Knowledge Representation

Overview

- Tables
- Linear Models
- Trees
- Rules (including exceptions)
- Instance-Based Representation
- Clusters
- More expressive rule forms

Tables

- Tables are the simplest knowledge-representation form.
- Characteristics:
  - Output mirrors input
  - Rows = conditions; output = class or numeric prediction
  - Decision table or regression table

Linear Models

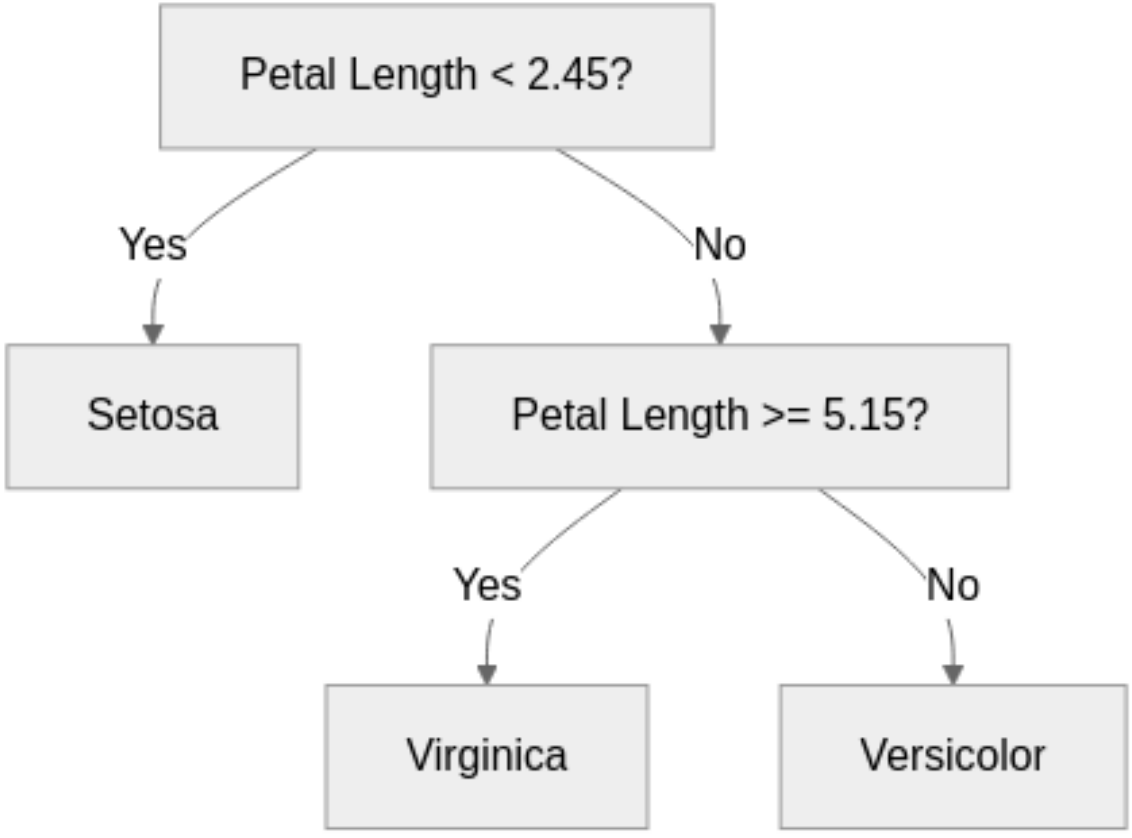
- Linear models compute weighted sums of attributes.
- Equation Example

```
performance = 37.06 + 2.47 * cache
```

Decision Trees

- A divide-and-conquer representation.
- Features
  - Internal nodes = attribute tests
  - Leaves = classification or numeric prediction
  - Works with nominal + numeric attributes

Example: Iris Dataset Decision Tree



Regression Trees & Model Trees

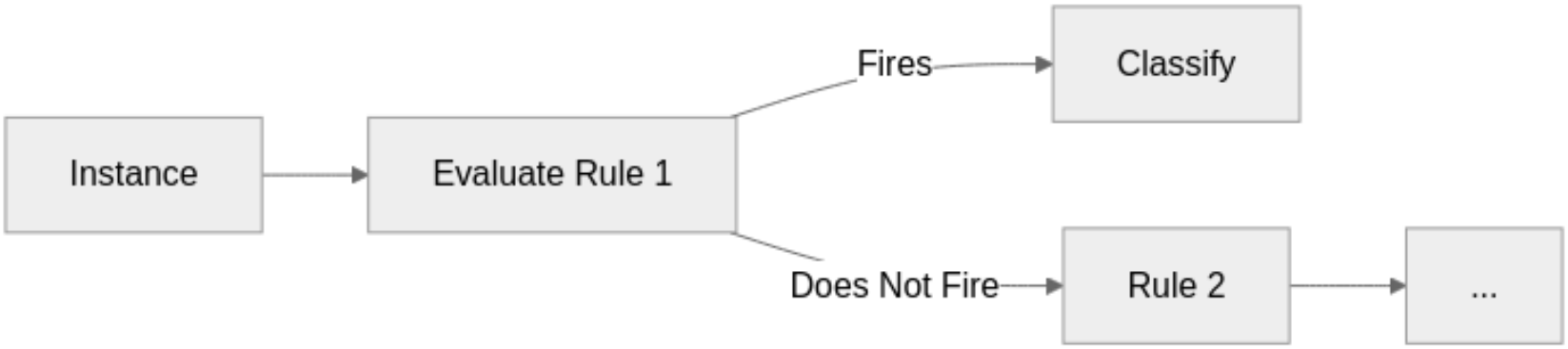
- Regression trees: numeric outputs at leaves
- Model trees: linear models at leaves
- Example Linear Model (LM5)

```
PRP = 285 - 1.46*MYCT + 1.02*CACH - 9.39*CHMIN
```

Rules

- Rules are an alternative to trees.
- Strengths
  - Modular
  - Human-readable
  - Compact for disjunctions
- Weaknesses
  - Potential rule conflicts
  - Need ordering or priorities

Rule Flowchart



Rules with Exceptions

- Example:

```
IF petal-length >= 2.45 AND petal-length < 4.45
THEN versicolor
EXCEPT IF petal-width < 1.0 THEN setosa
```

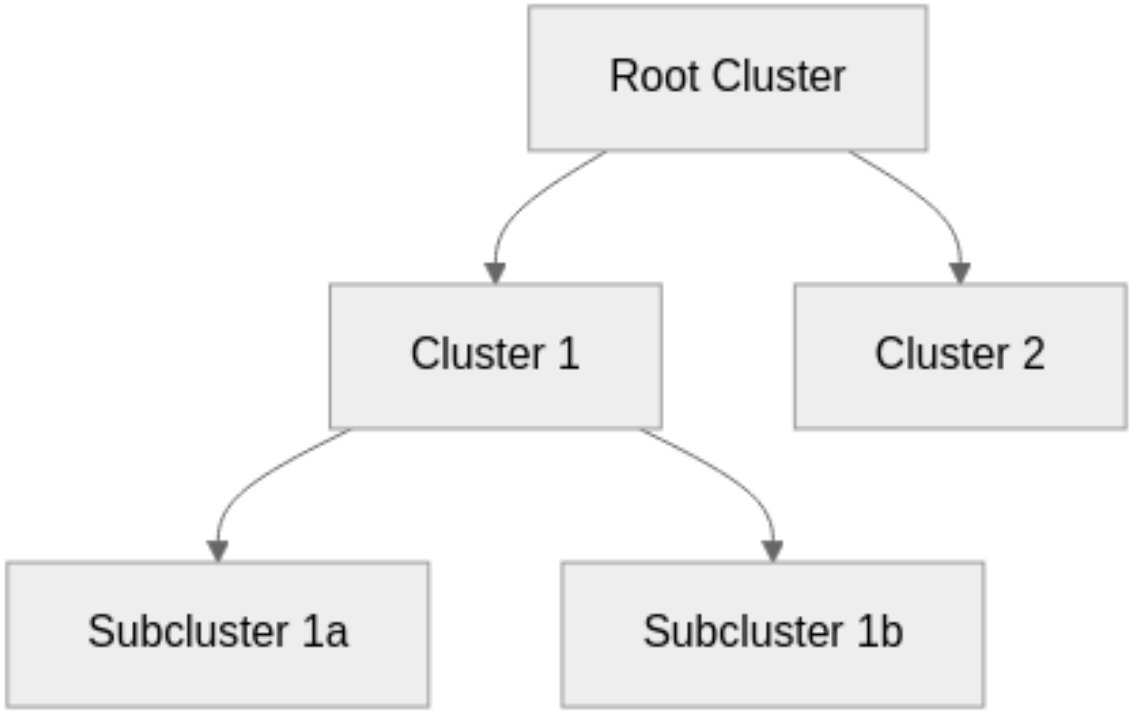
- Example Flowchart:

Instance-Based Learning

- Stores examples and classifies using similarity.
- Basic Algorithm
  1. Compute the distance between the new instance with all stored instances
  2. Keep the k nearest neighbors
  3. Vote or average the output

Clusters

- Clustering representations take a form that shows how the instances fall into clusters
- Example:



Summary

- Knowledge Representation Types
  - Tables: Lookup-based decisions
  - Linear Models: Weighted sums / hyperplanes
  - Trees: Recursive partitions
  - Rules: If-then logic + exceptions
  - Instance-based: Similarity-based
  - Clusters: Groupings without labels
- Takeaways
  - Representation affects interpretability
  - Exceptions and recursion increase expressive power
  - Different ML tasks benefit from different structures