

Durations, intervals and periods

Packages for this section

```
library(tidyverse)  
library(lubridate)
```

Exact time intervals

We previously got fractional days (of stays in hospital):

```
my_url <- "http://www.utsc.utoronto.ca/~butler/c32/hospital.csv"
stays <- read_csv(my_url)
stays %>% mutate(stay_days = (discharge - admit) / ddays(1))
```

| admit | discharge | stay_days |
|---------------------|---------------------|-----------|
| 1981-12-10 22:00:00 | 1982-01-03 14:00:00 | 23.666667 |
| 2014-03-07 14:00:00 | 2014-03-08 09:30:00 | 0.812500 |
| 2016-08-31 21:00:00 | 2016-09-02 17:00:00 | 1.833333 |

but what if we wanted days, hours and minutes?

Intervals

```
stays %>% mutate(stay = admit %--% discharge)
```

| admit | discharge | stay |
|------------------------|------------------------|--|
| 1981-12-10 22:00:00 | 1982-01-03 14:00:00 | 1981-12-10 22:00:00 UTC–1982-01-03 14:00:00 UTC |
| 2014-03-07 14:00:00 | 2014-03-08 09:30:00 | 2014-03-07 14:00:00 UTC–2014-03-08 09:30:00 UTC |
| 2016-08-31 21:00:00 | 2016-09-02 17:00:00 | 2016-08-31 21:00:00 UTC–2016-09-02 17:00:00 UTC |

- These are called *intervals*: they have a start point and an end point.

Periods

To work out the exact length of an interval, in human units, turn it into a period:

```
stays %>% mutate(stay = as.period(admit %--% discharge))
```

| admit | discharge | stay |
|---------------------|---------------------|---------------|
| 1981-12-10 22:00:00 | 1982-01-03 14:00:00 | 23d 16H 0M 0S |
| 2014-03-07 14:00:00 | 2014-03-08 09:30:00 | 19H 30M 0S |
| 2016-08-31 21:00:00 | 2016-09-02 17:00:00 | 1d 20H 0M 0S |

A period is exact as long as it has a start and an end (accounting for daylight savings, leap years etc).

Completed days

Take day of the periods:

```
stays %>% mutate(stay = as.period(admit %--% discharge)) %>%  
  mutate(days_of_stay = day(stay))
```

| admit | discharge | stay | days_of_stay |
|---------------------|---------------------|---------------|--------------|
| 1981-12-10 22:00:00 | 1982-01-03 14:00:00 | 23d 16H 0M 0S | 23 |
| 2014-03-07 14:00:00 | 2014-03-08 09:30:00 | 19H 30M 0S | 0 |
| 2016-08-31 21:00:00 | 2016-09-02 17:00:00 | 1d 20H 0M 0S | 1 |

Completed hours 1/2

- Not quite what you think:

```
stays %>% mutate(stay = as.period(admit %--% discharge)) %>%  
  mutate(hours_of_stay = hour(stay))
```

| admit | discharge | stay | hours_of_stay |
|---------------------|---------------------|---------------|---------------|
| 1981-12-10 22:00:00 | 1982-01-03 14:00:00 | 23d 16H 0M 0S | 16 |
| 2014-03-07 14:00:00 | 2014-03-08 09:30:00 | 19H 30M 0S | 19 |
| 2016-08-31 21:00:00 | 2016-09-02 17:00:00 | 1d 20H 0M 0S | 20 |

- These are completed hours *within* days.

Completed hours 2/2

- To get total hours, count each day as 24 hours also:

```
stays %>% mutate(stay = as.period(admit %--% discharge)) %>%  
  mutate(hours_of_stay = hour(stay) + 24*day(stay))
```

| admit | discharge | stay | hours_of_stay |
|---------------------|---------------------|---------------|---------------|
| 1981-12-10 22:00:00 | 1982-01-03 14:00:00 | 23d 16H 0M 0S | 568 |
| 2014-03-07 14:00:00 | 2014-03-08 09:30:00 | 19H 30M 0S | 19 |
| 2016-08-31 21:00:00 | 2016-09-02 17:00:00 | 1d 20H 0M 0S | 44 |

Durations

- What's the difference between duration and period?

```
stays %>% mutate(stay = as.duration(admit %--% discharge))
```

| admit | discharge | stay |
|---------------------|---------------------|------------------------|
| 1981-12-10 22:00:00 | 1982-01-03 14:00:00 | 2044800s (~3.38 weeks) |
| 2014-03-07 14:00:00 | 2014-03-08 09:30:00 | 70200s (~19.5 hours) |
| 2016-08-31 21:00:00 | 2016-09-02 17:00:00 | 158400s (~1.83 days) |

- A duration is always a number of *seconds*.
- Also shown is an approx equivalent on a more human scale (calculated from seconds).

Sometimes it matters

- Days and hours are always the same length (as a number of seconds).
- Months and years are not always the same length:
 - months have different numbers of days
 - years can be leap years or not
 - the actual length of 2 months depends *which* 2 months:

```
tribble(  
  ~start, ~end,  
  ymd("2020-01-15"), ymd("2020-03-15"),  
  ymd("2020-07-15"), ymd("2020-09-15")  
) %>% mutate(period = as.period(start %--% end)) %>%  
  mutate(duration = as.duration(start %--% end))
```

| start | end | period | duration |
|------------|------------|----------------|------------------------|
| 2020-01-15 | 2020-03-15 | 2m 0d 0H 0M 0S | 5184000s (~8.57 weeks) |
| 2020-07-15 | 2020-09-15 | 2m 0d 0H 0M 0S | 5356800s (~8.86 weeks) |

Comments

- Both periods are exactly two months
- but they have a different duration in seconds
- the first two-month period is shorter because it contains the short month February
- the second two-month period is longer because both July and August have 31 days.

Manchester United

Sometime in December 2019 or January 2020, I downloaded some information about the players that were then in the squad of the famous Manchester United Football (soccer) Club. We are going to use the players' ages (as given) to figure out exactly when the download happened.

```
my_url <- "http://ritsokiguess.site/STAD29/manu.csv"
read_csv(my_url) %>%
  select(name, date_of_birth, age) -> man_united
```

```
## Parsed with column specification:
## cols(
##   number = col_double(),
##   name = col_character(),
##   nationality = col_character(),
##   date_of_birth = col_character(),
##   age = col_double(),
##   country_of_birth = col_character(),
##   place_of_birth = col_character(),
##   position = col_character()
```

The data

man_united

| name | date_of_birth | age |
|------------------------------|------------------|-----|
| David de Gea Quintana | 7 November 1990 | 29 |
| Lee Grant | 27 January 1983 | 36 |
| Sergio Germán Romero | 22 February 1987 | 32 |
| Victor Nilsson Lindelöf | 17 July 1994 | 25 |
| Eric Bertrand Bailly | 12 April 1994 | 25 |
| Phil Jones | 21 February 1992 | 27 |
| Harry Maguire | 5 March 1993 | 26 |
| Faustino Marcos Alberto Rojo | 20 March 1990 | 29 |
| Ashley Young | 9 July 1985 | 34 |
| José Diogo Dalot Teixeira | 18 March 1999 | 20 |
| Luke Shaw | 12 July 1995 | 24 |
| Timothy Evans Fosu-Mensah | 2 January 1998 | 21 |
| Aaron Wan-Bissaka | 26 November 1997 | 22 |

Ages

- A player's age is the number of *completed* years since their birth
- This suggests:
 - guessing a download date
 - working out time since birth as *period*
 - extracting number of years
- After that, see if our calculations of age match actual ages

Guess download date and work out ages

Guess January 10, 2020 as download date (just to pick a date):

```
guess <- ymd("2020-01-10")
man_united %>%
  mutate(dob = dmy(date_of_birth)) %>%
  mutate(age_period = as.period(dob %--% guess)) %>%
  mutate(age_years = year(age_period)) -> d
```

Results (just the ages)

```
d %>% select(name, age, age_years)
```

| name | age | age_years |
|------------------------------|-----|-----------|
| David de Gea Quintana | 29 | 29 |
| Lee Grant | 36 | 36 |
| Sergio Germán Romero | 32 | 32 |
| Victor Nilsson Lindelöf | 25 | 25 |
| Eric Bertrand Bailly | 25 | 25 |
| Phil Jones | 27 | 27 |
| Harry Maguire | 26 | 26 |
| Faustino Marcos Alberto Rojo | 29 | 29 |
| Ashley Young | 34 | 34 |
| José Diogo Dalot Teixeira | 20 | 20 |
| Luke Shaw | 24 | 24 |
| Timothy Evans Fosu-Mensah | 21 | 22 |
| Aaron Wan-Bissaka | 22 | 22 |
| Axel Tuanzebe | 22 | 22 |
| Brandon Williams | 19 | 19 |
| Paul Pogba | 26 | 26 |
| Juan Manuel Mata García | 31 | 31 |
| Jesse Lingard | 26 | 27 |
| Andreas Hoelgebaum Pereira | 23 | 24 |
| Frederico Rodrigues Santos | 26 | 26 |

Which ones are different?

```
d %>% filter(age != age_years) %>%  
  select(name, date_of_birth, age, age_years)
```

| name | date_of_birth | age | age_years |
|----------------------------|------------------|-----|-----------|
| Timothy Evans Fosu-Mensah | 2 January 1998 | 21 | 22 |
| Jesse Lingard | 15 December 1992 | 26 | 27 |
| Andreas Hoelgebaum Pereira | 1 January 1996 | 23 | 24 |

- these three players were calculated wrong: we got one year too many.
- Our guessed date, January 10, was too *late*.
- These three players had a birthday since the actual download date
- actual download date must have been before Dec 15.

Try an earlier date

- say Dec 5:

```
guess <- ymd("2019-12-05")
man_united %>%
  mutate(dob = dmy(date_of_birth)) %>%
  mutate(age_period = as.period(dob %--% guess)) %>%
  mutate(age_years = year(age_period)) %>%
  filter(age != age_years) %>%
  select(name, date_of_birth, age, age_years) -> d2
```

Results

d2

| name | date_of_birth | age | age_years |
|-----------------|-----------------|-----|-----------|
| Scott McTominay | 8 December 1996 | 23 | 22 |

- Dec 5 was too early for the download date
- must have been later than Dec 8 (to get McTominay's age right)
- so must have been between Dec 8 and Dec 15 (Lingard's birthday)
- Actually I downloaded the data on Dec 10.