MANGO SOLUTIONS

A Whistle-Stop Tour of the Tidyverse

Aimee Gott

Senior Consultant

agott@mango-solutions.com

@aimeegott_R

In This Workshop

- You will learn…
  - What the **tidyverse** is & why bother using it
  - What tools are available in the **tidyverse**
  - A brief overview of core functionality
- https://gist.github.com/CSJCampbell/e88eb99aa63fbdf87765217979938706#file-tourtidyverse-r

Data for This Session

- Funding of Olympic sports
- UK Sport World Class Performance Programme
- Data from Sydney (2000) to Rio de Janeiro (2016)
- http://bit.ly/2uToU9I
- Extracted from

http://www.uksport.gov.uk/our-work/investing-in-sport/historical-funding-figures

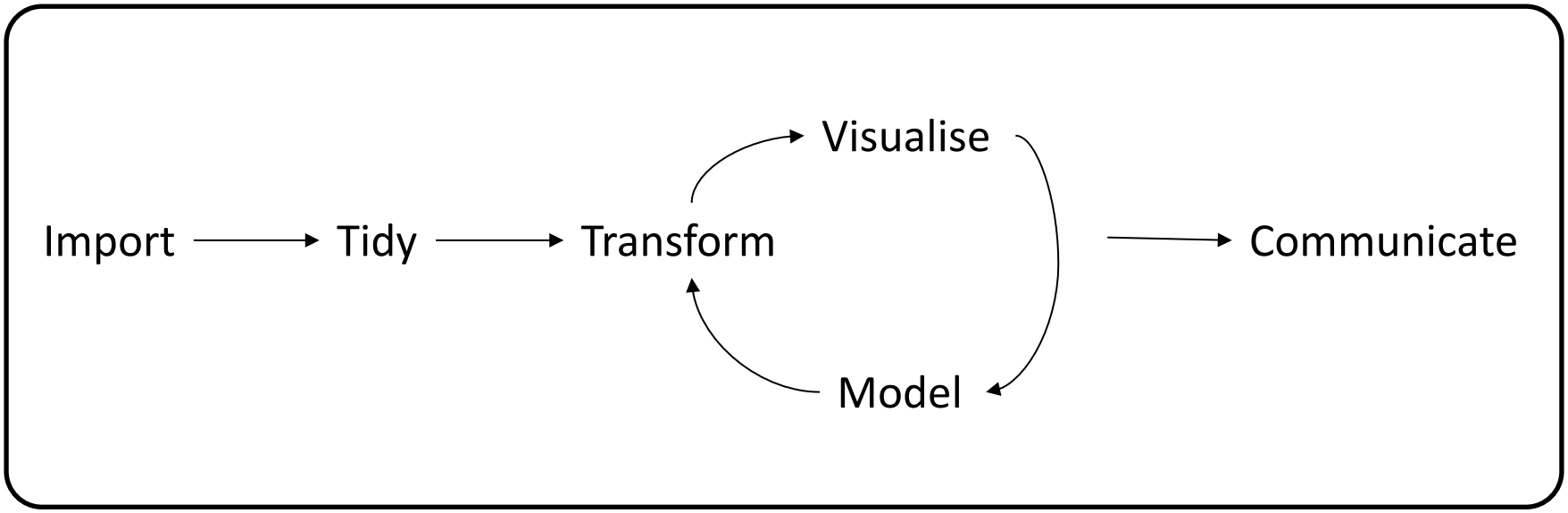
WHAT IS THE TIDYVERSE?

Unified Packages

- Set of unified packages covering the data analysis workflow
- Implementation of tidy philosophy
  - Reuse existing data structures
  - Compose simple functions with the pipe
  - Embrace functional programming
  - Design for humans

Pipe

- `magrittr::%>%`
- `ggplot2::+.gg`



Program

Useful Resouces

RStudio Cheat Sheets

https://www.rstudio.com/resources/cheatsheets/

(My advice – print them all and keep them on your desk!)

Further Reading

R for Data Science (2017), *Hadley Wickham & Garrett Grolemund*, O'Reilly

Available online:

http://r4ds.had.co.nz/

WHAT'S IN THE TIDYVERSE?

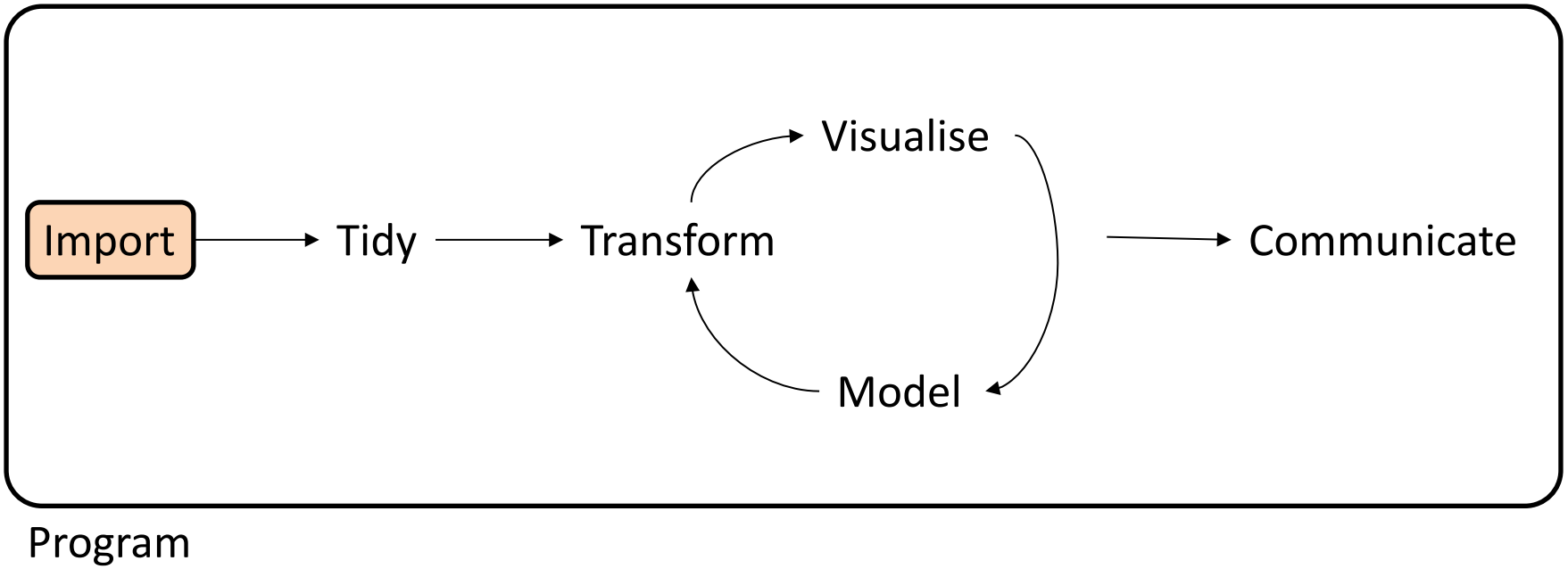
What are the Packages?

- 18 Core Packages
  - Loads more dependencies
- 6 Packages loaded with **tidyverse**
- All others installed and available

Packages Loaded By Default

- `ggplot2`
- `dplyr`
- `tidyr`
- `readr`
- `purrr`
- `tibble`

A DIVE INTO THE PACKAGES


Import
Tidy
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Visualise
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Import

- `readr`
- `haven`
- `httr`
- `jsonlite`
- `readxl`
- `rvest`
- `xml2`

Reading Web Data: rvest

```
read_html("www.myWebPage.co.uk")
```

- Includes lots of functions for extracting specific elements of a web page

Read Olympic Data

```
funding <-
   read_html("http://www.uksport.gov.uk/our
         -work/investing-in-sport/
         historical-funding-figures")

funding <- html_table(funding, header =
TRUE)
```

Reading Tabular Data: readr

```
read_csv("myFile.csv", na = c(" ", "NA"))
```

Other variants include:

- `read_tsv`
- `read_fwf`
- `read_delim`

Reading Summer Olympics Data

```
summer <-
read_csv("SummerOlympicsFunding.csv",
          na = c("n/a", "n/a**"),
          col_types = cols(
         .default = col_number(),
                Sport = col_character())
          )
```

Reading MS Excel Data: readxl

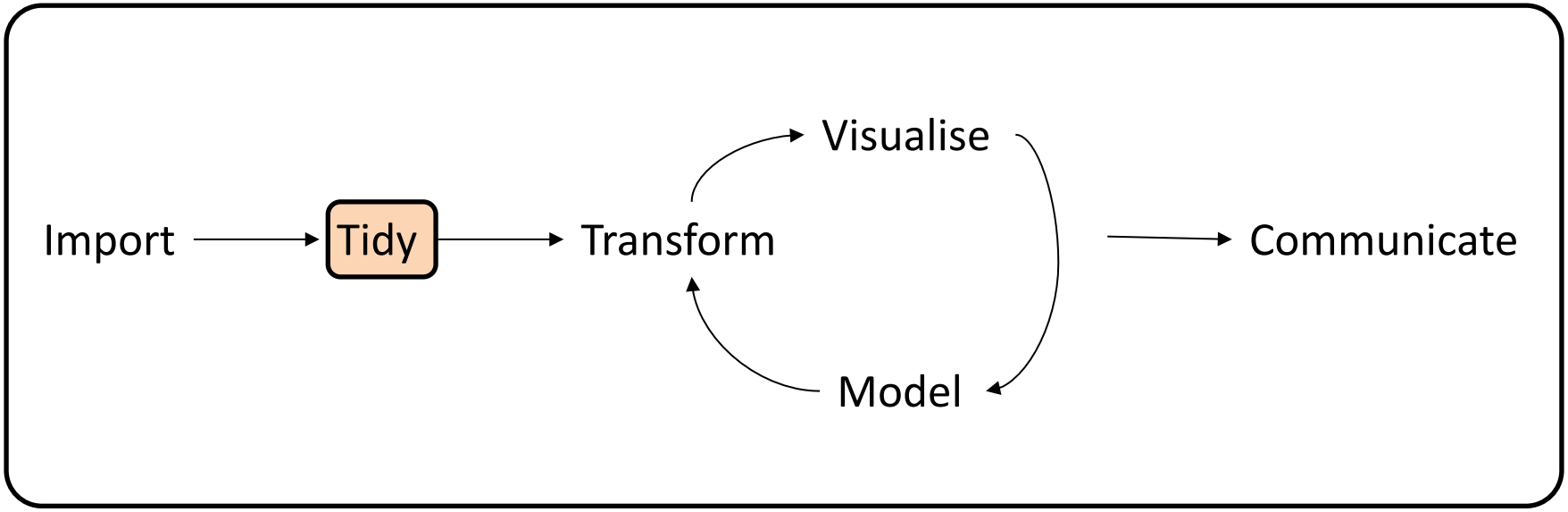
```
read_excel("myExcelFile.xlsx",
           sheet = "Sheet 1")
```

Reading Proprietary Data: haven

```
read_sas("mySASData.sas7bdat")
```

Other formats include:

- SPSS Data
- Stata Data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Tidy

- `tibble`
- `tidyr`

What is tibble?

- A tibble is an update to the data frame
- Generally works as a data frame but with extra features
  - Doesn’t change column names
  - Doesn't convert strings to factors
  - Doesn't allow partial matching of names
  - Doesn't create row names

Why tibble?

- Provides utility functions for working with tibble class
  - `print.tbl_df`
  - `$<-`

Functions in tibble

- `glimpse` – useful overview of data
- `tibble/tribble` – creation of tibbles
- `add_row/add_column` – helpful functions for adding elements to an existing tibble
- There are also a number of functions for converting rownames if needed

Creating a Tibble Row-wise

```
years <- tribble(
      ~Location, ~Year, ~Month, ~Day,
         "Sydney", 2000, 9, 15,
         "Athens", 2004, 8, 13,
         "Beijing", 2008, 8, 8,
         "London", 2012, 7, 27,
         "Rio de Janeiro", 2016, 8, 5
    )
```

Tidy Data

- The **tidyverse** is designed to work with tidy data
- A single structure that is common to all of the packages
  - Makes it easy to move from manipulation to visualisation to modelling without changing the data

What is Tidy Data?

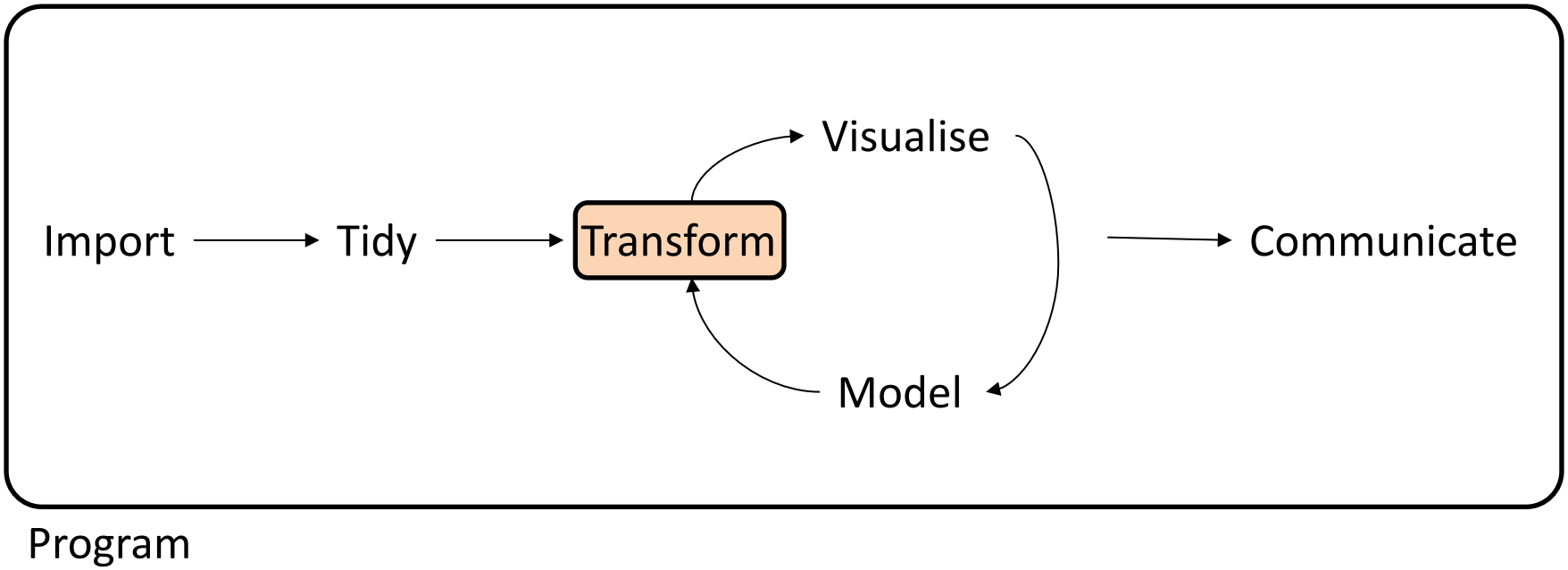
- Each variable has its own column
- Each observation has its own row
- Each value has its own cell

Tidying the Olympic Data

```
summer <- gather(summer,
                 Location,
                 Funding,
                 -Sport)
```

Working with Missing Values

```
summer <- replace_na(summer,
        replace = list(Funding = 0))
```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Transform

- dplyr
- forcats
- stringr
- hms
- lubridate

Data Manipulation: dplyr

- Standard manipulations
  - Filter
  - Select
  - Arrange
  - Mutate
  - Summarise
- Perform actions by group (group_by)

Join Related Data Sets

- Merge/Join two data sets
  - Full
  - Left/Right
  - Inner
  - Anti
  - Semi

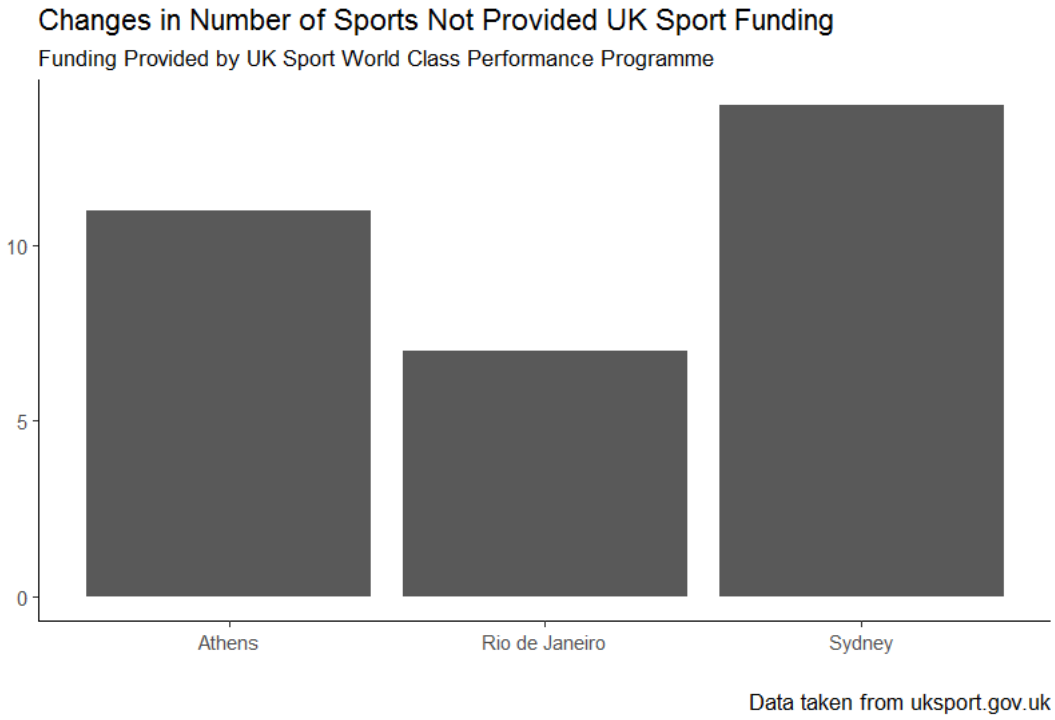
Joining Olympic Data

```
summer <- full_join(summer, years) %>%
  filter(Sport != "Total")
```

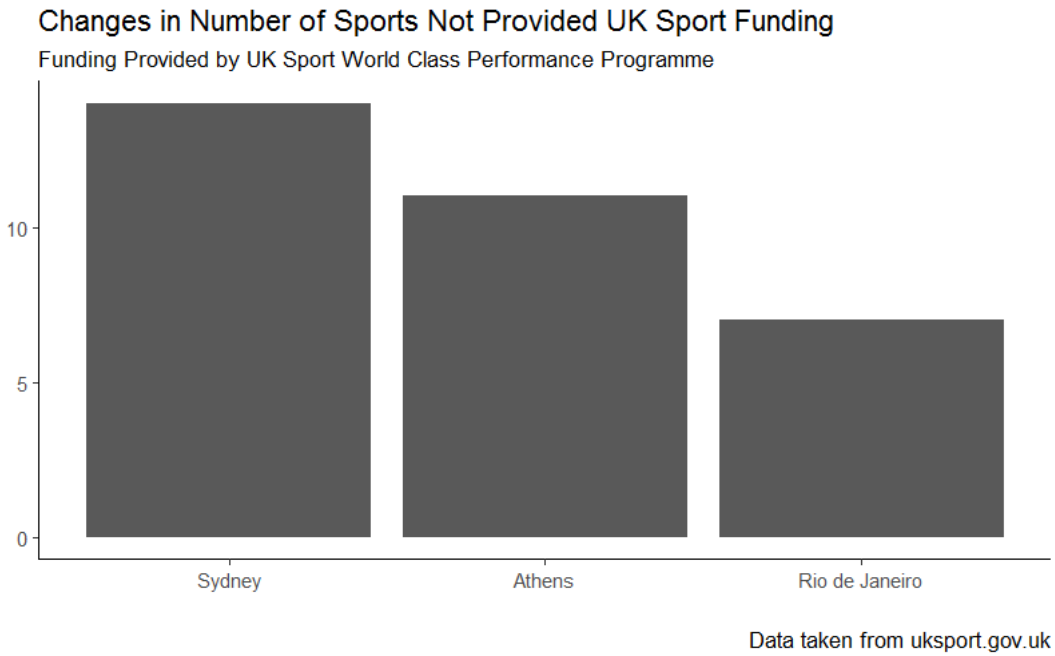
Manipulating Factors: forcats

- Factors are a representation of categorical data
- Forcats allows us to easily manipulate factors
  - Change names
  - Group levels
  - Reorder levels

Without Manipulation



With Manipulation



Reordering Olympic Years

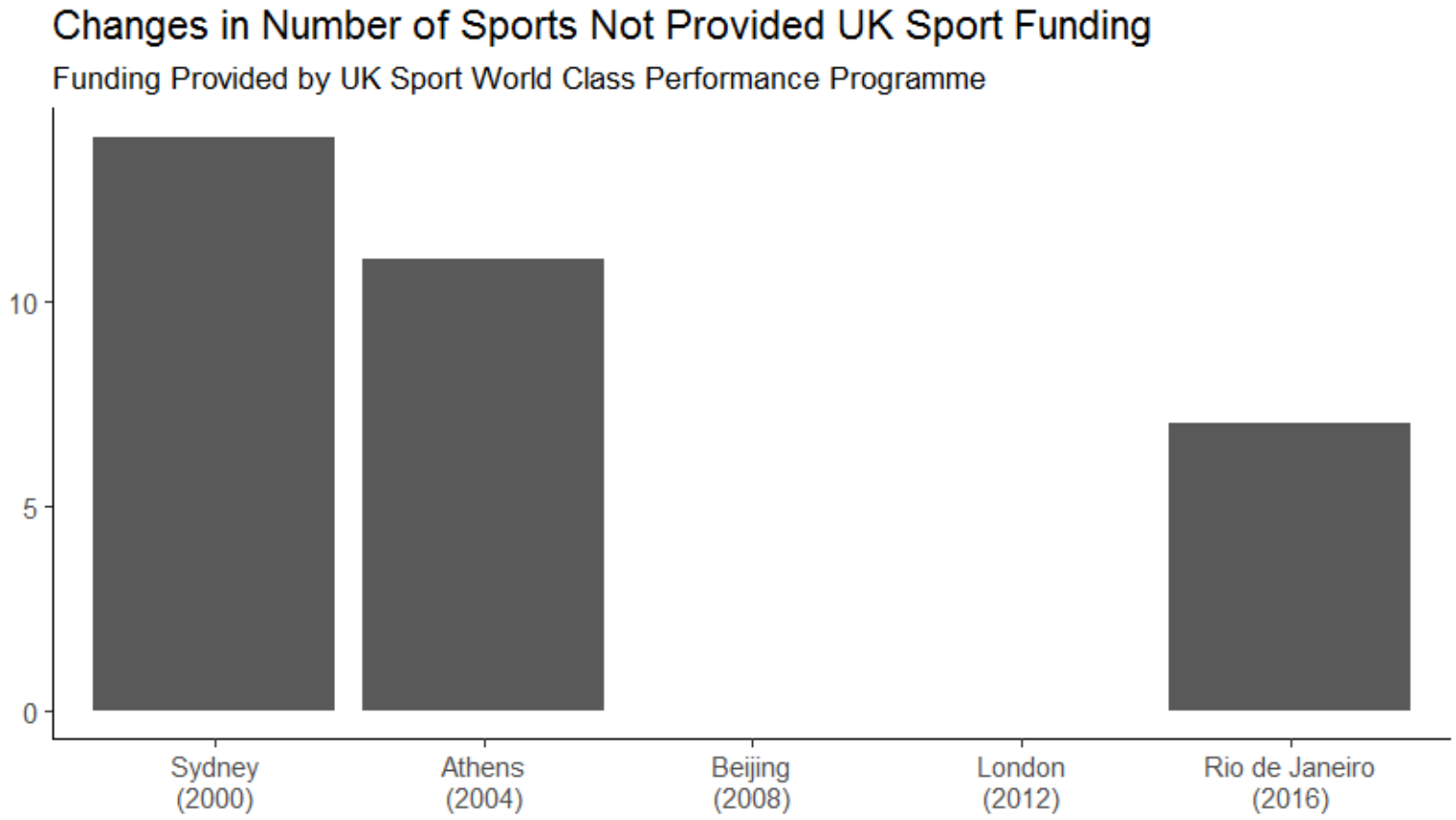
```
numberNoFund <- summer %>%
   filter(Funding == 0)
   count(Location) %>%
   left_join(years) %>%
   mutate(Location =
          fct_reorder(Location, Year))
```

Manipulating Characters: stringr

- The stringr package provides consistent functions for manipulating character strings
- Manipulations include:
  - Concatenation
  - Pattern search and replace
  - Subset with strings

Combining Location and Year

```
str_c(
   magrittr::use_series(years, Location),
   "\n(",
   magrittr::use_series(years, Year),
   ")"
   )
```



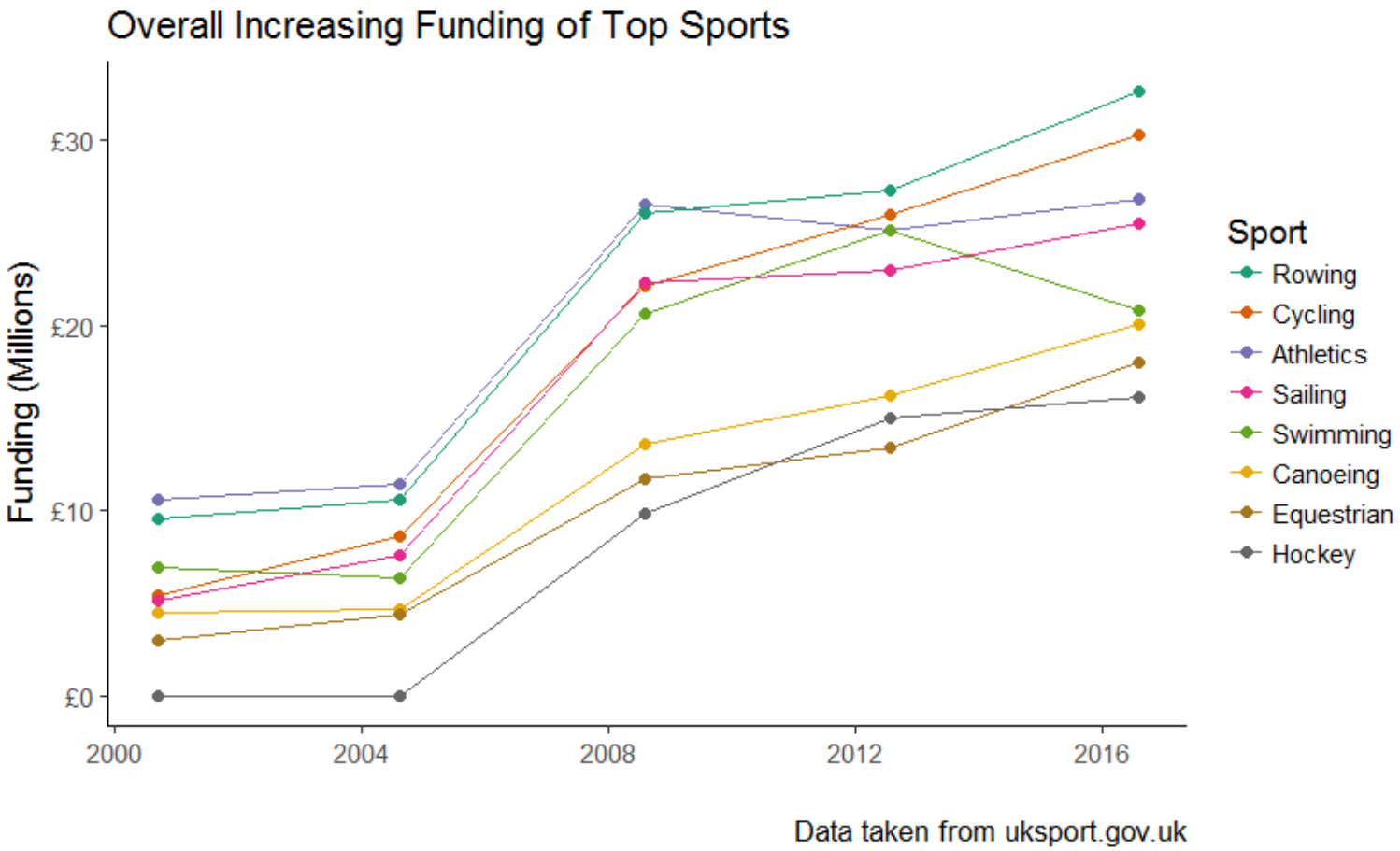
Data taken from uksport.gov.uk

Manipulating Dates: lubridate

- Easy to use functions to convert characters to date format
  - ymd
  - mdy
  - dmy
- Manipulation functions to extract elements of dates
- Functions for accounting for addition of time periods to dates e.g. accounting for 30/31 day months

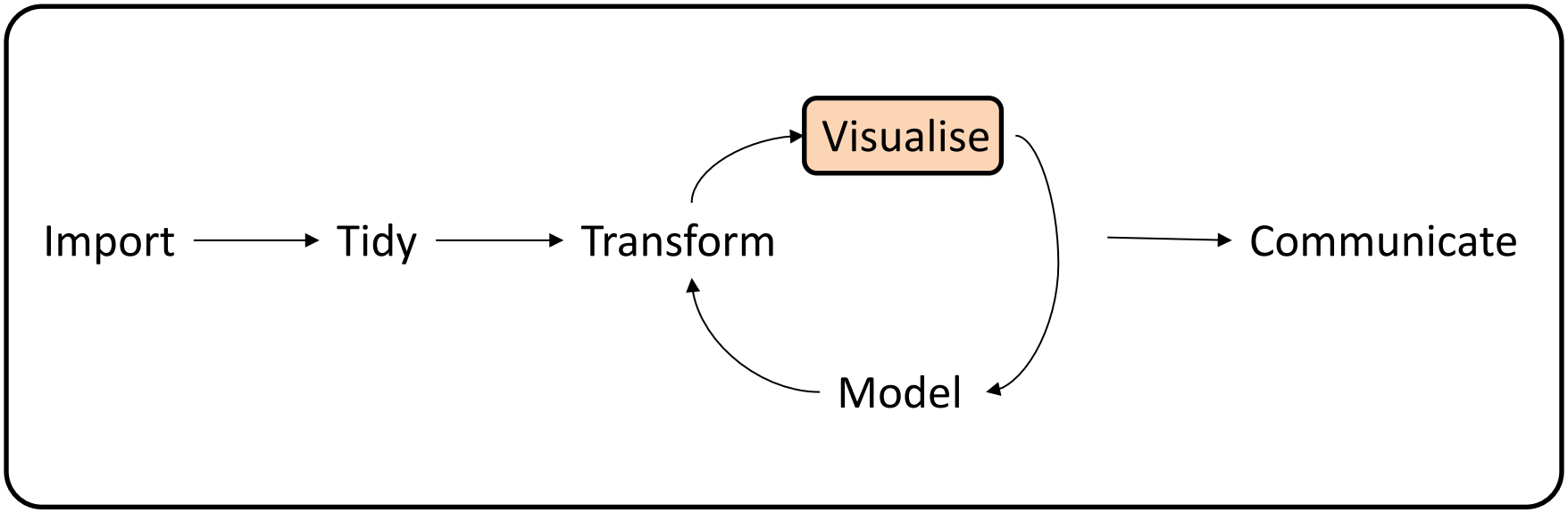
Creating Olympic Start Dates

```
summer <- mutate(summer,
   Date = str_c(Year, Month, Day, sep = "-"),
      Date = ymd(Date)
   )
```


Overall Increasing Funding of Top Sports
Funding (Millions)
£30
£20
£10
£0
2000
2004
2008
2012
2016
Data taken from uksport.gov.uk
Sport
Rowing
Cycling
Athletics
Sailing
Swimming
Canoeing
Equestrian
Hockey

Manipulating Times: HMS

- Allows working with just times
- Convert to just a time
  - hms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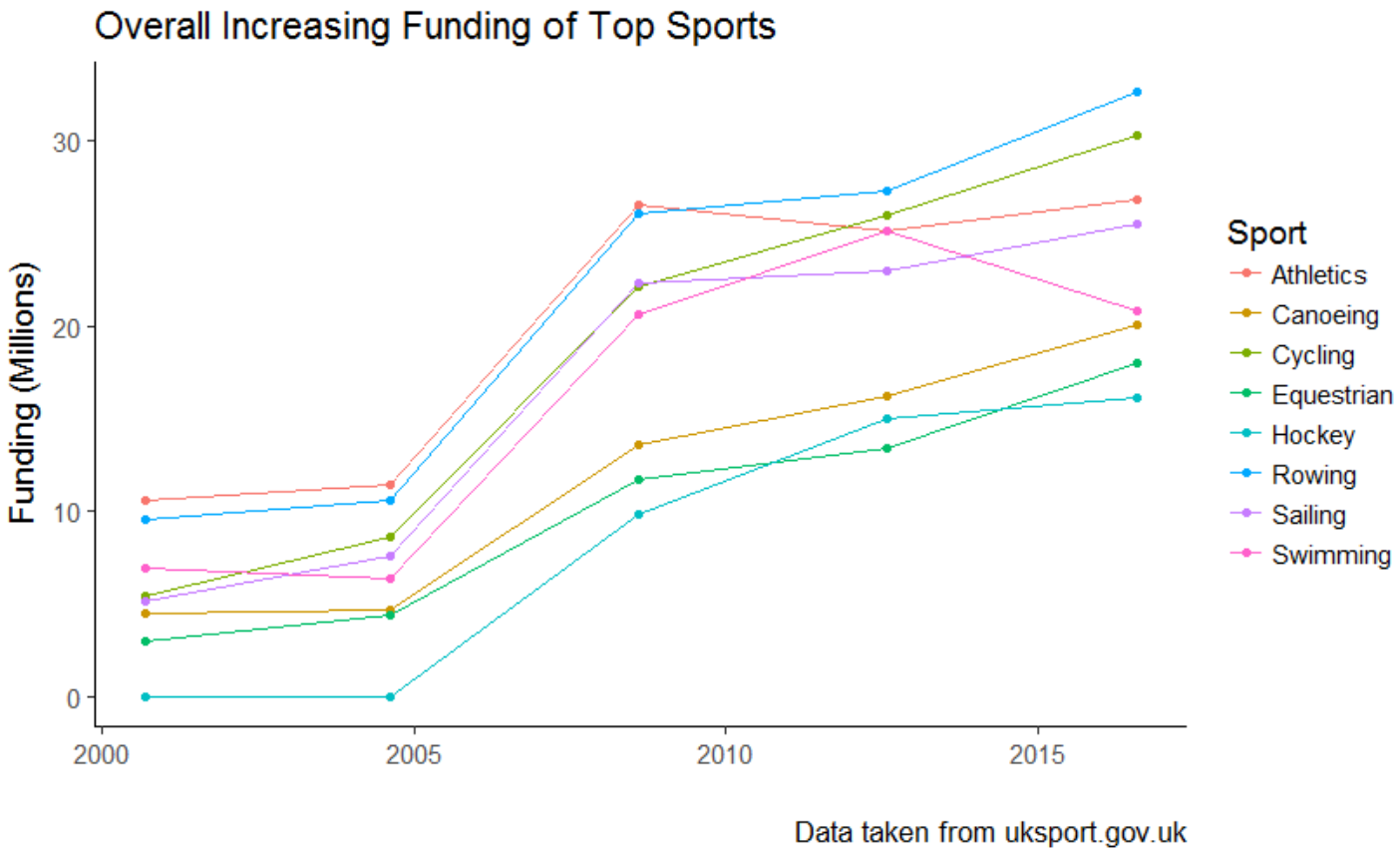
Visualise

- `ggplot2`

Creating Graphics: ggplot2

- Create quick plots with qplot
- Specify the type of plot using the geoms
- Add titles and labels with labs


Overall Increasing Funding of Top Sports
Funding (Millions)
30
20
10
0
2000
2005
2010
2015
Data taken from uksport.gov.uk
Sport
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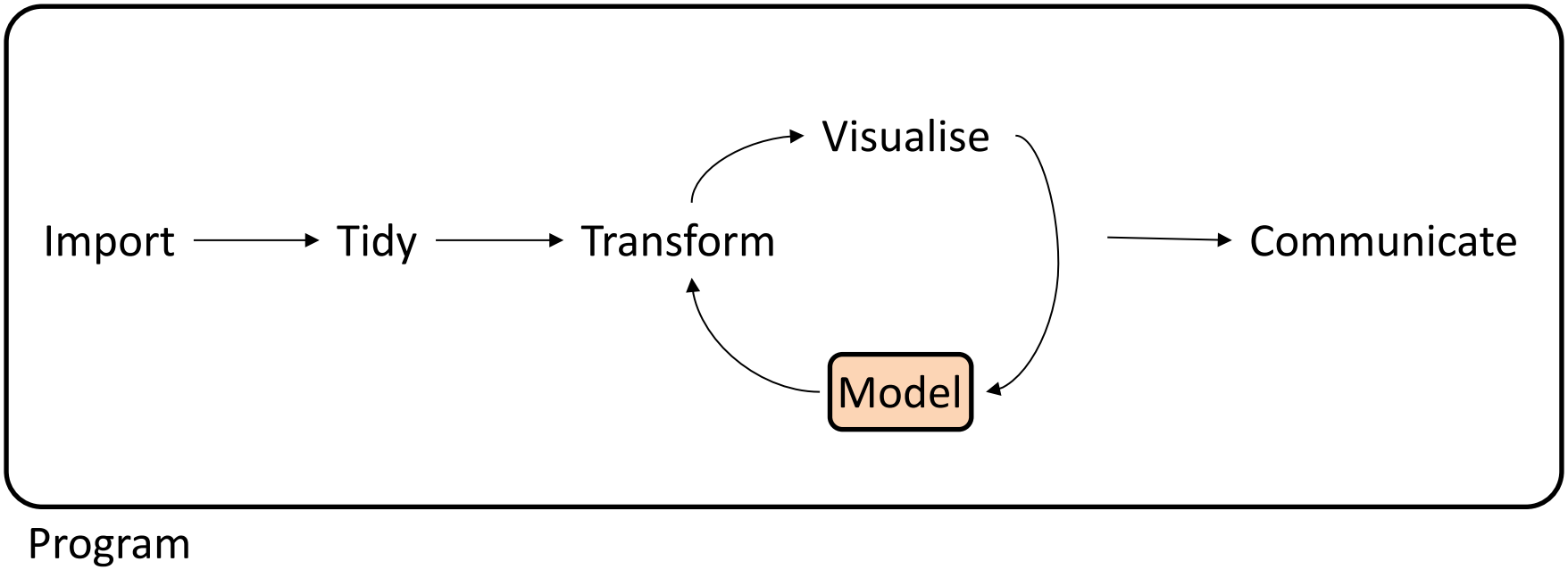
Canoeing
Cycling
Equestrian
Hockey
Rowing
Sailing
Swimming

Graphic of Olympic Funding

```
qplot(data = fundingTime,
      x = Date, y = Funding/1e6,
      colour = Sport,
      geom = c("line", "point")) +
  labs(title = "Increasing Funding ",
       x = "", y = "Funding (Millions)",
     colour = "Sport",
       caption = "Data taken from ...")
```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Model

- `modelr`
- `broom`

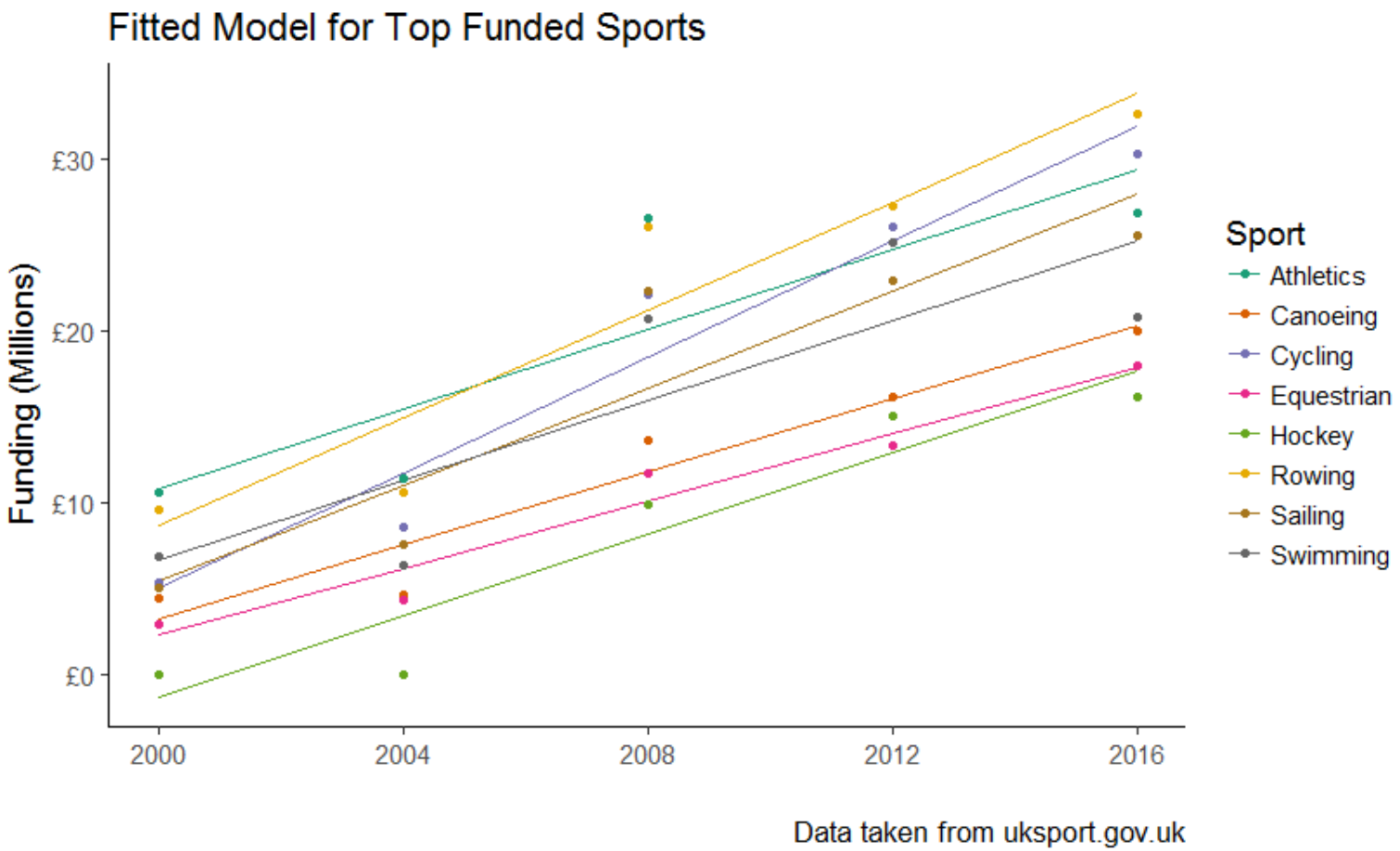
Fitting Models: modelr

- Functionality for bootstrapping/cross validation
- Model metrics – rsquare, rmse
- Extracting predictions and residuals

Predicting Olympic Funding

```
fundingModel <- lm(Funding ~ Sport*Year,
                   data = fundingTime)

modelGrid <- data_grid(fundingTime,
                       Year, Sport)
modelGrid <- modelGrid %>%
             add_predictions(fundingModel)
```


Fitted Model for Top Funded Sports
Funding (Millions)
£30
£20
£10
£0
2000
2004
2008
2012
2016
Data taken from uksport.gov.uk
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Athletics
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Investigating Model Residuals

```
fundingResid <- fundingTime %>%
          add_residuals(fundingModel)
```


Residual Values Suggests Further Fitting Required
Residual Values
5000000
2500000
0
-2500000
-5000000
2000
2004
2008
2012
2016
Data taken from uksport.gov.uk
Sport
Rowing
Cycling
Athletics
Sailing
Swimming
Canoeing
Equestrian
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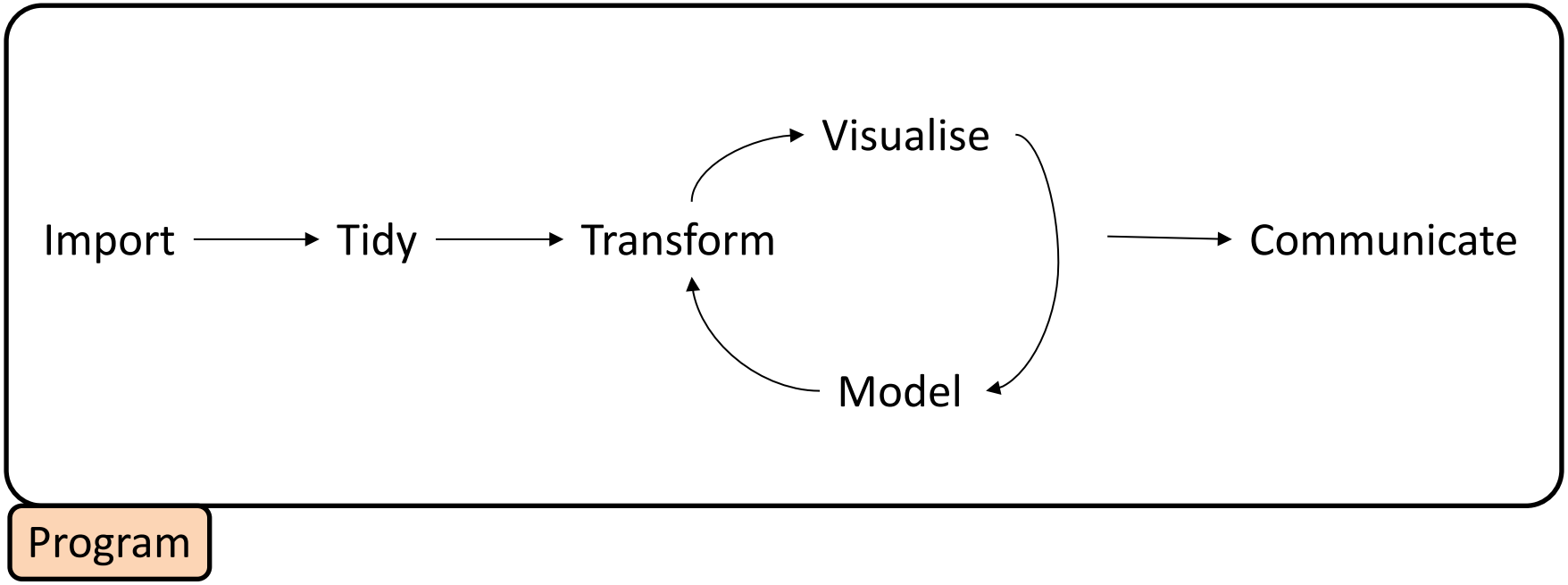
Assessing Model Quality: broom

- Provides functions for extracting details on the model fit
  - Model coefficients – tidy
  - Model diagnostics – glance

- Useful for working with multiple models to compare fit

Fit of Olympics Models

```
tidy(fundingModel)
glance(fundingModel)
```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Program

- `purrr`

Iterating: purrr

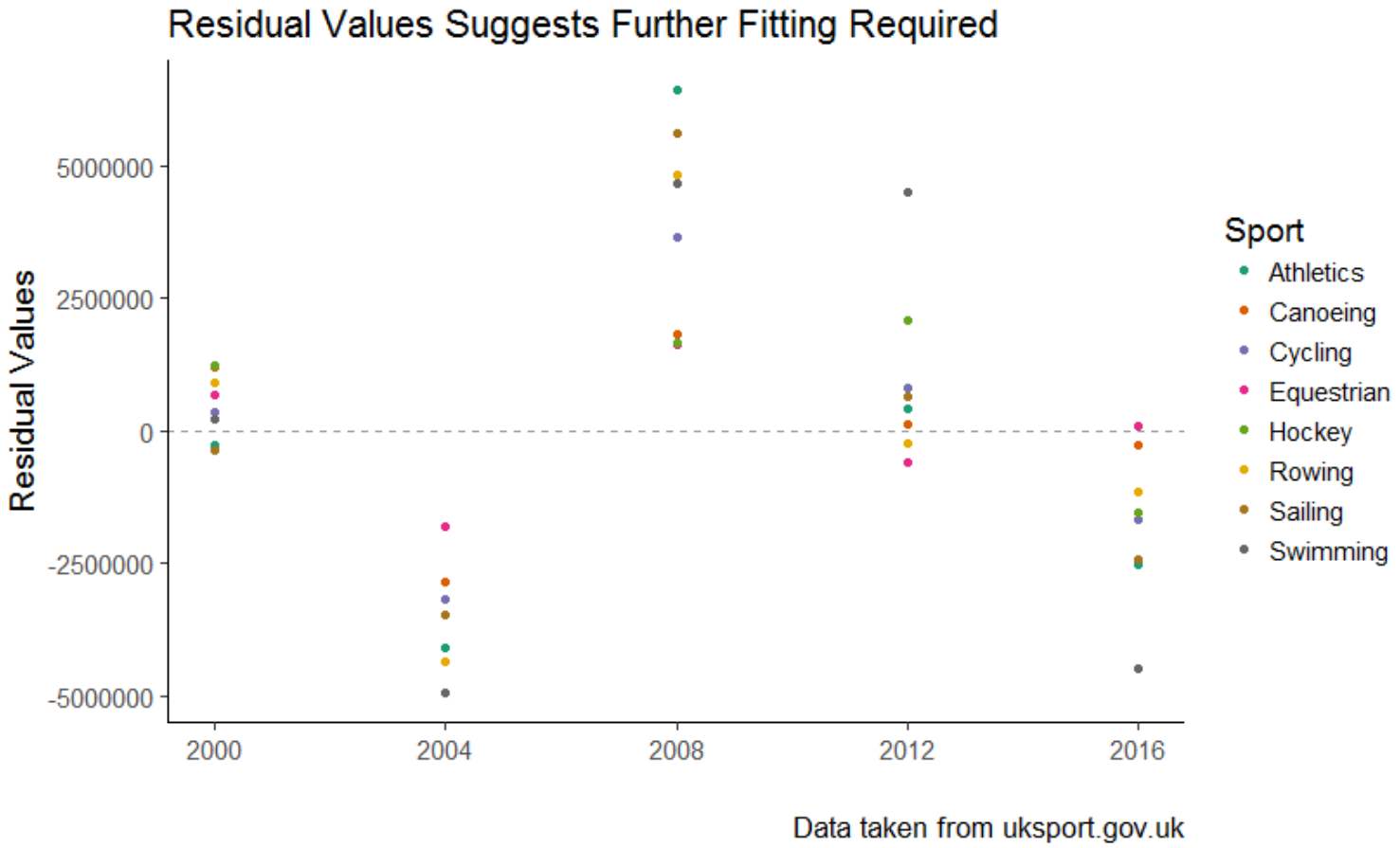
- Iterate (over a vector of values) or apply to multiple set/subsets of data
- Output can be one of many types based on the function used:
  - `map`
  - `map_df`
  - `map_dbl`
  - …

Model For Each Sport

```
sportData <- fundingTime %>%
  group_by(Sport) %>%
  nest()

sportsModels <- map(sportData$data,
        ~lm(Funding ~ Year, data = .))

sportResid <- map2_df(sportData$data,
           sportsModels,
           add_residuals, .id = "Sport")
```


Residual Values Suggests Further Fitting Required
Residual Values
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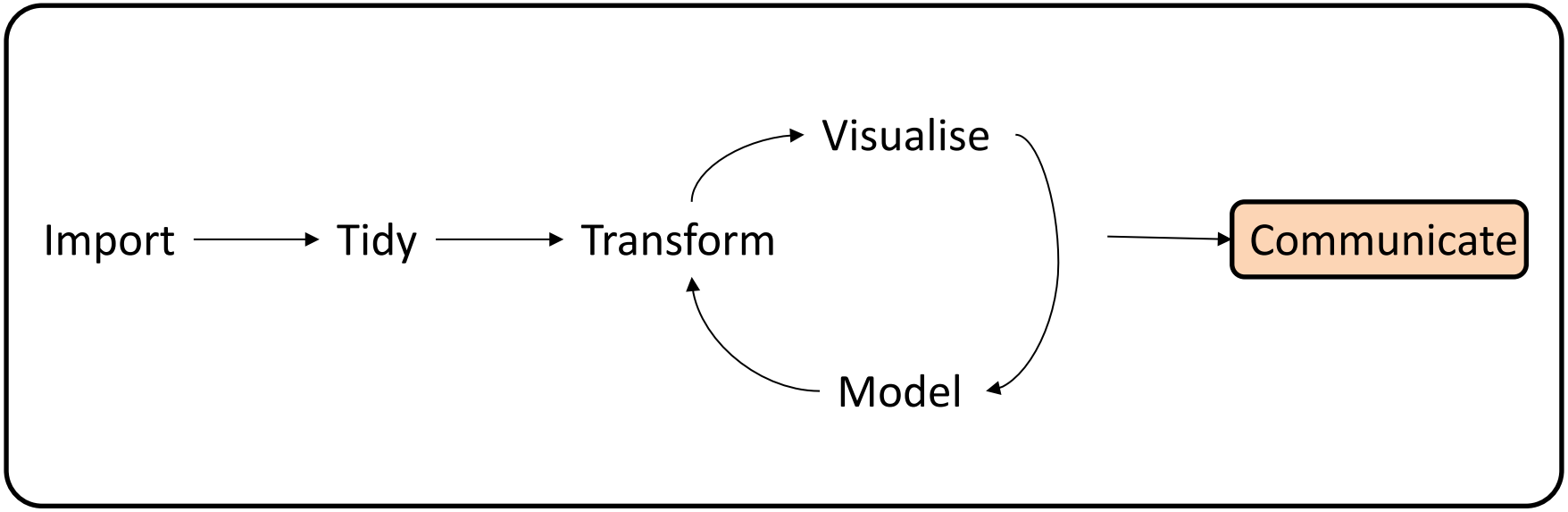
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Communicate

- There are no **tidyverse** packages directly aimed at communicating results (other than creating graphics)
- There are lots of packages that can be used to present results
  - shiny
  - rmarkdown
  - flexdashboard
  - ...

SUMMARY

Living in the Tidyverse

- Single unified approach to manipulating and analysing data
- Provides packages for all stages of the analysis lifecycle

Aimee Gott
agott@mango-solutions.com