CS 440: Probabilistic Search

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0.1 Abstract

In this project, we demonstrated searching for a cell given probabilities of its location and using prior beliefs while iterating.

0.2 Academic Integrity

0.3 Problem 1

Assume:

- Belief$[C_i]_t$ is the belief that the target is in cell C_i at time t. It is calculated using $P(in(C_i)|O_t)$.
- $P(F(C_j))$ is the probability that the target is not found when searching cell C_j. It is calculated using $P(F(C_j)|in(C_j)) * P(in(C_j)) + P(!in(C_j))$, the probability that the target is not found in C_j if the target is in C_j added to the probability that the target is not in C_j.
- $P(in(C_i))$ is the probability that the target is in cell C_i, 1/the number of cells.
- O_t is Observations at time t.
- $N_{i,t}$ is the number of times cell C_i has been observed and resulted in a failure at time t.
- Belief$[C_i]_{t+1}$, is belief that the target is in cell C_i after applying a new observation, that the target is not at C_j. It is calculated by $P(in(C_i|O_t \wedge F(C_j)$.

First, $P(O_t \wedge F(C_j|in(C_i)$ is equivalent to $(P(F(C_i|in(C_i) \wedge N_{i,t+1}) + (0 \wedge (\text{the number of observations that were not cell } C_i))$.

Bayes' Theorem can be used to convert Belief$[C_i]_{t+1}$ to
$P(O_t \wedge F(C_j|in(C_i) * P(in(C_i))/P(O_t \wedge F(C_j)$.

Bayes' Theorem can be used to convert Belief$[C_i]_t$ to
$P(O_t|in(C_i) * P(in(C_i))/P(O_t)$.

Dividing these the $t+1$ equation by the t equation will give you their multiplicative relationship:
$(P(F(C_i)|in(C_i)) \wedge (1 \text{ if } C_j \text{ is } C_i, 0 \text{ otherwise})) * (P(O_t)/P(O_t \wedge F(C_j)))$

So, to update a belief given a new observation:

1. If the new observation was on this cell, multiply the belief by the probability of finding the target in this cell given that the target is in this cell.

2. Then, multiply by the previous observations divided by the new observations.

0.4 Problem 2

The probability that the target will be found in cell C_i given observations is:
$\text{Belief}[C_i] * (1 - P(\text{Target not found in Cell}_i|\text{Target is in Cell}_i))$

0.5 Problem 3

0.6 Problem 4