Advanced Statistics

author: Bernhard Angele date: Class 1 (supplement), October 2, 2014

R commands and functions used so far

- Distribution functions
- Get an overview of all of them by typing `?Distributions` at the command prompt
- The function names follow a common pattern, where `xxx` stands for the abbreviated name of the distribution
  - Probability density function (PDF): `dxxx`, e.g. `dnorm`
  - Cumulative probability function (CDF) = area under the curve: `pxxx`, e.g. `pnorm`
  - Quantile function (allows you to specify the area under the curve and gives you the corresponding x value) = area under the curve: `qxxx`, e.g. `qnorm`
  - Random generator (generates random samples from the distribution): `rxxx`, e.g. `rnorm`

Using distribution functions

- Examples
- Generate 4 numbers from a normal distribution with mean = 10 and sd = 5

```
r rnorm(n = 4, mean = 10, sd = 5)
```

```
## [1] 12.021 7.988 -7.040 5.772
```
- What’s the probability of getting a value greater or equal to 22 from that distribution?

```
r 1 - pnorm(22, mean = 10, sd = 5)
```

```
## [1] 0.008198
```

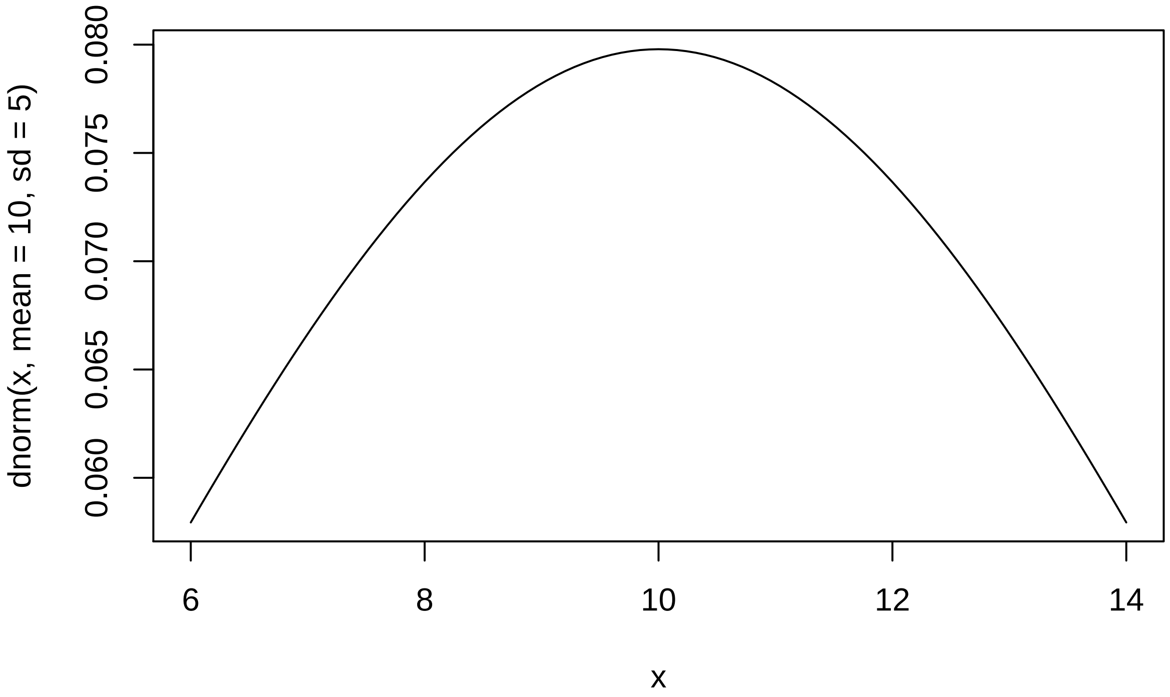
Using distribution functions

- More examples
- What x value is greater or equal to 95% of the samples from that distribution (mean = 10, sd = 5)?

```
r qnorm(.95, mean = 10, sd = 5)
```

```
## [1] 18.22
```
- Draw the curve of that distribution:

```
r curve(dnorm(x, mean = 10, sd = 5), from = 6, to = 14)
```



More R techniques used so far

- Calling functions with arguments
- Most functions will expect some kind of input
  - e.g. `mean` expects a vector of numbers

```
my_data <- c(23,6,78,4,3,2)
mean(x = my_data)
```

```
## [1] 19.33
```

- You do not have to call the arguments by name:

```
my_data <- c(23,6,78,4,3,2)
mean(my_data)
```

```
## [1] 19.33
```

Function arguments

- If you do not name the arguments of a function, they will be interpreted in the order that they are specified in the help file for the function (which you can get like this: `?rnorm`):
- e.g. `rnorm` expects the arguments `n`, `mean`, and `sd`

```r
rnorm(n = 5, mean = 10, sd = 2)
```

```
## [1] 12.860 10.831 10.780  7.592 11.643
```

```r
rnorm(5,10,2)
```

```
## [1]  8.677  9.063 11.255  9.351  7.815
```

- Specifying non-existent arguments will give you an error.

Default arguments

- Some arguments have default values
- You can find those out in the help file. For example, `rnorm` has `mean = 0` and `sd = 1` (the standard normal distribution). This can save you a lot of typing:

```
r rnorm(n = 3, mean = 0, sd = 1)
```

```
## [1] -0.6130 -0.3014 -1.3851
```

```
r rnorm(3)
```

`## [1] -0.3560 1.2618 0.3531` - Not all arguments have default values. Not specifying arguments without default values will give you an error.

More R techniques used so far (2)

- Nesting functions
- You can run a function on the output of another function.
- Example: Get the mean of a random sample of 100 from the standard normal distribution.

```
r mean(rnorm(100))
```

```
## [1] -0.1003
```

Defining functions

- You can define as many new functions as you like
- This capability is extremely powerful and can save you a lot of typing
- Example: Make a function that prints "Hello World"

```
r hello <- function() { print("Hello World") } hello()
```

```
## [1] "Hello World"
```

Defining functions (2)

- You can set your own arguments and default values
- Example: Make a function that generates `n` numbers from a normal distribution, then gives you the mean.

```
r rnorm_mean <- function(n, mean = 0, sd = 1) { mean(rnorm(n, mean, sd)) } rnorm_mean(n =
100, mean = 0, sd = 1)
```

```
## [1] 0.1496
```

```
r rnorm_mean(5, 2, 1)
```

```
## [1] 0.9977
```

Defining functions (3)

- The value (output) of a function is the value of the expression last evaluated in the function.

```
r my_function <- function() { 1 2 3 } my_function()
```

```
## [1] 3
```

Defining functions (3)

- Or you can make the output explicit by using `return`

```
r my_function <- function() { return(3) } my_function()
```

```
## [1] 3
```

Repeating things (important for simulations!)

- Several different ways
- `for` loops:

```
for(i in 1:5){
  print("Meow")
  }
```

```
## [1] "Meow"
## [1] "Meow"
## [1] "Meow"
## [1] "Meow"
## [1] "Meow"
```

Repeating things (2)

`replicate` function:

```
replicate(5, print("Meow"))
```

```
## [1] "Meow"
## [1] "Meow"
## [1] "Meow"
## [1] "Meow"
## [1] "Meow"
```

```
## [1] "Meow" "Meow" "Meow" "Meow" "Meow"
```

A more realistic application of replicate

```
rnorm_mean <- function(n, mean = 0, sd = 1) {
  mean(rnorm(n, mean, sd))
  }
replicate(5, rnorm_mean(20))
```

```
## [1] -0.066654  0.142142 -0.179482  0.191944 -0.006829
```

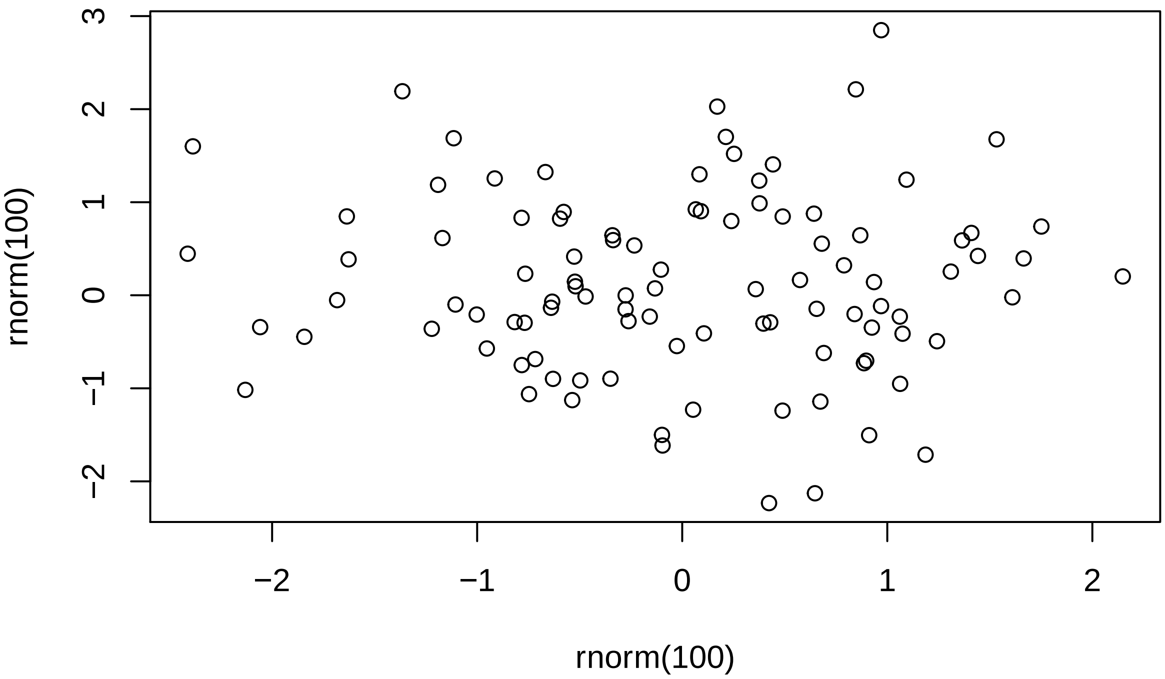
```
replicate(5, rnorm_mean(2000))
```

```
## [1] -0.01692 -0.02060  0.01189 -0.02124  0.01995
```

Finally: plotting

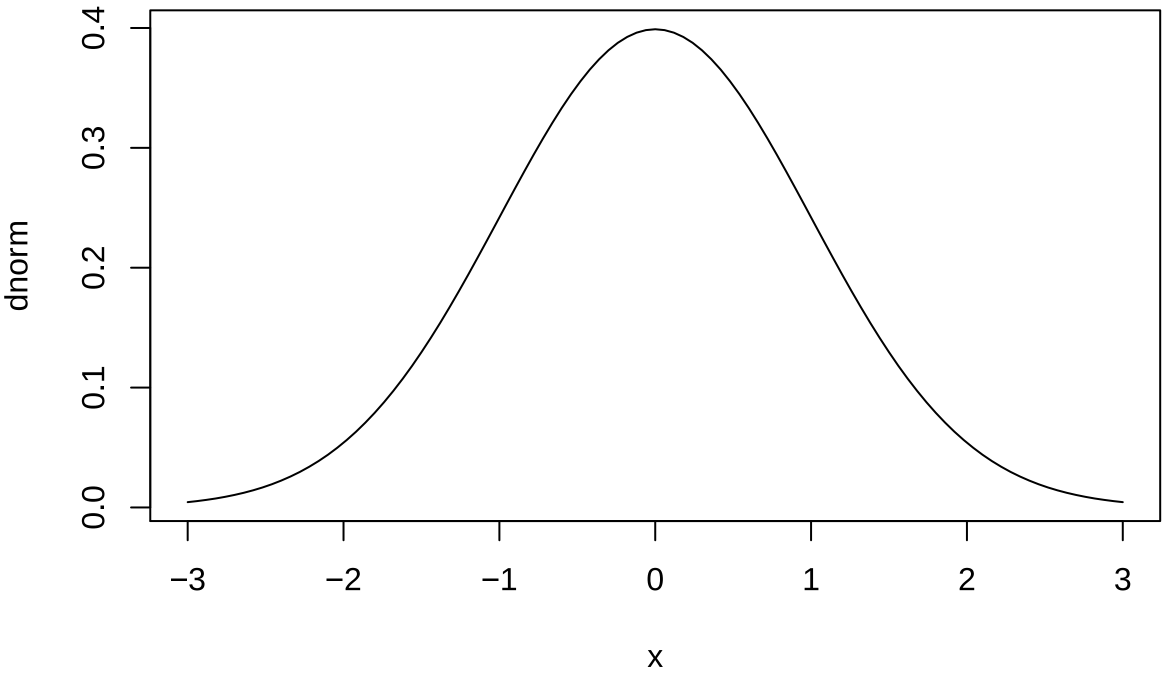
- For a quick overview of what's going on with your data, the standard `plot` command is quite good
- Let's try to plot two samples from a normal distribution against each other

```
    plot(x = rnorm(100), y = rnorm(100))
```



Plotting mathematical functions

```
plot(dnorm, from = -3, to = 3)
```


dnorm
x