

Conditional Probability and Monte Carlo simulations

Sumanta Basu

September 14, 2017

Problem Description

It is fall in Ithaca, and you are planning a picnic with your friends. However, the God of rain is not being nice to you.

Chances of rain: heavy (20%), mild (30%) and no rain (50%). Chances of having a fun picnic: 10% if heavy rain, 60% if mild rain and 80% if no rain.

Question: What are the chances of having a fun picnic?

Use law of total probability.

```
p_fun_picnic = 0.20*0.10 + 0.30*0.60 + 0.50*0.80  
p_fun_picnic
```

```
## [1] 0.6
```

Can we arrive at this answer by Monte Carlo?

```
# Assume you are the God of rain

# set seed
set.seed(1)
# simulate 100000 hypothetical days
day = rep('', 100000)

# set weathers on each days to heavy, mild or no rain
for (i in 1:length(day))
  day[i] = sample(c('Heavy', 'Mild', 'No'), 1, prob = c(0.2, 0.3, 0.5))

# see how the first few days are looking
head(day)
```

```
## [1] "No"      "No"      "Mild"    "Heavy"   "No"      "Heavy"
```

Now simulate a picnic on each of these days, and see if it was a fun picnic.

```
picnic = rep('', 100000)

# simulate 100000 picnics
for (i in 1:length(picnic)){
  if (day[i]=='Heavy')
    picnic[i] = sample(c('fun', 'not fun'), 1, prob=c(0.1, 1-0.1))
  if (day[i]=='Mild')
    picnic[i] = sample(c('fun', 'not fun'), 1, prob=c(0.6, 1-0.6))
  if (day[i]=='No')
    picnic[i] = sample(c('fun', 'not fun'), 1, prob=c(0.8, 1-0.8))
}

# see how the first few picnics turned out
head(picnic)
```

```
## [1] "fun"      "fun"      "fun"      "not fun"  "not fun"  "not fun"
```

Calculate the proportion of days with fun picnics

```
sum(picnic == 'fun')/length(picnic)
```

```
## [1] 0.59932
```

Question: What are the chances of no rain on a day, given you had a fun picnic on that day?

Try to use Bayes theorem and Monte Carlo simulation.