Lecture 4 Exercises

Isabel Fulcher

8/9/2018

Load packages

```
library("tidyverse") #ggplot2, dplyr, etc.
library("reshape2") #need this for melt()
library("car") #contains dataset
```

Part I: Basic data analysis using tidyverse

Open the Blackmore dataset in R. This contains data on 138 teenaged girls hospitalized for eating disorders and 98 control subjects. There are four variables: subject id, age in years, hours per week of exercise, and group (control vs. eating-disorder). There are multiple observations per subject.

```
data(Blackmore)
head(Blackmore)
```

```
##   subject   age exercise   group
## 1     100  8.00     2.71 patient
## 2     100 10.00     1.94 patient
## 3     100 12.00     2.36 patient
## 4     100 14.00     1.54 patient
## 5     100 15.92     8.63 patient
## 6     101  8.00     0.14 patient
```

Key commands

Pick observations by their values with filter()

```
Blackmore %>% filter(group=="patient")

# You do not have to use piping, just makes it cleaner
filter(Blackmore,group=="patient")

# You can also just use base R
Blackmore[Blackmore$group=="patient",]
```

Pick variables by their names with select()

```
Blackmore %>% dplyr::select(subject,exercise)

#and in base R...
Blackmore[c("subject","exercise")]
```

Create new variables with functions of existing variables with mutate()

```
Blackmore %>% mutate(age_new = age^2)

#and in base R...
Blackmore$age_new = Blackmore$age^2
```

Collapse many values down to a single summary with summarise()

```
Blackmore %>% summarise(age_mean = mean(age),age_sd = sd(age))

#and in base R...
mean(Blackmore$age)
sd(Blackmore$age)
```

To only perform the summarise command on a subset use group_by()

```
Blackmore %>% group_by(group) %>% summarise(age_mean = mean(age),age_sd = sd(age))

#and in base R...
mean(Blackmore[Blackmore$group=="patient",]$age)
mean(Blackmore[Blackmore$group=="patient",]$age)
sd(Blackmore[Blackmore$group=="control",]$age)
sd(Blackmore[Blackmore$group=="patient",]$age)
```

Plotting with ggplot2

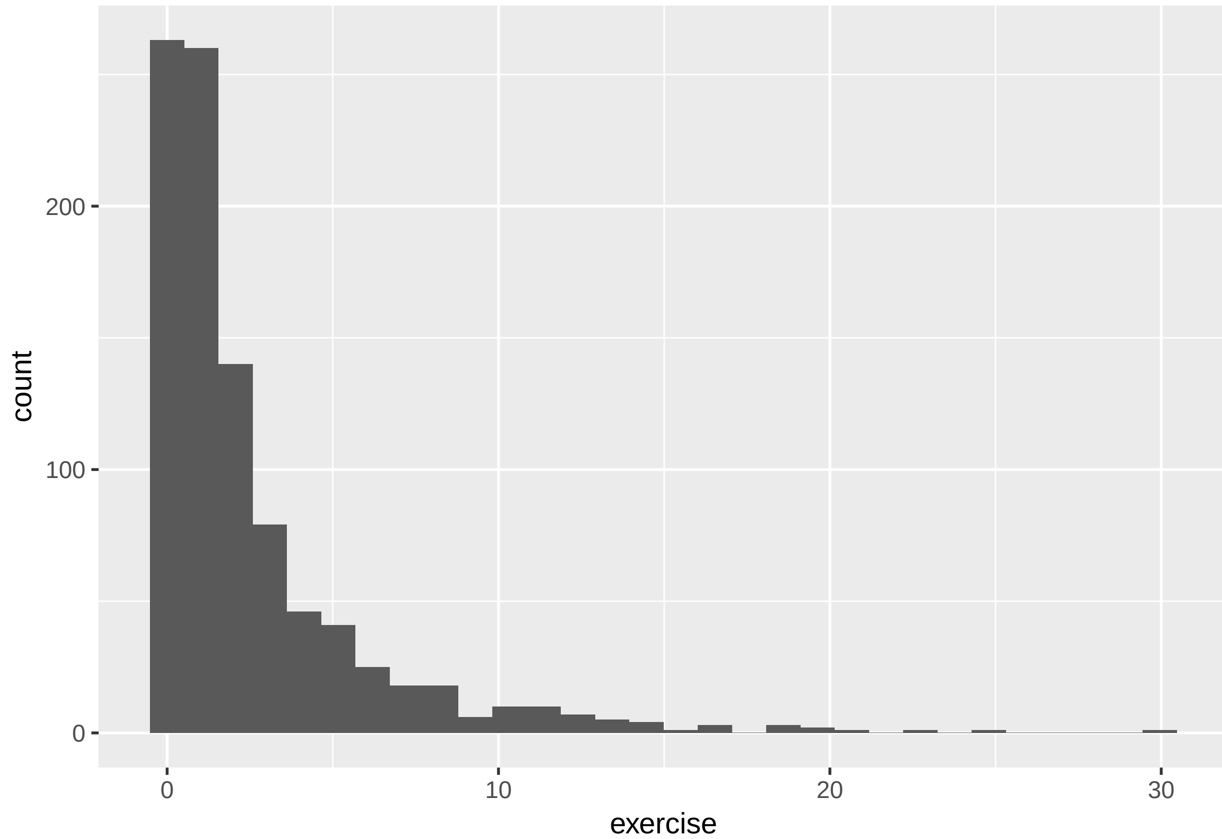
The basic idea

```
# Initialize the plot with data and aesthetics
p <- ggplot(data=NULL,mapping=aes(x=,y=,fill=,group=,color=))

# Add layers
p <- p + geom_histogram()

# Make pretty
p <- p + theme_bw() + labs(title="",x="",y="")
```

Example: Plot a histogram of hours per week of exercise across all observations.

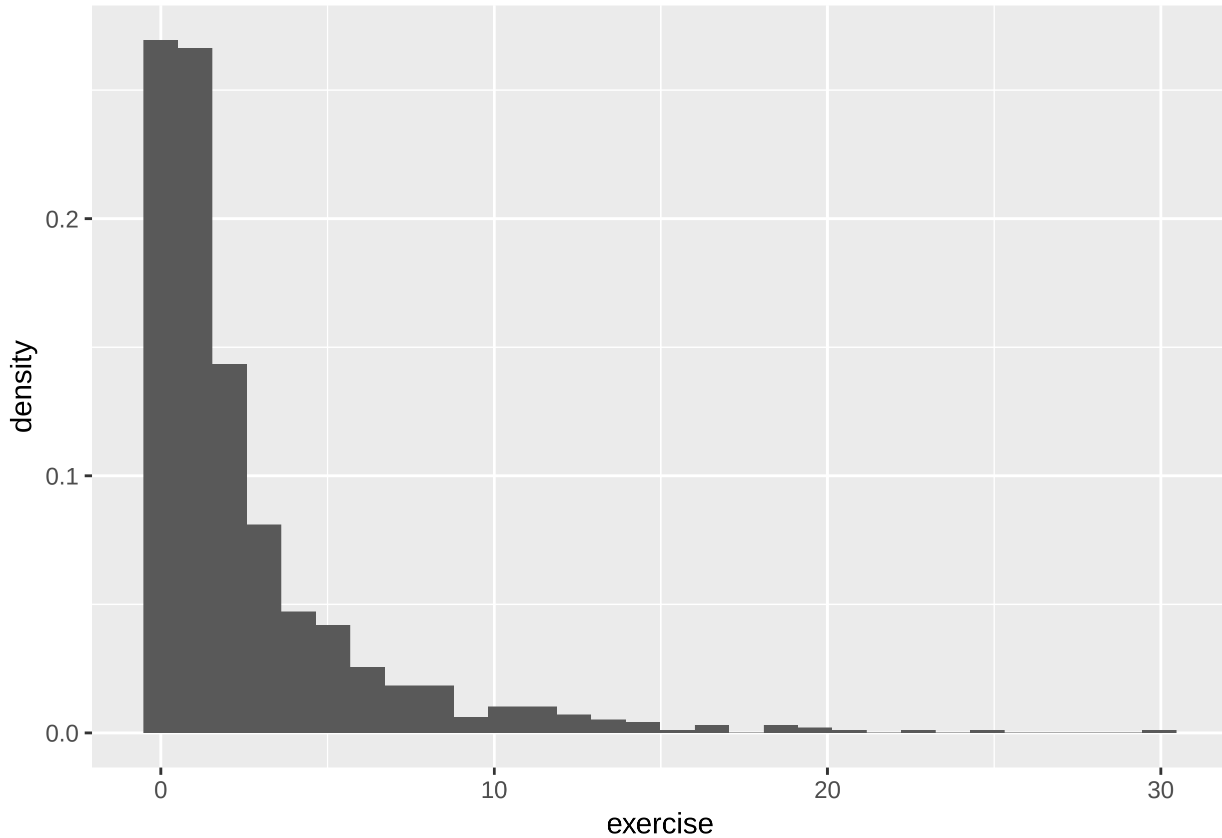
```
# Initialize the plot with data and aesthetics
p <- ggplot(Blackmore,aes(x=exercise))

# Add layer
p1 <- p + geom_histogram()
p1
```

```
## `stat_bin()` using `bins = 30`. Pick better value with `binwidth`.
```



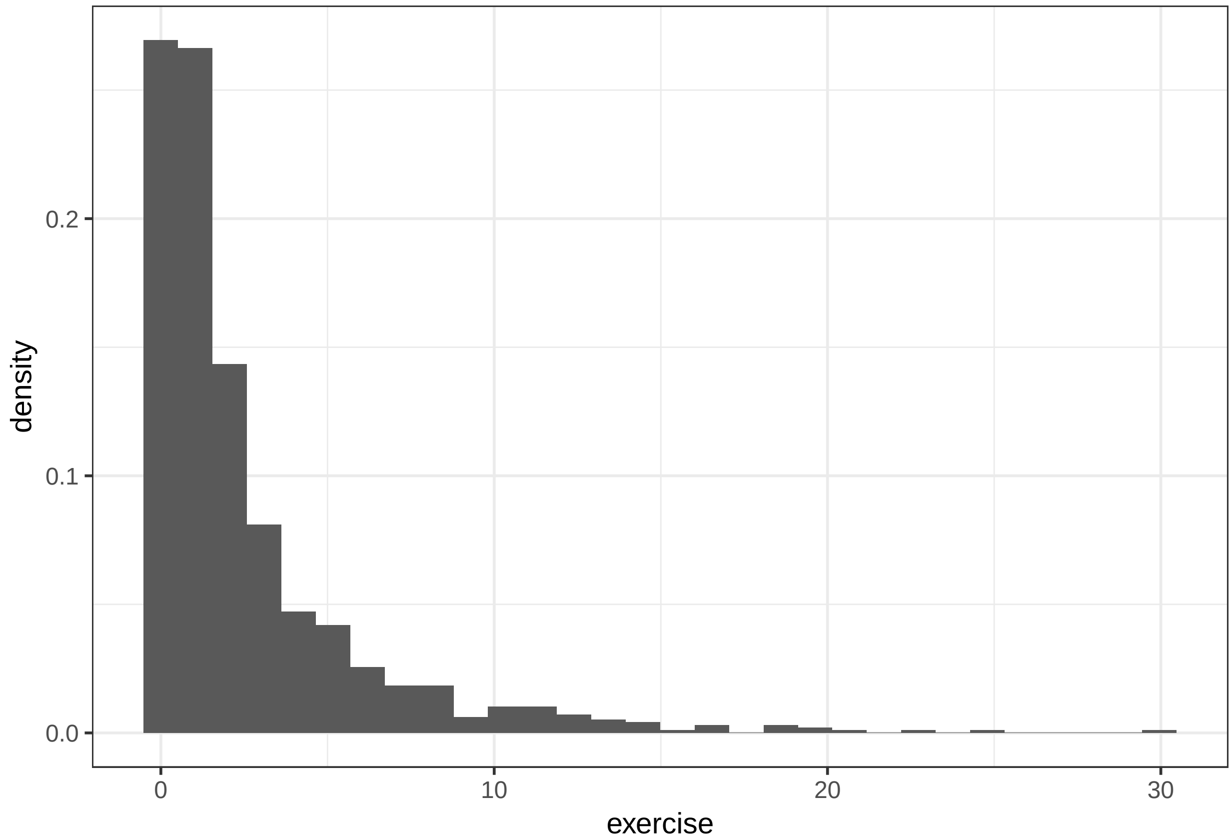

```r
p2 <- p + geom_histogram(aes(y=..density..))
p2
```

```
## `stat_bin()` using `bins = 30`. Pick better value with `binwidth`.
```




```r
# Make pretty
p2 + theme_bw()
```

```
## `stat_bin()` using `bins = 30`. Pick better value with `binwidth`.
```



Saving graphics

```
# Setting your working directory
setwd("your/file/path/here")

# Use ggsave
ggsave("plot_name.pdf",plot = p)
```

Part I: Exercises

1. Plot a line for each person that shows exercise at each age observation. Color the line by group.
2. Create a new data frame that only contains the subject id, group, and average exercise per person.
3. Using the data frame from question 2, plot two histograms of mean hours per week of exercise by group in the same figure.
4. Calculate the 95% confidence interval for the mean exercise hours for each group. The confidence interval is given by,

$$(\bar{X} - z_{.975}\sigma/\sqrt{n}, \bar{X} + z_{.975}\sigma/\sqrt{n})$$

To calculate $z_{.975}$, use a command we learned last class (hint: starts with a 'q' and ends with a 'norm'). You can use the estimated standard deviation in place of σ (for those of you who recognize that this is naughty, I'm unconcerned in this case becase n is large in each group).

5. Plot these two confidence intervals on the same plot using geom_errorbar()

Part II: Central Limit Theorem (CLT) exercise

The goal here is to illustrate the Central Limit Theorem. The Central Limit Theorem states that the sample mean will converge in distribution to a normal distribution. Given $X_1, ...X_n$ independent draws from some underlying distribution,

$$\frac{(\bar{X}_n - \mu)}{\sigma/\sqrt{n}} \rightarrow N(0,1)$$

1. Draw one random sample of size 100 from a Poisson distribution with event rate λ equal to 1.5. Use a histogram to display the empirical probability distribution. Include a vertical line indicating the sample mean using geom_vline().

```
set.seed(1567)
```

2. Draw 10,000 random samples of size 100 from a Poisson distribution with event rate λ equal to 1.5. Calculate the quantity on the left hand side of the above equation for each sample. Note that the poisson distribution has mean $E[X] = \mu = \lambda$ and $Var[X] = \sigma^2 = \lambda$.
3. Construct a histogram of the quantites from question 2.
4. On the figure from question 3, overlay the pdf of the normal distribution corresponding to the right hand side of the expression. Hint: use stat_function(fun=dnorm).
5. Now, repeat questions 2-4 using various sample sizes of $N = (5, 10, 25, 50, 100, 1000)$. You will want to collect all your results in one data frame for plotting.
6. Plot the results from question 5 in ONE figure (i.e. panel of six plots) using the facet_wrap() function. Depending on how you saved your results from 5, you may also need to use the melt() function to get your data frame into the appropriate format for ggplot2-ing.
7. Let's motivate how this relates to confidence intervals for the population mean! Calculate the confidence intevals for 100 random samples of size $n = 100$ from a Poisson distribution with λ equal to 1.5. Plot the confidence intervals and include a line for the true value of λ. How often is the true mean captured? Does this match expectations?

Tip: to make it easier to see which confidence intervals cover the true mean, you may want to sort or color the intervals.

```
set.seed(98)
```

8. Take a moment and interpret the implications from this exercise. How should we interpret a confidence interval?

Great references / more practice with tidyverse

- Hadley's R for Data Science book or website
- Specifically, the ggplot2 exercises
- Tidyverse cheatsheet by DataCamp