Session 4: Custom Functions, Iteration/Looping, & Branching
Foundations of Quantitative Ecology (EEOB 8896.11)

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Often, it’s helpful to create custom functions for tasks we’ll run more than once.

```r
## See ?function for details.
MyFuncName <- function(arg1, arg2, arg3 = default.value) {
    ## code that does something with the inputs
    return(output)
}
## To allow vector inputs, not just single-valued inputs
MyNewFunc <- Vectorize(MyFuncName, c("arg1", "arg2"))
## Speed things up!
library(compiler)
MyNewFunc <- cmpfun(MyFuncName)
```

Notice we’re passing functions as arguments to functions!
Functions

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Q: What happens if we call a function without parentheses?
Iteration and Looping

There are multiple ways to repeat procedures in R.
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Some are common to nearly all programming languages:

```r
## Like for loops, that iterate over a list
for (i in 1:100) {
  Output[i] <- Do.Something(i)
}

## or while loops, which repeat until a condition is met
i = 0
while (times[i] < end_time) {
  i <- i + 1
  Output[i] <- Do.Something(i)
  times[i] <- Update.time(i)
}
```
Others are specific to R, e.g., the apply() family of functions.

```r
## This is standard
for (i in 1:100) {
  Output[i] <- Do.Something(i)
}
## Equivalently, in R
Output <- lapply(1:100, Do.Something)
## See ?sapply, ?apply, ?mapply for details. To replicate something n times
## without varying input values:
replicate(n = 5, {
  xydata = data.frame(x = 1:100, y = rnorm(100, 1:100, 1))
  fit = lm(y ~ x, xydata)
  return(fit$coefficients)
})
```
Iteration and Looping

for and while loops are fundamental programming tools that help us with "computational thinking", BUT in practice, write **vectorized** code!

```
## Not vectorized!
...
Output[100] <- Do.Something(100)  ## Ugh!
## Still not vectorized, but better!
for (i in 1:100) {
  Output[i] <- Do.Something(i)
}
## Better, but on par with the for loop
Output <- lapply(1:100, Do.Something)
## Yes!
Output <- Do.Something(1:100)  ## See ?Vectorize
```
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## Yes!
Output <- Do.Something(1:100)  ## See ?Vectorize
```

Vectorized code is (1) easier to write/read, AND (2) computationally efficient. Vectorize() may not always be the solution!
## Function to benchmark

```r
Do.OneThing <- function(x=20,seed=1) {
    set.seed(seed)
    svd(matrix(rnorm(x),x))$d
}
```

```r
N=5000;
```

## How fast in a for loop?

```r
system.time({
    dummy=c(); for(i in 1:N) dummy[i] <- Do.OneThing(i)
})
```

```r
## user  system elapsed
##  4.23  0.00  4.87
```

## Using an apply function

```r
system.time(Output <- lapply(1:N, Do.OneThing))
```

```r
## user  system elapsed
##  4.37  0.00  4.37
```

## Or vectorize (literally!)

```r
Do.Something <- Vectorize(Do.OneThing,"x") ## See ?Vectorize
```

```r
system.time(Output <- Do.Something(1:N))
```

```r
## user  system elapsed
##  4.21  0.00  4.87
```
Exercises

**Ex. 1:** Write a while loop that draws exponentially distributed random variables (rate=1) until they sum up to 100. Output: the vector of values.

**Ex. 2:** Write something similar that draws 100 such exponentially distributed values using a for loop.

**Ex. 4:** Do the same, but using `replicate()`.

**Bonus:** Plot the likelihood of those data for rates in the range (0, 5).
Branching with if/else

Branching refers to doing different things depending on the input. For example:

```r
## See ?Control, ?ifelse for details
if (condition == TRUE) {
  Do.This()
} else {
  Do.That()
}
## or
if (condition == TRUE) {
  Do.This()
} else if (otherthing == TRUE) {
  Do.That()
} else {
  Do.nothing()
}
## or
ifelse(logical.vector, val.if.true, val.if.false)
## Ex: color points by sign of y values:
plot(x, y, col = ifelse(yval >= 0, "red", "blue"))
```
Regular Expressions

if/else conditions are often based on strings. Regular expressions help with parsing for such purposes.

```r
my.strs = c("Peter Piper picked", "a peck of pickled peppers.")
gsub("\\s+", ",", my.strs)  # see ?regex


grep("pickle", my.strs, value = TRUE)  # see ?grep

## [1] "a peck of pickled peppers."

grepl("pickle", my.strs)

## [1] FALSE  TRUE

strsplit(paste(my.strs, collapse = " "), "\\s+")

## [[1]]
## [1] "Peter" "Piper" "picked" "a" "peck" "of"
## [7] "pickled" "peppers."
```
Project

**Exercise:**

Download the BBS Data from the course website, and start a new project directory.

Write code that iterates through bird species, and if the name contains "Warbler", plot the trend data.

Modify your code to write the plots to files.