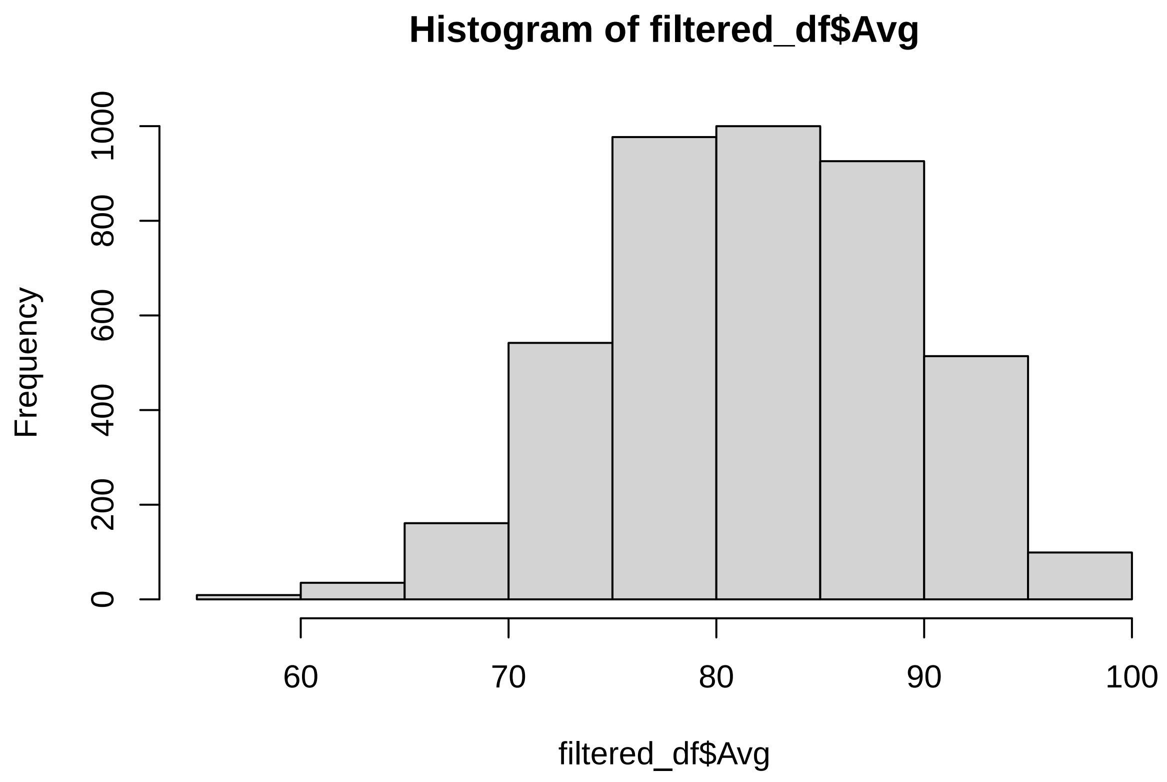
# STAT 344 Group Project - Appendix: R Code

## Reading in Data

```r
all_data_files = list.files("data")
all_df = read.csv(paste0("data/", all_data_files[1]))

for (i in 2 : length(all_data_files)) {
  all_df = rbind(all_df, read.csv(paste0("data/", all_data_files[i])))
}

filtered_df = all_df %>% filter(Section == "OVERALL") %>%
  mutate(CourseNum = ifelse(
    is.na(Detail), Course, paste0(Course, Detail)
  )) %>%
  select(-Campus, -Year, -Session, -Section, -Professor, -Course, -Detail)

N = nrow(filtered_df)
set.seed(2630)
filtered_df %>% slice(sample(N, 10))
```

```
##    Subject
## 1     ANTH
## 2     CPSC
## 3     ASTR
## 4     PPGA
## 5     ITST
## 6     PSYC
## 7     ASIA
## 8     FREN
## 9     MECH
## 10    LING
##                                                                      Title
## 1                                            Ethnography of Special Areas
## 2                                             Topics in Computer Systems
## 3                                                     Galactic Astronomy
## 4                                         Special Topics in Public Policy
## 5                                          Introduction to Italian Cinema
## 6                      Introduction to Biological and Cognitive Psychology
## 7                                      Introduction to Religions in Asia
## 8                                                          Women's Writing
## 9  Emerging Topics in Mechatronics, Manufacturing, Controls, and Automation
## 10                                    Linguistic Problems in a Special Area
##    Enrolled      Avg   Std.dev High Low X.50 X50.54 X55.59 X60.63 X64.67 X68.71
## 1        33 83.57576 12.922921   97  39    1      0      1      2      0      0
## 2          8 90.37500  3.739270   99   87    0      0      0      0      0      0
## 3          8 89.37500  5.527529   98   83    0      0      0      0      0      0
## 4         16 84.81250  1.869715   87   81    0      0      0      0      0      0
## 5         14 83.50000 15.776077   97   33    1      0      0      0      0      0
## 6       2122 71.86616 15.120886  100    0  120    118    150    151    176    234
## 7        101 66.33663 25.453989   95    0   22      1      2      5      2     10
## 8          9 78.44444 12.032364   90   52    0      1      0      0      0      0
## 9         13 83.07692  6.664102   91   71    0      0      0      0      0      2
## 10        10 87.20000  2.043961   91   86    0      0      0      0      0      0
##    X72.75 X76.79 X80.84 X85.89 X90.100 CourseNum
## 1       2      3      3      8      13      303D
## 2       0      0      0      5       3      538L
## 3       0      0      1      4       3      505B
## 4       0      0      6     10       0      591I
## 5       0      2      2      3       6       234
## 6     222    202    308    236     205       101
## 7       9     12     16     13       9       110
## 8       3      0      1      3       1       419
## 9       0      1      4      4       2      540A
## 10      0      0      0      8       2      530G
```

```r
histogram = hist(filtered_df$Avg)
```



```r
margin_of_error = 1 # desired width is 2%
sample_stdev_guess = 7 # intuitive guess since we don't have previous studies
```

```r
n1 = (1/(margin_of_error^2/(qnorm(0.975)^2*sample_stdev_guess^2) + 1/N)) %>% ceiling()
n1 # minimum sample size for the mean
```

```
## [1] 181
```

```r
margin_of_error = 0.05 # 2% width
conservative_squared_se = 0.5 * (1 - 0.5)
n2 = (1/(margin_of_error^2/(qnorm(0.975)^2*conservative_squared_se) + 1/N)) %>% ceiling()
n2 # minimum sample size for the proportion
```

```
## [1] 353
```

```r
n = max(n1, n2) # final decided sample size
n
```

```
## [1] 353
```

```r
set.seed(1)
srs = sample(filtered_df$Avg, n)
srs
```

```
##   [1] 74.56250 71.29213 91.22581 82.38462 75.32812 88.62500 90.33333 77.70563
##   [9] 93.63636 74.67647 78.22605 75.90698 82.68966 83.72727 83.57576 83.21176
##  [17] 75.77686 76.36039 86.11111 91.98361 62.62740 86.45455 76.51220 69.29897
##  [25] 84.25000 83.87619 81.00000 80.87143 93.33333 90.90000 75.72131 90.20833
##  [33] 78.67857 72.79200 83.06897 81.03704 75.95000 78.44578 66.02703 80.45238
##  [41] 81.35294 81.75000 85.73620 73.94118 87.06780 85.92683 86.07143 80.51515
##  [49] 91.38462 95.75000 79.85714 75.74747 84.56250 75.88889 91.58333 86.65000
##  [57] 76.47059 92.33333 83.11111 90.69565 71.75000 84.98291 79.82143 87.87500
##  [65] 79.30000 82.53191 82.73256 87.57143 89.92683 80.47619 95.19048 75.70968
##  [73] 88.13228 92.00000 74.70992 71.26263 82.66667 92.50000 77.78571 76.13793
##  [81] 87.58333 79.35435 86.69444 74.53982 93.10000 72.71951 93.66667 90.72727
##  [89] 80.63158 90.87500 69.23427 76.96667 69.82143 87.30000 68.88806 90.55556
##  [97] 80.44928 76.21818 72.16667 85.70588 85.88889 83.40441 93.02128 87.37500
## [105] 88.07317 85.54545 79.70513 81.17290 78.73077 80.45000 71.55556 79.50000
## [113] 77.26667 72.25989 84.60000 60.23077 91.27273 83.31250 87.26316 84.89062
## [121] 83.45238 88.54545 95.61538 88.64474 80.14545 81.80952 73.81690 78.90625
## [129] 74.73585 73.81767 67.89908 92.25000 81.10526 85.45161 88.30000 78.05882
## [137] 74.00000 75.92000 95.50000 94.14286 81.72308 73.29412 85.64286 84.80645
## [145] 88.00000 84.33333 88.55556 80.25000 88.65714 72.52941 69.92453 84.71429
## [153] 87.23077 79.77778 84.55556 89.83333 88.20000 78.57143 86.46667 72.50000
## [161] 82.13043 86.65217 76.41917 78.73077 78.76471 78.38095 82.10169 89.16667
## [169] 71.21429 75.18919 88.64706 72.67188 80.32967 76.21164 84.00000 77.33333
## [177] 90.36735 89.94737 91.66667 84.67188 74.38596 81.08537 78.59633 81.59259
## [185] 79.02386 84.95652 79.47917 87.65049 90.37037 87.00000 76.80000 93.50000
## [193] 84.66667 68.99180 73.65000 78.85106 74.17391 69.49717 69.74555 90.64815
## [201] 89.15385 82.28571 82.15686 81.13136 88.71429 84.28889 76.22222 89.04545
## [209] 71.17391 95.85417 88.80645 96.71429 78.74336 72.97500 92.88889 87.33333
## [217] 79.41463 84.81818 85.87097 76.30078 71.94118 81.04167 85.58621 71.67347
## [225] 92.20000 74.98361 96.75000 82.19444 85.10000 70.04762 92.64286 70.05714
## [233] 72.53333 81.22526 90.57143 81.58000 75.14815 74.10968 89.37037 87.14286
## [241] 84.40000 70.92500 83.96364 75.02899 89.50000 84.60000 66.71111 90.00000
## [249] 81.44444 89.18349 88.40000 84.57143 75.34545 86.24561 91.27500 80.83721
## [257] 80.72047 70.31959 90.20000 85.41176 72.18182 76.77778 73.60934 81.29249
## [265] 79.63804 80.84615 92.00000 85.37037 83.36559 82.62500 70.70492 81.16667
## [273] 71.16522 85.52632 66.55882 90.71429 93.35714 76.09091 85.66667 96.17647
## [281] 79.58824 88.09677 72.07143 89.00000 81.34783 94.00000 77.15385 85.56250
## [289] 79.92857 86.01852 83.00000 74.04167 72.73050 75.93220 80.81250 92.08696
## [297] 70.98392 88.60000 78.57642 72.31925 79.53333 78.87160 83.54902 73.92308
## [305] 75.66935 75.36538 95.75000 88.02353 86.66667 92.25000 91.00000 78.37500
## [313] 83.00000 67.23684 76.49123 82.36364 87.28571 84.84848 71.00000 77.00388
## [321] 86.85507 87.68182 77.37500 84.41667 84.33333 81.49287 88.93548 90.10000
## [329] 82.16667 58.03279 91.14815 71.92000 82.66667 75.73973 79.37838 77.55422
## [337] 88.00000 75.29787 67.70588 86.53333 94.26667 78.47619 82.44186 80.50000
## [345] 77.81720 76.87912 84.96392 85.30508 85.00000 80.04639 75.21212 94.65000
## [353] 91.93960
```

SRS for mean:

```
sample_mean = mean(srs); sample_mean
```

```
## [1] 81.89962
```

```
sample_se = sqrt((1-n/N)*sd(srs)^2/n); sample_se
```

```
## [1] 0.3723216
```

```
ci_lb = sample_mean - qnorm(0.975)*sample_se
ci_ub = sample_mean + qnorm(0.975)*sample_se

conf_int = c(ci_lb, ci_ub)
c("Confidence Interval for Average UBC Grades Across All Classes in 2021",
  "Winter Using Simple Random Sample",
  conf_int)
```

```
## [1] "Confidence Interval for Average UBC Grades Across All Classes in 2021"
## [2] "Winter Using Simple Random Sample"
## [3] "81.169882922767"
## [4] "82.6293567986551"
```

SRS for proportion of grades above 90%:

```
p_hat = length(srs[srs >= 90]) / n; p_hat
```

```
## [1] 0.1558074
```

```
se_p_hat = sqrt((1 - n / N) * (p_hat * (1 - p_hat)) / n); se_p_hat
```

```
## [1] 0.01848665
```

```
conf_int_p_hat = p_hat + c(-1, 1) * qnorm(0.975) * se_p_hat
c("Confidence Interval for Proportion of UBC Grades",
  "above 90% Across All Classes in 2021",
  "Winter Using Simple Random Sample",
  conf_int_p_hat)
```

```
## [1] "Confidence Interval for Proportion of UBC Grades"
## [2] "above 90% Across All Classes in 2021"
## [3] "Winter Using Simple Random Sample"
## [4] "0.119574204578259"
## [5] "0.192040526299928"
```

Preprocessing before stratifying:

```
process_faculty = function(faculty) {
  if (faculty == "Faculty of Arts" |
      faculty == "Faculty of Education") {
    return ("arts")
  } else if (faculty == "Faculty of Science" |
             faculty == "Faculty of Medicine") {
    return ("science")
  } else if (faculty == "Faculty of Applied Science") {
    return ("engineering")
  } else if (faculty == "Faculty of Comm and Bus Admin" |
             faculty == "Vancouver School of Economics") {
    return ("business")
  } else {
    return ("other")
  }
}
```

```
code2faculty = read.csv("summary.csv") %>%
  mutate(Faculty = Vectorize(process_faculty)(FacultyRaw)) %>%
  select(-Description, -FacultyRaw)
filtered_df = merge(code2faculty, filtered_df, by.x = "Subject")
```

```
counts = filtered_df %>% group_by(Faculty) %>%
  summarize(counts = length(Faculty)) %>% arrange(desc(counts))
```

Stratified sampling (proportional allocation):

```
stratas = counts$Faculty %>% as.vector()
num_stratas = length(stratas)
Nh = counts$counts
weights = Nh / N
nh = round(weights * n)

means = rep(0, num_stratas)
sd = rep(0, num_stratas)
props = rep(0, num_stratas)
```

```r
for (i in 1 : num_stratas) {
  subpopulation = filtered_df %>% filter(Faculty == stratas[i])
  sample = sample(subpopulation$Avg, nh[i])
  means[i] = mean(sample)
  sd[i] = sd(sample)
  props[i] = length(sample[sample >= 90]) / nh[i]
}

mean_average_str = sum(weights * means)
prop_str = sum(weights * props)

se = sd / sqrt(nh) * sqrt(1 - nh / Nh)
se_mean_average_str = sqrt(sum(weights^2 * se^2))

se_props_squared = props * (1 - props) / nh * (1 - nh / Nh)
se_prop_str = sqrt(sum(weights^2 * se_props_squared))

ci_mean_str =
  mean_average_str + c(-1, 1) * qnorm(0.975) * se_mean_average_str
ci_prop_str =
  prop_str + c(-1, 1) * qnorm(0.975) * se_prop_str
```