CS 3630 Project 2

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1. What is the difference between CDF and PMF?

CDF is the probability associated with the subset of outcomes with indices less than or equal to a given index i. $P(X \leq x) = \sum_{j \leq i} P(X = xi)$

PMF is a discrete probability distribution is the probability distribution of a random variable X, taking on one of K discrete values. $P(X = x_i)$

2. How did you implement maximum-probable explanation?

I first identify the known observations and actions and implement product1(s1,s2) to calculate the factor value of s1 and s2. Then to eliminate s1, I create a lookup table for s1 by looping through all two combinations of the states. For each state s2, I find the other pair of state s1 that gives them maximum factor value and record that state. At column s2 for both tables, I stored s1 into the lookup table and maximum factor value of s1 and s2 into value table for s1.

Similarly, to eliminate s2 and s3, I then compute product2(s2,s3), create lookup table for s2 and compute product3(s3). For lookup table for s3, I only loop through STATES once and record s3 with the maximum factor product and put these values into lookup table and value table respectively.

Finally, I compute back-substitute by using the lookup tables to find the most probable states and return those states in list.

3. What is the purpose of sampling and how is it used?

Given a distribution, sampling allows us to simulate a single variable or to draw sample from the distribution.

Firstly, we need to determine order to the outcomes, which we can do by adopting order associated with the (arbitrary) integer indices by which we enumerate outcomes, i.e.: $x_i < x_j$ if $i < j$. Given this order, we can the then compute the cumulative distribution function or CDF, $F(x_i) = P(X \leq x) = \sum_{j \leq i} P(X = xi)$

Then we generate random number $0 \leq u \leq 1$, then return x_i such that i is the smallest index such that $F(x_i) \geq u$.

4. What is a factor graph?

Factor graphs make inference tractable.

A factor graph is a bipartite graph F = (U, V, E) with two types of nodes: factors $\varphi_i \in U$ and variables $X_j \in V$. Edges $e_{ij} \in E$ are always between factor nodes and variables nodes. A factor graph F defines the factorization of a global function φ(X) as φ(X) = $\prod_i \varphi_i(Xi)$

5. What did you learn in this project?

In this project, I learned how to implement code to perform probabilistic inference in a grid world. I learned to apply what I learned in lectures by implementing functions to calculate different probability functions, sampling from these functions, as well as performing Bayes Net Inference.

It is my first time using Colaboratory, so I learned how to use that. I have not use python in a while, so through this project, I also reviewed python and explored different methods in Numpy package.

6. Screenshot and paste the output of running your unit tests here

<Insert Screenshot here.>

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----------------------------------------------------------------------
Ran 14 tests in 1.634s

OK
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7. Extra-Credit - MPE: Screenshot and paste the output of running your extra-credit unit tests here

<Insert Screenshot here.>

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Ran 1 test in 0.344s

OK
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8. Extra-Credit - Portal: Screenshot and paste the output of running your extra-credit unit tests here

<Insert Screenshot here.>

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----------------------------------------------------------------------
Ran 1 test in 0.008s

OK
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