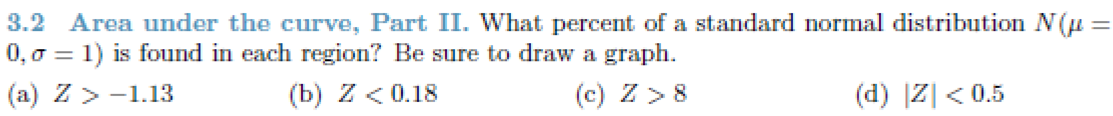
Data606 - Homework3

N Nedd

February 26, 2017

Question 1



3.2 Area under the curve, Part II. What percent of a standard normal distribution $N(\mu = 0, \sigma = 1)$ is found in each region? Be sure to draw a graph.

(a) $Z > -1.13$ (b) $Z < 0.18$ (c) $Z > 8$ (d) $|Z| < 0.5$

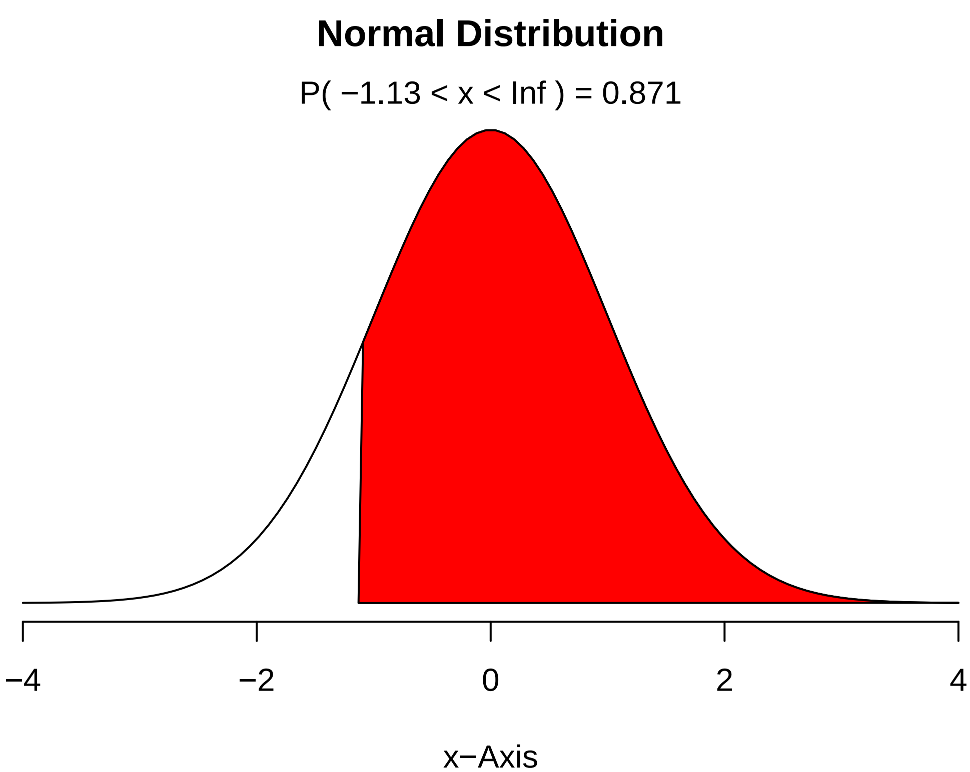
Figure 1: Question 1

Answer

(a) Z > -1.13

Graph of the distribution

```
normalPlot(bounds = c(-1.13, Inf), tails = FALSE)
```



Probability calculation

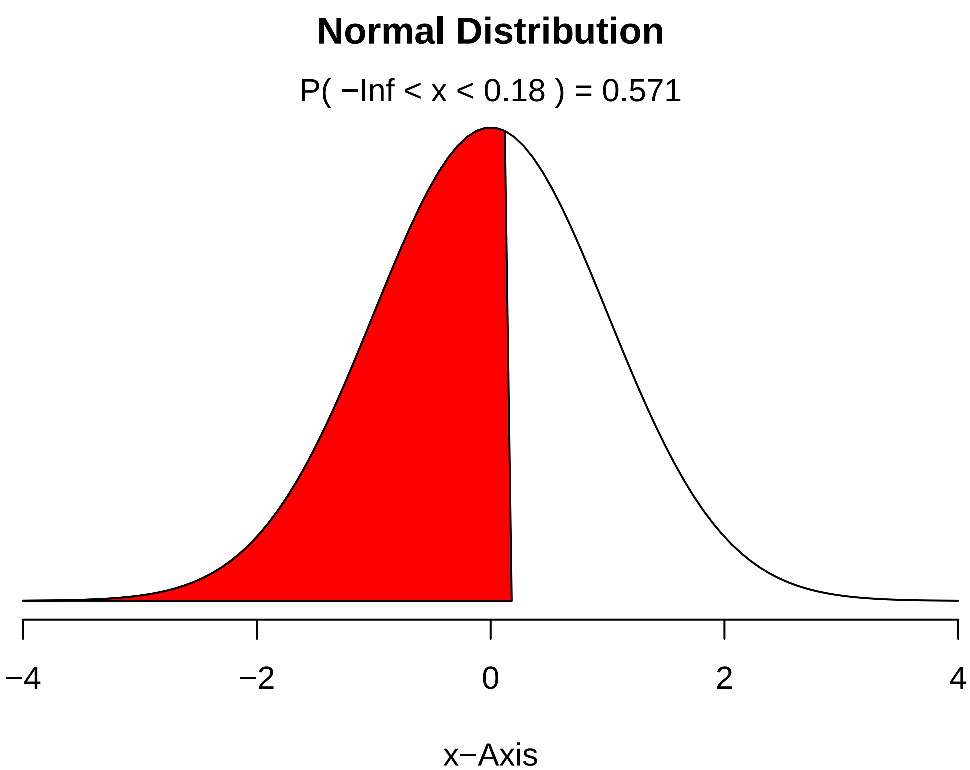
```
pnorm(q = -1.13, mean = 0, sd = 1, lower.tail = FALSE)
```

```
## [1] 0.8707619
```

(b) $Z < 0.18$

Graph of the distribution

```
normalPlot(bounds = c(-Inf,0.18), tails = FALSE)
```



Probability

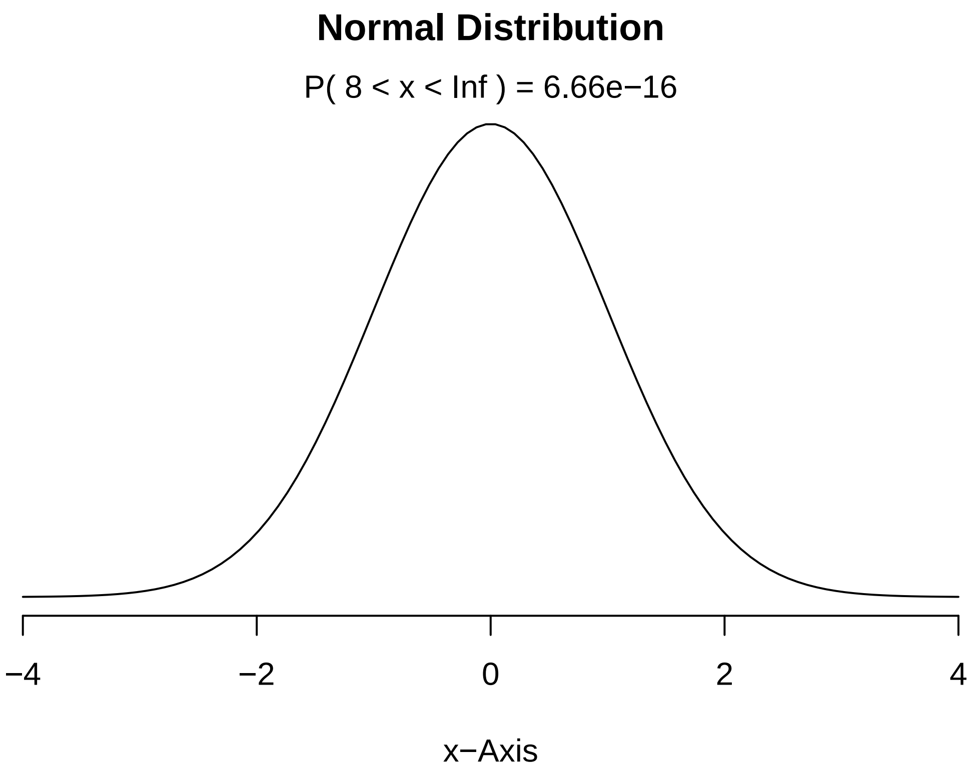
```
pnorm(q = 0.18, mean = 0, sd = 1, lower.tail = TRUE)
```

```
## [1] 0.5714237
```

(c) $Z > 8$

Graph of the distribution

```
normalPlot(bounds = c(8, Inf), tails = FALSE)
```



Probability calculation

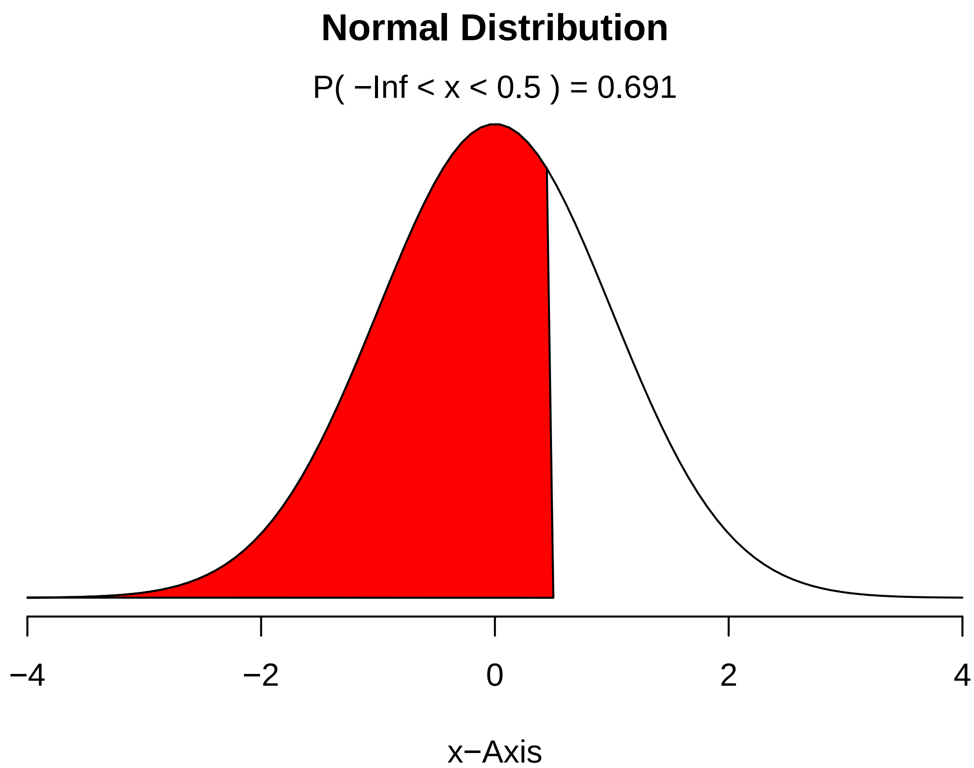
```r
pnorm(q = 8, mean = 0, sd = 1, lower.tail = FALSE)
```

```
## [1] 6.220961e-16
```

(d) $|\mathbf{Z}| < \mathbf{0.5}$

Graph of the distribution

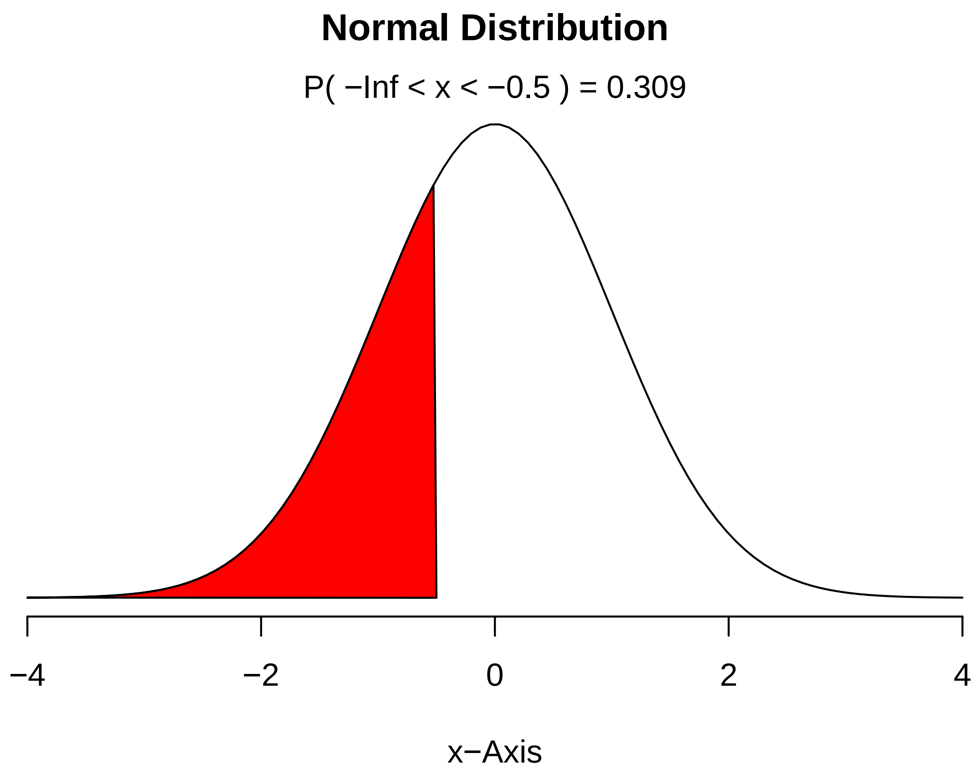
```r
normalPlot(bounds = c(-Inf, 0.5), tails = FALSE)
```




```
Part1 <- pnorm(q = 0.5 , mean = 0, sd = 1, lower.tail = TRUE)
```

Graph of the Distribution

```
normalPlot(bounds = c(-Inf, -0.5), tails = FALSE)
```




```
Part2 <- pnorm(q = -0.5 , mean = 0, sd = 1, lower.tail = TRUE)
```

Total probability

```
Part1 + Part2
```

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

Question 2

Answer

(a)

Let M represent the finishing times of Men and W represent the finishing times of Women,

M ~ N(4313, 583) W ~ N(5261, 807)

```
meanM <- 4313
sdM <- 583

meanW <- 5261
sdW <- 807
```

3.4 Triathlon times, Part I. In triathlons, it is common for racers to be placed into age and gender groups. Friends Leo and Mary both completed the Hermosa Beach Triathlon, where Leo competed in the *Men, Ages 30 - 34* group while Mary competed in the *Women, Ages 25 - 29* group. Leo completed the race in 1:22:28 (4948 seconds), while Mary completed the race in 1:31:53 (5513 seconds). Obviously Leo finished faster, but they are curious about how they did within their respective groups. Can you help them? Here is some information on the performance of their groups:

- The finishing times of the *Men, Ages 30 - 34* group has a mean of 4313 seconds with a standard deviation of 583 seconds.
- The finishing times of the *Women, Ages 25 - 29* group has a mean of 5261 seconds with a standard deviation of 807 seconds.
- The distributions of finishing times for both groups are approximately Normal.

Remember: a better performance corresponds to a faster finish.

(a) Write down the short-hand for these two normal distributions.
(b) What are the Z-scores for Leo's and Mary's finishing times? What do these Z-scores tell you?
(c) Did Leo or Mary rank better in their respective groups? Explain your reasoning.
(d) What percent of the triathletes did Leo finish faster than in his group?
(e) What percent of the triathletes did Mary finish faster than in her group?
(f) If the distributions of finishing times are not nearly normal, would your answers to parts (b) - (e) change? Explain your reasoning.

Figure 2: Question 2

(b)

```r
Leoz <- (4948 - meanM)/sdM
Maryz <- (5513 - meanW)/sdW
```

The z-score for Leo is: 1.0891938 The z-score for Mary is: 0.3122677

Both z scores indicate that the times for Mary and Leo are both above the mean with Leo's being more above the mean (one standard deviation above the mean)

(c)

Since the larger the number of seconds, the worse the performance, Mary performed better in her group since while both were above the mean, Mary was less above the mean. ### (d)

```r
probLeo <- pnorm(q=4908, mean = meanM, sd = sdM, lower.tail = FALSE)
percent(probLeo, 2)
```

```
## [1] 15.37%
```

(e)

```r
probMary <- pnorm(q=5513, mean = meanW, sd = sdW, lower.tail = FALSE)
percent(probMary,2)
```

```
## [1] 37.74%
```

(f)

Even if the distributions were not nearly normal, they can be approximated to Normal with sufficient sample size so I would expect the answers to be similar.

Question 3

3.18 Heights of female college students. Below are heights of 25 female college students.

1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25
54,	55,	56,	56,	57,	58,	58,	59,	60,	60,	60,	61,	61,	62,	62,	63,	63,	63,	64,	65,	65,	67,	67,	69,	73

(a) The mean height is 61.52 inches with a standard deviation of 4.58 inches. Use this information to determine if the heights approximately follow the 68-95-99.7% Rule.

(b) Do these data appear to follow a normal distribution? Explain your reasoning using the graphs provided below.

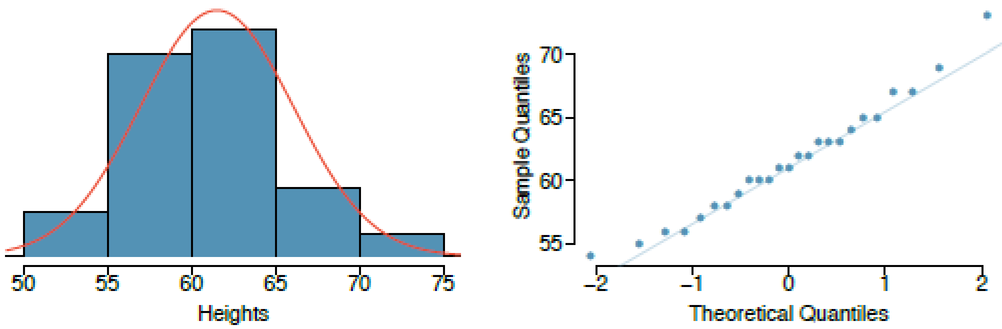


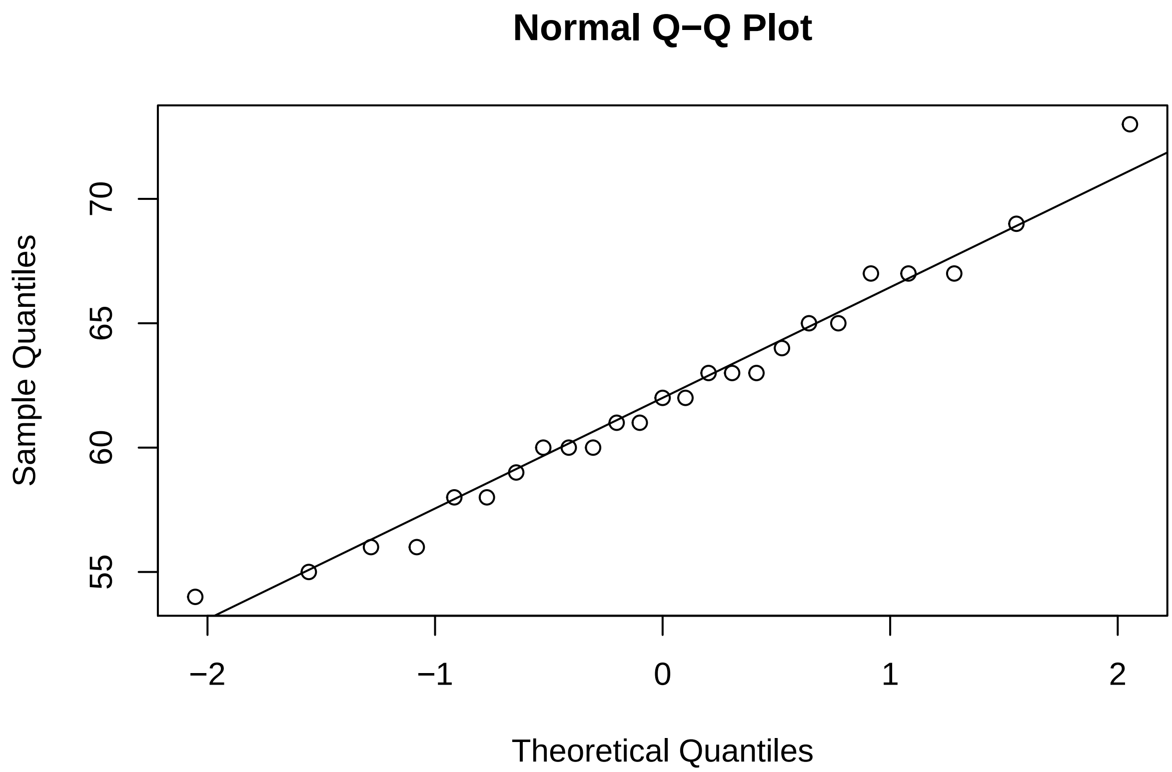
Figure 3: Question 3

Answer

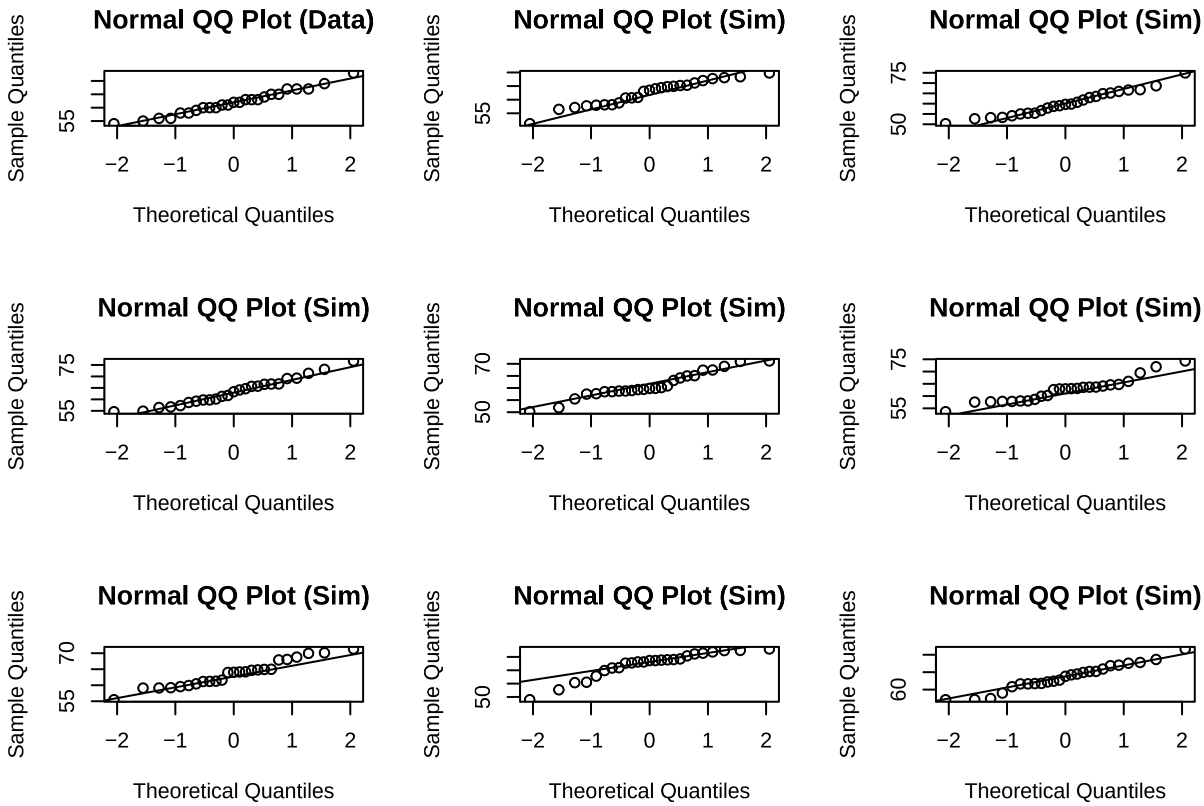
(a)

```r
data3 <- c(54,55,56,56,67,58,58,59,60,60,60,61,61,62,62,63,63,63,64,65,65,67,67,69,73)

qqnorm(data3)
qqline(data3)
```




```r
qqnormsim(data3)
```



(b) Yes the data seems to approximate the normal distribution. The histogram is somewhat bell-shaped and the points follow the line closely.

Question 4

3.22 Defective rate. A machine that produces a special type of transistor (a component of computers) has a 2% defective rate. The production is considered a random process where each transistor is independent of the others.

(a) What is the probability that the 10^{th} transistor produced is the first with a defect?

(b) What is the probability that the machine produces no defective transistors in a batch of 100?

(c) On average, how many transistors would you expect to be produced before the first with a defect? What is the standard deviation?

(d) Another machine that also produces transistors has a 5% defective rate where each transistor is produced independent of the others. On average how many transistors would you expect to be produced with this machine before the first with a defect? What is the standard deviation?

(e) Based on your answers to parts (c) and (d), how does increasing the probability of an event affect the mean and standard deviation of the wait time until success?

Figure 4: Question 4

Answer

(a)

```r
((1-0.02)^9)* 0.02
```

```
## [1] 0.01667496
```

(b)

```r
((1-0.02)^100)* 0.02
```

```
## [1] 0.002652391
```

(c)

```r
avg1 <- 1/0.02
sd1 <- sqrt((1-0.02)/(0.02^2))
```

Mean is 50 Sd is 49.4974747

(d)

```r
avg2 <- 1/0.05
sd2 <- sqrt((1-0.05)/(0.05^2))
```

Mean is 20 Sd is 19.4935887

(e)

Increasing the probability reduces the mean wait time until success and also reduces the sd.

Question 5

3.38 Male children. While it is often assumed that the probabilities of having a boy or a girl are the same, the actual probability of having a boy is slightly higher at 0.51. Suppose a couple plans to have 3 kids.

(a) Use the binomial model to calculate the probability that two of them will be boys.

(b) Write out all possible orderings of 3 children, 2 of whom are boys. Use these scenarios to calculate the same probability from part (a) but using the addition rule for disjoint outcomes. Confirm that your answers from parts (a) and (b) match.

(c) If we wanted to calculate the probability that a couple who plans to have 8 kids will have 3 boys, briefly describe why the approach from part (b) would be more tedious than the approach from part (a).

Figure 5: Question 5

Answer

X ~ B(3, 0.51)

(a)

P (X = 2)

```
dbinom(2, 3, 0.51)
```

```
## [1] 0.382347
```

(b)

The possibilities: BBG, BGB or GBB

```
BBG <- (dbinom(1,1,0.51) * dbinom(1,1,0.51) * dbinom(0,1,0.51))*3
BBG
```

```
## [1] 0.382347
```

The probabilities match

(c)

The approach from part B involves first writing out the possible combinations with 8 instead of three increasing the complexity. Part A does not require this, the calculation can be done in one step.

Question 6

3.42 Serving in volleyball. A not-so-skilled volleyball player has a 15% chance of making the serve, which involves hitting the ball so it passes over the net on a trajectory such that it will land in the opposing team's court. Suppose that her serves are independent of each other.

(a) What is the probability that on the 10^{th} try she will make her 3^{rd} successful serve?

(b) Suppose she has made two successful serves in nine attempts. What is the probability that her 10^{th} serve will be successful?

(c) Even though parts (a) and (b) discuss the same scenario, the probabilities you calculated should be different. Can you explain the reason for this discrepancy?

Figure 6: Question 6

Answer

Negative Binomial

(a)

10th try 3rd success p 0.15

```r
choose(9,2)* (0.15^3) *((1-0.15)^(10-3))
```

```
## [1] 0.03895012
```

(b)

```r
dbinom(1,1,0.15)
```

```
## [1] 0.15
```

(C)

Part b only asks what the probability is that the 10th serve will be successful. It was already understood that 2 serves were made in the first nine. Part a asks for the probability that the 3rd sucess will be made on the tenth try without giving the assumption that the two were already made in the nine serves.