User functions

2

Introducing ...
User functions

- All R commands are functions.
- Functions perform calculations, possibly involving several arguments, then return a value to the calling statement.
- The calculation maybe any process, might or might not have return value
  - It need not be arithmetic
- User functions extend the capabilities of R by adapting or creating new tasks that are tailored to your specific requirements.
- User functions are a special kind of object

Defining a new function

- Parts of function definition: name, arguments, procedural steps, return value

```
sqXplusX <- function(x){
    x^2 + x
}
```

- **sqXplusX** is the function name
- **x** is the single argument to this function and it exists only within the function
- everything between brackets { } are procedural steps
- the **last** calculated value is the function return value
- after defining the function, we can use it:

```
> sqXplusX(10)
[1] 110
```

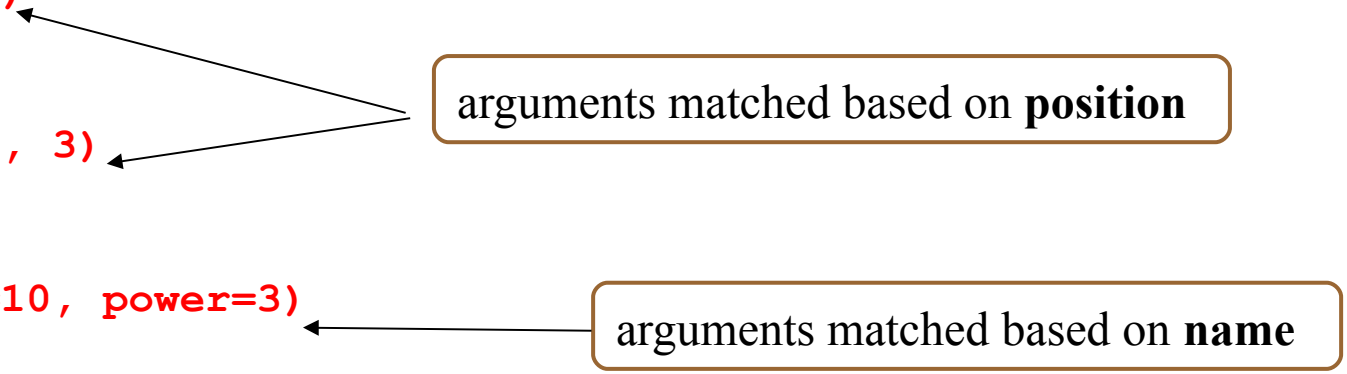
Named and default arguments

- Example of function with more than one named argument:

```
powXplusX <- function(x, power=2){
    x^power + x
}
```

- Now we have two arguments. The second argument has a default value of 2.
- Arguments without default value are required, those with default values are optional.

```
> powXplusX(10)
[1] 110
> powXplusX(10, 3)
[1] 1010
> powXplusX(x=10, power=3)
[1] 1010
```



Assignments with arguments
User functions

```
sqXplusX <- function(x){
   x^2 + x
}
```

You can use a blank document in gedit, nedit or other text editor to hold these commands for you, then copy / paste the instructions into R

- Now try this …

```
a <- matrix(1:100, ncol=10, byrow=T)  # make some dummy data
b <- sqXplusX(a)  # transform a by sqXplusX, assign result to b
b # to view the result
```

- sqXplusX user function is now an R object, check its arguments and list it in the current workspace

```
> args(sqXplusX)
> ls()
> sqXplusX
```

Don’t add brackets to see the definition of sqXplusX

Assigned or anonymous ...
User functions

- Functions may be assigned a name, or anonymously created within an operation
  - Anonymous functions are really useful in `apply()` style procedures

```
apply(object, margin, function)
```

  - E.g. I have a 10 x 10 matrix and want to square each item, and add the item to itself

```
a<-matrix(1:100, ncol=10, byrow=T)
a # to view new object
apply(a, c(1,2), function(x) x^2+x)
```

`x` is transiently assigned each item of `a`, and this is passed as an argument to the anonymous function

1 means by rows, 2 means by columns [1st or 2nd margin]
c(1,2) means do both rows and columns

Functions occupy their own space
User functions

- Objects created in functions are not available to the general environment unless returned.
  - they are said to be out of scope
    - Scope relates to the accessibility of an object.
- A function can only return one object.
- Custom functions disappear when R sessions end, unless the function object is saved in an Rdata file or sourced from a script.
  - A really useful function could be added to your .Rprofile file, and would always be ready for you at launch
- You could also make a package
  - Beyond the scope of the beginners course!!!!

Script / function tips
User functions

- If your script repeats the same style command more than twice, you should consider writing a function
- Writing functions makes your code more easily understandable because they encapsulate a procedure into a well-defined boundary with consistent input/output
- Functions should not be longer than one-to-two screens of code, keep functions clean and simple
- Look at other functions to get ideas for how to write your own …
  - Display function code by entering the function's name without brackets.

File commands for extending
scripts & user functions

Generic file commands

```
dir(...,pattern="txt")
```

Retrieve working directory file listing filtered by pattern. Note pattern is a regular expression, not a shell wildcard

```
glob2rx("*.txt")
```

Changes wildcards to regular expressions!

```
> glob2rx("*.txt")
[1] "^.*\\.txt$"
```

```
unlink(...)
```

Remove (permanently) a file from system

```
system(...)
```

Execute a shell command from within R

Result can not be coerced to an object, only available to linux R

Text manipulation for extending
scripts & user functions

- Text manipulation and file name mangling ... that's a technical term

```
grep( pattern, object )
```

  - If pattern is not found, grep returns a 0 length object.
    - Test for null with `is.null()`

```
sub( pattern, replacement, object )
```

```
gsub( pattern, replacement, object)
```

  - Sub replaces first occurrence only, gsub does them all.

```
cat( "...", file=...)
```

  - Outputs text to a file, or prints it on screen if file=""
    - cat requires "\n" to be given for new lines ... try ...

```
cat("Hello World!") ; cat("Hello World!",sep="\n") ; cat("Hello
   World!",sep="\n",file="world.txt")
```

  - cat is extremely useful for writing scripts or generating reports on-the-fly

Error reporting for extending scripts & user functions

- Your code should report errors if inconsistency is detected.

`stop(...)`

- Stops execution of a function and reports a custom error message

`is.family(...)`

- Functions that can be used to test for a variety of conditions place them inside `if` structures to check that all is well

```
if( !is.numeric(x) ){ stop ("Non numeric value entered.  Cannot
   continue.") }
```

If the object x is non numeric (e.g. Text has been entered when numbers were required), then stop execution and report message

The `is.family`

```
                 is.language          is.primitive
.array           is.leaf              is.qr
s.atomic         is.list              is.R
isBaseNamespace  is.loaded            is.raw
is.call          is.logical           is.real
is.character     is.matrix            is.recursive
isClass          is.mts               is.relistable
isClassDef       is.na                isRestart
isClassUnion     is.na<-              isS4
is.complex       is.na.data.frame     isSealedClass
is.data.frame    is.na<-.default      isSealedMethod
isdebugged       is.na<-.factor       isSeekable
is.double        is.name              is.single
is.element       isNamespace          is.stepfun
is.empty.model   is.nan               is.symbol
is.environment   is.na.POSIXlt        isSymmetric
is.expression    is.null              isSymmetric.matrix
is.factor        is.numeric           is.table
is.finite        is.numeric.Date      isTRUE
is.function      is.numeric.POSIXt    is.ts
isGeneric        is.numeric_version   is.tskernel
isGrammarSymbol  is.object            is.unsorted
isGroup          isOpen               is.vector
isIncomplete     is.ordered           isVirtualClass
s.infinite       isoreg               isXS3Class
.integer         is.package_version
nds              is.pairlist
```

Temperature conversion exercise
User functions

- Centigrade to Fahrenheit conversion is given by
  - F = 9/5 C +32
    - Write a function that converts between temperatures.
      - The function will need two named arguments
        - *temperature* ***(t)*** *is numeric*
        - *units* ***(unit)*** *is character*
        - *They will need default values, e.g t=0, unit="c"*
      - The function should report an appropriate error if inappropriate values are given

```
if( !is.numeric(t) ) { .... }
if( !(unit %in% c("c","f")) ){...}
```

      - The function should print out the temperature in F if given in C, and vica versa

Functions with named arguments are defined with the following syntax

```
myFunc<-function(arg=defaultValue,…)
```

- Why not add a third scale?

  K=C+273.15

Example code:
12_convTemp.R

Building the solution

- It is difficult to write large chunks of code, instead start with something that works and build upon it
- E.g. to solve the temperature conversion exercise:
  - start with the function powXplusX (from some slides ago)
  - modify the argument names
  - delete the old code, for now just print out the input arguments
  - save the function file, load it into R and try it out
  - now add the two lines for input checking from the previous slide
  - try it out, see if passing a character for temperature gives the expected error
  - now try to convert C into F and print out the result
  - when that works, add the conversion from F to C
- If you get stuck, call us to help you !

Temperature conversion script

```
convTemp<-function(t=0,unit="c"){ # convTemp is defined as a new user function requiring two
arguments, t and unit, the default values are 0 and "c", respectively.

     if( !is.numeric(t) ){
          stop("Non numeric temparture entered") # Exception error if character given for
temperature
     }

     if(!(unit %in% c("c","f","k"))){
          stop("Unrecognized temperature unit. \n Enter either (c)entigrade, (f)ahreneinheit
or (k)elvin") # Exception error if unrecognized units entered
     }
# Conversion for centigrade
     if(unit=="c"){
          fTemp <- 9/5 * t + 32
          kTemp <- t + 273.15
          output <- paste(t,"C is: \n",fTemp,"F \n",kTemp,"K \n")
          cat(output)
     }
# Conversion for Fahrenheit
     if(unit=="f"){
          cTemp <- 5/9 * (t-32)
          kTemp <- cTemp + 273.15
          output <- paste(t,"F is: \n",cTemp,"C \n",kTemp,"K \n")
          cat(output)
     }
# Conversion for Kelvin
     if(unit=="k"){
          cTemp <- t - 273.15
          fTemp <- 9/5 * cTemp + 32
          output <-paste(t,"K is: \n",cTemp,"C \n",fTemp,"F \n")
          cat(output)
     }
}
```

"\n" -> puts text on a new line

Units must be entered in quotes, as it's a character object

```
> convTemp(t=-273,unit="c")
-273 C is:
 -459.4 F
 0.149999999999977 K
```

Example code: 12_convTemp.R