vctrs: Creating custom vector classes with the vctrs package

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Slides: jessesadler.com/slides/RStudio2020.pdf


DANIEL. VANDER.
MEVLEN.
Aº 1583.


HESTER.DELLA.
FAILLE.
Aº 1583.

Factuere van 6 baelkens witte lijwaeten N° 97 · 98 · 99 · 100 · 101 · 102 · gemt als in margine door Joos de vogele uijt haerlem ouer Amsterdam op hamborch gesonden om van daer voorder ouer noremberg op Italien in handen van Fran^s^ Decheren beweecht te worden houden als volgt

N° 97 · houdende

N° 1	metende Antw:	@ 52	a ℓ	35	beloopen	£	7 · 11 · 8
2	— · — · —	@ 51	—	37½	— · —	£	7 · 19 · 4½
3	— · — · —	@ 51½	—	40	— · —	£	8 · 11 · 8
4	— · — · —	@ 50½	—	41	— · —	£	8 · 12 · 6½
5	— · — · —	@ 51	—	44	— · —	£	9 · 7 · 0
6	— · — · —	@ 51½	—	41	— · —	£	8 · 15 · 11½
7	— · — · —	@ 51	—	41	— · —	£	8 · 14 · 3
8	— · — · —	@ 51	—	42	— · —	£	8 · 18 · 6
9	— · — · —	@ 50½	—	43	— · —	£	9 · 0 · 11½
10	— · — · —	@ 50½	—	44	— · —	£	9 · 5 · 2
11	— · — · —	@ 51	—	45	— · —	£	9 · 11 · 3
12	— · — · —	@ 50	—	45	— · —	£	9 · 7 · 6
13	— · — · —	@ 50	—	46	— · —	£	9 · 11 · 8
14	— · — · —	@ 50½	—	46	— · —	£	9 · 13 · 7
15	— · — · —	@ 51	—	46	— · —	£	9 · 15 · 6
16	— · — · —	@ 50½	—	46½	— · —	£	9 · 15 · 0¼
17	— · — · —	@ 50	—	47	— · —	£	9 · 15 · 10
18	— · — · —	@ 50½	—	47	— · —	£	9 · 17 · 9½

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Per Imioglio ende oncosten

Compound unit arithmetic

	£	s.	d.
	28	15	8
	32	8	11
	54	18	7
	18	12	9
Answer	**£134**	**15s.**	**11d.**
Unit total	132	53	35
Divide by base	-	53 / 20	35 / 12
Carried forward	2	2	-
Remainder	-	13	11

Problem space

- Three separate units make up one value
- The units have non-decimal bases
- Need to use compound-unit arithmetic to normalize values
- The non-decimal bases differed by currency

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Simple normalization function

Fixed bases of 20s. and 12d.

```
# Normalize a numeric vector of length 3
normalize <- function(x) {
  pounds <- x[[1]] + ((x[[2]] + x[[3]] %/%
    12) %/% 20)
  shillings <- (x[[2]] + x[[3]] %/% 12) %% 20
  pence <- x[[3]] %% 12

  c(pounds, shillings, pence)
}

normalize(c(132, 53, 35))
#> [1] 134  15  11
```

Compound unit arithmetic

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Create an S3 class for non-decimal currencies

```
lsd <- function(x, bases = c(20, 12)) {
  structure(x,
            class = "lsd",
            bases = bases)
}

class(lsd(c(134, 15, 11)))
#> [1] 134 15 11
#> attr(,"class")
#> [1] "lsd"
#> attr(,"bases")
#> [1] 20 12
```

Create an S3 class for non-decimal currencies

To-do list

Use lists instead of vectors to have multiple values

Change normalization method

What other methods do w

Print

Concatenat

Subs

asting to other classes

Plots

What else do I have to do? 🤯😩

ic operators

Mathematical functions

https://vctrs.r-lib.org

Goals of vctrs

- Type stability
- Size stability
- Make it easier to build new S3 classes

What do you get by using vctrs?

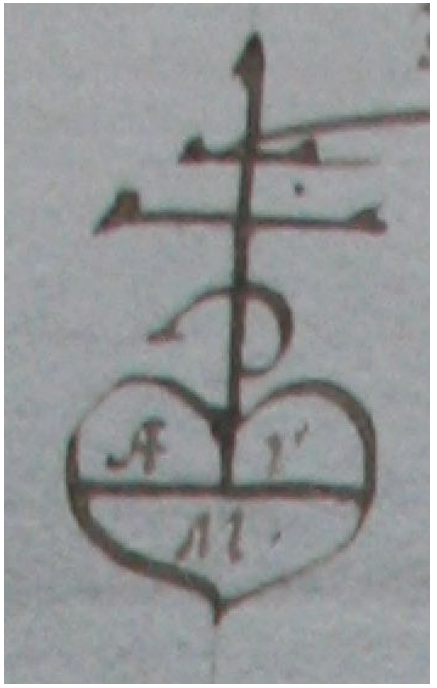
- Clear development path for creating an S3 class
- Consistency with base R functionality
- Integration with the tidyverse

Goals for the talk

- Why you might want to create your own S3 class
- Why you should use vctrs
- Point you to how you can do it

debvctrs

Why and how to use vctrs



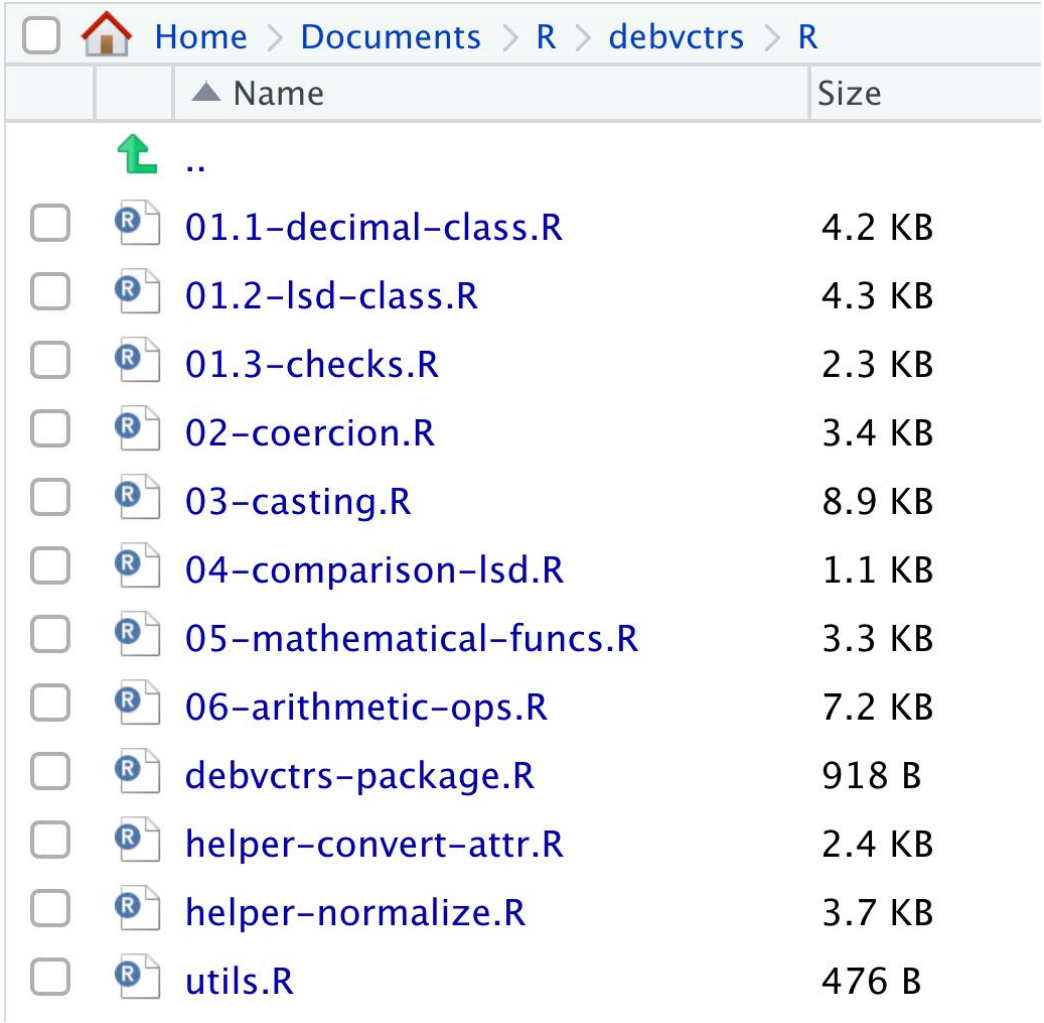
- debvctrs example package on GitHub:
  - github.com/jessesadler/debvctrs
- Simplified version of debkeepr:
  - jessesadler.github.io/debkeepr
- Step-by-step guide to building S3-vector classes with vctrs
  - Use in tandem with vctrs S3 vignette
  - https://vctrs.r-lib.org/articles/s3-vector

Creating S3 classes with vctrs

1. Creation of the class
2. Coercion: implicit transformation of a class: `c()`
3. Casting: explicit transformation of a class: `as.numeric()`
4. Equality and comparison: `>`, `<`, `==`, etc.
5. Mathematical functions: `sum()`, `mean()`, etc.
6. Arithmetic operations: `+`, `-`, `*`, `/`, etc.

Creating S3 classes with vctrs based on double vector

1. Creation of the class
2. Coercion: implicit transformation of a class: `c()`
3. Casting: explicit transformation of a class: `as.numeric()`
4. ~~Equality and comparison: `>`, `<`, `==`, etc.~~
5. ~~Mathematical functions: `sum()`, `mean()`, etc.~~
6. Arithmetic operations: `+`, `-`, `*`, `/`, etc.



debvctrs R scripts

github.com/jessesadler/debvctrs

Compound unit arithmetic

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Answer	**£134**	**15s.**	**11d.**
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Problem space

- Three separate units make up one value
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- Need to use compound-unit arithmetic to normalize values
- The non-decimal bases differed by currency

Design principles

deb_lsd

- A class that maintains the tripartite structure of non-decimal currencies
- Tracks the bases of shillings and pence units
- Vectors with different bases cannot be combined

deb_decimal

- Decimalized class as fall back
- Tracks the bases of shillings and pence units
- Vectors with different bases cannot be combined
- Choose and track unit represented by decimalized class
- Vectors with different units can be combined but need coercion path

1. Creation

01.1-decimal-class.R, 01.2-lsd-class.r, and 01.3-check.R

1. Constructor: `new_lsd()` and `new_decimal()`
2. Helper: `deb_lsd()` and `deb_decimal()`
3. Formally declare S3 class: `setOldClass()`
4. Attribute access: `deb_bases()` and `deb_unit()`
5. Class check: `deb_is_lsd()` and `deb_is_decimal()`
6. Format method
7. Abbreviated name type

1. Creation

01.1-decimal-class.R, 01.2-lsd-class.r, and 01.3-check.R

deb_lsd()

Arguments

```
# 1. Constructor
new_lsd <- function(l = double(),
                    s = double(),
                    d = double(),
                    bases = c(20L, 12L)) {

  vctrs::new_rcrd(list(l = l, s = s, d = d),
                  bases = bases,
                  class = "deb_lsd")
}
```

deb_decimal()

```
# 1. Constructor
new_decimal <- function(x = double(),
                        unit = c("l", "s", "d"),
                        bases = c(20L, 12L)) {

  vctrs::new_vctr(x = x,
                  unit = unit,
                  bases = bases,
                  class = "deb_decimal",
                  inherit_base_type = TRUE)
}
```

Creation of class

Structure of the classes

`deb_lsd()`

record-style vector

```
deb_lsd(l = c(17, 32, 18),
        s = c(16, 7, 12),
        d = c(6, 9, 3))
```

```
#> <deb_lsd[3]>
#> [1] 17:16s:6d 32:7s:9d
#> [3] 18:12s:3d
#> # Bases: 20s 12d
```

Bases attribute

Printing methods

`deb_decimal()`

double vector

```
deb_decimal(x = c(17.8250,
                  32.3875,
                  18.6125))
```

```
#> <deb_decimal[3]>
#> [1] 17.8250 32.3875
#> [3] 18.6125
#> # Unit: pounds
#> # Bases: 20s 12d
```

Unit attribute

Both work natively in a tibble

```
tibble(lsd = deb_lsd(l = c(17, 32, 18),
                     s = c(16, 7, 12),
                     d = c(6, 9, 3)),
       decimal = deb_decimal(x = c(17.8250,
                                   32.3875,
                                   18.6125)))
#> # A tibble: 3 x 2
#>               lsd      decimal
#>   <lsd[20s:12d]> <l[20s:12d]>
#> 1      17:16s:6d      17.8250
#> 2       32:7s:9d      32.3875
#> 3      18:12s:3d      18.6125
```

Coercion and casting with vctrs

1. Creation of the class
2. Coercion: implicit transformation of a class: `c()`
3. Casting: explicit transformation of a class: `as.numeric()`
4. Equality and comparison: `>`, `<`, `==`, etc.
5. Mathematical functions: `sum()`, `mean()`, etc.
6. Arithmetic operations: `+`, `-`, `*`, `/`, etc.

Coercion and casting workflow

1. Boilerplate
   - Define method for class
   - Default method for class for incompatible inputs
2. Methods within the class
3. Methods with compatible classes

Coercion and casting

- Coercion looks for the common type: `vec_ptype2(x, y)`
- Casting does the actual transformation: `vec_cast(x, to)`
- Casting makes comparison between classes possible

Design choices: coercion hierarchy

Define possibilities and implement hierarchy with: `vec_ptype2(x, y)`

Implementation with casting

Example of `deb_decimal()` to `deb_lsd()`

```
vec_cast.deb_lsd.deb_decimal <- function(x, to, ...) {
  bases_equal(x, to) # ensure that bases are equal
  # if else depending on the unit
  if (deb_unit(x) == "l") {
    lsd <- deb_lsd(x, 0, 0, bases = deb_bases(x))
  } else if (deb_unit(x) == "s") {
    lsd <- deb_lsd(0, x, 0, bases = deb_bases(x))
  } else if (deb_unit(x) == "d") {
    lsd <- deb_lsd(0, 0, x, bases = deb_bases(x))
  }
  # create normalized deb_lsd() vector
  deb_normalize(lsd)
}
```

Put it all together

```
# Combine multiple types
c(deb_lsd(134, 15, 11), deb_decimal(14.875), 28.525)
#> <deb_lsd[3]>
#> [1] 134:15s:11d 14:17s:6d   28:10s:6d
#> # Bases: 20s 12d

# Compare different types
deb_decimal(3255, unit = "d") > deb_lsd(15, 13, 4)
#> [1] FALSE

# Arithmetic with different types
deb_decimal(3255, unit = "d") + deb_lsd(15, 13, 4)
#> <deb_lsd[1]>
#> [1] 29:4s:7d
#> # Bases: 20s 12d
```

You can create your own S3 vector

- Extend the capabilities of R to fit your own needs
- vctrs provides a clear development path

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Resources

- Slides: jessesadler.com/slides/RStudio2020.pdf
- debvctrs: github.com/jessesadler/debvctrs
- debkeepr: jessesadler.github.io/debkeepr
- vctrs websitesite: vctrs.r-lib.org
  - The S3 vignette is particularly helpful
- Hadley Wickham, *Advanced R:* Chapter 13: S3