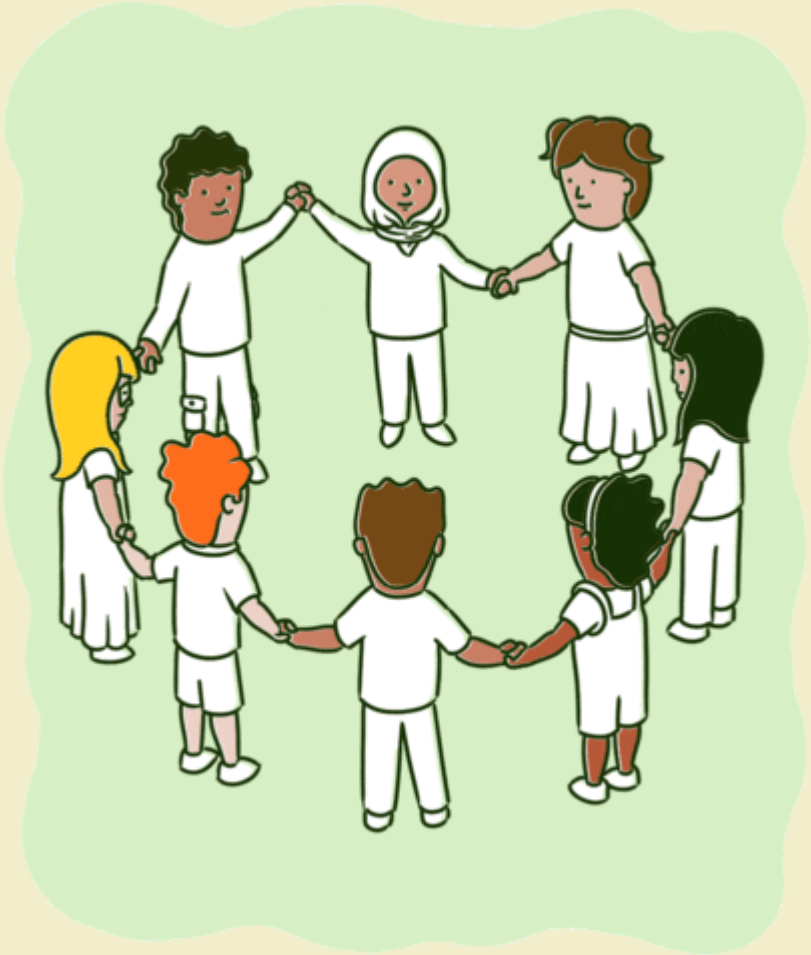
Review of Statistical Inference

Stat 230

March 30 2022

Your Turn 1

10:00



- Look for your group association in moodle
- Find your group mates, say hi and try to seat together
- Go to this google form
- Discuss your answer to the question posed in the next 4 slides, one by one.
- One member from a group enter the answer to questions

Question 1

What is the difference between a population and a sample? What is the difference between a parameter and a statistic?

- Give an example of a parameter and a statistic, using "common" notation for each.

Question 2

Suppose you are told a 95% confidence interval for the proportion of registered voters for Trump just before the 2020 election is 0.38 to 0.44.

- What does this mean?
- What is the margin of error for this CI?
- What does "95% confidence" mean?

Question 3

A study found that participants who spent money on others instead of themselves had significantly lower blood pressure (two-sided p-value=0.012).

- What are the hypotheses for this test?
- What does the p-value mean?

Question 4

Inference methods rely on understanding the **sampling distribution** of the statistic that we used to estimate our unknown parameter.

- What does the sampling distribution of the sample mean look like?
- What does the standard error of the sample mean measure?
- How is the sampling distribution used in a hypothesis test?
- How is it used with confidence intervals?

Data Analysis Plan

1. Data: load and clean/manipulate (if needed)
2. EDA: exploratory data analysis
3. Inference: run tests/CIs and check assumptions!
4. Conclusion: interpret results, avoid lots of stats jargon!

Real-life Data: `agstrat`

Data from a stratified random sample of size 300 from the U.S. 1992 Census of Agriculture.

Type	Variable Description
`Sampling`	counties
`Strata`	region (North Central, Northeast, South, West)
`response`	number of farms in 1992 (farms92)

Do the average number of farms per county differ in the western and north central regions in 1992?

Data available in the `SDaA` package

Read and inspect the data

```
agstrat <- read.csv("https://raw.githubusercontent.com/deepbas/statdatasets/main/agstrat.csv")
```

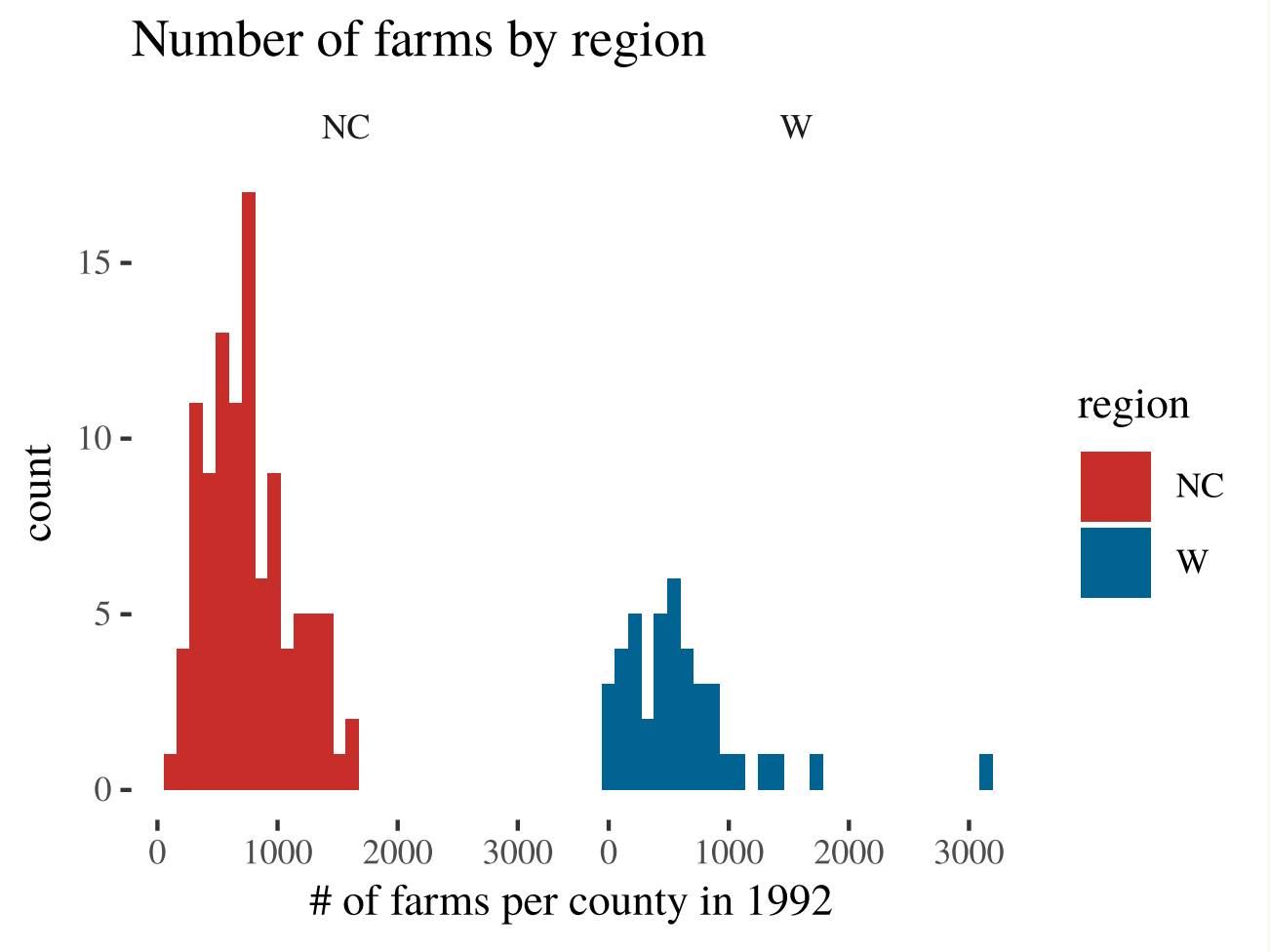
```
names(agstrat)
 [1] "county"   "state"    "acres92"  "acres87"  "acres82"  "farms92"
 [7] "farms87"  "farms82"  "largef92" "largef87" "largef82" "smallf92"
[13] "smallf87" "smallf82" "region"   "rn"       "weight"
```

```
table(agstrat$region)

 NC  NE   S   W
103  21 135  41
```

Faceted Histograms

```
library(ggthemes)
ggplot(agstrat2,
       aes(x = farms92,
           group= region)) +
  geom_histogram(aes(fill = region)) +
  facet_wrap(~region) +
  labs(title = "Number of farms by regi
       x = "# of farms per county in 19
  scale_fill_wsj()  # color ans fill sc
```



Summary stats by region

```
# 5-number summary + mean
tapply(agstrat2$farms92, agstrat2$region, summary)
$NC
   Min. 1st Qu.  Median    Mean 3rd Qu.    Max. 
   58.0   489.5   738.0   750.7   968.5  1669.0 

$W
   Min. 1st Qu.  Median    Mean 3rd Qu.    Max. 
   16.0   257.0   495.0   602.3   733.0  3157.0 
```

```
# std. deviation
tapply(agstrat2$farms92, agstrat2$region, sd)
       NC         W 
358.0873 558.1294 
```

Summary stats by region

We can also pipe (%>%) together `dplyr` commands to get the mean and sd of `farms92` grouped by `region`

`%>%` passes result on left into first argument of function on right

```
agstrat2 %>%
  group_by(region) %>%
  summarize(mean(farms92), sd(farms92))
# A tibble: 2 × 3
  region `mean(farms92)` `sd(farms92)`
  <chr>            <dbl>         <dbl>
1 NC                751.          358.
2 W                 602.          558.
```

05:00

Your Turn 2

Please download the class activity 2 .Rmd file from moodle and save it into your course project folder. Work in a group to answer the following questions.

Filter the West and North Central data

Make a boxplot and faceted histograms as you were shown in the previous slides.

05:00

Your Turn 3

Discuss how would you answer these questions with your group.

- What county has the unusually high number of farms in the western region?
- How many farms do they have?
- Any ideas why it is so large?
- How do the summary stats change when this county is omitted?

Outlier

```
which(agstrat2$farms92 > 3000)
[1] 118
```

```
agstrat2[118,]  # see row 118
           county state acres92 acres87 acres82 farms92 farms87 farms82
118 HAWAII COUNTY    HI  926607 1007287 1172448    3157    2810    2539
    largef92 largef87 largef82 smallf92 smallf87 smallf82 region  rn   weig
118       55       60       58     1960     1602     1468      W 142 10.292
```

```
slice(agstrat2, 118) # another way to see row 118
          county state acres92 acres87 acres82 farms92 farms87 farms82 large
1 HAWAII COUNTY    HI  926607 1007287 1172448    3157    2810    2539
  largef87 largef82 smallf92 smallf87 smallf82 region  rn   weight
1       60       58     1960     1602     1468      W 142 10.29268
```

Redo without outlier

```
agstrat2_noOutlier  <- agstrat2 %>%
  slice(-118) # remove row 118
```

```
agstrat2_noOutlier  %>%
  group_by(region) %>%  # group by region
  summarize(mean(farms92), sd(farms92), median(farms92), IQR(farms92))
# A tibble: 2 × 5
  region `mean(farms92)` `sd(farms92)` `median(farms92)` `IQR(farms92)`
  <chr>            <dbl>         <dbl>             <dbl>           <dbl>
1 NC               751.          358.               738             479
2 W                538.          385.               492.            464
```

Statistical Inference

After understanding the dataset better, we would like to infer useful information from the data using **statistical tests**.

- Use a relatively small sample of data to infer about the population
- May have to do extensive data cleaning and outlier detection and removal on a case-by-case basis

Statistical Inference: `t-test`

```
t.test(farms92 ~ region, data = agstrat2)

    Welch Two Sample t-test

data:  farms92 by region
t = 1.5775, df = 53.618, p-value = 0.1206
alternative hypothesis: true difference in means between group NC and group
95 percent confidence interval:
 -40.22256 336.89885
sample estimates:
mean in group NC  mean in group W
        750.6796          602.3415
```

Statistical Inference

```
t.test(farms92 ~ region, data = agstrat2_noOutlier)

    Welch Two Sample t-test

data:  farms92 by region
t = 3.0179, df = 66.775, p-value = 0.003601
alternative hypothesis: true difference in means between group NC and group
95 percent confidence interval:
  71.8464 352.5628
sample estimates:
mean in group NC  mean in group W
        750.6796          538.4750
```

03:00

Your Turn 4

Run the t-test with and without the outlier and answer the given questions

Do the average number of farms per county differ in the western and north central regions in 1992?