Project 1

Zach Ginder and Makenna Meyer

```
#Load in libraries
library(tidyverse)
```

Data Reading

First, we read in the CSV file. This file contains comma delimited information from the census about education and enrollment in the US.

```
#Reading in comma delimited data
census_2010 <- read_csv("https://www4.stat.ncsu.edu/~online/datasets/EDU01a.csv")
```

Data Processing, with and without Functions

Question 1: Column Selection and Renaming

The first step of data processing is selecting the necessary variables. For this project, we are selecting the variables corresponding to area name, STCOU, and any column ending in "D". We also rename the area name variable.

```
#Without function
selected_columns <- census_2010 |>
  select(Area_name, STCOU, ends_with("D")) |> #Selecting area name, STCOU, and all columns en
  rename(area_name = Area_name) #Renaming Area_name
head(selected_columns, n = 5L) #Returning first 5 rows
```

```
# A tibble: 5 x 12
  area_name     STCOU EDU010187D EDU010188D EDU010189D EDU010190D EDU010191D
  <chr>         <chr>      <dbl>      <dbl>      <dbl>      <dbl>      <dbl>
```

```
1 UNITED STATES 00000   40024299   39967624   40317775   40737600   41385442
2 ALABAMA       01000     733735     728234     730048     728252     725541
3 Autauga, AL   01001       6829       6900       6920       6847       7008
4 Baldwin, AL   01003      16417      16465      16799      17054      17479
5 Barbour, AL   01005       5071       5098       5068       5156       5173
# i 5 more variables: EDU010192D <dbl>, EDU010193D <dbl>, EDU010194D <dbl>,
#   EDU010195D <dbl>, EDU010196D <dbl>
```

Question 2: Long Format Conversion

The next step of data processing is converting the data file to the proper form. In this case, instead of a wide tibble, we want a long tibble where each row is an enrollment value corresponding to a particular census survey and area.

```
#Without function
long_format <- selected_columns |>
  #taking the columns ending in D (corresponding to different census surveys)
  #and creating individual rows for each
  pivot_longer(cols = ends_with("D"), names_to = "surveys")
head(long_format, n = 5L) #Returning first 5 rows of the new tibble
```

```
# A tibble: 5 x 4
  area_name     STCOU surveys       value
  <chr>         <chr> <chr>         <dbl>
1 UNITED STATES 00000 EDU010187D 40024299
2 UNITED STATES 00000 EDU010188D 39967624
3 UNITED STATES 00000 EDU010189D 40317775
4 UNITED STATES 00000 EDU010190D 40737600
5 UNITED STATES 00000 EDU010191D 41385442
```

We can also create a function that performs both the column selection and renaming steps from question one, and performs the wide to long tibble conversion from step two. This function could be used on other tibbles, thereby making additional data cleaning easier.

```
#With function
#Function that does question 1 and 2
#Convert the tibble into long format
long_conversion <-function(tibble, value = "values for enrollment") {
  long_format <- tibble |>
    #Selecting appropriate columns
    select(Area_name, STCOU, ends_with("D")) |>
    #Renaming area name
    rename(area_name = Area_name) |>
    #taking the columns ending in D (corresponding to different census surveys)
    #and creating individual rows for each
    pivot_longer(cols = ends_with("D"), names_to = "surveys")
  return(long_format)
}
```

Question 3: Create Year and Measurement Columns

```
#Without function
#Parse the Survey column to create measurement and year columns
long_updated <- long_format |>
  #Pulling year from the 8th and 9th characters of the surveys column
  mutate(years = as.numeric(substr(surveys, 8, 9))) |>
  #Converting year into a 4 digit year
  mutate(years = ifelse(years <= 25 & years >= 0, years + 2000, years + 1900)) |>
  #Pulling the measurement name from the 1st through 7th character of the surveys column
  mutate(measurements = substr(surveys, 1, 7))
head(long_updated, n = 5L)
```

```
# A tibble: 5 x 6
  area_name     STCOU surveys       value years measurements
  <chr>         <chr> <chr>         <dbl> <dbl> <chr>
1 UNITED STATES 00000 EDU010187D 40024299  1987 EDU0101
2 UNITED STATES 00000 EDU010188D 39967624  1988 EDU0101
3 UNITED STATES 00000 EDU010189D 40317775  1989 EDU0101
4 UNITED STATES 00000 EDU010190D 40737600  1990 EDU0101
5 UNITED STATES 00000 EDU010191D 41385442  1991 EDU0101
```

```
#Function that does question 3
surveys_year_measurements <- function(long_format) {
  long_updated <- long_format |>
  #Pulling year from the 8th and 9th characters of the surveys column
  mutate(years = as.numeric(substr(surveys, 8, 9))) |>
  #Converting year into a 4 digit year
  mutate(years = ifelse(years <= 25 & years >= 0, years + 2000, years + 1900)) |>
  #Pulling the measurement name from the 1st through 7th character of the surveys column
  mutate(measurements = substr(surveys, 1, 7))
  return(long_updated)
}
```

Question 4: Creating County and State Tibbles

```
#Without function
#Finding the indices corresponding to the counties
indices <- grep(pattern = ", \\w\\w", long_updated$area_name)

#Creating a county tibble that contains the county indices
county_tibble <- long_updated[indices,]
#Adding "county" as a class to the county tibble
class(county_tibble) <- c("county", class(county_tibble))

#Creating a state tibble that does not contain the county indices
state_tibble <- long_updated[-c(indices),]
#Adding "state" as a class to the state tibble
class(state_tibble) <- c("state", class(state_tibble))

#Displaying 10 rows of each tibble
head(county_tibble, n=10L)
```

```
# A tibble: 10 x 6
   area_name   STCOU surveys    value years measurements
   <chr>       <chr> <chr>      <dbl> <dbl> <chr>
 1 Autauga, AL 01001 EDU010187D  6829  1987 EDU0101
 2 Autauga, AL 01001 EDU010188D  6900  1988 EDU0101
 3 Autauga, AL 01001 EDU010189D  6920  1989 EDU0101
 4 Autauga, AL 01001 EDU010190D  6847  1990 EDU0101
 5 Autauga, AL 01001 EDU010191D  7008  1991 EDU0101
 6 Autauga, AL 01001 EDU010192D  7137  1992 EDU0101
 7 Autauga, AL 01001 EDU010193D  7152  1993 EDU0101
 8 Autauga, AL 01001 EDU010194D  7381  1994 EDU0101
 9 Autauga, AL 01001 EDU010195D  7568  1995 EDU0101
10 Autauga, AL 01001 EDU010196D  7834  1996 EDU0101
```

```
head(state_tibble, n=10L)
```

```
# A tibble: 10 x 6
```

```
   area_name     STCOU surveys       value years measurements
   <chr>         <chr> <chr>         <dbl> <dbl> <chr>
 1 UNITED STATES 00000 EDU010187D 40024299  1987 EDU0101
 2 UNITED STATES 00000 EDU010188D 39967624  1988 EDU0101
 3 UNITED STATES 00000 EDU010189D 40317775  1989 EDU0101
 4 UNITED STATES 00000 EDU010190D 40737600  1990 EDU0101
 5 UNITED STATES 00000 EDU010191D 41385442  1991 EDU0101
 6 UNITED STATES 00000 EDU010192D 42088151  1992 EDU0101
 7 UNITED STATES 00000 EDU010193D 42724710  1993 EDU0101
 8 UNITED STATES 00000 EDU010194D 43369917  1994 EDU0101
 9 UNITED STATES 00000 EDU010195D 43993459  1995 EDU0101
10 UNITED STATES 00000 EDU010196D 44715737  1996 EDU0101
```

Question 5: Creating State Variable for County Tibble

```r
#Without function
county_q5 <- county_tibble |>
  mutate(state = substr(area_name, (nchar(area_name) - 1), nchar(area_name)))
```

```r
#With function
#Function to perform step 5
adding_state_to_county <- function(county_tibble){
  county_w_state <- county_tibble |>
    mutate(state = substr(area_name, (nchar(area_name) - 1), nchar(area_name)))
  return(county_w_state)
}
```

Question 6: Creating Division Variable for Non-County Tibble

```r
#Without function
non_county_q6 <- state_tibble |>
  mutate(division =
           case_when(area_name %in% c("CONNECTICUT", "MAINE", "MASSACHUSETTS",
                                      "NEW HAMPSHIRE","RHODE ISLAND", "VERMONT")
                     ~ "New England",
                     area_name %in% c("NEW JERSEY", "NEW YORK", "PENNSYLVANIA")
                     ~ "Mid-Atlantic",
                     area_name %in% c("ILLINOIS", "INDIANA", "MICHIGAN", "OHIO",
                                      "WISCONSIN") ~ "East North Central",
                     area_name %in% c("IOWA", "KANSAS", "MINNESOTA", "MISSOURI",
                                      "NEBRASKA", "NORTH DAKOTA", "SOUTH DAKOTA")
                     ~ "West North Central",
                     area_name %in% c("DELAWARE", "District of Columbia",
                                      "DISTRICT OF COLUMBIA", "FLORIDA", "GEORGIA",
                                      "MARYLAND", "NORTH CAROLINA", "SOUTH CAROLINA",
                                      "VIRGINIA", "WEST VIRGINIA") ~ "South Atlantic",
                     area_name %in% c("KENTUCKY", "TENNESSEE", "MISSISSIPPI", "ALABAMA")
                     ~ "East South Central",
                     area_name %in% c("ARKANSAS", "LOUISIANA", "OKLAHOMA", "TEXAS")
                     ~ "West South Central",
                     area_name %in% c("ARIZONA", "COLORADO", "IDAHO", "MONTANA", "NEVADA",
                                      "NEW MEXICO", "UTAH", "WYOMING") ~ "Mountain",
                     area_name %in% c("ALASKA", "CALIFORNIA", "HAWAII", "OREGON",
                                      "WASHINGTON") ~ "Pacific",
                     TRUE ~ "ERROR"))
```

```
#With function

#Function to perform step 6
adding_division_to_noncounty <- function(state_tibble){
  noncounty_w_division <- state_tibble |>
    mutate(division =
             case_when(area_name %in% c("CONNECTICUT", "MAINE", "MASSACHUSETTS",
                                      "NEW HAMPSHIRE","RHODE ISLAND", "VERMONT")
                     ~ "New England",
                     area_name %in% c("NEW JERSEY", "NEW YORK", "PENNSYLVANIA")
                     ~ "Mid-Atlantic",
                     area_name %in% c("ILLINOIS", "INDIANA", "MICHIGAN", "OHIO",
                                      "WISCONSIN") ~ "East North Central",
                     area_name %in% c("IOWA", "KANSAS", "MINNESOTA", "MISSOURI",
                                      "NEBRASKA", "NORTH DAKOTA", "SOUTH DAKOTA")
                     ~ "West North Central",
                     area_name %in% c("DELAWARE", "District of Columbia",
                                      "DISTRICT OF COLUMBIA", "FLORIDA", "GEORGIA",
                                      "MARYLAND", "NORTH CAROLINA", "SOUTH CAROLINA",
                                      "VIRGINIA", "WEST VIRGINIA") ~ "South Atlantic",
                     area_name %in% c("KENTUCKY", "TENNESSEE", "MISSISSIPPI", "ALABAMA")
                     ~ "East South Central",
                     area_name %in% c("ARKANSAS", "LOUISIANA", "OKLAHOMA", "TEXAS")
                     ~ "West South Central",
                     area_name %in% c("ARIZONA", "COLORADO", "IDAHO", "MONTANA", "NEVADA",
                                      "NEW MEXICO", "UTAH", "WYOMING") ~ "Mountain",
                     area_name %in% c("ALASKA", "CALIFORNIA", "HAWAII", "OREGON",
                                      "WASHINGTON") ~ "Pacific",
                     TRUE ~ "ERROR"))
  return(noncounty_w_division)
}
```

```
#Writing function that uses Step 3 output and performs Steps 4, 5, and 6

creating2tibbles_addingstateordivision <- function(long_updated){
  indices <- grep(pattern = ", \\w\\w", long_updated$area_name)
  county_tibble <- long_updated[indices,]
  class(county_tibble) <- c("county", class(county_tibble))

  state_tibble <- long_updated[-c(indices),]
  class(state_tibble) <- c("state", class(state_tibble))

  county_state_final <- adding_state_to_county(county_tibble)
  noncounty_division_final <- adding_division_to_noncounty(state_tibble)

  return(list("county_final" = county_state_final,
              "noncounty_final" = noncounty_division_final))
}
```

Combining Data Functions

Creating a Wrapper Function

```
wrapper_function <- function(url, value="values for enrollment") {
  tibbles <- read_csv(url) |>
    long_conversion(value = value) |>
    surveys_year_measurements() |>
    creating2tibbles_addingstateordivision()
  return(tibbles)
}
```

Create Function to Combine Tibbles From Wrapper Iterations

```
#Test wrapper function on two data sets and combine them
combine_tibbles <- function(tibble1,tibble2) {
  county_combined_tibble <- bind_rows(tibble1[["county_final"]],
                                    tibble2[["county_final"]])
  state_combined_tibble <- bind_rows(tibble1[["noncounty_final"]],
                                    tibble2[["noncounty_final"]])
  return(list("county_combined" = county_combined_tibble,
              "state_combined" = state_combined_tibble))
}
```

Generic Functions

Writing Generic Functions for Summarizing

```
#Create plot.state function
plot.state <- function(state_tibble,var_name="value") {
  mean_tibble <- state_tibble |>
    group_by(division, years) |>
    filter(!division %in% c("ERROR")) |>
    summarise(mean_enrollment = mean(get(var_name), na.rm = TRUE))
  return(ggplot(mean_tibble,
                aes(x = years, y = mean_enrollment, group = division, color = division))
         + geom_line())
}
```

```
#Create plot.county function
plot.county <- function(county_data,State="KY",top_or_bottom="top",
                      number_investigated=5,var_name="value") {
  mean_tibble <- county_data |>
    filter(state %in% (State)) |>
    group_by(area_name) |>
    summarise(mean_enrollment = mean(get(var_name), na.rm = TRUE))

  if(top_or_bottom == "top") {
    final_tibble <- mean_tibble |>
      arrange(desc(mean_enrollment)) |>
      head(n = number_investigated) |>
```

```r
      select(area_name)
  } else {
    final_tibble<-mean_tibble|>
      arrange(mean_enrollment)|>
      head(n = number_investigated)|>
      select(area_name)
  }
return(final_tibble)
}
```

Putting It All Together

Testing the functions on the initial two datasets

```
#Process two data sets and combine them
tibble1 <- wrapper_function(url="https://www4.stat.ncsu.edu/~online/datasets/EDU01a.csv",
                            value = value)
tibble2 <- wrapper_function(url="https://www4.stat.ncsu.edu/~online/datasets/EDU01b.csv",
                            value = value)

combined <- combine_tibbles(tibble1, tibble2)
combined
```

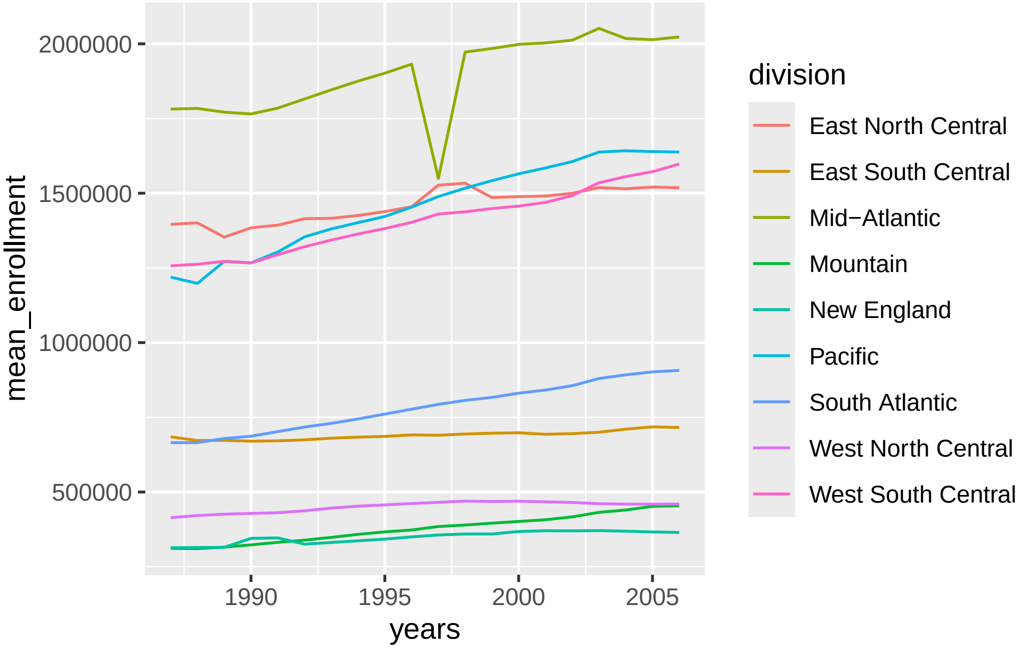
```
$county_combined
# A tibble: 62,900 x 7
   area_name   STCOU surveys    value years measurements state
   <chr>       <chr> <chr>      <dbl> <dbl> <chr>        <chr>
 1 Autauga, AL 01001 EDU010187D  6829  1987 EDU0101      AL
 2 Autauga, AL 01001 EDU010188D  6900  1988 EDU0101      AL
 3 Autauga, AL 01001 EDU010189D  6920  1989 EDU0101      AL
 4 Autauga, AL 01001 EDU010190D  6847  1990 EDU0101      AL
 5 Autauga, AL 01001 EDU010191D  7008  1991 EDU0101      AL
 6 Autauga, AL 01001 EDU010192D  7137  1992 EDU0101      AL
 7 Autauga, AL 01001 EDU010193D  7152  1993 EDU0101      AL
 8 Autauga, AL 01001 EDU010194D  7381  1994 EDU0101      AL
 9 Autauga, AL 01001 EDU010195D  7568  1995 EDU0101      AL
10 Autauga, AL 01001 EDU010196D  7834  1996 EDU0101      AL
# i 62,890 more rows

$state_combined
# A tibble: 1,060 x 7
   area_name     STCOU surveys       value years measurements division
   <chr>         <chr> <chr>         <dbl> <dbl> <chr>        <chr>
 1 UNITED STATES 00000 EDU010187D 40024299  1987 EDU0101      ERROR
 2 UNITED STATES 00000 EDU010188D 39967624  1988 EDU0101      ERROR
 3 UNITED STATES 00000 EDU010189D 40317775  1989 EDU0101      ERROR
 4 UNITED STATES 00000 EDU010190D 40737600  1990 EDU0101      ERROR
 5 UNITED STATES 00000 EDU010191D 41385442  1991 EDU0101      ERROR
 6 UNITED STATES 00000 EDU010192D 42088151  1992 EDU0101      ERROR
 7 UNITED STATES 00000 EDU010193D 42724710  1993 EDU0101      ERROR
 8 UNITED STATES 00000 EDU010194D 43369917  1994 EDU0101      ERROR
 9 UNITED STATES 00000 EDU010195D 43993459  1995 EDU0101      ERROR
10 UNITED STATES 00000 EDU010196D 44715737  1996 EDU0101      ERROR
# i 1,050 more rows
```

Using the Plot Function on the State Data Frame

```
#Use the plot function on the state data frame
plot(combined[[2]])
```

```
`summarise()` has grouped output by 'division'. You can override using the
`.groups` argument.
```



Plotting the County Data Frame

State is “NC”, group is “top”, and looking at 20

```r
#Use the plot function on the county data frame
#Specify state to be NC, group top, number 20
plot(combined[[1]], State = "NC", top_or_bottom = "top", number_investigated = 20)
```

```
# A tibble: 20 x 1
   area_name
   <chr>
 1 Mecklenburg, NC
 2 Wake, NC
 3 Guilford, NC
 4 Cumberland, NC
 5 Forsyth, NC
 6 Gaston, NC
 7 Durham, NC
 8 Buncombe, NC
 9 Robeson, NC
10 Davidson, NC
11 Catawba, NC
12 Cabarrus, NC
13 New Hanover, NC
14 Union, NC
15 Onslow, NC
16 Randolph, NC
17 Pitt, NC
18 Iredell, NC
19 Alamance, NC
20 Johnston, NC
```

State is “SC”, group is “bottom”, and looking at 7

```r
#Use the plot function on the county data frame
#Specify state to be SC, group bottom, number 7
plot(combined[[1]], State = "SC", top_or_bottom = "bottom", number_investigated = 7)
```

```
# A tibble: 7 x 1
  area_name
  <chr>
```

```
1 McCormick, SC
2 Calhoun, SC
3 Allendale, SC
4 Saluda, SC
5 Jasper, SC
6 Bamberg, SC
7 Lee, SC
```

Default values

```
#Use the plot function with defaults
plot(combined[[1]])
```

```
# A tibble: 5 x 1
  area_name
  <chr>
1 Jefferson, KY
2 Fayette, KY
3 Kenton, KY
4 Hardin, KY
5 Daviess, KY
```

State is “PA”, group is “top”, and looking at 8

```
#Use the plot function on the county data frame
#Specify state to be PA, group top, number 8
plot(combined[[1]], State = "PA", top_or_bottom = "top", number_investigated = 8)
```

```
# A tibble: 8 x 1
  area_name
  <chr>
1 Philadelphia, PA
2 Allegheny, PA
3 Montgomery, PA
4 Bucks, PA
5 Delaware, PA
6 Lancaster, PA
7 Berks, PA
8 Chester, PA
```

Testing functions on four additional datasets

Running the Data Processing (Wrapping) Functions on Each of the Four Datasets

```
tibble1 <- wrapper_function(url="https://www4.stat.ncsu.edu/~online/datasets/PST01a.csv",
                            value = value)
```

```
Rows: 3198 Columns: 42
-- Column specification --------------------------------------------------------
Delimiter: ","
chr (22): Area_name, STCOU, PST015171N1, PST015171N2, PST015172N1, PST015172...
dbl (20): PST015171F, PST015171D, PST015172F, PST015172D, PST015173F, PST015...

i Use `spec()` to retrieve the full column specification for this data.
i Specify the column types or set `show_col_types = FALSE` to quiet this message.
```

```
tibble2 <- wrapper_function(url="https://www4.stat.ncsu.edu/~online/datasets/PST01b.csv",
                            value = value)
```

```
Rows: 3198 Columns: 42
-- Column specification --------------------------------------------------------
Delimiter: ","
chr (22): Area_name, STCOU, PST025182N1, PST025182N2, PST025183N1, PST025183...
dbl (20): PST025182F, PST025182D, PST025183F, PST025183D, PST025184F, PST025...

i Use `spec()` to retrieve the full column specification for this data.
i Specify the column types or set `show_col_types = FALSE` to quiet this message.
```

```
tibble3 <- wrapper_function(url="https://www4.stat.ncsu.edu/~online/datasets/PST01c.csv",
                            value = value)
```

```
Rows: 3198 Columns: 42
-- Column specification --------------------------------------------------------
Delimiter: ","
chr (22): Area_name, STCOU, PST035191N1, PST035191N2, PST035192N1, PST035192...
dbl (20): PST035191F, PST035191D, PST035192F, PST035192D, PST035193F, PST035...

i Use `spec()` to retrieve the full column specification for this data.
i Specify the column types or set `show_col_types = FALSE` to quiet this message.
```

```
tibble4 <- wrapper_function(url="https://www4.stat.ncsu.edu/~online/datasets/PST01d.csv",
                           value = value)
```

```
Rows: 3198 Columns: 42
-- Column specification --------------------------------------------------------
Delimiter: ","
chr (22): Area_name, STCOU, PST045200N1, PST045200N2, PST045201N1, PST045201...
dbl (20): PST045200F, PST045200D, PST045201F, PST045201D, PST045202F, PST045...

i Use `spec()` to retrieve the full column specification for this data.
i Specify the column types or set `show_col_types = FALSE` to quiet this message.
```

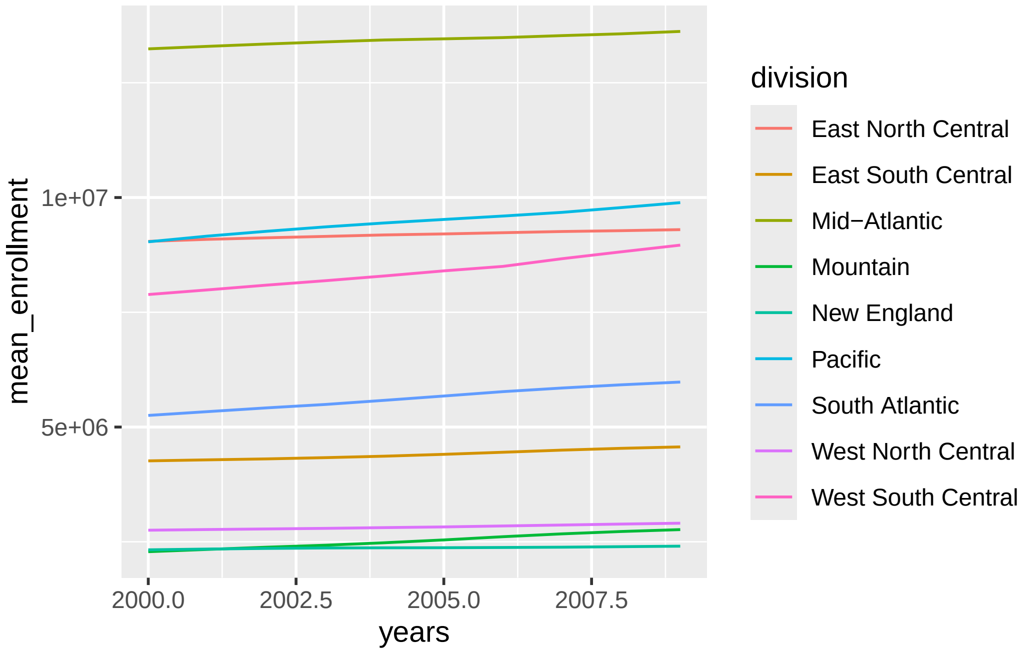
Creating a Singular Object Using the Data Combining Function

```
combined12 <- combine_tibbles(tibble1, tibble2)
combined123 <- combine_tibbles(combined12, tibble3)
combined1234 <- combine_tibbles(combined123, tibble4)
```

Using the Plot Function on the State Data Frame

```
#Use the plot function on the state data frame
plot(combined1234[[2]])
```

```
`summarise()` has grouped output by 'division'. You can override using the
`.groups` argument.
```



Using the Plot Function on the County Data Frame

State is "CA", group is "top", and looking at 15

```r
plot(combined1234[[1]], State = "CA", top_or_bottom = "top", number_investigated = 15)
```

```
# A tibble: 15 x 1
   area_name
   <chr>
 1 Los Angeles, CA
 2 Orange, CA
 3 San Diego, CA
 4 San Bernardino, CA
 5 Riverside, CA
 6 Santa Clara, CA
 7 Alameda, CA
 8 Sacramento, CA
 9 Contra Costa, CA
10 Fresno, CA
11 San Francisco, CA
12 Ventura, CA
13 Kern, CA
14 San Mateo, CA
15 San Joaquin, CA
```

State is "TX", group is "top", and looking at 4

```r
plot(combined1234[[1]], State = "TX", top_or_bottom = "top", number_investigated = 4)
```

```
# A tibble: 4 x 1
  area_name
  <chr>
1 Harris, TX
2 Dallas, TX
3 Tarrant, TX
4 Bexar, TX
```

Default values

```
plot(combined1234[[1]])
```

```
# A tibble: 5 x 1
  area_name
  <chr>
1 Jefferson, KY
2 Fayette, KY
3 Kenton, KY
4 Boone, KY
5 Warren, KY
```

State is "NY", group is "top", and looking at 10

```
plot(combined1234[[1]], State = "NY", top_or_bottom = "top", number_investigated = 10)
```

```
# A tibble: 10 x 1
   area_name
   <chr>
 1 Kings, NY
 2 Queens, NY
 3 New York, NY
 4 Suffolk, NY
 5 Bronx, NY
 6 Nassau, NY
 7 Westchester, NY
 8 Erie, NY
 9 Monroe, NY
10 Richmond, NY
```