

# Appendix

Luke Coughlin

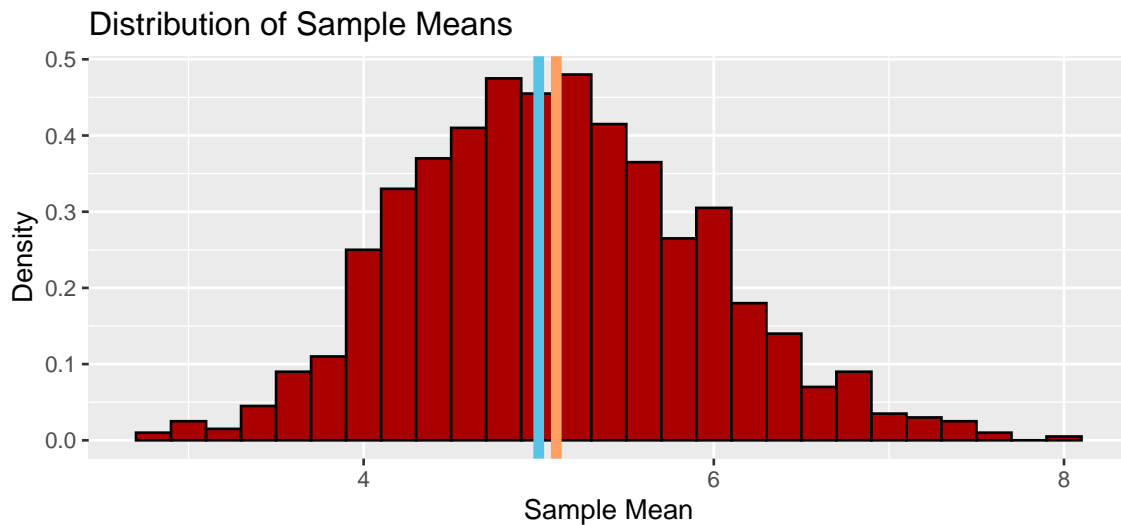
5/30/2020

```
## ----setup, include=FALSE-----
knitr::opts_chunk$set(echo = FALSE)

## ----Load_Libraries, message = FALSE-----
library(tidyverse); library(gridExtra)
phi <- (1+sqrt(5))/2 #For dimensions

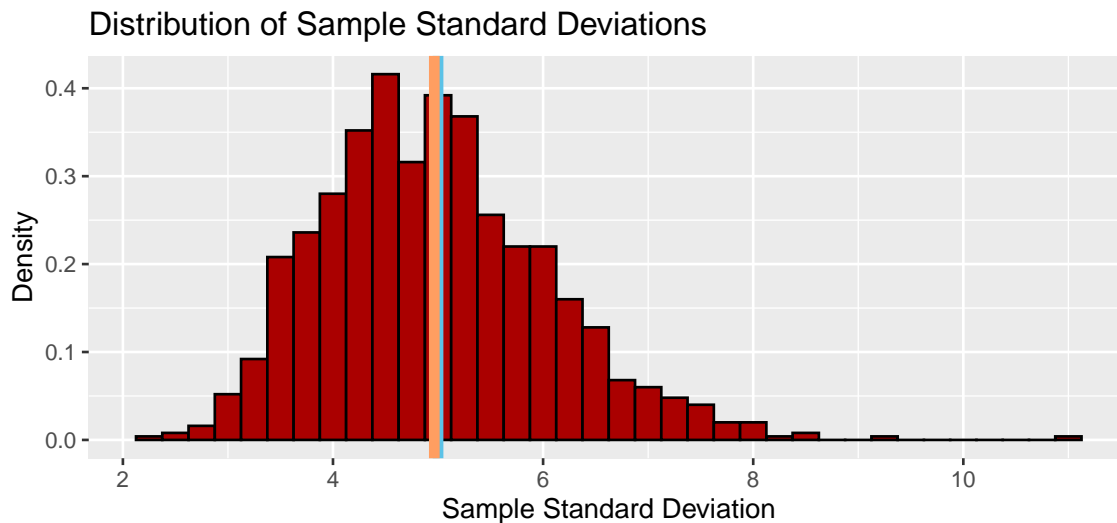
## ----Simulation-----
set.seed(1618033)
n <- 40
sims <- 1000
l <- 0.2 #lambda
multipleObs <- matrix(rexp(n*sims, l), sims, n)
means <- apply(multipleObs, 1, mean)
sds <- apply(multipleObs, 1, sd)

## ----Histogram_of_Sample_Means, fig.height= 3, fig.width = 3*phi-----
muplot <- ggplot(data.frame(x = means), aes(x)) +
  geom_histogram(binwidth = 0.2, aes(y = ..density..),
    fill = "#AA0000", colour = "#000000") +
  labs(x = "Sample Mean", y = "Density") +
  ggtitle("Distribution of Sample Means")
muplot + geom_vline(xintercept = 1/l, lwd = 2, colour = "#5BC2E7") +
  geom_vline(xintercept = mean(means), lwd = 2, colour = "#FF9E61")
```



```
## ----Histogram_of_sds, fig.height= 3, fig.width = 3*phi-----
plot <- ggplot(data.frame(x = sds), aes(x)) +
  geom_histogram(binwidth = 0.25, aes(y = ..density..),
    fill = "#AA0000", colour = "#000000") +
  geom_vline(xintercept = 1/l, lwd = 2, colour = "#5BC2E7") +
  geom_vline(xintercept = mean(sds), lwd = 2, colour = "#FF9E61") +
  labs(x = "Sample Standard Deviation", y = "Density") +
  ggtitle("Distribution of Sample Standard Deviations")
```

plot



```
## ----Outlier_Row-----
multipleObs[sds > 10,]
```

```
## [1] 1.1115223 69.5594991 2.5845742 4.1456691 0.9881980 0.5764390
## [7] 10.8931832 15.0100879 5.7394382 6.7351328 5.6811038 3.2551634
## [13] 2.9895914 1.7589532 1.1060825 1.1251588 0.2900541 1.2472671
## [19] 10.5095757 2.2223170 5.0132533 2.6577173 7.1168531 2.3240154
## [25] 1.9439511 3.7382340 10.2663309 2.2563026 3.0793852 1.1044089
## [31] 4.5625495 9.5708496 6.3844310 17.5178723 5.6246395 4.6515142
## [37] 2.4609859 0.9532821 0.2766272 0.2400065
```

```
## ----Exp_Dist-----
exsam <- rexp(sims,1)

## ----Plot_Densities, fig.height= 3, fig.width = 3*phi-----
explot <- ggplot(data.frame(x = exsam), aes(x))+
  geom_density(lwd = 2) +
  labs(x = "Value of Sample Data Points", y = "Density") +
  ggtitle("Exponential Distribution")
g1 <- explot +
  geom_vline(xintercept = mean(exsam),
    colour = "#FF0000", lwd = 2) +
  geom_vline(xintercept = median(exsam),
    colour = "#5BC2E7", lwd = 2)

CLTplot <- ggplot(data.frame(x = means), aes(x)) +
  geom_density(lwd = 2) +
  labs(x = "Sample Means", y = "Density") +
  ggtitle("Sample Mean Distribution")
g2 <- CLTplot +
  geom_vline(xintercept = mean(means),
```

```

    colour = "#FF0000", lwd = 2) +
    geom_vline(xintercept = median(means),
              colour = "#5BC2E7", lwd = 2)

```

```

grid.arrange(g1, g2, ncol = 2)

```

