

## Dates and Times

## Packages for this section

```
library(tidyverse)
```

```
-- Attaching core tidyverse packages -----  
v dplyr      1.1.2      v readr      2.1.4  
v forcats    0.5.0      v stringr    1.5.0  
v ggplot2    3.4.2      v tibble     3.2.1  
v lubridate  1.9.2      v tidyr      1.3.0  
v purrr      1.0.1  
-- Conflicts ----- tid  
x dplyr::filter() masks stats::filter()  
x dplyr::lag()     masks stats::lag()  
i Use the conflicted package (<http://conflicted.r-lib.org/)  
# library(lubridate)
```

lubridate is the package that handles dates and times, but is now part of the tidyverse, so no need to load separately.

# Dates

- Dates represented on computers as “days since an origin”, typically Jan 1, 1970, with a negative date being before the origin:

```
mydates <- c("1970-01-01", "2007-09-04", "1931-08-05")
(somedates <- tibble(text = mydates) %>%
  mutate(
    d = as.Date(text),
    numbers = as.numeric(d)
  ))
```

```
# A tibble: 3 x 3
```

	text	d	numbers
	<chr>	<date>	<dbl>
1	1970-01-01	1970-01-01	0
2	2007-09-04	2007-09-04	13760
3	1931-08-05	1931-08-05	-14029

## Doing arithmetic with dates

- ▶ Dates are “actually” numbers, so can add and subtract (difference is 2007 date in d minus others):

```
somedates %>% mutate(plus30 = d + 30, diffs = d[2] - d)
```

```
# A tibble: 3 x 5
```

	text	d	numbers	plus30	diffs
	<chr>	<date>	<dbl>	<date>	<drtn>
1	1970-01-01	1970-01-01	0	1970-01-31	13760 days
2	2007-09-04	2007-09-04	13760	2007-10-04	0 days
3	1931-08-05	1931-08-05	-14029	1931-09-04	27789 days

## Reading in dates from a file

- ▶ `read_csv` and the others can guess that you have dates, if you format them as year-month-day, like column 1 of this `.csv`:

```
date,status,dunno
2011-08-03,hello,August 3 2011
2011-11-15,still here,November 15 2011
2012-02-01,goodbye,February 1 2012
```

- ▶ Then read them in:

```
my_url <- "http://ritsokiguess.site/datafiles/mydates.csv"
ddd <- read_csv(my_url)
```

```
Rows: 3 Columns: 3
-- Column specification -----
Delimiter: ","
chr (2): status, dunno
date (1): date
```

i Use ``spec()`` to retrieve the full column specification for

## The data as read in

```
ddd
```

```
# A tibble: 3 x 3
```

	date	status	dunno
	<date>	<chr>	<chr>

1	2011-08-03	hello	August 3 2011
---	------------	-------	---------------

2	2011-11-15	still here	November 15 2011
---	------------	------------	------------------

3	2012-02-01	goodbye	February 1 2012
---	------------	---------	-----------------

## Dates in other formats

- ▶ Preceding shows that dates should be stored as text in format yyyy-mm-dd (ISO standard).
- ▶ To deal with dates in other formats, use package lubridate and convert. For example, dates in US format with month first:

```
tibble(usdates = c("05/27/2012", "01/03/2016", "12/31/2015"),  
       mutate(iso = mdy(usdates)))
```

```
# A tibble: 3 x 2
```

usdates	iso
<chr>	<date>

1 05/27/2012	2012-05-27
2 01/03/2016	2016-01-03
3 12/31/2015	2015-12-31

## Trying to read these as UK dates

```
tibble(usdates = c("05/27/2012", "01/03/2016", "12/31/2015"),  
       mutate(uk = dmy(usdates)))
```

Warning: There was 1 warning in `mutate()`.

i In argument: `uk = dmy(usdates)`.

Caused by warning:

! 2 failed to parse.

# A tibble: 3 x 2

usdates	uk
<chr>	<date>

1 05/27/2012	NA
--------------	----

2 01/03/2016	2016-03-01
--------------	------------

3 12/31/2015	NA
--------------	----

- For UK-format dates with month second, one of these dates is legit, but the other two make no sense.



## Our data frame's last column:

► Back to this:

```
ddd
```

```
# A tibble: 3 x 3
```

	date	status	dunno
	<date>	<chr>	<chr>

1	2011-08-03	hello	August 3 2011
---	------------	-------	---------------

2	2011-11-15	still here	November 15 2011
---	------------	------------	------------------

3	2012-02-01	goodbye	February 1 2012
---	------------	---------	-----------------

► Month, day, year in that order.

so interpret as such

```
(ddd %>% mutate(date2 = mdy(dunno)) -> d4)
```

```
# A tibble: 3 x 4
```

	date	status	dunno	date2
	<date>	<chr>	<chr>	<date>
1	2011-08-03	hello	August 3 2011	2011-08-03
2	2011-11-15	still here	November 15 2011	2011-11-15
3	2012-02-01	goodbye	February 1 2012	2012-02-01

## Are they really the same?

- ▶ Column date2 was correctly converted from column dunno:

```
d4 %>% mutate(equal = identical(date, date2))
```

```
# A tibble: 3 x 5
```

	date	status	dunno	date2	equal
	<date>	<chr>	<chr>	<date>	<lgl>
1	2011-08-03	hello	August 3 2011	2011-08-03	TRUE
2	2011-11-15	still here	November 15 2011	2011-11-15	TRUE
3	2012-02-01	goodbye	February 1 2012	2012-02-01	TRUE

- ▶ The two columns of dates are all the same.

# Making dates from pieces

Starting from this file:

```
year month day
```

```
1970 1 1
```

```
2007 9 4
```

```
1940 4 15
```

```
my_url <- "http://ritsokiguess.site/datafiles/pieces.txt"
dates0 <- read_delim(my_url, " ")
```

```
Rows: 3 Columns: 3
```

```
-- Column specification -----
```

```
Delimiter: " "
```

```
dbl (3): year, month, day
```

i Use ``spec()`` to retrieve the full column specification for

i Specify the column types or set ``show_col_types = FALSE``

## Making some dates

```
dates0
```

```
# A tibble: 3 x 3
  year month   day
<dbl> <dbl> <dbl>
1  1970     1     1
2  2007     9     4
3  1940     4    15
```

```
dates0 %>%
  unite(dates, day, month, year) %>%
  mutate(d = dmy(dates)) -> newdates
```

# The results

```
newdates
```

```
# A tibble: 3 x 2
  dates      d
  <chr>    <date>
1 1_1_1970 1970-01-01
2 4_9_2007 2007-09-04
3 15_4_1940 1940-04-15
```

- ▶ `unite` glues things together with an underscore between them (if you don't specify anything else). Syntax: first thing is new column to be created, other columns are what to make it out of.
- ▶ `unite` makes the original variable columns year, month, day *disappear*.
- ▶ The column `dates` is text, while `d` is a real date.

## Extracting information from dates

```
newdates %>%  
  mutate(  
    mon = month(d),  
    day = day(d),  
    weekday = wday(d, label = T)  
  )
```

# A tibble: 3 x 5

	dates	d	mon	day	weekday
	<chr>	<date>	<dbl>	<int>	<ord>
1	1_1_1970	1970-01-01	1	1	Thu
2	4_9_2007	2007-09-04	9	4	Tue
3	15_4_1940	1940-04-15	4	15	Mon

## Dates and times

- ▶ Standard format for times is to put the time after the date, hours, minutes, seconds:

```
(dd <- tibble(text = c(
  "1970-01-01 07:50:01", "2007-09-04 15:30:00",
  "1940-04-15 06:45:10", "2016-02-10 12:26:40"
)))
```

```
# A tibble: 4 x 1
```

```
text
```

```
<chr>
```

```
1 1970-01-01 07:50:01
2 2007-09-04 15:30:00
3 1940-04-15 06:45:10
4 2016-02-10 12:26:40
```



## Converting text to date-times:

- ▶ Then get from this text using `ymd_hms`:

```
dd %>% mutate(dt = ymd_hms(text))
```

```
# A tibble: 4 x 2
```

	text	dt
	<chr>	<dtm>
1	1970-01-01 07:50:01	1970-01-01 07:50:01
2	2007-09-04 15:30:00	2007-09-04 15:30:00
3	1940-04-15 06:45:10	1940-04-15 06:45:10
4	2016-02-10 12:26:40	2016-02-10 12:26:40

# Timezones

- ▶ Default timezone is “Universal Coordinated Time”. Change it via `tz=` and the name of a timezone:

```
dd %>%  
  mutate(dt = ymd_hms(text, tz = "America/Toronto")) -> dd  
dd %>% mutate(zone = tz(dt))
```

# A tibble: 4 x 3

	text	dt	zone
	<chr>	<dtm>	<chr>
1	1970-01-01 07:50:01	1970-01-01 07:50:01	America/Toronto
2	2007-09-04 15:30:00	2007-09-04 15:30:00	America/Toronto
3	1940-04-15 06:45:10	1940-04-15 06:45:10	America/Toronto
4	2016-02-10 12:26:40	2016-02-10 12:26:40	America/Toronto

## Extracting time parts

► As you would expect:

```
dd %>%  
  select(-text) %>%  
  mutate(  
    h = hour(dt),  
    sec = second(dt),  
    min = minute(dt),  
    zone = tz(dt)  
  )
```

# A tibble: 4 x 5

	dt	h	sec	min	zone
	<dtm>	<int>	<dbl>	<int>	<chr>
1	1970-01-01 07:50:01	7	1	50	America/Toronto
2	2007-09-04 15:30:00	15	0	30	America/Toronto
3	1940-04-15 06:45:10	6	10	45	America/Toronto
4	2016-02-10 12:26:40	12	40	26	America/Toronto

## Same times, but different time zone:

```
dd %>%  
  select(dt) %>%  
  mutate(oz = with_tz(dt, "Australia/Sydney"))
```

# A tibble: 4 x 2

	dt	oz
	<dtm>	<dtm>
1	1970-01-01 07:50:01	1970-01-01 22:50:01
2	2007-09-04 15:30:00	2007-09-05 05:30:00
3	1940-04-15 06:45:10	1940-04-15 21:45:10
4	2016-02-10 12:26:40	2016-02-11 04:26:40

In more detail:

```
dd %>%  
  mutate(oz = with_tz(dt, "Australia/Sydney")) %>%  
  pull(oz)
```

```
[1] "1970-01-01 22:50:01 AEST" "2007-09-05 05:30:00 AEST"  
[3] "1940-04-15 21:45:10 AEST" "2016-02-11 04:26:40 AEDT"
```

## How long between date-times?

- ▶ We may need to calculate the time between two events. For example, these are the dates and times that some patients were admitted to and discharged from a hospital:

`admit,discharge`

`1981-12-10 22:00:00,1982-01-03 14:00:00`

`2014-03-07 14:00:00,2014-03-08 09:30:00`

`2016-08-31 21:00:00,2016-09-02 17:00:00`

## Do they get read in as date-times?

- ▶ These ought to get read in and converted to date-times:

```
my_url <- "http://ritsokiguess.site/datafiles/hospital.csv"
stays <- read_csv(my_url)
```

Rows: 3 Columns: 2

-- Column specification -----

Delimiter: ","

dtm (2): admit, discharge

- i Use ``spec()`` to retrieve the full column specification for
- i Specify the column types or set ``show_col_types = FALSE``

```
stays
```

# A tibble: 3 x 2

	admit <dtm>	discharge <dtm>
1	1981-12-10 22:00:00	1982-01-03 14:00:00
2	2014-03-07 14:00:00	2014-03-08 09:30:00

## Subtracting the date-times

► In the obvious way, this gets us an answer:

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

```
# A tibble: 3 x 3
```

	admit <dtm>	discharge <dtm>	stay <drtn>
1	1981-12-10 22:00:00	1982-01-03 14:00:00	568.0 hours
2	2014-03-07 14:00:00	2014-03-08 09:30:00	19.5 hours
3	2016-08-31 21:00:00	2016-09-02 17:00:00	44.0 hours

► Number of hours; hard to interpret.

# Days

- Fractional number of days would be better:

```
stays %>%  
  mutate(  
    stay_days = as.period(admit %--% discharge) / days(1))
```

# A tibble: 3 x 3

	admit <dtm>	discharge <dtm>	stay_days <dbl>
1	1981-12-10 22:00:00	1982-01-03 14:00:00	23.7
2	2014-03-07 14:00:00	2014-03-08 09:30:00	0.812
3	2016-08-31 21:00:00	2016-09-02 17:00:00	1.83



## Completed days

- Pull out with `day()` etc, as for a date-time:

```
stays %>%  
  mutate(  
    stay = as.period(admit %--% discharge),  
    stay_days = day(stay),  
    stay_hours = hour(stay)  
  ) %>%  
  select(starts_with("stay"))
```

# A tibble: 3 x 3

	stay	stay_days	stay_hours
	<Period>	<dbl>	<dbl>
1	23d 16H 0M 0S	23	16
2	19H 30M 0S	0	19
3	1d 20H 0M 0S	1	20

## Comments

- ▶ Date-times are stored internally as seconds-since-something, so that subtracting two of them will give, internally, a number of seconds.
- ▶ Just subtracting the date-times is displayed as a time (in units that R chooses for us).
- ▶ Convert to fractional times via a “period”, then divide by `days(1)`, `months(1)` etc.
- ▶ These ideas useful for calculating time from a start point until an event happens (in this case, a patient being discharged from hospital).