Probability and Statistics Final

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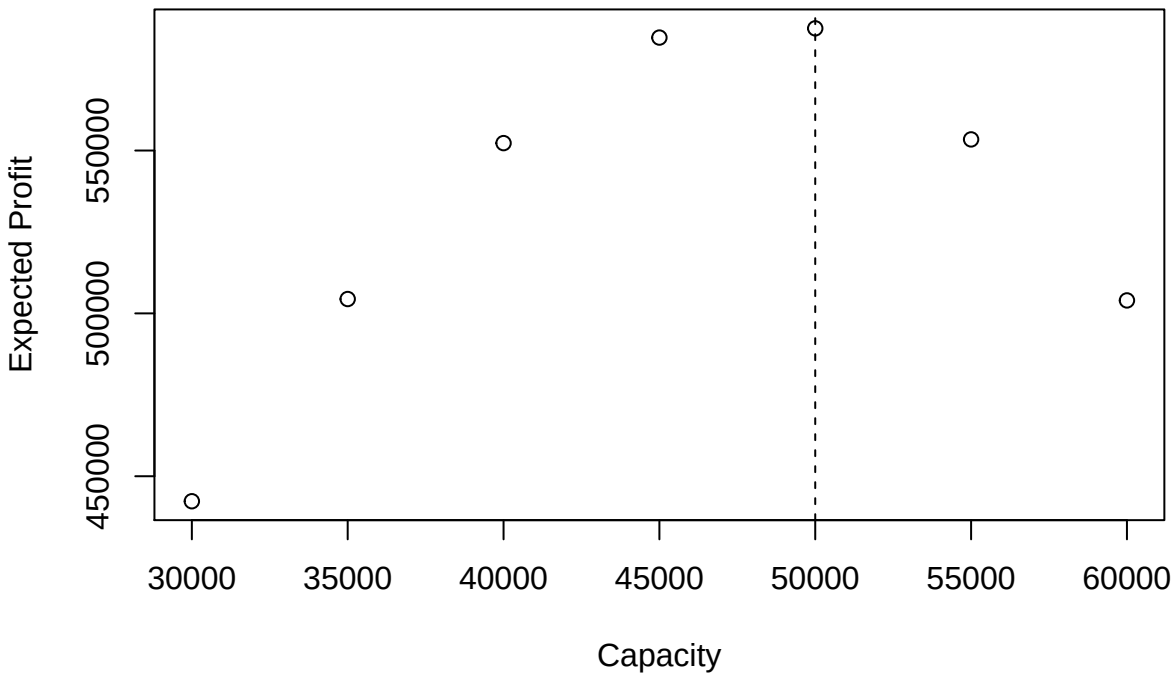
Drugs

Question 1

```
rm(list=ls())
mean <- 50000
stdev <- 12000
time <- 10

capacity <- c(30000, 35000, 40000, 45000, 50000, 55000, 60000)

profitmatrix <- matrix(nrow=length(capacity), ncol = 2)
dimnames(profitmatrix) <- list(NULL, c('Capacity', 'Profit'))

profits <- rep(0, 1000)

for(i in 1:7){
  for(j in 1:1000){
    q <- capacity[i]
    demand <- rnorm(10, mean, stdev)
    profitmatrix[i,1] <- q
    cost <- rep(0, 10)
    revenue <- rep(0, 10)
    for(k in 1:10){
      if(q > demand[k]){
        cost[k] <- .2*demand[k] + .4*q
        revenue[k] <- 3.7*demand[k]
      }
      else{
        cost[k] <- .2*q + .4*q
        revenue[k] <- 3.70*q
      }
    }
    fullrev <- sum(revenue)
    plantcost <- 16*q
    producecost <- sum(cost)
    profits[j] <- fullrev - plantcost - producecost
    }
    profitmatrix[i,2] <- mean(profits)
}
print(paste("Maximum Profit of $", round(max(profitmatrix[,2]),2), "occurs at ",
            profitmatrix[which.max(profitmatrix[,2]),1]," units."))
```

```
## [1] "Maximum Profit of $ 587509.13 occurs at  50000  units."
```

```
plot(x = profitmatrix[,1], y = profitmatrix[,2], xlab = 'Capacity', ylab = 'Expected Profit')
abline(v=profitmatrix[which.max(profitmatrix[,2])], lty=2)
```


Expected Profit
450000
500000
550000
30000
35000
40000
45000
50000
55000
60000
Capacity

Question 2

```
profits <- rep(0,1000)

for(j in 1:1000){
    q <- profitmatrix[which.max(profitmatrix[,2])]
    demand <- rnorm(10, mean, stdev)
    cost <- rep(0, 10)
    revenue <- rep(0, 10)
    for(k in 1:10){
      if(q > demand[k]){
        cost[k] <- .2*demand[k] + .4*q
        revenue[k] <- 3.7*demand[k]
      }
      else{
        cost[k] <- .2*q + .4*q
        revenue[k] <- 3.70*q
      }
    }
    fullrev <- sum(revenue)
    plantcost <- 16*q
    producecost <- sum(cost)
    profits[j] <- fullrev - plantcost - producecost
}


cilow <- mean(profits) - (1.96*sd(profits)/sqrt(1000))
cihigh <- mean(profits) + (1.96*sd(profits)/sqrt(1000))
print(paste("The 95% confidence interval: $",
            round(cilow, 2), "to $", round(cihigh,2)))
```

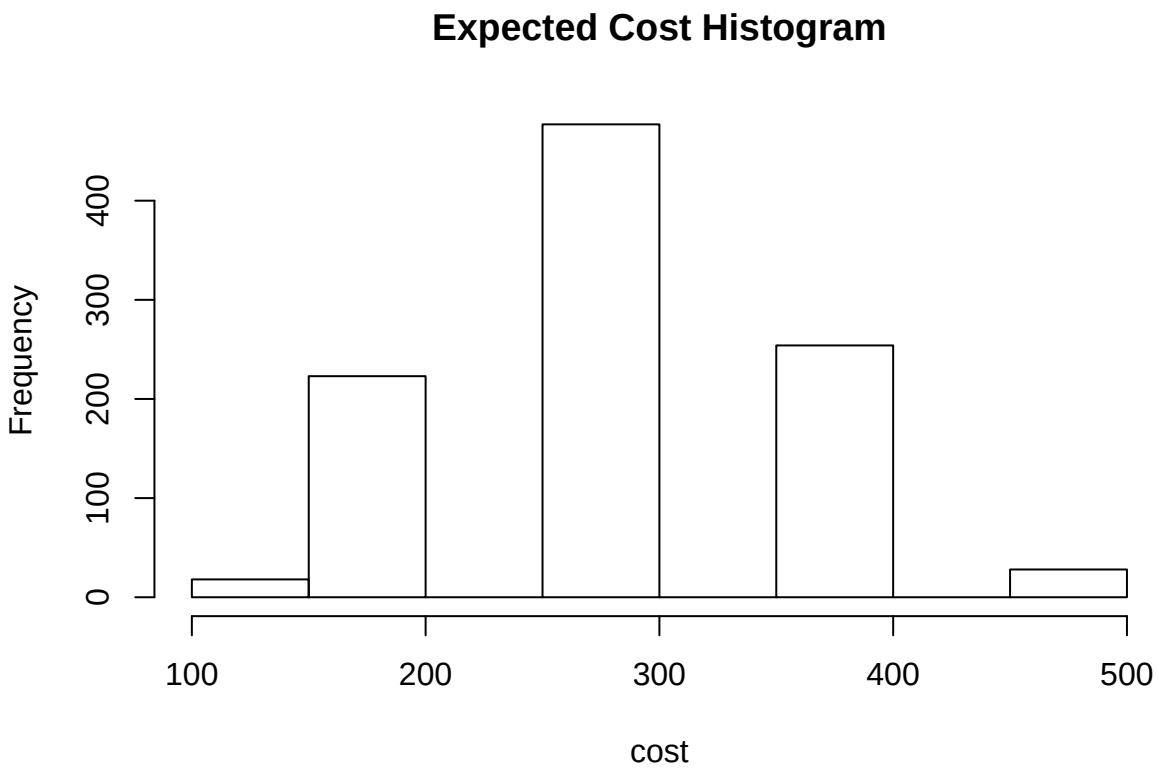
```
## [1] "The 95% confidence interval: $ 576364.1 to $ 586084.5"
```

Warranty

```
cost <- rep(0, 1000)
nofailures <- rep(0, 1000)
devices <- rep(0, 1000)
for(i in 1:1000){
totalc <- 100
failure <- rgamma(1, shape = 2, scale = 0.5)
failure_stop <- failure
devicesno <- 1
warrantychange <- 0
while(failure < 6){
  if(failure_stop > 1){
    totalc <- totalc + 100
    devicesno <- devicesno + 1
  }
  if(failure_stop <= 1){
    devicesno <- devicesno + 1
    warrantychange <- warrantychange + 1
  }
  failure_stop <- rgamma(1, shape = 2, scale = 0.5)
  failure <- failure_stop + failure
}
cost[i] <- totalc
nofailures[i] <- warrantychange
devices[i] <- devicesno
}
parta <- round(mean(cost))
partb <- round(mean(nofailures))
partc <- round(mean(devices))

print(paste("Question 3"))
```

```
## [1] "Question 3"
```

```
hist(cost, main='Expected Cost Histogram')
```




```
print(paste("Expected total cost: $", parta))
```

```
## [1] "Expected total cost: $ 305"
```

```
#expected that number of failures = number of devices - 1

print(paste("Question 4"))
```

```
## [1] "Question 4"
```

```
hist(nofailures, main = 'Expected Number of Failures Histogram')
```

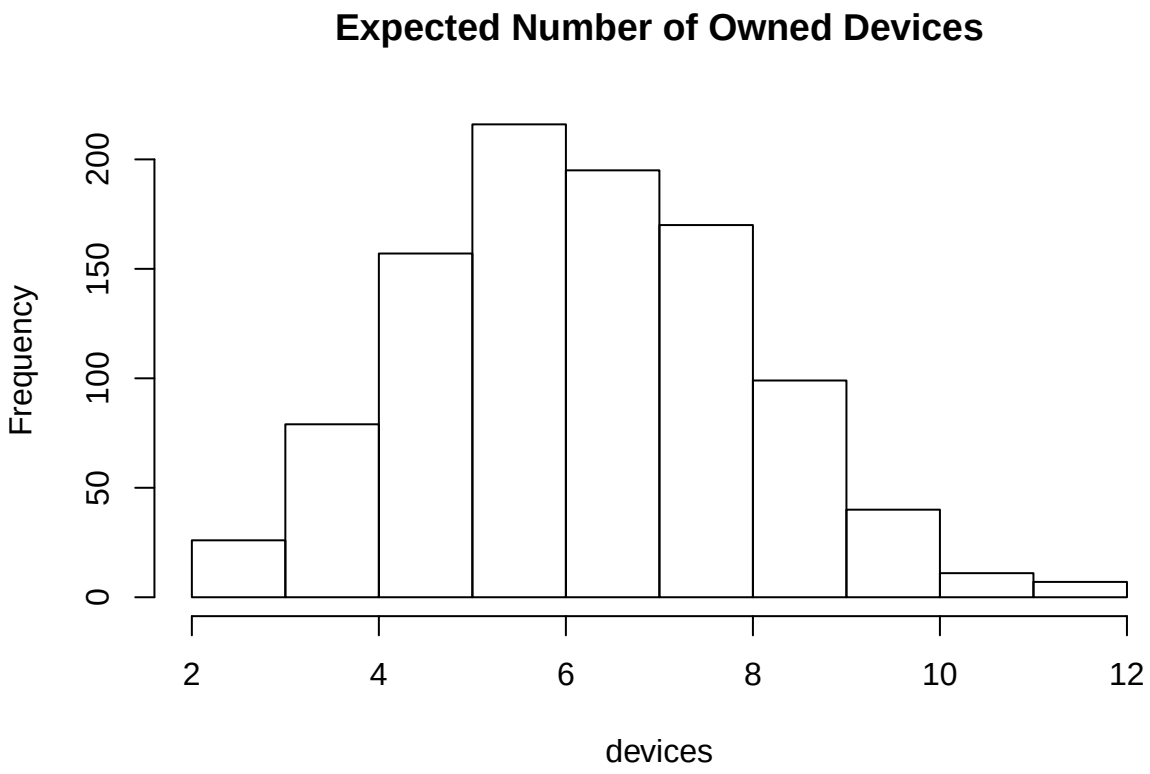

```
print(paste("Number of failures: ", partb))
```

```
## [1] "Number of failures:  4"
```

```
#This is given as a mean, so there
#is some variation between what the value should be in
#theory to what it is calculated as.

print(paste("Question 5"))
```

```
## [1] "Question 5"
```

```
hist(devices, main='Expected Number of Owned Devices')
```




```
print(paste("Number of Owned Devices: ", partc))
```

```
## [1] "Number of Owned Devices:  7"
```

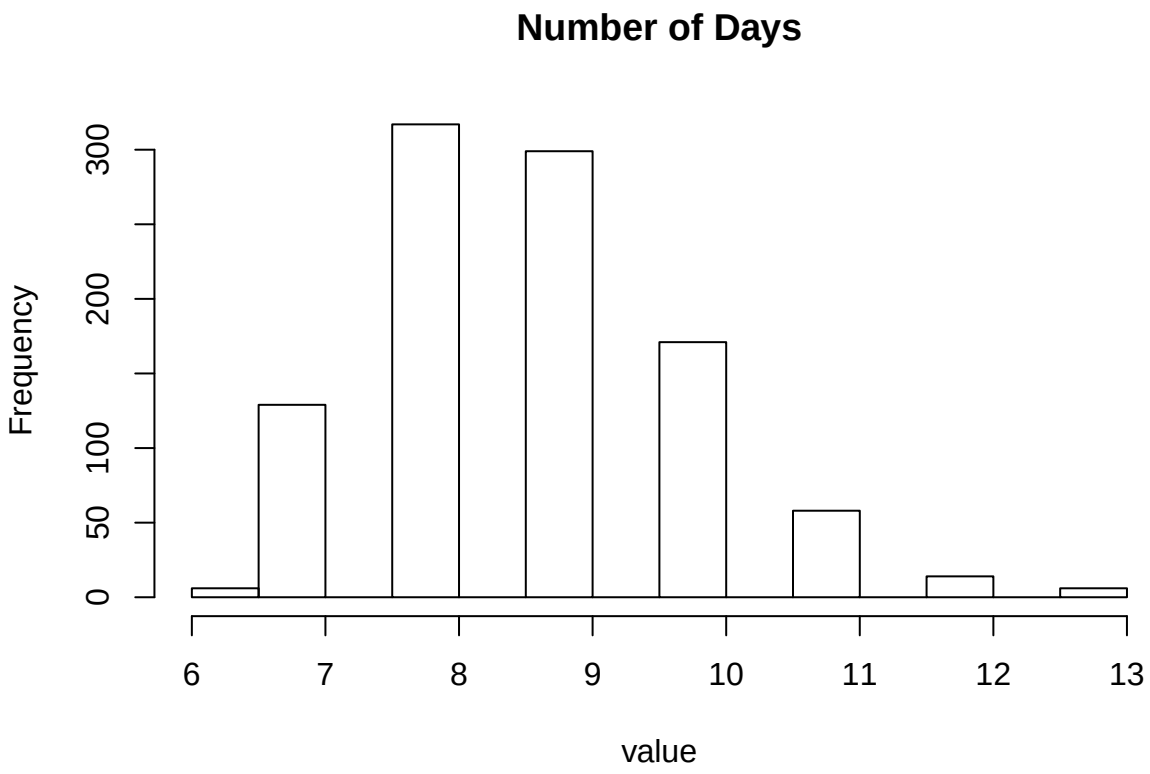
Cleareance

Question 6

```
machines <- 12

cust <- c(0,1,2,3,4)
prob <- c(.15, .25, .3, .2, .1)

value <- rep(0, 1000)

for(j in 1:1000){
  t <- 5
  r <- 4
  f <- 3
  days <- 0
  while (t + r + f > 0){
    day <- sample(cust, size = 1, prob = prob, replace = T)
    interest <- round(rbinom(1, days, .6))
    if(interest > 0){
      for(i in 1:interest){
        need <- sample(x = c(1,2,3), size =1, prob = c(.4, .25, .35), replace = T)
        if(need == 1){
          if( t > 0){
            t <- t - 1
          }
        }
        if(need == 2){
          if( r > 0){
            r <-  r - 1
          }
        }
        if(need == 3){
          if(f > 0){
            f <-  f - 1
          }
        }
      }
    }
    days <- days + 1
  }
value[j] <- days
}
print(paste("Number of days required: ", round(mean(value))))
```

```
## [1] "Number of days required:  9"
```

```
hist(value, main='Number of Days')
```


Number of Days
Frequency
0
50
100
200
300
6
7
8
9
10
11
12
13
value

Waiting Room

Question 7

```
student <- c(1:12)
complete <- c(8, 12, 26, 10, 23, 21, 16, 22, 18, 17, 36, 9)
mu <- mean(complete)
stdev <- sd(complete)
print(paste("Mean of Completion Times (min): ", mu))
```

```
## [1] "Mean of Completion Times (min):  18.1666666666667"
```

```
print(paste("Standard Deviation (min): ", stdev))
```

```
## [1] "Standard Deviation (min):  8.11097273992946"
```

Question 8

```
cilow <- mu - qnorm(.99)*(stdev/sqrt(12))
cihigh <- mu + qnorm(.99)*(stdev/sqrt(12))
print(paste("Confidence Interval (min): (", cilow, ",", cihigh, ")"))
```

```
## [1] "Confidence Interval (min): ( 12.7196716629743 , 23.6136616703591 )"
```

Question 9

```
desiredmax <- mu + 8

n <- ((qnorm(.99)*stdev)/(desiredmax - mu))^2
print(paste("Approximate Desired Sample Size: ", round(n)))
```

```
## [1] "Approximate Desired Sample Size:  6"
```

Scenarios

Question 10

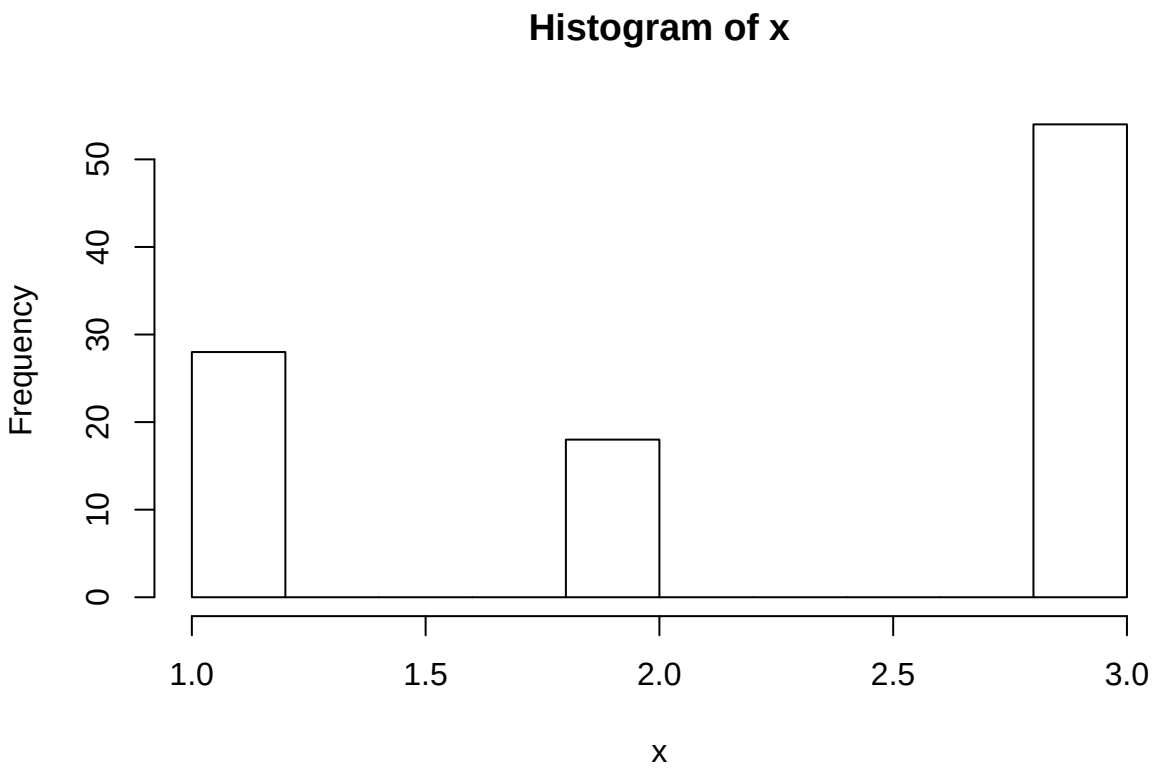
By using scenarios, there are more availability for capturing the audience's attention. Looking at a strict quantitative model and/or trying to explain that model can be difficult to a room of people who only care about the real-world forecasting. By placing that model into a real-world setting, or multiple real-world settings, can help to capture the audience and allow for a more realistic model. In addition, strict quantitative models can have a theoretical bias, while we want to show more a realistic bias - we want to convince the audience that something will/will not happen because we have done our calculations within a real-world scenario.

Multiple Choice

Question 11 C. Heteroscedasticity

Question 12 C. Density Plot

```
x <- sample(c(1,2,3), prob=c(.3,.2, .5), replace = T, size = 100)
hist(x)
```



Question 13 A. acf

Question 14 C. Binomial distribtion of the 500 widgets with a 8% success rate for being defective.

Question 15 B. $pbinom(50, 500, 0.08)$

Question 16 D. 40

```
value <- rep(0, 100000)
for(i in 1:100000){
  value[i] <- rbinom(1, 500, 0.08)
}
expected <- mean(value)
print(paste("Expected Number of Defectives: ", expected))
```

```
## [1] "Expected Number of Defectives:  40.0222"
```

```
stdev <- sd(value)
print(paste("Expected Standard Deviation: ", stdev))
```

```
## [1] "Expected Standard Deviation:  6.08018230369522"
```

```
# 0.08*500
```

Question 17 D. 7

Short Answer in R

Question 18

```r
prob <- pnorm(460, mean= 480, sd = 10, lower.tail=T)
print(paste("Probability single cup is less than 460 grams: ", prob))
```

```
## [1] "Probability single cup is less than 460 grams:  0.0227501319481792"
```

Question 19

```r
ExpectedWeight <- rnorm(1, mean=460, sd=10) + rnorm(1, mean=460, sd=10)
Variance <- 10^2 + 10^2 + 2*10*10*.77
sd <- sqrt(Variance)
print(paste("Expected Total Weight (grams): ", ExpectedWeight))
```

```
## [1] "Expected Total Weight (grams):  934.111846466452"
```

```r
print(paste("Standard Deviation: ", sd))
```

```
## [1] "Standard Deviation:  18.8148877222268"
```

Question 20

```r
prob <- pnorm(920, mean=ExpectedWeight, sd=sd, lower.tail=T)
print(paste("Probability total weight under 920 grams: ", prob))
```

```
## [1] "Probability total weight under 920 grams:  0.226616458138314"
```

Question 21

```r
mu <- 460-qnorm(.95)*10
print(paste("Mean: ", mu))
```

```
## [1] "Mean:  443.551463730485"
```