P-values with the Ti83/Ti84

Note: The majority of the commands used in this handout can be found under the DISTR menu which you can access by pressing [2nd] [VARS]. You should see the following:

```
DISTR DRAW
1: normalpdf(
2: normalcdf(
3: invNorm(
4: invT(
5: tPdf(
6: tcdf(
7: xPdf(
```

NOTE: The calculator does not have a key for infinity ($\infty$). In some cases when finding a p-value we need to use infinity as a lower or upper bound. Because the calculator does not have such a key we must use a number that acts as infinity. Usually it will be a number that would be “off the chart” if we were to use one of the tables. Please note this in the following examples.

1. **Z-table p-values:** use choice 2: normalcdf(

   NOTE: Recall for the standard normal table (the z-table) the z-scores on the table are between –3.59 and 3.59. In essence for this table a z-score of 10 is off the charts, we could use 10 to “act like” infinity.

   a. **Left-tailed test (H1: $\mu < $ some number).**

      The p-value would be the area to the left of the test statistic.

      Let our test statistics be $z = -2.01$. The p-value would be $P(z <-2.01)$ or the area under the standard normal curve to the left of $z = -2.01$.

      ![Diagram showing a left-tailed test](image)

      Notice that the p-value is .0222.

      We can find this value using the Normalcdf feature of the calculator found by pressing [2nd] [VARS] as noted above.
The calculator will expect the following: Normalcdf(lowerbound, upperbound). Try typing in: Normalcdf(-10, -2.01), after pressing [ENTER] you should get the same p-value as above. It will look like the following on the calculator:

```
normalcdf(-10, -2.01)
```

.0222155248

Notice the p-value matches the one under the normal curve given earlier. It also matches the p-value you would get if you used the standard normal table.

Note: For the p-value in our example we need the area from \( z = -\infty \) to \( z = -2.01 \). The calculator does not have a key for \( -\infty \), so we need to chose a value that will act like \( -\infty \). If we type in Normalcdf(-10, -2.01) the –10 is acting as “\( -\infty \)”.

b. **Right tailed test (H1: \( \mu > \) some number):**
The p-value would be the area to the right of the test statistic.

Let our test statistics be \( z = 1.85 \). The p-value would be \( P(z > 1.85) \) or the area under the standard normal curve to the right of \( z = 1.85 \). The p-value would the area to the right of 1.85 on the z-table.

![Diagram](image)

Notice that the p-value is .0322, or \( P(z > 1.85) = .0322 \).

We could find this value directly using Normalcdf(1.85,10). Again, the 10 is being used to act like infinity. We could use a larger value, anything that is large enough to be off the standard normal curve would suffice.
On the calculator this would look like the following:

\[
\text{normalcdf}(2.45, 10) \approx 0.0071428147
\]

Notice that the p-value is the same as would be found using the standard normal table.

c. **Two –tailed test (H1: \(\mu \neq \text{some number}\)):**
   Do the same as with a right tailed or left-tailed test but multiply your answer by 2. Just recall that for a two-tailed test that:
   - The p-value is the area to the left of the test statistic if the test statistics is on the left.
   - The p-value is the area to the right of the test statistic if the test statistic is on the right.

2. **T-table p-values:** use choice 6: tcdf(

   The p-values for the t-table are found in a similar manner as with the z-table, except we must include the degrees of freedom. The calculator will expect tcdf(loweround, upperbound, df).

   a. **Left-tailed test (H1: \(\mu < \text{some number}\))**

      Let our test statistics be \(-2.05\) and \(n = 16\), so \(df = 15\).
      The p-value would be the area to the left of \(-2.05\) or \(P(t < -2.05)\)

      Notice the p-value is \(0.0291\), we would type in tcdf(-10, -2.05,15) to get the same p-value. It should look like the following:
Note: We are again using $-10$ to act like $-\infty$. Also, finding p-values using the t-distribution table is limited; you will be able to get a much more accurate answer using the calculator.

b. **Right tailed test (H1: $\mu >$ some number):**

Let our test statistic be $t = 1.95$ and $n = 36$, so $df = 35$.
The value would be the area to the right of $t = 1.95$.

\[ t_{cdf}(-10, -2.05, 15) \]
\[ .0291338715 \]

Notice the p-value is .0296. We can find this directly by typing in $t_{cdf}(1.95, 10, 35)$.
On the calculator this should look like the following:

\[ t_{cdf}(1.95, 10, 35) \]
\[ .0296111722 \]

c. **Two – tailed test (H1: $\mu \neq$ some number):**

Do the same as with a right tailed or left-tailed test but multiply your answer by 2. Just recall that for a two-tailed test that:
- The p-value is the area to the left of the test statistic if the test statistic is on the left.
- The p-value is the area to the right of the test statistic if the test statistic is on the right.
3. **Chi-Square table p-values**: use choice 8: \( \chi^2 cdf \)

The p-values for the \( \chi^2 \)-table are found in a similar manner as with the t-table. The calculator will expect \( \chi^2 cdf \) (loweround, upperbound, df).

**a. Left-tailed test (H1: \( \sigma < \) some number)**

Let our test statistic be \( \chi^2 = 9.34 \) with \( n = 27 \) so df = 26.
The p-value would be the area to the left of the test statistic or to the left of \( \chi^2 = 9.34 \). To find this with the calculator type in \( \chi^2 cdf(0, 9.34, 26) \), on the calculator this should look like the following:

\[
\chi^2 cdf(0, 9.34, 26) = 0.001118475
\]

So the p-value is .00118475, or \( P(\chi^2 < 9.34) = .0011 \)

Note: recall that \( \chi^2 \) values are always positive, so using –10 as a lower bound does not make sense, the smallest possible \( \chi^2 \) value is 0, so we use 0 as a lower bound.

**b. Right – tailed test (H1: \( \sigma > \) some number)**

Let our test statistic be \( \chi^2 = 85.3 \) with \( n = 61 \) and df = 60.
The p-value would be the area to the right of the test statistic or the right of \( \chi^2 = 85.3 \). To find this with the calculator type in \( \chi^2 cdf(85.3, 200, 60) \), on the calculator this should look like the following:

\[
\chi^2 cdf(85.3, 200, 60) = 0.0176017573
\]

So the p-value is .0176 or \( P(\chi^2 < 85.3) = .0176 \)
Note: $\chi^2$ values can be much larger than $z$ or $t$ values, so our upper bound in this example was 200. You can always look at the $\chi^2$ to get an idea of how large to pick your upper bound.

c. Two-tailed tests H1: $\sigma \neq$ some number:

Do the same as with a right tailed or left-tailed test but multiply your answer by 2. Just recall that for a two-tailed test that:

- The p-value is the area to the left of the test statistic if the test statistics is on the left.
- The p-value is the area to the right of the test statistic if the test statistic is on the right.