**Using SE to Determine if Two Means are Really Different:**
Comparing the Average Heights of Bio 120 Students

**Observation**: The Bio 120 guys look pretty tall when compared to the women.
**Question**: Are men generally taller than women?
**Hypothesis**: On average, men are taller than women.

The data was taken from two sections of Bio 120L students:

19 male students, ranging from 67" to 76" tall, had an average height of 71".
20 female students, ranging from 60" to 75" tall, had an average height of 65".
Both data sets had a 1" standard error of the mean.

1) An average height of 65" for women does seem to be shorter than the average of 71" for men. (Though note that some of the women were still taller than some of the men.)

2) 10% of 65" is 6.5", and 10% of 71" is 7.1". For both groups, the SE of 1" is less than 10% of the mean, so our sample sizes are big enough to provide reliable data.

3) If we sampled another section or two of students, would we get the same result? Is our initial result repeatable? Are we confident that men really are usually taller than women?

To address point #3, we use the SE values as follows. (We assume the data has a normal distribution so that 68% of the time, the means of new samples should be within +/- 1 SE of the population's mean, and that 95% of the time, means of new samples should be within +/- 2 SE of the true mean).

**For men:** **71" +/- 1 SE**: 71" - 1" = 70" and 71" + 1" = 72"
**71" +/- 2 SE**: 71" - 2" = 69" and 71" + 2" = 73"

This tells us that 68% of the time, if we get the average height for a new group of guys, it will fall between 70" and 72". 95% of the time, it will be between 69" and 73".

**For women:** **65" +/- 1 SE**: 65" - 1" = 64" and 65" + 1" = 66"
**65" +/- 2 SE**: 65" - 2" = 63" and 65" + 2" = 67"

So, 68% of the time, if we take the average height of a new sample of gals, it will fall between 64" and 66". 95% of the time, the new average will be between 63" and 67".

You can see from the table below even if you go out 2 SE values in either direction from the means, the range of values you'd expect to see for men and women still doesn't overlap, and so we can feel confident that our result of men being taller than women is repeatable.

| | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | -2 SE | -1 SE | M | 1 SE | 2 SE | | | |
| | -2 SE | -1 SE | W | 1 SE | 2 SE | | | | | | | | | |
| **62"** | **(63"** | **64"** | **65"** | **66"** | **67")** | **68"** | **(69"** | **70"** | **71"** | **72"** | **73")** | **74"** | **75"** | **76"** |

To summarize: based on our SE values, at least 95% of the time, if we resample guys versus gals, the average height of the guys will be between 69" and 73" while the average for women will be between 63" and 67". The shortest average height you'd expect to see for guys is 69", which is still greater than 67", the greatest average height you'd expect to get for women.

**Based on our data, the hypothesis than men are on average taller than women is supported because at least 95% of the time, if we resample, that is the result we should get.**

** According to the last U.S. census, the average height for men is 5' 9.5", or 69.5", while for women it is 5' 4", or 64".