

Introduction to Probability, Examples

CSU, Chico Math 314

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outline

Set Operations

Conditional Probability

Mutual Independence

System Reliability

Association Rules

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Set Operations, homework

Suppose you have a vector of indices of the months from 2011 to 2012, let's call it `time`, and further that you have two other vectors of indices `winter2011` and `winter2012`, which store the indices of the winter months from their respective years. Use set operations to find the indices of the non-winter months.

```
time <- 1:24 # Jan 11 - Dec 12
winter2011 <- c(1,2) # Jan, Feb 11
# Nov, Dec, 11 and Jan, Feb 12
winter2012 <- c(11, 12, 13, 14)
## Hint: ?union
```

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Conditional Probability, example

Four cards are to be dealt successively at random and without replacement from a standard deck of cards. Find the probability of drawing, a club, a heart, a spade, and then a diamond.

Conditional Probability, homework

At a county fair carnival game, there are 25 balloons on a board, 10 of which are yellow, 8 red, and 7 green. Given that the first balloon hit is yellow, what is the probability that the next balloon hit will also be yellow? Hence, find $P(1_y \cap 2_y)$.

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Mutual Independence, example

Roll a die once. Let $E_1 = \{1, 2, 3\}$, $E_2 = \{3, 4, 5\}$, and $E_3 = \{1, 2, 3, 4\}$. Does

$$P(E_1 \cap E_2 \cap E_3) = P(E_1)P(E_2)P(E_3)?$$

Are E_1 and E_2 independent?

Mutual Independence, homework

Roll a die once. Let $E_1 = \{1, 2\}$ and $E_2 = \{2\}$. Are E_1 and E_2 independent?

Mutual Independence, homework

Roll a die once. Let $E_1 = \{1, 2\}$ and $E_2 = \{2, 3, 4\}$. Are E_1 and E_2 independent?

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System Reliability, motivation

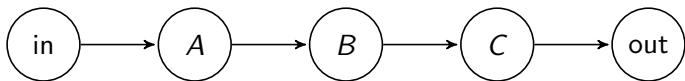


Figure 1: Sequential system

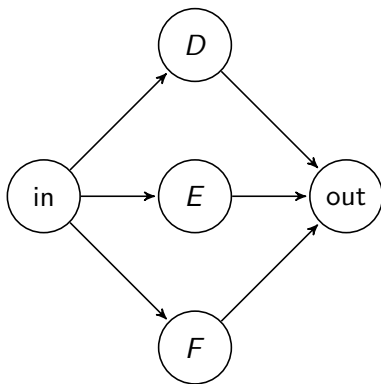


Figure 2: Parallel system

System Reliability, example 1

The three components of the sequential system, A , B , and C , will fail with probabilities $p_A = 0.1$, $p_B = 0.15$, and $p_C = 0.2$, independently of each other. What is the probability the sequential system will fail?

System Reliability, example 1: solution 1

Failure of any subset of the system would cause the whole system to fail.

System Reliability, example 1: solution better

If we could easily find $P(\text{no component fails})$ then set operations could save us.

System Reliability, homework

The three components of the parallel system, D , E , and F , will function with probabilities $p_D = 0.9$, $p_E = 0.85$, and $p_F = 0.8$, independently of each other. What is the probability the parallel system will function?

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Association Rules, homework

Consider the dataset `arules::Groceries`.

```
suppressMessages(library(arules))
data(Groceries)
arGroceries <- apriori(Groceries,
  parameter=list(supp=0.001, conf=0.8))
## output intentionally hidden, cause cat() is stupid
## calculate rows 3 and 4
## using the rules we developed in lecture Probability
## you can't use arules::apriori, you use mean, &, and |
## use https://roualdes.us/data/groceries.csv
inspect(head(arGroceries, n=4))
## use complete sentences to
## interpret the numbers you get.
```

references I

Michael G. Akritas. *Probability and Statistics with R for Engineers and Scientists*. Pearson Education, Inc., 2016.