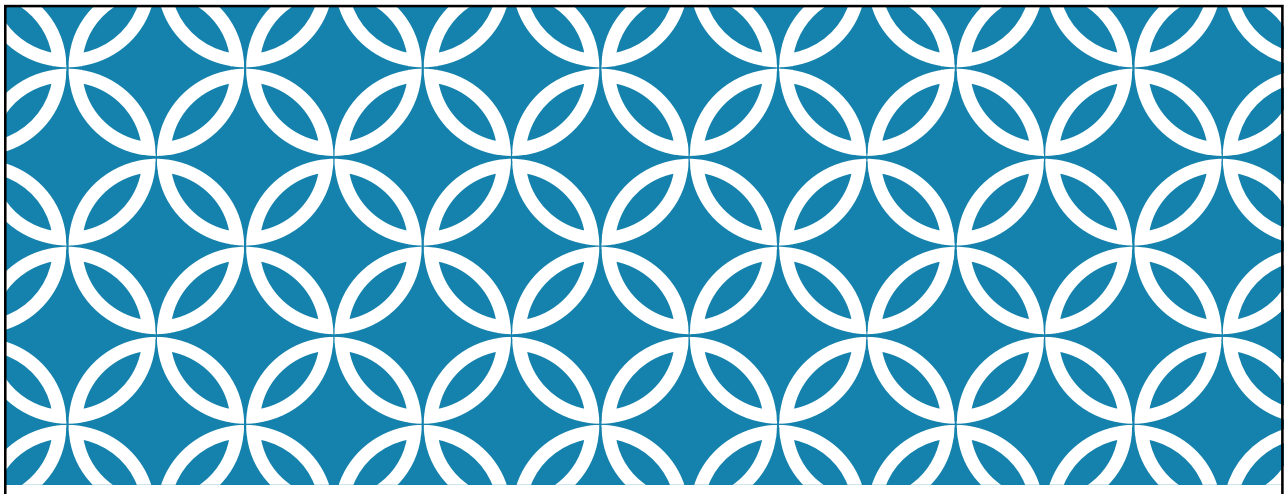

Data Understanding: Grouping and Summarizing Data

Patrick Mathias
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Goals

1. Learn dplyr tools for grouping and summarizing data in R

Objectives

1. Calculate a summary statistic for a variable using the summarize() function
2. Creates groupings of data using the group_by() function
3. Combine group_by() and summarize() functions to calculate summary statistics for groups of data

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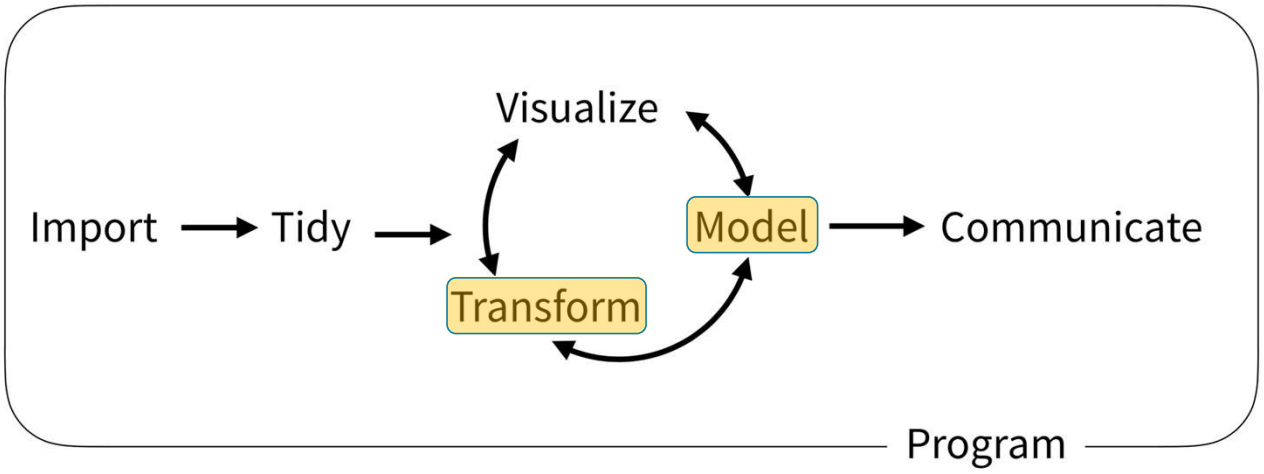
Typical Data Science Pipeline



From *R for Data Science* (https://r4ds.had.co.nz/introduction.html)

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Summarize the data set

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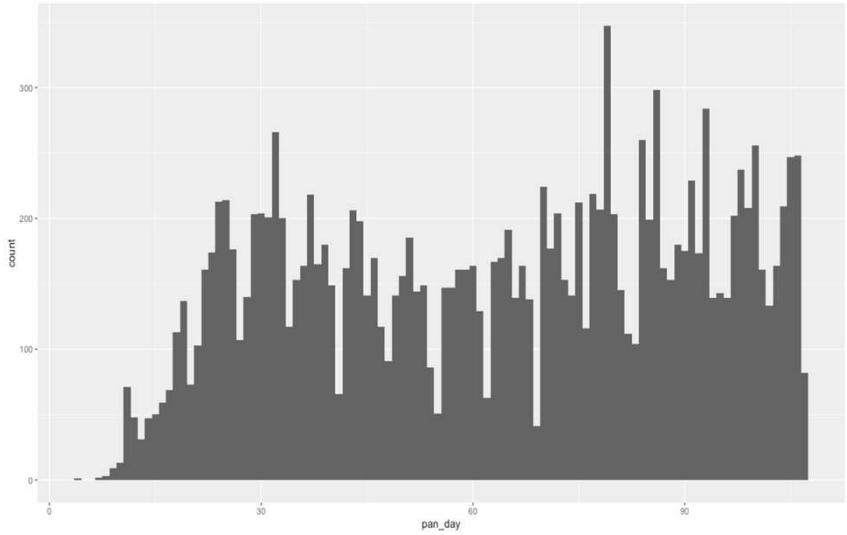
Q: How many tests are ordered per day?



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summarize()

- Make summaries of your data

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summarize()

- Make summaries of your data

```
covid_testing %>%
    summarize(new_variable = calculation)
```

name for new variable

Value or function

Performs calculation across all rows of data frame

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summarize()

- Make summaries of your data

function that returns number of observations

```
covid_testing %>%
    select(mrn, pan_day)  %>%
    head(4) %>%
    summarize(order_count = n())
```

mrn	pan_day
5001412	4
5000533	7
5009134	7
5008518	8

→

order_count
4

8

summarize()

- Additional summaries = new columns

```
covid_testing %>%
      select(mrn, pan_day)  %>%
      head(4) %>%
      summarize(order_count = n(),
                day_count = n_distinct(pan_day))
```

function that returns number of distinct values

mrn	pan_day
5001412	4
5000533	7
5009134	7
5008518	8

→

order_count	day_count
4	3

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summarize()

- Summarize supports calculations on summary stats

```
covid_testing %>%
      summarize(order_count = n(),
                day_count = n_distinct(pan_day),
                orders_per_day = order_count/day_count)
```

mrn	pan_day
5001412	4
5000533	7
5009134	7
5008518	8

→

order_count	day_count	orders_per_day
15524	102	152

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Your Turn #1

- Open "05 – Group and Summarize.Rmd"
- Run the setup chunk
- Fill-in the gaps to calculate the mean count of orders per clinic

05:00

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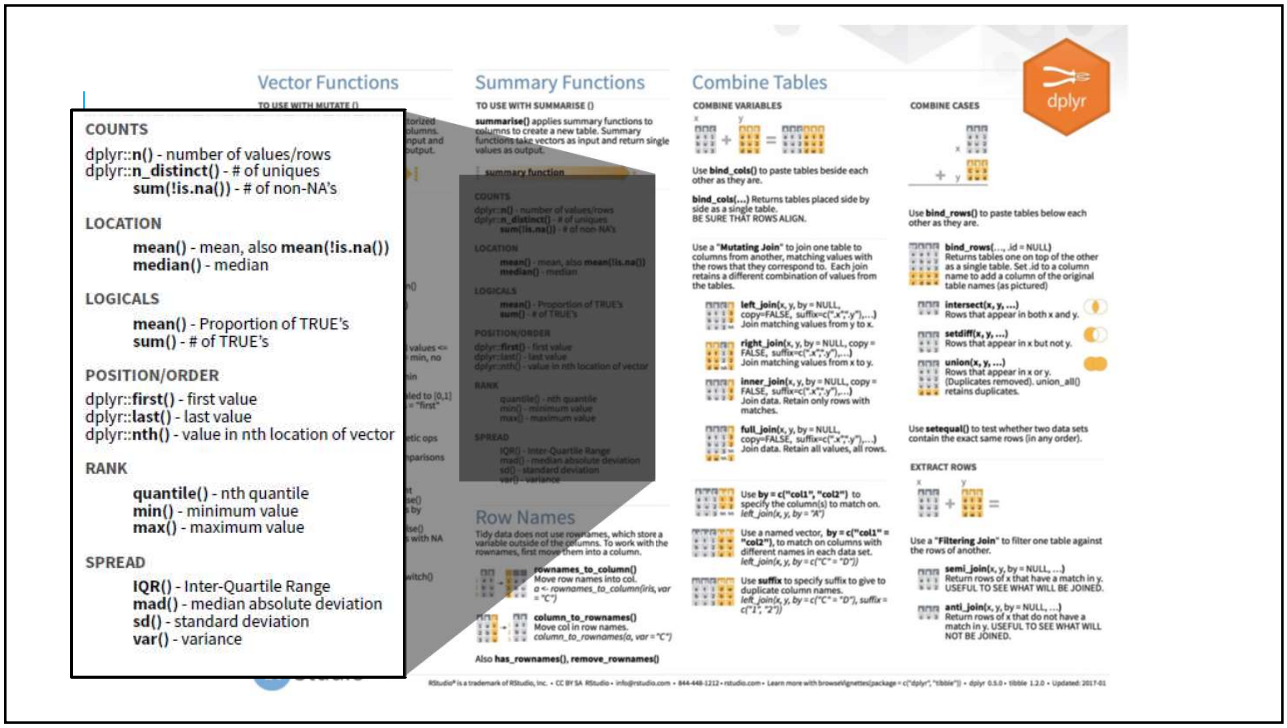

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Output the last day

```
covid_testing %>%
    summarize(last_day = last(pan_day))
```

mrn	pan_day
5001412	4
5000533	7
5009134	7
5008518	8

→

last_day
8

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Calculate the mean turnaround time

```
covid_testing %>%
  mutate(col_ver_tat = col_rec_tat + rec_ver_tat) %>%
  summarize(col_ver_tat_mean = mean(col_ver_tat))
```

mrn	pan_day	col_ver_tat
5001412	4	6
5000533	7	8
5009134	7	10
5008518	8	11

→

col_ver_tat_mean
8.75

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Calculate the 75th percentile turnaround time

```
covid_testing %>%
 mutate(col_ver_tat = col_rec_tat + rec_ver_tat) %>%
 summarize(col_ver_tat_mean = mean(col_ver_tat),
           col_ver_75_pctile = quantile(col_ver_tat, 0.75)
```

mrn	pan_day	col_ver_tat
5001412	4	6
5000533	7	8
5009134	7	10
5008518	8	11

→

col_ver_tat_mean	col_ver_tat_mean
8.75	9.6

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Your Turn #2

For the covid_testing data frame, calculate both the median and the 95th percentile collect-to-verify turnaround time.

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Pop Quiz

How would you calculate the median number of orders per day?

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Grouping your data

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group_by()

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group_by()

- *Grouping observations based on a specific variable's values*

```
covid_testing %>%
    group_by(variable)
```

name of variable to group by

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group_by()

- *Group observations by pan_day*

```
covid_testing %>%
    group_by(pan_day)
```

```
# A tibble: 15,524 x 17
# Groups:   pan_day [102]
      mrn first_name last_name gender pan_day
    <dbl> <chr>      <chr>     <chr>    <dbl>
1 5.00e6 jhezane    westerli… female       4
2 5.00e6 penny      targaryen female       7
3 5.01e6 grunt      rivers    male         7
4 5.01e6 melisandre swyft     female       8
5 5.01e6 rolley     karstark  male         8
```

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group_by()

- *Group observations by `pan_day` and `clinic_name`*

```
covid_testing %>%
    select(mrn, pan_day, clinic_name) %>%
    group_by(pan_day, clinic_name)
```

```
# A tibble: 15,524 x 3
# Groups:   pan_day, clinic_name [2,526]
      mrn pan_day clinic_name
    <dbl>   <dbl> <chr>
1 5001412       4 inpatient ward a
2 5000533       7 clinical lab
3 5009134       7 clinical lab
4 5008518       8 clinical lab
5 5008967       8 emergency dept
```

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group_by() %>% summarize()

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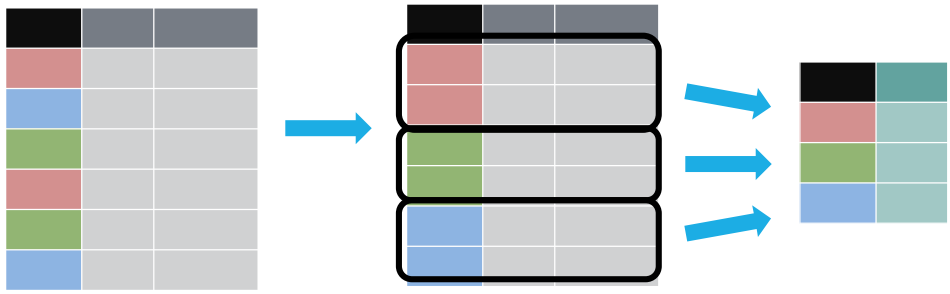
group_by() %>% summarize()

Make summaries of your data *by group*



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group_by() %>% summarize()

- Make summaries of your data

```
covid_testing %>%

      summarize(order_count = n())
```

mrn	pan_day
5001412	4
5000533	7
5009134	7
5008518	8

→

order_count
15524

25

group_by() %>% summarize()

- Make summaries of your data

```
covid_testing %>%
      group_by(pan_day) %>%
      summarize(order_count = n())
```

mrn	pan_day
5001412	4
5000533	7
5009134	7
5008518	8

→

pan_day	order_count
4	1
7	2
8	3
9	9

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Your Turn #3

Calculate:

a) The median collect-to-verify turnaround time for each day

b) The median collect-to-verify turnaround time for each clinic/unit

c) The median number of orders per day

05:00

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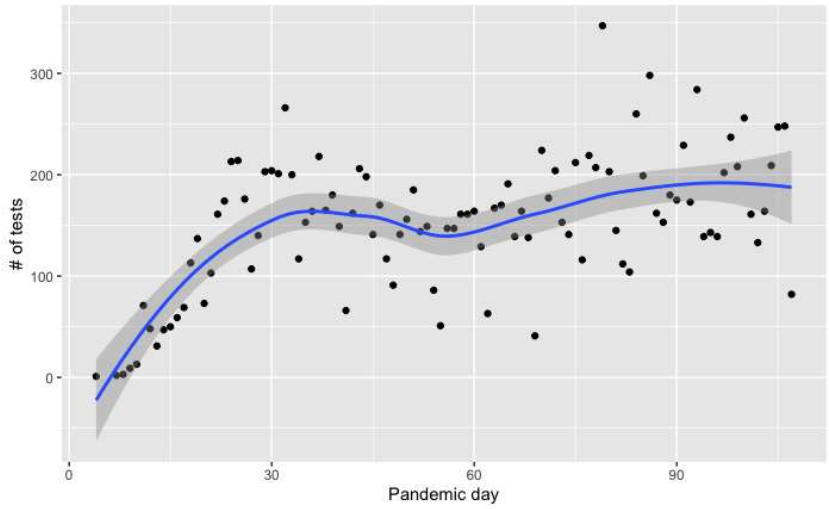
group_by() %>% summarize(): Example



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Recap

Summarize() is a function that enables us to calculate summaries of variables (columns).

Common summary activities include counting observations using **n()**, counting unique observations using **n_distinct()**, and calculating means using **mean()**.

Group_by() is a function that enables us to create subsets of data by a variable. Data can also be grouped by multiple variables.

Combining the **group_by()** and **summarize()** functions is a powerful way to look at summarizations across groups.

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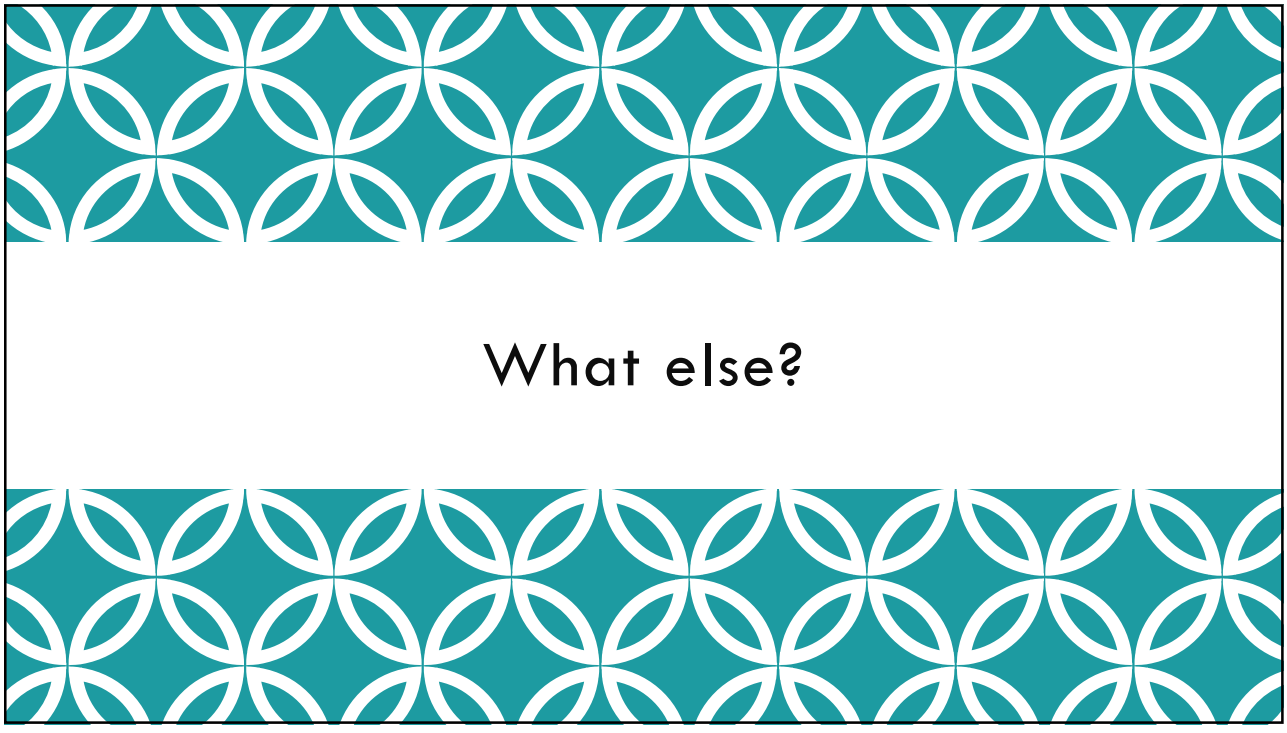
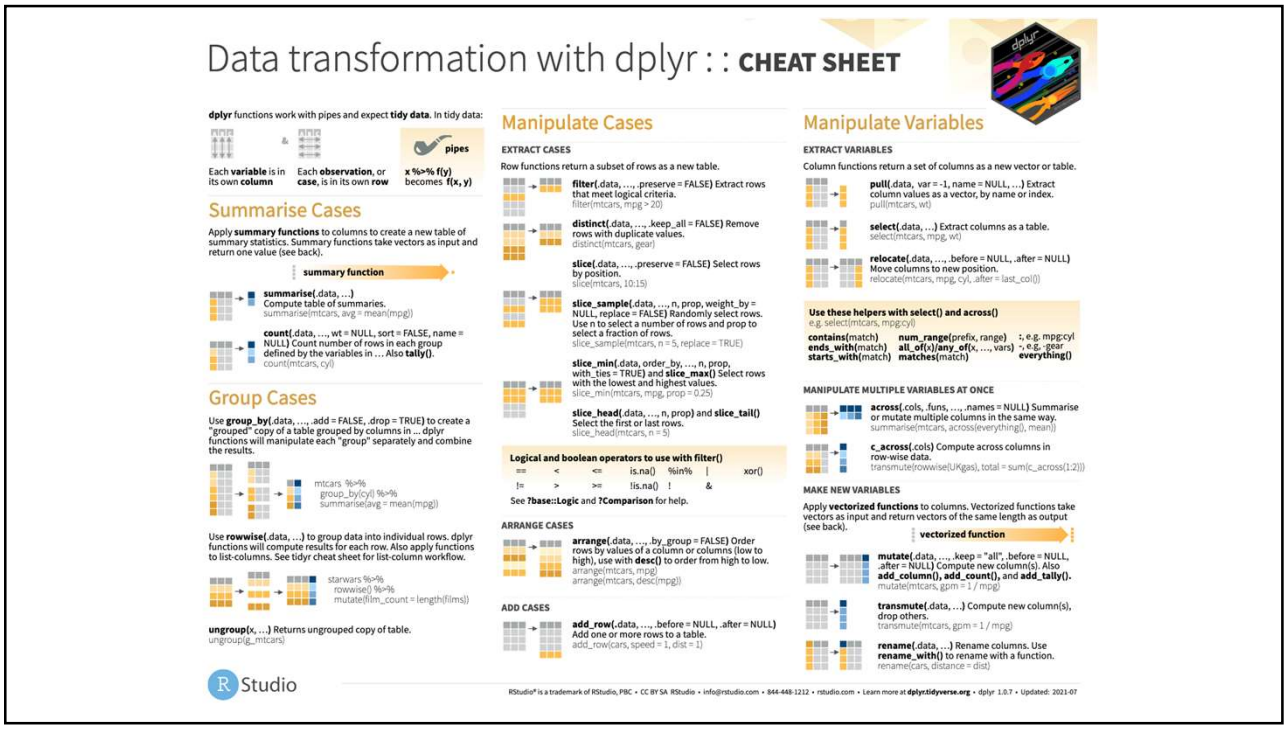


30



Data transformation with dplyr : : CHEAT SHEET

dplyr functions work with pipes and expect **tidy data**. In tidy data:

Each **variable** is in its own **column** & Each **observation**, or **case**, is in its own **row**

pipes — x %>% f(y) becomes **f(x, y)**

Summarise Cases

Apply **summary functions** to columns to create a new table of summary statistics. Summary functions take vectors as input and return one value (see back).

summary function

summarise(.data, …**)** Compute table of summaries.
summarise(mtcars, avg = mean(mpg))

count(.data, …, wt = NULL, sort = FALSE, name = NULL**)** Count number of rows in each group defined by the variables in … Also **tally()**.
count(mtcars, cyl)

Group Cases

Use **group_by(**.data, …, .add = FALSE, .drop = TRUE**)** to create a "grouped" copy of a table grouped by columns in … dplyr functions will manipulate each "group" separately and combine the results.

mtcars %>%
group_by(cyl) %>%
summarise(avg = mean(mpg))

Use **rowwise(**.data, …**)** to group data into individual rows. dplyr functions will compute results for each row. Also apply functions to list-columns. See tidyr cheat sheet for list-column workflow.

starwars %>%
rowwise() %>%
mutate(film_count = length(films))

ungroup(x, …**)** Returns ungrouped copy of table.
ungroup(g_mtcars)

Manipulate Cases

EXTRACT CASES

Row functions return a subset of rows as a new table.

filter(.data, …, .preserve = FALSE**)** Extract rows that meet logical criteria.
filter(mtcars, mpg > 20)

distinct(.data, …, .keep_all = FALSE**)** Remove rows with duplicate values.
distinct(mtcars, gear)

slice(.data, …, .preserve = FALSE**)** Select rows by position.
slice(mtcars, 10:15)

slice_sample(.data, …, n, prop, weight_by = NULL, replace = FALSE**)** Randomly select rows. Use n to select a number of rows and prop to select a fraction of rows.
slice_sample(mtcars, n = 5, replace = TRUE)

slice_min(.data, order_by, …, n, prop, with_ties = TRUE**)** and **slice_max()** Select rows with the lowest and highest values.
slice_min(mtcars, mpg, prop = 0.25)

slice_head(.data, …, n, prop**)** and **slice_tail()** Select the first or last rows.
slice_head(mtcars, n = 5)

Logical and boolean operators to use with filter()

==	<	<=	is.na()	%in%	xor()
!=	>	>=	!is.na()	!	&

See **?base::Logic** and **?Comparison** for help.

ARRANGE CASES

arrange(.data, …, .by_group = FALSE**)** Order rows by values of a column or columns (low to high), use with **desc()** to order from high to low.
arrange(mtcars, mpg)
arrange(mtcars, desc(mpg))

ADD CASES

add_row(.data, …, .before = NULL, .after = NULL**)** Add one or more rows to a table.
add_row(cars, speed = 1, dist = 1)

Manipulate Variables

EXTRACT VARIABLES

Column functions return a set of columns as a new vector or table.

pull(.data, var = -1, name = NULL, …**)** Extract column values as a vector, by name or index.
pull(mtcars, wt)

select(.data, …**)** Extract columns as a table.
select(mtcars, mpg, wt)

relocate(.data, …, .before = NULL, .after = NULL**)** Move columns to new position.
relocate(mtcars, mpg, cyl, .after = last_col())

Use these helpers with select() and across()
e.g. select(mtcars, mpg:cyl)

contains(match**)** — **num_range(**prefix, range**)** — :, e.g. mpg:cyl
ends_with(match**)** — **all_of(**x**)/any_of(**x, …, vars**)** — -, e.g. -gear
starts_with(match**)** — **matches(**match**)** — **everything()**

MANIPULATE MULTIPLE VARIABLES AT ONCE

across(.cols, .funs, …, .names = NULL**)** Summarise or mutate multiple columns in the same way.
summarise(mtcars, across(everything(), mean))

c_across(.cols**)** Compute across columns in row-wise data.
transmute(rowwise(UKgas), total = sum(c_across(1:2)))

MAKE NEW VARIABLES

Apply **vectorized functions** to columns. Vectorized functions take vectors as input and return vectors of the same length as output (see back).

vectorized function

mutate(.data, …, .keep = "all", .before = NULL, .after = NULL**)** Compute new column(s). Also **add_column()**, **add_count()**, and **add_tally()**.
mutate(mtcars, gpm = 1 / mpg)

transmute(.data, …**)** Compute new column(s), drop others.
transmute(mtcars, gpm = 1 / mpg)

rename(.data, …**)** Rename columns. Use **rename_with()** to rename with a function.
rename(cars, distance = dist)

RStudio

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Q: Is there an association between insurance product and SARS-CoV-2 RT-PCR positivity?

payor_group_fac <chr>	negative <int>	positive <int>
commercial	3549	86
government	3318	242
other	309	17
unassigned	7182	520

4 rows

```
data %>%
  fisher.test(simulate.p.value = T)
```

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Data wrangling - 1

function that flexibly assigns values

```
covid_testing_2 <- covid_testing %>%
  mutate(payor_group_fac = case_when(
                             is.na(payor_group)                          ~ "unassigned",
                             payor_group %in% c("charity care",
                                                "medical assistance",
                                                "self pay",
                                                 "other")                ~ "other",
                                                                       TRUE ~ payor_group)
  ) %>%
  filter(result %in% c("positive", "negative"))
```

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Data wrangling - 2

```
# Generate counts
tmp_table_tall <- covid_testing_2 %>%
  group_by(payor_group_fac, result) %>%
  summarize(n = n()) %>%
  ungroup()
tmp_table_tall

# Pivot from tall to wide table
tmp_table_wide <- tmp_table_tall %>%
  spread(key = "result", value = "n")
tmp_table_wide
```

Remove groupings

Maps key values to separate columns

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Testing for association

payor_group_fac <chr>	negative <int>	positive <int>
commercial	3549	86
government	3318	242
other	309	17
unassigned	7182	520

4 rows

```
data %>%
  fisher.test(simulate.p.value = T)
```

```
        Fisher's Exact Test for Count Data with simulated p-value (based on 2000 replicates)

data:  .
p-value = 0.0004998
alternative hypothesis: two.sided
```

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Regression Modeling

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> Q: Is the association between test positivity and a government insurance product explained by the age of the patient?

```
tmp <- covid_testing_2 %>%
  filter(payor_group_fac %in% c("commercial", "government")) %>%
  mutate(result_fac = factor(result,
                             levels=c("negative", "positive"),
                             ordered=T),
         payor_group_fac = (payor_group == "government"))
tmp_fit <- glm(result_fac ~ payor_group_fac + age,     # model formula
               data = tmp,                             # dataset
               family = "binomial"                     # type of model
  )
summary(tmp_fit)
exp(coefficients(tmp_fit))                             # odds
```

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Output for logistic regression

```
Call:
glm(formula = result_fac ~ payor_group_fac + age, family = "binomial",
    data = tmp)

Deviance Residuals:
    Min       1Q   Median       3Q      Max
-1.6365  -0.3468  -0.2532  -0.1985   2.8393

Coefficients:
                    Estimate Std. Error z value Pr(>|z|)
(Intercept)         -4.016195   0.119611 -33.577  < 2e-16 ***
payor_group_facTRUE  1.136566   0.128761   8.827  < 2e-16 ***
age                  0.032897   0.004436   7.416 1.21e-13 ***
---
Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1

(Dispersion parameter for binomial family taken to be 1)

    Null deviance: 2666.6  on 7194  degrees of freedom
Residual deviance: 2535.2  on 7192  degrees of freedom
AIC: 2541.2

Number of Fisher Scoring iterations: 6

       (Intercept) payor_group_facTRUE                 age
         0.01802141          3.11604971          1.03344368
```

Odds for Payor Group and Age

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