Using R, Chapter 6: Normal Distributions
The `pnorm` and `qnorm` functions.

- **Getting probabilities from a normal distribution with mean μ and standard deviation σ**

```
pnorm(x, mean = , sd = , lower.tail= )
```

If x is a normally distributed random variable, with mean $= \mu$ and standard deviation $= \sigma$, then

$P(x < x_{max}) =$ `pnorm(x_max, mean = μ, sd = σ, lower.tail=TRUE)`

$P(x > x_{min}) =$ `pnorm(x_min, mean = μ, sd = σ, lower.tail=FALSE)`

$P(x_{min} < x < x_{max}) =$ `pnorm(x_max, mean = μ, sd = σ, lower.tail=TRUE)`
`- pnorm(x_min, mean = μ, sd = σ, lower.tail=TRUE)`

Examples:
Suppose IQ's are normally distributed with a mean of 100 and a standard deviation of 15.

1. What percentage of people have an IQ less than 125?

   `pnorm(125, mean = 100, sd = 15, lower.tail=TRUE)` = **.9522** or about 95%

2. What percentage of people have an IQ greater than 110?

   `pnorm(110, mean = 100, sd = 15, lower.tail=FALSE)` = **.2525** or about 25%

3. What percentage of people have an IQ between 110 and 125?

   `pnorm(125, mean = 100, sd = 15, lower.tail=TRUE)`
   `- pnorm(110, mean = 100, sd = 15, lower.tail=TRUE)`
   = **0.2047** or about 20%

- **Usage for the standard normal (z) distribution ($\mu = 0$ and $\sigma = 1$).**

In the text we first convert x scores to z scores using the formula $z = (x-\mu)/\sigma$ and then find probabilities from the z-table. These probabilities can be found with the `pnorm` function as well. It is actually the default values for μ and σ with the `pnorm` function.

$P(z < z_{max}) =$ `pnorm(z_max)`

$P(z > z_{min}) =$ `pnorm(z_min, lower.tail=FALSE)`

$P(z_{min} < z < z_{max}) =$ `pnorm(z_max) - pnorm(x_min)`

- **Getting percentiles from a normal distribution with mean μ and standard deviation σ**

```
qnorm(lower tail area, mean= , sd = , lower.tail=TRUE)
```

Suppose you want to find the x-value that separates the bottom $k\%$ of the values from a distribution with mean μ and standard deviation σ. We denote this value in the text as P_k.

$P_k =$ `qnorm(k (in decimal form), mean =` μ`, sd =` σ`, lower.tail=TRUE)`

$P_{25} =$ `qnorm(.25, mean =` μ`, sd =` σ`, lower.tail=TRUE)`

$P_{90} =$ `qnorm(.90, mean =` μ`, sd =` σ`, lower.tail=TRUE)`

Examples:
Suppose IQ's are normally distributed with a mean of 100 and a standard deviation of 15.

1. What IQ separates the lower 25% from the others? (Find P_{25}.)

   $P_{25} =$ `qnorm(.25, mean = 100, sd = 15, lower.tail=TRUE)` $=$ **89.88**

2. What IQ separates the top 10% from the others? (Find P_{90}.)

   $P_{90} =$ `qnorm(.90, mean = 100, sd = 15, lower.tail=TRUE)` $=$ **119.22**

- **Usage for the standard normal (z) distribution ($\mu = 0$ and $\sigma = 1$).**

These are actually the default values for μ and σ in the `qnorm` function. So getting z-scores is quite easy.

$P_k =$ `qnorm(k (in decimal form))`

$P_{25} =$ `qnorm(.25) = -0.67449` $\rightarrow$ `-0.67`

$P_{90} =$ `qnorm(.90) = 1.28155` $\rightarrow$ `1.28`