Special data types

01-14-2020

Today, we will spend some time talking about some special data types in R. - factors (categorial data) - date and time

Factors

When importing data to R, base R has a burning desire to turn character information into factor. See for example, `read.table`, and `read.csv`.

```
library(tidyverse)
```

```
# to illustrate the issue of `read.csv`, let's write a csv file out of the flights dataset
library(nycflights13)
write_csv(flights %>% sample_n(100), "flights.csv")
```

```
# base R function, character variables are automatically converted to factors
read.csv("flights.csv")
```

```
# tidyverse function, character variables are imported as is
read_csv("flights.csv")
# there are several workarounds,
# 1. we could use `mutate_if` to force the conversion
read_csv("flights.csv") %>%
  mutate_if(is.character, as_factor)
read_csv("flights.csv") %>%
  mutate_if(~ is.character(.) && n_distinct(.) < 50, as_factor)

# 2. we could specify the column types
read_csv("flights.csv", col_types = "iiiddddddfccffddddT")

# 3. use the rstudio import interface
```

Factor inspection

Let's consider the dataset `gss_cat`: A sample of categorical variables from the General Social survey

```
class(gss_cat$partyid)
```

```
## [1] "factor"
```

```
levels(gss_cat$partyid)
```

```
##  [1] "No answer"          "Don't know"         "Other party"
##  [4] "Strong republican"  "Not str republican" "Ind,near rep"
##  [7] "Independent"        "Ind,near dem"       "Not str democrat"
## [10] "Strong democrat"
```

```
fct_unique(gss_cat$partyid)
```

```
##  [1] No answer          Don't know         Other party        Strong republican
##  [5] Not str republican Ind,near rep       Independent        Ind,near dem
##  [9] Not str democrat   Strong democrat
## 10 Levels: No answer Don't know Other party ... Strong democrat
```

```
nlevels(gss_cat$partyid)
```

```
## [1] 10
```

```
gss_cat %>% count(partyid)
```

```
## # A tibble: 10 x 2
##    partyid                n
##    <fct>              <int>
##  1 No answer            154
##  2 Don't know             1
##  3 Other party          393
##  4 Strong republican   2314
##  5 Not str republican  3032
##  6 Ind,near rep        1791
##  7 Independent         4119
##  8 Ind,near dem        2499
##  9 Not str democrat    3690
## 10 Strong democrat     3490
```

```
gss_cat$partyid %>% fct_count(sort = TRUE)
```

```
## # A tibble: 10 x 2
##    f                      n
##    <fct>              <int>
##  1 Independent         4119
##  2 Not str democrat    3690
##  3 Strong democrat     3490
##  4 Not str republican  3032
##  5 Ind,near dem        2499
##  6 Strong republican   2314
##  7 Ind,near rep        1791
##  8 Other party          393
##  9 No answer            154
## 10 Don't know             1
```

Combining factors

```
fa <- factor("a")
fb <- factor("b")
fab <- factor(c("a", "b"))

c(fa, fb, fab)  # not what you want!
```

```
## [1] 1 1 1 2
```

```
fct_c(fa, fb, fab)
```

```
## [1] a b a b
## Levels: a b
```

Dropping unused levels

The number of levels won't change even all the rows corresponding to specific factor level are dropped.

```
gss_cat2 <- gss_cat %>%
  filter(partyid %in% c("Independent", "Strong democrat", "Strong republican"))
nlevels(gss_cat2$partyid)
```

```
## [1] 10
```

```
# drop unused levels of a specific factor
gss_cat2$partyid <- gss_cat2$partyid %>% fct_drop()
# equivalently
gss_cat2 <- gss_cat2 %>% mutate(partyid = fct_drop(gss_cat2$partyid))

levels(gss_cat2$partyid)
```

```
## [1] "Strong republican" "Independent"       "Strong democrat"
```

```
# drop unused levels for all the factors in a data frame
gss_cat2 <- gss_cat2 %>% droplevels()
```

Change order of the levels

```
gss_cat$partyid %>%
  levels()
```

```
##  [1] "No answer"          "Don't know"         "Other party"
##  [4] "Strong republican"  "Not str republican" "Ind,near rep"
##  [7] "Independent"        "Ind,near dem"       "Not str democrat"
## [10] "Strong democrat"
```

```
## order by frequency
gss_cat %>% mutate(partyid = partyid %>% fct_infreq())
```

```
## # A tibble: 21,483 x 9
##     year marital     age race  rincome    partyid     relig     denom    tvhours
##    <int> <fct>     <int> <fct> <fct>      <fct>       <fct>     <fct>      <int>
##  1  2000 Never ma~    26 White $8000 to ~ Ind,near r~ Protesta~ Souther~      12
##  2  2000 Divorced     48 White $8000 to ~ Not str re~ Protesta~ Baptist~      NA
##  3  2000 Widowed      67 White Not appli~ Independent Protesta~ No deno~       2
```

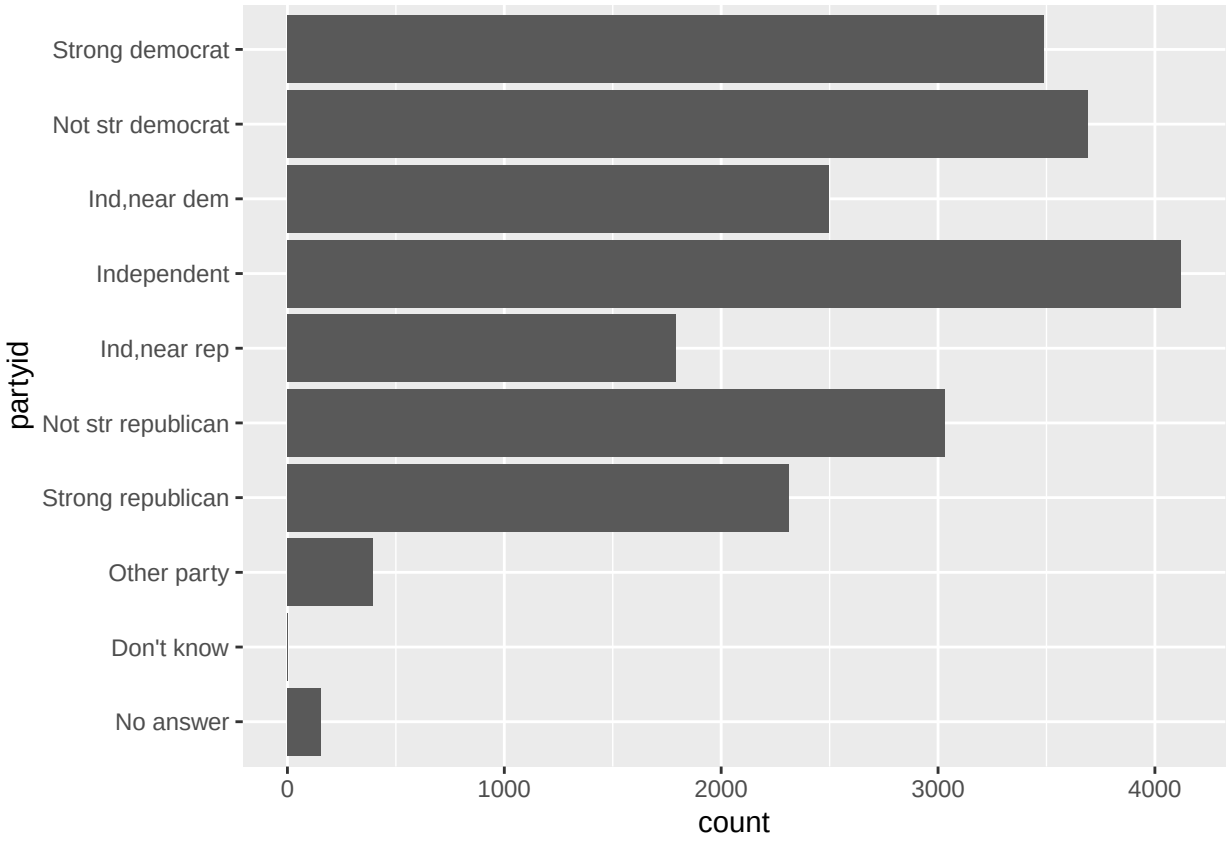
```
##  4  2000 Never ma~    39 White Not appli~ Ind,near r~ Orthodox~ Not app~       4
##  5  2000 Divorced     25 White Not appli~ Not str de~ None      Not app~       1
##  6  2000 Married      25 White $20000 - ~ Strong dem~ Protesta~ Souther~      NA
##  7  2000 Never ma~    36 White $25000 or~ Not str re~ Christian Not app~       3
##  8  2000 Divorced     44 White $7000 to ~ Ind,near d~ Protesta~ Luthera~      NA
##  9  2000 Married      44 White $25000 or~ Not str de~ Protesta~ Other          0
## 10  2000 Married      47 White $25000 or~ Strong rep~ Protesta~ Souther~       3
## # ... with 21,473 more rows
```

```
## backwards!
gss_cat %>% mutate(partyid = partyid %>% fct_infreq() %>% fct_rev())
```

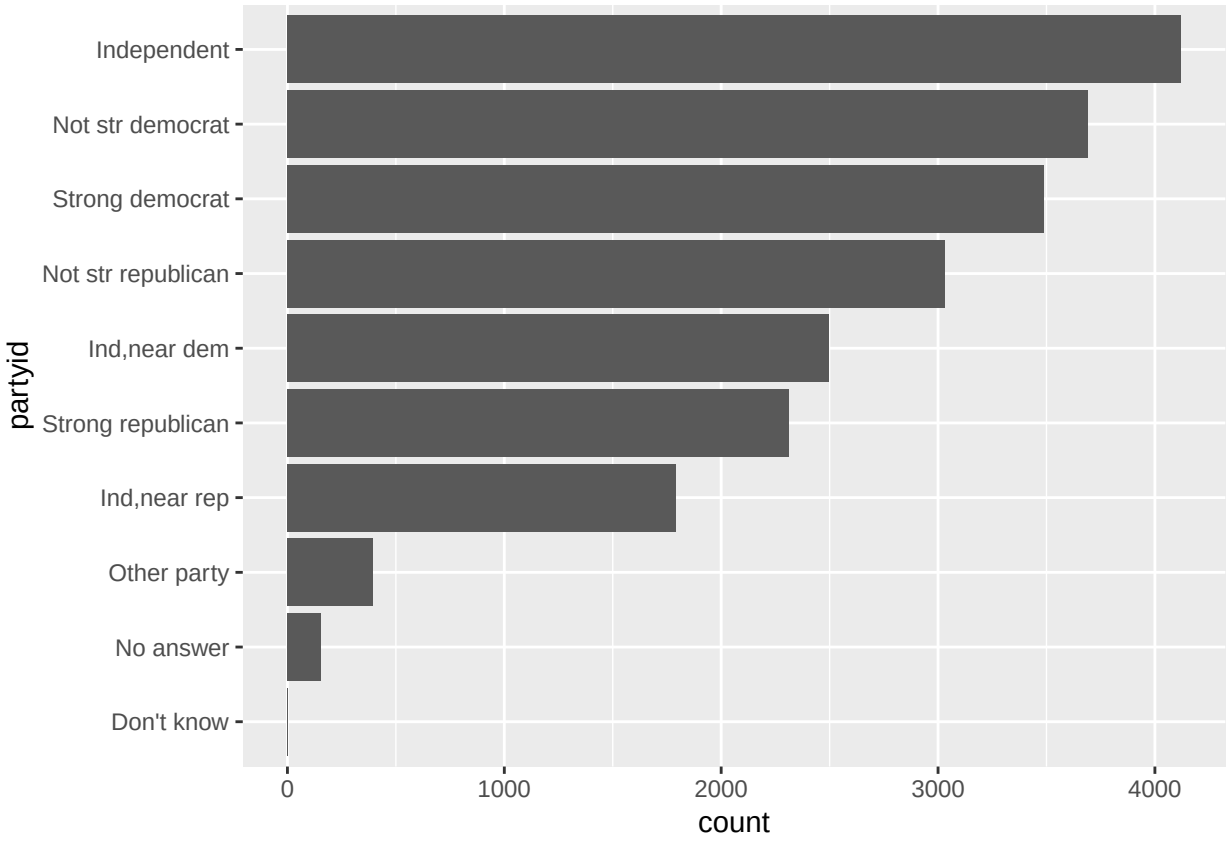
```
## # A tibble: 21,483 x 9
##     year marital     age race  rincome    partyid     relig     denom    tvhours
##    <int> <fct>     <int> <fct> <fct>      <fct>       <fct>     <fct>      <int>
##  1  2000 Never ma~    26 White $8000 to ~ Ind,near r~ Protesta~ Souther~      12
##  2  2000 Divorced     48 White $8000 to ~ Not str re~ Protesta~ Baptist~      NA
##  3  2000 Widowed      67 White Not appli~ Independent Protesta~ No deno~       2
##  4  2000 Never ma~    39 White Not appli~ Ind,near r~ Orthodox~ Not app~       4
##  5  2000 Divorced     25 White Not appli~ Not str de~ None      Not app~       1
##  6  2000 Married      25 White $20000 - ~ Strong dem~ Protesta~ Souther~      NA
##  7  2000 Never ma~    36 White $25000 or~ Not str re~ Christian Not app~       3
##  8  2000 Divorced     44 White $7000 to ~ Ind,near d~ Protesta~ Luthera~      NA
##  9  2000 Married      44 White $25000 or~ Not str de~ Protesta~ Other          0
## 10  2000 Married      47 White $25000 or~ Strong rep~ Protesta~ Souther~       3
## # ... with 21,473 more rows
```

Why?

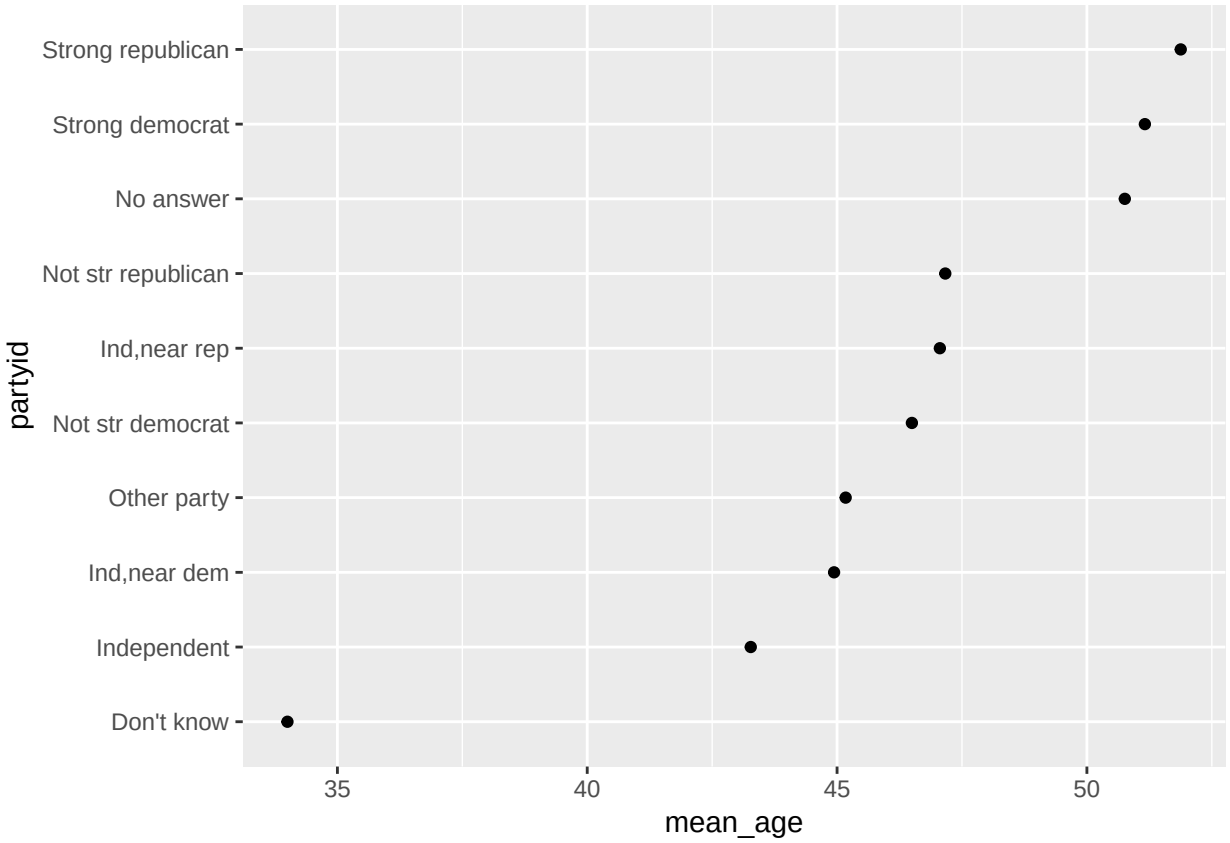
```
ggplot(gss_cat) + geom_bar(aes(partyid)) + coord_flip()
```




```
ggplot(gss_cat) + geom_bar(aes(partyid %>% fct_infreq() %>% fct_rev())) +
  xlab("partyid") + coord_flip()
```




```
# reorder factor according to values of another variable
gss_cat %>%
  group_by(partyid) %>%
  summarize(mean_age = mean(age, na.rm = TRUE)) %>%
  ggplot(aes(x = mean_age, y = fct_reorder(partyid, mean_age))) +
  geom_point() + ylab("partyid")
```



Change to any order

```
gss_cat$partyid %>% levels()
```

```
##  [1] "No answer"          "Don't know"         "Other party"
##  [4] "Strong republican"  "Not str republican" "Ind,near rep"
##  [7] "Independent"        "Ind,near dem"       "Not str democrat"
## [10] "Strong democrat"
```

```
gss_cat$partyid %>%
  fct_relevel("Strong republican", "Strong democrat") %>%
  levels()
```

```
##  [1] "Strong republican"  "Strong democrat"    "No answer"
##  [4] "Don't know"         "Other party"        "Not str republican"
##  [7] "Ind,near rep"       "Independent"        "Ind,near dem"
## [10] "Not str democrat"
```

```
# use mutate verb to modifly the data frame
gss_cat %>% mutate(partyid = partyid %>% fct_relevel("Strong republican", "Strong democrat"))
```

```
## # A tibble: 21,483 x 9
```

```
##     year marital     age race  rincome    partyid     relig     denom    tvhours
##    <int> <fct>     <int> <fct> <fct>      <fct>       <fct>     <fct>      <int>
##  1  2000 Never ma~    26 White $8000 to ~ Ind,near r~ Protesta~ Souther~      12
##  2  2000 Divorced     48 White $8000 to ~ Not str re~ Protesta~ Baptist~      NA
##  3  2000 Widowed      67 White Not appli~ Independent Protesta~ No deno~       2
##  4  2000 Never ma~    39 White Not appli~ Ind,near r~ Orthodox~ Not app~       4
##  5  2000 Divorced     25 White Not appli~ Not str de~ None      Not app~       1
##  6  2000 Married      25 White $20000 - ~ Strong dem~ Protesta~ Souther~      NA
##  7  2000 Never ma~    36 White $25000 or~ Not str re~ Christian Not app~       3
##  8  2000 Divorced     44 White $7000 to ~ Ind,near d~ Protesta~ Luthera~      NA
##  9  2000 Married      44 White $25000 or~ Not str de~ Protesta~ Other          0
## 10  2000 Married      47 White $25000 or~ Strong rep~ Protesta~ Souther~       3
## # ... with 21,473 more rows
```

Recode levels

```
gss_cat$partyid %>% levels()
```

```
##  [1] "No answer"          "Don't know"         "Other party"
##  [4] "Strong republican"  "Not str republican" "Ind,near rep"
##  [7] "Independent"        "Ind,near dem"       "Not str democrat"
## [10] "Strong democrat"
```

```
gss_cat$partyid %>%
  fct_recode(
    "Independent,near rep" = "Ind,near rep",
    "Independent,near dem" = "Ind,near dem"
  ) %>%
  levels()
```

```
##  [1] "No answer"            "Don't know"           "Other party"
##  [4] "Strong republican"    "Not str republican"   "Independent,near rep"
##  [7] "Independent"          "Independent,near dem" "Not str democrat"
## [10] "Strong democrat"
```

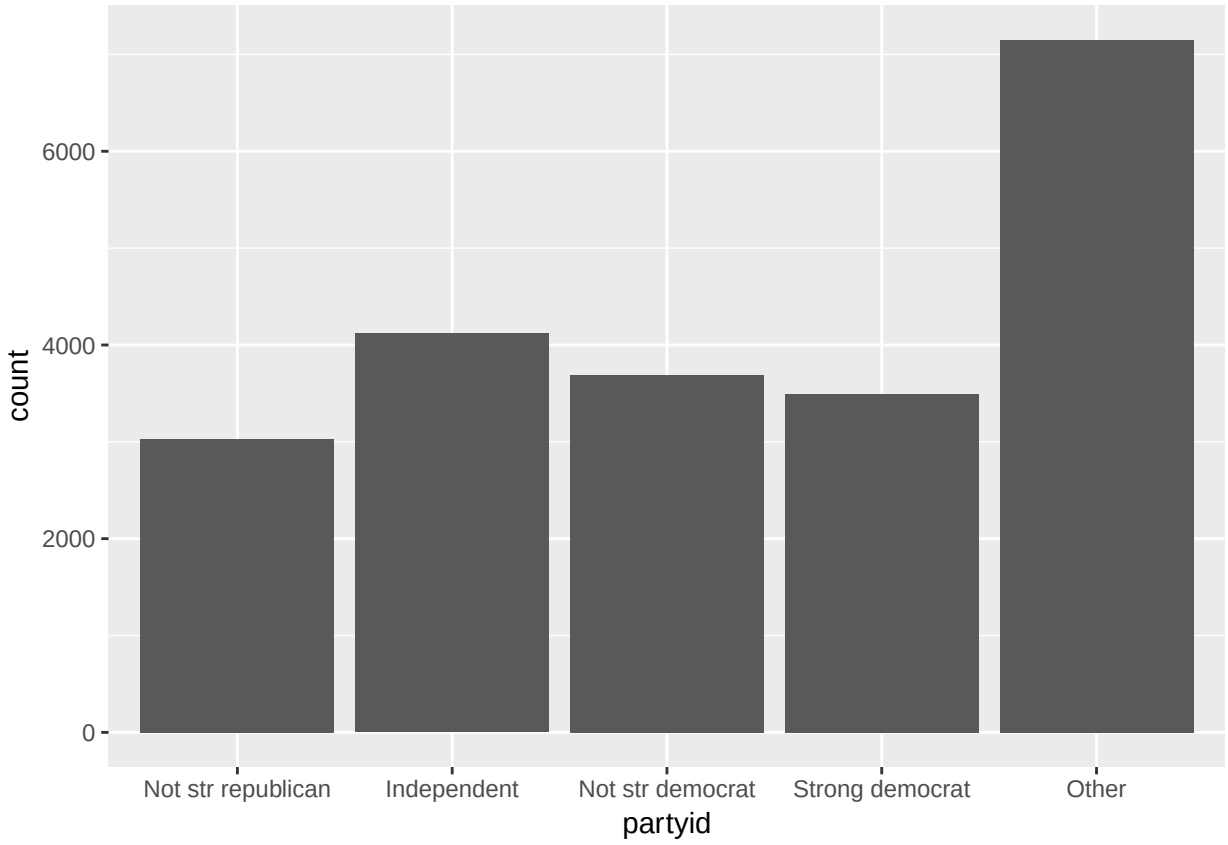
```
# if we need to modifly the data frame, then
gss_cat %>% mutate(partyid = partyid %>%
  fct_recode(
    "Independent,near rep" = "Ind,near rep",
    "Independent,near dem" = "Ind,near dem"
  ))
```

```
## # A tibble: 21,483 x 9
##     year marital     age race  rincome    partyid     relig     denom    tvhours
##    <int> <fct>     <int> <fct> <fct>      <fct>       <fct>     <fct>      <int>
##  1  2000 Never ma~    26 White $8000 to ~ Independen~ Protesta~ Souther~      12
##  2  2000 Divorced     48 White $8000 to ~ Not str re~ Protesta~ Baptist~      NA
##  3  2000 Widowed      67 White Not appli~ Independent Protesta~ No deno~       2
##  4  2000 Never ma~    39 White Not appli~ Independen~ Orthodox~ Not app~       4
##  5  2000 Divorced     25 White Not appli~ Not str de~ None      Not app~       1
```

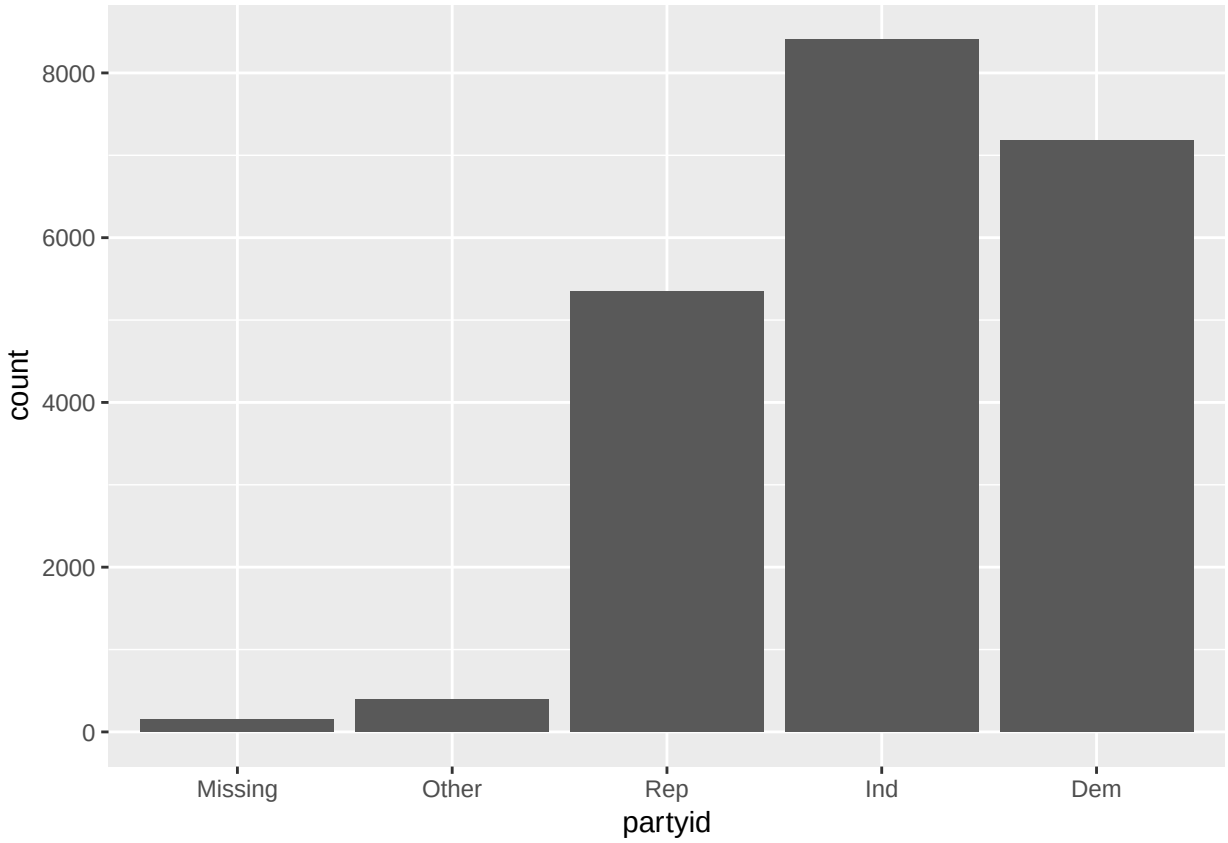
```
##  6  2000 Married      25 White $20000 - ~ Strong dem~ Protesta~ Souther~      NA
##  7  2000 Never ma~    36 White $25000 or~ Not str re~ Christian Not app~      3
##  8  2000 Divorced     44 White $7000 to ~ Independen~ Protesta~ Luthera~      NA
##  9  2000 Married      44 White $25000 or~ Not str de~ Protesta~ Other         0
## 10  2000 Married      47 White $25000 or~ Strong rep~ Protesta~ Souther~      3
## # ... with 21,473 more rows
```

Collapse levels

```
# collapse small levels automatically
gss_cat %>%
  mutate(partyid = partyid %>% fct_lump(4)) %>%
  ggplot() + geom_bar(aes(partyid))
```




```
# collapse manually
gss_cat %>%
  mutate(partyid = partyid %>% fct_collapse(
    Missing = c("No answer", "Don't know"),
    Rep = c("Strong republican", "Not str republican"),
    Ind = c("Ind,near rep", "Independent", "Ind,near dem"),
    Dem = c("Not str democrat", "Strong democrat"),
    Other = c("Other party")
  )) %>%
  ggplot() + geom_bar(aes(partyid))
```



Remark: there is a bug in forcats v0.4.0 such that the argument `group_other` in `fct_collapse` is malfunction.

Date and time

```
library(lubridate)
```

```
##
## Attaching package: 'lubridate'
```

```
## The following object is masked from 'package:base':
##
##     date
```

```
today()
```

```
## [1] "2020-01-16"
```

```
now(tz = "UTC") # in UTC (Coordinated Universal Time)
```

```
## [1] "2020-01-16 18:48:02 UTC"
```

```r
# internally, time is stored as the so called "unix time"
# the number of seconds since 1970-01-01 00:00:00 UTC
as.double(now())
```

```
## [1] 1579200483
```

```r
as_datetime(1579192970)
```

```
## [1] "2020-01-16 16:42:50 UTC"
```

```r
ymd("2017-01-31")
```

```
## [1] "2017-01-31"
```

```r
mdy("January 31st, 2017")
```

```
## [1] "2017-01-31"
```

```r
dmy("31-Jan-2017")
```

```
## [1] "2017-01-31"
```

```r
ymd_hms("2017-01-31 20:11:59")
```

```
## [1] "2017-01-31 20:11:59 UTC"
```

```r
mdy_hm("01/31/2017 08:01")
```

```
## [1] "2017-01-31 08:01:00 UTC"
```

```r
mdy_hm("01/31/2017 08:01", tz = "US/Eastern")
```

```
## [1] "2017-01-31 08:01:00 EST"
```

```r
# OlsonNames() prints all the time zones
# for the us time zones
OlsonNames() %>% keep(~str_starts(., "US/"))
```

```
##  [1] "US/Alaska"          "US/Aleutian"        "US/Arizona"
##  [4] "US/Central"         "US/East-Indiana"    "US/Eastern"
##  [7] "US/Hawaii"          "US/Indiana-Starke"  "US/Michigan"
## [10] "US/Mountain"        "US/Pacific"         "US/Pacific-New"
## [13] "US/Samoa"
```

```r
(t1 <- mdy_hm("01/31/2017 08:01", tz = "US/Eastern"))
```

```
## [1] "2017-01-31 08:01:00 EST"
```

```r
# convert timezone
with_tz(t1, tzone = "US/Pacific")
```

```
## [1] "2017-01-31 05:01:00 PST"
```

```r
# fix a timezone
force_tz(t1, tzone = "US/Pacific")
```

```
## [1] "2017-01-31 08:01:00 PST"
```

From individual components

```r
library(nycflights13)
flights %>%
  select(year, month, day, hour, minute)
```

```
## # A tibble: 336,776 x 5
##     year month   day  hour minute
##    <int> <int> <int> <dbl>  <dbl>
##  1  2013     1     1     5     15
##  2  2013     1     1     5     29
##  3  2013     1     1     5     40
##  4  2013     1     1     5     45
##  5  2013     1     1     6      0
##  6  2013     1     1     5     58
##  7  2013     1     1     6      0
##  8  2013     1     1     6      0
##  9  2013     1     1     6      0
## 10  2013     1     1     6      0
## # ... with 336,766 more rows
```

```r
(flights_dt <- flights %>%
  select(year, month, day, hour, minute) %>%
  mutate(
    date = make_date(year, month, day),
    time = make_datetime(year, month, day, hour, minute)
  ))
```

```
## # A tibble: 336,776 x 7
##     year month   day  hour minute date       time
##    <int> <int> <int> <dbl>  <dbl> <date>     <dttm>
##  1  2013     1     1     5     15 2013-01-01 2013-01-01 05:15:00
##  2  2013     1     1     5     29 2013-01-01 2013-01-01 05:29:00
##  3  2013     1     1     5     40 2013-01-01 2013-01-01 05:40:00
##  4  2013     1     1     5     45 2013-01-01 2013-01-01 05:45:00
```

```
##  5  2013     1     1     6      0 2013-01-01 2013-01-01 06:00:00
##  6  2013     1     1     5     58 2013-01-01 2013-01-01 05:58:00
##  7  2013     1     1     6      0 2013-01-01 2013-01-01 06:00:00
##  8  2013     1     1     6      0 2013-01-01 2013-01-01 06:00:00
##  9  2013     1     1     6      0 2013-01-01 2013-01-01 06:00:00
## 10  2013     1     1     6      0 2013-01-01 2013-01-01 06:00:00
## # ... with 336,766 more rows
```

Remark: something was wrong above!

Get components

```
datetime <- ymd_hms("2016-07-08 12:34:56")

year(datetime)
```

```
## [1] 2016
```

```
month(datetime)
```

```
## [1] 7
```

```
month(datetime, label = TRUE)
```

```
## [1] Jul
## 12 Levels: Jan < Feb < Mar < Apr < May < Jun < Jul < Aug < Sep < ... < Dec
```

```
mday(datetime)
```

```
## [1] 8
```

```
yday(datetime)
```

```
## [1] 190
```

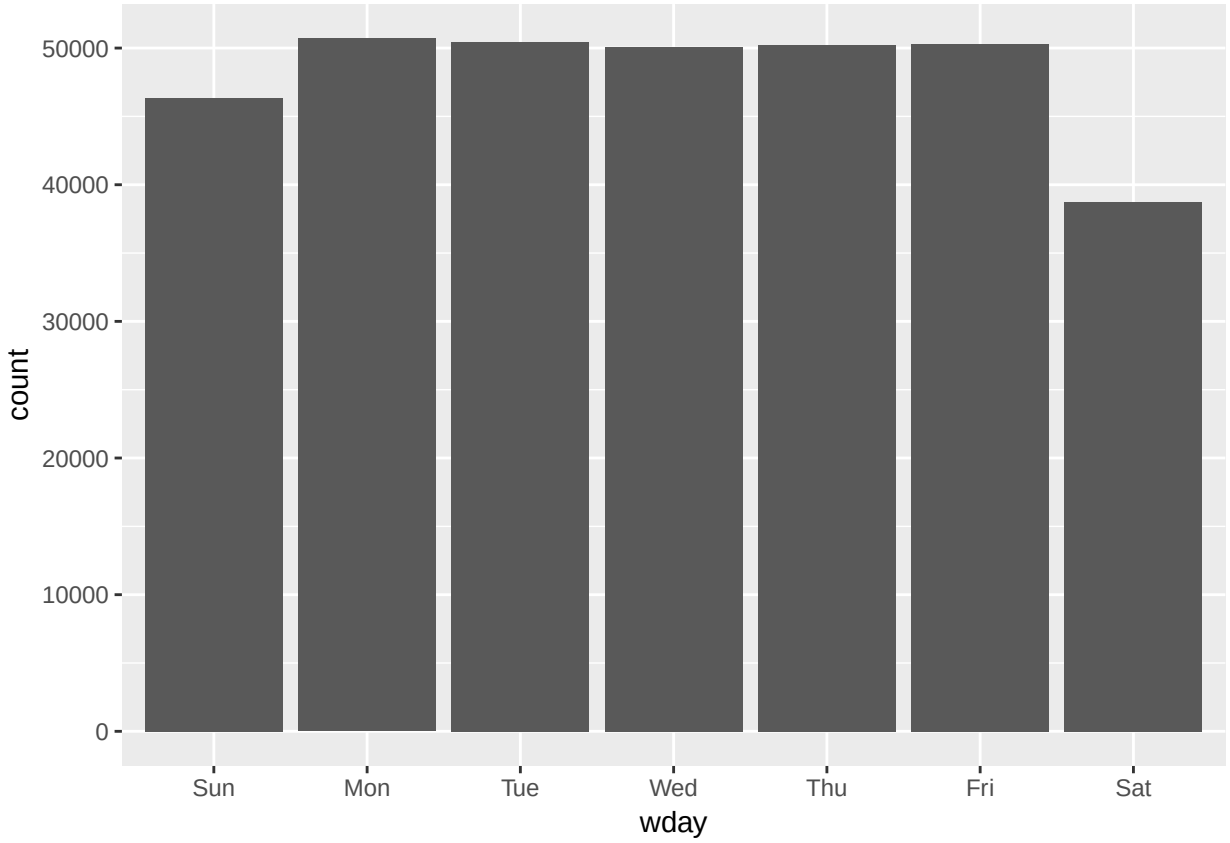
```
wday(datetime)
```

```
## [1] 6
```

```
wday(datetime, label = TRUE, abbr = FALSE)
```

```
## [1] Friday
## 7 Levels: Sunday < Monday < Tuesday < Wednesday < Thursday < ... < Saturday
```

```
flights_dt %>%
  mutate(wday = wday(time, label = TRUE)) %>%
  ggplot(aes(x = wday)) +
  geom_bar()
```



Math on data and time

```
nor <- ymd_hms("2018-01-01 01:30:00",tz="US/Eastern")
nor + minutes(90)
```

```
## [1] "2018-01-01 03:00:00 EST"
```

```
nor + dminutes(90)
```

```
## [1] "2018-01-01 03:00:00 EST"
```

```
gap <- ymd_hms("2018-03-11 01:30:00",tz="US/Eastern")
gap + minutes(90)
```

```
## [1] "2018-03-11 03:00:00 EDT"
```

```
gap + dminutes(90)
```

```
## [1] "2018-03-11 04:00:00 EDT"
```

```
leap <- ymd("2019-03-01")
leap + years(1)
```

```
## [1] "2020-03-01"
```

```
leap + dyears(1)
```

```
## [1] "2020-02-29"
```

References

https://r4ds.had.co.nz https://lubridate.tidyverse.org/ https://forcats.tidyverse.org/