Stat 110: Section 2

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Creating Probability Simulations...

We create vectors filled with 0 or 1.

0 means that an event didn't occur, 1 means that the event did occur.

These 0/1 (off/on) values are indicator variables. If a vector has half 1's and half 0's, then the mean is 1/2, implying that the event occurred 50% of the time.

We use `runif(1)` to generate a random number between 0 and 1 uniformly.

Remember: You can always figure out what a built-in R function does by typing `help("function_name)` in the console!

Now, to make sure your simulation is reproducible, we use `set.seed`. This function sets and keeps track of your random values being generated. Leave out `set.seed` if you'd like to get different random results from each simulation.

```
set.seed(1)
#1 is just a number that helps us reference back to this particular seed.
```

Now we create vectors to track our indicator variables within our simulations. In this case, we have 1000 simulations.

```
sims = 1000
success_simulation = rep(0,sims)
```

Now we use a for loop to conduct our simulation

```
# run the loop
for(i in 1:sims)
{

  # flip to see what the value of a simulation is
  event = runif(1)

  # If value from our experiment is less than or equal to zero, success.
  if(event <= .5)
  {
      success_simulation[i] = 1
  }
```

```
# Otherwise, we have a failure and success[i] will continue to equal 0.

# We should get around .5 for our probability of success

ans = mean(success_simulation)
}
```

Our probability of success from our simulation is equal to the probability we calculated of $\frac{1}{2}$.

```
print(ans)
```

```
## [1] 0.52
```

... with a condition

Let's consider a specific example.

Suppose your decision to attend a 9am section is dependent on when you went to bed the night before. If you went to bed before 11pm, your probability of attending section is 0.8. If you went to bed after 11pm, your probability of going to section is 0.4. Imagine that, on any given day, there is a 0.3 probability that you will sleep before 11pm.

Let P(A) be the probability that you attend section, and P(B) be the probability that you went to bed before 11pm. If we want to find P(A), we can break the probability into two cases: when B occurs and when B^c occurs. By employing LOTP, we get:

$P(A) = P(A|B)P(B) + P(A|B^c)P(B^c)$

$= 0.8(0.3) + 0.4(0.7) = 0.52$

```
sims = 1000

#create vectors for early bed time and section attendance
bedtime_before_11 = rep(0, sims)
attend_section = rep(0, sims)

#run the loop
for(i in 1:sims){
  # Randomly generate a whole number between 1 to 10
  bedtime = sample(1:10,1)
  # Randomly generate a probability that you attend section
  attend= runif(1)
  #Probability that you sleep before 11pm is 0.3.  3/10 = 0.3
  if(bedtime <= 3){
    #mark that you slept before 11pm.
    bedtime_before_11[i] = 1
```

```
    #You attend section with probability 0.8 in this case
    if(attend <= .8){
      attend_section[i] = 1
    }
  }
  #the case where you did not sleep before 11pm.
  if(bedtime > 3){
    #You attend class with probability 0.4 in this case
    if(attend <= .4){
      attend_section[i] = 1
    }
  }
}
mean(bedtime_before_11); mean(attend_section)
```

```
## [1] 0.314
```

```
## [1] 0.537
```

Our simulation should give us probabilities roughly equal to 0.3 and 0.52 for the event where you go to bed before 11 and the event where you attend section respectively.

Bayes' Rule

Frodo needs to return a piece of jewelry to the Mordor dollar store. His friend, Sam, has a car, and if Sam goes with Frodo, there is a 0.9 probability that Frodo gets the jewelry to the store. However, if Sam doesn't go with Frodo, Frodo only has a .1 probability of making it to the store. There is a 0.8 probability that Sam goes with Frodo. Conditioned on the fact that Frodo successfully returned the jewelry to Mordor, what is the probability that Sam went with him?

Hint:

$$P(S|F) = \frac{P(F|S)P(S)}{P(F)}$$

Now let's simulate:

```
#inital parameters
set.seed(110)
sims = 1000

#set paths for Sam coming/Frodo making it
Sam = rep(0, sims)
Frodo = rep(0, sims)
```

```r
#run the loop
for(i in 1:sims){

  #flip for each Sam and Frodo
  Sam.flip = runif(1)
  Frodo.flip = runif(1)

  #the case where Sam comes
  if(Sam.flip <= .8){

    #mark that Sam came
    Sam[i] = 1

    #Frodo makes it with .9 probability
    if(Frodo.flip <= .9){
      Frodo[i] = 1
    }
  }

  #the case where Sam didn't come
  if(Sam.flip > .8){

    #Frodo makes it with .1 probability
    if(Frodo.flip <= .1){
      Frodo[i] = 1
    }
  }
}

mean(Sam)
```

```
## [1] 0.829
```

Do the values approximate what was calculated with Bayes' rule? What do you think would happen if we increased the number of simulations?