

Lists and functions

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Review of Week Thus Far

- ▶ Reading data into R `{read.table()}`
- ▶ Subsetting vectors `{[ind]}` and data frames `{[row,col]}`
- ▶ Creating logical tests for variables in your dataset
- ▶ Creating new variables
 - ▶ Binary
 - ▶ Categorical
 - ▶ Transforming, e.g. `log()`, `exp()`, `sqrt()`
- ▶ Summarizing variables
 - ▶ Basic statistics, e.g. `mean()`, `sum()`, `sd()`
 - ▶ One variable by levels of another variable: `tapply()`
 - ▶ Basic exploratory plots

You should feel comfortable doing most of the above

Data

- ▶ We will be using multiple data sets in this lecture:
 - ▶ Salary, Monument, and Circulator from OpenBaltimore: <https://data.baltimorecity.gov/browse?limitTo=datasets>
 - ▶ Gap Minder - very interesting way of viewing longitudinal data
 - ▶ Data is here - <http://www.gapminder.org/data/>
 - ▶ http://spreadsheets.google.com/pub?key=rMsQHawT0bBb6_U2ESjKXYw&output=xls

Lists

- ▶ One other data type that is the most generic are lists.
- ▶ Can be created using `list()`
- ▶ Can hold vectors, strings, matrices, models, list of other list, lists upon lists!
- ▶ Can reference data using `$` (if the elements are named), or using `[]`, or `[[]]`

```
> mylist <- list(letters=c("A", "b", "c"),  
+               numbers=1:3, matrix(1:25, ncol=5))
```

List Structure

```
> head(mylist)
```

```
$letters
```

```
[1] "A" "b" "c"
```

```
$numbers
```

```
[1] 1 2 3
```

```
[[3]]
```

	[,1]	[,2]	[,3]	[,4]	[,5]
[1,]	1	6	11	16	21
[2,]	2	7	12	17	22
[3,]	3	8	13	18	23
[4,]	4	9	14	19	24
[5,]	5	10	15	20	25

List referencing

```
> mylist[1] # returns a list
```

```
$letters  
[1] "A" "b" "c"
```

```
> mylist["letters"] # returns a list
```

```
$letters  
[1] "A" "b" "c"
```

List referencing

```
> mylist[[1]] # returns the vector 'letters'
```

```
[1] "A" "b" "c"
```

```
> mylist$letters # returns vector
```

```
[1] "A" "b" "c"
```

```
> mylist[["letters"]] # returns the vector 'letters'
```

```
[1] "A" "b" "c"
```

List referencing

You can also select multiple lists with the single brackets.

```
> mylist[1:2] # returns a list
```

```
$letters
```

```
[1] "A" "b" "c"
```

```
$numbers
```

```
[1] 1 2 3
```


List referencing

You can also select down several levels of a list at once

```
> mylist$letters[1]
```

```
[1] "A"
```

```
> mylist[[2]][1]
```

```
[1] 1
```

```
> mylist[[3]][1:2,1:2]
```

	[,1]	[,2]
[1,]	1	6
[2,]	2	7

Splitting Data Frames

The `split()` function is useful for splitting `data.frames`

“`split` divides the data in the vector `x` into the groups defined by `f`. The replacement forms replace values corresponding to such a division. `unsplit` reverses the effect of `split`.”

```
> dayList = split(circ,circ$day)
```

Splitting Data Frames

Here is a good chance to introduce `lapply`, which performs a function within each list element:

```
> # head(dayList)
> lapply(dayList, head, n=2)
```

\$Friday

	day	date	orangeAverage	purpleAverage	greenAverage
5	Friday	01/15/2010	1644.0	NA	
12	Friday	01/22/2010	1394.5	NA	

	bannerAverage	daily
5	NA	1644.0
12	NA	1394.5

\$Monday

	day	date	orangeAverage	purpleAverage	greenAverage
1	Monday	01/11/2010	952.0	NA	
8	Monday	01/18/2010	999.5	NA	

```
> # head(dayList)
> lapply(dayList, dim)
```

```
$Friday
[1] 164  7
```

```
$Monday
[1] 164  7
```

```
$Saturday
[1] 163  7
```

```
$Sunday
[1] 163  7
```

```
$Thursday
[1] 164  7
```

```
$Tuesday
[1] 164  7
```

Writing your own functions

This is a brief introduction. The syntax is:

```
functionName = function(inputs) {  
< function body >  
  return(value)  
}
```

Then you would run the 4 lines of the code, which adds it to your workspace.

Writing your own functions

Here we will write a function that returns the second element of a vector:

```
> return2 = function(x) {  
+   return(x[2])  
+ }  
> return2(c(1,4,5,76))
```

```
[1] 4
```

Writing your own functions

Note that your function will automatically return the last line of code run:

```
> return2a = function(x) {  
+   x[2]  
+ }  
> return2a(c(1,4,5,76))
```

```
[1] 4
```

And if your function is really one line or evaluation, like here, you do not need the curly brackets, and you can put everything on one line:

```
> return2b = function(x) x[2]  
> return2b(c(1,4,5,76))
```

```
[1] 4
```

Writing your own functions

Also note that functions can take multiple inputs. Maybe you want users to select which element to extract

```
> return2c = function(x,n) x[n]  
> return2c(c(1,4,5,76), 3)
```

```
[1] 5
```


Writing a simple function

Let's write a function, `sqdif`, that:

1. takes two numbers `x` and `y` with default values of 2 and 3.
2. takes the difference
3. squares this difference
4. then returns the final value

Writing a simple function

```
> sqdif <- function(x=2,y=3){  
+   (x-y)^2  
+ }  
>  
> sqdif()
```

```
[1] 1
```

```
> sqdif(x=10,y=5)
```

```
[1] 25
```

```
> sqdif(10,5)
```

```
[1] 25
```

Writing your own functions

Try to write a function called `top()` that takes a `matrix` or `data.frame`, and returns the first `n` rows and columns, with the default value of `n=5`.

Writing your own functions

Try to write a function called `top()` that takes a matrix or `data.frame`, and returns the first `n` rows and columns

```
> top = function(mat,n=5) mat[1:n,1:n]
> my.mat = matrix(1:1000,nr=100)
> top(my.mat) #note that we are using the default value for
```

	[,1]	[,2]	[,3]	[,4]	[,5]
[1,]	1	101	201	301	401
[2,]	2	102	202	302	402
[3,]	3	103	203	303	403
[4,]	4	104	204	304	404
[5,]	5	105	205	305	405

Custom functions in apply

You can use any function you want in apply statements. For example, from our split Circulator data

```
> lapply(dayList, top, n = 2)
```

\$Friday

	day	date
5	Friday	01/15/2010
12	Friday	01/22/2010

\$Monday

	day	date
1	Monday	01/11/2010
8	Monday	01/18/2010

\$Saturday

	day	date
6	Saturday	01/16/2010

Custom functions in apply

You can also designate functions “on the fly”

```
> lapply(dayList, function(x) x[1:2,1:2])
```

\$Friday

	day	date
5	Friday	01/15/2010
12	Friday	01/22/2010

\$Monday

	day	date
1	Monday	01/11/2010
8	Monday	01/18/2010

\$Saturday

	day	date
6	Saturday	01/16/2010
13	Saturday	01/23/2010

Simple apply

sapply() is a user-friendly version and wrapper of lapply by default returning a vector, matrix, or array

```
> sapply(dayList, dim)
```

	Friday	Monday	Saturday	Sunday	Thursday	Tuesday	Wednesday
[1,]	164	164	163	163	164	164	164
[2,]	7	7	7	7	7	7	7

```
> sapply(circ, class)
```

day	date	orangeAverage	purpleAverage	gr
"character"	"character"	"numeric"	"numeric"	
bannerAverage	daily			
"numeric"	"numeric"			

```
> myList = list(a=1:10, b=c(2,4,5), c = c("a","b","c"),  
+             d = factor(c("boy","girl","girl")))  
> tmp = lapply(myList,function(x) x[1])  
> tmp
```

\$a

[1] 1

\$b

[1] 2

\$c

[1] "a"

\$d

[1] boy

Levels: boy girl

```
> sapply(tmp, class)
```



```
> sapply(myList,function(x) x[1])
```

a	b	c	d
"1"	"2"	"a"	"1"

```
> sapply(myList,function(x) as.character(x[1]))
```

a	b	c	d
"1"	"2"	"a"	"boy"