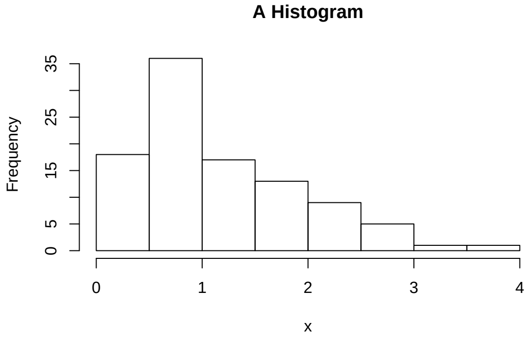
Statistics Review Questions ‡ Spring 2021

(1) You have been tasked with collecting data on the herd of bighorn sheep that live in the Almont Triangle.
   (a) Describe a data set that you will collect.
      (i) What are the cases or observations?
      (ii) What are three possible variables?
   (b) For each of your three variables: is it categorical or numerical?
   (c) Give a question that you could ask about a possible correlation between two variables in these data.
   (d) For your question directly above, what are the explanatory and response variables?

(2) The values 110 110 93 110 175 105 245 62 95 123 123 180 180 180 205 215 230 66 52 65 97 150 150 245 175 66 91 113 264 175 335 109 are the horsepower ratings of 32 cars, (Data are from `mtcars$hp` in the data included with the R software.) Find the

   (a) mean
   (b) median
   (c) standard deviation
   (d) Q1
   (e) Q3

(3) For the variable whose histogram is shown below, which statistic should you use to report the center of the distribution? Which statistic should you use to report the spread? Why?



(4) The length of the thorax of a population of fruit flies is normally distributed with mean 0.8 mm and standard deviation 0.078 mm.
   (a) What proportion of the fruit flies have thorax length less than 0.72 mm?
   (b) What proportion of the fruit flies have thorax length greater than 0.82 mm?
   (c) What proportion of the fruit flies have thorax length between 0.7 and 0.9 mm?
   (d) We wish to select the fruit flies with the highest 20% of thorax length. What is the shortest thorax length we should consider?

(5) This table represents the first 3 observations from a sample of 2000 results from the US Census American Community Survey, 2012. Individuals reported their annual income, age, gender, marital status and education level.

	income	age	gender	married	edu
1	60000	68	female	no	college
2	0	88	male	no	hs or lower
3	0	12	female	no	hs or lower

(a) Which of these five variables are numerical? (There may be none or more than one.)

(i) `income`
(ii) `age`
(iii) `gender`
(iv) `married`
(v) `edu`

(b) Which type of plot would be appopriate to use to view the relationship between `income` and `gender`? (There may be none or more than one.)

(i) single histogram
(ii) hollow histograms
(iii) single boxplot
(iv) side by side boxplot
(v) scatter plot

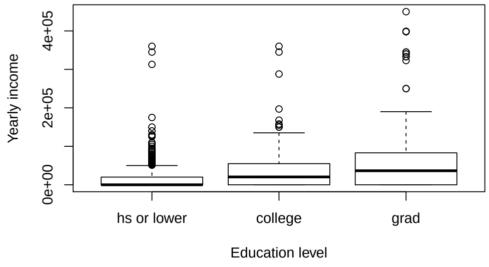
(c) Below are some summary statistics from the `age` variable.

```
Min.   1st Qu. Median  Mean    3rd Qu.    Max.          St. Dev.
0.00   19.75   40.00   40.22   59.00      94.00         23.66
```

Which of the following is <u>true</u>? (There may be none or more than one.)

(i) The standard deviation and the inter quartile range give similar information.
(ii) There is little or no evidence that the distribution of `age` is skewed.
(iii) The minimum value of 0 would be identified as out outlier in a box plot.
(iv) Half of the individuals are between 19.75 and 59 years old.

(d) Here is a side by side boxplot of the `edu` and `income` variables.



Which of the following is <u>true</u>? (There may be none or more than one.)

(i) The data show no difference in yearly income between different education levels.
(ii) There are more outliers in `income` for `grad` than for `hs or lower`.
(iii) The data are right-skewed in all three groups.
(iv) The inter quartile range is greater for `hs or lower` than for `grad`.

(6) In the 2010 election, John Hickenlooper won 51 percent of the votes in Colorado. A pollster takes a survey of Colorado voters who voted in the 2010 election and finds that 48 percent of those surveyed voted for Hicknlooper in 2010.

(a) The 51 percent is a __________ and the 48 percent is a __________.

(i) statistic; parameter
(ii) parameter; statistic
(iii) population; sample
(iv) sample; population
(v) none of the above

(b) The people who voted in the 2010 election is the __________ and the people the pollster talked to is a __________.

(i) statistic; parameter
(ii) parameter; statistic
(iii) population; sample
(iv) sample; population
(v) none of the above

(7) Based on a random sample of 120 rhesus monkeys, a 95% confidence interval for the proportion of rhesus monkeys that live in a captive breeding facility and were assigned to research studies is (0.67, 0.83). Which of the following is true?

(a) 95 of the sampled monkeys were assigned to research studies
(b) the margin of error for the confidence interval is 0.16
(c) a larger sample size would yield a wider confidence interval
(d) if we used a different confidence level, the interval would not be symmetric about the sample proportion
(e) none of the above are true

(8) Approximately 19% of physics majors in the US are women. Western doesn't have a physics major, but we might start one. To test whether we differ significantly from this national average, you take a random sample of 50 Western students who say they would consider a physics major and find that 23 are female.

(a) What is your point estimate for the proportion of Western students who would consider a physics major who are female?
(b) Using a normal model for the proportion, what is the standard error in your estimate?
(c) Give a 95% confidence interval for the proportion of potential physics majors at Western who are female.
(d) If you would like your margin of error to be at most ±5%, assuming that the proportion of potential physics majors who are female does not change, how many potential physics majors would you have to include in your sample?

(9) Complete the following sentence: When conducting a hypothesis test, we ____________ and then evaluate the test results to determine if there is enough evidence to ____________.

(a) Assume that the null hypothesis is false; accept the null hypothesis
(b) Assume that the null hypothesis is true; reject the null hypothesis
(c) Assume that the alternative hypothesis is true; reject the null hypothesis
(d) Assume the alternative hypothesis is false; reject the alternative hypothesis

(10) A coin is flipped 1000 times. It comes up heads 532 times. Is this a fair coin?

(a) Give appropriate null and alternative hypotheses.
(b) Give the test statistic, degrees of freedom if appropriate, and p-value for the test.
(c) Give a 95% confidence interval for the probability that the coin comes up heads.

(d) Clearly interpret your results in a sentence.

(11) An ecologist hypothesizes that a lake's fish population is stable when the ratios of three types of fish are 10:5:2. The ecologist samples the fish in the lake collects the following data.

fish type	**count**
fish A	650
fish B	412
fish C	120
total	1182

Do a hypothesis test using the χ^2 statistic to evaluate this model.

(a) What are your null and alternate hypotheses?

(b) How many of fish A do we expect to find out of 1182 total fish if the 10:5:2 model is correct?

(c) What are the degrees of freedom, the χ^2 statistic, and the p-value?

(d) What is your conclusion based on your test?

(12) An ecologist wants to know if the distributions of three types of fish are the same in two lakes. She collects the following data.

fish type	**Blue Lake**	**Green Lake**	**totals**
fish A	650	408	1058
fish B	412	387	799
fish C	120	68	188
totals	1182	863	2045

Do a hypothesis test using the χ^2 statistic.

(a) What are your null and alternate hypotheses?

(b) How many of fish A do we expect to see in Green Lake if the distributions are the same in both lakes?

(c) What are the degrees of freedom, the χ^2 statistic, and the p-value?

(d) Do you think that the distributions of fish types are the same in both lakes? Explain.

(13) Researchers measured the metabolic rate (in kCal/day) for 12 participants in a study. The measurements recorded were as follows: 995 1425 1396 1418 1502 1256 1189 913 1124 1052 1347 1204.

The researchers would like to know if the metabolic rates for this group differ from the presumed baseline metabolic rate of 1500 kCal/day.

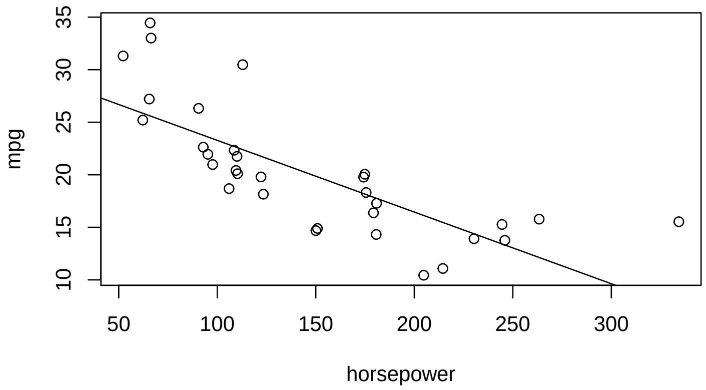
(a) Give appropriate null and alternative hypotheses.

(b) Give the test statistic, degrees of freedom, and p-value for the test.

(c) Give a 95% confidence interval for the mean metabolic rate in this group.

(d) Clearly interpret your results in a sentence.

(14) Road tests of 32 cars produced data, included in R as the `mtcars` dataset, including horsepower and gas mileage. The output of a linear model is shown.



```
Coefficients:
            Estimate Std. Error t value Pr(>|t|)
(Intercept) 30.09886    1.63392  18.421  < 2e-16 ***
mtcars$hp   -0.06823    0.01012  -6.742 1.79e-07 ***
```

(a) What was the null hypotheses tested for the `mtcars$hp` coefficient?

(b) What can you conclude about the relationship between horsepower and gas mileage?

(c) One of the assumptions that underlies linear regression is that the residuals are normally distributed and do not depend on the explanatory variable. Is this assumption satisfied by this model? Explain.

(15) Data are in `mtcars`. The same data set also contains the number of cylinders for each car and the time in seconds for each car to travel a quarter mile, starting from a stop, in seconds. Summary statistics for the quarter mile time for the 4, 6, and 8 cylinder cars are:

cylinders	Min.	1st Qu.	Median	Mean	3rd Qu.	Max.	sd
4	16.70	18.56	18.90	19.14	19.95	22.90	1.68
6	15.50	16.74	18.30	17.98	19.17	20.22	1.71
8	14.50	16.10	17.18	16.77	17.55	18.00	1.20

(a) Make a plot comparing the quarter mile times for the different size engines. Does it look like there is a difference?

(b) Are the conditions for ANOVA satisfied? Explain.

(c) Here is the output of doing ANOVA. Based on this test, what can you conclude about the relationship between number of cylinders and quarter mile times?

```
                  Df Sum Sq Mean Sq F value  Pr(>F)
factor(mtcars$cyl)  2  34.61   17.30   7.794 0.00196 **
Residuals          29  64.38    2.22
```

(16) Veterinarians at a nonhuman primate research center are interested in estimating the true average birth weight of rhesus monkeys born in captivity. Below are the summary statistics of the data and output from the analysis testing if the true average birth weight of the monkeys is 0.4kg. What is the correct calculation to estimate the true average birth weight of rhesus monkeys with a 95% confidence interval?

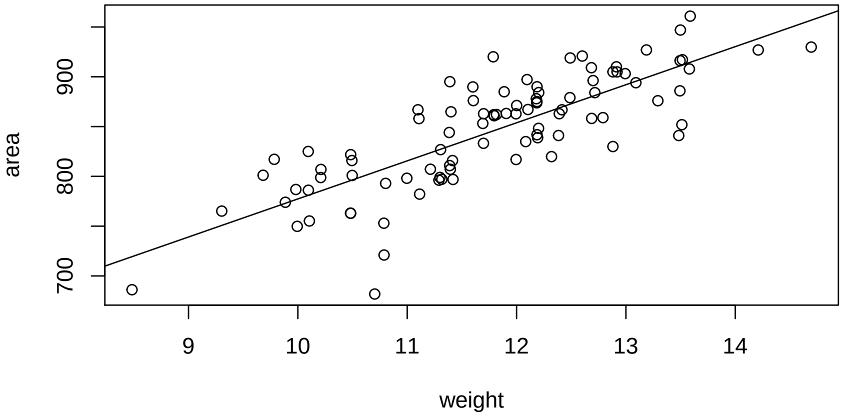
```
  min   Q1 median  Q3  max mean   sd  n missing
 0.27 0.37   0.39 0.5 0.68 0.44 0.12 10       0

t = 1.0853, df = 9, p-value = 0.306
alternative hypothesis: true mean is not equal to 0.4
95 percent confidence interval:
 XXXXXXX XXXXXXX
```

(a) $0.44 \pm 1.0853 \times 0.12/\sqrt{9}$
(b) $0.44 \pm 1.0853 \times 0.12$
(c) $0.44 \pm 2.26 \times 0.12/\sqrt{10}$
(d) $0.39 \pm 1.96 \times 0.12$
(e) $0.39 \pm 2.26 \times 0.12/\sqrt{9}$

(17) An ecologist researching Monarch butterfly migration studies the relationship between wing weight in milligrams and wing area in square millimeters. A scatterplot of the data along with a linear regression line are shown below. This line has equation $y = 395.01 + 38.23x$ and correlation coefficient $r = 0.802$

(a) Do you trust the regression line? Why or why not?
(b) What is the biological meaning of the intercept 395.01? Do you trust this? Why or why not?
(c) What is the biological meaning of the slope 38.23?
(d) What does the model predict for the area of a wing weighing 10 milligrams?


area
weight