Lecture 5: Processing across rows

Managing and Manipulating Data Using R

1 Introduction

Logistics

Required reading for next week:

- Grolemund and Wickham 5.6 - 5.7 (grouped summaries and mutates)
- Xie, Allaire, and Grolemund 4.1 (R Markdown, ioslides presentations) LINK HERE and 4.3 (R Markdown, Beamer presentations) LINK HERE
  - Why? Lectures for this class are `beamer_presentation` output type.
  - `ioslides_presentation` are the most basic presentation output format for RMarkdown, so learning about `ioslides` will help you understand `beamer`
- Any slides from lecture we don't cover

Explanation about `beamer_header.tex` in YAML header:

- What does it do? Why do we include this?
- Incorporating updates to `beamer_header.tex`

What we will do today

1. Introduction

2. Introduce group_by() and summarise()
   - 2.1 group_by
   - 2.2 summarise()

3. Combining group_by() and summarise()
   - 3.1 summarise() and Counts
   - 3.2 summarise() and means
   - 3.3 summarise() and logical vectors, part II
   - 3.4 Attach aggregate measures to your data frame

Libraries we will use today

"Load" the package we will use today (output omitted)

- **you must run this code chunk**

```
library(tidyverse)
```

If package not yet installed, then must install before you load. Install in "console" rather than .Rmd file

- Generic syntax: `install.packages("package_name")`
- Install "tidyverse": `install.packages("tidyverse")`

Note: when we load package, name of package is not in quotes; but when we install package, name of package is in quotes:

```
install.packages("tidyverse")
```

```
library(tidyverse)
```

Data we will use today

Data on off-campus recruiting events by public universities

Object `df_event`

One observation per university, recruiting event

```r
rm(list = ls()) # remove all objects

#load dataset with one obs per recruiting event
load(url("https://github.com/ozanj/rclass/raw/master/data/recruiting/recruit_eve
#load("../../data/recruiting/recruit_event_allvars.Rdata")
```

Processing across observations, introduction

Creation of analysis datasets often requires calculations across obs

Examples:

- You have a dataset with one observation per student-term and want to create a variable of credits attempted per term
- You have a dataset with one observation per student-term and want to create a variable of GPA for the semester or cumulative GPA for all semesters
- Number of off-campus recruiting events university makes to each state
- Average household income at visited versus non-visited high schools

Note

in today's lecture, I'll use the terms "observations" and "rows" interchangeably

Processing across variables vs. processing across observations

Visits by UC Berkeley to public high schools

```
#> # A tibble: 5 x 6
#>   school_id    state tot_stu_pub fr_lunch pct_fr_lunch med_inc
#>   <chr>        <chr>       <dbl>    <dbl>        <dbl>   <dbl>
#> 1 340882002126 NJ           1846       29       0.0157 178732
#> 2 340147000250 NJ           1044       50       0.0479  62288
#> 3 340561003796 NJ           1505      298       0.198  100684.
#> 4 340165005124 NJ           1900       43       0.0226 160476.
#> 5 341341003182 NJ           1519      130       0.0856 144346
```

- So far, we have focused on “processing across variables”
  - Performing calculations across columns (i.e., vars), typically within a row (i.e., observation)
  - Example: percent free-reduced lunch (above)
- Processing across obs (focus of today’s lecture)
  - Performing calculations across rows (i.e., obs), often within a column (i.e., variable)
  - Example: Average household income of visited high schools, by state

2 Introduce group_by() and summarise()

Strategy for teaching processing across obs

In `tidyverse` the `group_by()` and `summarise()` functions are the primary means of performing calculations across observations

- Usually, processing across observations requires using `group_by()` and `summarise()` together
- `group_by()` and `summarise()` usually aren't very useful by themselves (like peanut butter and jelly)

How we'll teach:

- introduce `group_by()` and `summarise()` separately
  - goal: you understand what each function does
- then we'll combine them

2.1 group_by

group_by()

`group_by()` converts a data frame object into groups. After grouping, functions performed on data frame are performed "by group"

- part of **dplyr** package within **tidyverse**; not part of **Base R**
- works best with pipes `%>%` and `summarise()` function [described below]

Basic syntax:

- `group_by(object, vars to group by separated by commas)`

Typically, "group_by" variables are character, factor, or integer variables

- Possible "group by" variables in `df_event` data:
  - university name/id; event type (e.g., public HS, private HS); state

Example: in `df_event`, create frequency count of `event_type`

```
names(df_event)
#without group_by()
df_event %>% count(event_type)
df_event %>% count(instnm)
#group_by() university
df_event %>% group_by(instnm) %>% count(event_type)
```

`group_by()`

By itself `group_by()` doesn’t do much; it just prints data

Below, group `df_event` data by university, event type, and event state

```
#without pipes
group_by(df_event, univ_id, event_type, event_state)
#with pipes
df_event %>% group_by(univ_id, event_type, event_state)
```

But once an object is grouped, all subsequent functions are run separately “by group”

```
df_event  %>% count()
df_event %>% group_by(univ_id) %>% count()
df_event %>% group_by(univ_id) %>% count() %>% str()
df_event %>% group_by(univ_id, event_type) %>% count()
df_event %>% group_by(univ_id, event_type) %>% count() %>% str()
df_event %>% group_by(univ_id, event_type, event_state) %>% count()
```

Grouping not retained unless you **assign** it

Below, we'll use `class()` function to show whether data frame is grouped

- will talk more about `class()` next week, but for now, just think of it as a function that provides information about an object
- similar to `typeof()`, but `class()` provides different info about object

Grouping is not retained unless you **assign** it

```
class(df_event)
#> [1] "tbl_df"     "tbl"        "data.frame"
df_event_grp <- df_event %>% group_by(univ_id, event_type, event_state) # using
class(df_event_grp)
#> [1] "grouped_df" "tbl_df"     "tbl"        "data.frame"
```

Use `ungroup(object)` to un-group grouped data

```
df_event_grp <- ungroup(df_event_grp)
class(df_event_grp)
#> [1] "tbl_df"     "tbl"        "data.frame"
rm(df_event_grp)
```

`group_by()` student exercise

1. Group by “instnm” and get a frequency count.

    How many rows and columns do you have? What do the number of rows mean?

2. Now group by “instnm” **and** “event_type” and get a frequency count.

    How many rows and columns do you have? What do the number of rows mean?

3. **Bonus:** In the same code chunk, group by “instnm” and “event_type”, but this time filter for observations where “med_inc” is greater than 75000 and get a frequency count.

group_by() student exercise solutions

1. Group by “instnm” and get a frequency count.

   How many rows and columns do you have? What do the number of rows mean?

```
df_event %>%
  group_by(instnm) %>%
  count()
#> # A tibble: 16 x 2
#>    instnm          n
#>    <chr>       <int>
#>  1 Arkansas      994
#>  2 Bama         4258
#>  3 Cinci         679
#>  4 CU Boulder   1439
#>  5 Kansas       1014
#>  6 NC State      640
#>  7 Pitt         1225
#>  8 Rutgers      1135
#>  9 S Illinois    549
#> 10 Stony Brook   730
#> 11 UC Berkeley   879
#> 12 UC Irvine     539
#> 13 UGA           827
#> 14 UM Amherst    908
#> 15 UNL          1397
#> 16 USCC         1467
```

group_by() student exercise solutions

2. Now group by “instnm” **and** “event_type” and get a frequency count.

   How many rows and columns do you have? What do the number of rows mean?

```
df_event %>%
  group_by(instnm, event_type) %>%
  count()
#> # A tibble: 80 x 3
#>    instnm   event_type      n
#>    <chr>    <chr>       <int>
#>  1 Arkansas 2yr college    32
#>  2 Arkansas 4yr college    14
#>  3 Arkansas other         112
#>  4 Arkansas private hs    222
#>  5 Arkansas public hs     614
#>  6 Bama     2yr college   127
#>  7 Bama     4yr college   158
#>  8 Bama     other         608
#>  9 Bama     private hs    963
#> 10 Bama     public hs    2402
#> # ... with 70 more rows
```

`group_by()` student exercise solutions

3. **Bonus:** Group by “instnm” and “event_type”, but this time filter for observations where “med_inc” is greater than 75000 and get a frequency count.

```
df_event %>%
  group_by(instnm, event_type) %>%
  filter(med_inc > 75000) %>%
  count()
#> # A tibble: 80 x 3
#>    instnm   event_type      n
#>    <chr>    <chr>       <int>
#>  1 Arkansas 2yr college     7
#>  2 Arkansas 4yr college     3
#>  3 Arkansas other          30
#>  4 Arkansas private hs     99
#>  5 Arkansas public hs     303
#>  6 Bama     2yr college    21
#>  7 Bama     4yr college    42
#>  8 Bama     other         249
#>  9 Bama     private hs    477
#> 10 Bama     public hs    1478
#> # ... with 70 more rows
```

2.2 summarise()

`summarise()` function

`summarise()` does calculations across rows; then collapses into single row

Usage (i.e., syntax): `summarise(.data, ...)`

Arguments

- `.data`: a data frame; omit if using `summarise()` after pipe `%>%`
- `...`: Name-value pairs of summary functions.
  - The name will be the name of the variable in the result.
  - Value should be expression that returns a single value like `min(x)`, `n()`

Value (what `summarise()` returns/creates)

- Object of same class as `.data.`; object will have one obs per “by group”

Useful functions (i.e., “helper functions”)

- Standalone functions called *within* `summarise()`, e.g., `mean()`, `n()`
- Count function `n()` takes no arguments; returns number of rows in group

Example: Count total number of events

```r
summarise(df_event, num_events=n()) # without pipes
sum_object <- df_event %>% summarise(num_events=n()) # using pipes
df_event %>% summarise(num_events=n()) # using pipes
```

`summarise()` function

Useful functions (i.e., “helper functions”)

- Center: `mean()`, `median()`
- Spread: `sd()`, `IQR()`, `mad()`
- Range: `min()`, `max()`, `quantile()`
- Position: `first()`, `last()`, `nth()`,
- Count: `n()`, `n_distinct()`
- Logical: `any()`, `all()`

Investigate objects created by `summarise()`

Example: Count total number of events

```
df_event %>% summarise(num_events=n())
df_event %>% summarise(num_events=n()) %>% str()
```

Example: What is max value of `med_inc` across all events

```
df_event %>% summarise(max_inc=max(med_inc, na.rm = TRUE))
df_event %>% summarise(max_inc=max(med_inc, na.rm = TRUE)) %>% str()
```

Example: Count total number of events AND max value of median income

```
df_event %>% summarise(num_events=n(),
                       max_inc=max(med_inc, na.rm = TRUE))
df_event %>% summarise(num_events=n(),
                       max_inc=max(med_inc, na.rm = TRUE)) %>% str()
```

Takeaway

by default, objects created by `summarise()` are data frames that contain variables created within `summarise()` and one observation [per "by group"]

Retaining objects created by `summarise()`

Object created by summarise() not retained unless you **assign** it

```
event_temp <- df_event %>% summarise(num_events=n(),
  mean_inc=mean(med_inc, na.rm = TRUE))

event_temp
#> # A tibble: 1 x 2
#>   num_events mean_inc
#>        <int>    <dbl>
#> 1      18680   89089.
rm(event_temp)
```

`summarise()` student exercise

1. What is the min value of `med_inc` across all events?

   Hint: Use min()

2. What is the mean value of `fr_lunch` across all events?

   Hint: Use mean()

`summarise()` student exercise

1. What is min value of `med_inc` across all events?

```
df_event %>%
  summarise(min_med_income = min(med_inc, na.rm = TRUE))
#> # A tibble: 1 x 1
#>   min_med_income
#>            <dbl>
#> 1          12894.
```

`summarise()` student exercise

2. What is the mean value of `fr_lunch` across all events?

   Hint: Use mean()

```
df_event %>%
  summarise(mean_fr_lunch = mean(fr_lunch, na.rm = TRUE))
#> # A tibble: 1 x 1
#>   mean_fr_lunch
#>           <dbl>
#> 1          475.
```

3 Combining group_by() and summarise()

Combining `summarise()` and `group_by`

`summarise()` on ungrouped vs. grouped data:

- By itself, `summarise()` performs calculations across all rows of data frame then collapses the data frame to a single row
- When data frame is grouped, `summarise()` performs calculations across rows within a group and then collapses to a single row for each group

Example: Count the number of events for each university

```
df_event %>% summarise(num_events=n())
df_event %>% group_by(instnm) %>% summarise(num_events=n())
```

- Investigate the object created above

```
df_event %>% group_by(instnm) %>% summarise(num_events=n()) %>% str()
```

- Or we could retain object for later use

```
event_by_univ <- df_event %>% group_by(instnm) %>% summarise(num_events=n())
str(event_by_univ)
event_by_univ # print
rm(event_by_univ)
```

Combining `summarise()` and `group_by`

Task

Count number of recruiting events by event_type for each university

```
df_event %>% group_by(instnm, event_type) %>%
  summarise(num_events=n())

df_event %>% group_by(instnm, event_state, event_type) %>%
  summarise(num_events=n())

#investigate object created
df_event %>% group_by(instnm, event_type) %>%
  summarise(num_events=n()) %>% str()
```

Task

By university and event type, count the number of events and calculate the avg. pct white in the zip-code

```
df_event %>% group_by(instnm, event_type) %>%
  summarise(num_events=n(),
    mean_pct_white=mean(pct_white_zip, na.rm = TRUE)
  )

#investigate object you created
df_event %>% group_by(instnm, event_type) %>%
  summarise(num_events=n(),
    mean_pct_white=mean(pct_white_zip, na.rm = TRUE)
  ) %>% str()
```

Combining `summarise()` and `group_by`

Recruiting events by UC Berkeley

```
df_event %>% filter(univ_id == 110635) %>%
  group_by(event_type) %>% summarise(num_events=n())
```

Let's create a dataset of recruiting events at UC Berkeley

```
event_berk <- df_event %>% filter(univ_id == 110635)

event_berk %>% count(event_type)
```

The "char" variable `event_inst` equals "In-State" if event is in same state as the university

```
event_berk %>% arrange(event_date) %>%
  select(pid, event_date, event_type, event_state, event_inst) %>%
  slice(1:8)
#> # A tibble: 8 x 5
#>     pid event_date event_type  event_state event_inst
#>   <int> <date>     <chr>       <chr>       <chr>
#> 1 13100 2017-04-11 other       HI          Out-State
#> 2 13089 2017-04-14 public hs   GA          Out-State
#> 3 13088 2017-04-23 private hs  CT          Out-State
#> 4 13086 2017-04-23 other       CA          In-State
#> 5 13091 2017-04-24 private hs  NY          Out-State
#> 6 13087 2017-04-24 public hs   CA          In-State
#> 7 13092 2017-04-25 other       NY          Out-State
#> 8 13099 2017-04-25 2yr college CA          In-State
```

3.1 summarise() and Counts

`summarise()`: Counts

The count function `n()` takes no arguments and returns the size of the current group

```
event_berk %>% group_by(event_type, event_inst) %>%
  summarise(num_events=n())
```

Object not retained unless we **assign**

```
berk_temp <- event_berk %>% group_by(event_type, event_inst) %>%
  summarise(num_events=n())
berk_temp
typeof(berk_temp)
str(berk_temp)
```

Because counts are so important, `dplyr` package includes separate `count()` function that can be called outside `summarise()` function

```
event_berk %>% group_by(event_type, event_inst) %>% count()

berk_temp2 <- event_berk %>% group_by(event_type, event_inst) %>% count()

berk_temp == berk_temp2 # TAKEAWAY: these two objects are identical!
rm(berk_temp,berk_temp2)
```

`summarise()` : count with logical vectors and `sum()`

Logical vectors have values `TRUE` and `FALSE`.

- When used with numeric functions, `TRUE` converted to 1 and `FALSE` to 0.

`sum()` is a numeric function that returns the sum of values

```
sum(c(5,10))
sum(c(TRUE,TRUE,FALSE,FALSE))
```

`is.na()` returns `TRUE` if value is `NA` and otherwise returns `FALSE`

```
is.na(c(5,NA,4,NA))
#> [1] FALSE  TRUE FALSE  TRUE

sum(is.na(c(5,NA,4,NA,5)))
#> [1] 2
sum(!is.na(c(5,NA,4,NA,5)))
#> [1] 3
```

Application: How many missing/non-missing obs in variable [**very important**]

```
event_berk %>% group_by(event_type) %>%
  summarise(
    n_events = n(),
    n_miss_inc = sum(is.na(med_inc)),
    n_nonmiss_inc = sum(!is.na(med_inc)),
    n_nonmiss_fr_lunch = sum(!is.na(fr_lunch))
  )
```

`summarise()` and count student exercise

Use one code chunk for this exercise. You could tackle this a step at a time and run the entire code chunk when you have answered all parts of this question. Create your own variable names.

1. Using the `event_berk` object, filter observations where `event_state` is VA and group by `event_type` .
   1.1 Using the summarise function to create a variable that represents the count for each `event_type` .

   1.2 Create a variable that represents the sum of missing obs for `med_inc` .

   1.3 create a variable that represents the sum of non-missing obs for `med_inc` .

   1.4 **Bonus**: Arrange variable you created representing the count of each `event_type` in descending order.

`summarise()` and count student exercise SOLUTION

1. Using the `event_berk` object filter observations where `event_state` is VA and group by `event_type`.

   1.1 Using the summarise function, create a variable that represents the count for each `event_type`.

   1.2 Now get the sum of missing obs for `med_inc`.

   1.3 Now get the sum of non-missing obs for `med_inc`.

```
event_berk %>%
  filter(event_state == "VA") %>%
  group_by(event_type) %>%
  summarise(
    n_events = n(),
    n_miss_inc = sum(is.na(med_inc)),
    n_nonmiss_inc = sum(!is.na(med_inc))) %>%
  arrange(desc(n_events))
#> # A tibble: 3 x 4
#>   event_type n_events n_miss_inc n_nonmiss_inc
#>   <chr>         <int>      <int>         <int>
#> 1 public hs        20          0            20
#> 2 private hs       13          0            13
#> 3 other             3          0             3
```

3.2 summarise() and means

`summarise()` : means

The `mean()` function within `summarise()` calculates means, separately for each group

```
event_berk %>% group_by(event_inst, event_type) %>% summarise(
  n_events=n(),
  mean_inc=mean(med_inc, na.rm = TRUE),
  mean_pct_white=mean(pct_white_zip, na.rm = TRUE))
#> # A tibble: 10 x 5
#>    event_inst event_type  n_events mean_inc mean_pct_white
#>    <chr>      <chr>          <int>    <dbl>          <dbl>
#>  1 In-State   2yr college      111   78486.           40.1
#>  2 In-State   4yr college       14  131691.           58.0
#>  3 In-State   other             49   75040.           37.6
#>  4 In-State   private hs        35   95229.           48.4
#>  5 In-State   public hs        259   87097.           39.6
#>  6 Out-State  2yr college        1  153070.           89.7
#>  7 Out-State  4yr college        4   76913.           65.8
#>  8 Out-State  other             89   69004.           56.5
#>  9 Out-State  private hs       134   87654.           64.3
#> 10 Out-State  public hs        183  103603.           62.0
```

`summarise()` : means and `na.rm` argument

- Default behavior of "aggregation functions" (e.g., `summarise()`)
  - if *input* has any missing values (`NA`), than output will be missing.
- Many functions have argument `na.rm` (means "remove `NAs` ")
  - `na.rm = FALSE` [the default for `mean()`]
    - Do not remove missing values from input before calculating
    - Therefore, missing values in input will cause output to be missing
  - `na.rm = TRUE`
    - Remove missing values from input before calculating
    - Therefore, missing values in input will not cause output to be missing

```
#na.rm = FALSE; the default setting
event_berk %>% group_by(event_inst, event_type) %>% summarise(
  n_events=n(),
  n_miss_inc = sum(is.na(med_inc)),
  mean_inc=mean(med_inc, na.rm = FALSE),
  n_miss_frlunch = sum(is.na(fr_lunch)),
  mean_fr_lunch=mean(fr_lunch, na.rm = FALSE))
#na.rm = TRUE
event_berk %>% group_by(event_inst, event_type) %>% summarise(
  n_events=n(),
  n_miss_inc = sum(is.na(med_inc)),
  mean_inc=mean(med_inc, na.rm = TRUE),
  n_miss_frlunch = sum(is.na(fr_lunch)),
  mean_fr_lunch=mean(fr_lunch, na.rm = TRUE))
```

Student exercise

1. Using the `event_berk` object, group by `instnm`, `event_inst`, & `event_type`.
    1.1 Create vars for number non_missing for these racial/ethnic groups (`pct_white_zip`, `pct_black_zip`, `pct_asian_zip`, `pct_hispanic_zip`, `pct_amerindian_zip`, `pct_nativehawaii_zip`)
    1.2 Create vars for mean percent for each racial/ethnic group

Student exercise solutions

```
event_berk %>% group_by(instnm, event_inst, event_type) %>%
  summarise(
  n_events=n(),
  n_miss_white = sum(!is.na(pct_white_zip)),
  mean_white = mean(pct_white_zip, na.rm = TRUE),
  n_miss_black = sum(!is.na(pct_black_zip)),
  mean_black = mean(pct_black_zip, na.rm = TRUE),
  n_miss_asian = sum(!is.na(pct_asian_zip)),
  mean_asian = mean(pct_asian_zip, na.rm = TRUE),
  n_miss_lat = sum(!is.na(pct_hispanic_zip)),
  mean_lat = mean(pct_hispanic_zip, na.rm = TRUE),
  n_miss_na = sum(!is.na(pct_amerindian_zip)),
  mean_na = mean(pct_amerindian_zip, na.rm = TRUE),
  n_miss_nh = sum(!is.na(pct_nativehawaii_zip)),
  mean_nh = mean(pct_nativehawaii_zip, na.rm = TRUE)) %>%
  head(6)
#> # A tibble: 6 x 16
#>   instnm event_inst event_type n_events n_miss_white mean_white
#>   <chr>  <chr>      <chr>         <int>        <int>      <dbl>
#> 1 UC Be~ In-State   2yr colle~      111          106       40.1
#> 2 UC Be~ In-State   4yr colle~       14           12       58.0
#> 3 UC Be~ In-State   other            49           48       37.6
#> 4 UC Be~ In-State   private hs       35           35       48.4
#> 5 UC Be~ In-State   public hs       259          258       39.6
#> 6 UC Be~ Out-State  2yr colle~        1            1       89.7
#> # ... with 10 more variables: n_miss_black <int>, mean_black <dbl>,
#> #   n_miss_asian <int>, mean_asian <dbl>, n_miss_lat <int>,
```

3.3 summarise() and logical vectors, part II

`summarise()`: counts with logical vectors, part II

Logical vectors (e.g., `is.na()`) useful for counting obs that satisfy some condition

```
is.na(c(5,NA,4,NA))
#> [1] FALSE  TRUE FALSE  TRUE
typeof(is.na(c(5,NA,4,NA)))
#> [1] "logical"
sum(is.na(c(5,NA,4,NA)))
#> [1] 2
```

Task: Using object `event_berk`, create object `gt50p_lat_bl` with the following measures for each combination of `event_type` and `event_inst`:

- count of number of rows for each group
- count of rows non-missing for both `pct_black_zip` and `pct_hispanic_zip`
- count of number of visits to communities where the `sum` of Black and Latinx people comprise more than 50% of the total population

```
gt50p_lat_bl <- event_berk %>% group_by (event_inst, event_type) %>%
  summarise(
    n_events=n(),
    n_nonmiss_latbl = sum(!is.na(pct_black_zip) & !is.na(pct_hispanic_zip)),
    n_majority_latbl= sum(pct_black_zip+ pct_hispanic_zip>50, na.rm = TRUE)
  )
gt50p_lat_bl # print object
str(gt50p_lat_bl)
```

`summarise()` : logical vectors to count *proportions*

Synatx: `group_by(vars) %>% summarise(prop = mean(TRUE/FALSE conditon))`

Task: separately for in-state/out-of-state, what proportion of visits to public high schools are to communities with median income greater than $100,000?

Steps:

1. Filter public HS visits
2. group by in-state vs. out-of-state
3. Create measure

```
event_berk %>% filter(event_type == "public hs") %>% # filter public hs visits
  group_by (event_inst) %>% # group by in-state vs. out-of-state
  summarise(
    n_events=n(), # number of events by group
    n_nonmiss_inc = sum(!is.na(med_inc)), # w/ nonmissings values median inc,
    p_incgt100k = mean(med_inc>100000, na.rm=TRUE)) # proportion visits to $100K
#> # A tibble: 2 x 4
#>   event_inst n_events n_nonmiss_inc p_incgt100k
#>   <chr>         <int>         <int>       <dbl>
#> 1 In-State        259           256       0.273
#> 2 Out-State       183           183       0.519
```

`summarise()` : logical vectors to count *proportions*

What if we forgot to put `na.rm=TRUE` in the above task?

Task: separately for in-state/out-of-state, what proportion of visits to public high schools are to communities with median income greater than $100,000?

```
event_berk %>% filter(event_type == "public hs") %>% # filter public hs visits
  group_by (event_inst) %>% # group by in-state vs. out-of-state
  summarise(
    n_events=n(), # number of events by group
    n_nonmiss_inc = sum(!is.na(med_inc)), # w/ nonmissings values median inc,
    p_incgt100k = mean(med_inc>100000)) # proportion visits to $100K+ commmuniti
#> # A tibble: 2 x 4
#>   event_inst n_events n_nonmiss_inc p_incgt100k
#>   <chr>         <int>         <int>       <dbl>
#> 1 In-State        259           256      NA    
#> 2 Out-State       183           183       0.519
```

`summarise()` : Other “helper” functions

Lots of other functions we can use within `summarise()`

Common functions to use with `summarise()` :

Function	Description
`n`	count
`n_distinct`	count unique values
`mean`	mean
`median`	median
`max`	largest value
`min`	smallest value
`sd`	standard deviation
`sum`	sum of values
`first`	first value
`last`	last value
`nth`	nth value
`any`	condition true for at least one value

Note: These functions can also be used on their own or with `mutate()`

`summarise()` : Other functions

Maximum value in a group

```
max(c(10,50,8))
#> [1] 50
```

Task: For each combination of in-state/out-of-state and event type, what is the maximum value of `med_inc` ?

```
event_berk %>% group_by(event_type, event_inst) %>%
  summarise(max_inc = max(med_inc))
#> # A tibble: 10 x 3
#>    event_type  event_inst max_inc
#>    <chr>       <chr>        <dbl>
#>  1 2yr college In-State        NA
#>  2 2yr college Out-State  153070.
#>  3 4yr college In-State        NA
#>  4 4yr college Out-State       NA
#>  5 other       In-State        NA
#>  6 other       Out-State       NA
#>  7 private hs  In-State    250001
#>  8 private hs  Out-State       NA
#>  9 public hs   In-State        NA
#> 10 public hs   Out-State  223556.

event_berk %>% group_by(event_type, event_inst) %>%
  summarise(max_inc = max(med_inc, na.rm = TRUE))
#> # A tibble: 10 x 3
#>    event_type  event_inst max_inc
```

`summarise()`: Other functions

Isolate first/last/nth observation in a group

```
x <- c(10,15,20,25,30)
first(x)
last(x)
nth(x,1)
nth(x,3)
nth(x,10)
```

Task: after sorting object `event_berk` by `event_type` and `event_datetime_start`, what is the value of `event_date` for:

first event for each event type?

the last event for each event type?

the 50th event for each event type?

```
event_berk %>% arrange(event_type, event_datetime_start) %>%
  group_by(event_type) %>%
  summarise(
    n_events = n(),
    date_first= first(event_date),
    date_last= last(event_date),
    date_50th= nth(event_date, 50)
  )
```

Student exercise

Identify value of `event_date` for the *nth* event in each by group

Specific task:

- arrange (i.e., sort) by `event_type` and `event_datetme_start`, then group by `event_type`, and then identify the value of `event_date` for:
  - the first event in each by group (`event_type`)
  - the second event in each by group
  - the third event in each by group
  - the fourth event in each by group
  - the fifth event in each by group

Student exercise solution

```
event_berk %>% arrange(event_type, event_datetime_start) %>%
  group_by(event_type) %>%
  summarise(
    n_events = n(),
    date_1st= first(event_date),
    date_2nd= nth(event_date,2),
    date_3rd= nth(event_date,3),
    date_4th= nth(event_date,4),
    date_5th= nth(event_date,5))
#> # A tibble: 5 x 7
#>   event_type n_events date_1st   date_2nd   date_3rd   date_4th
#>   <chr>         <int> <date>     <date>     <date>     <date>
#> 1 2yr colle~      112 2017-04-25 2017-09-05 2017-09-05 2017-09-06
#> 2 4yr colle~       18 2017-04-30 2017-05-01 2017-05-06 2017-09-13
#> 3 other           138 2017-04-11 2017-04-23 2017-04-25 2017-04-29
#> 4 private hs      169 2017-04-23 2017-04-24 2017-04-29 2017-04-30
#> 5 public hs       442 2017-04-14 2017-04-24 2017-04-26 2017-04-27
#> # ... with 1 more variable: date_5th <date>
```

3.4 Attach aggregate measures to your data frame

Attach aggregate measures to your data frame

We can attach aggregate measures to a data frame by using group_by without summarise()

What do I mean by "attaching aggregate measures to a data frame"?

- Calculate measures at the by_group level, but attach them to original object rather than creating an object with one row for each by_group

Task: Using `event_berk` data frame, create (1) a measure of average income across all events and (2) a measure of average income for each event type

- resulting object should have same number of observations as `event_berk`

Steps:

1. create measure of avg. income across all events without using `group_by()` or `summarise()` and assign as (new) object
2. Using object from previous step, create measure of avg. income across by event type using `group_by()` without `summarise()` and assign as new object

Attach aggregate measures to your data frame

Task: Using `event_berk` data frame, create (1) a measure of average income across all events and (2) a measure of average income for each event type

1. Create measure of average income across all events

```
event_berk_temp <- event_berk %>%
  arrange(event_date) %>% # sort by event_date (optional)
  select(event_date, event_type,med_inc) %>% # select vars to be retained (optio
  mutate(avg_inc = mean(med_inc, na.rm=TRUE)) # create avg. inc measure

dim(event_berk_temp)
event_berk_temp %>% head(5)
```

2. Create measure of average income by event type

```
event_berk_temp <- event_berk_temp %>%
  group_by(event_type) %>% # grouping by event type
  mutate(avg_inc_type = mean(med_inc, na.rm=TRUE)) # create avg. inc measure

str(event_berk_temp)
event_berk_temp %>% head(5)
```

Attach aggregate measures to your data frame

Task: Using `event_berk_temp` from previous question, create a measure that identifies whether `med_inc` associated with the event is higher/lower than average income for all events of that type

Steps:

1. Create measure of average income for each event type [already done]
2. Create 0/1 indicator that identifies whether median income at event location is higher than average median income for events of that type

```
# average income at recruiting events across all universities
event_berk_tempv2 <- event_berk_temp %>%
  mutate(gt_avg_inc_type = med_inc > avg_inc_type) %>%
  select(-(avg_inc)) # drop avg_inc (optional)
event_berk_tempv2 # note how med_ic = NA are treated
```

Same as above, but this time create integer indicator rather than logical

```
event_berk_tempv2 <- event_berk_tempv2 %>%
  mutate(gt_avg_inc_type = as.integer(med_inc > avg_inc_type))
event_berk_tempv2  %>% head(4)
```

Student exercise

Task: is `pct_white_zip` at a particular event higher or lower than the average pct_white_zip for that `event_type`?

- Note: all events attached to a particular zip_code
- `pct_white_zip`: pct of people in that zip_code who identify as white

Steps in task:

- Create measure of average pct white for each event_type
- Compare whether pct_white_zip is higher or lower than this average

Student exercise solution

Task: is `pct_white_zip` at a particular event higher or lower than the average pct_white_zip for that `event_type` ?

```
event_berk_tempv3 <- event_berk %>%
  arrange(event_date) %>% # sort by event_date (optional)
  select(event_date, event_type, pct_white_zip) %>% #optional
  group_by(event_type) %>% # grouping by event type
  mutate(avg_pct_white = mean(pct_white_zip, na.rm=TRUE),
         gt_avg_pctwhite_type = as.integer(pct_white_zip > avg_pct_white))
event_berk_tempv3 %>% head(4)
#> # A tibble: 4 x 5
#>   event_date event_type pct_white_zip avg_pct_white gt_avg_pctwhite_type
#>   <date>     <chr>              <dbl>         <dbl>                <int>
#> 1 2017-04-11 other               37.2          49.7                    0
#> 2 2017-04-14 public hs           78.3          48.9                    1
#> 3 2017-04-23 private hs          84.7          61.0                    1
#> 4 2017-04-23 other               20.9          49.7                    0
```