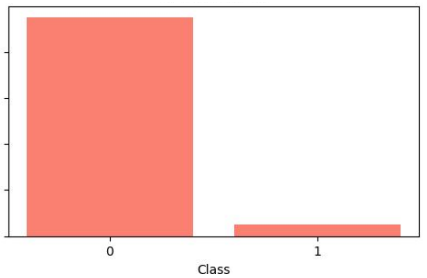


H=0.29



Decision Tree

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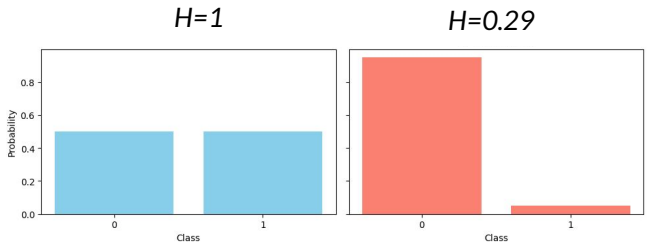
Entropy



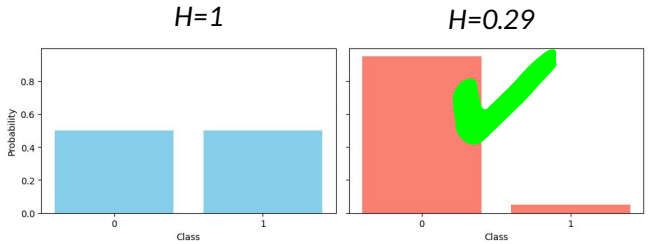
$$IG(T, a) = \mathrm{H}(T) - \mathrm{H}(T|a),$$

where $\mathrm{H}(T|a)$ is the conditional entropy of T given the value of attribute a.

Decision Tree

- What metrics are used for split point determination?

Entropy



$$IG(T, a) = \mathrm{H}(T) - \mathrm{H}(T|a),$$

where $\mathrm{H}(T|a)$ is the conditional entropy of T given the value of attribute a.

Decision Tree

How to randomize Trees?

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- Random sampling of features
- Randomizing feature combinations

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This will also allow us to build advanced models: Random Forest

QA