**Case-based Reasoning**

- **Idea:** experiences themselves are stored. These are called cases.

- Given a new example, the most appropriate case(s) in the knowledge base are found and these are used to predict properties of the new example.
Extremes of Case-based Reasoning

- The cases are simple and for each new example the agent has seen many identical instances. Use the statistics of the cases.
- The cases are simple but there are few exact matches. Use a distance metric to find the closest cases.
- The cases are complex, there are no matches. You need sophisticated reasoning to determine why an old case is like the new case.

Examples: legal reasoning, case-based planning.
**k-nearest Neighbors**

- Need a distance metric between examples.
- Given a new example, find the $k$ nearest neighbors of that example.
- Predict the classification by using the mode, median, or interpolating between the neighbors.
- Often want $k > 1$ because there can be errors in the case base.
Euclidean Distance

Define a metric for each dimension (convert the values to a numerical scale).

The **Euclidean distance** between examples $x$ and $y$ is:

$$d(x, y) = \sqrt{\sum_A w_A (x_A - y_A)^2}$$

- $x_A$ is the numerical value of attribute $A$ for example $x$
- $w_A$ is a nonnegative real-valued parameter that specifies the relative weight of attribute $A$. 
Like a decision tree, but examples are stored at the leaves.

The aim is to build a balanced tree; so a particular example can be found in log $n$ time when there are $n$ examples.

Not all leaves will be an exact match for a new example.

Any exact match can be found in $d = \log n$ time

All examples that miss on just one attribute can be found in $O(d^2)$ time.