Spring 2022 - Question 6. Bayes Nets

When a 20 ~ 50 years' working professional takes a job interview.

- 20% of people will prepare for the interview for over 10 hours, and 90% of people will dress properly.
- For the people preparing for the interview for over 10 hours and dressing properly, they will have a 30% chance of getting a new job offer.
- For the people preparing for an interview for over 10 hours, and NOT dressing properly, they will have a 20% chance of getting a new job offer.
- For people NOT preparing for an interview for over 10 hours, but dressing properly, they will have a 25% chance of getting a new job offer.
- For people NOT preparing for an interview for over 10 hours, and NOT dressing properly, they will have a 10% chance of getting a new job offer.

For all 20 ~ 50 years' old working professionals,

- 60% of people are married people.
- 80% of married people have kids. Only 40% of unmarried people have kids.

When they make an immediate decision whether or not to purchase a home or car,

- When a person both gets a job offer and has kids, he (or she) has 40% chance of planning to purchase a new home, and 30% chance of planning to purchase a new car.
- When a person both gets a job offer and does not have kids, he (or she) has 30% chance of planning to purchase a new home, and 20% chance of planning to purchase a new car.

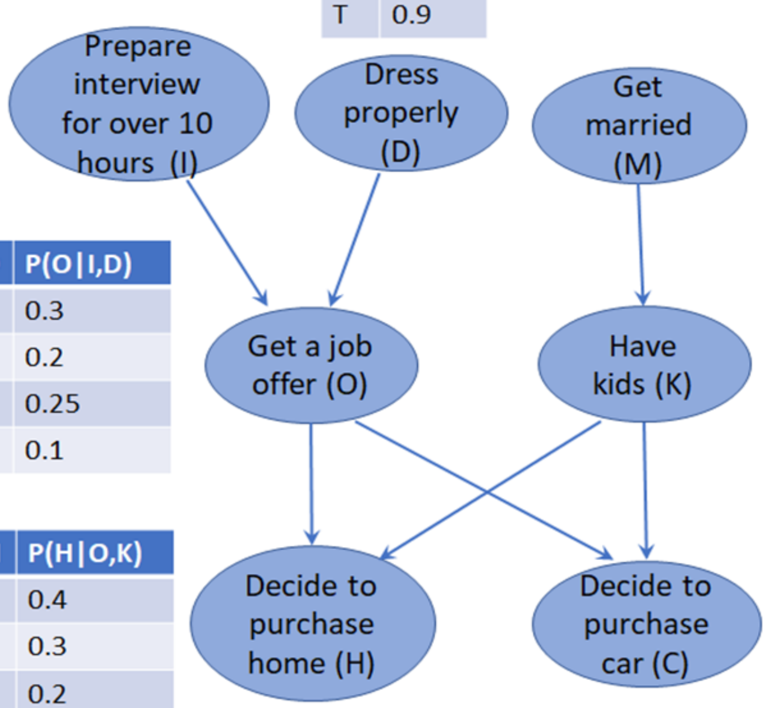
- When a person does not get a job offer and has kids, he (or she) has 20% chance of planning to purchase a new home, and 10% chance of planning to purchase a new car.
- When a person does NOT get a job offer and does NOT have kids, he (or she) has 10% chance of planning to purchase a new home, and 5% chance of planning to purchase a new car.

Use the 7 nodes: Prepare interview more than 10 hours (I), Dress properly in interview (D), Get a new job offer (O), Get married (M), Have kids (K), Decide to purchase a home (H) and Decide to purchase a car (C) to build a Bayes network. The marginal and conditional probability tables are also listed with the network. Then answer the 3 questions below:

D	P(D)
T	0.9

I	P(I)
T	0.2

M	P(M)
T	0.6



I	D	O	P(O|I,D)
T	T	T	0.3
T	F	T	0.2
F	T	T	0.25
F	F	T	0.1

M	K	P(K|M)
T	T	0.8
F	T	0.4

O	K	H	P(H|O,K)
T	T	T	0.4
T	F	T	0.3
F	T	T	0.2
F	F	T	0.1

O	K	C	P(C|O,K)
T	T	T	0.3
T	F	T	0.2
F	T	T	0.1
F	F	T	0.05

Question 1 (No partial credit):

What are the correct conditional independence relationships for ($M \perp H \mid K$) and ($I \perp M \mid C$)? ($A \perp B \mid C$ means that A is conditionally independent of B given C).

A: Conditional independence, Conditional independence

B: Conditional independence, Not conditional independence (Correct)

C: Not conditional independence, Conditional independence

D: Not conditional independence, Not conditional independence

Question 2 (No partial credit):

Which of the following are true? Mark all that apply. ($A \perp B \mid C$ means that A is conditionally independent of B given C).

A: $I \perp C \mid O$; $O \perp K$ (Correct)

B: $H \perp C$; $I \perp D \mid C$

C: $O \perp K \mid C$; $H \perp C \mid M$

D: $I \perp M \mid H$; $H \perp C \mid K$

E. $D \perp K \mid C$; $D \perp M \mid O$

Question 3 (Partial credit 3 is for no normalization, joint probability 0.015336):

Assume that a married person prepares over 10 hours to take a job interview, and finally was rejected. What is the probability that this person plans to purchase a home immediately after getting the interview decision? This question requires to calculate conditional probability $P(H \mid I, \sim O, M)$.

_____________ **(Note: Full point requires accuracy to 6 decimals)**

Solution 1 _ Regular.

P (I, ~O) = P (I) * P(D) * P (~O|I,D) + P (I) * P(~D) * P (~O|I, ~D)

= 0.2 * 0.9 * (1-0.3) + 0.2 * (1-0.9) * (1-0.2)

= 0.18 * 0.7 + 0.02 * 0.8

= 0.142

P (I, ~O, M, H) = P (I, ~O, M, K, H) + P (I, ~O, M, ~K, H)

= P (I, ~O) * P (M, K) * P (H | ~O, K)

+ P (I, ~O) * P (M, ~K) * P (H | ~O, ~K)

= 0.142 * (0.6 * 0.8) * 0.2 + 0.142 * (0.6 * (1-0.8)) * 0.1

= 0.013632+ 0.001704

= 0.015336

P (I, ~O, M, ~H) = P (I, ~O, M, K, ~H) + P (I, ~O, M, ~K, ~H)

= P (I, ~O) * P (M, K) * P (~H | ~O, K)

+ P (I, ~O) * P (M, ~K) * P (~H | ~O, ~K)

= 0.142 * (0.6 * 0.8) * (1- 0.2) + 0.142 * (0.6 * (1-0.8)) * (1-0.1)

= 0.054528 + 0.015336

= 0.069864

P (H | I, ~O, M) = P (I, ~O, M, H) /(P (I, ~O, M, H) + P (I, ~O, M, ~H))

= 0.015336 / (0.015336+ 0.069864)

= 0.015336 / 0.0852

= 0.180000

Solution 2 _ Simple.

We know he got rejected, so I and H are now independent.

$$P(H|I,\sim O,M)=P(H|\sim O,M)$$

$$
\begin{aligned}
P(H|\sim O,M)&=P(H|\sim O,K)*P(K|M)+P(H|\sim O,\sim K)*P(\sim K|M)\\
&=0.2*0.8+0.1*0.2\\
&=0.180000
\end{aligned}
$$