Test 2 will cover the material in chapters 7, 8, and 9 that was covered during class.

The main theme was statistical inference—inferring something about a population parameter based on a sample statistic. The primary statistics that gave us insight were

$$Z = \frac{\widehat{p} - p}{\mathsf{SD}(\widehat{p})}, \quad Z = \frac{\widehat{p} - p}{\mathsf{SE}(\widehat{p})}, \quad T = \frac{\bar{X} - \mu}{\mathsf{SE}(X)}, \quad T = \frac{(\bar{X}_1 - \bar{X}_2) - (\mu_1 - {}_2)}{\mathsf{SE}(X_1 - X_2)}.$$

The key thing to understand is that under assumptions on the sample, these statistics have **known sampling distributions**. Using this we can formulate probability statements about unknown population parameters.

For **confidence intervals** we use the distribution of the statistics to say, for example,

$$P(-t^* \leq T \leq t^*) = 1 - \alpha$$

has a solution for t^* is α is known and vice versa. For this choice of t^* we can solve to say that with probability $(1-\alpha)$ μ, the unknown population parameter is in the random interval $(\bar{X} - t^*\mathsf{SE}, \bar{X} + t^*\mathsf{SE})$. A confidence interval isn't a guarantee that the unknown population parameter is in the interval, it only happens most of the time, $(1-\alpha)100\%$.

A significance test is another form of statistical inference. This time we make an assumption about the unknown population parameter (H_0). We then calculate the probability the test statistic has the single observed value or is more extreme. To define "more extreme" an alternative hypothesis is proposed (H_A). For our tests the alternative was one of three possibilities: less, greater, not equal. This probability is called a p-value. Small p-values cause us to doubt the accuracy of the null hypothesis. Sometimes we will say we reject the null hypothesis, sometimes we will say the differences of the observed and the expected are statistically significant, and sometimes we just report the p-value and let the reader decide.

A special role is played in all the above by the **standard error**. In general, this comes from the standard deviation by estimating the unknown population parameters. Depending on the assumptions different statistics are used for the estimation. This is most apparent in the two-sample t-test when the variance is or isn't assumed to be equal, and in the formulas for proportions where you use SE for a confidence level, but SD for a significance test.

The form of our basic test statistics is

$$\frac{\text{observed} - \text{expected}}{\mathsf{SE}}$$

We expect that a difference between the observed and expected gives us insight into the problem of inference. This difference is made concrete by usimg the standard error as a scale (just like with z-scores).

In summary, we learned the following confidence intervals: one for π, one for μ. We learned significance tests for proportions, means (t-test), and medians (sign test). As well for difference of proportions and difference of means (with equal or unequal variance, and for paired data.).

Using the computer, we have two key functions that compute all of these: `prop.test()` and `t.test()`.

What follows are problems that you can do on the computer, or we will do in class.

1. A poll of 100 betters finds 65% think the San Antonio Spurs will win the NBA finals. If the sample was a random sample from all possible betters, find a 90% confidence interval for the population proportion of all betters.

2. A newspaper reports a poll of 1100 individuals has sample proportion .42 and a margin of error of 2.9 percentage points. What was the confidence level?

3. A class of 30 students is split randomly into two groups of 15. One group is forced to come to office hours atleast twice a week. A test is given, if 10 of the office-hours group passed and only 5 of the non-office-hours group passed is the difference statistically significant?

4. A seed company promises 60% germination. A student plants 100 seeds and only 58% germinate. Is this statistical evidence that the germination rate is less than .6?

5. The data set `rivers` can be loaded with the command

   ```
   > data(rivers)
   ```

   It contains the length of the longest 141 rivers in North America. The mean population length is

   ```
   > mean(rivers)
   ```

   ```
   [1] 591.2
   ```

   Treat the data as the population, a random sample of size 10 is found with the command

   ```
   > sam = sample(rivers, 10)
   ```

   Make a sample of size 10 and then use `t.test()` to generate a "95% confidence interval". Did it get the population mean? Will it always? Should you expect it to contain the population mean 95% of the time? Why or why not? (Hint: use the boxplot Luke.)

6. Load and attach the dataset `fat` with the commands

   ```
   > source("http://www.math.csi.cuny.edu/st/R/fat.R")
   > attach(fat)
   > names(fat)
   ```

   ```
    [1] "case"          "body.fat"      "body.fat.siri"
    [4] "density"       "age"           "weight"
    [7] "height"        "BMI"           "ffweight"
   [10] "neck"          "chest"         "abdomen"
   [13] "hip"           "thigh"         "knee"
   [16] "ankle"         "bicep"         "forearm"
   [19] "wrist"
   ```

   If appropriate, use `t.test()` to find 95% confidence intervals for `ankle`, `wrist`, `thigh`, `forearm` and `weight`.

7. Load and attach the data set `shoes` with the command

```
> data(shoes, package = "MASS")
> attach(shoes)
```

The variable `A` and `B` contain measurement of shoe wear. Ten children were each given two types of shoes to wear. The amount of wear for each type, `A` or `B`, is recorded. Perform a significance test to see if the difference of the means is statistically significant. What do you assume about the data? (Normal? equal variance? independent samples?)

8. Look at the data set `UCBAdmissions` as follows

```
> data(UCBAdmissions)
> ftable(UCBAdmissions)
```

```
                Dept   A   B   C   D   E   F
Admit    Gender
Admitted Male        512 353 120 138  53  22
         Female       89  17 202 131  94  24
Rejected Male        313 207 205 279 138 351
         Female       19   8 391 244 299 317
```

The table shows admissions rate by gender, and dept. For Department `A` do a significant test to see if the difference in admission rates between the genders is statistically significant.

9. A clinical trial is performed with a treatment group and a control group. The control group was given a placebo, the treatment group a drug therapy. After the trial success was measured by a numeric quantity. The recorded data is

```
n   xbar  s
=============
12  10.3  5.4
10   8.7  4.9
```

Is the difference statistically significant?

10. A random sample of healthy patients medical charts finds the following data on normal body temperature

```
n   xbar    s
==============
20  98.31  .75
```

Is this data consistent with the claim that 98.6 degrees is normal body temperature?