**Homework # 3:**

***Note: Please circle your answers as appropriate.***

***Remember - for all problems, show your work!***

Do ***NOT*** use R for problems 1 - 4.

**1)** You observe 9 birds sitting on a wire outside your window. 2 of them are juncos and 7 of them are chickadees (juncos and chickadees are different kinds of birds).

(a) How many different ways could your 9 birds line up on the wire?

For example, JJCCCCCCC is one arrangement, JCCJCCCCC is another arrangement, and so on.

You do NOT want to actually list all possible arrangements - instead, use what you learned in class to calculate this.

(b) Now suppose you saw 7 juncos and 2 chickadees. How many different arrangements can you get? *Does this make sense? Why or why not?*

(c) How many arrangements do you have for 5 juncos and 4 chickadees?

(d) How many arrangements do you have for 1 junco and 8 chickadees?

(e) How many arrangements do you have for 0 juncos and 9 chickadees?

**2)** Refer to problem (1). Suppose you now have 12 birds.

(a) How many arrangements do you have for 6 juncos and 6 chickadees?

(b) How many arrangements do you have for 1 junco and 11 chickadees?

(c) How many arrangements do you have for 0 juncos and 12 chickadees?

**3)** According to information collected from driver's licenses, about 53% of people in the U.S. have brown or black eyes. You randomly select 11 people. Calculate the following probabilities (let $Y$ = # of people with brown or black eyes):

a) $\Pr\{Y = 5\}$ b) $\Pr\{Y = 3\}$ c) $\Pr\{Y < 1\}$

d) The probability of at least one person with brown or black eyes (= $\Pr\{Y > 0\}$). *Hint - use (c) to answer this and* ***make sure you know why this works****)*

e) You have at least two people with blue eyes your sample ( = $\Pr\{Y > 1\}$). See (d) for a hint.

**4)** Refer to problem 3. Suppose you only had 3 people in your sample. Calculate the probability of every possible outcome (you need to do four calculations).

**5)** Let's learn some miscellaneous R (see instructions at end).

(a) Calculate 63! (b) Calculate 132! (c) Calculate 534!

(c) Refer to problem (1). Suppose you have 39 juncos and 53 chickadees (that's a lot of birds sitting outside your window!). How many different arrangements can you get?

(d) Refer to problem (1). Suppose now you have 1 junco and 3,333 chickadees. How many different arrangements can you get?

**6)** Let's do some more R....

Refer to problem 3, but let's suppose you had 13 people in your sample.

a) Use R to figure out the probability for every single possible outcome. In other words, you need to calculate:

Pr{0 people with brown eyes in a sample of 13}
Pr{1 person with brown eyes in a sample of 13}
.
. etc.
.
Pr{13 people with brown eyes in a sample of 13}

b) Once you have this information, you need to plot a barplot that shows you what this distribution looks like.

As you might guess, you'll need to use the binomial (in R) to solve this problem. Make sure you present all your results (you should have a list of ***probabilities and the barplot***).

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*Some R instructions to help you are on the next pages. Instructions for copying graphs in/from R are also included at the end.*

**For R problems:** be prepared to sketch or list your results. You may also be asked to show your graphs to the class using zoom or blackboard.

## ***Never just hand in a R printout: Clean it up:***

- **Clearly label everything**
- **Number your problems**
- **Circle your answers**
- **Annotate as needed**
- **Get rid of stuff that's not needed**
- **Etc.**

## ***You will not do very well if all you do is hand in a printout!***

**Remember: Copying answers from other students, web sites, previous classes or using AI is a violation of the honor code!!**

***Due in recitation Wednesday, June 10th.***

**R commands:**

**Caution:** Be careful copying and pasting commands into R. Some characters may not copy correctly and give you error messages. This is particularly true for quotes. R does not recognize quotes that look like ", only quotes that are straight like this: " . I tried to fix this below, but can't guarantee I caught everything.

*Factorials:*

Calculating factorials is pretty easy in R. Here's an example calculating 27!:

```
factorial(27)
```

and R should return 1.088887e+28

*Binomial coefficients:*

Using the binomial coefficient in R is just a bit more complicated since we need two numbers. Suppose we wanted to calculate $\binom{45}{13}$

In R we would do (make sure you put *n* first, or you'll just get 0):

```
choose(45,13)
```

and R should return 73006209045

*Binomial probabilities:*

Here's an example using beans instead of people. Suppose you had a jar with 32% black beans (the rest are white beans). Suppose you took a sample of size 8.

Based on this you should be able to modify the following as needed to answer question 6:

*For probabilities:*

Suppose you want the probabilities for 0 through 8 beans. First we need to create *y* with 8 numbers:

```
y <- c(0:8)
```

This command says to give "`y`" the numbers 0 - 8 in sequence; technically "`0:8`" tells R it's a sequence of numbers, and the "`c`" out front means to combine all the numbers. The "`c`" isn't really needed (try it!) this time, but it is required in many similar situations so it's a good habit to get into to.

Now we just "feed" our *y* into the binomial function to get our answers (assuming you have 32% black beans):

```
p <- dbinom( y, size = 8, prob = .32)
```

This should give you "p" with all the binomial probabilities (they'll be in order from 0 to 8; type "p" to get/see the probabilities)

If you want to make it look nice, you can do:

```
pr <- data.frame(y,p)
pr
```

to make it look even better, follow this with:

```
print(pr,row.names = FALSE)
```

The data.frame command combines the variables you list (in this case, y and p) into a single data set. Unfortunately if you then type "pr" R will insist on printing row names as well. If you want to get rid of the row names (they're not needed), you need to use the print statement as given above.

*Barplots:*

To get a barplot, you simply do:

```
barplot(p)
```

This won't look very nice, so you should try to improve it:

```
barplot(p,names.arg = y)
```

Here "names.arg" is the variable that holds the labels you want to put on the x axis (remember we put the numbers 0 - 8 into y). Just try it - you'll see how it works.

If you want to improve your graph even more, you can do (review the caution statement above if you have trouble copying and pasting this):

```
barplot(p,names.arg = y, ylab = "frequency", xlab = "number of dark beans")
```

Or even fancier:

```
barplot(p,names.arg = y, ylab = "frequency", xlab = "number of dark beans", col =
"blue")
```

(Of course you want to refer to people with blue eyes, not beans).

*(Instructions for exporting/saving graphs are on the next page - we went over most of this in recitation already.)*

**To copy/save graphs generated in R or RStudio:**

You're going to want to save your graphs or copy them into a word processor so that you can hand them in or refer to them during presentations.

***If you are using RStudio:***

*(If you're given a choice of format to use as you follow these instructions (usually under Windows), choose "metafile")*

Make sure the graph you want is visible in the graphics window.

Click on "export" near the top of the plot window.

Select "Copy Plot to Clipboard"

The click on "Copy Plot"

Open your favorite word processor and paste the graph into your document.

***Comment:*** copying graphs this way doesn't always give you the best looking graphs (particularly if you're using Linux). Saving the plot as a high resolution image and then inserting this into your document often gives better results (see instructions for "not using Rstudio" below).

Another possibility is to save the graph as a pdf, and then import this into your document (most recent word processors can handle pdf graphics imports). This usually gives very high quality graphs.

***If for some strange reason you're not using RStudio (or want to do this using commands):***

Windows:

In R, right click the graph, select "copy as metafile" (don't use bitmap), then open your favorite word processor and paste the graph.

Mac OS:

You should be able to copy the graph (make sure the graph window is active) from the menu, and then simply paste the graph into Word (or whatever word processor you use). If this doesn't work for some reason, the Linux instructions will work (they'll work with Windows as well).

Linux:

This is a bit complicated. A simple way to do it is to use the print screen key, but it'll look horrible. Here's one example of getting good looking graphs:

1) generate the graph on-screen (just as usual) to make sure it looks right.

2) type "`jpeg()`" in the command line. *There are actually several formats you can pick but jpeg is probably the easiest.*

3) generate the graph again (make the graph again). *You'll notice that nothing seems to happen*. That's okay. It's writing the graph to a jpeg file.

4) now type "`dev.off()`" on the command line.

5) the graphics file should now be in your home directory. It'll have a name like "Rplotxxx.jpeg", where xxx is some number. You can always sort by modification date in your file browser to find it quickly.

6) You should now be able to insert or copy the file into your text document (e.g. Word, LibreOffice, or whatever you're using).

7) The jpeg may not look terrific (it'll look a lot better than "print-screen"). You can increase the resolution by doing (in step 2 above):

```
jpeg(width = 1000,height = 1000)
```

The jpeg command defaults 480 x 480, which isn't that great. You can also use the jpeg command to give it a filename that makes sense, if you want:

```
jpeg(filename = "your-file-name",width = xxx, height =
xxx)
```