# Statistics Package Exercise: Using the Normal Distribution

**Learning Objective: Find probabilities associated with the normal distribution.**

The purpose of this activity is to show you how to solve word problems involving the normal distribution. Most statistical software packages, much like the normal table, are set up to give answers to problems involving "less than." This means that the software does the "finding z-scores and looking up the table" work for us, but we still need to make sure that we pose the question in terms of "less than," and/or, if needed, adjust the answer that the software gives us.

Recall that we have two types of problems that are of interest: finding probabilities given values, and finding values given probabilities. Below are the instructions for both types.

## Finding Probabilities (Given Values)

To illustrate this we'll use an example from a previous activity: Finding P(X > 700) where X is the SAT-M score which has a normal distribution with a mean of 507 and standard deviation of 111.

- R StatCrunch TI Calculator Minitab Excel

**R Instructions**

One advantage of R is that it will find probabilities without first requiring you to reduce the data to z-scores. To find the probability P(X < 700), start R and enter the command:

```
pnorm(700, mean=507, sd=111).
```

You should see that the probability is equal to 0.9589596. To calculate the probability P(X > 700) = 1 - P(X < 700), enter

```
1- pnorm(700, mean=507, sd=111).
```

Note that when we solved this problem using the table in an earlier activity, we rounded z-scores and therefore our answer was slightly different, but very close (.0409).

Similarly, if we wanted to find P(400 < X < 600), we would need to do two separate calculations; one for P(X < 600), and one for P(X < 400), and subtract.

Now use R to work through the following exercise:

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## Learn By Doing (1/1 point)

Adult male height (X) follows (approximately) a normal distribution with a mean of 69 inches and a standard deviation of 2.8 inches. (a) What proportion of males are less than 65 inches tall? In other words, what is P(X < 65)? (b) What proportion of males are more than 75 inches tall? In other words, what is P(X > 75)? (c) What proportion of males are between 66 and 72 inches tall? In other words, what is P(66 < X < 72)?

**Your Answer:**

A. 0.07656373
B. 0.01606229
C. 0.7160232

**Our Answer:**

RStatCrunchTI Calculator Minitab Excel R (a) R provides: So roughly 7.66% of males are less than 65 inches tall. (b) R provides: So roughly 1.6% of males are more than 75 inches tall. (c) R provides: So roughly 71.6% of males are between 66 and 72 inches tall. StatCrunch (a) StatCrunch provides: So

roughly 7.66% of males are less than 65 inches tall. (b) StatCrunch provides: So roughly 1.6% of males are more than 75 inches tall. (c) StatCrunch provides: and therefore P(66 < X < 72) = .8580116 - .14198838 = .71602322. So roughly 71.6% of males are between 66 and 72 inches tall. TI Calculator (a) The TI Calculator provides: So roughly 7.66% of males are less than 65 inches tall. (b) The TI Calculator provides: So roughly 1.6% of males are more than 75 inches tall. (c) The TI Calculator provides: So roughly 71.6% of males are between 66 and 72 inches tall. Minitab (a) Minitab provides: So roughly 7.66% of males are less than 65 inches tall. (b) Minitab provides: P(X > 75) = 1 − 0.983938 = 0.016062, so roughly 1.6% of males are more than 75 inches tall. (c) Minitab provides: and therefore P(66 < X < 72) = 0.858012 − 0.141988 = 0.716024. Roughly 71.6% of males are between 66 and 72 inches tall. Excel (a) Excel provides: So roughly 7.66% of males are less than 65 inches tall. (b) Excel provides: P(X > 75) = 1 − 0.983938 = 0.016062, so roughly 1.6% of males are more than 75 inches tall. (c) Excel provides: and therefore P(66 < X < 72) = 0.858012 − 0.141988 = 0.716024. Roughly 71.6% of males are between 66 and 72 inches tall.

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## Finding Value (Given Probability)

As mentioned before, is set up to find a value x that satisfies P(X < x) = some given probability. To illustrate this, we'll use an example from a previous activity: Finding the value of x that satisfies P(X > x) = .02 where X is the SAT-M score, which has a normal distribution with a mean of 507 and standard deviation of 111. Before we start, it will be useful to rephrase the problem in terms of "X < x"; we are looking for the value of x that satisfies P(X < x) = .98.

- R
- StatCrunch
- TI Calculator
- Minitab
- Excel

**R Instructions**
To do this with R, we're going to do the inverse of the procedure we described above.

This time, we're given the population mean and standard deviation, but instead of being given an X and asked to find the probability, we're given a probability and asked to find the corresponding X value.

To find the X value, enter the command:

```
qnorm(0.98, mean=507, sd=111)
```

R tells us that the value that we are looking for (the 98th percentile) is 734.966. Our solution in the previous activity using the table gave us the answer 734.55 due to rounding.

Now use R to work through the following exercise:

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## Learn By Doing (1/1 point)

Recall that adult male height follows a normal distribution with a mean of 69 inches and a standard deviation of 2.8 inches. (a) How tall must a male be in order to be among the shortest 0.5% of males? (b) How tall must a male be in order to be among the tallest 0.25% of males?

**Your Answer:**

A. 61.8 inches
B. 76.9 inches

**Our Answer:**
RStatCrunchTI CalculatorMinitabExcel R (a) Here we need to find the value x that satisfies P(X < x) = 0.005. R provides: So, in order for a male to be among the shortest 0.5% of males, he needs to be less than 61.8 inches tall. (b) Here we need to find the value x that satisfies P(X > x) = 0.0025, or P(X < x) = 0.9975. R provides: So, in order for a male to be among the tallest 0.25% of males, he needs to be more than 76.9 inches tall. StatCrunch (a) Here we need to find the value x that satisfies P(X < x) = 0.005. StatCrunch provides: So, in order for a male to be among the shortest 0.5% of males, he needs to be less than 61.8 inches tall. (b) Here we need to find the value x that satisfies P(X > x) = 0.0025, or P(X < x) = 0.9975. StatCrunch provides: So, in order for a male to be among the tallest 0.25% of males, he needs to be more than 76.9 inches tall. TI Calculator (a) Here we need to find the value x that satisfies P(X < x)

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