CHARLOTTE WICKHAM

SOLVING ITERATION PROBLEMS WITH PURRR

YOUR TURN

GETTING SETUP

1. Download slides @ http://bit.ly/purrr-slides

2. Check you have packages:

```
library(tidyverse)
library(repurrrsive)   # devtools::install_github("jennybc/repurrrsive")
```

ITERATION PROBLEMS

You are already solving them:

copy & paste, for loops, `(l/s)apply()`

I'll show you an alternative `purrr::map()` & friends

https://github.com/tidyverse/purrr

SOLVE ITERATION PROBLEMS

FOR EACH ____ DO ____

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copy & paste, for loops, `(l/s)apply()`

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https://github.com/tidyverse/purrr

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YOUR TURN

```
library(repurrrsive)

# includes objects: sw_films, sw_people, sw_vehicles,
# sw_starships, sw_planets & sw_species
```

1. How many elements are in `sw_people`?
2. Who is the first person listed in `sw_people`? What information is given for this person?
3. What is the difference between `sw_people[1]` and `sw_people[[1]]`?

BEWARE!
ANSWERS ON FOLLOWING SLIDE

Download slides @ http://bit.ly/purrr-slides

```
length(sw_people)
## [1] 87
```

```
sw_people[[1]]
## $name
## [1] "Luke Skywalker"
##
## $height
## [1] "172"
##
## $mass
## [1] "77"
##
## $hair_color
## [1] "blond"
##
## $skin_color
## [1] "fair"
##
## $eye_color
## [1] "blue"
##
## $birth_year
## [1] "19BBY"
##
## $gender
## [1] "male"
##
## $homeworld
## [1] "http://swapi.co/api/planets/1/"
##
## $films
## [1] "http://swapi.co/api/films/6/"
## [2] "http://swapi.co/api/films/3/"
## [3] "http://swapi.co/api/films/2/"
## [4] "http://swapi.co/api/films/1/"
## [5] "http://swapi.co/api/films/7/"
##
## $species
## [1] "http://swapi.co/api/species/1/"
##
## $vehicles
## [1] "http://swapi.co/api/vehicles/14/"
## [2] "http://swapi.co/api/vehicles/30/"
##
## $starships
## [1] "http://swapi.co/api/starships/
12/"
## [2] "http://swapi.co/api/starships/
22/"
##
## $created
## [1] "2014-12-09T13:50:51.644000Z"
##
## $edited
## [1] "2014-12-20T21:17:56.891000Z"
##
## $url
## [1] "http://swapi.co/api/people/1/"
```

map()

```
map( .x, .f, ...)
```

for each element of `.x` do `.f`

`.x`

- **a vector**
- a list
- a data frame (for each column)

`.f`

We'll get to that...

HOW MANY STARSHIPS HAS EACH CHARACTER BEEN IN?

for each person in `sw_people`, **count the number of starships**

```
map(sw_people, ____ )
```

STRATEGY

1. Do it for one element
2. Turn it into a recipe
3. Use `map()` to do it for all elements

```
luke <- sw_people[[1]]
```

HOW MANY STARSHIPS HAS LUKE BEEN IN?

Write a line of code to find out.

Bored? Find the names of those starships…

DO IT FOR ONE

Solve the problem for one element

```
luke <- sw_people[[1]]
```

```
length(luke$starships)
```

DO IT FOR ONE

Solve the problem for one element

```
luke <- sw_people[[1]]
```

```
length(luke$starships)
```

DO IT FOR ONE

Solve the problem for one element

```
leia <- sw_people[[5]]
```

```
length(leia$starships)
```

DO IT FOR ONE

Solve the problem for one element

```
____ <- sw_people[[?]]

     length(____$starships)
```

TURN IT INTO A RECIPE

Make it a formula

Use .x as a pronoun

```
length(____$starships)
```

TURN IT INTO A RECIPE

Make it a formula

Use .x as a pronoun

```
~ length(____$starships)
```

A formula

TURN IT INTO A RECIPE

Make it a formula

Use .x as a pronoun

```
~ length(   .x$starships)
```

A formula

purrr's "pronoun" for
one element of our vector

DO IT FOR ALL! Your recipe is the second argument to map

```
~ length(        $starships)
```

A formula

DO IT FOR ALL!

Your recipe is the second argument to map

```
map(          ,
   ~ length(       $starships) )
```

A formula

DO IT FOR ALL!

Your recipe is the second argument to map

```
map( sw_people,
  ~ length(   .x$starships) )
```

A formula

purrr's "pronoun" for
one element of our vector

```
map(sw_people, ~ length(.x$starships))
```

Copy and paste ME.

YOUR TURN

Create `planet_lookup` (ignore details for now):

```
planet_lookup <- map_chr(sw_planets, "name")  %>%
  set_names(map_chr(sw_planets, "url"))
planet_lookup
```

FIND THE NAME OF EACH CHARACTERS HOME WORLD.

Bored? Find the body mass index (BMI) of all characters.

bmi = (mass in kg) / ((height in m)^2)

```
luke$homeworld
## [1] "http://swapi.co/api/planets/1/"

planet_lookup[luke$homeworld]
## http://swapi.co/api/planets/1/
##                     "Tatooine"

map(sw_people, ~ planet_lookup[.x$homeworld])
## [[1]]
## http://swapi.co/api/planets/1/
##                     "Tatooine"

## [[2]]
## http://swapi.co/api/planets/1/
##                    "Tatooine"

## [[3]]
## http://swapi.co/api/planets/8/
##                        "Naboo"
...
```

ARE YOU PURRRING YET?

ROADmap()

```
map_lgl( .x, .f, ...)
```

Other types of output

Other ways of specifying .f

Other iteration functions

ROADmap()

```
map( .x, length, ...)
```

Other types of output

Other ways of specifying .f

Other iteration functions

ROADmap()

```
map2( .x, .y, .f, ...)
```

Other types of output

Other ways of specifying .f

Other iteration functions

map() details

`map()` **always** returns a **list**

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SIMPLER OUTPUT:

`map()` **always** returns a **list**

SIMPLER OUTPUT:

`map_lgl()` **logical** vector

`map()` **always** returns a **list**

SIMPLER OUTPUT:

`map_lgl()` **logical** vector

`map_int()` **integer** vector

`map()` **always** returns a **list**

SIMPLER OUTPUT:

`map_lgl()`	**logical** vector
`map_int()`	**integer** vector
`map_dbl()`	**double** vector

`map()` **always returns a list**

SIMPLER OUTPUT:

`map_lgl()`	**logical** vector
`map_int()`	**integer** vector
`map_dbl()`	**double** vector
`map_chr()`	**character** vector

`map()` **always returns a list**

SIMPLER OUTPUT:

`map_lgl()`	**logical** vector
`map_int()`	**integer** vector
`map_dbl()`	**double** vector
`map_chr()`	**character** vector

`walk()` - when you want nothing at all,
use a function for its side effects

`map()` **always returns a list**

SIMPLER OUTPUT:

`map_lgl()`	**logical** vector
`map_int()`	**integer** vector
`map_dbl()`	**double** vector
`map_chr()`	**character** vector

`walk()` - when you want nothing at all,
use a function for its side effects

Result: No surprises!

vector same length as `.x` or an `ERROR`

YOUR TURN

```
# names can be useful
sw_people <- sw_people %>% set_names(map_chr(sw_people, "name"))
```

REPLACE map() WITH THE APPROPRIATELY TYPED FUNCTION

```
# How many starships has each character been in?
map(sw_people, ~ length(.x[["starships"]]))

# What color is each character's hair?
map(sw_people, ~ .x[["hair_color"]])

# Is the character male?
map(sw_people, ~ .x[["gender"]] == "male")

# How heavy is each character?
map(sw_people, ~ .x[["mass"]])
```

```
# How many starships has each character been in?
map_int(sw_people, ~ length(.x[["starships"]]))

##    Luke Skywalker  C-3PO   R2-D2   Darth Vader
##                 2      0       0             1  ...

# What color is each character's hair?
map_chr(sw_people, ~ .x[["hair_color"]])

##    Luke Skywalker   C-3PO    R2-D2    Darth Vader
##           "blond"   "n/a"    "n/a"         "none" ...

# Is the character male?
map_lgl(sw_people, ~ .x[["gender"]] == "male")

##    Luke Skywalker    C-3PO   R2-D2    Darth Vader
##              TRUE    FALSE   FALSE           TRUE ...
```

```
# How heavy is each character?
map_dbl(sw_people, ~ .x[["mass"]])
## Error: Can't coerce element 1 from a character to a double
# Doesn't work...because we get a string back
map(sw_people, ~ .x[["mass"]])
## [[1]]
## [1] "77"
##
## [[2]]
## [1] "75"
...
```

```
# A little risky

map_dbl(sw_people, ~ as.numeric(.x[["mass"]]))

## [1]  77.0   75.0   32.0   136.0  49.0  120.0   75.0   32.0   84.0
## ...
## There were 29 warnings (use warnings() to see them)


# Probably want something like:

map_chr(sw_people, ~ .x[["mass"]]) %>%

  readr::parse_number(na = "unknown")

## [1]   77.0   75.0   32.0  136.0   49.0  120.0   75.0   32.0   84.0
## ...
```

.f CAN BE A FORMULA

```
map(.x, .f =  ~ DO SOMETHING WITH .x)
```

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map_int(sw_people, ~ length(.x[["starships"]]))
```

.f CAN BE A FORMULA

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map(.x, .f =  ~ DO SOMETHING WITH .x)
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```
map_int(sw_people, ~ length(.x[["starships"]]))
map_chr(sw_people, ~ .x[["hair_color"]])
```

.f CAN BE A FORMULA

```
map(.x, .f =  ~ DO SOMETHING WITH .x)
```

```
map_int(sw_people, ~ length(.x[["starships"]]))
map_chr(sw_people, ~ .x[["hair_color"]])
map_chr(sw_people, ~ .x[["mass"]])
```

`.f` CAN BE A STRING OR INTEGER

For each element, extract the named/numbered element

```
map(.x, .f = ”some_name”)
```

equivalent to

```
map(.x, ~ .x[[”some_name”]])
```

`.f` CAN BE A STRING OR INTEGER

For each element, extract the named/numbered element

```
map(.x, .f =  some_number )
```

equivalent to

```
map(.x, ~ .x[[some_number]])
```

.f CAN BE A STRING OR INTEGER

For each element, extract the named/numbered element

```
map(.x, .f = some_number )
```

equivalent to

```
map(.x, ~ .x[[some_number]])
```

```
map_chr(sw_people, ~ .x[["hair_color"]])
# becomes
map_chr(sw_people, "hair_color")
```

.f CAN BE A FUNCTION

```
map(.x, .f = some_function, ...)
```

.f CAN BE A FUNCTION

```
map(.x, .f = some_function, ...)
```

equivalent to

```
map(.x, ~ some_function(.x, ...))
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.f CAN BE A FUNCTION

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map(.x, .f = some_function, ...)
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equivalent to

```
map(.x, ~ some_function(.x, ...))
```

gets passed on to .f

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map(.x, .f = some_function, ...)
```

equivalent to

```
map(.x, ~ some_function(.x, ...))
```

gets passed on to .f

```
char_starships <- map(sw_people, ”starships”)
```

.f CAN BE A FUNCTION

```
map(.x, .f = some_function, ...)
```

equivalent to

```
map(.x, ~ some_function(.x, ...))
```

gets passed on to .f

```
char_starships <- map(sw_people, "starships")
map_int(char_starships, length)
```

.f CAN BE A FUNCTION

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map(.x, .f = some_function, ...)
```

equivalent to

```
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gets passed on to .f

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char_starships <- map(sw_people, "starships")
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# In one go
```

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equivalent to

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map(.x, ~ some_function(.x, ...))
```

gets passed on to .f

```
char_starships <- map(sw_people, "starships")
map_int(char_starships, length)

# In one go
map(sw_people, "starships") %>% map_int(length)
```

.f CAN BE A FUNCTION

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map(.x, .f = some_function, ...)
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equivalent to

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gets passed on to .f

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char_starships <- map(sw_people, "starships")
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# In one go
map(sw_people, "starships") %>% map_int(length)
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.f CAN BE A FUNCTION

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equivalent to

```
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gets passed on to .f

```
char_starships <- map(sw_people, "starships")
map_int(char_starships, length)

# In one go
map(sw_people, "starships") %>% map_int(length)

# also equivalent to
```

.f CAN BE A FUNCTION

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map(.x, .f = some_function, ...)
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gets passed on to .f

```
char_starships <- map(sw_people, "starships")
map_int(char_starships, length)

# In one go
map(sw_people, "starships") %>% map_int(length)

# also equivalent to
map_int(sw_people, ~ length(.x[["starships"]]))
```

.f CAN BE A FUNCTION

```
map(.x, .f = some_function, ...)
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equivalent to

```
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```
char_starships <- map(sw_people, "starships")
map_int(char_starships, length)

# In one go
map(sw_people, "starships") %>% map_int(length)

# also equivalent to
map_int(sw_people, ~ length(.x[["starships"]]))
```

don't be afraid to do things in little steps and pipe them together

FROM EARLIER...

Create `planet_lookup` (ignore details for now):

```
planet_lookup <- map_chr(sw_planets, ”name”)  %>%
  set_names(map_chr(sw_planets, ”url”))
planet_lookup
```

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planet_lookup <- map_chr(sw_planets, "name") %>%
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planet_lookup
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planet_lookup <- map_chr(sw_planets, ”name”)  %>%
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FROM EARLIER...

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planet_lookup <- map_chr(sw_planets, "name")  %>%
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FROM EARLIER...

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planet_lookup <- map_chr(sw_planets, "name")  %>%
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planet_lookup
```

FROM EARLIER...

Create `planet_lookup` ~~(ignore details for now)~~:

```
planet_lookup <- map_chr(sw_planets, "name")  %>%
  set_names(map_chr(sw_planets, "url"))
planet_lookup
```

```
x %>% set_names(y)
```

equivalent to

```
names(x) <- y
x
```

WHAT ABOUT `sapply()` & `lapply()`?

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What type of object does `sapply()` return?

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- consistent syntax for more complicated iteration

STAR WARS CHALLENGES

Which film (see `sw_films`) has the most characters?

Which `sw_species` has the most possible eye colors?

Which `sw_planets` do we know the least about (i.e. have the most `"unknown"` entries)?

BREAK?

```
# Which film (see sw_films) has the most characters?

map(sw_films, ”characters”) %>%

  map_int(length) %>%

  set_names(map_chr(sw_films, ”title”)) %>%

  sort()
```

```
# Which species has the most possible eye colors?
sw_species[[1]]$eye_colors


map_chr(sw_species, "eye_colors") %>%
  strsplit(", ") %>%
  map_int(length)
# this is lazy, what about n/a and unknown?
```

More iteration functions

to each element of .x apply .f

```
map(  .x ,  .f          )
```

to each element of .x apply .f

```
map(     ,             )
```

to each element of .x apply .f

map(,)

to each element of .x apply .f

map(, give_fish) to each cat apply .f

```
map(      , give_fish)
```

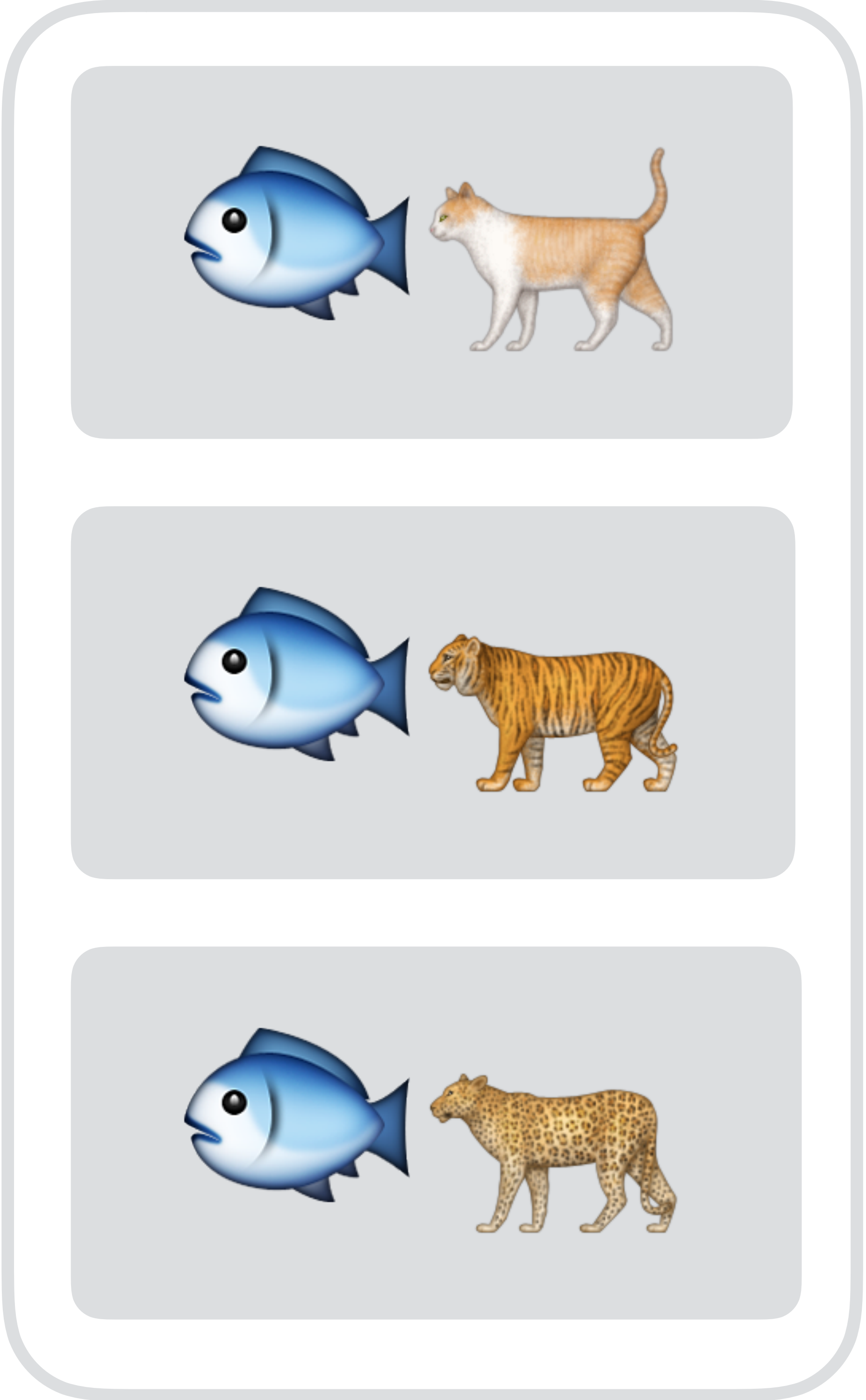
to each `cat` apply `give_fish`

```
map(
```

```
, give_fish)
```

to each `cat` apply `give_fish`

`map(` `, give_fish)`



to each element of .x apply .f

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

to each element of .x apply .f

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

Expect nothing in return

to each element of .x apply .f

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

Expect nothing in return

You actually get .x invisibly back,
good for piping

to each element of .x apply .f

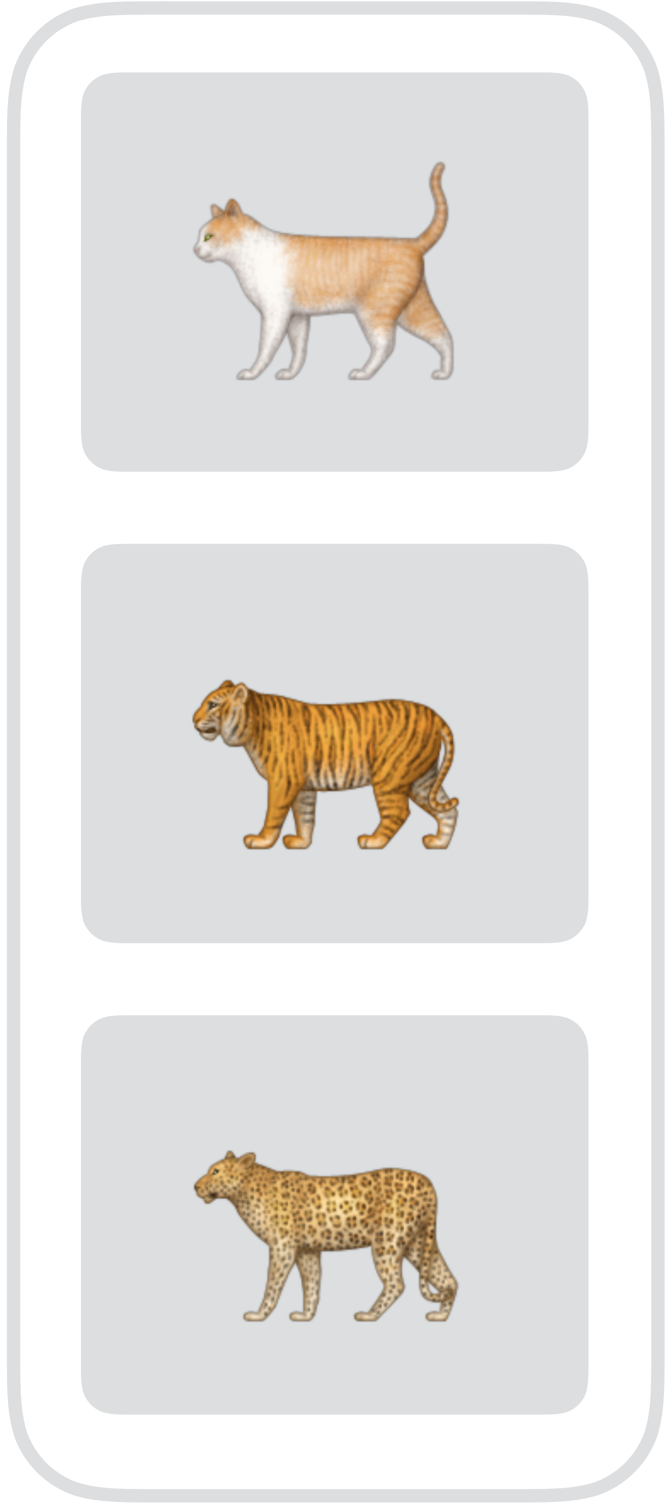
```
walk(     ,     )
```

to each element of .x apply .f

`walk(` `,` `)`

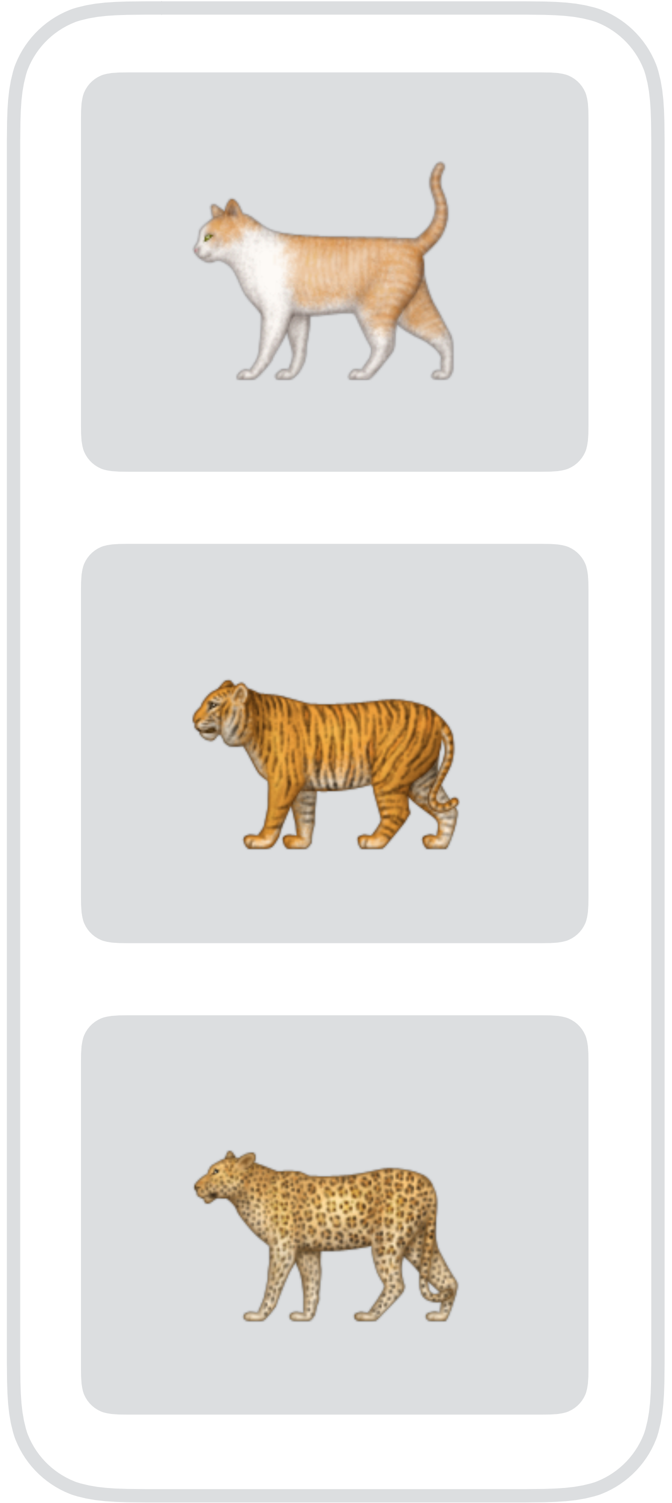
to each element of .x apply .f

```
walk(
```



```
, love )
```

to each cat apply .f

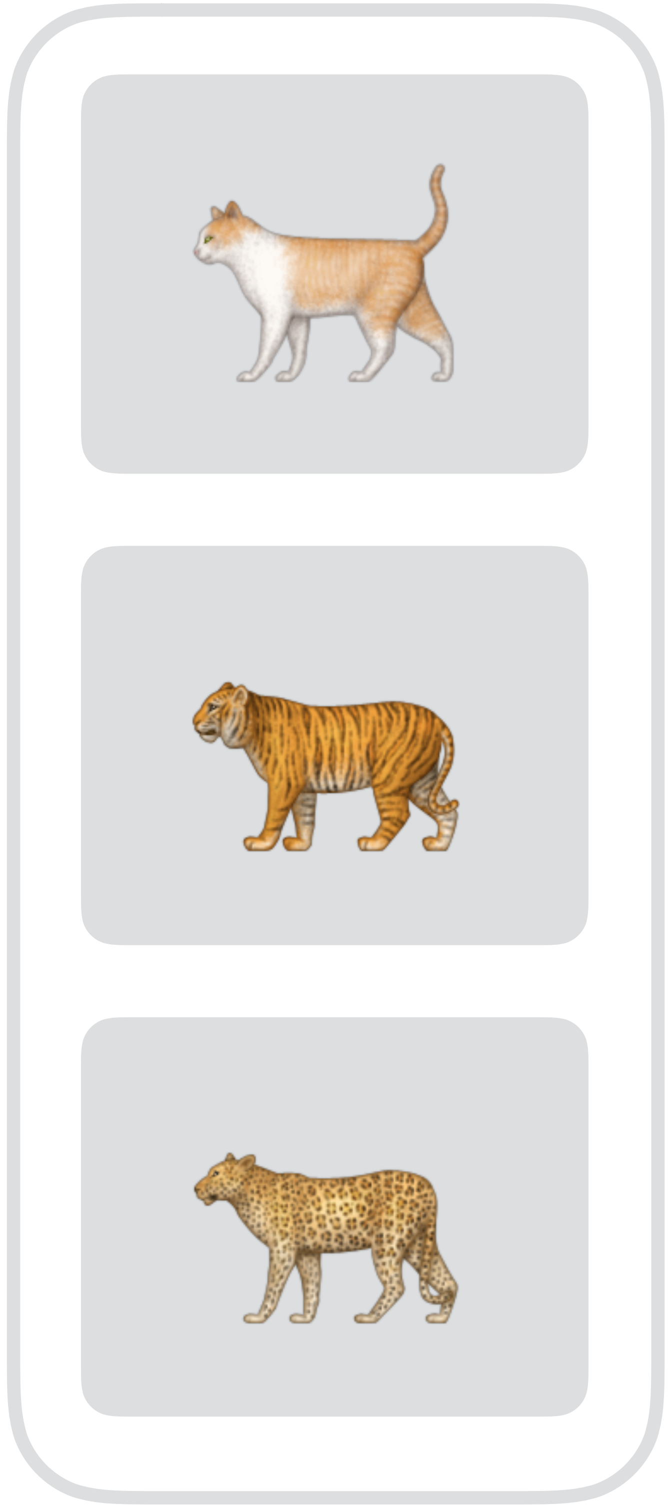
walk( , love) to each cat apply love

walk(, love) to each cat apply love

walk(, love)

Expect nothing in return

to each `cat` apply `love`

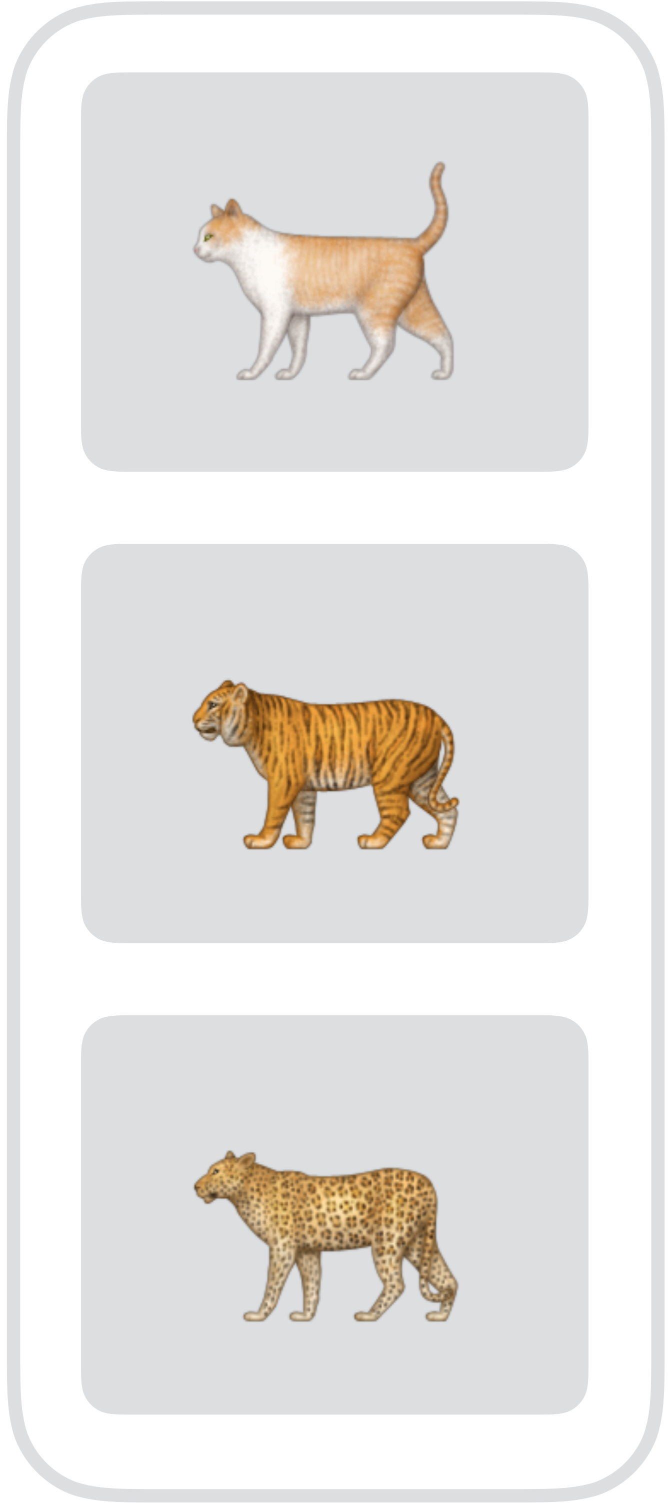
`walk(`  `, love )`

Expect nothing in return

You actually get .x invisibly back,
good for piping

to each `cat` apply `love`

```
walk(
```



```
, love )
```

Expect nothing in return

You actually get .x invisibly back, good for piping

For functions called for their side effects:

- printing to screen
- plotting to graphics device
- file manipulation (saving, writing, moving etc.)
- system calls

to each element of **.x** and corresponding element of **.y** apply **.f**

```
map2(  .x ,   .y ,  .f)
```

to each element of **.x** and corresponding element of **.y** apply **.f**

```
map2(      ,      ,     )
```

Always get a list back, or use:

```
walk2(), map2_lgl(), map2_int(), map2_dbl(), map2_chr()
```

to each element of **.x** and corresponding element of **.y** apply **.f**

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map2(                    ,              ,        )
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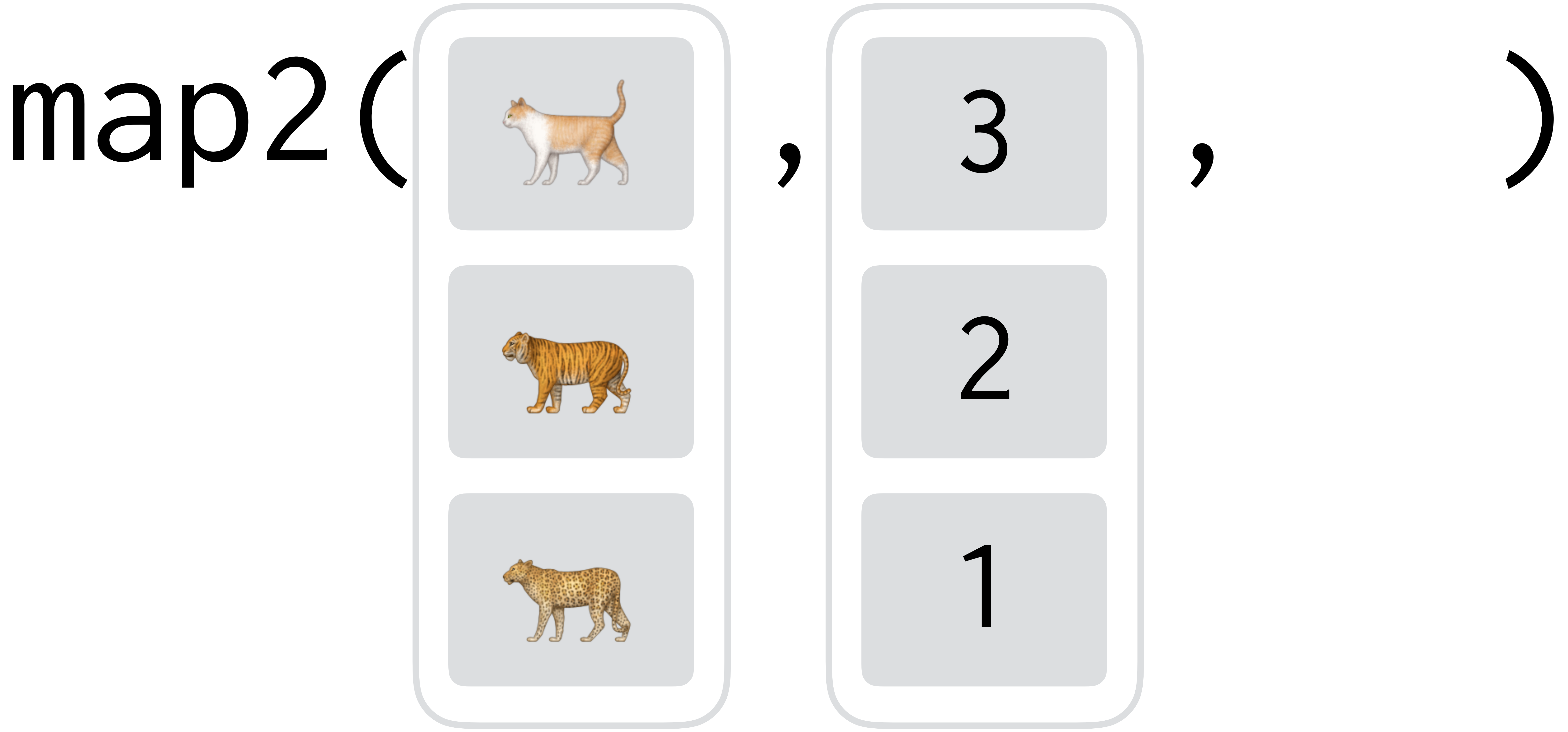
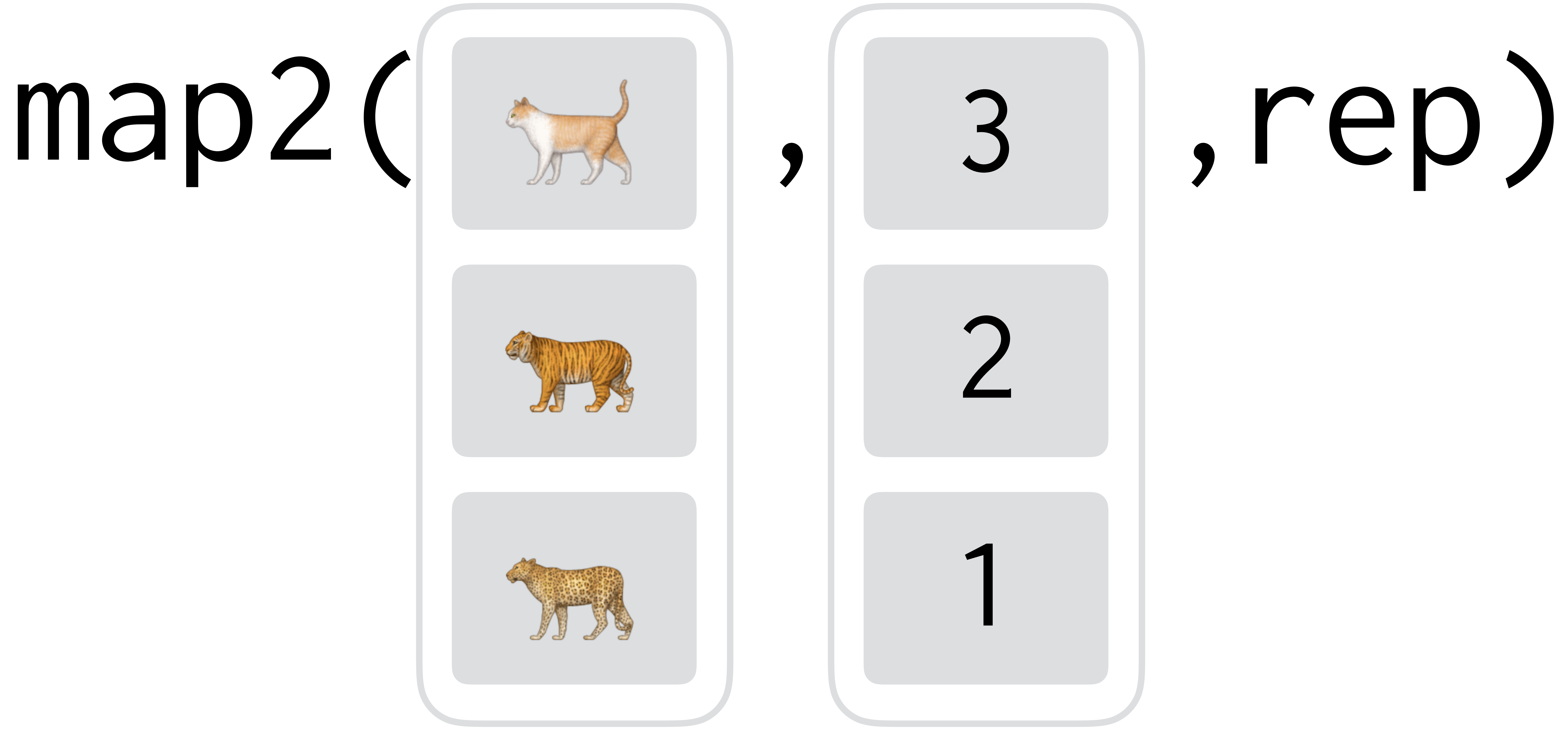


Always get a list back, or use:

`walk2(), map2_lgl(), map2_int(), map2_dbl(), map2_chr()`

to each element of **.x** and corresponding element of **.y** apply **.f**



Always get a list back, or use:

`walk2(), map2_lgl(), map2_int(), map2_dbl(), map2_chr()`

to each cat and corresponding element of .y apply .f

map2(

,

3

2

1

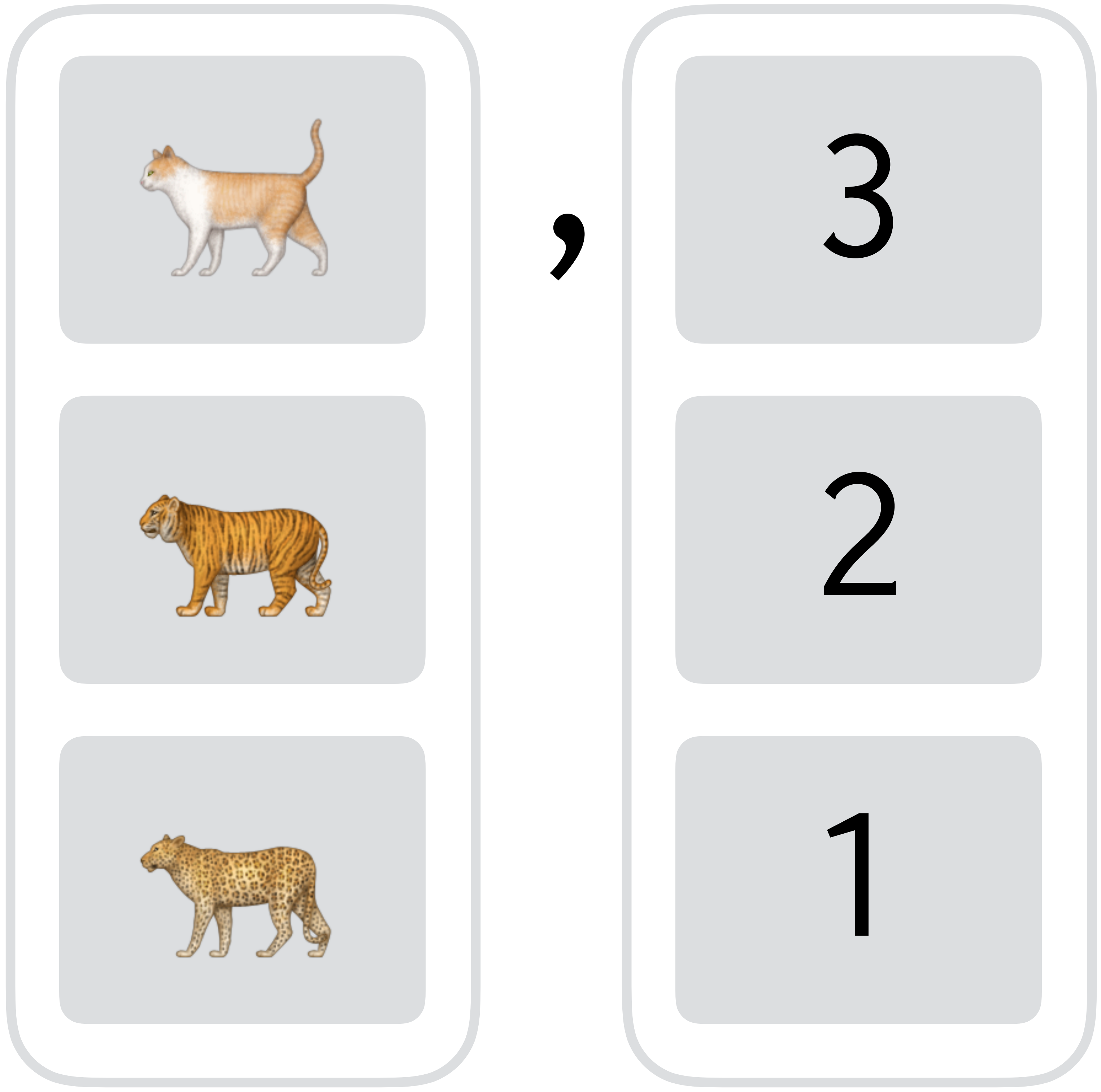
,rep)

Always get a list back, or use:

`walk2(), map2_lgl(), map2_int(), map2_dbl(), map2_chr()`

to each `cat` and corresponding `times` apply .f

```
map2(
```

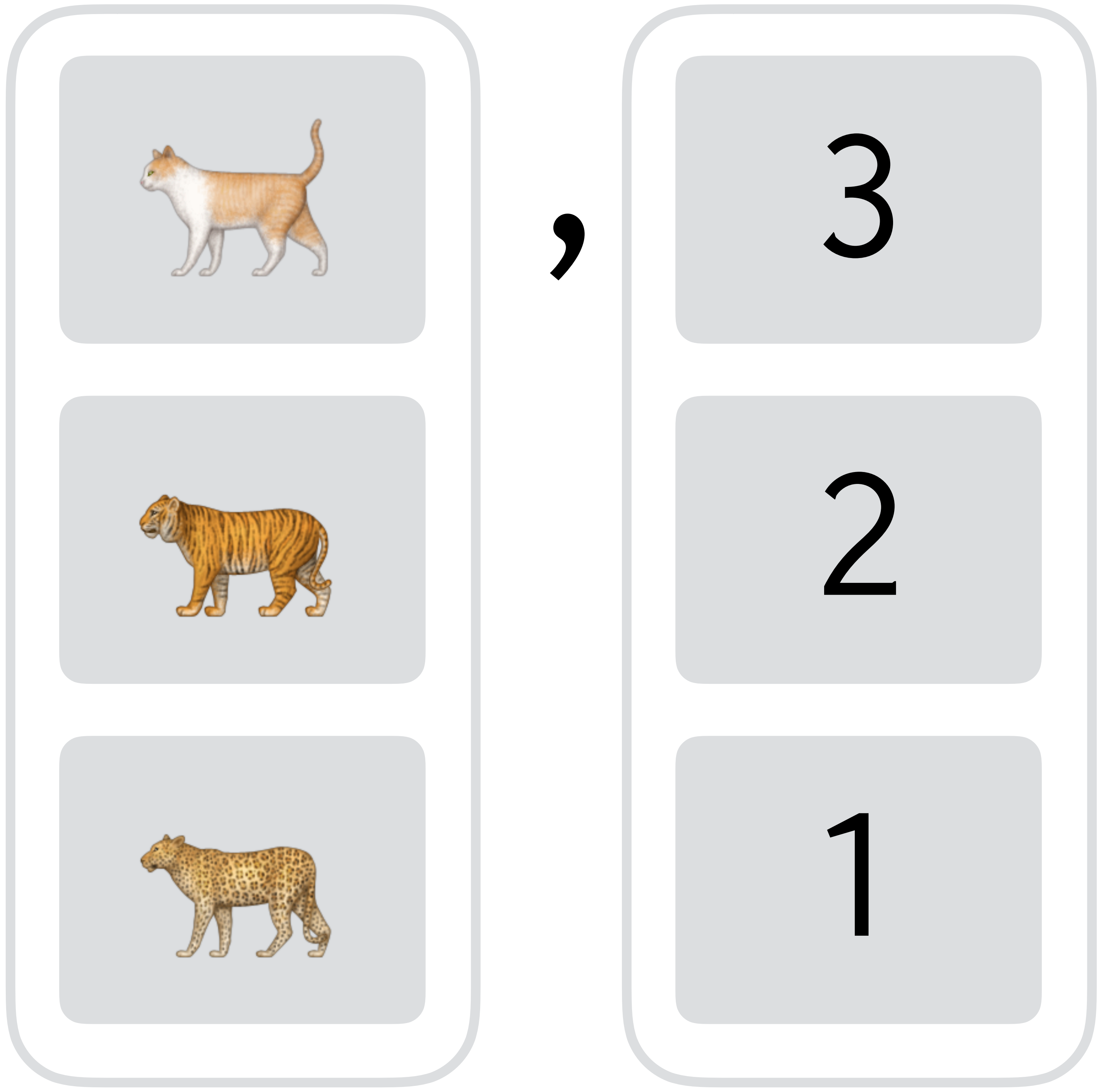


```
,rep)
```

Always get a list back, or use:

```
walk2(), map2_lgl(), map2_int(), map2_dbl(), map2_chr()
```

to each `cat` and corresponding `times` apply `rep`

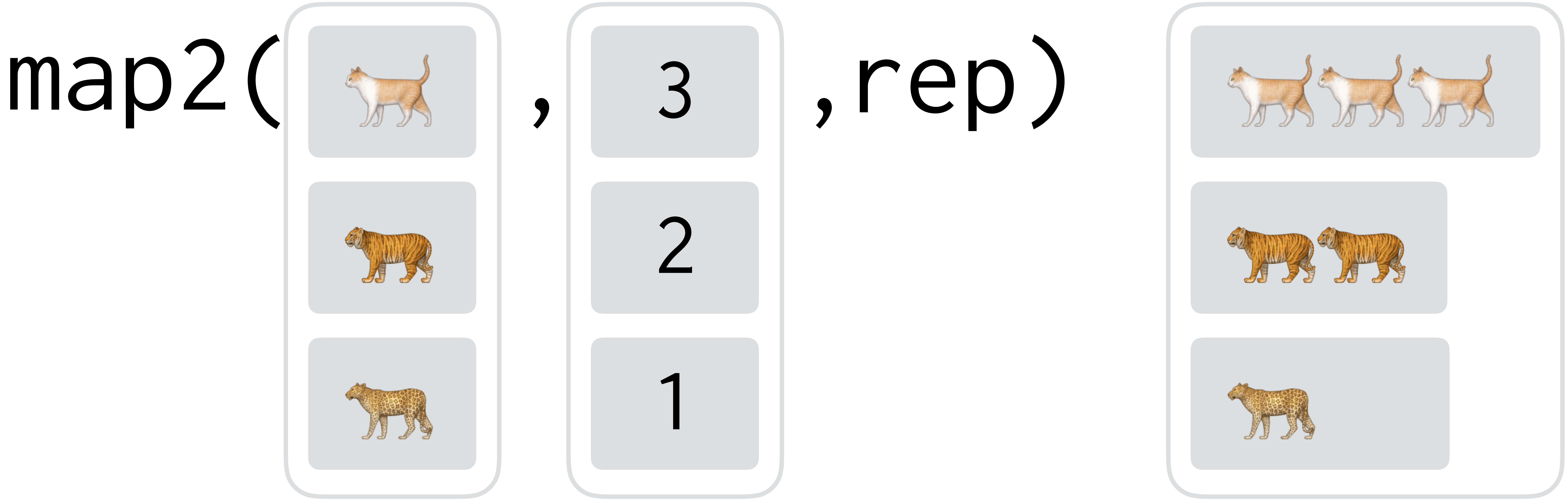
`map2(` 

`,rep)`

Always get a list back, or use:

`walk2(), map2_lgl(), map2_int(), map2_dbl(), map2_chr()`

to each `cat` and corresponding `times` apply `rep`



Always get a list back, or use:

```
walk2(), map2_lgl(), map2_int(), map2_dbl(), map2_chr()
```

DISCUSS WITH YOUR NEIGHBOR

1. For each function, which two arguments might be useful to iterate over?

   `download.file()`

   `rnorm()`

   `lm()`

   `predict.lm()`

   `write.csv()`

2. For which functions above should we use `walk2()` or a typed version of `map2()`?

`walk2(), map2_int()`

`walk2(), map2_int()`

`walk2()`

`download.file()` for each `url` download to `destfile` `walk2(), map2_int()`

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`download.file()` for each `url` download to `destfile` `walk2(), map2_int()`

`rnorm()` for each `n` generate a Normal sample with mean `mean` (or `sd`)

(See `purrr::rerun()` for repeating a function many times)

`walk2()`

`download.file()` for each `url` download to `destfile` `walk2(), map2_int()`

`rnorm()` for each `n` generate a Normal sample with mean `mean` (or `sd`)

(See `purrr::rerun()` for repeating a function many times)

`lm()` for each `data` fit a model (`formula`)

`walk2()`

`download.file()` for each `url` download to `destfile` `walk2()`, `map2_int()`

`rnorm()` for each `n` generate a Normal sample with mean `mean` (or `sd`)
(See `purrr::rerun()` for repeating a function many times)

`lm()` for each `data` fit a model (`formula`)

`predict.lm()` for each model (`object`), generate predictions at data (`newdata`)

`walk2()`

`download.file()` for each `url` download to `destfile` `walk2(), map2_int()`

`rnorm()` for each `n` generate a Normal sample with mean `mean` (or `sd`)
(See `purrr::rerun()` for repeating a function many times)

`lm()` for each `data` fit a model (`formula`)

`predict.lm()` for each model (`object`) , generate predictions at data (`newdata`)

`readr::write_csv()` for each data frame (`x`) save to `path`
Similar for `ggplot::ggsave()` for each `plot` save to `filename` `walk2()`

```
jan_sales <- read_csv("jan.csv")
jan_sales <- mutate(jan_sales, month = "jan")

feb_sales <- read_csv("feb.csv")
feb_sales <- mutate(feb_sales, month = "feb")

mar_sales <- read_csv("mar.csv")
mar_sales <- mutate(mar_sales, month = "mar")

sales <- bind_rows(jan_sales, feb_sales, mar_sales)
```

WHAT DOES THIS CODE DO?

REDUCE DUPLICATION (AND MISTAKES) WITH PURRR

```
months <- c("jan", "feb", "mar")

files <- paste0(months, ".csv")

sales_list <- map(files, read_csv)
```

Now...For each **element** (do) **add a month column**

USE THE SAME STRATEGY!

DO IT FOR ONE

Solve the problem for one element

```
mutate(sales_list[[1]],
       month = months[[1]])
```

DO IT FOR ONE

Solve the problem for one element

```
mutate(sales_list[[1]],
          month = months[[1]])
```

DO IT FOR ONE

Solve the problem for one element

```
mutate(sales_list[[2]],
       month = months[[2]])
```

DO IT FOR ONE

Solve the problem for one element

```
mutate(sales_list[[2]],
          month = months[[2]])
```

Iterating over two objects!

TURN IT INTO A RECIPE

Make it a formula

Use .x and .y

```
mutate(sales_list[[2]],
        month = months[[2]])
```

TURN IT INTO A RECIPE

Make it a formula

Use .x and .y

```
~ mutate(sales_list[[2]],
         month = months[[2]])
```

A formula

TURN IT INTO A RECIPE

Make it a formula

Use .x and .y

```
~ mutate(    .x          ,
        month =    .y      )
```

A formula

DO IT FOR ALL! Your recipe is the .f argument to map2

```
~ mutate(    .x           ,
        month =    .y          ))
```

A formula

DO IT FOR ALL!

Your recipe is the .f argument to map2

```
map2(.x =                    ,
     .y =              ,
  ~ mutate(      .x          ,
             month =    .y      ))
```

A formula

DO IT FOR ALL!

Your recipe is the .f argument to map2

```
map2(.x = sales_files,
     .y =          ,
  ~ mutate(    .x       ,
            month =   .y    ))
```

A formula

DO IT FOR ALL!

Your recipe is the .f argument to map2

```
map2(.x = sales_files,
     .y = months,
  ~ mutate(    .x         ,
               month =    .y      ))
```

A formula

```
months <- c("jan", "feb", "mar")

files <- paste0(months, ".csv")

sales_list <- map(files, read_csv)

sales_list_months <- map2(.x = sales_list,

                          .y = months,

                          .f = ~ mutate(.x, month = .y)

bind_rows(sales_list_months)
```

```r
library(repurrrsive)

gap_split_small <- gap_split[1:10]

countries <- names(gap_split_small)
```

FOR EACH COUNTRY CREATE A GGPLOT OF LIFE EXPECTANCY THROUGH TIME WITH A TITLE

Need a hint? For one country, see next slide

Bored? For each plot, save it to a .pdf, with an appropriate file name

```r
# For one country
ggplot(gap_split[[1]], aes(year, lifeExp)) +
  geom_line() +
  labs(title = countries[[1]])
```

```r
# For all countries
plots <- map2(gap_split_small, countries,
  ~ ggplot(.x, aes(year, lifeExp)) +
      geom_line() +
      labs(title = .y))

plots[[1]]

# Display all plots
walk(plots, print) # this might take awhile
```

purrr and list columns

PURRR AND LIST COLUMNS

Data should be in a data frame as soon as it makes sense!

Data frame: **cases** in rows, **variables** in columns

YOUR TURN:

What are the **cases** and **variables** in the `sw_people` data?

```
# A tibble: 87 × 4
             name     films height                             species
            <chr>    <list>  <dbl>                               <chr>
1  Luke Skywalker <chr [5]>    172 http://swapi.co/api/species/1/
2           C-3PO <chr [6]>    167 http://swapi.co/api/species/2/
3           R2-D2 <chr [7]>     96 http://swapi.co/api/species/2/
4     Darth Vader <chr [4]>    202 http://swapi.co/api/species/1/
5     Leia Organa <chr [5]>    150 http://swapi.co/api/species/1/
# ... with 82 more rows
# A tibble: 87 × 4
              name     films height                       species
             <chr>    <list>  <dbl>                         <chr>
1 Luke Skywalker <chr [5]>    172 http://swapi.co/api/species/1/
2          C-3PO <chr [6]>    167 http://swapi.co/api/species/2/
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5    Leia Organa <chr [5]>    150 http://swapi.co/api/species/1/
# ... with 82 more rows
```

PURRR CAN HELP TURN LISTS INTO TIBBLES

```
library(tidyverse)

people_tbl <- tibble(

  name    =                              ,

  films   =                            ,

  height  =

                                                    ,

  species =

)
```

PURRR CAN HELP TURN LISTS INTO TIBBLES

```
library(tidyverse)

people_tbl <- tibble(

  name    = sw_people %>% map_chr("name"),

  films   = sw_people %>% map("films"),

  height  = sw_people %>% map_chr("height") %>%

              readr::parse_number(na = "unknown"),

  species = sw_people %>% map_chr("species", .null = NA_character_)

)
```

PURRR CAN HELP TURN LISTS INTO TIBBLES

```
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  name    = sw_people %>% map_chr("name"),

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```

will result in list column

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              readr::parse_number(na = "unknown"),

  species = sw_people %>% map_chr("species", .null = NA_character_)

)
```

will result in list column

needs some parsing

PURRR CAN HELP TURN LISTS INTO TIBBLES

```
library(tidyverse)

people_tbl <- tibble(

  name    = sw_people %>% map_chr("name"),

  films   = sw_people %>% map("films"),

  height  = sw_people %>% map_chr("height") %>%

             readr::parse_number(na = "unknown"),

  species = sw_people %>% map_chr("species", .null = NA_character_)

)
```

will result in list column

needs some parsing

isn't in every element

COMBINE PURRR WITH DPLYR TO WORK WITH LIST COLUMNS

```
people_tbl$films


people_tbl %>%
  mutate(
    film_numbers = map(films, ~ film_number_lookup[.x]),
    n_films = map_int(films, length)
)
```

COMBINE PURRR WITH DPLYR TO WORK WITH LIST COLUMNS

```
people_tbl$films


people_tbl %>%
  mutate(
    film_numbers = map(films, ~ film_number_lookup[.x]),
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)
```

COMBINE PURRR WITH DPLYR TO WORK WITH LIST COLUMNS

```
people_tbl$films


people_tbl %>%
  mutate(
    film_numbers = map(films, ~ film_number_lookup[.x]),
    n_films = map_int(films, length)
)
```

```
library(tidyverse)
library(repurrrsive)

# A useful lookup table -----------------------------------------------
film_number_lookup <- map_chr(sw_films, "url") %>%
  map(~ stringr::str_split_fixed(.x, "/", 7)[, 6])  %>%
  as.numeric() %>%
  set_names(map_chr(sw_films, "url"))

people_tbl <- tibble(
  name    = sw_people %>% map_chr("name"),
  films   = sw_people %>% map("films"),
  height  = sw_people %>% map_chr("height") %>%
    readr::parse_number(na = "unknown"),
  species = sw_people %>% map_chr("species", .null = NA_character_)
)

# Turning parts of our list to a tibble -------------------------------------
people_tbl$films

# Use map with mutate to manipulate list columns
people_tbl <- people_tbl %>%
  mutate(
    film_numbers = map(films,
      ~ film_number_lookup[.x]),
    n_films = map_int(films, length)
  )

people_tbl %>% select(name, film_numbers, n_films)
```

Copy and paste ME.

YOUR TURN

Create a new character column that collapses the film numbers into a single string,

e.g. for Luke: " 6, 3, 2, 1, 7"

```
?paste
```

```
people_tbl <- people_tbl %>%
  mutate(films_squashed = map_chr(film_numbers, paste,
                                   collapse = ", "))

people_tbl %>% select(name, n_films, films_squashed)
```

CHALLENGES @ https://github.com/cwickham/purrr-tutorial

`challenges/01-mtcars.R` - Fit and summarise many regression models

`challenges/02-word_count.R` - Count the number of words of all files in a directory

`challenges/03-starwars.R` - Print who used which vehicles in the films

`challenges/04-weather.R` - Download, tidy, plot and save daily temperatures

`challenges/05-swapi.R` - Download all Star Wars data using `rwars` package

Next up: a few remaining iteration functions, a comment about other functions in purrr, wrap up.

OTHER FEATURES OF PURRR

to each element of each vector in .l, apply **.f**

```
pmap( .l , .f , ...)
```

to each element of each vector in .l, apply **.f**

```
pmap( .l , .f , ...)
```

```
.f(.l[[1]][[1]], .l[[2]][[1]], .l[[3]][[1]], ...)
```

to each element of each vector in .l, apply .f

```
pmap( .l , .f , ...)
```

```
    .f(.l[[1]][[1]], .l[[2]][[1]], .l[[3]][[1]], ...)

    .f(.l[[1]][[2]], .l[[2]][[2]], .l[[3]][[1]], ...)
```

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pmap( .l , .f , ...)
```

```
.f(.l[[1]][[1]], .l[[2]][[1]], .l[[3]][[1]], ...)

.f(.l[[1]][[2]], .l[[2]][[2]], .l[[3]][[1]], ...)

.f(.l[[1]][[3]], .l[[2]][[3]], .l[[3]][[1]], ...)
```

to each element of each vector in .l, apply .f

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pmap( .l , .f , ...)
```

```
.f(.l[[1]][[1]], .l[[2]][[1]], .l[[3]][[1]], ...)

.f(.l[[1]][[2]], .l[[2]][[2]], .l[[3]][[1]], ...)

.f(.l[[1]][[3]], .l[[2]][[3]], .l[[3]][[1]], ...)
```

and so on

to each element of each vector in .l, apply **.f**

```
pmap( .l , .f , ...)
```

```
.f(.l[[1]][[1]], .l[[2]][[1]], .l[[3]][[1]], ...)

.f(.l[[1]][[2]], .l[[2]][[2]], .l[[3]][[1]], ...)

.f(.l[[1]][[3]], .l[[2]][[3]], .l[[3]][[1]], ...)
```

and so on

or by name if supplied

to each element of each vector in .l, apply .f

```
pmap(data.frame(      ,      ,      ),    )
```

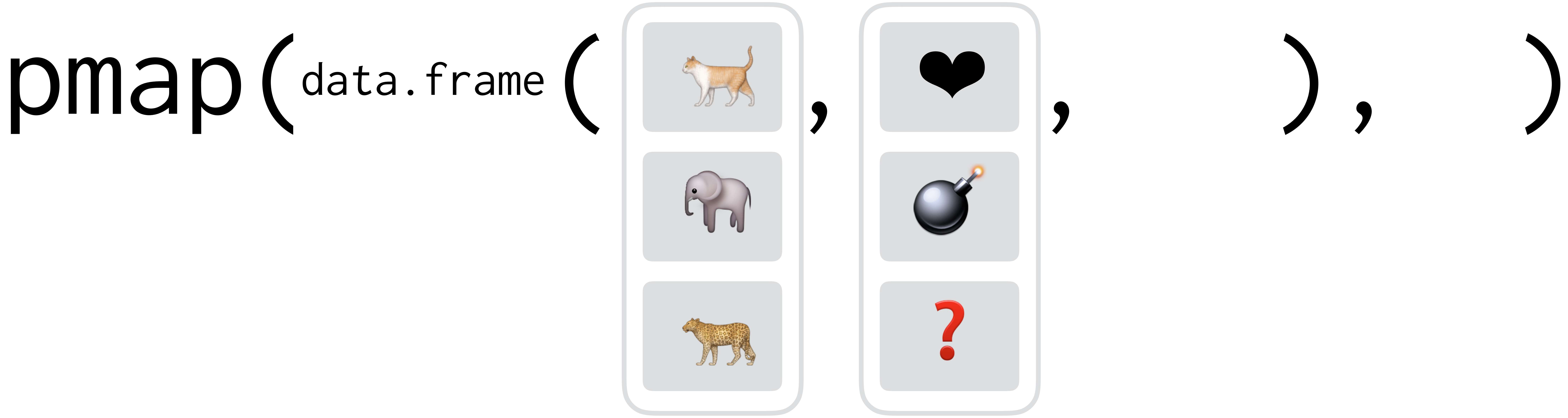
no formula shortcut

to each element of each vector in .l, apply .f

pmap(data.frame(,   ,   ),   )

no formula shortcut

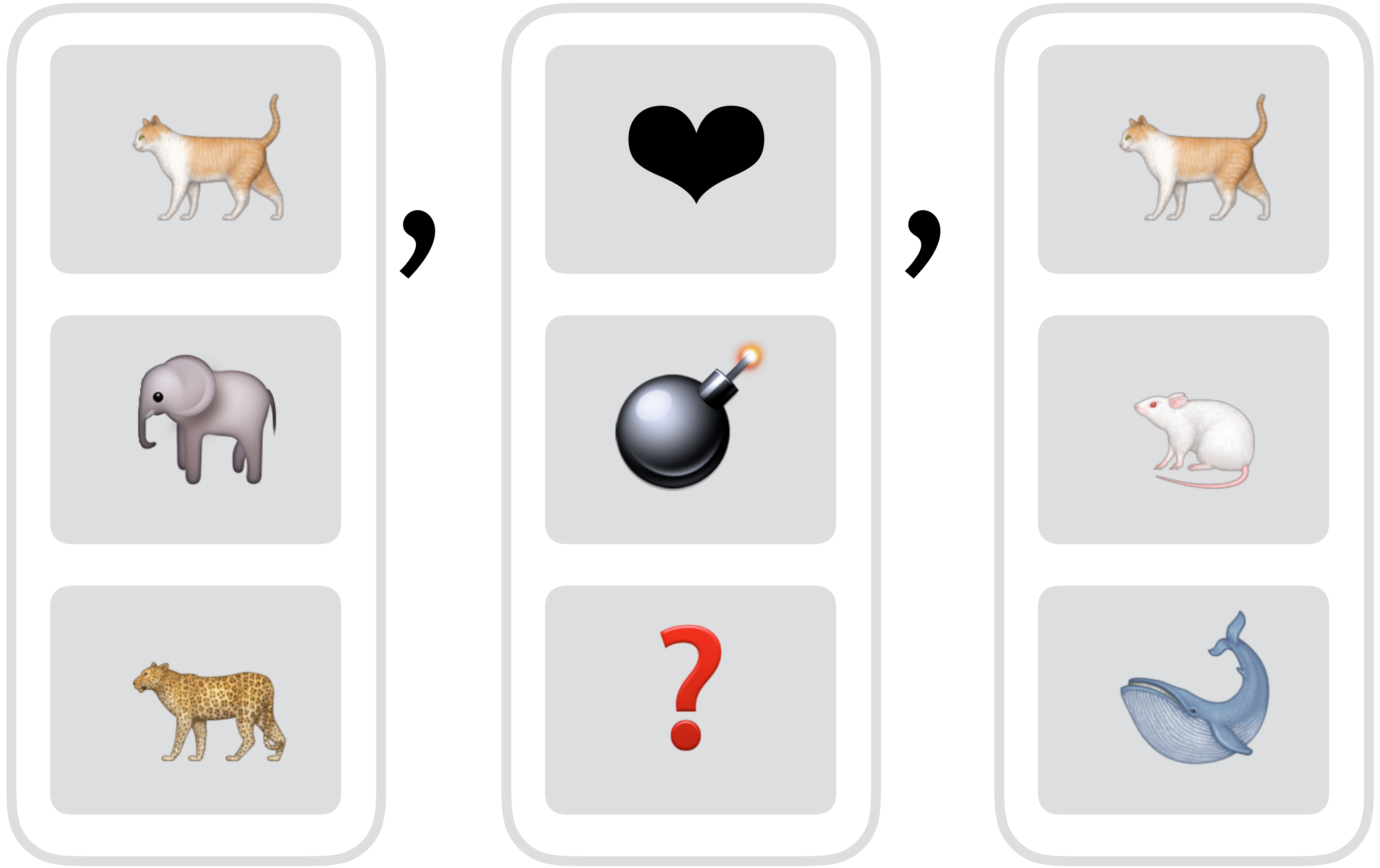
to each element of each vector in .l, apply .f



no formula shortcut

to each element of each vector in .l, apply .f

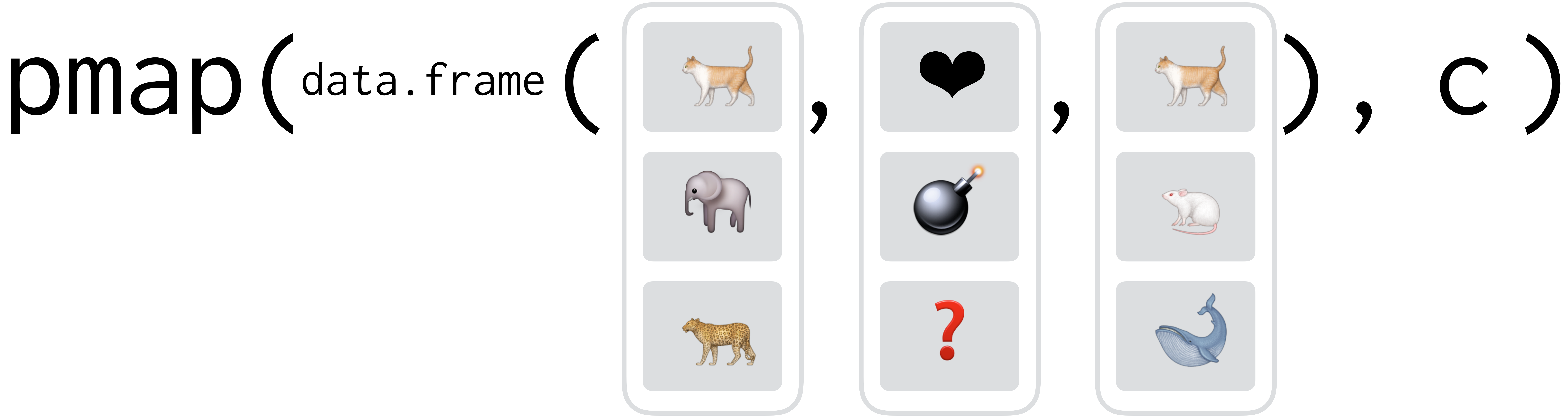
pmap(data.frame(



), ,)

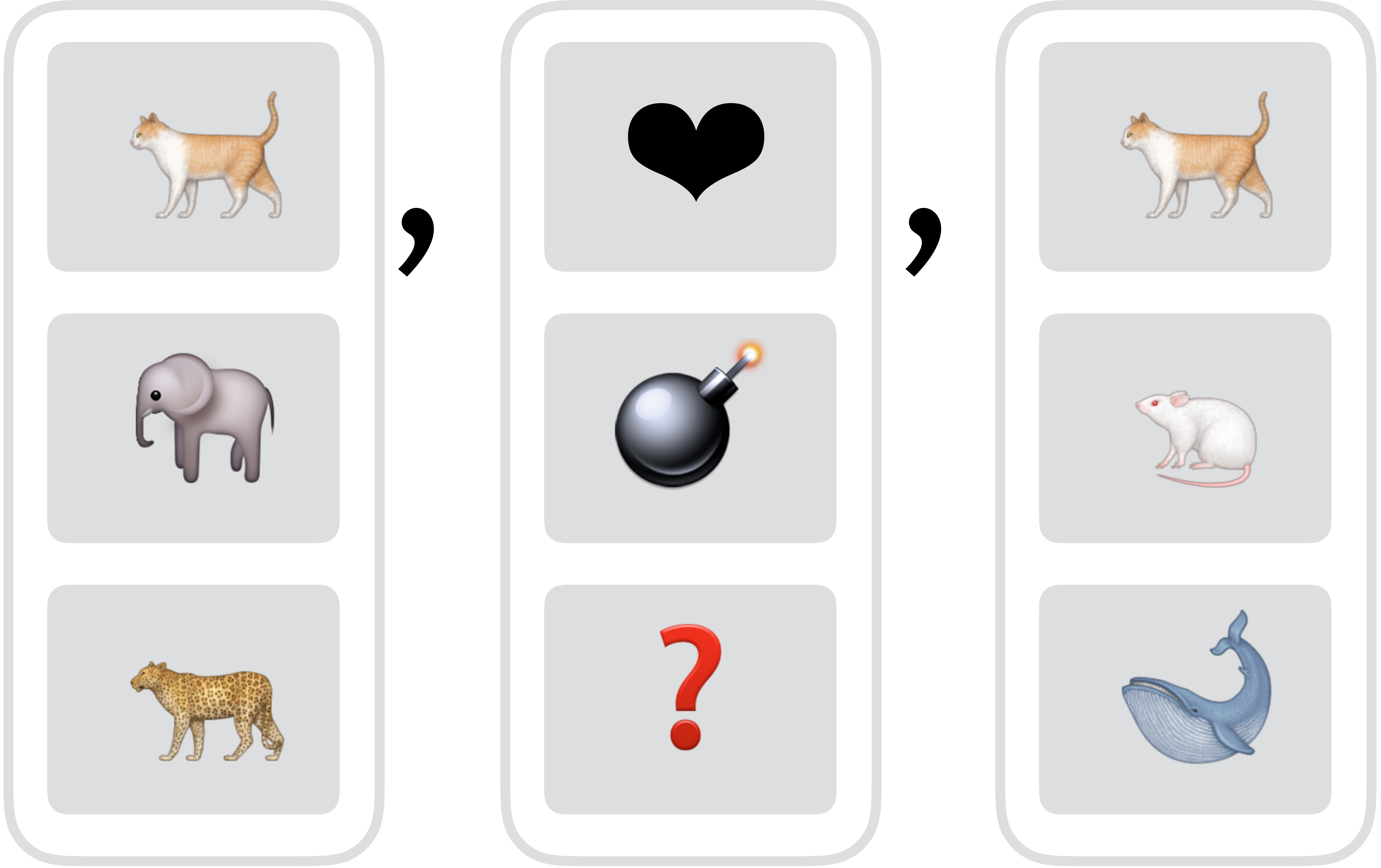
no formula shortcut

to each element of each vector in .l, apply .f



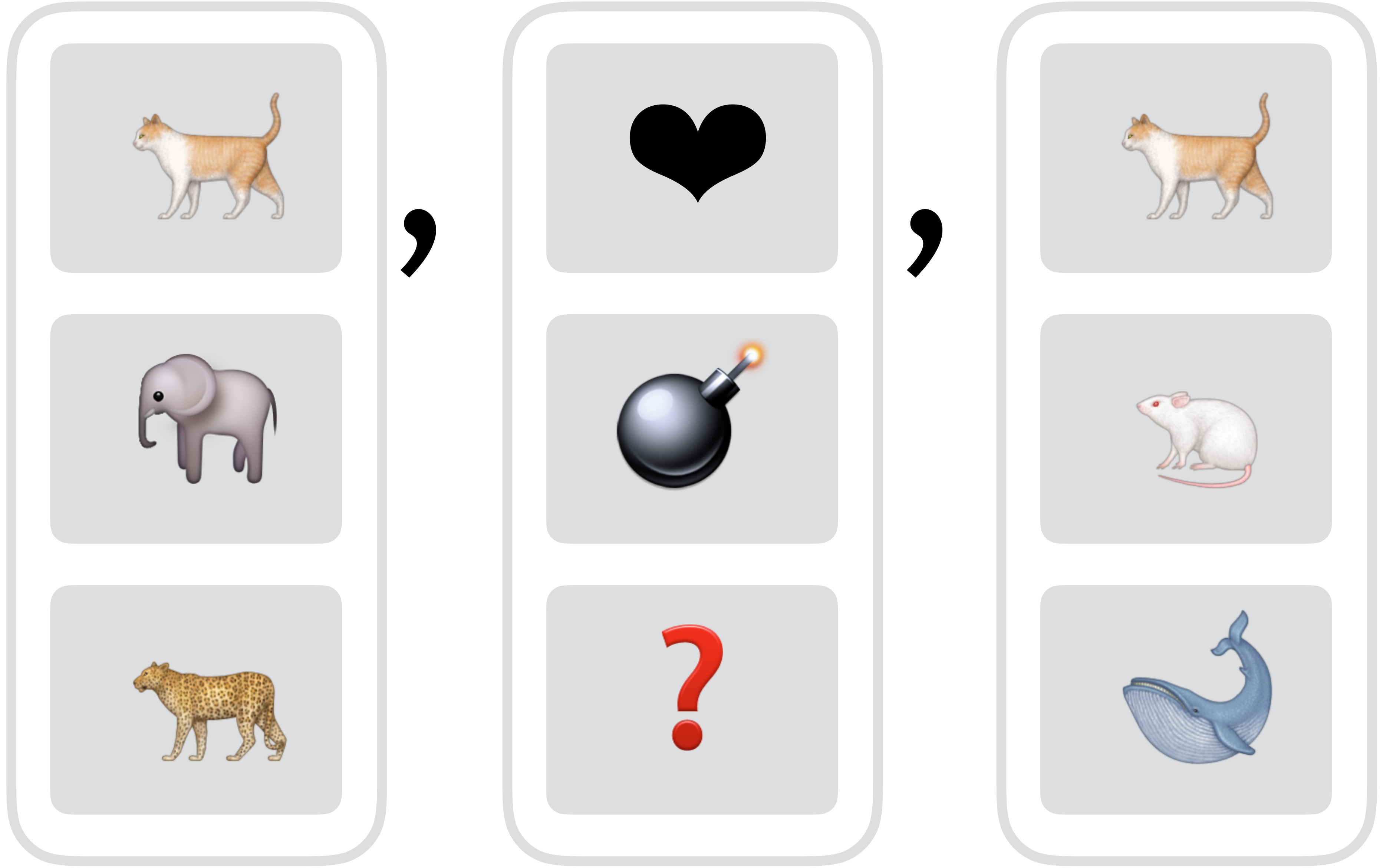
no formula shortcut

to each element `in animal, reaction, and animal2`, apply .f

pmap(`data.frame` (), c)

no formula shortcut

to each element `in animal, reaction, and animal2`, apply `c`

pmap(`data.frame` (), c)

no formula shortcut

to each element `in animal, reaction, and animal2`, apply `c`

pmap(data.frame(🐈 🐘 🐆 , 🖤 💣 ❓ , 🐈 🐁 🐋), c)

🐈❤️🐈

🐘💣🐁

🐆❓🐋

no formula shortcut

for each function in **.f**, apply it to **.x**

```
invoke_map(.f, .x, ...)
```

for each function in **.f**, apply it to **.x**

```
invoke_map(.f, .x, ...)
```

```
    .f[[1]](.x, ...)
```

for each function in **.f**, apply it to **.x**

`invoke_map(.f, .x, ...)`

```
.f[[1]](.x, ...)

.f[[2]](.x, ...)
```

for each function in **.f**, apply it to **.x**

`invoke_map(.f, .x, ...)`

```
.f[[1]](.x, ...)

.f[[2]](.x, ...)

.f[[3]](.x, ...)
```

for each function in **.f**, apply it to **.x**

```
invoke_map(.f, .x, ...)
```

```
.f[[1]](.x, ...)

.f[[2]](.x, ...)

.f[[3]](.x, ...)
```

and so on

for each function in **.f**, apply it to **.x**

```
invoke_map(          ,  )
```

for each function in .f, apply it to .x

```
invoke_map( give_fish  ,   )
            double
            count_legs
```

for each function in .f, apply it to .x

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invoke_map( give_fish  , 🐈)
            double
            count_legs
```

for each function in .f, apply it to .x

```
invoke_map( give_fish , 🐈)
            double
            count_legs
```

```
🐟🐈
🐈🐈
4
```

LISTS AND FUNCTIONS

Key objects in `purrr`

`purrr` provides a pile of functions to make working with them easier

Functions: `safely()`, `possibly()`, `partial()`

Lists: `transpose()`, `accumulate()`, `reduce()`, `every()`, `order_by()`

WRAP UP

purrr provides:

- functions that write for loops for you
- with consistent syntax, and
- convenient shortcuts for specifying functions to iterate

Choosing the right function depends on:

- type of iteration
- type of output

LEARNING MORE

R for Data Science:

- http://r4ds.had.co.nz/iteration.html
- http://r4ds.had.co.nz/many-models.html

DataCamp Writing functions in R
https://www.datacamp.com/courses/writing-functions-in-r

Jenny Bryan's purrr tutorial
https://github.com/jennybc/purrr-tutorial

THANK YOU

Slides @ http://bit.ly/purrr-slides

All materials (code files too): https://github.com/cwickham/purrr-tutorial

🐦 @cvwickham

http://cwick.co.nz

cwickham@gmail.com

FOR HIRE