Tania Soutonglang

CS 583-01

Feb. 5, 2024

Assignment 1

# Theoretical Assignments

1. We are given the random variables , and . Answer the following questions.
   1. Assuming every variable is binary, how many independent parameters are needed to represent ?

For *n* binary variables there would be possible outcomes and for *m* binary variables there would be possible outcomes. So for a joint probability table there would need to be entries. The last probability can be determined from the others since the sum must be 1 so to represent dependencies you need independent parameters.

* 1. Assuming every variable has three possible values, how many independent parameters are needed to represent ?

Similar to (a), there would need to be independent parameters.

* 1. Assuming each has *i* possible values and similarly, every has *i* possible values, how many independent parameters are needed to represent ?

* 1. Assuming every variable is binary, how many independent parameters are needed to represent ?
  2. Assuming every variable has three possible values, how many independent parameters are needed to represent ?
  3. Assuming each has *i* possible values and similarly every has *i* possible values, how many independent parameters are needed to represent ?

1. We are given the following Bayesian network. Please answer the following questions.

A diagram of a network

Description automatically generated

* 1. Write down the join distribution as a factorization over this Bayesian network.
  2. Assuming each variable is discrete and can take *n* possible values, how many independent parameters are needed for this Bayesian network?
  3. Are the following independence statements true or false?
     1. A Ʇ B
     2. A Ʇ B | C
     3. A Ʇ B | J
     4. A Ʇ B | G
     5. A Ʇ B | E
     6. A Ʇ B | H
     7. A Ʇ H
     8. A Ʇ H | J
     9. A Ʇ H | D, J
     10. D Ʇ J
     11. B Ʇ E
     12. B Ʇ E | J
     13. B Ʇ E | J, H

1. We have a distribution P over the variables A, B, C, D, E, and G. We would like to build a Bayesian network that is a minimal I-Map for P. In reality, you have access to P, which you can query for independencies, but for the purposes of this problem, we will assume the following structure is a P-Map for P. Create minimal I-Maps for P, using the following variable orders.

A diagram of a network

Description automatically generated

* 1. C, A, B, E, D, G
  2. D, B, A, E, C, G
  3. G, E, D, C, B, A
  4. G, A, C, E, D, B