Before problems, lets review: Peforming a significance test involves the following steps:

1. Formulating a null and alternative hypothesis
2. Observing some data (we assume it is a random sample from our population)
3. Finding an appropriate test statistic (below) and computing the observed value from your sample
4. Computing the p-value using the alternative hypothesis as a guide and the null hypothesis to specify a probability model which allows you to know which table to use to look up probabilities.
5. If the p-value is **less** than $\alpha = 0.05$ then the difference **is** statistically significant. If the data is **more** than $\alpha = 0.05$ then the data **is not** statistically significant.

We've learned 4 test statistics so far. They all look generically like

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

but these vary depending on the situtation.

One sample test of proportion For this we have if the sample is large enough that the following test statistic has the normal distribution

$$Z = \frac{\hat{p} - p}{\sqrt{p(1-p)/n}}.$$

Two sample test of proportion For a test to see if two population proportions are identical we can use (when the samples are large enough) the test statistic

$$Z = \frac{\hat{p}_1 - \hat{p}_2}{\sqrt{\widehat{p}(1-\widehat{p})/n}}.$$

This has a normal distribution. Here $\widehat{p} = (x_1 + x_2)/(n_1 + n_2)$.

One sample test of mean For a test on the mean when the population is assumed to be normal we can use this test statistic

$$T = \frac{\bar{x} - \mu}{s/\sqrt{n}}$$

This has the t-distribution with $n-1$ degrees of freedom.

Two sample test of mean For a test it two population means are equal when we have (a) normal populations and (b) *independent* random samples we can use the test statistic

$$T = \frac{\bar{x}_1 - \bar{x}_2}{\sqrt{s_1^2/n_1 + s_2^2/n_2}}$$

T has the t-distribution. Although it isn't technically the best we can do, we will use the smaller of $n_1 - 1$ or $n_2 - 1$ for the degrees of freedom.

Now for some sample problems

Excercise 1. The VOT (voice onset time) is a measurement of how long it takes to initiate the speaking of some word. Can it be used to distinguish children from adults? Suppose a voice researcher measures 10 randomly sampled children and 20 adults and records the following

```
    Group    n   xbar   s
----------------------------
Children    10   3.6   33
Adults      20   23.2  50
```

Find the p-value for the test

$$H_0 : \mu_1 = \mu_2, \qquad H_A : \mu_1 < \mu_2$$

where μ_1 is the mean for the children.

Excercise 2. College financial aid is based, in part, on the amount of summer earnings a student can be expected to make. Is there a gender difference in the mean amount?

A large study finds the following

```
Group     n    xbar     2
------------------------------
Females  675   3297    2394
Males    621   2380    1815
```

Is the difference statistically significant? (Find the p-value and compare to $\alpha = 0.05$.) What is the null and alternative?

Excercise 3. Is there a gender difference in the resting pulse rates of men and women? A random sample of 23 men and 18 women found this data

```
Group    n    xbar    s
--------------------------
Men     23    73.7   10
Women   18    82.2   13
```

Is there statistically significant evidence (at the $\alpha = 0.05$ level) that women have a higher resting pulse rate?

Excercise 4. Newcomb attempted to measure the speed of light. In 66 measurements, his sample mean was 27.75 (in suitable units) with a sample standard deviation of 5.08. Suppose the accepted idea was that the speed of light was 27.5. Is this difference statistically significant at the $\alpha = 0.05$ level?

Excercise 5. A random sample of 5 one-bedroom apartments has these rents

```
500 650 600 505 450
```

Is there statistically significant evidence that the mean rent for a one-bedroom apartment is more than $500? You might be interested in

```
> x = c(500, 650, 600, 505, 450)
> c(xbar = mean(x), s = sd(x))
```

```
     xbar         s
541.00000  81.57818
```

Excercise 6. A public radio station has an annual fund raiser. Historically they have received an average of $72 per contributor. They would like this to increase. They think by suggesting a donation of 1 dollar a day ($365) that people will give more. In the first two hourse of the fund raiser, they raised $1875 with this summary:

```
n    xbar     s
---------------
25    75     25
```

Is there statistically significant evidence that the mean contribution amount has gone up?

Excercise 7. Another headline touts record low numbers in a presidential approval polls. Sure the sample proportions are down, but is the population proportion?

Assume the proportion two weeks ago that approve of the president's job was 36%. A survey of 1,100 likely votes has the approval at 33%. Is this statistically significant evidence that the rating has declined?

Excercise 8. Of course, the 36% in the previous question came from a sample an so actually has variability that needs to be accounted for. Suppose the two samples are summarized by

```
Which Sample     n   phat
--------------------------
last month      1000  0.36
recent          1100  0.33
```

At the $\alpha = 0.05$ significance level, is there statistically significant evidence that the population proportion has decreased?