# 1. The p-Value Approach to Hypothesis Testing

There are two different conventions for statistical hypothesis testing under the classical (i.e. non-Bayesian) paradigm:

- the *p*-value method
- the critical value method

The *p*-value and critical value methods produce the same results. We will use the *p*-value method in this class.

> The ***p*-value** is the probability of obtaining a test statistic equal to or more extreme than the result obtained from the sample data, given that that the null hypothesis $H_0$ is true.

**Performing Statistical Inference Using the *p*-value Method**

It is assumed that you wish to test a hypothesis about some population characteristic (e.g., the population mean, $\mu$). For this, you collect and analyze data taken from a sample of size *n*.

Steps:

1. State the null hypothesis, $H_0$. This may be that a population parameter (e.g., the population mean, $\mu$) is equal to some constant, *c*.

2. State the alternative hypothesis, $H_1$. This may assert that the same population parameter is not equal to (≠), greater than (>), or less than (<) the same constant (*c*) used in $H_0$.

3. Choose the **level of statistical significance**, $\alpha$. This stipulates the acceptable risk of a Type 1 error (rejecting $H_0$ when $H_0$ is true). Typical values for $\alpha$ are 0.05 and 0.01. If there is some danger (e.g., health risk with releasing a new medicine that is not better than an old one), we set $\alpha$ lower, $\alpha = .001$.

4. Choose which test statistic to use. For a hypothesis concerning a population mean, we use one of the following:

   ***Z* test Statistic for $\mu$ ($\sigma$ Known)**

   $$Z = \frac{\overline{X} - \mu}{\frac{\sigma}{\sqrt{n}}}$$

   ***t* test Statistic for $\mu$ ($\sigma$ Unknown)**

   $$t = \frac{\overline{X} - \mu}{\frac{S}{\sqrt{n}}}$$

   (where S above is the sample standard deviation i.e., *s*)

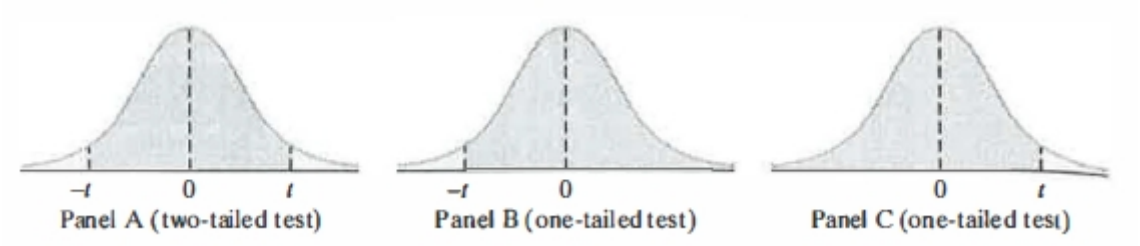
5. Compute the value of the appropriate test statistic. Example:

$H_0$: $\mu = 10$.
$H_1$: $\mu \neq 10$.

Sample mean = 12, $n = 100$, $s = 8$

Test statistic = $t$ = (Sample mean – $\mu$) / [$s$ / $\sqrt{n}$]

6. Calculate the *p*-value of the test statistic. For a test of a mean, this is the area in the tail(s) of a standard normal distribution (*z*) or *t* distribution (*t*) corresponding to the calculated value of your test statistic.




7. Compare this *p*-value to your original $\alpha$.

- If $p < \alpha$, reject $H_0$. Conclude that $H_1$ is plausible.
- If $p \geq \alpha$ do not reject $H_0$. You do not conclude that $H_1$ is plausible.

**One and Two-Tailed Significance Tests**

Sometimes we want to know if a population parameter is greater (or less) than some expected value; then we perform a **one-tailed significanc**e test. Other times we only want to know if a population parameter is different from some expected value; then we perform a **two-tailed significance** test.

A *two-tailed test* rejects the null hypothesis if the sample estimate (e.g., sample mean) is significantly *different* than the hypothesized value of the population parameter.

$H_0$: Parameter = hypothesized value (e.g., $\mu = 27$)
$H_1$: Parameter $\neq$ hypothesized value (e.g., $\mu \neq 27$)

A *one-tailed* stipulates in $H_1$ whether you predict the sample estimate to be *higher* or else *lower* than the hypothesized value of the population parameter.

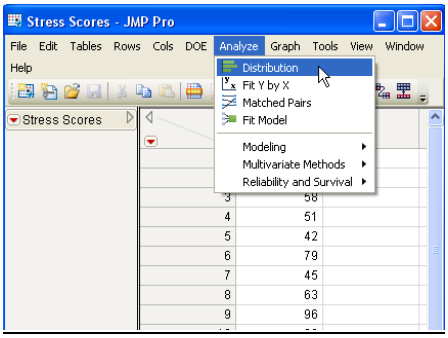
$H_0$: Parameter = hypothesized value (e.g., $\mu = 27$)
$H_1$: Parameter < hypothesized value (e.g., $\mu < 27$; left-tailed test)
or
$H_1$: Parameter > hypothesized value (e.g., $\mu > 27$; right-tailed test )

# 2. Testing One Sample Mean Using JMP

Follow same steps as with estimating a credible/confidence interval.

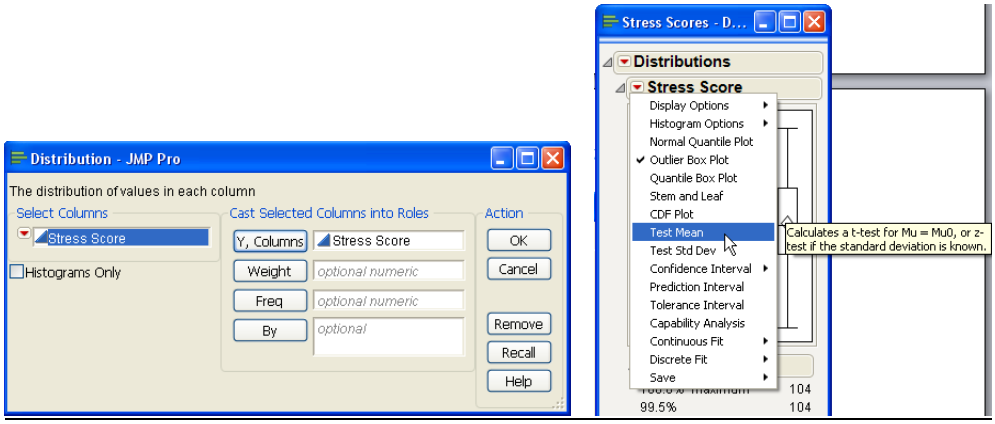
Statistics 312 – Dr. Uebersax
20 1- and 2-Tailed Tests – Testing One Sample Mean

1. Start JMP
2. Make new Data Table
3. Paste/type data into Column
4. Highlight Column
5. **Analyze** > **Distribution**



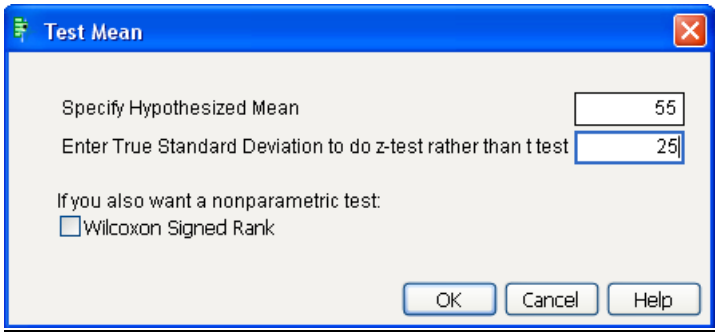

**Step 5**

6. In pop-up window designate your variable as Y, Columns and press OK
7. Click red arrow in histogram (Distributions) area
8. Select Test Mean in drop-down menu



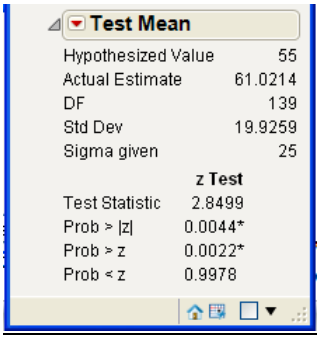

**Steps 6 (Left) and 8 (Right)**

9. Type in mean (for $H_0$)
10. Type in population standard deviation (if known)
11. Press OK



**Steps 9 and 10**

12. Results will appear in report in new section titled Test Mean. For more detail, click red arrow and choose PValue Animation.




**Step 12**

# 3. Videos

**Khan Academy**
One-Tailed and Two-Tailed Tests: http://www.youtube.com/watch?v=mvye6X_0upA
Z-statistics vs. T-statistics: http://www.youtube.com/watch?v=5ABpgVSx33I

**Homework:** Read pp. 398–411 (Skip "Critical-Value Approach")
Work Problem 9.7(a):

- Set up formulas, with correct values.
- Solve using formulas and/or with JMP
- Answers are in back of book (Appendix E-8)
- Bring to class

If you have any problems, just do your best; will be graded for effort.