

Project 1 Fish McDowell

Data is everywhere. Its power is immeasurable with finding patterns, modeling relationships, and driving decisions. In order to be able to do those things, data must be handled appropriately. In this report, we will go through the motions of loading in and preprocessing some data so that its true power can be used as discussed above.

Initial Data Cleaning

Question 1: Selecting Columns

First, we will load in the appropriate data set and select only `Area_name`, `STCOU`, and any columns that end with the letter D, as this is the only information we need. We will also lower case the `Area_name` variable.

```
sec1 <- read_csv("../data/EDU01a.csv", col_names = TRUE)
```

```
Rows: 3198 Columns: 42
```

```
-- Column specification -----
```

```
Delimiter: ","
```

```
chr (22): Area_name, STCOU, EDU010187N1, EDU010187N2, EDU010188N1, EDU010188...
```

```
dbl (20): EDU010187F, EDU010187D, EDU010188F, EDU010188D, EDU010189F, EDU010...
```

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.

```
sec1_new <- sec1 |>
  select(area_name = Area_name,
         STCOU,
         ends_with("D"))

head(sec1_new, n = 5)
```

```
# 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>
```

The selected columns look to be what we hoped, with all that aren't `area_name` and `STCOU` end with "D".

Question 2: Long Formatted Data

Next, we will convert this data into long format with only one row per enrollment value for that area name. We will put the column names into a separate new variable to keep that information.

```
sec1_long <- sec1_new |>
  pivot_longer(cols = 3:12,
               names_to = "survey_type",
               values_to = "enrollment")

head(sec1_long, n = 5)
```

```
# A tibble: 5 x 4
  area_name      STCOU survey_type enrollment
  <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
```

This looks to match the pivot we hoped to make.

Question 3: Further Splitting Data

As above, we notice that the entries of one of the new columns (labeled `survey_type`) corresponds to the old column names that end with “D”. We know that the information in this column represents multiple pieces of information. Namely, the first 3 characters represent the survey, the next 4 represent the value type, and the last 2 digits represent the year of measurement. Knowing this information, we will now parse through those strings and create a new variable with the numeric date represented as YYYY. We will also do that with the first 3 and remaining 4 characters in the string.

```
long_updated <- sec1_long |>
  mutate(
    year = as.numeric(paste0("19", substr(sec1_long$survey_type, 8, 9))),
    survey = substr(sec1_long$survey_type, 1, 3),
    val_type = substr(sec1_long$survey_type, 4, 7)
  )

head(long_updated, n = 5)
```

```
# A tibble: 5 x 7
  area_name      STCOU survey_type enrollment   year survey val_type
  <chr>          <chr> <chr>          <dbl> <dbl> <chr> <chr>
1 UNITED STATES 00000 EDU010187D    40024299 1987 EDU    0101
2 UNITED STATES 00000 EDU010188D    39967624 1988 EDU    0101
3 UNITED STATES 00000 EDU010189D    40317775 1989 EDU    0101
4 UNITED STATES 00000 EDU010190D    40737600 1990 EDU    0101
5 UNITED STATES 00000 EDU010191D    41385442 1991 EDU    0101
```

Looking at the head of this data set, we have split the `survey_type` variable into the 3 separate pieces of information that it represents.

Question 4: Splitting Into County and Non-County Data

Next, we want to create two datasets, with one containing only non-county data, and the other containing only county data. We are able to do this based on how the `area_name` column is set up. We also want to create new variables corresponding to either the county or state based on which dataset it is placed into.

```
subset_index <- grep(pattern = ", \\w\\w", long_updated$area_name)

state_tibble <- long_updated[-subset_index, ]
county_tibble <- long_updated[subset_index, ]

class(county_tibble) <- c("county", class(county_tibble))
class(state_tibble) <- c("state", class(state_tibble))

head(county_tibble, 10)
```

```
# A tibble: 10 x 7
  area_name STCOU survey_type enrollment year survey val_type
  <chr>      <chr> <chr>          <dbl> <dbl> <chr> <chr>
1 Autauga, AL 01001 EDU010187D      6829  1987 EDU    0101
2 Autauga, AL 01001 EDU010188D      6900  1988 EDU    0101
3 Autauga, AL 01001 EDU010189D      6920  1989 EDU    0101
4 Autauga, AL 01001 EDU010190D      6847  1990 EDU    0101
5 Autauga, AL 01001 EDU010191D      7008  1991 EDU    0101
6 Autauga, AL 01001 EDU010192D      7137  1992 EDU    0101
7 Autauga, AL 01001 EDU010193D      7152  1993 EDU    0101
8 Autauga, AL 01001 EDU010194D      7381  1994 EDU    0101
9 Autauga, AL 01001 EDU010195D      7568  1995 EDU    0101
10 Autauga, AL 01001 EDU010196D      7834  1996 EDU    0101
```

```
head(state_tibble, 10)
```

```
# A tibble: 10 x 7
  area_name STCOU survey_type enrollment year survey val_type
  <chr>      <chr> <chr>          <dbl> <dbl> <chr> <chr>
1 UNITED STATES 00000 EDU010187D  40024299  1987 EDU    0101
2 UNITED STATES 00000 EDU010188D  39967624  1988 EDU    0101
3 UNITED STATES 00000 EDU010189D  40317775  1989 EDU    0101
4 UNITED STATES 00000 EDU010190D  40737600  1990 EDU    0101
5 UNITED STATES 00000 EDU010191D  41385442  1991 EDU    0101
6 UNITED STATES 00000 EDU010192D  42088151  1992 EDU    0101
7 UNITED STATES 00000 EDU010193D  42724710  1993 EDU    0101
8 UNITED STATES 00000 EDU010194D  43369917  1994 EDU    0101
9 UNITED STATES 00000 EDU010195D  43993459  1995 EDU    0101
10 UNITED STATES 00000 EDU010196D  44715737  1996 EDU    0101
```

Question 5: Creating new variable for county tibble

Next, we want to create a new variable in our county tibble that describes which state the county-level observation corresponds to. In order to do this, we need to get the last two characters in the string `area_name`, and since this exact number varies based on how many characters are in the county name, we will utilize the `nchar()` function to determine the starting and stopping point in the `substr()` function.

```
county_tibble <- county_tibble |>
  mutate(state_name = substr(area_name, nchar(area_name) - 1, nchar(area_name)))
```

Question 6: Creating new variable for state tibble

Lastly for the initial data processing part, we want to create a new variable for the state tibble corresponding to the division.

```
state_tibble <- 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("ALABAMA", "KENTUCKY", "MISSISSIPPI",
                    "TENNESSEE") ~ "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"
  ))
```

Creating Functions

Now that we have completed the data processing for our first dataset, we want to repeat the same process for our other dataset. Rather than copying and pasting all of our original code, it is much more efficient for us to create functions that can do the above data cleaning for this new dataset.

Function for steps 1 and 2

```
function1and2 <- function(messydata, val_name = "enrollment"){  
  long_data <- messydata |>  
    select(area_name = Area_name,  
           STCOU,  
           ends_with("D")) |>  
    pivot_longer(cols = 3:12,  
                 names_to = "survey_type",  
                 values_to = val_name)  
  return(long_data)  
}
```

Function for step 3

```
function3 <- function(long_data){  
  clean_data <- long_data |>  
    mutate(  
      year = as.numeric(paste0("19", substr(long_data$survey_type, 8, 9))),  
      survey = substr(long_data$survey_type, 1, 3),  
      val_type = substr(long_data$survey_type, 4, 7)  
    )  
  return(clean_data)  
}
```

Function for steps 5 and 6

```
function5 <- function(county_tibble){  
  county_tibble <- county_tibble |>  
    mutate(state_name = substr(area_name, nchar(area_name) - 1, nchar(area_name)))
```

```

    return(county_tibble)
}

function6 <- function(state_tibble){
  state_tibble <- 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("ALABAMA", "KENTUCKY", "MISSISSIPPI",
        "TENNESSEE") ~ "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(state_tibble)
}

```

Function for step 4

```

function4 <- function(clean_data){
  subset_index <- grep(pattern = ", \\w\\w", clean_data$area_name)
  state_tibble <- clean_data[-subset_index, ]
  county_tibble <- clean_data[subset_index, ]
  class(county_tibble) <- c("county", class(county_tibble))
  class(state_tibble) <- c("state", class(state_tibble))
  county <- function5(county_tibble)
}

```

```
state <- function6(state_tibble)
return(list(county = county, state = state))
}
```

Putting it all into one function

Now that we have created functions that do all of the data cleaning we want, we want to combine everything into one big function that does everything for us.

```
my_wrapper <- function(url, default_var_name = "enrollment"){
  final <- read_csv(url, col_names = TRUE) |>
    function1and2() |>
    function3() |>
    function4()
  return(final)
}
```

Now we can call this new function for both of our datasets and combine them.

```
data1 <- my_wrapper("https://www4.stat.ncsu.edu/~online/datasets/EDU01a.csv")
```

```
Rows: 3198 Columns: 42
```

```
-- Column specification -----
```

```
Delimiter: ","
```

```
chr (22): Area_name, STCOU, EDU010187N1, EDU010187N2, EDU010188N1, EDU010188...
```

```
dbl (20): EDU010187F, EDU010187D, EDU010188F, EDU010188D, EDU010189F, EDU010...
```

```
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.
```

```
data2 <- my_wrapper("https://www4.stat.ncsu.edu/~online/datasets/EDU01b.csv")
```

```
Rows: 3198 Columns: 42
```

```
-- Column specification -----
```

```
Delimiter: ","
```

```
chr (22): Area_name, STCOU, EDU010197N1, EDU010197N2, EDU010198N1, EDU010198...
```

```
dbl (20): EDU010197F, EDU010197D, EDU010198F, EDU010198D, EDU010199F, EDU010...
```

```
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.
```



```
combined_data <- function(data1, data2){
  combined_county <- dplyr::bind_rows(data1$county, data2$county)
  combined_state <- dplyr::bind_rows(data1$state, data2$state)
  return(list(county = combined_county, state = combined_state))
}

combined_data(data1, data2)
```

\$county

A tibble: 62,900 x 8

	area_name	STCOU	survey_type	enrollment	year	survey	val_type	state_name
	<chr>	<chr>	<chr>	<dbl>	<dbl>	<chr>	<chr>	<chr>
1	Autauga, AL	01001	EDU010187D	6829	1987	EDU	0101	AL
2	Autauga, AL	01001	EDU010188D	6900	1988	EDU	0101	AL
3	Autauga, AL	01001	EDU010189D	6920	1989	EDU	0101	AL
4	Autauga, AL	01001	EDU010190D	6847	1990	EDU	0101	AL
5	Autauga, AL	01001	EDU010191D	7008	1991	EDU	0101	AL
6	Autauga, AL	01001	EDU010192D	7137	1992	EDU	0101	AL
7	Autauga, AL	01001	EDU010193D	7152	1993	EDU	0101	AL
8	Autauga, AL	01001	EDU010194D	7381	1994	EDU	0101	AL
9	Autauga, AL	01001	EDU010195D	7568	1995	EDU	0101	AL
10	Autauga, AL	01001	EDU010196D	7834	1996	EDU	0101	AL

i 62,890 more rows

\$state

A tibble: 1,060 x 8

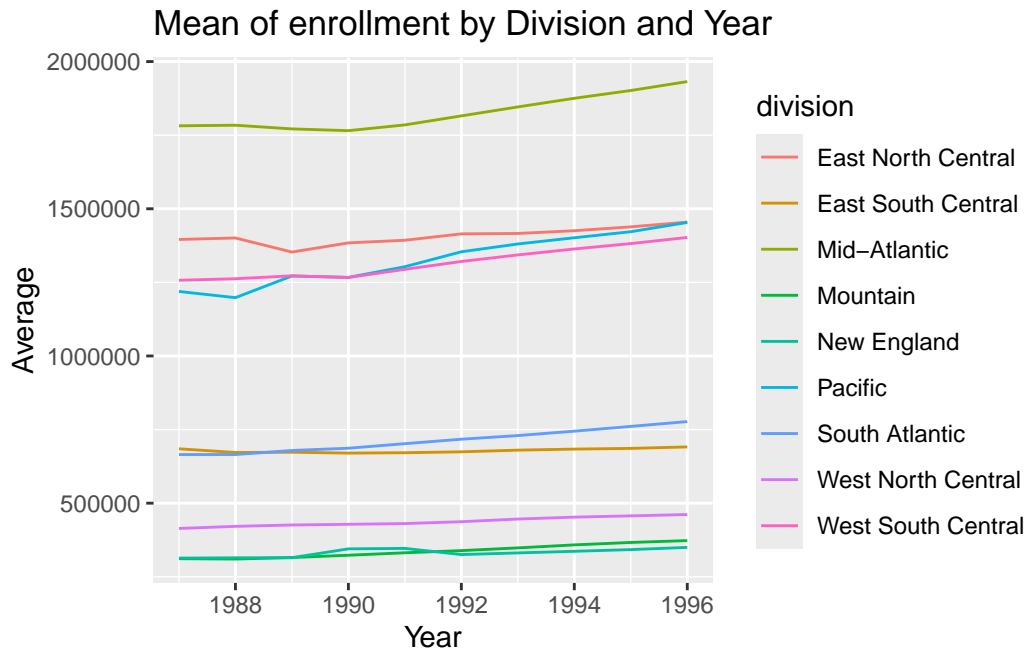
	area_name	STCOU	survey_type	enrollment	year	survey	val_type	division
	<chr>	<chr>	<chr>	<dbl>	<dbl>	<chr>	<chr>	<chr>
1	UNITED STATES	00000	EDU010187D	40024299	1987	EDU	0101	ERROR
2	UNITED STATES	00000	EDU010188D	39967624	1988	EDU	0101	ERROR
3	UNITED STATES	00000	EDU010189D	40317775	1989	EDU	0101	ERROR
4	UNITED STATES	00000	EDU010190D	40737600	1990	EDU	0101	ERROR
5	UNITED STATES	00000	EDU010191D	41385442	1991	EDU	0101	ERROR
6	UNITED STATES	00000	EDU010192D	42088151	1992	EDU	0101	ERROR
7	UNITED STATES	00000	EDU010193D	42724710	1993	EDU	0101	ERROR
8	UNITED STATES	00000	EDU010194D	43369917	1994	EDU	0101	ERROR
9	UNITED STATES	00000	EDU010195D	43993459	1995	EDU	0101	ERROR
10	UNITED STATES	00000	EDU010196D	44715737	1996	EDU	0101	ERROR

i 1,050 more rows

Functions for plotting

Now, we will make a function for plotting the objects that comes out of these functions we have written above. We will start with the `state` tibble. Our goal is to plot the average value of a specified numeric variable within the data frame input into the function. These average values will also be computed by geographic division and year.

```
plot.state <- function(state_data, var_name = "enrollment"){  
  
  #get rid of errors  
  state_sum <- state_data |>  
    filter(division != "ERROR") |>  
    group_by(division, year) |>  
    mutate(avg_vals = mean(get(var_name), na.rm = TRUE))  
  
  #use ggplot to plot  
  state_sum |>  
    ggplot(aes(x = year, y = avg_vals, color = division)) +  
    geom_line() +  
    labs(title = paste("Mean of", var_name, "by Division and Year"),  
         x = "Year",  
         y = paste("Average"), var_name)  
}  
plot.state(data.frame(state_tibble))
```



We will now make a function to plot the county data as well. This function will allow the user to specify the state that they want to plot (with a default to NC), whether they want to plot the counties with the highest or lowest average enrollment values, and how many of those counties they wish to incorporate.

```
plot.county <- function(county_data, var_name = "enrollment", state = "NC",
                        side = "top", amount = 5){
  county_sum <- county_data |>
    filter(state_name == state) |>
    group_by(area_name) |>
    summarize(avg_vals = mean(get(var_name), na.rm = TRUE))

  if (side == "top"){
    which_counties <- county_sum |>
      arrange(desc(avg_vals)) |>
      slice_head(n = amount) |>
      pull(area_name)
  } else if (side == "bottom"){
    which_counties <- county_sum |>
      arrange(desc(avg_vals)) |>
      slice_head(n = amount) |>
      pull(area_name)
  }
}
```

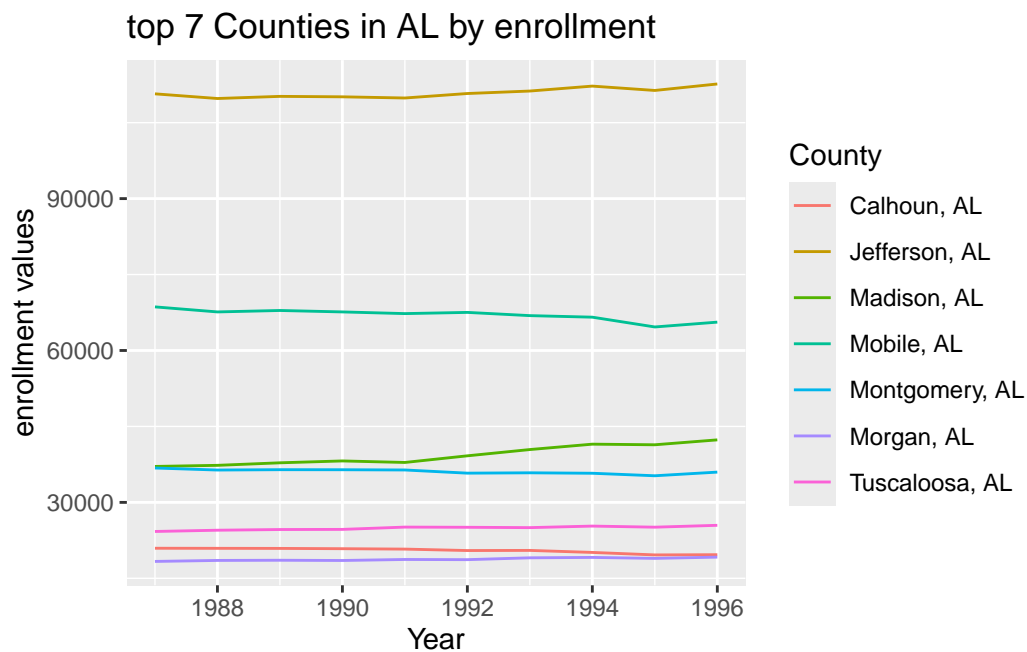
```

plot_data <- county_data |>
  filter(area_name %in% which_counties)

ggplot(plot_data, aes(x = year, y = get(var_name), color = area_name)) +
  geom_line() +
  labs(title = paste(side, amount, "Counties in", state, "by", var_name),
       x = "Year",
       y = paste(var_name, "values"),
       color = "County"
  )
}

plot.county(county_tibble, state = "AL", amount = 7)

```



Putting it all together

We will now utilize all of the functions we have written to take in raw data, preprocess it, split it into two tibbles, and plot them accordingly. Some examples are below.

- Run your data processing function on the two enrollment URLs given previously, specifying an appropriate name for the enrollment data column.
- Run your data combining function

to put these into one object (with two data frames) – Use appropriate indexing (ex. `[[1]]`) to reference the correct data frame • Use the plot function on the state data frame • Use the plot function on the county data frame – Once specifying the state to be “NC”, the group being the top, the number looked at being 20 – Once specifying the state to be “SC”, the group being the bottom, the number looked at being 7 – Once without specifying anything (defaults used) – Once specifying the state to be “PA”, the group being the top, the number looked at being 8

```
# run data processing function on the two enrollment URLs given previously
data1 <- my_wrapper("https://www4.stat.ncsu.edu/~online/datasets/EDU01a.csv")
```

```
Rows: 3198 Columns: 42
```

```
-- Column specification -----
```

```
Delimiter: ","
```

```
chr (22): Area_name, STCOU, EDU010187N1, EDU010187N2, EDU010188N1, EDU010188...
```

```
dbl (20): EDU010187F, EDU010187D, EDU010188F, EDU010188D, EDU010189F, EDU010...
```

```
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.
```

```
data2 <- my_wrapper("https://www4.stat.ncsu.edu/~online/datasets/EDU01b.csv")
```

```
Rows: 3198 Columns: 42
```

```
-- Column specification -----
```

```
Delimiter: ","
```

```
chr (22): Area_name, STCOU, EDU010197N1, EDU010197N2, EDU010198N1, EDU010198...
```

```
dbl (20): EDU010197F, EDU010197D, EDU010198F, EDU010198D, EDU010199F, EDU010...
```

```
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.
```

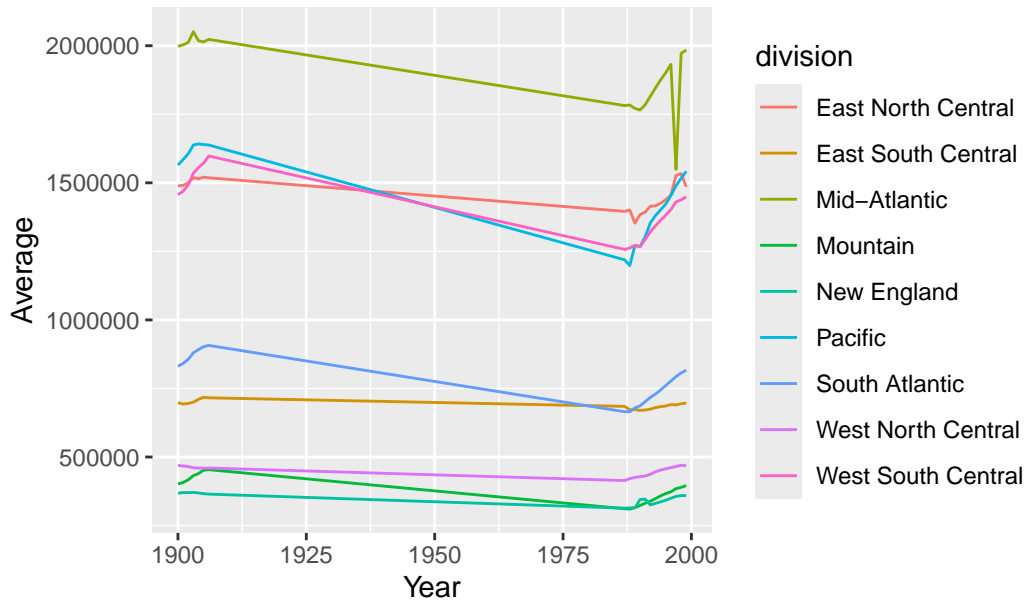
```
# run the data combining function
```

```
data12 <- combined_data(data1, data2)
```

```
# plot the state data frame
```

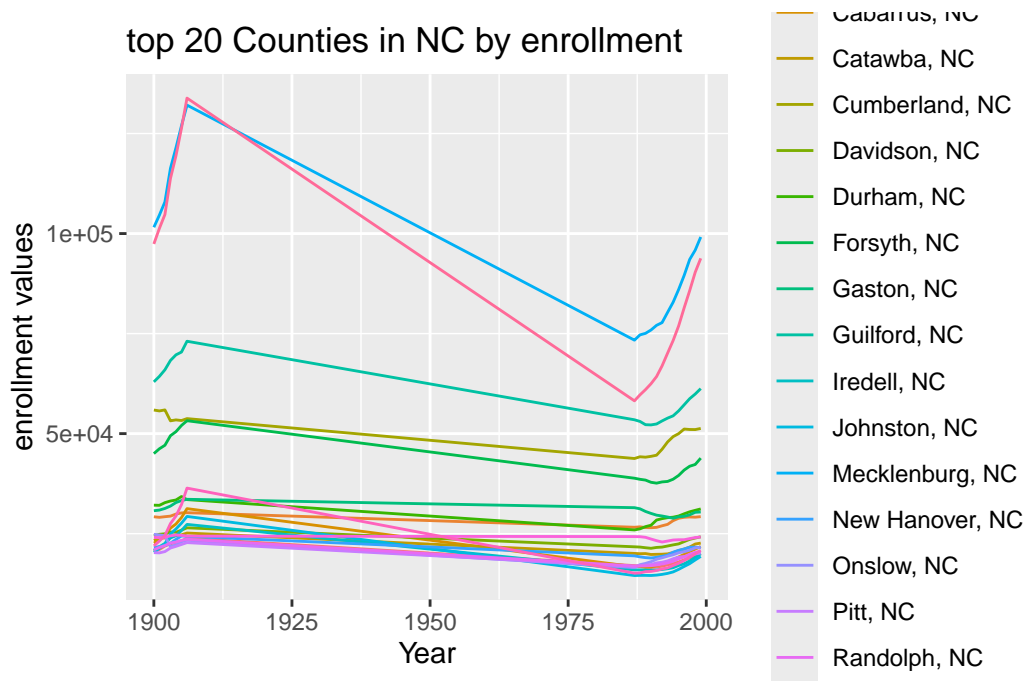
```
plot.state(data12[[2]])
```

Mean of enrollment by Division and Year

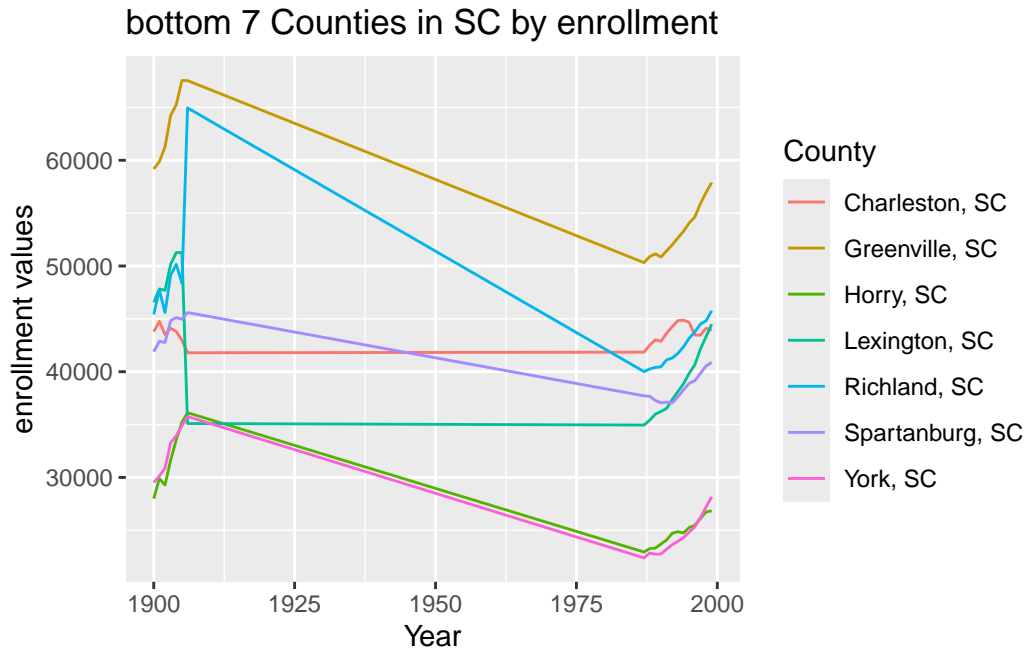


```
plot.county(data12[[1]], state = "NC", side = "top", amount = 20)
```

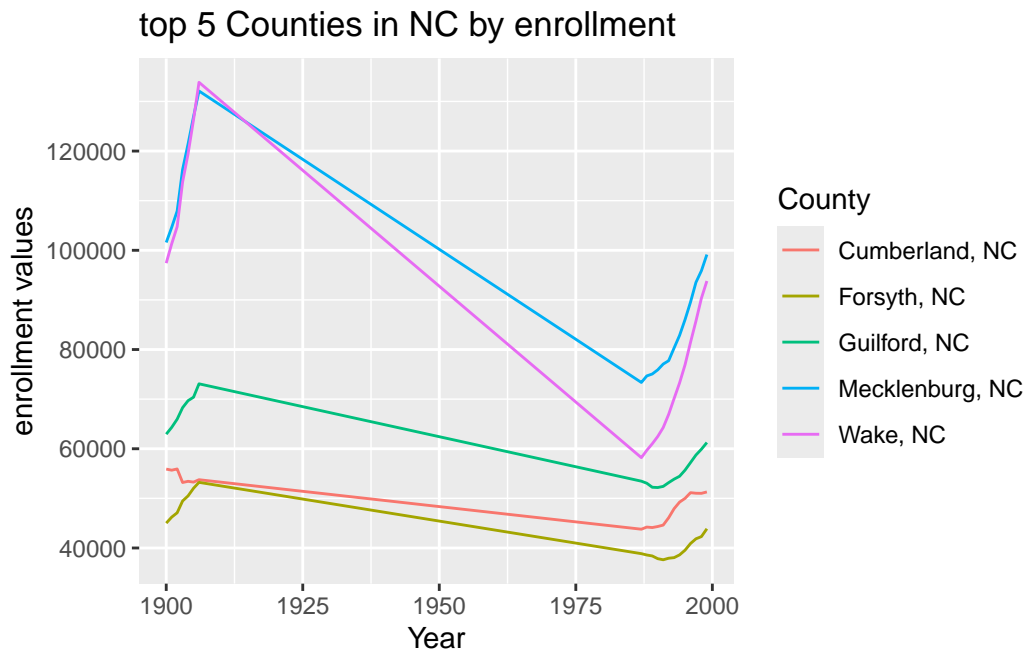
top 20 Counties in NC by enrollment



```
plot.county(data12[[1]], state = "SC", side = "bottom", amount = 7)
```



```
plot.county(data12[[1]])
```



```
plot.county(data12[[1]], state = "PA", side = "top", amount = 8)
```

