1 Module 14: Decision Trees

Contents

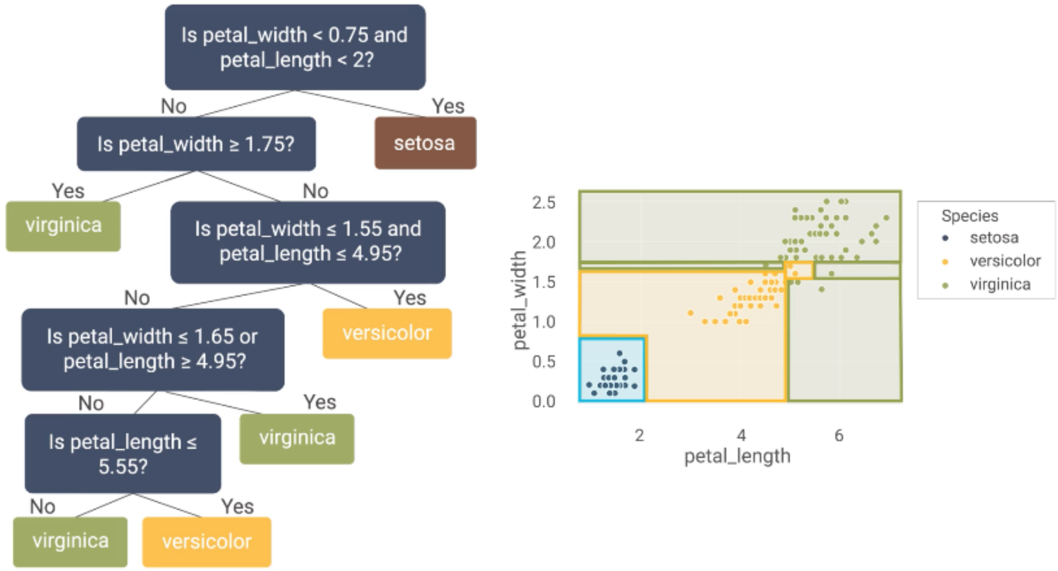
Decision trees benefit from...

- being very interpretable
- require much less training data
- capable of intaking categorical data
- handle collinearity well

Composition
Root node: beginning of tree
Internal nodes: can be split further (2 or more branches)
Leaf nodes: can no longer be split
Impure nodes: leaf nodes which do not encapsulate a single class (have multiple classes w/i)

Algorithm

- Determine root node
- Calculate class entropy
- Calculate entropy for each attribute after split
- Calculate information gain from each split
- Perform splits until decision tree is complete
- Assess accuracy of decision tree




```python
from sklearn import tree

model = tree.DecisionTreeClassifier(criterion = 'entropy')
model.fit(X, y)

# Visualize tree thru sklearn
tree.plot_tree( model, feature_names = list, class_names = list, rounded =
↪  True, filled = True )

# Viz thru Graphviz
import graphviz
data = tree.export_graphviz( model, out_file = None, feature_names = list,
↪  class_names = list, rounded = True, filled = True )
graph = graphviz.Source(data)
graph.render( format = 'png', filename = 'iris_tree' )
```

Entropy

$$S = -\sum_c p_c \log_2 p_c$$

for proportion of each class c: p_c

Entropy cases:

$-1\log_2 1 = 0$: All data in node is part of same class

$-0.5\log_2 0.5 - 0.5\log_2 0.5 = 1$: Data is evenly split between two classes

$3 \times -0.33\log_2 0.33 = 1.58$: Evenly split between three classes

... $C \times -\frac{1}{C}\log_2\frac{1}{C} = \log_2 C$: Evenly split between C classes

Weighted Entropy: entropy $\times$ fraction of samples in that node, s.t. weighted entropy decreases at each level

We use weighted entropy to decide which split to use – we want the highest change in weighted entropy.

1.1 Overfitting

For decision trees, more features $\neq$ overfitting

To avoid overfitting, restrict decision tree complexity.

Prevent (unnecessary) growth

- Disallow splitting after a sample threshold i.e. ¡1% using min_sample_split
- Cap node depth using max_depth
- Do not create splits where weighted entropy is too small i.e. $\delta WS < 0.01$

Pruning: Allow tree to grow & cut branches afterward

- Use validation set to prune – run model with & without branch