FE8828 Programming Web Applications in Finance

- Session 3 -

Data Manipulation and EDA/2

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Lecture 7: Data Manipulation and EDA/2

Joins

`left_/right_/anti_/full_join`

Sample data:

- data_day1

Date	Position_id	Buy/Sell	Quantity	Risk Factor	Traded Price
2019-11-07	00010001	B	100	DCE_IO_1901	505.3
2019-11-07	00010002	B	100	DCE_IO_1901	506.8

- data_day2

Date	Position_id	Buy/Sell	Quantity	Risk Factor	Traded Price
2019-11-07	00010001	B	100	DCE_IO_1901	505.3
2019-11-07	00010002	B	100	DCE_IO_1901	506.8

Date	Position_id	Buy/Sell	Quantity	Risk Factor	Traded Price
2019-11-08	00010003	S	-100	DCE_IO_1901	507.9

Positions are additive (to close a position, we won't change the original position but to do a new reverse trade). Suppose we have two days of position data.

left_/right_/anti_/full_join

In order to find the new positions. We will use:

```
# order matters, data_day2 needs to be placed first.
# anti_join is like "data_day2 - data_day1"
anti_join(data_day2, data_day1, by = "position_id")
```

In order to find old positions, we will use:

```
# inner_join ignores order
# find the common positions
inner_join(data_day2, data_day1, by = "position_id")
left_join(data_day1, data_day2, by = "position_id") # produce the same result
right_join(data_day1, data_day2, by = "position_id") # produce the same result
left_join(data_day2, data_day1, by = "position_id") # produce all items in data_day2
```

`left_join / right_join`

They can be used to do mapping table (aka. vlookup)

Table `Product`:

```
| type_code | type_name |
| 1         | orange    |
| 2         | banana    |
```

Table `Transaction`:

```
| type_code | quantity | customer_id |
| 1         | 1        | A           |
| 2         | 3        | B           |
| 3         | 4        | C           |
| 2         | 2        | D           |
| 1         | 6        | B           |
```

Table `Customer`:

```
| customer_id | customer_phone |
| A           | +123           |
| B           | +456           |
| C           | +789           |
```

Use `left_join` to create a full report

```
left_join(Transaction, Product, by = "type_code") %>%
left_join(Customer, by = "customer_id")

| type_code | quantity | customer_id | type_name | customer_phone |
|-----------|----------|-------------|-----------|----------------|
| 1         | 1        | A           | orange    | +123           |
| 2         | 3        | B           | banana    | +456           |
| 3         | 4        | C           | NA        | +789           |
| 2         | 2        | D           | banana    | NA             |
| 1         | 6        | B           | orange    | +456           |
```

full_join and anti_join

- full_join(a, b): Find all combinations between table a and b.
- anti_join(a, b): Find those in a but not in b.

```
# From something simple
df <- full_join(data_frame(a = 1:2), data_frame(a = 2:4), by = "a")
## Warning: `data_frame()` is deprecated, use `tibble()`.
## This warning is displayed once per session.
```

a
1
2
3
4

```
df <- anti_join(data_frame(a = 1:2), data_frame(a = 2:4), by = "a")
```

a

a

l

full_join and anti_join More

```
# All possible combination between job and education
x <- full_join(distinct(bank, job) %>% mutate(dummy = 1),
               distinct(bank, education) %>% mutate(dummy = 1),
               by = "dummy") %>%
     select(-dummy)
y <- distinct(bank, job, education)

nrow(x)
## [1] 48
nrow(y)
## [1] 48

df1 <- anti_join(x, y, by = c("job", "education"))
df2 <- anti_join(y, x, by = c("job", "education"))
```

- df1: Empty result

job education

- df2: Empty result

job education

Join is a set operation

- `full_join` is `*`
- `anti_join` is −
- `inner_joins` is −, `/`
- `left_join/right_join` is either just the same, or `*`, `/`.

`group_by` / `summarize`

`group_by` is the way leading to analyze the data at high-dimension. `group_by` is used together with `summarize`

```
group_by(df, ...) ... is the list of variables
summarize(df, new_field = some_func_can_process_bulk_data())
```

Functions can process bulk data:

- sum/mean/median/sd: basic statistics
- min(x), quantile(x, 0.25), max(x): min/max/quantile
- n()/n_distinct(): count and count distint
- ntile: a rough divide into a few groups
- first(x), last(x), nth(x, 2)
- …

group_by / summarize: Examples

```
# Add paramter na.rm, if there is NA among the data.
df <- data.frame(a = c(1, 3, 4, NA))
```

a
1
3
4
NA

```
summarise(df, total = sum(a))
```

total
NA

```
summarise(df, total = sum(a, na.rm = TRUE))
```

total

total
8

```
summarise(df, total = mean(a))
```

total
NA

```
summarise(df, total = mean(a, na.rm = TRUE))
```

total
2.666667

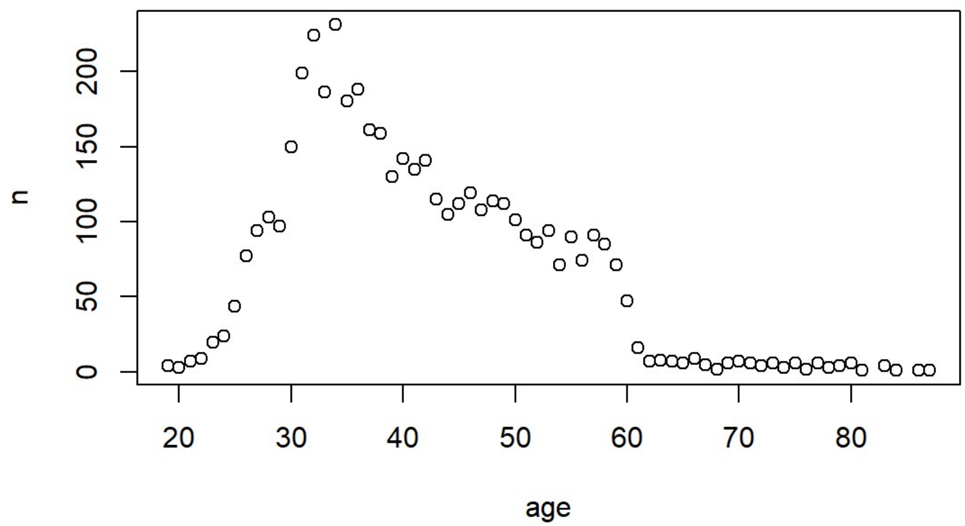
`group_by` / `summarize`: Examples

```r
# count number of people in each age group
group_by(bank, age) %>% summarise(n = n())
```

age	n
19	4
20	3
21	7
22	9
23	20
24	24
…	

group_by / summarize: Examples

```
group_by(bank, age) %>% summarise(n = n()) %>% plot
```



group_by / summarize: Examples

```
bank_age <- group_by(bank, age) %>%
         summarise(balance_mean = mean(balance),
                   count = n(),
                   default_count = sum(ifelse(default == "no", 0, 1)))
```

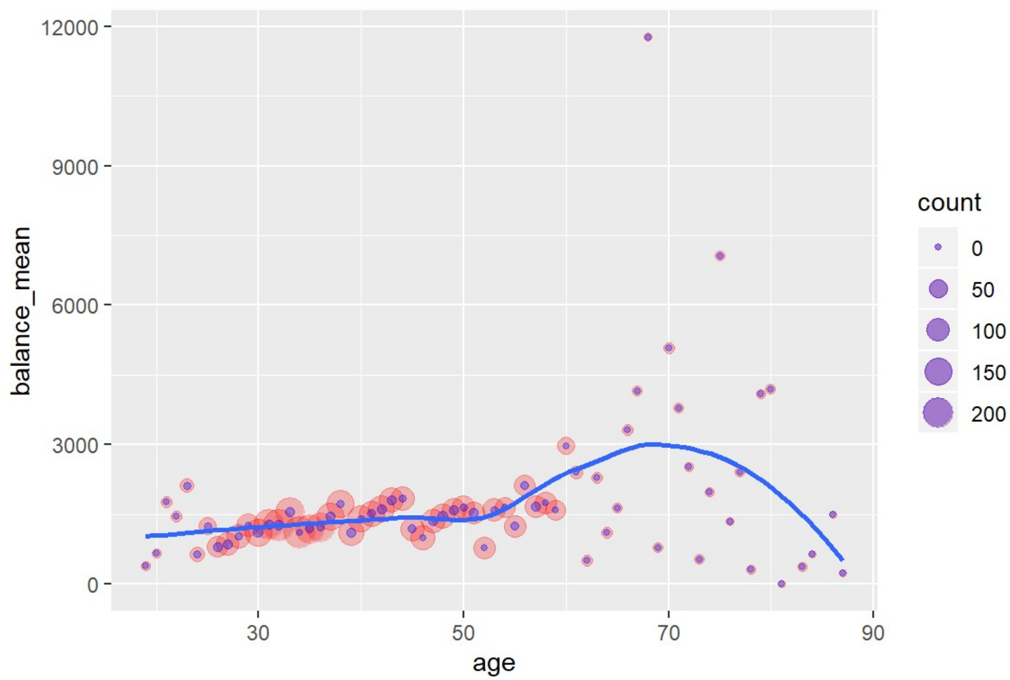
age	balance_mean	count	default_count
19	393.5000	4	0
20	661.3333	3	0
21	1774.2857	7	0
22	1455.3333	9	0
23	2117.9500	20	1
24	634.6250	24	1
25	1240.0682	44	1
26	788.5584	77	3
27	851.7766	94	4
28	1025.0971	103	1

age balance_mean count default_count

...

group_by / summarize: Examples

```
# If combined with ggplot, to be learnt in next session
bank_age %>%
  ggplot(aes(x = age, y = balance_mean)) +
  geom_point(aes(size = count), alpha = 1/4, color = "red") +
  geom_point(aes(size = default_count), alpha = 1/3, color = "blue") +
  geom_smooth(se = FALSE)
## `geom_smooth()` using method = 'loess' and formula 'y ~ x'
```



Group filter

```
# Find the maximum and minimum balance on each age.
df <- bank %>%
  group_by(age) %>%
  filter(min_rank(balance) == 1 | min_rank(desc(balance)) == 1) %>%
  arrange(age, balance)
```

age	job	marital	education	default	balance	housing	loan	contact
19	student	single	unknown	no	0	no	no	cellular
19	student	single	unknown	no	1169	no	no	cellular
20	student	single	secondary	no	291	no	no	telephone
20	student	single	secondary	no	1191	no	no	cellular
21	student	single	secondary	no	6	no	no	unknown
21	student	single	secondary	no	6844	no	no	cellular
22	student	single	unknown	no	47	no	no	cellular
22	admin.	single	secondary	no	4111	no	yes	cellular
23	technician	single	secondary	no	-306	yes	no	unknown

age	job	marital	education	default	balance	housing	loan	contact
23	student	single	secondary	no	9216	no	no	cellular
…								

Count for condition

TRUE => 1, FALSE => 0

```
# Generate a report for balance and job
d1 <- group_by(bank, job) %>%
  summarise(`balance > 500` = sum(balance > 500))
d2 <- group_by(bank, job) %>%
  summarise(`balance <= 500` = sum(balance <= 500))
# df collects all jobs, in case some jobs are missing from either d1 or
        d2
# This is a typical example for collecting data.
df <- distinct(bank, job) %>% arrange(job)
df <- left_join(df, d1, by = "job")
df <- left_join(df, d2, by = "job")
df <- mutate(df, total = `balance > 500` + `balance <= 500`)
```

job	balance > 500	balance <= 500	total
admin.	226	252	478
blue-collar	423	523	946
entrepreneur	74	94	168
housemaid	42	70	112

job	balance > 500	balance <= 500	total
management	521	448	969
retired	127	103	230
self-employed	89	94	183
services	154	263	417
student	41	43	84
technician	353	415	768
unemployed	63	65	128
unknown	21	17	38

`group_by` and `summarise/summarize`: Further explain

- `group_by` is a like folding a paper without tearing it later.
- `summarise` tears the paper to do individual pieces.
- Therefore, `group_by` can be used with other verbs, `mutate`, `filter`, which will work within the group.
- `summarise` can be used without group_by, then it will apply to entire data as one whole group.

group_by

```
# mutate with group_by
df <- group_by(data.frame(a = 1:10), quantile = ntile(a, 2)) %>%
  mutate(b = a / sum(a))
```

a	quantile	b
1	1	0.0666667
2	1	0.1333333
3	1	0.2000000
4	1	0.2666667
5	1	0.3333333
6	2	0.1500000
7	2	0.1750000
8	2	0.2000000
9	2	0.2250000
10	2	0.2500000

group_by / 2

```
# filter with group_by
df <- group_by(bank, age) %>% filter(balance == max(balance))
```

age	job	marital	education	default	balance	housing	loan	contact
22	admin.	single	secondary	no	4111	no	yes	cellular
78	housemaid	married	secondary	no	499	no	no	telephon
23	student	single	secondary	no	9216	no	no	cellular
46	management	married	secondary	no	12186	no	no	unknown
64	retired	married	unknown	no	2923	no	no	cellular
77	retired	married	tertiary	no	7802	no	no	telephon
39	management	single	tertiary	no	12437	no	no	telephon
28	student	single	secondary	no	11555	no	no	cellular
81	retired	married	secondary	no	1	no	no	cellular
33	housemaid	single	tertiary	no	23663	yes	no	cellular
40	self-	married	tertiary	no	13669	no	no	cellular

age	job	marital	education	default	balance	housing	loan	contact
	employed							
31	housemaid	single	primary	no	26965	no	no	cellular
30	management	single	tertiary	no	19358	no	no	cellular
67	blue-collar	married	secondary	no	16353	no	no	cellular
49	retired	single	primary	no	25824	no	no	unknown

…

summarize/summarise

```
# summarise with group_by
df <- group_by(data.frame(a = 1:10), quantile = ntile(a, 2)) %>%
  summarise(b = sum(a))
```

quantile	b
1	15
2	40

```
# summarise without a group_by. It will treat entire df as a whole.
df <- summarise(bank,
                with_housing = sum(housing == "yes") / n(),
                age_min = min(age),
                duration_mean = mean(duration))
```

with_housing	age_min	duration_mean
0.5660252	19	263.9613

group_by/ungroup

`ungroup()` removes group definition, restores the "ungrouped"" data frame back to entire data. Because `group_by` will leave a trace

```
# wrong
df_wrong <- group_by(bank, age) %>%
  filter(balance == max(balance)) %>%
  summarize(balance = mean(balance)) %>%
  head(n = 3)

# correct
df_correct <- group_by(bank, age) %>%
  filter(balance == max(balance)) %>%
  ungroup %>%
  summarize(balance = mean(balance))
```

age	balance
19	1169
20	1191
21	6844

balance

13541.21

group_by/ungroup

```
# We can't remove age
# R will prompt for "Adding missing grouping variables: `age`"
df1 <- group_by(bank, age) %>%
  filter(balance == max(balance)) %>%
  select(-age) %>% head(n = 3)
## Adding missing grouping variables: `age`

# We can remove age with ungroup
df2 <- group_by(bank, age) %>%
  filter(balance == max(balance)) %>%
  ungroup %>%
  select(-age) %>% head(n = 3)
```

age	job	marital	education	default	balance	housing	loan	contact
22	admin.	single	secondary	no	4111	no	yes	cellular
78	housemaid	married	secondary	no	499	no	no	telephone
23	student	single	secondary	no	9216	no	no	cellular

job	marital	education	default	balance	housing	loan	contact	day
admin.	single	secondary	no	4111	no	yes	cellular	19

job	marital	education	default	balance	housing	loan	contact	day
housemaid	married	secondary	no	499	no	no	telephone	16
student	single	secondary	no	9216	no	no	cellular	5

rowwise

Sometimes, we need to use `rowwise()` which is a special `group_by` which makes every one row a group. `rowwise()` use case, it applies to complex logic that can't be applied as a group.

```
df <- data.frame(throw_dices = 1:10)
df <- rowwise(df) %>% mutate( mean = mean(sample(1:6, throw_dices,
        replace = TRUE)))
```

throw_dices	mean
1	4.000000
2	3.500000
3	2.666667
4	3.250000
5	3.400000
6	3.500000
7	3.000000

throw_dices	mean
8	2.625000
9	4.000000
10	3.400000

bind_rows

- bind_rows is the + operator for data frames.

```
# add empty data frame is the same.
df1 <- bind_rows(data.frame(a = 3:4), data.frame())
```

a
3
4

```
df2 <- bind_rows(data.frame(), data.frame(a = 3:4))
```

a
3
4

bind_rows: Use case

I usually use bind_rows to collect results. For example,

```
new_positions <- data.frame()
closed_positions <- data.frame()

for (i in length(dates)-1) {
  old_date <- dates[i]
  new_date <- dates[i+1]

  new_data <- filter(position, date == new_date)
  old_data <- filter(position, date == old_date)

  new_positions <- bind_rows(new_positions,
                             anti_join(new_data, old_data, by = "position_id"))
}

# new_positions contains all new positions on their day 1
```

bind_rows: Use case

If row order matters, bind_row can be used to re-order/splice and recombine.

```
# Get head and tail
# Note: use { } to use the .
df <- arrange(bank, age) %>%
      { bind_rows(head(., n = 5), tail(., n = 5)) }
```

age	job	marital	education	default	balance	housing	loan	contact	da
19	student	single	primary	no	103	no	no	cellular	1
19	student	single	unknown	no	0	no	no	cellular	1
19	student	single	secondary	no	302	no	no	cellular	1
19	student	single	unknown	no	1169	no	no	cellular	
20	student	single	secondary	no	502	no	no	cellular	3
83	retired	divorced	primary	no	0	no	no	telephone	3
83	retired	divorced	primary	no	1097	no	no	telephone	
84	retired	divorced	primary	no	639	no	no	telephone	1

age	job	marital	education	default	balance	housing	loan	contact	da
86	retired	married	secondary	no	1503	no	no	telephone	1
87	retired	married	primary	no	230	no	no	cellular	3

`bind_rows`: Use case

```
# summary
df1 <- summarise_if(bank, is.numeric, mean)
```

age	balance	day	duration	campaign	pdays	previous
41.1701	1422.658	15.91528	263.9613	2.79363	39.76664	0.5425791

```
# add summary to the records
df2<- tail(bind_rows(bank, summarise_if(bank, is.numeric, mean)), n =
        1)
```

	age	job	marital	education	default	balance	housing	loan	contac
4522	41.1701	NA	NA	NA	NA	1422.658	NA	NA	NA

bind_rows: Use case

```r
# bind_rows can match column names and type.
# let's adjust the column order.
# As due-deligence, better to check the result.
# I remember earlier version of dplyr doesn't do match.
df <- tail(bind_rows(bank, summarise_if(bank, is.numeric, mean) %>%
  select(balance, day, everything())), n = 1)
```

	age	job	marital	education	default	balance	housing	loan	contac
4522	41.1701	NA	NA	NA	NA	1422.658	NA	NA	NA

bind_cols

- bind_cols is to extend the data frame in width.

Use cases

- It's a lazyman's `left_join` or `select`
- It copies the columns
- I usually find it useful to generate data frame for reports.

```
dt1 <- bind_cols(select(bank, job), select(bank, education))
dt1[1:3,]
```

job	education
unemployed	primary
services	secondary
management	tertiary

bind_cols

```
dt2 <- bind_cols(dt1, dt1)
dt2[1:3,]
```

job	education	job1	education1
unemployed	primary	unemployed	primary
services	secondary	services	secondary
management	tertiary	management	tertiary

bind_cols: Use cases

```
d1 <- filter(bank, month == "sep") %>%
  summarize(duration = mean(duration)) %>%
  rename(`Duration Sep` = duration)
d2 <- filter(bank, month == "oct") %>%
  summarize(duration = mean(duration)) %>%
  rename(`Duration Oct` = duration)
d3 <- filter(bank, month == "nov") %>%
  summarize(duration = mean(duration)) %>%
  rename(`Duration Nov` = duration)

df <- bind_cols(d1, d2, d3)
```

Duration Sep	Duration Oct	Duration Nov
215.7308	272.8	272.0668

Exercise

1. How to know the row number of the wrong date

```
df <- data.frame(dt = c("2019-10-01", "2019-31-12", "2019-03-17",
         "2019-02-29", "2019-09-30"))
```

dt
2018-10-01
2018-31-12
2018-03-17
2018-02-29
2018-09-30

Output:

```
## Wrong dates on rows: 2, 4
```

Exercise

2. How to get sub-total and total on mean of age and balance, group by job and education?

job	**education**	**mean(Age)**	**median(Balance)**
services	primary	…	…
services			
services	+	…	…
…			
+	+	…	…

Exercise

3. To evaluate a portfolio of options for its total value.

```
GBSOption(TypeFlag = "p", S = 3500, X = 3765,
          Time = 1/12, r = 0, b = 0, sigma = 0.3)@price
## [1] 300.0049
df <- data.frame(type = sample(c("c", "p"), 100, replace = TRUE),
                 strike = round(runif(100) * 100, 0),
                 underlying = round(runif(100) * 100, 0),
                 Time = 1,
                 r = 0.01,
                 b = 0,
                 sigma = 0.3)
```

tidyr: `gather/spread`

Wide format <=> Long format

- Wide format is more familiar to us. Column name is the data attribute.
- Long format is what we reformat the data that common attributes are gathered together as a single variable.
- Reference: Tidy data https://en.wikipedia.org/wiki/Tidy_data

Wide v.s. Long

Wide format

```
wfmt <- data_frame(date = seq(from = as.Date("2019-01-01"), by = "day",
          length.out = 5),
                   Copper_qty = round(runif(5) * 1000, 0),
                   Gold_qty = round(runif(5) * 1000, 0),
                   Silver_qty = round(runif(5) * 1000, 0))
## Warning: `data_frame()` is deprecated, use `tibble()`.
## This warning is displayed once per session.
```

date	Copper_qty	Gold_qty	Silver_qty
2018-01-01	916	689	778
2018-01-02	315	11	851
2018-01-03	693	991	741
2018-01-04	30	55	7
2018-01-05	953	446	586

Wide v.s. Long

Long format

```
library(tidyr)
df <- gather(wfmt, key, value, -date)
```

date	key	value
2018-01-01	Copper_qty	916
2018-01-02	Copper_qty	315
2018-01-03	Copper_qty	693
2018-01-04	Copper_qty	30
2018-01-05	Copper_qty	953
2018-01-01	Gold_qty	689
2018-01-02	Gold_qty	11
2018-01-03	Gold_qty	991
2018-01-04	Gold_qty	55
2018-01-05	Gold_qty	446

date	key	value
2018-01-01	Silver_qty	778
2018-01-02	Silver_qty	851
2018-01-03	Silver_qty	741
2018-01-04	Silver_qty	7
2018-01-05	Silver_qty	586

`spread/gather` convert for Wide format <=> Long format

```
# Original help
gather(data, key, value, ...)
# My annotated version
gather(data,
       new_key_col_name,
       new_value_col_name,
       -columns_to_be_included_in_the_left)
```

… is where you want to make as independent columns. You need to specify all columns that should be `gather`ed (or before `gather`, remove all columns that should *not* be `gather`ed).

`gather` example with *Bank* dataset

```
wfmt <- group_by(bank, job) %>% summarize(yy = sum(ifelse(default ==
          "yes", 1, 0)), nn = sum(ifelse(default == "no", 1, 0)))
df <- gather(wfmt, default, value, -job) %>% arrange(job, default)
```

job	yy	nn
admin.	6	472
blue-collar	14	932
entrepreneur	7	161
housemaid	2	110
management	14	955
retired	3	227
self-employed	4	179

…

job	default	value
admin.	nn	472

job	default	value
admin.	yy	6
blue-collar	nn	932
blue-collar	yy	14
entrepreneur	nn	161
entrepreneur	yy	7
housemaid	nn	110

…

spread

```
# Original help
spread(data, key, value)
# My annotated version
spread(data, colname_to_be_header, value_to_be_filled_under_header)
```

spread example with *Bank* dataset

```
lfmt <- group_by(bank, job, default) %>% summarize(nn = n())
df <- spread(lfmt, default, nn)
# How to take care of converting NA to zero?
```

job	default	nn
admin.	no	472
admin.	yes	6
blue-collar	no	932
blue-collar	yes	14
entrepreneur	no	161
entrepreneur	yes	7
housemaid	no	110

…

job	no	yes
admin.	472	6

job	**no**	**yes**
blue-collar	932	14
entrepreneur	161	7
housemaid	110	2
management	955	14
retired	227	3
self-employed	179	4

…

Combine different columns' Quantity

date	Copper_qty	Gold_qty	Silver_qty
2018-01-01	211	9	145
2018-01-02	225	408	682
2018-01-03	764	854	685
2018-01-04	911	887	688
2018-01-05	208	997	623

…

```
df <- wfmt %>%
      gather(key, value, -date) %>%
      group_by(date) %>%
      summarize(value1 = sum(value)) %>%
      rename(value = value1) %>%
      mutate(key = "Total") %>%
      spread(key = key, value = value) %>%
      inner_join(wfmt, ., by = "date")
```

date	Copper_qty	Gold_qty	Silver_qty	Total

date	Copper_qty	Gold_qty	Silver_qty	Total
2018-01-01	211	9	145	365
2018-01-02	225	408	682	1315
2018-01-03	764	854	685	2303
2018-01-04	911	887	688	2486
2018-01-05	208	997	623	1828

```
# although this works...
# It takes "Hard coding" of column names "Copper_qty Gold_qty
        Silver_qty".
df <- wfmt %>% mutate(total = Copper_qty + Gold_qty + Silver_qty)
```

date	Copper_qty	Gold_qty	Silver_qty	total
2018-01-01	211	9	145	365
2018-01-02	225	408	682	1315
2018-01-03	764	854	685	2303
2018-01-04	911	887	688	2486
2018-01-05	208	997	623	1828

separate/unite

```
separate(data, col, into, sep = "[^[:alnum:]]+", remove = TRUE,
  convert = FALSE, extra = "warn", fill = "warn", ...)

#> # A tibble: 6 × 3
#>       country  year               rate
#> *       <chr> <int>              <chr>
#> 1 Afghanistan  1999       745/19987071
#> 2 Afghanistan  2000      2666/20595360
#> 3      Brazil  1999    37737/172006362
#> 4      Brazil  2000    80488/174504898
#> 5       China  1999 212258/1272915272
#> 6       China  2000 213766/1280428583

separate(df, rate, into = c("cases", "population"))
separate(df, rate, into = c("cases", "population"), convert = TRUE)

unite(df, century, year) # default sep is "_"
unite(df, century, year, sep = "") # seamless unite
```

Rules of Thumb for use list of data frame

- Use list to store app data, i.e. configuration.
  `conf <- list(use_calendar_days = TRUE, do_fx_conversion`

- User data frame to store repeating data of similar structure.

- Every data frame is better to have a id column, like **item_id**. It can be number or character. Make it unique. If **item_id** is a number, when insert new record to the data frame, we need to increment it somewhere. So, use a variable to keep it somewhere, or use `max(item_id) + 1` (It will do calculation for all ids. Performance still good with small data set)

- Delete is not good for enterprise. We need to leave an audit trail. And we can prevent from wrong operation. Add a column name with a common name, e.g. SYS_DEL. Its default value is FALSE, when you want to delete it, set it to TRUE. When extracting data, use `filter(df1, !SYS_DEL)`. The advanced version involves the user and datetime, i.e. SYS_DEL_USER, SYS_DEL_DATETIME.

```
| position_id | call_put | amount | strike | SYS_DEL |
| X123        |          |        |        |
```

CRUD in dplyr

Create:

- add new rows. bind_rows()

Read:

- You have known enough: filter/select/joins/… to get what you need.

Update:

- Use either data frame way or mutate.

```
# get all row numbers for students
# . refers to the output of the pipe %>%. .$nnn => df$nnn
row_nums <- mutate(bank, nnn = 1:n()) %>%
            filter(job == "student" & age < 22) %>%
            select(nnn) %>%
            .$nnn

bank1 <- bank
bank1[row_nums, "taxable"] <- "no"
bank1[setdiff(1:nrow(bank), row_nums), "taxable"] <- "yes"

# use dplyr
bank1 <- mutate(bank, taxable = ifelse(job == "student" & age < 22, "no", "yes"))
distinct(bank1, taxable)
```

Delete:

- Use filter to exclude the row(s).
- (Advanced version) Create a column `SYS_DEL` of logic type, described in detail in previous slide.

Assignment

1. Exploratory Data Work on the bank dataset. Find 10 findings from data. Use R Markdown.

````
---
title: "FE8828 Assignment for Exploratory Data Analysis"
author: "Yang Ye <sub> <Email:yy@runchee.com> </sub>"
date: "Sep 2019"
output: html_document
---

```{r setup, include=FALSE}
library(tidyverse)
library(lubridate)
library(bizdays)
# Use echo = TRUE for assignment is an exception, so code is visible.
knitr::opts_chunk$set(echo = TRUE, fig.align="center", collapse = TRUE, cache = TRUE)
bank <- read.csv("https://goo.gl/PBQnBt", sep = ";")
```

# Finding #1
This data contains `r nrow(data)` rows.

# Finding #2
```{r}
# Find the big age group
bank %>%
  group_by(age_group = (age %/% 10) * 10) %>%
  summarise(count = n()) %>%
  arrange(age_group) -> res

res
````
````

```
plot(res$age_group, res$count)
```
```

# Discover insights of data frame: bank
- Employment
- Social attributes.
- Count for sub-total / total, plot graph
```

Assignment

2. Book option trades

1.1 Copy the options data from https://www.nasdaq.com/symbol/goog/option-chain?dateindex=1

```
Gather data for "Dec 20, 2019" and store into following data frame format.

    | Expiry Date | Strike | Open Interest | Underlying | Call/Put | Bid | Ask
```

1.2 Count the total valuation of 1) call alone, 2) put alone, 3) call and put.
`Open Interest * (Bid + Ask) / 2`

1.3 Find those in the money and get their total `Open Interest`.

1.4. Plot the volatility curve, strike v.s. vol. For strike < current price, use puts' price; for strike > current price, use calls' price.

```
# GBSVolatility(price, TypeFlag, S, X, Time, r, b, tol, maxiter)
# Use Price to back-out implied volatility. Assume r = 0.03
# Example:
```

```
GBSVolatility(867.30, "c", 1135.67, 240,
              as.numeric((as.Date("2019-12-20") -
        as.Date("2019-09-16")))/365, r = 0.03, b = 0)
## [1] 6.86679e-19
GBSVolatility(256.50, "c", 1135.67, 880.00,
              as.numeric((as.Date("2019-12-20") -
        as.Date("2019-09-16")))/365, r = 0.03, b = 0)
## [1] 0.2962245
GBSVolatility(53.62, "c", 1135.67, 1120.00,
              as.numeric((as.Date("2019-12-20") -
        as.Date("2019-09-16")))/365, r = 0.03, b = 0)
## [1] 0.1995225
```