✖

Variable Elimination

9/9 得分 (100%)

测验通过！

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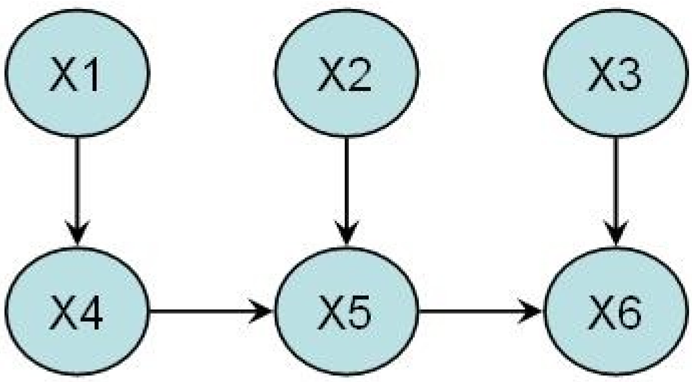
1.

Intermediate Factors. Consider running variable elimination on the following Bayesian network over binary variables. Which of the nodes, if eliminated first, results in the largest intermediate factor? By largest factor we mean the factor with the largest number of entries.



X_5

正确

Eliminating X_5 results in the intermediate factor $\tau(X_2, X_4, X_6)$, which is larger than for any of the other options.

- ○ X_6
- ○ X_1
- ○ X_2

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2.

Elimination Orderings. Which of the following characteristics of the variable elimination algorithm are affected by the choice of elimination ordering? You may select 1 or more options.

- [x] Size of the largest intermediate factor

正确

The elimination ordering can affect the size of the largest intermediate factor.

- [x] Memory usage of the algorithm

正确

The elimination ordering affects the size of the largest factor created, which determines the memory usage of the algorithm.

- [ ] Which marginals can be computed correctly

未选择的是正确的

- [x] Runtime of the algorithm

正确

The elimination ordering affects the size of the largest factor created, which determines the runtime of the algorithm.

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3.

Marginalization. Suppose we run variable elimination on a Bayesian network where we eliminate all the variables in the network. What number will the algorithm produce?

1

正确回答

Bayesian networks represent valid probability distributions, and so summing up all the possible states will always return 1.

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4.

Marginalization. Suppose we run variable elimination on a Markov network where we eliminate all the variables in the network. What number will the algorithm produce?

- ○ A positive number, always between 0 and 1, which depends on the structure of the network.
- ◉ Z , the partition function for the network.

正确

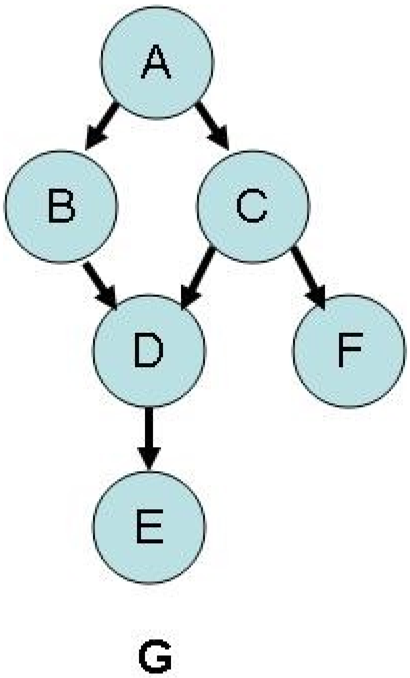
Eliminating all the variables yields the partition function for the network.

- ○ $1/Z$, where Z is the partition function for the network.
- ○ 1

1 / 1 分

5.

Intermediate Factors. If we perform variable elimination on the graph shown below with the variable ordering B, A, C, F, E, D , what is the intermediate factor produced by the third step (just before summing out C)?



- $\psi(A, B, C, D, F)$
- $\psi(C, D, F)$

正确

After eliminating B we have a new factor $\tau_1(A, D, C)$, and after eliminating A , the factor becomes $\tau_2(D, C)$, then when eliminating C , the intermediate factor is $\psi(C, D, F) = \tau_2(D, C)P(F|C)$. This is because the only factors involving C at this point are $\tau_2(D, C)$ and $P(F|C)$. The only other factor involving C , $P(C|A)$ was already used to compute $\tau_2(D, C)$ when eliminating A , so including it again would be incorporating information from this factor twice.

- [ ] $\psi(C, F)$
- [ ] $\psi(D, F)$

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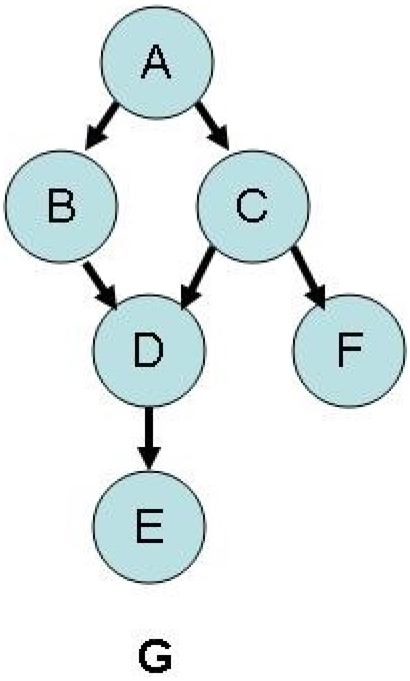
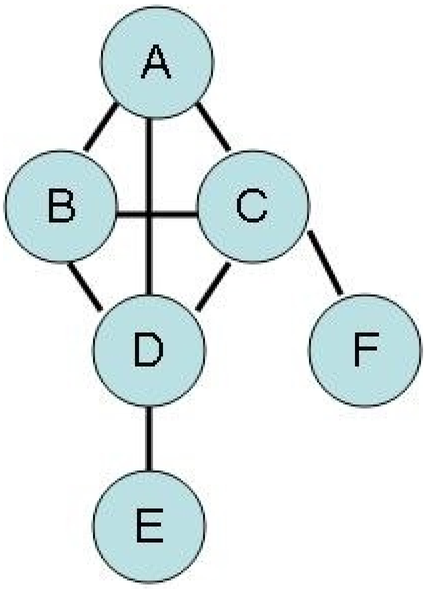
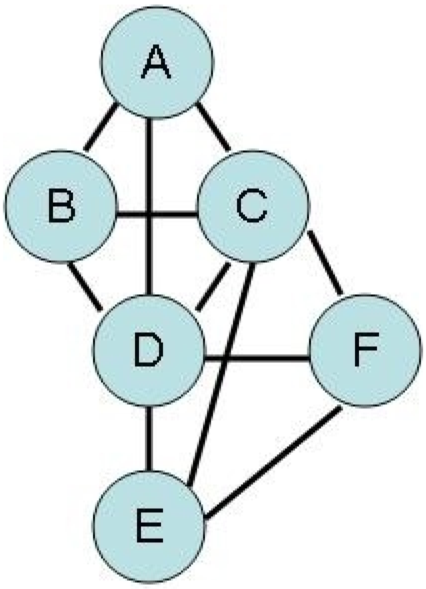
6.

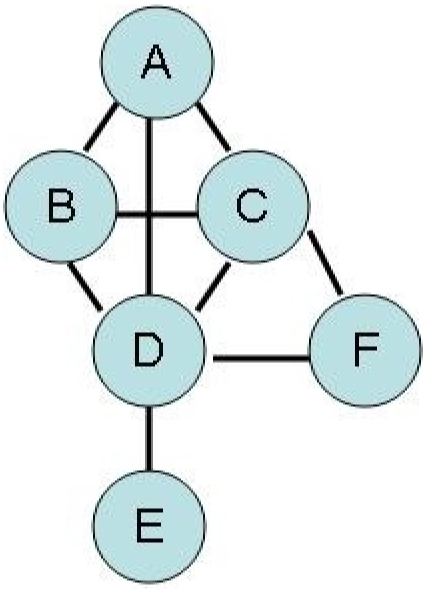
Induced Graphs. If we perform variable elimination on the graph shown below with the variable ordering B, A, C, F, E, D , what is the induced graph for the run?



- [ ]


A
B
C
D
F
E


A
B
C
D
F
E



正确

This is correct. There is an edge in the induced graph between every pair of variables that is present together in a factor during a run of variable elimination.

- [ ] None of these

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7.

***Time Complexity of Variable Elimination.** Consider a Bayesian network taking the form of a chain of n variables, $X_1 \to X_2 \to \cdots \to X_n$, where each of the X_i can take on k values. What is the computational cost of running variable elimination on this network if we eliminate the X_i in order (i.e., first X_1 , then X_2 and so on)?

- [ ] $O(nk^3)$
- [ ] $O(k^n)$
- [x] $O(nk^2)$

正确

When eliminating X_1, we sum out X_1 from $P(X_1)P(X_2|X_1)$ to obtain $\phi_1(X_2)$. For each value of X_2, we have to do k multiplications and $k-1$ summations, which is $O(k)$. Since X_2 can take k different values, to compute $\phi_1(X_2)$, the computational cost is $O(k^2)$ operations. The process continues for each X_i, so in total the cost is $O(nk^2)$.

- [ ] $O(nk)$

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8.
Time Complexity of Variable Elimination. Suppose we eliminate all the variables in a Markov network using the variable elimination algorithm. Which of the following could affect the runtime of the algorithm? You may select 1 or more options.

- [x] Number of factors in the network

正确
This will affect the number of computations that needs to be carried out and hence the algorithm's runtime.

- [x] Whether there is evidence

正确
If there is evidence, the number of variables in the network is effectively reduced, since factors involving the evidence variables are reduced.

- [x] The variable elimination ordering

正确
This potentially affects the size of the largest factor in the network, which is a key component of the algorithm's runtime.

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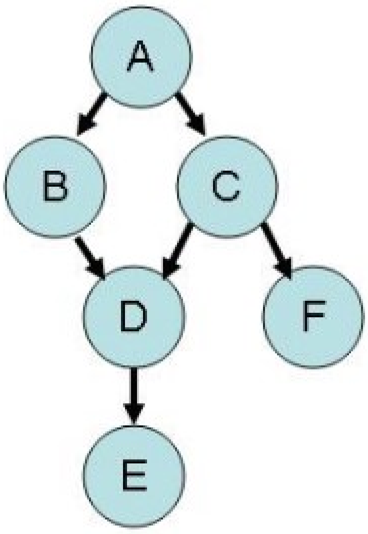
9.

Intermediate Factors. If we perform variable elimination on the graph shown below with the variable ordering F, E, D, C, B, A , what is the intermediate factor produced by the third step (just before summing out D)?



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- $\psi(B, C, D, E, F)$
- $\psi(B, C, D, E)$
- $\psi(B, C, D)$

正确

This is correct. The factors involved in eliminating D are $\phi(B, C, D) = P(D \mid B, C)$ and $\tau_2(D)$ (from eliminating E), so the intermediate factor generated before eliminating D is the product of these two factors, $\psi(B, C, D) = \phi(B, C, D)\tau_2(D)$.

- $\psi(B, C)$
- $\psi(A, B, C, D)$