D. Testing: Choose between 2 scientific hypotheses

1. Ex.,
   a. you might want to know whether cure rate of a new treatment is different from the known cure rate of some standard treatment.
   b. you might want to know whether the average return on a certain kind of investment is higher than a certain fixed rate you are comparing it to, or whether it is the same.
   c. Factory manager might want to know whether average measurement of a part is what it should be or if it is different.

2. Formal problem: Test which of 2 hypotheses about data generation is true.
   a. One hypothesis is called null \( H_0 \): generally one that isn't very interesting and that researchers generally want to disprove
   b. Other is called alternative \( H_a \): one that researchers would like to demonstrate.
c. Characterize Errors:

<table>
<thead>
<tr>
<th>Really $H_0$ true</th>
<th>Really $H_a$ true</th>
</tr>
</thead>
<tbody>
<tr>
<td>Say $H_0$ true</td>
<td>Correct</td>
</tr>
<tr>
<td>Say $H_A$ true</td>
<td>Type II error</td>
</tr>
<tr>
<td></td>
<td>Type I error</td>
</tr>
<tr>
<td></td>
<td>Correct</td>
</tr>
</tbody>
</table>

d. Type I error more important:
   i. Often times, one or a few studies in which $H_A$ accepted will close discussion of the question,
   ii. Since $H_0$ consists of only one point, type I error rate is less variable.

e. Standard case:
   i. $H_0$ is that parameter takes a particular value, although this is not necessary.
   ii. $H_A$ is that parameter is either greater than, less than, or different from null value.

f. Want both error rates to be small.
   i. When testing from CI, Type I error rate is 5%.
   ii. Type II error rate depends on population mean.
      • Since Type II error rate might be really bad, usually don’t say we accept $H_0$, but that we can’t reject $H_0$.
      • Symmetrically say we reject $H_0$ if we accept $H_A$: This is said
Lecture 15

to be a statistically significant result.

g. Type I called significance level and denoted by $\alpha$.
   i. Common choices are 5% or 1%.

h. Type II error denoted by $\beta$.
   i. Note that the lower $\alpha$, the higher $\beta$. 