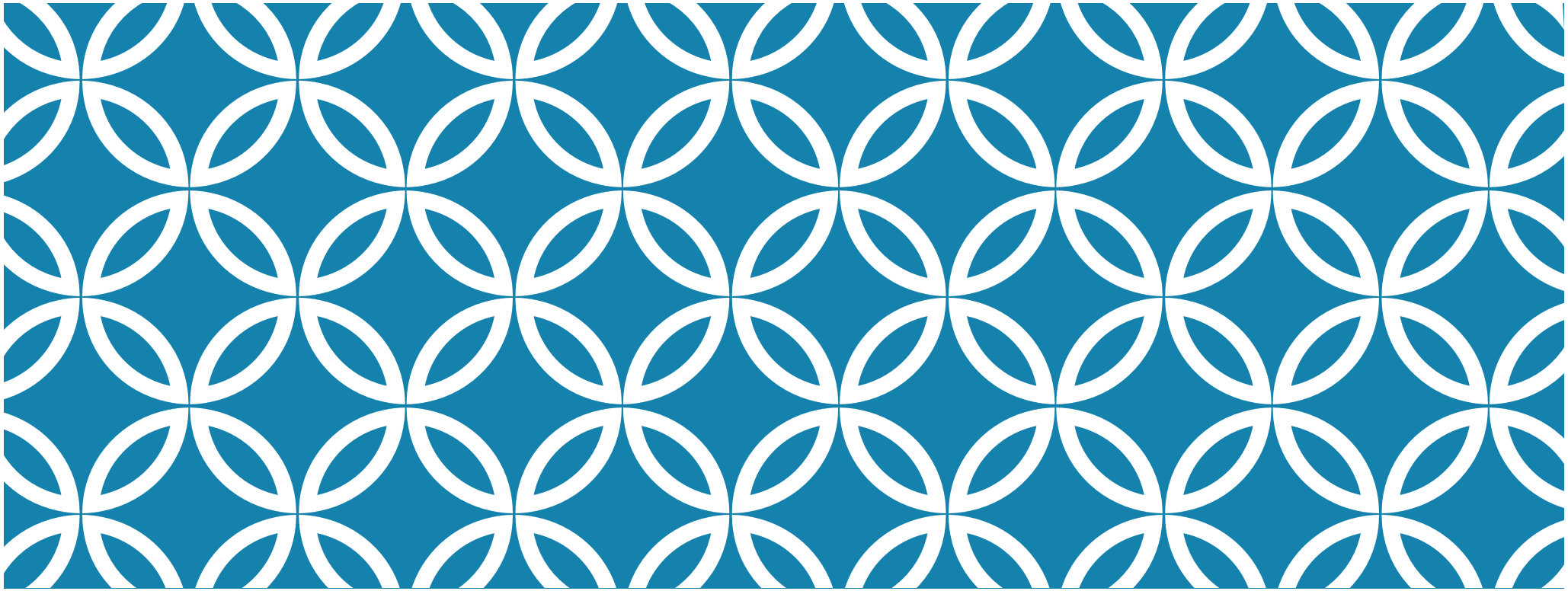


Statistical Analyses in R

Session 5

Dan Herman

Introduction to R Workshop

July 17, 2020

July 16 2020	**Session**	**Instructor**
1:00 pm - 1:30 pm	Instructor Introductions, Introduction to technology	Amrom Obstfeld
1:30 pm - 2:15 pm	Introduction to R and RStudio	Joe Rudolf
2:30 pm - 3:15 pm	R basics for Reproducible Reporting	Patrick Mathias
3:30 pm - 5:00 pm	Data Visualization in R	Stephan Kadauke
July 17 2020		
1:00 pm - 2:30 pm	Data Transformation	Amrom Obstfeld
2:45 pm - 4:15 pm	Statistical Analysis in R	Dan Herman
4:30 pm - 5:00 pm	Advanced Reporting in R	Patrick Mathias

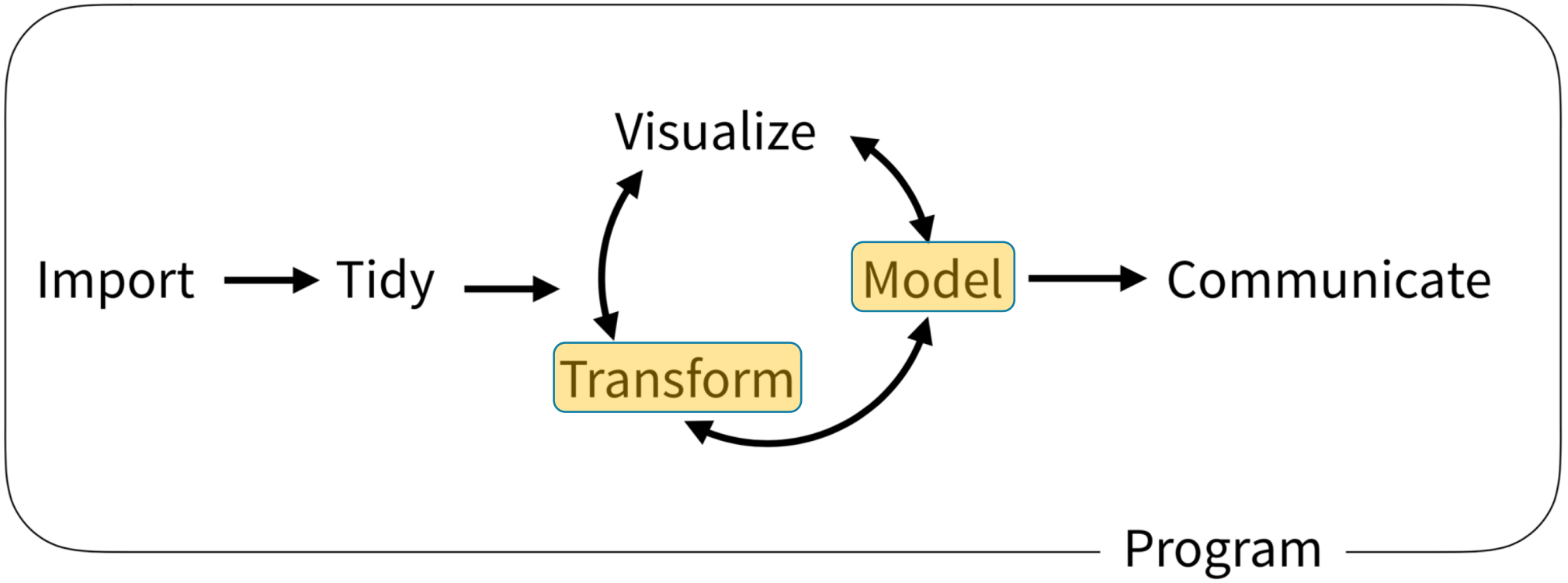
Goals

1. Learn how to summarize and assess data

Objectives

1. Calculate a summary statistic for a variable using `summarize`
2. Calculate of summary statistic for a variable separately for a group of observations, using `group_by` and `summarize`
3. Perform a simple test for association

Typical Data Science Pipeline

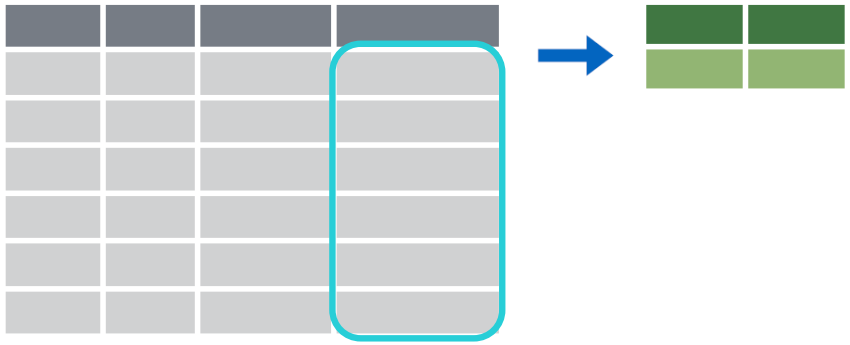


From *R for Data Science* (https://r4ds.had.co.nz/introduction.html)

Summarize()

summarize()

- Make summaries of your data



summarize()

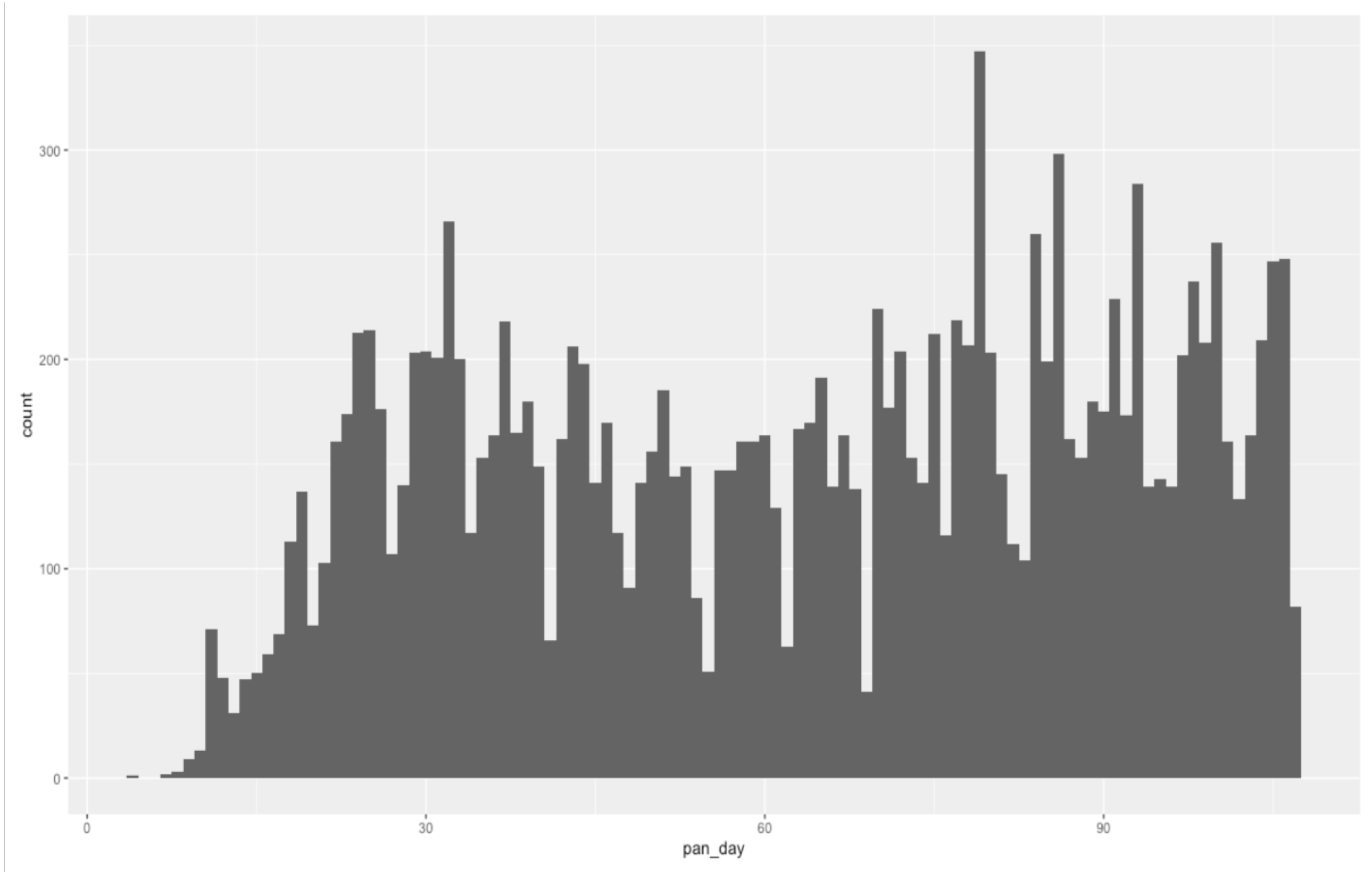
- Make summaries of your data

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

name for new variable

Value or function

Q: How many tests are ordered per day?



summarize()

- Make summaries of your data

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

function that returns number of observations

mrn	pan_day
5001412	4
5000533	7
5009134	7
5008518	8

→

order_count
4

summarize()

- Make summaries of your data

```
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

Your Turn 1

Add onto the code in the above chunk to calculate:

a) Mean count of orders per `pan_day`

b) Mean count of orders per clinic

Vector Functions

TO USE WITH MUTATE ()

COUNTS

dplyr::**n()** - number of values/rows
dplyr::**n_distinct()** - # of uniques
sum(!is.na()) - # of non-NA's

LOCATION

mean() - mean, also **mean(!is.na())**
median() - median

LOGICALS

mean() - Proportion of TRUE's
sum() - # of TRUE's

POSITION/ORDER

dplyr::**first()** - first value
dplyr::**last()** - last value
dplyr::**nth()** - value in nth location of vector

RANK

quantile() - nth quantile
min() - minimum value
max() - maximum value

SPREAD

IQR() - Inter-Quartile Range
mad() - median absolute deviation
sd() - standard deviation
var() - variance

Summary Functions

TO USE WITH SUMMARISE ()

summarise() applies summary functions to columns to create a new table. Summary functions take vectors as input and return single values as output.

summary function

COUNTS

dplyr::**n()** - number of values/rows
dplyr::**n_distinct()** - # of uniques
sum(!is.na()) - # of non-NA's

LOCATION

mean() - mean, also **mean(!is.na())**
median() - median

LOGICALS

mean() - Proportion of TRUE's
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POSITION/ORDER

dplyr::**first()** - first value
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dplyr::nth() - value in nth location of vector

RANK

quantile() - nth quantile
min() - minimum value
max() - maximum value

SPREAD

IQR() - Inter-Quartile Range
mad() - median absolute deviation
sd() - standard deviation
var() - variance

Row Names

Tidy data does not use rownames, which store a variable outside of the columns. To work with the rownames, first move them into a column.

rownames_to_column()
Move row names into col.
a <- rownames_to_column(iris, var = "C")

column_to_rownames()
Move col in row names.
column_to_rownames(a, var = "C")

Also **has_rownames()**, **remove_rownames()**

Combine Tables

COMBINE VARIABLES

x + y =

Use **bind_cols()** to paste tables beside each other as they are.

bind_cols(…) Returns tables placed side by side as a single table.
BE SURE THAT ROWS ALIGN.

Use a "**Mutating Join**" to join one table to columns from another, matching values with the rows that they correspond to. Each join retains a different combination of values from the tables.

left_join(x, y, by = NULL, copy=FALSE, suffix=c(".x",".y"),…)
Join matching values from y to x.

right_join(x, y, by = NULL, copy = FALSE, suffix=c(".x",".y"),…)
Join matching values from x to y.

inner_join(x, y, by = NULL, copy = FALSE, suffix=c(".x",".y"),…)
Join data. Retain only rows with matches.

full_join(x, y, by = NULL, copy=FALSE, suffix=c(".x",".y"),…)
Join data. Retain all values, all rows.

Use **by = c("col1", "col2")** to specify the column(s) to match on.
left_join(x, y, by = "A")

Use a named vector, **by = c("col1" = "col2")**, to match on columns with different names in each data set.
left_join(x, y, by = c("C" = "D"))

Use **suffix** to specify suffix to give to duplicate column names.
left_join(x, y, by = c("C" = "D"), suffix = c("1", "2"))

COMBINE CASES

x + y

Use **bind_rows()** to paste tables below each other as they are.

bind_rows(…, .id = NULL)
Returns tables one on top of the other as a single table. Set .id to a column name to add a column of the original table names (as pictured)

intersect(x, y, …)
Rows that appear in both x and y.

setdiff(x, y, …)
Rows that appear in x but not y.

union(x, y, …)
Rows that appear in x or y. (Duplicates removed). union_all() retains duplicates.

Use **setequal()** to test whether two data sets contain the exact same rows (in any order).

EXTRACT ROWS

x + y =

Use a "**Filtering Join**" to filter one table against the rows of another.

semi_join(x, y, by = NULL, …)
Return rows of x that have a match in y.
USEFUL TO SEE WHAT WILL BE JOINED.

anti_join(x, y, by = NULL, …)
Return rows of x that do not have a match in y. USEFUL TO SEE WHAT WILL NOT BE JOINED.

summarize() examples

- Last pandemic day (in data)
- Median turnaround time

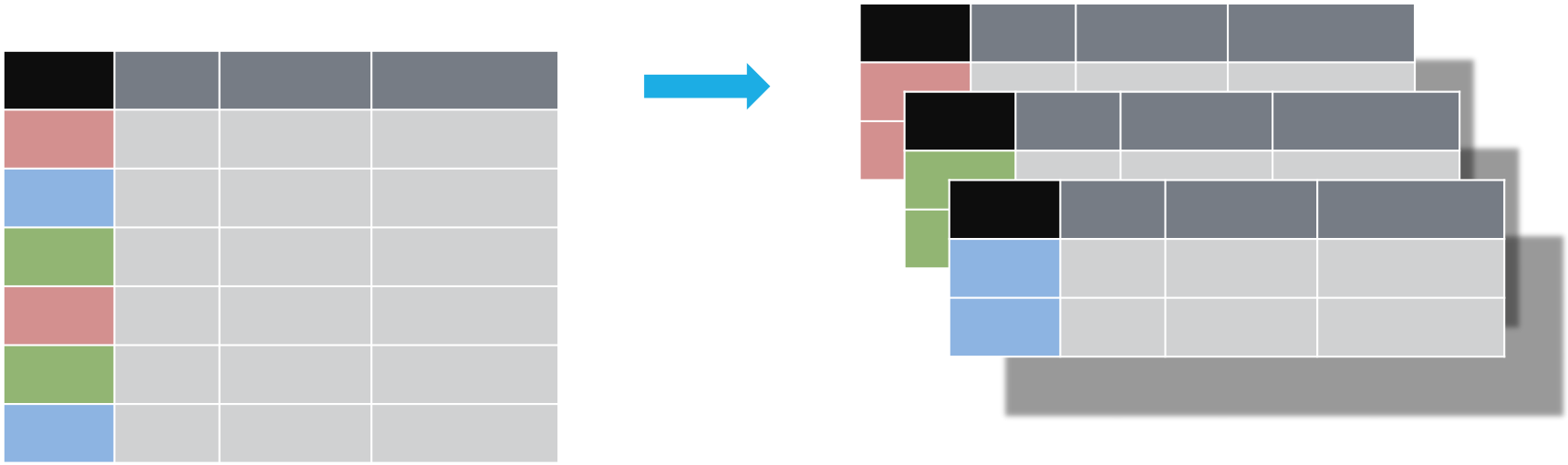
Your Turn 2

Consider:

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

group_by()

group_by()



group_by()

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

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

name of variable to group by

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
```

group_by()

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

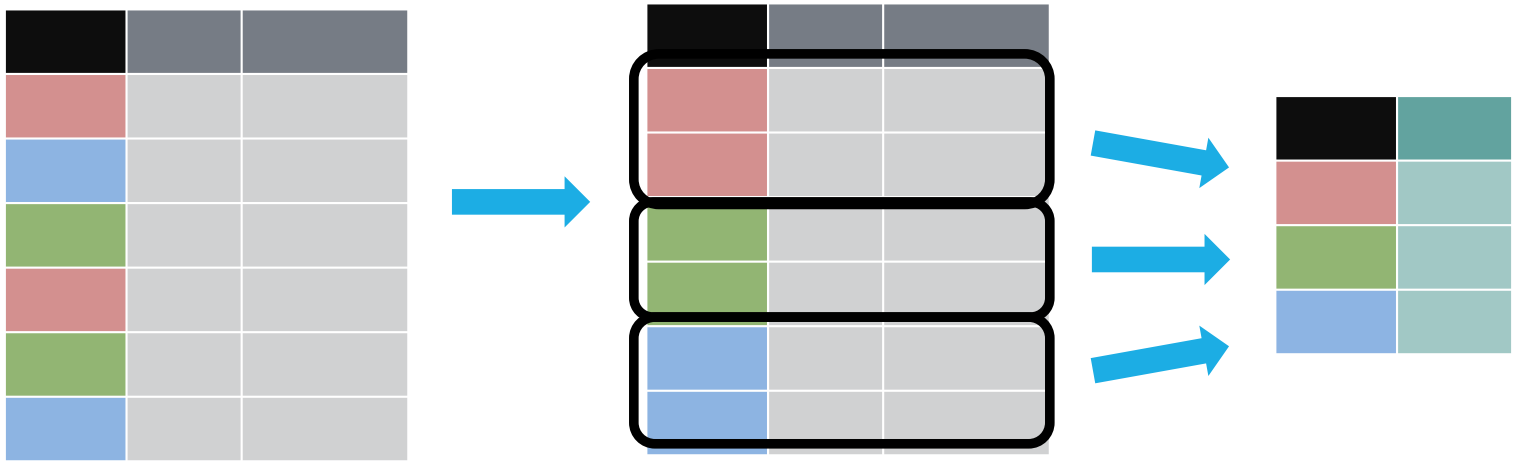
```
covid_testing %>%
    select(mrn, pan_day, clinic_name) %>%
    group_by(pan_day, clinic_name)
```

```
# 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
```

group_by() %>% summarize()

group_by() %>% summarize()

Make summaries of your data *by group*



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
4

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

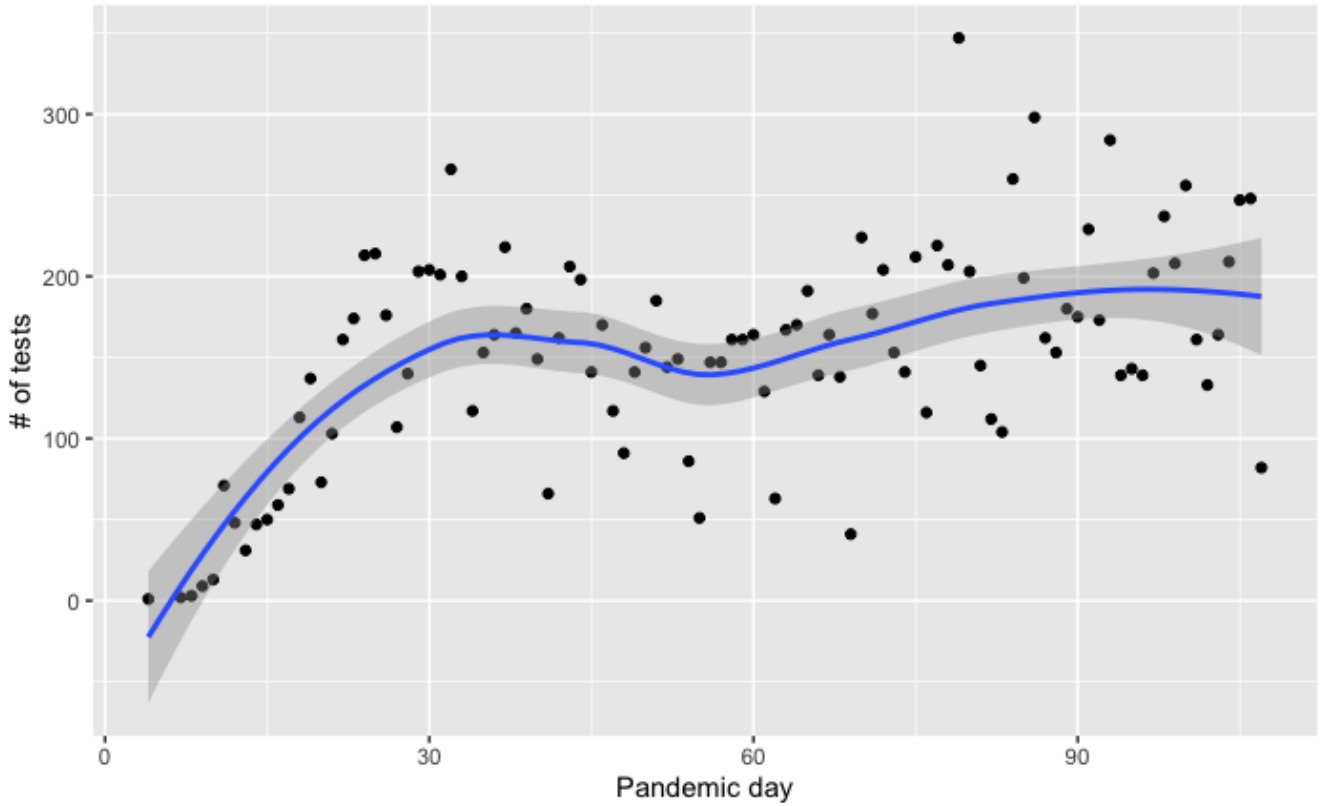
Your Turn 3

Calculate:

a) The median turnaround time for each day

c) (**Extra**) The median number of orders per day

group_by() %>% summarize(): Example



Stats

Q: Is there an association between insurance 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)
```

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

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

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"))
```

Data wrangling - 2

Remove groupings

Map key values to separate columns

```
# C
tmp
  g                    , result) %>%
  s
  un
tmp_table   all

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

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
```

Your Turn 4

What is the relative odds of a positive test result between patients with government or commercial insurance?

What Else?

Logistic regression

```
tmp_fit <- tmp %>%
  glm(result_fac ~ payor_group_fac + age,  # model formula
      data=.,                              # dataset
      family="binomial")                   # type of model

summary(tmp_fit)
```

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