

Lecture 3: Pipes and creating variables using `mutate()`

EDUC 263: Managing and Manipulating Data Using R

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1 Introduction

What we will do today

1. Introduction

1.1 Finish lecture 2, filter and arrange (i.e., sort)

1.2 Data for lecture 3

2. Pipes

3. Creating variables using mutate

3.1 Introduce mutate() function

3.2 Using ifelse() function within mutate()

3.3 Using recode() function within mutate()

3.4 Using case_when() function within mutate()

3.5 Alternative approach to creating 0/1 indicators

Libraries we will use today

“Load” the package we will use today (output omitted)

- o **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

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

- o `install.packages("tidyverse")`
- o `library(tidyverse)`

1.1 Finish lecture 2, filter and arrange (i.e., sort)

Load data for lecture 2

Data on off-campus recruiting events by public universities

```
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_event.rda"))
#load dataset with one obs per high school
load(url("https://github.com/ozanj/rclass/raw/master/data/recruiting/recruit_school.rda"))
```

Object `df_event`

- Off-campus recruiting project; one obs per university, recruiting event

Object `df_school`

- Off-campus recruiting project; one obs per high school (visited and non-visited)

Work through lecture 2 slides on `filter()` and `arrange()`

1.2 Data for lecture 3

Lecture 3 data: prospects purchased by Western Washington U.

The “Student list” business

- Universities identify/target “prospects” by buying “student lists” from College Board/ACT (e.g., \$.40 per prospect)
- Prospect lists contain contact info (e.g., address, email), academic achievement, socioeconomic, demographic characteristics
- Universities choose which prospects to purchase by filtering on criteria like zip-code, GPA, test score range, etc.

```
#load prospect list data
```

```
load(url("https://github.com/ozanj/rclass/raw/master/data/prospect_list/wwlist_m
```

Object `wwlist`

- De-identified list of prospective students purchased by Western Washington University from College Board
- We collected these data using FOIA request
 - ASIDE: Become an expert on collecting data via FOIA requests and you will become a superstar!

Lecture 3 data: prospects purchased by Western Washington U.

Observations on `wwlist`

- each observation represents a prospective student

```
typeof(wwlist)
#> [1] "list"
dim(wwlist)
#> [1] 268396      31
```

Variables on `wwlist`

- some vars provide de-identified data on individual prospects
 - ▷ e.g., `psat_range`, `state`, `sex`, `ethn_code`
- some vars provide data about zip-code student lives in
 - ▷ e.g., `med_inc`, `pop_total`, `pop_black`
- some vars provide data about school student enrolled in
 - ▷ e.g., `fr_lunch` is number of students on free/reduced lunch
 - ▷ note: bad merge between prospect-level data and school-level data

```
names(wwlist)
str(wwlist)
```

2 Pipes

What are “pipes”, %>%

Pipes are a means of performing multiple steps in a single line of code

- Pipes are part of **tidyverse** suite of packages, not **base R**

- When writing code, the pipe symbol is `%>%`

- Basic flow of using pipes in code:

▶ `object %>% some_function %>% some_function, \ldots`

- Pipes work from left to right:

▶ The object/result from left of `%>%` pipe symbol is the input of function to the right of the `%>%` pipe symbol

▶ In turn, the resulting output becomes the input of the function to the right of the next `%>%` pipe symbol

Intuitive mnemonic device for understanding pipes

- whenever you see a pipe `%>%` think of the words “**and then...**”

- Example: `wwlist %>% filter(firstgen == "Y")`

▶ in words: start with object `wwlist` **and then** filter first generation students

Do task with and without pipes

Task:

- Using object `wwlist` print data for “first-generation” prospects
(`firstgen == "Y"`)

```
filter(wwlist, firstgen == "Y") # without pipes  
wwlist %>% filter(firstgen == "Y") # with pipes
```

Comparing the two approaches:

- In the “without pipes” approach, the object is the first argument `filter()` function
- In the “pipes” approach, you don’t specify the object as the first argument of `filter()`
 - Why? Because `%>%` “pipes” the object to the left of the `%>%` operator into the function to the right of the `%>%` operator

Main takeaway:

- When writing code using pipes, functions to right of `%>%` pipe operator should not explicitly name object that is the input to the function.
- Rather, object to the left of `%>%` pipe operator is automatically the input.

More intuition on the pipe operator, `%>%`

The pipe operator “pipes” (verb) an object from left of `%>%` operator into the function to the right of the `%>%` operator

Example:

```
str(wwlist) # without pipe
```

```
wwlist %>% str() # with pipe
```

Do task with and without pipes

Task: Using object `wwlist`, print data for “first-gen” prospects for selected variables [output omitted]

#Without pipes

```
select(filter(wwlist, firstgen == "Y"), state, hs_city, sex)
```

#With pipes

```
wwlist %>% filter(firstgen == "Y") %>% select(state, hs_city, sex)
```

Comparing the two approaches:

- In the “without pipes” approach, code is written “inside out”
 - ▷ The first step in the task – identifying the object – is the innermost part of code
 - ▷ The last step in task – selecting variables to print – is the outermost part of code
- In “pipes” approach the left-to-right order of code matches how we think about the task
 - ▷ First, we start with an object **and then** (`%>%`) we use `filter()` to isolate first-gen students **and then** (`%>%`) we select which variables to print

Note the object “piped” into `select()` from `filter()`

```
wwlist %>% filter(firstgen == "Y") %>% str()
```

Do task with and without pipes

Task:

- Count the number “first-generation” prospects from the state of Washington

Without pipes

```
count(filter(wwlist, firstgen == "Y", state == "WA"))  
#> # A tibble: 1 x 1  
#>       n  
#>   <int>  
#> 1 32428
```

With pipes

```
wwlist %>% filter(firstgen == "Y", state == "WA") %>% count()  
#> # A tibble: 1 x 1  
#>       n  
#>   <int>  
#> 1 32428
```

Do task with and without pipes

Task: Create frequency table of `school_type` for non first-gen prospects from WA

without pipes

```
wwlist_temp <- filter(wwlist, firstgen == "N", state == "WA")
table(wwlist_temp$school_type, useNA = "always")
#>
#> private   public    <NA>
#>      11   46146   12489
rm(wwlist_temp) # cuz we don't need after creating table
```

With pipes

```
wwlist %>% filter(firstgen == "N", state == "WA") %>% count(school_type)
#> # A tibble: 3 x 2
#>   school_type     n
#>   <chr>         <int>
#> 1 private         11
#> 2 public        46146
#> 3 <NA>          12489
```


Comparing the two approaches

Comparison of two approaches

- without pipes, task requires multiple lines of code; this is quite common
 - first line creates object; second line analyzes object
- with pipes, task can be completed in one line of code and you aren't left with objects you don't care about

Student exercises with pipes

1. Using object `wwlist` select the following variables (state, firstgen, ethn_code) and assign them to object `wwlist_temp`.
2. Using the object you just created `wwlist_temp`, create a frequency table of `ethn_code` for first-gen prospects from California.
3. **Bonus:** Try doing question 1 and 2 together. Use original object `wwlist`, but do not assign to a new object.

Once finished you can `rm(wwlist_temp)`

Solution to exercises with pipes

1. Using object `wwlist` select the following variables (state, firstgen, ethn_code) and assign them to object `wwlist_small`

```
wwlist_temp <- wwlist %>%  
  select(state, firstgen, ethn_code)
```

Solution to exercises with pipes

- Using the object you just created `wwlist_temp`, create a frequency table of `ethn_code` for first-gen prospects from California.

```
#names(wwlist)
wwlist_temp %>%
  filter(firstgen == "Y", state == "CA") %>% count(ethn_code)
#> # A tibble: 11 x 2
#>   ethn_code      n
#>   <fct>      <int>
#> 1 American Indian or Alaska Native      4
#> 2 Asian or Native Hawaiian or Other Pacific Islander    81
#> 3 Asian or Native Hawaiian or Other Pacific IslanderH    5
#> 4 Black or African American      10
#> 5 Cuban      1
#> 6 Mexican/Mexican American    643
#> 7 Not reported    113
#> 8 Other-2 or more    4197
#> 9 Other Spanish/Hispanic    179
#> 10 Puerto Rican      8
#> 11 White    2933
```

Solution to exercises with pipes

3. **Bonus:** Try doing question 1 and 2 together.

```
wwlist %>%  
  select(state, firstgen, ethn_code) %>%  
  filter(firstgen == "Y", state == "CA") %>%  
  count(ethn_code)  
#> # A tibble: 11 x 2  
#>   ethn_code      n  
#>   <fct>      <int>  
#> 1 American Indian or Alaska Native      4  
#> 2 Asian or Native Hawaiian or Other Pacific Islander    81  
#> 3 Asian or Native Hawaiian or Other Pacific IslanderH     5  
#> 4 Black or African American      10  
#> 5 Cuban      1  
#> 6 Mexican/Mexican American    643  
#> 7 Not reported    113  
#> 8 Other-2 or more   4197  
#> 9 Other Spanish/Hispanic    179  
#> 10 Puerto Rican      8  
#> 11 White    2933  
#rm(wwlist_temp)
```

```
rm(wwlist_temp)
```

3 Creating variables using mutate

Our plan for learning how to create new variables

Recall that `dplyr` package within `tidyverse` provide a set of functions that can be described as “verbs”: **subsetting**, **sorting**, and **transforming**

What we've done

Subsetting data

- `select()` variables
- `filter()` observations

Sorting data

- `arrange()`

Where we're going

Transforming data

- `mutate()` creates new variables
- `summarize()` calculates across rows
- `group_by()` to calculate across rows within groups

Today

- o we'll use `mutate()` to create new variables based on calculations across columns within a row

Next week

- o we'll combine `mutate()` with `summarize()` and `group_by()` to create variables based on calculations across rows

Create new data frame based on `df_school_all`

Data frame `df_school_all` has one obs per US high school and then variables identifying number of visits by particular universities

```
load(url("https://github.com/ozanj/rclass/raw/master/data/recruiting/recruit_school_all.csv"))
names(df_school_all)
```

```
#> [1] "state_code"      "school_type"      "necessch"
#> [4] "name"            "address"          "city"
#> [7] "zip_code"        "pct_white"        "pct_black"
#> [10] "pct_hispanic"    "pct_asian"        "pct_amerindian"
#> [13] "pct_other"       "num_fr_lunch"     "total_students"
#> [16] "num_took_math"   "num_prof_math"    "num_took_qla"
#> [19] "num_prof_qla"    "avgmedian_inc_2564" "latitude"
#> [22] "longitude"       "visits_by_196097" "visits_by_186380"
#> [25] "visits_by_215293" "visits_by_201885" "visits_by_181464"
#> [28] "visits_by_139959" "visits_by_218663" "visits_by_100751"
#> [31] "visits_by_199193" "visits_by_110635" "visits_by_110653"
#> [34] "visits_by_126614" "visits_by_155317" "visits_by_106397"
#> [37] "visits_by_149222" "visits_by_166629" "total_visits"
#> [40] "inst_196097"     "inst_186380"      "inst_215293"
#> [43] "inst_201885"     "inst_181464"      "inst_139959"
#> [46] "inst_218663"     "inst_100751"      "inst_199193"
#> [49] "inst_110635"     "inst_110653"      "inst_126614"
#> [52] "inst_155317"     "inst_106397"      "inst_149222"
#> [55] "inst_166629"
```


Create new data frame based on `df_school_all`

Let's create new version of this data frame, called `school_v2`, which we'll use to introduce how to create new variables

```
school_v2 <- df_school_all %>%  
  select(-contains("inst_")) %>% # remove vars that start with "inst_"  
  rename(  
    visits_by_berkeley = visits_by_110635,  
    visits_by_boulder = visits_by_126614,  
    visits_by_bama = visits_by_100751,  
    visits_by_stonybrook = visits_by_196097,  
    visits_by_rutgers = visits_by_186380,  
    visits_by_pitt = visits_by_215293,  
    visits_by_cinci = visits_by_201885,  
    visits_by_nebraska = visits_by_181464,  
    visits_by_georgia = visits_by_139959,  
    visits_by_scarolina = visits_by_218663,  
    visits_by_ncstate = visits_by_199193,  
    visits_by_irvine = visits_by_110653,  
    visits_by_kansas = visits_by_155317,  
    visits_by_arkansas = visits_by_106397,  
    visits_by_sillinois = visits_by_149222,  
    visits_by_umass = visits_by_166629,  
    num_took_read = num_took_rla,  
    num_prof_read = num_prof_rla,  
    med_inc = avgmedian_inc_2564)  
  
names(school_v2)
```

3.1 Introduce mutate() function

Introduce `mutate()` function

`mutate()` is **tidyverse** approach to creating variables (not **Base R** approach)

Description of `mutate()`

- `mutate()` creates new columns (variables) that are functions of existing columns
- After creating a new variable using `mutate()`, every row of data is retained
- `mutate()` works best with pipes `%>%`

Task:

- Using data frame `school_v2` create new variable that measures the pct of students on free/reduced lunch (output omitted)

```
school_sml <- school_v2 %>% # create new dataset with fewer vars; not necessary
  select(ncesssch, school_type, num_fr_lunch, total_students)
```

```
school_sml %>%
  mutate(pct_fr_lunch = num_fr_lunch/total_students) # create new var

rm(school_sml)
```

Syntax for `mutate()`

Let's spend a couple minutes looking at help file for `mutate()`

```
?mutate
```

Usage (i.e., syntax)

- `mutate(.data, ...)`

Arguments

- `.data` : a data frame
 - ▷ if using `mutate()` after pipe operator `%>%`, then this argument can be omitted
 - Why? Because data frame object to left of `%>%` "piped in" to first argument of `mutate()`
- `...` : expressions used to create new variables
 - ▷ Can create multiple variables at once

Value

- returns an object that contains the original input data frame and new variables that were created by `mutate()`

Useful functions (i.e., "helper functions")

- These are standalone functions can be called *within* `mutate()`
 - ▷ e.g., `if_else()`, `recode()`, `case_when()`
- will show examples of this in subsequent slides

Introduce `mutate()` function

New variable not retained unless we **assign** `<-` it to an object (existing or new)

`mutate()` **without assignment**

```
school_v2 %>% mutate(pct_fr_lunch = num_fr_lunch/total_students)  
  
names(school_v2)
```

`mutate()` **with assignment**

```
school_v2_temp <- school_v2 %>%  
  mutate(pct_fr_lunch = num_fr_lunch/total_students)  
  
names(school_v2_temp)  
rm(school_v2_temp)
```

Aside: Base R approach to creating new variables

Task:

- Create measure of percent of students on free-reduced lunch

dplyr/tidyverse approach

```
school_v2_temp <- school_v2 %>%  
  mutate(pct_fr_lunch = num_fr_lunch/total_students)
```

Base R approach

```
school_v2_temp <- school_v2 # create copy of dataset; not necessary  
  
school_v2_temp$pct_fr_lunch <- school_v2_temp$num_fr_lunch/school_v2_temp$total_  
  
names(school_v2_temp)  
rm(school_v2_temp)
```

Good to know both Base R and tidyverse approaches; sometimes you need to use one or the other

- But overwhelming to learn both approaches at once
- We'll focus mostly on learning tidyverse approaches
- But I'll try to work-in opportunities to learn Base R approach

`mutate()` can create multiple variables at once

`mutate()` can create multiple variables at once

```
school_v2 %>%  
  mutate(pct_fr_lunch = num_fr_lunch/total_students,  
         pct_prof_math= num_prof_math/num_took_math) %>%  
  select(num_fr_lunch, total_students, pct_fr_lunch,  
         num_prof_math, num_took_math, pct_prof_math)
```

Or we could write code this way:

```
school_v2 %>%  
  select(num_fr_lunch, total_students, num_prof_math, num_took_math) %>%  
  mutate(pct_fr_lunch = num_fr_lunch/total_students,  
         pct_prof_math= num_prof_math/num_took_math)
```

Student exercise using mutate()

1. Using the object `school_v2`, select the following variables (`num_prof_math`, `num_took_math`, `num_prof_read`, `num_took_read`) and create a measure of percent proficient in math `pct_prof_math` and percent proficient in reading `pct_prof_read`.
2. Now using the code for question 1, filter schools where at least 50% of students are proficient in math & reading.
3. If you have time, count the number of schools from question 2.

Solutions for exercise using mutate()

1. Using the object `school_v2`, select the following variables (`num_prof_math`, `num_took_math`, `num_prof_read`, `num_took_read`) and create a measure of percent proficient in math and percent proficient in reading.

```
school_v2 %>%  
  select(num_prof_math, num_took_math, num_prof_read, num_took_read) %>%  
  mutate(pct_prof_math = num_prof_math/num_took_math,  
         pct_prof_read = num_prof_read/num_took_read)  
#> # A tibble: 21,301 x 6  
#>   num_prof_math num_took_math num_prof_read num_took_read pct_prof_math  
#>   <dbl>         <dbl>         <dbl>         <dbl>         <dbl>  
#> 1      24.8           146           25.0           147           0.17  
#> 2       1.7            17            1.7            17           0.10  
#> 3       3.5            14            3.5            14           0.25  
#> 4       3             30            3              30           0.1  
#> 5       2.8           28            2.8           28           0.10  
#> 6       2.5           25            2.4           24           0.1  
#> 7       1.55          62            1.55          62           0.025  
#> 8       2.1           21            2.2           22           0.1  
#> 9       2.3           23            2.3           23           0.10  
#> 10      1.9           19            1.9           19           0.10  
#> # ... with 21,291 more rows, and 1 more variable: pct_prof_read <dbl>
```

Solutions for exercise using mutate()

- Now using the code for question 1, filter schools where at least 50% of students are proficient in math & reading.

```
school_v2 %>%
  select(num_prof_math, num_took_math, num_prof_read, num_took_read) %>%
  mutate(pct_prof_math = num_prof_math/num_took_math,
         pct_prof_read = num_prof_read/num_took_read) %>%
  filter(pct_prof_math >= 0.5 & pct_prof_read >= 0.5)
#> # A tibble: 7,760 x 6
#>   num_prof_math num_took_math num_prof_read num_took_read pct_prof_math
#>   <dbl>         <dbl>         <dbl>         <dbl>         <dbl>
#> 1      135.         260         149.         261         0.520
#> 2      299.         475         418         475         0.63
#> 3      213.         410         332.         410         0.52
#> 4       54.6         105          96.6         105         0.52
#> 5      111.         121         118.         121         0.92
#> 6     1057.        1994        1477.        2204         0.530
#> 7      100.         103         125.         128         0.975
#> 8       56.4          99         84.4         148         0.570
#> 9      445.         586         392.         594         0.76
#> 10      56.0          59         53.1          61         0.95
#> # ... with 7,750 more rows, and 1 more variable: pct_prof_read <dbl>
```

Solutions for exercise using mutate()

3. If you have time, count the number of schools from question 2.

```
school_v2 %>%  
  select(num_prof_math, num_took_math, num_prof_read, num_took_read) %>%  
  mutate(pct_prof_math = num_prof_math/num_took_math,  
         pct_prof_read = num_prof_read/num_took_read) %>%  
  filter(pct_prof_math >= 0.5 & pct_prof_read >= 0.5) %>%  
  count()  
#> # A tibble: 1 x 1  
#>       n  
#>   <int>  
#> 1  7760
```

3.2 Using ifelse() function within mutate()

Using `ifelse()` function within `mutate()`

`?if_else`

Description

- if `condition` `TRUE`, assign a value; if `condition` `FALSE` assign a value

Usage (i.e., syntax)

- `if_else(logical condition, true, false, missing = NULL)`

Arguments

- `logical condition`: a condition that evaluates to `TRUE` or `FALSE`
- `true`: value to assign if condition `TRUE`
- `false`: value to assign if condition `FALSE`

Value

- “Where condition is `TRUE`, the matching value from `true`, where it's `FALSE`, the matching value from `false`, otherwise `NA`.”
- missing values from “input” var are assigned missing values in “output var”, unless you specify otherwise

Example: Create 0/1 indicator of whether high school got at least one visit from Berkeley

```
school_v2 %>%  
  mutate(got_visit_berkeley = ifelse(visits_by_berkeley>0,1,0)) %>%  
  count(got_visit_berkeley)
```

Using `ifelse()` function within `mutate()`

Task

- Create 0/1 indicator if school has median income greater than \$100,000

Usually a good idea to investigate “input” variables before creating analysis vars

```
school_v2 %>% count(med_inc) # this isn't very helpful

school_v2 %>% filter(is.na(med_inc)) %>% count(med_inc)
# shows number of obs w/ missing med_inc
```

Create variable

```
school_v2 %>% select(med_inc) %>%
  mutate(inc_gt_100k= ifelse(med_inc>100000,1,0)) %>%
  count(inc_gt_100k) # note how NA values of med_inc treated
#> # A tibble: 3 x 2
#>   inc_gt_100k      n
#>   <dbl> <int>
#> 1         0 18632
#> 2         1  2045
#> 3        NA   624
```

Using `ifelse()` function within `mutate()`

Task

- Create 0/1 indicator variable `nonmiss_math` which indicates whether school has non-missing values for the variable `num_took_math`
 - ▷ note: `num_took_math` refers to number of students at school that took state math proficiency test

Usually a good to investigate “input” variables before creating analysis vars

```
school_v2 %>% count(num_took_math) # this isn't very helpful
school_v2 %>% filter(is.na(num_took_math)) %>% count(num_took_math) # shows number of schools with missing values
```

Create variable

```
school_v2 %>% select(num_took_math) %>%
  mutate(nonmiss_math= ifelse(!is.na(num_took_math),1,0)) %>%
  count(nonmiss_math) # note how NA values treated
#> # A tibble: 2 x 2
#>   nonmiss_math      n
#>   <dbl> <int>
#> 1         0  4103
#> 2         1 17198
```

Student exercises `ifelse()`

1. Using the object `school_v2`, create 0/1 indicator variable `in_state_berkeley` that equals `1` if the high school is in the same state as UC Berkeley (i.e., `state_code=="CA"`).
2. Create 0/1 indicator `berkeley_and_irvine` of whether a school got at least one visit from UC Berkeley **AND** from UC Irvine.
3. Create 0/1 indicator `berkeley_or_irvine` of whether a school got at least one visit from UC Berkeley **OR** from UC Irvine.

Exercise `ifelse()` solutions

1. Using the object `school_v2`, create 0/1 indicator variable `in_state_berkeley` that equals 1 if the high school is in the same state as UC Berkeley (i.e., `state_code=="CA"`).

```
school_v2 %>% mutate(in_state_berkeley=ifelse(state_code=="CA",1,0)) %>%  
  count(in_state_berkeley)
```

Exercise `ifelse()` solutions

2. Create 0/1 indicator `berkeley_and_irvine` of whether a school got at least one visit from UC Berkeley **AND** from UC Irvine.

```
school_v2 %>%  
  mutate(berkeley_and_irvine=ifelse(visits_by_berkeley>0 & visits_by_irvine>0,1,  
    count(berkeley_and_irvine)
```

Exercise `ifelse()` solutions

3. Create 0/1 indicator `berkeley_or_irvine` of whether a school got at least one visit from UC Berkeley **OR** from UC Irvine.

```
school_v2 %>%  
  mutate(berkeley_or_irvine=ifelse(visits_by_berkeley>0 | visits_by_irvine>0,1,0)  
  count(berkeley_or_irvine)
```

3.3 Using recode() function within mutate()

Using `recode()` function within `mutate()`

Description: Recode values of a variable

Usage (i.e., syntax)

- `recode(x, ..., .default = NULL, .missing = NULL)`

Arguments [see help file for further details]

- `.x` A vector (e.g., variable) to modify
- `...` Specifications for recode, of the form
`current_value = new recoded value`
- `.default` : If supplied, all values not otherwise matched given this value.
- `.missing` : If supplied, any missing values in `.x` replaced by this value.

Example: Using data frame `wwlist`, create new 0/1 indicator `public_school` from variable `school_type`

```
str(wwlist$school_type)
wwlist %>% count(school_type)

wwlist_temp <- wwlist %>% select(school_type) %>%
  mutate(public_school = recode(school_type, "public" = 1, "private" = 0))

wwlist_temp %>% head(n=10)
str(wwlist_temp$public_school)
wwlist_temp %>% count(public_school)
rm(wwlist_temp)
```

Using `recode()` function within `mutate()`

Recoding `school_type` could have been accomplished using `if_else()`

- Use `recode()` when new variable has more than two categories

Task: Create `school_catv2` based on `school_category` with these categories:

- "regular"; "alternative"; "special"; "vocational"

Investigate input var

```
str(wwlist$school_category)
wwlist %>% count(school_category)
```

Recode

```
wwlist_temp <- wwlist %>% select(school_category) %>%
  mutate(school_catv2 = recode(school_category,
    "Alternative Education School" = "alternative",
    "Alternative/other" = "alternative",
    "Regular elementary or secondary" = "regular",
    "Regular School" = "regular",
    "Special Education School" = "special",
    "Special program emphasis" = "special",
    "Vocational Education School" = "vocational")
  )
str(wwlist_temp$school_catv2)
wwlist_temp %>% count(school_catv2)
wwlist %>% count(school_category)
```

Using `recode()` within `mutate()` [do in pairs/groups]

Task: Create `school_catv2` based on `school_category` with these categories:

- “regular”; “alternative”; “special”; “vocational”
- This time use the `.missing` argument to recode `NA`s to “unknown”

```
wwlist_temp <- wwlist %>% select(school_category) %>%  
  mutate(school_catv2 = recode(school_category,  
    "Alternative Education School" = "alternative",  
    "Alternative/other" = "alternative",  
    "Regular elementary or secondary" = "regular",  
    "Regular School" = "regular",  
    "Special Education School" = "special",  
    "Special program emphasis" = "special",  
    "Vocational Education School" = "vocational",  
    .missing = "unknown")  
  )  
str(wwlist_temp$school_catv2)  
wwlist_temp %>% count(school_catv2)  
wwlist %>% count(school_category)  
rm(wwlist_temp)
```

Using `recode()` within `mutate()` [do in pairs/groups]

Task: Create `school_catv2` based on `school_category` with these categories:

- “regular”; “alternative”; “special”; “vocational”
- This time use the `.default` argument to assign the value “regular”

```
wwlist_temp <- wwlist %>% select(school_category) %>%  
  mutate(school_catv2 = recode(school_category,  
    "Alternative Education School" = "alternative",  
    "Alternative/other" = "alternative",  
    "Special Education School" = "special",  
    "Special program emphasis" = "special",  
    "Vocational Education School" = "vocational",  
    .default = "regular")  
  )  
str(wwlist_temp$school_catv2)  
wwlist_temp %>% count(school_catv2)  
wwlist %>% count(school_category)  
rm(wwlist_temp)
```


Using `recode()` within `mutate()` [do in pairs/groups]

Task: Create `school_catv2` based on `school_category` with these categories:

- This time create a numeric variable rather than character:
 - ▷ 1 for "regular"; 2 for "alternative"; 3 for "special"; 4 for "vocational"

```
wwlist_temp <- wwlist %>% select(school_category) %>%  
  mutate(school_catv2 = recode(school_category,  
    "Alternative Education School" = 2,  
    "Alternative/other" = 2,  
    "Regular elementary or secondary" = 1,  
    "Regular School" = 1,  
    "Special Education School" = 3,  
    "Special program emphasis" = 3,  
    "Vocational Education School" = 4)  
  )  
str(wwlist_temp$school_catv2)  
wwlist_temp %>% count(school_catv2)  
wwlist %>% count(school_category)  
rm(wwlist_temp)
```

Student exercise using `recode()` within `mutate()`

1. Using object `df_event`, create `event_typev2` based on `event_type` with these categories:
 - o 1 for "2yr college"; 2 for "4yr college"; 3 for "other"; 4 for "private hs"; 5 for "public hs"
 - o Assign new object `df_event_temp`
2. This time use the `.default` argument to assign the value 5 for "public hs"

Exercise using `recode()` within `mutate()` solutions

```
#load(url("https://github.com/ozanj/rclass/raw/master/data/recruiting/recruit_ev
#names(df_event)
str(df_event$event_type)
#> chr [1:18680] "public hs" "public hs" "public hs" "public hs" ...
df_event %>% count(event_type)
#> # A tibble: 5 x 2
#>   event_type      n
#>   <chr>        <int>
#> 1 2yr college   951
#> 2 4yr college   531
#> 3 other       2001
#> 4 private hs   3774
#> 5 public hs   11423
```

1. Using object `df_event`, create `event_typev2` based on `event_type` with these categories:
 - o 1 for "2yr college"; 2 for "4yr college"; 3 for "other"; 4 for "private hs"; 5 for "public hs"Assign new object `df_event_temp`

```
df_event_temp <- df_event %>%
  select(event_type) %>%
  mutate(event_typev2 = recode(event_type,
                                "2yr college" = 1,
                                "4yr college" = 2,
                                "other" = 3,
```

Exercise using `recode()` within `mutate()` solutions

2. This time use the `.default` argument to assign the value `5` for "public hs"

```
df_event %>% select(event_type) %>%  
  mutate(event_typev2 = recode(event_type,  
    "2yr college" = 1,  
    "4yr college" = 2,  
    "other" = 3,  
    "private hs" = 4,  
    .default = 5)  
)
```

```
#> # A tibble: 18,680 x 2  
#>   event_type event_typev2  
#>   <chr>      <dbl>  
#> 1 public hs      5  
#> 2 public hs      5  
#> 3 public hs      5  
#> 4 public hs      5  
#> 5 public hs      5  
#> 6 private hs      4  
#> 7 private hs      4  
#> 8 public hs      5  
#> 9 private hs      4  
#> 10 public hs      5  
#> # ... with 18,670 more rows  
str(df_event_temp$event_typev2)  
#> num [1:18680] 5 5 5 5 5 4 4 5 4 5 ...  
df_event_temp %>% count(event_typev2)
```

3.4 Using `case_when()` function within `mutate()`

Using `case_when()` function within `mutate()`

Description Useful when the variable you want to create is more complicated than variables that can be created using `ifelse()` or `recode()`

- For example, useful when new variable is a function of multiple “input” variables

Usage (i.e., syntax): `case_when(...)`

Arguments [from help file; see help file for more details]

- `...`: A sequence of two-sided formulas.
 - ▷ The left hand side (LHS) determines which values match this case.
 - LHS must evaluate to a logical vector.
 - ▷ The right hand side (RHS) provides the replacement value.

Example task: Using data frame `wwlist` and input vars `state` and `firstgen`, create a 4-category var with following categories:

- “instate_firstgen”; “instate_nonfirstgen”; “outstate_firstgen”; “outstate_nonfirstgen”

```
wwlist_temp <- wwlist %>% select(state,firstgen) %>%  
  mutate(state_gen = case_when(  
    state == "WA" & firstgen == "Y" ~ "instate_firstgen",  
    state == "WA" & firstgen == "N" ~ "instate_nonfirstgen",  
    state != "WA" & firstgen == "Y" ~ "outstate_firstgen",  
    state != "WA" & firstgen == "N" ~ "outstate_nonfirstgen")  
  )  
str(wwlist_temp$state_gen)
```

Using `case_when()` function within `mutate()`

Task: Using data frame `wwlist` and input vars `state` and `firstgen`, create a 4-category var with following categories:

- "instate_firstgen"; "instate_nonfirstgen"; "outstate_firstgen"; "outstate_nonfirstgen"

Let's take a closer look at how values of inputs are coded into values of outputs

```
wwlist %>% select(state,firstgen) %>% str()
count(wwlist,state)
count(wwlist,firstgen)

wwlist_temp <- wwlist %>% select(state,firstgen) %>%
  mutate(state_gen = case_when(
    state == "WA" & firstgen == "Y" ~ "instate_firstgen",
    state == "WA" & firstgen == "N" ~ "instate_nonfirstgen",
    state != "WA" & firstgen == "Y" ~ "outstate_firstgen",
    state != "WA" & firstgen == "N" ~ "outstate_nonfirstgen")
  )

wwlist_temp %>% count(state_gen)
wwlist_temp %>% filter(is.na(state)) %>% count(state_gen)
wwlist_temp %>% filter(is.na(firstgen)) %>% count(state_gen)
```

Student exercise using `case_when()` within `mutate()`

1. Using the object `school_v2` and input vars `school_type`, and `state_code`, create a 4-category var with following categories:
 - o "instate_public"; "instate_private"; "outstate_public"; "outstate_private"

Exercise using `case_when()` within `mutate()` solution

Investigate

```
school_v2 %>% select(state_code,school_type) %>% str()
#> Classes 'tbl_df', 'tbl' and 'data.frame': 21301 obs. of 2 variables:
#> $ state_code : chr "AK" "AK" "AK" "AK" ...
#> $ school_type: chr "public" "public" "public" "public" ...
count(school_v2,state_code)
#> # A tibble: 51 x 2
#>   state_code     n
#>   <chr>         <int>
#> 1 AK             84
#> 2 AL            440
#> 3 AR            266
#> 4 AZ            455
#> 5 CA           1770
#> 6 CO            350
#> 7 CT            252
#> 8 DC             46
#> 9 DE             51
#> 10 FL           792
#> # ... with 41 more rows
count(school_v2,school_type)
#> # A tibble: 2 x 2
#>   school_type     n
#>   <chr>         <int>
#> 1 private      3822
#> 2 public      17479
```

Exercise using `case_when()` within `mutate()` solution

1. Using the object `school_v2` and input vars `school_type`, and `state_code`, create a 4-category var with following categories:
 - o "instate_public"; "instate_private"; "outstate_public"; "outstate_private"

```
school_v2_temp <- school_v2 %>% select(state_code, school_type) %>%  
  mutate(state_type = case_when(  
    state_code == "CA" & school_type == "public" ~ "instate_public",  
    state_code == "CA" & school_type == "private" ~ "instate_private",  
    state_code != "CA" & school_type == "public" ~ "outstate_public",  
    state_code != "CA" & school_type == "private" ~ "outstate_private")  
  )
```

```
school_v2_temp %>% count(state_type)
```

```
#> # A tibble: 4 x 2
```

```
#>   state_type      n
```

```
#>   <chr>      <int>
```

```
#> 1 instate_private    366
```

```
#> 2 instate_public    1404
```

```
#> 3 outstate_private  3456
```

```
#> 4 outstate_public  16075
```

```
#school_v2_temp %>% filter(is.na(state_code)) %>% count(state_type) #no missing
```

```
#school_v2_temp %>% filter(is.na(school_type)) %>% count(state_type) #no missing
```

Mutate to create indicator variables

We often create dichotomous (0/1) indicator variables of whether something happened (or whether something is TRUE)

- Variables that are of substantive interest to project
 - e.g., did student graduate from college
- Variables that help you investigate data, check quality
 - e.g., indicator of whether an observation is missing/non-missing for a particular variable

Let's conduct some investigations of `df_school`, which has one observation for each high school

Creating indicators for `df_schoolv2` data frame

Create TRUE/FALSE indicator that median household income greater than \$50,000

```
school_v2_temp <- school_v2 %>% mutate(incgt50k = med_inc>50000)
```

```
school_v2_temp %>% select(med_inc, incgt50k) %>% head(n=3)
```

```
#> # A tibble: 3 x 2
```

```
#>   med_inc incgt50k
```

```
#>   <dbl> <lgl>
```

```
#> 1   76160 TRUE
```

```
#> 2   76160 TRUE
```

```
#> 3      NA NA
```

```
school_v2_temp %>% filter(is.na(med_inc)) %>% count(incgt50k)
```

```
#> # A tibble: 1 x 2
```

```
#>   incgt50k      n
```

```
#>   <lgl>    <int>
```

```
#> 1 NA        624
```

Important takeaway:

- Variable created by `mutate()` equals `NA` for obs if input variable to `mutate()` is missing for that obs. This is a good thing!

3.5 Alternative approach to creating 0/1 indicators

Creating indicators for school_v2 data frame

PATRICIA - I WROTE THESE BELOW SLIDES IN SUMMER BEFORE I KNEW ABOUT `ifelse()` ; YOU MAKE A RECOMMENDATION TO ME ABOUT WHETHER THESE SLIDES SHOULD BE CUT Create TRUE/FALSE indicator that school is less than 50 percent white

```
school_v2_temp <- school_v2 %>% mutate(lt50pctwhite = pct_white<50)
school_v2_temp %>% select(pct_white,lt50pctwhite) %>% head(n=3)
#> # A tibble: 3 x 2
#>   pct_white lt50pctwhite
#>   <dbl>    <lgl>
#> 1    11.8    TRUE
#> 2     0     TRUE
#> 3     0     TRUE
str(school_v2_temp$lt50pctwhite)
#> logi [1:21301] TRUE TRUE TRUE TRUE TRUE TRUE TRUE ...
```

Create 0/1 integer indicator rather than logical indicator

```
df_schoolv2_temp <- school_v2 %>% mutate(lt50pctwhite = as.integer(pct_white<50))
df_schoolv2_temp %>% select(pct_white,lt50pctwhite) %>% head(n=3)
#> # A tibble: 3 x 2
#>   pct_white lt50pctwhite
#>   <dbl>    <int>
#> 1    11.8         1
#> 2     0         1
#> 3     0         1
str(df_schoolv2_temp$lt50pctwhite)
```

Student exercises

0/1 indicators of whether school received visit from each university

```
school_v2 %>% count(visits_by_berkeley)
```

```
#> # A tibble: 4 x 2
```

```
#>   visits_by_berkeley      n
```

```
#>           <int> <int>
```

```
#> 1             0 20732
```

```
#> 2             1   528
```

```
#> 3             2    36
```

```
#> 4             3     5
```

```
school_v2_temp <- school_v2 %>% mutate(yesvis_berkeley = visits_by_berkeley>0)
```

```
school_v2_temp %>% filter(visits_by_berkeley>0) %>% select(visits_by_berkeley,vi
```

```
#> # A tibble: 569 x 1
```

```
#>   visits_by_berkeley
```

```
#>           <int>
```

```
#> 1                 2
```

```
#> 2                 2
```

```
#> 3                 2
```

```
#> 4                 1
```

```
#> 5                 1
```

```
#> 6                 1
```

```
#> 7                 1
```

```
#> 8                 1
```

```
#> 9                 1
```

```
#> 10                1
```

```
#> # ... with 559 more rows
```