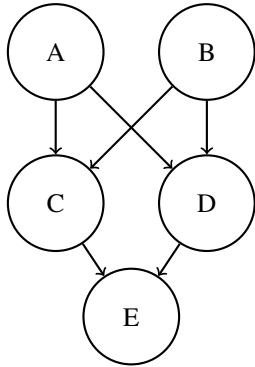


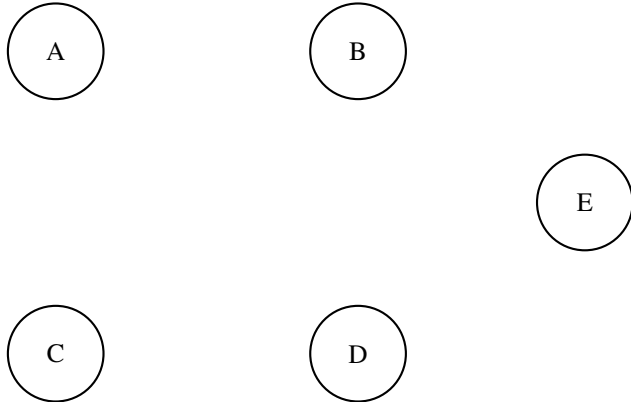
### Q1. Bayes Nets and Joint Distributions

(a) Write down the joint probability distribution associated with the following Bayes Net. Express the answer as a product of terms representing individual conditional probabilities tables associated with this Bayes Net:



(b) Draw the Bayes net associated with the following joint distribution:

$$P(A) \cdot P(B) \cdot P(C|A, B) \cdot P(D|C) \cdot P(E|B, C)$$



(c) Do the following products of factors correspond to a valid joint distribution over the variables  $A, B, C, D$ ? (Circle FALSE or TRUE.)

(i)    FALSE    TRUE     $P(A) \cdot P(B) \cdot P(C|A) \cdot P(C|B) \cdot P(D|C)$

(ii)    FALSE    TRUE     $P(A) \cdot P(B|A) \cdot P(C) \cdot P(D|B, C)$

(iii)    FALSE    TRUE     $P(A) \cdot P(B|A) \cdot P(C) \cdot P(C|A) \cdot P(D)$

(iv)    FALSE    TRUE     $P(A|B) \cdot P(B|C) \cdot P(C|D) \cdot P(D|A)$

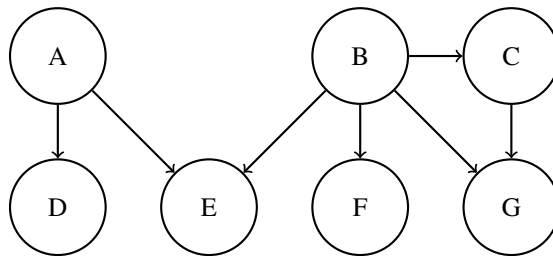
(d) What factor can be multiplied with the following factors to form a valid joint distribution? (Write “none” if the given set of factors can’t be turned into a joint by the inclusion of exactly one more factor.)

(i)  $P(A) \cdot P(B|A) \cdot P(C|A) \cdot P(E|B, C, D)$

(ii)  $P(D) \cdot P(B) \cdot P(C|D, B) \cdot P(E|C, D, A)$

(e) Answer the next questions based off of the Bayes Net below:

All variables have domains of  $\{-1, 0, 1\}$



(i) Before eliminating any variables or including any evidence, how many entries does the factor at G have?

(ii) Now we observe  $e = 1$  and want to query  $P(D|e = 1)$ , and you get to pick the first variable to be eliminated.

- Which choice would create the **largest** factor  $f_1$ ?

- Which choice would create the **smallest** factor  $f_1$ ?