Nectric

WOMBAT 2024: Advanced R Tips & Tricks

Quirky R

workshop.nectric.com.au/advr-wombat24

Outline

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Hello!

I’m Mitch!

I make lots of R packages, and teach lots of people!

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I make lots of R packages, and teach lots of people!

Among other things…

- PhD candidate at Monash University
- Data consulting and workshops at Nectric
- Specialised in time series analysis
- Develops R packages (fable, vitae, etc.)
- Grows all the things (hobby permaculturist)

Workshop materials

Are all on the website:

https://workshop.nectric.com.au/advr-wombat24/

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Here you'll find…

- these slides
- demonstrated code
- video recordings
- everything you'll need (for the workshop)

Today's goals (very ambitious!)

1. Understand (and embrace) the quirks of using R
2. 'Appreciate' how 'helpful' R tries to be
3. Use vctrs to avoid common problems with vectors
4. Learn functional programming
5. Write code that writes and runs code (metaprogramming)
6. Use non-standard evaluation for code design

Expectations

1. Follow the code of conduct
2. Be kind and respectful
3. Ask relevant questions any time
4. General Q&A during breaks
5. Make mistakes and learn!

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Ask lots of questions!

We'll have the most fun exploring the depths of R together.

The first question

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Your turn!

Why are you here?
What motivates you to learn ‘advanced R’ tips and tricks?

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- make better R packages?

The first question

Your turn!

Why are you here?
What motivates you to learn ‘advanced R’ tips and tricks?

- improve your analysis code?
- make better R packages?
- something else?

Outline

R is weird!

Featured in Kelly Bodwin's useR! 2024 keynote "Keep R weird".

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- *functional* programming design
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These quirks are often ‘helpful’ for data analysis.

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> **!** R’s ‘help’ can hurt!
>
> Unlike stricter languages, sometimes R’s helpful nature can cause *nasty* programming problems.

Workshop content

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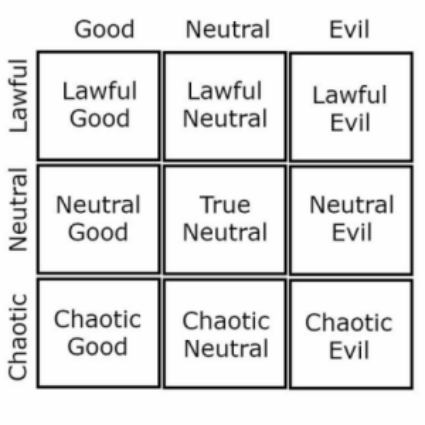

Workshop content

! Chaotic evil

We can explore the ‘dark side’ and produce truly evil code…

Workshop content

❗ Chaotic evil

We can explore the ‘dark side’ and produce truly evil code…

💡 Lawful good

Or create lovely code which effortlessly solves problems.

The dark side

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- `attach(structure(list(), class = "UserDefinedDatabase"))`

Workshop content

Today we'll learn **useful** tips and tricks for R.

- Avoid common mistakes
- Use powerful features

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This workshop will focus on three R-centric topics:

- Vectorisation
- Functional programming
- Non-standard evaluation

Workshop content

Textbook reference

Much more Advanced R can be found in Hadley Wickham's Advanced R book. It's freely available online here: https://adv-r.hadley.nz/

Outline

Vectorisation

R's design around vectors is perfect for data.

Vectors are objects which store data (several datum) together.

Your turn!

What *types* of vectors ('data') do we have?

Types of vectors

There are two types of vectors in R:

- Atomic (single-type)
- List (mixed-type)

Types of vectors

Your turn!

Which of the following vectors are ‘atomic’ in R?

- Random numbers
- Today’s date
- A dataset (data.frame)
- A matrix
- $\sqrt{-1}$ (a complex number)
- `NULL`

Subsetting vectors: `x[i]`

```
letters
```

```
 [1] "a" "b" "c" "d" "e" "f" "g" "h" "i" "j" "k" "l" "m" "n" "o" "p" "q" "r" "s"
[20] "t" "u" "v" "w" "x" "y" "z"
```

```
# What's the 13th letter?
letters[13L]
```

```
[1] "m"
```

```
# What's the last letter?
letters[length(letters)]
```

```
[1] "z"
```

Subsetting vectors: `x[i]`

Remember: indexing starts at 1!

```
letters[0L]
```

```
character(0)
```

Subsetting vectors: `x[i]`

Remember: indexing starts at 1!

```
letters[0L]
```

```
character(0)
```

Negative indices

Remember: R is weird!

```
letters[-1L]
```

```
 [1] "b" "c" "d" "e" "f" "g" "h" "i" "j" "k" "l" "m" "n" "o" "p" "q" "r" "s" "t"
[20] "u" "v" "w" "x" "y" "z"
```

Subsetting vectors: `x[i]`

```
# What's the first three letters?
letters[1:3]
```

```
[1] "a" "b" "c"
```

Subsetting vectors: `x[i]`

```
# What's the first three letters?
letters[1:3]
```

```
[1] "a" "b" "c"
```

Safe sequences

Using `1:n` is unsafe in general code. `seq_len(n)` is safer.

```
# What's the first 'zero' letters?
n <- 0
letters[1:n]
```

```
[1] "a"
```

```
letters[seq_len(n)]
```

```
character(0)
```

Subsetting vectors: `x[i, j]`

When subsetting matrices (or arrays) we use multiple indices.

```
# Get the first row and third column
volcano[1L,3L]
```

```
[1] 101
```

Subsetting vectors: `x[i, j]`

When subsetting matrices (or arrays) we use multiple indices.

```
# Get the first row and third column
volcano[1L,3L]
```

```
[1] 101
```

Subsetting simplification

By default R will simplify matrices/arrays into 1-d vectors. It's often safer to prevent this with `drop = FALSE`.

Subsetting vectors: `x[i, j]`

```
# What's the first column?
volcano[,1L]
```

```
 [1] 100 101 102 103 104 105 105 106 107 108 109 110 110 111 114 116 118 120 120
[20] 121 122 122 123 124 123 123 120 118 117 115 114 115 113 111 110 109 108 108
[39] 107 107 107 108 109 110 111 111 112 113 113 114 115 115 114 113 112 111 111
[58] 112 112 112 113 114 114 115 115 116 116 117 117 116 114 112 109 106 104 102
[77] 101 100 100  99  99  99  99  98  98  97  97
```

```
# But with keeping the matrix
# (empty arguments for positioning is also quirky!)
volcano[,1L,drop=FALSE]
```

```
     [,1]
 [1,]  100
 [2,]  101
 [3,]  102
 [4,]  103
```

Subsetting vectors: `x[[i]]`

Your turn!

What's the difference between x[i] and x[[i]]?

This code gives the same result...

```
letters[13L]
```

```
[1] "m"
```

```
letters[[13L]]
```

```
[1] "m"
```

Subsetting (list) vectors: `x[[i]]`

`x[[i]]` is used to subset (list) vectors into their element's type.

Key differences:

- Only works for single indices `i`
- Drops the (list) structure of `x`

```
Orange[2L]
```

```
   age
1  118
2  484
3  664
4 1004
5 1231
6 1372
7 1582
```

```
Orange[[2L]]
```

```
 [1]  118  484  664 1004 1231 1372 1582  11
[16]  484  664 1004 1231 1372 1582  118  48
[31]  664 1004 1231 1372 1582
```

Subsetting (list) vectors: `x$col`

Often we use the list vector's names for subsetting.

```
Orange$age
```

```
 [1]  118  484  664 1004 1231 1372 1582  118  484  664 1004 1231 1372 1582  118
[16]  484  664 1004 1231 1372 1582  118  484  664 1004 1231 1372 1582  118  484
[31]  664 1004 1231 1372 1582
```

This also works for `x[["col"]]`.

```
Orange[["age"]]
```

```
 [1]  118  484  664 1004 1231 1372 1582  118  484  664 1004 1231 1372 1582  118
[16]  484  664 1004 1231 1372 1582  118  484  664 1004 1231 1372 1582  118  484
[31]  664 1004 1231 1372 1582
```

Subsetting (list) vectors: `x$col`

Often we use the list vector's names for subsetting.

Your turn!

What happens with the following code?

```
Orange["age"]
Orange["age",]
Orange[,"age"]
```

Subsetting (list) vectors: `x$col`

! Caution! R's eager to please.

`Orange["age",]` should probably error, but it doesn't. There was no rowname called "age", so it gives a 'missing' row.

What does `Orange[NA,]` do?

What about `Orange$a` and `Orange[["a"]]`? What if we also had a column called 'alpine'?

Subsetting (list) vectors: `x$col`

A tibble is stricter than `data.frame` (it also looks nicer).

By being less 'helpful', it is (a bit) safer.

Your turn!

Convert `Orange` into a tibble with `as_tibble()`, then try various subsets.

```
library(dplyr)
orange_trees <- as_tibble(Orange)
orange_trees$a
orange_trees["age",]
orange_trees[NA,]
```

Combining vectors: c(x, y)

Vectors are combined with `c()`, short for ‘combine’.

```
c(1, 2, 3)
```

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

! Confusing combinations

What happens when you combine vectors of different types?
Try it!

Combining vectors: vec_c(x, y)

The vctrs package makes combining vectors much stricter when you use `vec_c()`.

This is used widely in tidyverse packages now, to make data analysis in the tidyverse safer than base R.

> **Your turn!**
>
> Use `vec_c()` from `{vctrs}` to combine different vectors. What works, and what errors (safely)?

Casting vectors: as_*(), vec_cast()

This vector converting process is known as ‘casting’.

Explicit casting with `as.numeric()`, `as.Date()` or `vec_cast()` is good practice.

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Parsing data from text

It is also safer to explicitly specify column types when reading in data.
The readr package writes this code for you - just copy it!

Recycling: vec_recycle()

What happens when you use two vectors of different length?

```
x <- 1:10
b <- 2
b^x
```

Recycling: vec_recycle()

What happens when you use two vectors of different length?

```
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b^x
```

```
 [1]    2    4    8   16   32   64  128  256  512 1024
```

So helpful!

R ‘recycles’ `b` to be the same length as `x`.
This aspect of R’s vectorisation is great since we don’t need to write a loop.

Recycling: vec_recycle()

What if we're calculating the revenue of fruit sales...

```
fruit <- c("apple", "banana", "kiwi")
sales <- c(10, 3, 8)
price <- c(2.99, 4.39)
sales*price
```

```
Warning in sales * price: longer object length is not a multiple of shorter
object length
```

```
[1] 29.90 13.17 23.92
```

! Reckless recycling

R 'helpfully' recycles everything, regardless of if their lengths match. At least it warned us something was amiss!

Recycling: vec_recycle()

It is safer to only recycle length 1 vectors, which is done in the tidyverse via `vec_recycle()`. If you're ...

- writing packages recycle safely with `vec_recycle()`.
- undertaking analysis be careful of mismatched vector lengths (using data.frame/tibble helps)

Distribution statistics

The p/d/q/r functions in R are notoriously bad at recycling. My {distributional} package has much safer behaviour.