Figures often beguile me, particularly when I have the arranging of them myself; in which case the remark attributed to Disraeli would often apply with justice and force: "There are three kinds of lies: lies, damned lies and statistics."
- *Mark Twain's Own Autobiography: The Chapters from the North American Review*

Drawn by Peter Newell.

Illustration by Peter Newell from COSMOPOLITAN, August 1898

The year 2010 marks the 175th anniversary of his birth,
the 125th anniversary of Twain's pinnacle work Adventures of Huckleberry Finn,
and the 100th anniversary of his death.

www.twainquotes.com

Hypothesis Testing

Null Hypothesis, H_o
Alternative Hypothesis a.k.a. Research Hypothesis, H_1

		Scientific Conclusion	
		H_0 Accepted	H_1 Accepted
Truth	H_0	Correct Conclusion!	Type 1 Error (false positive)
	H_1	Type 2 Error (false negative)	Correct Conclusion!

	Null Hypothesis (H_0) is true He truly is innocent	Alternative Hypothesis (H_1) is true He truly is guilty
Accept Null Hypothesis	Right decision	Wrong decision Type II Error
Reject Null Hypothesis	Wrong decision Type I Error	Right decision

Type 1 & Type 2 Errors

Suppose you get HIV tested.
Suppose the HIV test has an accuracy of 99.9%. (Some tests are more accurate.)
<u>Null Hypothesis</u>: You are healthy, no virus.
<u>Alternative Hypothesis</u>: You are infected with the virus.

<u>Type 1 Error: "false positive"</u>
Chance: 1 in 1000.
You are healthy, but the test suggests that you have HIV.
This is a scary situation, and you will need and want to get tested again right away.

<u>Type 2 Error: "false negative"</u>
Chance: 1 in 1000.
You are infected, but the test suggests that you are not infected.
This is a dangerous situation because there does not seem to be a need to test again.

CDC Department of Health and Human Services
Centers for Disease Control and Prevention

Each year, approximately 16-22 million persons in the United States are tested for HIV.
By 2002, an estimated 38%-44% of all adults had been tested for HIV.
However, at the end of 2003, approximately 252,000-320,000 persons were unaware of their HIV infection.
http://www.cdc.gov/hiv/topics/testing/index.htm

Type 1 Errors in Medicine: Test Again!

Suppose you get HIV tested.
Suppose the HIV test has an accuracy of 99.9%. (Some tests are more accurate.)
Null Hypothesis: You are healthy, no virus.
Alternative Hypothesis: You are infected with the virus.

Type 1 Error in Test #1: "false positive"
Chance: 1 in 1000.
You are healthy, but the test suggests that you have HIV.
This is a scary situation, and you will need and want to get tested again right away.

Type 1 Error in Test #2: "false positive"
Chance: 1 in 1000.

Type 1 Error in 2 Tests overall: "false positive"
Chance: 1 in 1,000,000.

Type 1 & 2 Errors in Science: Replication, Replication, Replication!

Suppose you have a new chemical reaction with a yield typically above 80%.
Null Hypothesis: The reaction works.
Alternative Hypothesis: The reaction does not work.

Type 1 Error: "false positive"
One run gives you a yield well below 80%.
Does that mean the reaction does not work? Of course not!
You do the reaction at least 10 times anyways and you throw out the "outlier".

Type 2 Error: "false negative"
One run gives you a actual yield below 80% but you think
the yield is above 80%; i.e., spectrometer malfunction.
So what, take the good yield and be happy!

Confidence Interval
Reliability of Estimate

Characterize Complete Sample (i.e., outcome of test):
- Known, fixed number of data points.
- Compute Average.
- Compute Standard Deviation.

Characterize Incomplete Sample (i.e., poll):
- Small sample of data points. Extrapolate to huge number of data points.
- Compute Average of the data points you actually have.
- Compute Standard Deviation of the data points you actually have.
- Compute Confidence Interval.