CS 188 HW 8 Challenge Question

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1 Decision Networks and HMMs

6.1)

$$\begin{cases} EU(theater) = (0.5)(100) + (0.5)(10) = 55 \\ EU(rent) = (0.5)(80) + (0.5)(40) = 60 \end{cases}$$
$$\implies MEU(\emptyset) = 60$$
$$\implies \underset{A}{\text{argmax}}\, EU(A) = rent$$

6.2)

Since F is unobserved, S and M are independent due to common effect
$$\implies P(M|+s) = P(M)$$
$$\implies \begin{cases} EU(theater|+s) = EU(theater) = 55 \\ EU(rent|+s) = EU(rent) = 60 \end{cases}$$
$$\implies MEU(\{+s\}) = MEU(\{-s\}) = 60$$
$$\implies \text{Optimal action for both +s and -s} = rent$$
$$\implies VPI(S) = 60 - 60 = 0$$

6.3)

$$MEU(G) = \max_a \sum_m P(m|G)\, U(m,a)$$
$$EU(theater| + g) = (0.644)(100) + (0.356)(10) = 67.96$$
$$EU(rent| + g) = (0.644)(80) + (0.356)(40) = 65.76$$
$$\implies MEU(+g) = 67.96$$
$$EU(theater| - g) = (0.293)(100) + (0.707)(10) = 36.37$$
$$EU(rent| - g) = (0.293)(80) + (0.707)(40) = 51.72$$
$$\implies MEU(-g) = 51.72$$
$$\implies VPI(G) = (67.96)(0.59) + (51.72)(0.41) - 60 = 1.3016$$

6.4) (i)
- A is false. VPI is nonnegative.
- B is true. $S \perp\!\!\!\perp M$ when F is unobserved.
- C is false. See above.
- D is false.

$$MEU(+f) = 81.37, MEU(-f) = 43.8$$
$$VPI(F) = 65.5906 - 60 = 5.5906$$

- E is false. $VPI(G) = 1.3016$

(ii)
- A is false. VPI is nonnegative.
- B is potentially true. For example. M-F might be a trivial edge.
- C is potentially true. Observing G activates the path from S to M
- D is potentially true. Depends on the CPT.
- E is potentially true. Same reason as above.

(iii)
- A is false. VPI is nonnegative.
- B is true. Observing F blocks the path from G to M.
- C is false. See above.
- D is false. $VPI(F) > 0$.
- E is false. $VPI(G) > 0$.

(iv)
- A is false. See calculated value.
- B is true.
- C is false.
- D is true.
- E is false.

6.5)
- A is equivalent. Marginalization + memoryless property.
- B is equivalent. Same as A by memoryless property.
- C is not equivalent. Need to eliminate X_T.
- D is not equivalent. Same reason as above.

6.6) Since we want backward recursion,

$$\beta(X_t) = \sum_{x_{t+1}} \beta(X_{t+1} = x_{t+1}) P(X_{t+1} = x_{t+1} | X_t) P(E_{t+1} = e_{t+1} | X_{t+1} = x_{t+1})$$

(CEBF)

6.7)
- A is false. Cannot eliminate X_t
- B is false. Equals $P(X_t, E_{1:T})$ instead
- C is true. Equivalent to $\frac{P(X_t, E_{1:T})}{P(E_{1:T})}$
- D is false. Missing $E_{t+1:T}$