purrr beyond map()

(fun)ctional programming in R

```
result <- purrr::modify(.x = , .f = )
```

PREDICTIVE INSIGHTS

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The obligatory preamble

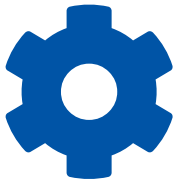
Making sure we are all on the same page

Disclaimer

- *purrr fantatic* ¬□ *purrr expert*
- 15min ≠ enough time

Admissions

- I'm an *extreme centrist* w.r.t. `tidyverse` and `data.table`
- I love to `%>%`



Setup

- Working in RStudio in an `.Rproj` context
- Using same set of packages throughout
- Using the `mpg` dataset (`ggplot2`) throughout

```
library(data.table)
library(tidyverse)
```

The purrr package

what is it and why should I care?

> *A complete and consistent functional programming toolkit for R*
> *- `help(purrr)`*
>
> *… to give you similar expressiveness to a classical FP language, while allowing you to write code that looks and feels like R*
> *- purrr 0.1.0*

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map() is the posterchild, but Narnia lies beyond

- Other functions get less press
  - Terse official documentation
  - lack of package vignettes
  - few "*deep dive* tutorials and resources online

Things get good when you dive in

- purrr offers one of the highest rates of return on investment for any R package

purrr: what is it good for?

Absolutely ~~nothing~~ ~~everything~~ lots of stuff

Iterative tasks

- `lapply++`
  - more consistent, more general, more powerful

Working with lists

- Yes, even complex, nested lists
- It's lists, all the way down

Creating consistent, robust functions/routines

- Consistent syntax
- Fail loudly
- Nice error handling

Some tips

Useful things to keep in mind when using purrr

When not to use `purrr`

- `lapply()` is the base equivalent to `map()` (sans `purrr` *helpers* support)
  - if you're only using `map()` from purrr, you can skip the additional dependency and use `lapply()` directly
- there is no need to map if the operation is already appropriately vectorised

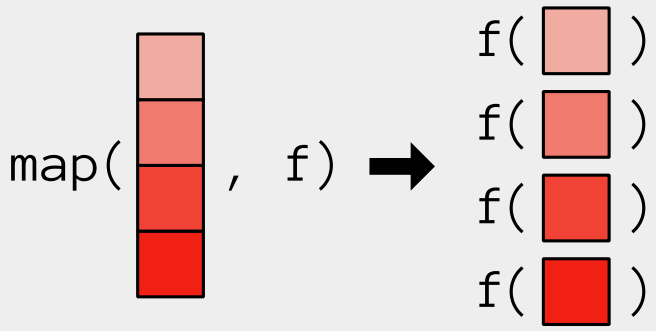
Avoiding nasty surprises

- `map*()` and `modify()` functions always return output of the same length as the input

Never forget

- a data frame is simply a list of [consistently typed] vectors of equal length

A map() primer

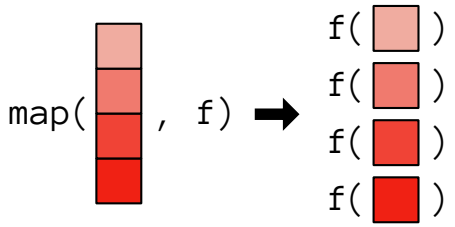


map()

Apply to all

`map(.x, .f)`

call function `.f` once for each element of vector `.x`; return the result as a list



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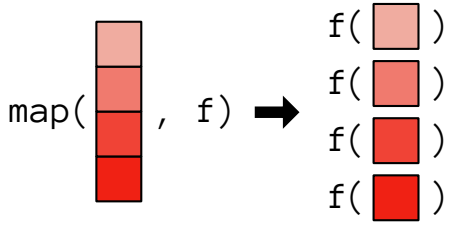


Get the square of each number from 1 to 5

```
# function to get square of number
my_square <- function(x) x^2

# get square of each number 1:5 and output as list
res1 <- 1:5 %>% map(my_square)                 # direct call
res2 <- 1:5 %>% map(~my_square(.))            # for backward compatibility
res3 <- 1:5 %>% map(~my_square(.x))           # formula
res4 <- 1:5 %>% map(function(x) my_square(x)) # inline anonymous function

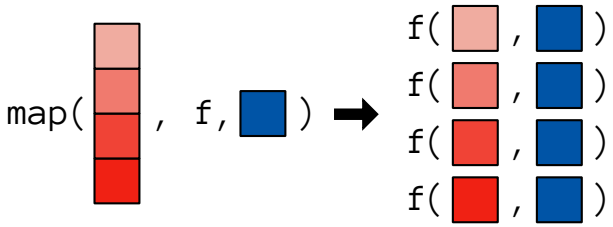
# test equivalence
identical(res1, res2) & identical(res2, res3) & identical(res3, res4)
```

```
[1] TRUE
```

Passing arguments with . . .

Many ways to do to the same thing

`map(.x, .f, ...)`
passes arguments specified in ... along



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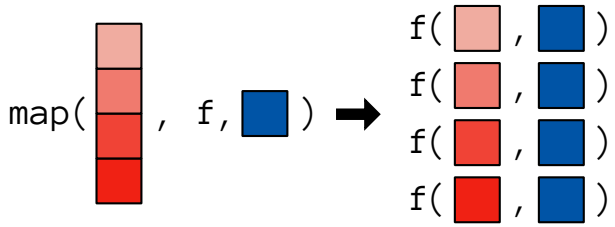

Use `paste()` to add 'min' as suffix to each number from 1 to 5

```
# pass arguments along
spec1 <- 1:5 %>% map(paste, 'min')

# formula specification (two variants)
spec2 <- 1:5 %>% map(~paste(., 'min'))
spec3 <- 1:5 %>% map(~paste(.x, 'min'))

# inline anonymous function specification
spec4 <- 1:5 %>% map(function(x) paste(x, 'min'))

# test equivalence
list(spec2, spec3, spec4) %>% map_lgl(identical, y = spec1)
```

```
[1] TRUE TRUE TRUE
```

Passing arguments: via `...` vs in function

A seemingly subtle, yet important difference

Not all that seems vecorised is...

- `map()` is only vectorised over its first argument so arguments passed to `map()` after `.f` will be
  - passed along as is and
  - evaluated once

What is that supposed to mean?

- Has implications if you pass arguments to function via `...`
  - errors if you pass vectors as arguments to functions that do not accept vectors as arguments
  - potentially wrong results even if arguments specified correctly

Passing arguments: via `...` vs in function

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```
# function that multiplies input (arg1) by specified constant (arg2)
temp_func <- function(x, constant = 2) {
  glue::glue('{x} x {constant} = {x*constant}')
}

# method 1: pass parameterised arg2 directly to map_chr
1:5 %>% map_chr(temp_func, constant = sample(1:10, 1))

# method 2: pass parameterised arg2 into inline anonymous function
1:5 %>% map_chr(function(x) temp_func(x, constant = sample(1:10, 1)))
```

```
[1] "1 x 2 = 2"  "2 x 2 = 4"  "3 x 2 = 6"  "4 x 2 = 8"  "5 x 2 = 10"
[1] "1 x 8 = 8"  "2 x 1 = 2"  "3 x 7 = 21" "4 x 7 = 28" "5 x 7 = 35"
```

map_*()

Specifying the output format

`map_*(.x, .f, ...)`

call function `.f` once for each element of vector `.x`; return the result as an atomic vector of type `*`; error if impossible

- `map_chr(.x, .f)`: character
- `map_lgl(.x, .f)`: logical
- `map_dbl(.x, .f)`: real
- `map_int(.x, .f)`: integer
- `map_dfr(.x, .f)`: data frame (`bind_rows`)
- `map_dfc(.x, .f)`: data frame (`bind_cols`)

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- `map_dfc(.x, .f)`: data frame (`bind_cols`)

```
1:5 %>% map_chr(paste, 'min') %>% class()
```

```
[1] "character"
```

```
1:5 %>% map_lgl(function(x) x < 3) %>% class()
```

```
[1] "logical"
```

```
1:5 %>% map_int(function(x) x * 2L) %>% class()
```

```
[1] "integer"
```

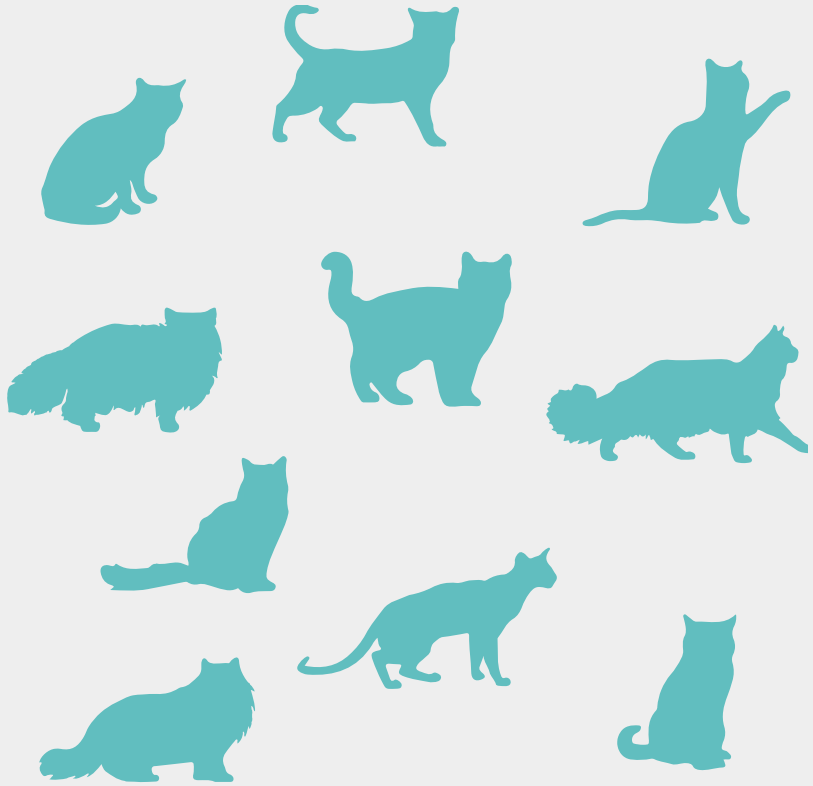
```
1:5 %>% map_dfr(function(x) tibble(value = x)) %>% class()
```

```
[1] "tbl_df"     "tbl"        "data.frame"
```

```
1:5 %>% map_dfc(function(x) data.table(value = x)) %>% class()
```

```
[1] "data.table" "data.frame"
```

Map variants



`walk()` and `modify()`

`map()` has siblings...

`walk(.x, .f, ...)`

call function `.f` once for each element of `.x`; return nothing

`modify(.x, .f, ...)`

call function `.f` once for each element of `.x`; return the result as an object of the same type as `.x`

walk() and modify()

map() has siblings...

`walk(.x, .f, ...)`

call function `.f` once for each element of `.x`; return nothing

```
# no output
1:5 %>% walk(paste, 'min')
```

```
# output, but not what you might have expected
1:5 %>% walk(function(x) x ^ 2) %>% print()
```

```
[1] 1 2 3 4 5
```

```
# proof that walk is actually doing stuff
1:5 %>% walk(function(x) print(x ^ 2)) %>% print()
```

```
[1] 1
[1] 4
[1] 9
[1] 16
[1] 25
[1] 1 2 3 4 5
```

`modify(.x, .f, ...)`

call function `.f` once for each element of `.x`; return the result as an object of the same type as `.x`

```
# obviously a character vector
x <- c('1', '2', '3', '4', '5')
```

```
# try to convert each element to integer using map_dbl
x %>% map_dbl(as.integer)
```

```
[1] 1 2 3 4 5
```

```
# try to convert each element to integer using modify
x %>% modify(as.integer)
```

```
[1] "1" "2" "3" "4" "5"
```

Why `walk()`? Why `modify()`?

What's the point?

`walk(.x, .f, ...)`

call function `.f` once for each element of `.x`; return nothing

`modify(.x, .f, ...)`

call function `.f` once for each element of `.x`; return the result as an object of the same type as `.x`



Just do stuff

- Some functions just need to do stuff, not necessarily return stuff
  - E.g.: `cat()`, `message()`, `saveRDS()`, etc
- Particularly useful for disk I/O operations
- Allows input "passthrough"



Change the content; keep the wrapper

- Some functions just need to change stuff, not necessarily create stuff
- Not everything needs to be coerced
  - What if input is already of the type we want as output?
  - Type preservation can be essential
- Particularly useful are the `modify_if()` and `modify_at()` variants

`map()` variants cheatsheet

Basic rules & the matrix of understanding

map variant rules:

1. `map()` returns list; `map_*()` returns vector of type specified
2. `modify()` returns same type as input
3. `walk()` returns nothing
4. Iterate over two inputs with `map2()`, `walk2()`, `modify2()`
5. Iterate over input and index with `imap()`, `imodify()`, `iwalk()`
6. Iterate over any number of inputs with `pmap()` and `pwalk()`

map variant matrix:

- map family of functions has orthogonal input and outputs
- can organise all the family into a matrix, with inputs in the rows and outputs in the columns

arguments	list	atomic	preserve type	nothing
one argument	`map()`	`map_lgl(), ...`	`modify()`	`walk()`
two arguments	`map2()`	`map2_lgl(), ...`	`modify2()`	`walk2()`
one argument + index	`imap()`	`imap_lgl(), ...`	`imodify()`	`iwalk()`
n arguments	`pmap()`	`pmap_lgl(), ...`	`NA`	`pwalk()`

Using `walk()`

Iteratively write data to disk using `purrr::pwalk()`

❓ For each manufacturer in the `mpg` dataset, write a `.csv` file to disk containing only the data for that manufacturer

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# check for files (show that there are none)
list.files('data/mpg')
```

```
character(0)
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```
# create files by taking the mpg df %>% collapsing the data for each manufacturer into a list column %>% walking
over the two columns in the df and for each pair (i.e. row of manufacturer and data values) doing: {create path
variable to point to the path where the data should be written %>% write the data to disk in .csv format}
mpg %>%
  group_nest(manufacturer, keep = T) %>%
  pwalk(function(manufacturer, data) {
    path <- file.path('data/mpg', glue::glue('df_{manufacturer}.csv'))
    write_csv(data, path)
  })
```

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    write_csv(data, path)
  })
```

```
# check for files again (show that there are now files)
list.files('data/mpg') %>% {c(head(., 2), tail(., 2))}
```

```
[1] "df_audi.csv"       "df_chevrolet.csv"  "df_toyota.csv"     "df_volkswagen.csv"
```

Using `iwalk()`

Iteratively read data into `purrr::iwalk()`

❓ Read each of the `.csv` files just written to disk into R's global environment as a data frames. Use each file's name (without the `.csv` extension) as the name for its data frame.

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```
# get a list of all of the .csv files located in data/mpg %>% using set_names, name each element in this list with
its filename sans the .csv extension %>% using iwalk to apply the assign function to each element in the list.
Specifically, use fread to read the csv file from disk into a data frame and then assign that data frame as a named
object to R's global environment
list.files('data/mpg', pattern = '.csv', full.names = T) %>%
  set_names(str_remove(basename(.), '.csv$')) %>%
  iwalk(function(x, i) assign(i, fread(x), .GlobalEnv))
```

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Using `modify_*()`

Conditionally change contents using `purrr::modify_if()`

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```
# define function to express each element in vector as % deviation from mean
myfunc <- function(x) x / mean(x, na.rm = T) - 1
```

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```
# data.table approach
# take mpg %>% convert to data.table %>% group by
manufacturer, then use modify_if to target all numeric
columns and modify each using the deviation function
a <- mpg %>%
  setDT() %>%
  .[by = .(manufacturer),
    j = modify_if(.SD, is.numeric, myfunc)]
```

```
# dplyr approach
# take mpg %>%  group by manufacturer %>%  use mutate_if
to mutate all numeric columns using the deviation
function %>% ungroup the data
b <- mpg %>%
  group_by(manufacturer) %>%
  mutate_if(is.numeric, myfunc) %>%
  ungroup()
```

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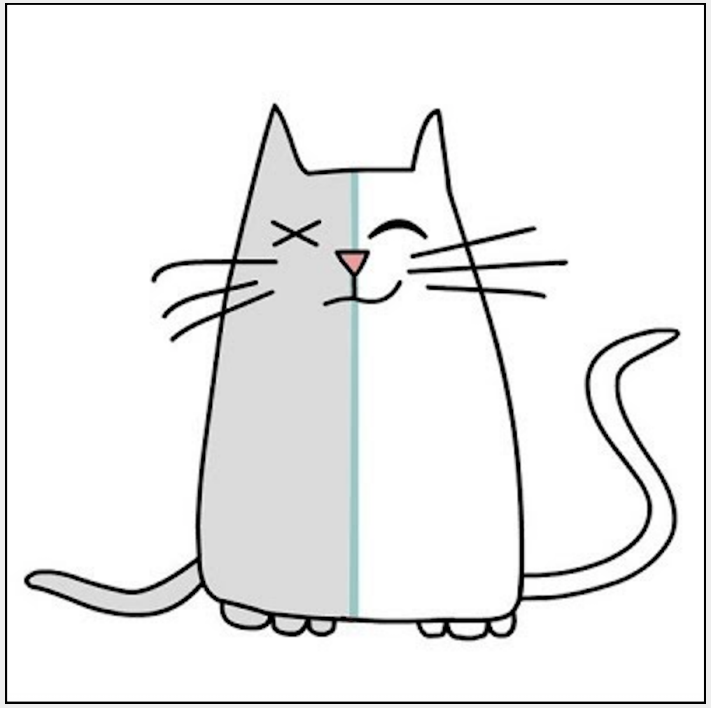
```

```
# show that methods produce equivalent outputs
all_equal(a, b)
```

```
[1] TRUE
```

Predicate functionals

A predicate function is a function that either returns `TRUE` or `FALSE`. Predicate functionals take vector `.x` and predicate function `.f` and do something useful.



Using `every()` and `some()`

All or ~~nothing~~ some!

❓ For which manufacturers in the `mpg` dataset do the city miles per gallon (`cty`) exceed (a) 15mpg on at least some models and/or (b) 25 mpg on all models?

```
# take mpg %>%  group by manufacturer %>%  use
summarise to create 2 summary columns: all_above_15
captures whether every value of cty > 15, while
some_above_25 captures whether some values of cty >
25 %>% ungroup the data
mpg %>%
  group_by(manufacturer) %>%
  summarise(
    all_above_15 = every(cty, function(x) x > 15),
    some_above_25 = some(cty, function(x) x > 25))
%>%
  ungroup()
```

Using every() and some()

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```

```
# A tibble: 15 x 3
   manufacturer all_above_15 some_above_25
   <chr>        <lgl>        <lgl>
 1 audi         FALSE        FALSE
 2 chevrolet    FALSE        FALSE
 3 dodge        FALSE        FALSE
 4 ford         FALSE        FALSE
 5 honda        TRUE         TRUE
 6 hyundai      TRUE         FALSE
 7 jeep         FALSE        FALSE
 8 land rover   FALSE        FALSE
 9 lincoln      FALSE        FALSE
10 mercury      FALSE        FALSE
11 nissan       FALSE        FALSE
12 pontiac      TRUE         FALSE
13 subaru       TRUE         FALSE
14 toyota       FALSE        TRUE
15 volkswagen   TRUE         TRUE
```

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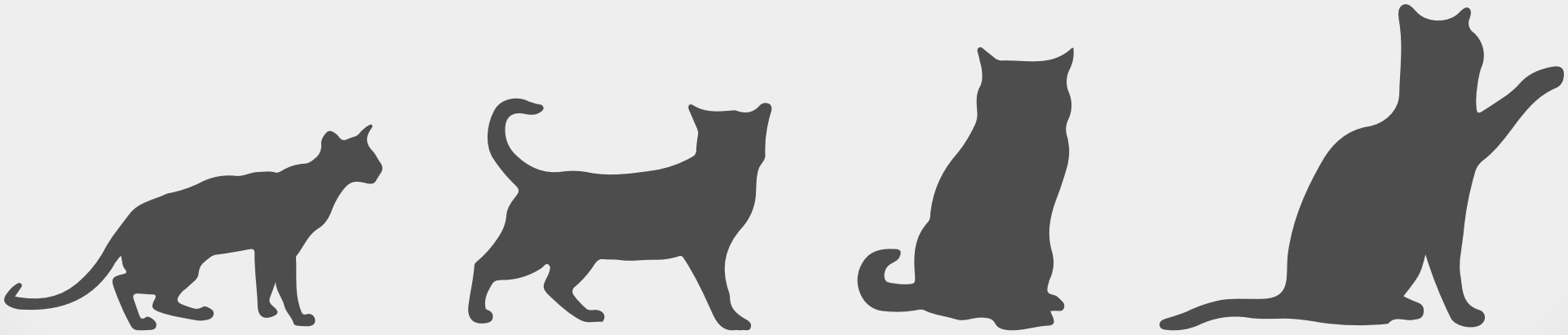
%>%
  ungroup()
```

Bonus:

```
# take mpg %>%  group by manufacturer %>%  filter to
keep only data for manufacturers whose models all
have cty > 15mpg
mpg %>%
  group_by(manufacturer) %>%
  filter(every(cty, function(x) x > 15))
```

```
# A tibble: 15 x 3
   manufacturer all_above_15 some_above_25
   <chr>        <lgl>        <lgl>
 1 audi         FALSE        FALSE
 2 chevrolet    FALSE        FALSE
 3 dodge        FALSE        FALSE
 4 ford         FALSE        FALSE
 5 honda        TRUE         TRUE
 6 hyundai      TRUE         FALSE
 7 jeep         FALSE        FALSE
 8 land rover   FALSE        FALSE
 9 lincoln      FALSE        FALSE
10 mercury      FALSE        FALSE
11 nissan       FALSE        FALSE
12 pontiac      TRUE         FALSE
13 subaru       TRUE         FALSE
14 toyota       FALSE        TRUE
15 volkswagen   TRUE         TRUE
```

other vector transformations



`reduce()` and `accumulate()`

Collapsing it all or building it up

`reduce(.x, .f, ..., .init)`

use function `.f` to combine elements of `.x` by passing the result of each itteration as an initial value to the next itteration; return single result from final itteration

`accumulate(.x, .f, ..., .init)`

use function `.f` to combine elements of `.x` by passing the result of each itteration as an initial value to the next itteration; return list of results from each itteration

reduce() and accumulate()

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```
# return cumulative sum of 1:5
1:5 %>% reduce(`+`)
1:5 %>% reduce(function(x, y) x + y)
```

```
[1] 15
```

```
# which numbers appear in the vector 1:5
1:5 %>% reduce(function(x, y) paste(x, 'and', y))
```

```
[1] "1 and 2 and 3 and 4 and 5"
```

```
# return each step in cumulative sum of 1:5
1:5 %>% accumulate(`+`)
1:5 %>% accumulate(function(x, y) x + y)
```

```
[1]  1  3  6 10 15
```

```
# which numbers appear in each itteration
1:5 %>% accumulate(function(x, y) paste(x, 'and', y))
```

```
[1] "1"                          "1 and 2"
"1 and 2 and 3"            "1 and 2 and 3 and 4"
[5] "1 and 2 and 3 and 4 and 5"
```

Why `reduce()`? Why `accumulate()`?

what's the point?

`reduce(.x, .f, ..., .init)`
use function `.f` to combine elements of `.x` by passing the result of each itteration as an initial value to the next itteration; return single result from final itteration

`accumulate(.x, .f, ..., .init)`
use function `.f` to combine elements of `.x` by passing the result of each itteration as an initial value to the next itteration; return list of results from each itteration



E pluribus unum

- I want just one thing
- Getting that thing requires repeating (effectively) the same additive operation
  - E.g.: `bind_rows()`, `bind_cols()`, `left_join()`, `merge`, etc



Build something bit by bit

- Some functions just need to change stuff, not necessarily create stuff
- Not everything needs to be coerced
  - What if input is already of the type we want as output?
  - Type preservation can be essential
- Particularly useful are the `modify_if()` and `modify_at()` variants

Using `accumulate()`

Building up a model using `purrr::accumulate()`

❓ Starting with `cty ~ manufacturer` as a base, **(1)** build up several linear model specifications for estimating the city miles per gallon (`cty`) in the `mpg` dataset by incrementally adding the `trans`, `drv`, and `class` terms to the model. **(2)** Estimate each model and report the adjusted R-squared.

Using `accumulate()`

Building up a model using `purrr::accumulate()`

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1

```
# create a vector of model specifications by taking
the relevant column names %>% accumulating each into
the base specification using paste and a ' + '
separator  %>% number each model sequentially using
set_names %>% print the results in a neatly formatted
tibble
models <- c('trans', 'drv', 'class') %>%
  accumulate(function(x, y) paste(x, y, sep = ' + '),
             .init = 'cty ~ manufacturer') %>%
  set_names(1:length(.))
enframe(models, name = 'model', value = 'spec')
```

```
# A tibble: 4 x 2
  model spec
  <chr> <chr>
1 1     cty ~ manufacturer
2 2     cty ~ manufacturer + trans
3 3     cty ~ manufacturer + trans + drv
4 4     cty ~ manufacturer + trans + drv + class
```

Using `accumulate()`

Building up a model using `purrr::accumulate()`

Starting with `cty ~ manufacturer` as a base, **(1)** build up several linear model specifications for estimating the city miles per gallon (`cty`) in the `mpg` dataset by incrementally adding the `trans`, `drv`, and `class` terms to the model. **(2)** Estimate each model and report the adjusted R-squared.

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  set_names(1:length(.))
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```

```
# A tibble: 4 x 2
  model spec
  <chr> <chr>
1 1     cty ~ manufacturer
2 2     cty ~ manufacturer + trans
3 3     cty ~ manufacturer + trans + drv
4 4     cty ~ manufacturer + trans + drv + class
```

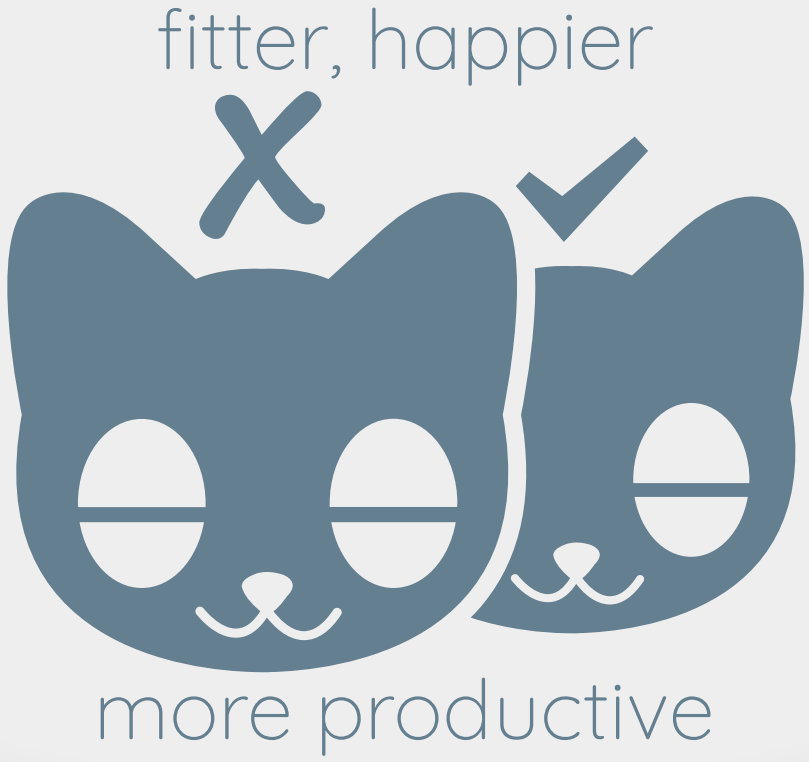
2

```
# take models %>% estimate each by using map to apply
the lm function %>% get the summary for each set of
results by using map to apply the summary function
%>% extract the adjust r-squared for each set of
summary results by using map_dbl to extract it by
name %>% print the results in a neatly formatted
tibble
models %>%
  map(lm, data = mpg) %>%
  map(summary) %>%
  map_dbl("adj.r.squared") %>%
  enframe(name = 'model', value = 'Adj-R2')
```

```
# A tibble: 4 x 2
  model `Adj-R2`
  <chr>    <dbl>
1 1        0.528
2 2        0.551
3 3        0.687
4 4        0.713
```

Adverbs

modify the action of a function; taking a function as input and returning a function with modified action as output



`compose()` and `partial()`

Why work so hard?

`compose(..., .dir = c('backward, 'forward))`

apply functions `...` in order in the direction `.dir` specified

`partial(.f, ...)`

modify function `.f` by pre-filling and fixing some of its arguments

compose() and partial()

Why work so hard?

`compose(..., .dir = c('backward, 'forward))`

apply functions `...` in order in the direction `.dir` specified

```
round(mean(log(1:20), na.rm = T), digits = 2)
```

```
[1] 2.12
```

```
round(mean(log(5:100), na.rm = T), digits = 2)
```

```
[1] 3.76
```

```
# compose steps into a function
mycomp <- compose(log,
                  ~ mean(.x, na.rm = T),
                  ~ round(.x, digits = 2),
                  .dir = 'forward')
mycomp(1:20)
```

```
[1] 2.12
```

```
mycomp(5:100)
```

```
[1] 3.76
```

`partial(.f, ...)`

modify function `.f` by pre-filling and fixing some of its arguments

```
round(0.532131245, digits = 2)
```

```
[1] 0.53
```

```
round(12394.13498134, digits = 2)
```

```
[1] 12394.13
```

```
# prefill and fix parameter (WARNING!)
myround <- partial(round, digits = 2)

myround(0.532131245)
```

```
[1] 0.53
```

```
myround(12394.13498134)
```

```
[1] 12394.13
```

```
myround(1/3, digits = 2)
```

```
Error in (function (x, digits = 0) : formal argument
"digits" matched by multiple actual arguments
```

Using compose( )

There's more than one way to ~~skin~~ pet a cat

❓ Compose a function that can be used to estimate each model in the previously defined `models` vector and report the adjusted R-squared.

Using compose( )

There's more than one way to ~~skin~~ pet a cat

Compose a function that can be used to estimate each model in the previously defined `models` vector and report the adjusted R-squared.

previously

```
# take models %>% estimate each by using map to apply
the lm function %>% get the summary for each set of
results by using map to apply the summary function
%>% extract the adjust r-squared for each set of
summary results by using map_dbl to extract it by
name %>% print the results in a neatly formatted
tibble
models %>%
  map(lm, data = mpg) %>%
  map(summary) %>%
  map_dbl("adj.r.squared") %>%
  enframe(name = 'model', value = 'Adj-R2')
```

```
# A tibble: 4 x 2
  model `Adj-R2`
  <chr>    <dbl>
1 1        0.528
2 2        0.551
3 3        0.687
4 4        0.713
```

Using compose( )

There's more than one way to ~~skin~~ pet a cat

Compose a function that can be used to estimate each model in the previously defined `models` vector and report the adjusted R-squared.

previously

```
# take models %>% estimate each by using map to apply
the lm function %>% get the summary for each set of
results by using map to apply the summary function
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models %>%
  map(lm, data = mpg) %>%
  map(summary) %>%
  map_dbl("adj.r.squared") %>%
  enframe(name = 'model', value = 'Adj-R2')
```

```
# A tibble: 4 x 2
  model `Adj-R2`
  <chr>    <dbl>
1 1        0.528
2 2        0.551
3 3        0.687
4 4        0.713
```

alternative

```
# compose a function that sends arguments to lm, then
passes the results to summary, then plucks the r-
squared from those results, then enframes
mycomp <- compose(lm, summary, ~pluck(.x,
'adj.r.squared'), ~enframe(.x, name = 'model', value
= 'adj.r.squared'),   .dir = 'forward')

# take models %>% estimate each by using map_dfr to
apply the mycomp function and row bind
models %>%
  map_dfr(~mycomp(.x, data = mpg))
```

```
# A tibble: 4 x 2
  model adj.r.squared
  <int>         <dbl>
1     1         0.528
2     1         0.551
3     1         0.687
4     1         0.713
```

`safely()`, `possibly()`, and `insistently()`

Failure is ~~not~~ an option!

`safely(.f, otherwise = NULL, quiet = TRUE)`

modifies function `.f` to return a list with components `result` (result if not error, NA otherwise) and `error` (error message if error, NULL otherwise).

`possibly(.f, otherwise, quiet = TRUE)`

modifies function `.f` to return `otherwise` if error occurs.

`insistently(f, rate = rate_backoff())`

modifies function `.f` to retry specified times on error.

safely(), possibly(), and insistently()

Failure is ~~not~~ an option!

`safely(.f, otherwise = NULL, quiet = TRUE)`

modifies function `.f` to return a list with components `result` (result if not error, NA otherwise) and `error` (error message if error, NULL otherwise).

`possibly(.f, otherwise, quiet = TRUE)`

modifies function `.f` to return `otherwise` if error occurs.

`insistently(f, rate = rate_backoff())`

modifies function `.f` to retry specified times on error.

```
# define bad function that only works on odd numbers
badfunc <- function(x) if (x %% 2 == 0) stop('Only odd numbers allowed')  else (x)

# define safe version of badfunc , possible, and insistent versions of badfunc
safely_badfunc <- safely(badfunc)

# define possible version of badfunc
possibly_badfunc <- possibly(badfunc, otherwise = NA_real_)

# define insistent version of badfunc
insistently_badfunc <- insistently(badfunc, rate = rate_backoff(pause_cap = 1, max_times = 4))
```

safely(), possibly(), and insistently()

Failure is ~~not~~ an option!

`safely(.f, otherwise = NULL, quiet = TRUE)`
modifies function `.f` to return a list with components `result` (result if not error, NA otherwise) and `error` (error message if error, NULL otherwise).

`possibly(.f, otherwise, quiet = TRUE)`
modifies function `.f` to return `otherwise` if error occurs.

`insistently(f, rate = rate_backoff())`
modifies function `.f` to retry specified times on error.

"Good" value

```
# test functions of "good" value
badfunc(1)
```

```
[1] 1
```

```
safely_badfunc(1)
```

```
$result
[1] 1

$error
NULL
```

```
possibly_badfunc(1)
```

```
[1] 1
```

```
insistently_badfunc(1)
```

```
[1] 1
```

"Bad" value

```
# test functions of "bad" value
badfunc(2)
```

```
Error in badfunc(2): Only odd numbers allowed
```

```
safely_badfunc(2)
```

```
$result
NULL

$error
<simpleError in .f(...): Only odd numbers allowed>
```

```
possibly_badfunc(2)
```

```
[1] NA
```

```
insistently_badfunc(2)
```

```
Error: Request failed after 4 attempts
```

Why `safely()`? Why `possibly()`? Why `insistently()`

what's the point?

`safely(.f, otherwise = NULL, quiet = TRUE)`
modifies function `.f` to return a list with components `result` (result if not error, NA otherwise) and `error` (error message if error, NULL otherwise).

`possibly(.f, otherwise, quiet = TRUE)`
modifies function `.f` to return `otherwise` if error occurs.

`insistently(f, rate = rate_backoff())`
modifies function `.f` to retry specified times on error.

Give me the info and let me decide what to do

- Ever called an API?
- Allows for robust, flexible error handling

Let's pretend that didn't happen, okay?

- Don't get bogged down with failures
- You care (a bit) about the fact that there was an error, but not enough to want to stop.
- You don't care at all about the reason for the error or you're fairly confident about why there is an error

If at first you don't succeed

- Get back on that horse!
- Really only useful if you expect the chance of success to change with repeated attempts
    - i.e. the input to the function could change over successive calls

More `purrr` fun(ctions)

But wait, there's more...

Generalisations

- `keep()` and `discard` as generalisations of `dplyr::select_if()`
- `pluck()` as generalisation of `[[` and `dplyr::pull()`
- etc.

Companions

- `prepend()` as companion to `append()`
- `negate()` as companion to any predicate function

etc

- more predicate functionals
- more vector transformations
- etc.

I'm intrigued...

Where can I learn more?

Reference (R/Rstudio)

- `help(package = purrr)`
- F1 to show function help
- F2 to inspect function

Reference (online)

- `purrr` cheatsheet
- `purrr` reference

Learning and understanding

- Hadley Wickham's Advanced R Chapter 9: Functionals
- Jenny Bryan's purrr tutorial
- Emil Hvitfeldt's Purrr - tips and tricks
- Emily Robinson's Going Off the Map: Exploring purrr's Other Functions
- Colin Fay's 6-part A Crazy Little Thing Called {purrr}