

# Dates and Times

## Packages for this section

```
library(tidyverse)  
# 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)
```

- `read_csv` guessed that the 1st column is dates, but not 3rd.

## 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))
```

```
# 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 wrong), 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 <date>	status <chr>	dunno <chr>	date2 <date>	equal <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, " ")
```

# 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 = TRUE)  
  )
```

# 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)) %>% pull(dt)
```

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

# 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

## Finding a timezone name

- Use `OlsonNames()`. Some of them:

```
sample(OlsonNames(), 10)
```

[1] "America/Cayman"	"Asia/Macau"
[3] "Europe/Malta"	"Australia/Broken_Hill"
[5] "Asia/Srednekolymsk"	"Asia/Hong_Kong"
[7] "Africa/Mogadishu"	"America/Belize"
[9] "America/Asuncion"	"Australia/Adelaide"

## 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"
```

“Australian Eastern Time”, Standard or Daylight. Note when the Australian summer is.

## 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)
stays
```

```
# A tibble: 3 x 2
  admit          discharge
  <dtm>          <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
3 2016-08-31 21:00:00 2016-09-02 17:00:00
```

- and so it proves.



## 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 <Period>	stay_days <dbl>	stay_hours <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).