Computer Science Department
Stanford University
Comprehensive Examination in Artificial Intelligence
Autumn 1996

Solution Samples

1 Blind Search

Breadth-first with variable costs (or lengths) is called Uniform Cost Search. All we need to change is to attach to each node in L a variable g with the cost of the path from the root to the node itself. Then, we choose from L the node with the smallest g, rather than the first node of the list.

2 Adversary Search

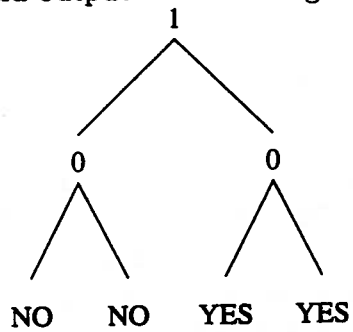
a. You should move to node D, whose value is 7.

b. All 15 will be evaluated if you go left-to-right.

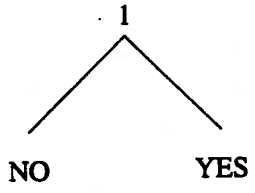
c. Going right-to-left, 8 leaves will be evaluated: all three leaves under J, the 9 under I, both under H, and both under G.

3 Learning

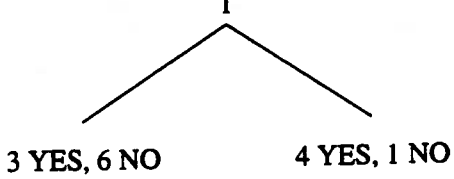
ID-3 would output the following tree:



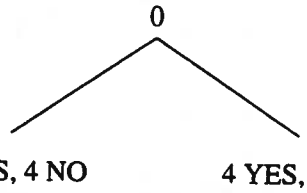
or equivalently



The important thing to notice about this tree is that feature 1 is at the root. The reason for this choice is that feature 1 splits the training set as follows:



while feature 0 splits it as follows:



This shows feature 1 to yield the highest information gain. In fact, feature 0 does next to nothing to the balance of positive and negative features in the training set, while feature 1 splits the training set into mostly negative and mostly positive instances.

4 Probability

Let A be the event "a person smokes", and B be the event "a person is male". We can then define the following probabilities or fractions:

$$\begin{aligned} P(A) &= \text{fraction of smokers in the entire population} = 0.25 \\ P(B) &= \text{fraction of males in the population} = 0.47 \\ P(A|B) &= \text{fraction of smokers in the male population} = 0.30\,. \end{aligned}$$

The required probability is then given by Bayes' theorem:

$$\begin{aligned} 1 - P(B|A) &= \text{fraction of females among all smokers} \\ &= 1 - \frac{P(A|B)P(B)}{P(A)} = 1 - \frac{0.30 \times 0.47}{0.25} = 1 - 0.564 = 0.436\,. \end{aligned}$$

Thus, 43.6 percent of smokers are female.

5 Vision

Edges of type 1 are photometric events, that is, they relate to how light bounces off different surfaces into the camera. Edges of type 2 are geometric events, that is, they relate to the shape of objects. The fact that these are completely different phenomena should already raise a flag: why should edges of the two types coincide at all? Examples of edges of type 1 (photometric) that correspond to no edge of type 2 abound: any surface marking (text on an object, change in paint color, etc) generates a photometric edge, but corresponds to no surface or tangent discontinuity. The converse (geometric edges without photometric edges) occurs quite often when the foreground and the background happen to have the same brightness in the image. Chameleons in the jungle and polar bears in snowy environments rely on this lack of coincidence for their survival.