Graphical Representations of Statistical Dependencies

박태준

March 3, 2023

0.1 General Hierarchical Modeling framework

- Statistical modeling often becomes simpler by modeling a series of conditional models.
  - ▷ Let $[A]$ be the distribution of a random variable A and
  - ▷ $[A|B]$ be the conditional distribution of a random variable A given a random variable B.
  - ▷ Let also $[A, B, C]$ be the joint distribution of A, B and C.
- Note that $[A, B, C]$ can be decomposed into $[A|B, C][B|C][C]$.
- In hierarchical modeling, consider three primary states:
  - ▷ Stage1: Date model [data | process, parameters]
  - ▷ Stage2: Process model [process | parameters]
  - ▷ State3: Parameter model [parameters]
    - Stage3 is for Bayesian Hierarchical modeling.

0.2 Introduction

- **Spatial independence** is a property of probability distribution
- Two random quantities A and B are (statistically) independent if

$$[A, B] = [A][B]$$

  - ▷ In other words, to know the joint distribution, it is enough to know the marginal distributions and to put the joint distribution equal to their product.

- Statistical dependence is the absence of statistical independence.
- According to this definition, there are myriad ways that two or more random quantities could be (statistically) dependent.
- A key component of statistical modeling of complex phenomena is to specify the dependence structure.
- One way to visualize dependence structures is through a graph.

1 Directed and Undirected Graphs

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