

Processing and Manipulating Data

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```
#|message=FALSE
#|warning=FALSE

# Load in necessary packages here!
suppressPackageStartupMessages(library(tidyverse))
```

Data Processing

First Steps: Importing Data

Our overall goal in this project is to process and manipulate data using common techniques and R packages. In this instance, we are using data from the 2010 census as an example! The first step in any data science project is to read in the data from wherever we are importing it from. In this case, we have some comma separated value (csv) files. Luckily, R makes this pretty easy with the `read.csv()` function!

```
#|message=FALSE

# Read in the first dataset using read.csv
census_1 <- read.csv(file = "https://www4.stat.ncsu.edu/~online/datasets/EDU01a.csv",
                     header = TRUE)

# Convert to a tibble for ease of use
census_1 <- as_tibble(census_1)
```

1: Selecting Columns

Now that we have some data to work with, we can use the `dplyr` package to select the columns we care about and take a look to make sure that everything got read in properly.

```
# Select Area_name, STCOU, and any column ending with a D
census_1_small <- census_1 |>
  select(Area_name, STCOU, ends_with("D")) |>
  rename(area_name = Area_name) #rename variable

#View our selection!
head(census_1_small, n = 5)
```

```
# A tibble: 5 x 12
  area_name      STCOU EDU010187D EDU010188D EDU010189D EDU010190D EDU010191D
  <chr>          <int>      <int>      <int>      <int>      <int>      <int>
1 UNITED STATES      0    40024299    39967624    40317775    40737600    41385442
2 ALABAMA           1000     733735     728234     730048     728252     725541
3 Autauga, AL        1001      6829      6900      6920      6847      7008
4 Baldwin, AL        1003     16417     16465     16799     17054     17479
5 Barbour, AL        1005      5071      5098      5068      5156      5173
# i 5 more variables: EDU010192D <int>, EDU010193D <int>, EDU010194D <int>,
#   EDU010195D <int>, EDU010196D <int>
```

Looks good!

2: Pivoting Data

There is some information stored in the column names that we care about in our data, and it isn't exactly easy to analyze that data when it's stored in the name. As such, we are going to pivot this data into a longer dataframe.

```
#Pivot longer so that we can access data stored in some column names
census_1_long <- census_1_small |>
  pivot_longer(cols = 3:12,
               names_to = "survey_ID",
               values_to = "enrollment")

#View results!
head(census_1_long, n = 5)
```

```
# A tibble: 5 x 4
  area_name      STCOU survey_ID enrollment
  <chr>          <int> <chr>          <int>
1 UNITED STATES      0 EDU010187D    40024299
```

2	UNITED STATES	0	EDU010188D	39967624
3	UNITED STATES	0	EDU010189D	40317775
4	UNITED STATES	0	EDU010190D	40737600
5	UNITED STATES	0	EDU010191D	41385442

Notice how there is only one measurement per row now!

3: Parsing Strings

Let's take a closer look at the `survey_ID` column now. According to the data information sheet provided, the first three letters and first four numbers represent the type of survey that was completed. For example, row one has the value `EDU0101` which represents school survey_ID. The next two digits represent the year the survey was taken. Using the first row as an example again, we see that those two digits are `87`, meaning that the survey was taken in 1987. We can parse this column to get some meaningful data year-over-year.

```
#Parse the survey_ID column:
#survey_ID - first three letters plus first four digits (ex. EDU0101)
#year - next two digits (ex. 87 becomes 1987)
long_updated <- census_1_long |>
  mutate(year = substr(survey_ID, 8, 9),
         survey_ID = substr(survey_ID, 1, 7)) |>
  #Add 1900 (or 2000) to the year column to get the YYYY instead of YY
  mutate(year = case_when(
    as.numeric(year) >= 87 ~ 1900 + as.numeric(year),
    .default = 2000 + as.numeric(year)
  ))

#View results!
head(long_updated, n = 5)
```

```
# A tibble: 5 x 5
  area_name      STCOU survey_ID enrollment  year
  <chr>         <int> <chr>         <int> <dbl>
1 UNITED STATES     0 EDU0101     40024299 1987
2 UNITED STATES     0 EDU0101     39967624 1988
3 UNITED STATES     0 EDU0101     40317775 1989
4 UNITED STATES     0 EDU0101     40737600 1990
5 UNITED STATES     0 EDU0101     41385442 1991
```

Now we have two columns to explain the survey information in a more intuitive manner.

4: Splitting the Dataset

Note that when we first imported the dataset, we saw that there was data for the country as a whole, as well as individual states as well as the counties within the states. If we wished to analyze the data, it may make more sense to be able to easily subset it by county and non-county data so we can get better insights. As such, let's split the data into a county set and a non-county set. We can use `dplyr`'s `slice()` function to accomplish this, using an expression provided that returns the indices of all rows that match a given condition!

```
#Filter tibble into two separate tibbles using county as the identifier
county_tibble <- long_updated |>
  slice(grep(pattern = "\w\\w", area_name))

#We can invert using the 'invert' argument in grep() as well
state_tibble <- long_updated |>
  slice(grep(pattern = "\w\\w", area_name, invert = TRUE))

#Add the custom classes to the tibbles for future use
class(county_tibble) <- c("county", class(county_tibble))
class(state_tibble) <- c("state", class(state_tibble))

head(county_tibble, n = 10)
```

```
# A tibble: 10 x 5
  area_name STCOU survey_ID enrollment year
  <chr>      <int> <chr>          <int> <dbl>
1 Autauga, AL 1001 EDU0101      6829 1987
2 Autauga, AL 1001 EDU0101      6900 1988
3 Autauga, AL 1001 EDU0101      6920 1989
4 Autauga, AL 1001 EDU0101      6847 1990
5 Autauga, AL 1001 EDU0101      7008 1991
6 Autauga, AL 1001 EDU0101      7137 1992
7 Autauga, AL 1001 EDU0101      7152 1993
8 Autauga, AL 1001 EDU0101      7381 1994
9 Autauga, AL 1001 EDU0101      7568 1995
10 Autauga, AL 1001 EDU0101      7834 1996
```

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

```
# A tibble: 10 x 5
  area_name STCOU survey_ID enrollment year
```

	<chr>	<int>	<chr>	<int>	<dbl>
1	UNITED STATES	0	EDU0101	40024299	1987
2	UNITED STATES	0	EDU0101	39967624	1988
3	UNITED STATES	0	EDU0101	40317775	1989
4	UNITED STATES	0	EDU0101	40737600	1990
5	UNITED STATES	0	EDU0101	41385442	1991
6	UNITED STATES	0	EDU0101	42088151	1992
7	UNITED STATES	0	EDU0101	42724710	1993
8	UNITED STATES	0	EDU0101	43369917	1994
9	UNITED STATES	0	EDU0101	43993459	1995
10	UNITED STATES	0	EDU0101	44715737	1996

5: Splitting Strings in the County Data

We may want to subset by state in our analysis, so let's subset the county data to separate the county's name and state by using the comma as a delimiter.

```
#Split the county name and state using , as a delimiter
county_1_split <- county_tibble |>
  # separate() indicates that it is superseded per help file
  # Using separate_wider_delim() in favor of separate()
  separate_wider_delim(area_name, ",", names = c("county", "state")) |>
  # Trim the whitespace on the state column
  mutate(state = trimws(state))

#View results
head(county_1_split, n = 5)
```

```
# A tibble: 5 x 6
  county state STCOU survey_ID enrollment year
  <chr>  <chr> <int> <chr>         <int> <dbl>
1 Autauga AL      1001 EDU0101         6829 1987
2 Autauga AL      1001 EDU0101         6900 1988
3 Autauga AL      1001 EDU0101         6920 1989
4 Autauga AL      1001 EDU0101         6847 1990
5 Autauga AL      1001 EDU0101         7008 1991
```

6: Designating Regions in Non-County Data

Similar to what we did in the county data above, we can describe the non-county data by larger groups. For the county data, this was the state each county was located in. For the

non-county data, it will be the the divisions described by the [Census Bureau's designation](#). In other words, there are nine defined divisions that the Census Bureau that could be useful for our analysis. In order to indicate divisions we will have to use the `case_when` function in conjunction with the `%in%` operator to check and see if each entry is contained within a specific list of states belonging to a division.

```
#Create string vectors of the states for clarity in the mutate call
ne <- c("CONNECTICUT", "MAINE", "MASSACHUSETTS",
        "NEW HAMPSHIRE", "RHODE ISLAND", "VERMONT")
ma <- c("NEW JERSEY", "NEW YORK", "PENNSYLVANIA")
enc <- c("ILLINOIS", "INDIANA", "MICHIGAN", "OHIO", "WISCONSIN")
wnc <- c("IOWA", "KANSAS", "MINNESOTA",
        "MISSOURI", "NEBRASKA", "NORTH DAKOTA",
        "SOUTH DAKOTA")
sa <- c("DELAWARE", "DISTRICT OF COLUMBIA", "FLORIDA",
        "GEORGIA", "MARYLAND", "NORTH CAROLINA",
        "SOUTH CAROLINA", "VIRGINIA", "WEST VIRGINIA")
esc <- c("ALABAMA", "KENTUCKY", "MISSISSIPPI", "TENNESSEE")
wsc <- c("ARKANSAS", "LOUISIANA", "OKLAHOMA", "TEXAS")
mtn <- c("ARIZONA", "COLORADO", "IDAHO",
        "MONTANA", "NEVADA", "NEW MEXICO",
        "UTAH", "WYOMING")
pac <- c("ALASKA", "CALIFORNIA", "HAWAII", "OREGON", "WASHINGTON")

# Add the division variable to indicate Census-designated divisions
non_county_1_div <- state_tibble |>
  mutate(division = case_when(
    area_name %in% ne ~ "New England",
    area_name %in% ma ~ "Mid-Atlantic",
    area_name %in% enc ~ "East North Central",
    area_name %in% wnc ~ "West North Central",
    area_name %in% sa ~ "South Atlantic",
    area_name %in% esc ~ "East South Central",
    area_name %in% wsc ~ "West South Central",
    area_name %in% mtn ~ "Mountain",
    area_name %in% pac ~ "Pacific",
    .default = "ERROR"
  ))

#View results from the end
#since the US data is first and will return ERROR
tail(non_county_1_div, n = 5)
```

```
# A tibble: 5 x 6
  area_name STCOU survey_ID enrollment  year division
  <chr>      <int> <chr>          <int> <dbl> <chr>
1 WYOMING    56000 EDU0101      101715 1992 Mountain
2 WYOMING    56000 EDU0101      100729 1993 Mountain
3 WYOMING    56000 EDU0101      100899 1994 Mountain
4 WYOMING    56000 EDU0101      100369 1995 Mountain
5 WYOMING    56000 EDU0101       99859 1996 Mountain
```

With that, we've done everything that we'll need to do for our analysis! However, there is one key step that we need to do to make this process easily reproducible.

Generalizing into Function Calls

This census data has two key characteristics that are relevant right now: the data that is imported follows the same general format, and we want to process the data in several different ways. That is, we want to easily be able to do the same processes without having to do a bunch of copying-and-pasting work. Luckily, we can write our own functions to take care of that!

There will have to be some generalizations made. For example, what if we want to observe data for a different metric? The census takes record of many different aspects of American demographics, and we may be interested in analyzing a different survey one day. Also, the latest observations that we have in the data we read in previously are from 1996, which is almost 30 years ago! We will want to read in some more recent records as well to get a bigger picture on survey_ID data.

So, we will write functions to generalize the processes performed above, and we will write a function to merge datasets in order to conglomerate our newer and older data in one (well, two, because we still want to split the data by county status) data frame(s)!

```
#---STATE STRINGS---
#We will need these again for one of the helper functions
ne <- c("CONNECTICUT", "MAINE", "MASSACHUSETTS",
        "NEW HAMPSHIRE", "RHODE ISLAND", "VERMONT")
ma <- c("NEW JERSEY", "NEW YORK", "PENNSYLVANIA")
enc <- c("ILLINOIS", "INDIANA", "MICHIGAN", "OHIO", "WISCONSIN")
wnc <- c("IOWA", "KANSAS", "MINNESOTA",
        "MISSOURI", "NEBRASKA", "NORTH DAKOTA",
        "SOUTH DAKOTA")
sa <- c("DELAWARE", "DISTRICT OF COLUMBIA", "FLORIDA",
        "GEORGIA", "MARYLAND", "NORTH CAROLINA",
```

```

      "SOUTH CAROLINA", "VIRGINIA", "WEST VIRGINIA")
esc <- c("ALABAMA", "KENTUCKY", "MISSISSIPPI", "TENNESSEE")
wsc <- c("ARKANSAS", "LOUISIANA", "OKLAHOMA", "TEXAS")
mtn <- c("ARIZONA", "COLORADO", "IDAHO",
        "MONTANA", "NEVADA", "NEW MEXICO",
        "UTAH", "WYOMING")
pac <- c("ALASKA", "CALIFORNIA", "HAWAII", "OREGON", "WASHINGTON")

#---HELPER FUNCTIONS---
#This is steps 1 and 2, selecting columns and pivoting data
select_and_pivot <- function(tib, name) {
  #Step 1: Select Columns
  result <- tib |>
    select(Area_name, STCOU, ends_with("D")) |>
    rename(area_name = Area_name) |> #rename variable
    pivot_longer(cols = 3:12,
                 names_to = "survey_ID",
                 values_to = name)

  return(result)
}

#This is step 3, where we parse the old column names in survey_ID
# as well as the survey_stat_name column
parse_survey_ID <- function(tib) {
  result <- tib |>
  mutate(year = substr(survey_ID, 8, 9),
         survey_ID = substr(survey_ID, 1, 7)) |>
  #Add 1900 (or 2000) to the year column to get the YYYY instead of YY
  mutate(year = case_when(
    as.numeric(year) >= 26 ~ 1900 + as.numeric(year),
    .default = 2000 + as.numeric(year)
  ))

  return(result)
}

#This is steps 4-6, where we split data and did some more parsing of strings
split_by_county_status <- function(tib) {
  #Take the county data and add state column
  result_c <- tib |>

```



```

    slice(grep(pattern = ", \\w\\w", area_name)) |>
    # separate() indicates that it is superseded per help file
    # Using separate_wider_delim() in favor of separate()
    separate_wider_delim(area_name, ",", names = c("county", "state")) |>
    # Trim the whitespace on the state column
    mutate(state = trimws(state))

#Add custom county class
class(result_c) <- c("county", class(result_c))

#Take the non-county data and add division column
result_nc <- tib |>
  slice(grep(pattern = ", \\w\\w", area_name, invert = TRUE)) |>
  mutate(division = case_when(
    area_name %in% ne ~ "New England",
    area_name %in% ma ~ "Mid-Atlantic",
    area_name %in% enc ~ "East North Central",
    area_name %in% wnc ~ "West North Central",
    area_name %in% sa ~ "South Atlantic",
    area_name %in% esc ~ "East South Central",
    area_name %in% wsc ~ "West South Central",
    area_name %in% mtn ~ "Mountain",
    area_name %in% pac ~ "Pacific",
    .default = "ERROR"
  ))

#Add custom state class
class(result_nc) <- c("state", class(result_nc))

#Return a list of two tibbles
return(list(result_c, result_nc))
}

#---MAIN FUNCTION CALL---
#This just calls all the helper functions in order
#and returns the final product
process_census_data <- function(url, survey_stat_name = "enrollment") {
  #Quick sanity check to make sure we have a character string
  if (!is.character(url)) {
    stop("url argument must be a character string!")
  }
}

```

```

#Run through the helper functions and return the results
result <- as_tibble(read.csv(file = url, header = TRUE)) |>
  select_and_pivot(name = survey_stat_name) |>
  parse_survey_ID() |>
  split_by_county_status()

#Returns a list of 2 tibbles
return(result)
}

#---DATA COMBINING FUNCTION---
#This will take two lists of two tibbles each and
# combine them into one list of two tibbles

combine_census_data <- function(x, y) {
  #Sanity checks: make sure each list is a list of size 2
  if(!is_tibble(x[[1]]) || !is_tibble(x[[2]])) {
    stop("First list argument does not exclusively contain tibbles.")
  }

  if(!is_tibble(y[[1]]) || !is_tibble(y[[2]])) {
    stop("Second list argument does not exclusively contain tibbles.")
  }

  if(length(x) != length(y) || length(x) != 2) {
    stop("Lists must be of length 2. Current length: ", length(x))
  }

  #Combine the first element of each list (county data) together
  result_c <- bind_rows(x[[1]], y[[1]])
  #Combine the second element of each list (non-county data) together
  result_nc <- bind_rows(x[[2]], y[[2]])

  #Return the result datasets!
  return(list(result_c, result_nc))
}

```

Now that we've written our functions, all that's left to do is call them. If everything works properly, we should see a list of two different tibbles: one with county data from 1987-2006, and another with non-county data from 1987-2006. These datasets should be formatted exactly like the example data we used above!

```
#Call the functions we just made!
county_data_test <- process_census_data(url = "https://www4.stat.ncsu.edu/~online/datasets/EDU")
state_data_test <- process_census_data(url = "https://www4.stat.ncsu.edu/~online/datasets/EDU")

#Combine the two lists together
census_test <- combine_census_data(county_data_test, state_data_test)
```

Let's do a quick sort and take a look at some of the data to see if everything looks okay.

```
#View results
census_test[[1]] |>
  arrange(county, year) |>
  head(n = 20)
```

A tibble: 20 x 6

	county	state	STCOU	survey_ID	enrollment_count	year
	<chr>	<chr>	<int>	<chr>	<int>	<dbl>
1	Abbeville	SC	45001	EDU0101	3941	1987
2	Abbeville	SC	45001	EDU0101	3934	1988
3	Abbeville	SC	45001	EDU0101	3880	1989
4	Abbeville	SC	45001	EDU0101	3834	1990
5	Abbeville	SC	45001	EDU0101	3806	1991
6	Abbeville	SC	45001	EDU0101	3780	1992
7	Abbeville	SC	45001	EDU0101	3804	1993
8	Abbeville	SC	45001	EDU0101	3750	1994
9	Abbeville	SC	45001	EDU0101	3780	1995
10	Abbeville	SC	45001	EDU0101	3803	1996
11	Abbeville	SC	45001	EDU0101	3821	1997
12	Abbeville	SC	45001	EDU0101	3730	1998
13	Abbeville	SC	45001	EDU0101	3861	1999
14	Abbeville	SC	45001	EDU0102	3927	2000
15	Abbeville	SC	45001	EDU0102	3871	2001
16	Abbeville	SC	45001	EDU0102	3967	2002
17	Abbeville	SC	45001	EDU0152	3812	2003
18	Abbeville	SC	45001	EDU0152	3777	2004
19	Abbeville	SC	45001	EDU0152	3680	2005
20	Abbeville	SC	45001	EDU0152	3616	2006

Looks good on the county side. Let's check the non-counties as well.

```
#View results, from the end this time for the sake of it.
census_test[[2]] |>
  arrange(division, area_name, year) |>
  tail(n = 20)
```

A tibble: 20 x 6

	area_name	STCOU	survey_ID	enrollment_count	year	division
	<chr>	<int>	<chr>	<int>	<dbl>	<chr>
1	TEXAS	48000	EDU0101	3209515	1987	West South Central
2	TEXAS	48000	EDU0101	3236867	1988	West South Central
3	TEXAS	48000	EDU0101	3282956	1989	West South Central
4	TEXAS	48000	EDU0101	3268933	1990	West South Central
5	TEXAS	48000	EDU0101	3382509	1991	West South Central
6	TEXAS	48000	EDU0101	3464371	1992	West South Central
7	TEXAS	48000	EDU0101	3535742	1993	West South Central
8	TEXAS	48000	EDU0101	3601839	1994	West South Central
9	TEXAS	48000	EDU0101	3670193	1995	West South Central
10	TEXAS	48000	EDU0101	3740260	1996	West South Central
11	TEXAS	48000	EDU0101	3828975	1997	West South Central
12	TEXAS	48000	EDU0101	3891877	1998	West South Central
13	TEXAS	48000	EDU0101	3945367	1999	West South Central
14	TEXAS	48000	EDU0102	3991783	2000	West South Central
15	TEXAS	48000	EDU0102	4059619	2001	West South Central
16	TEXAS	48000	EDU0102	4163447	2002	West South Central
17	TEXAS	48000	EDU0152	4331751	2003	West South Central
18	TEXAS	48000	EDU0152	4405215	2004	West South Central
19	TEXAS	48000	EDU0152	4525394	2005	West South Central
20	TEXAS	48000	EDU0152	4599509	2006	West South Central

Looks good here, too. Now that we have a way to easily process the data we are looking for, it's time to start thinking about how we are going to summarize and analyze it.

Using Functions to Summarize Data

We will start by plotting the data based on state as the location. Our plan is to create a function that plots the mean value of `enrollment_count` across the years for each Division.

```
#make function as directed
plot.state <- function(tib, var_name="enrollment_count") {

#creating an object to change y axis based on var_name
```

```

y_label <- paste("Mean", gsub("_", " ", var_name))

tib |> #inputting our intended data frame
  filter(division != "ERROR") |> #removing error values from division
  group_by(year, division) |> #grouping by year then division
  #getting mean of the variable from var_name
  summarise(mean_value = mean(get(var_name), na.rm=T), .groups = "drop") |>
  ggplot(aes(x=year, y=mean_value, color=division)) +
  #aesthetics of plot, followed by a line plot
  geom_line() +
  labs(x= "Year",
       y = y_label,
       title = "Census Data by Division") +
  scale_color_discrete("Division")
}

```

Next we are going to create a plotting function for the **county** level data. The goal of this function will be for the user to be able to input a state of interest using the 2-letter abbreviated (the default value is NC), determine whether the **top** or **bottom** most counties are the target (default of **top**), and finally an instruction to determine how many of the ‘top’ or bottom most counties should be investigated (default of 5).

```

plot.county <- function(tib, var_name = "enrollment_count",
                        state.name="NC",
                        top_bottom = "top",
                        n_counties = 5) {

  #creating an object to change y axis based on var_name
  y_label <- paste("Mean", gsub("_", " ", var_name))

  #creating an object to change title based on inputs
  plot_title <- paste("Census Data from",
                     top_bottom,
                     n_counties,
                     "Counties in",
                     state.name)

  #filter data by state
  state_data <- tib |>
    filter(state == state.name)
}

```

```

#calculate mean of the chosen variable (default enrollment_count) for each county.
county_means <- state_data |>
  group_by(county) |>
  summarise(mean_var_name = mean(get(var_name), na.rm=TRUE), .groups="drop")

#using the mean value, sort base on if top or bottom is requested
#then slice based on number of counties requested
sorted_county_means <- if (top_bottom == "top") {
  county_means |>
    arrange(desc(mean_var_name))
  } else {
  county_means |>
    arrange(mean_var_name)
  }

#pull out counties based on chosen rank and n
selected_counties <- sorted_county_means |>
  slice_head (n = n_counties) |>
  pull (county)

#Use initial data then filter from the subset after calculating means
plot_data <- state_data |>
  filter(county %in% selected_counties)

#Plot the values
ggplot(plot_data, aes(x = year, y= get(var_name), color = county)) +
  geom_line() +
  labs(x= "Year",
       y = y_label,
       title = plot_title) +
  scale_color_discrete("County") +
  guides(color= guide_legend(ncol = 2))
}

```

Demonstrating our Functions to Put it Together

We are now going to put all of our functions together to test their use.

The first iteration will be using the initial data we used to create the functions. The first step is to process the data utilizing the `enrollment data` column. We will then combine the 2 data frames to make 1 list.

```
#processing the data using the 2 data sets with our function
county_data <- process_census_data(url = "https://www4.stat.ncsu.edu/~online/datasets/EDU01a")
state_data <- process_census_data(url = "https://www4.stat.ncsu.edu/~online/datasets/EDU01b")

#using our function to make a list with the 2 data sets
census <- combine_census_data(county_data, state_data)

#indexing to display the first 15 values of the county data
census[[1]] |>
  head(n=15)
```

```
# A tibble: 15 x 6
  county state STCOU survey_ID enrollment_count year
  <chr>   <chr> <int> <chr>          <int> <dbl>
1 Autauga AL      1001 EDU0101          6829 1987
2 Autauga AL      1001 EDU0101          6900 1988
3 Autauga AL      1001 EDU0101          6920 1989
4 Autauga AL      1001 EDU0101          6847 1990
5 Autauga AL      1001 EDU0101          7008 1991
6 Autauga AL      1001 EDU0101          7137 1992
7 Autauga AL      1001 EDU0101          7152 1993
8 Autauga AL      1001 EDU0101          7381 1994
9 Autauga AL      1001 EDU0101          7568 1995
10 Autauga AL      1001 EDU0101          7834 1996
11 Baldwin AL     1003 EDU0101         16417 1987
12 Baldwin AL     1003 EDU0101         16465 1988
13 Baldwin AL     1003 EDU0101         16799 1989
14 Baldwin AL     1003 EDU0101         17054 1990
15 Baldwin AL     1003 EDU0101         17479 1991
```

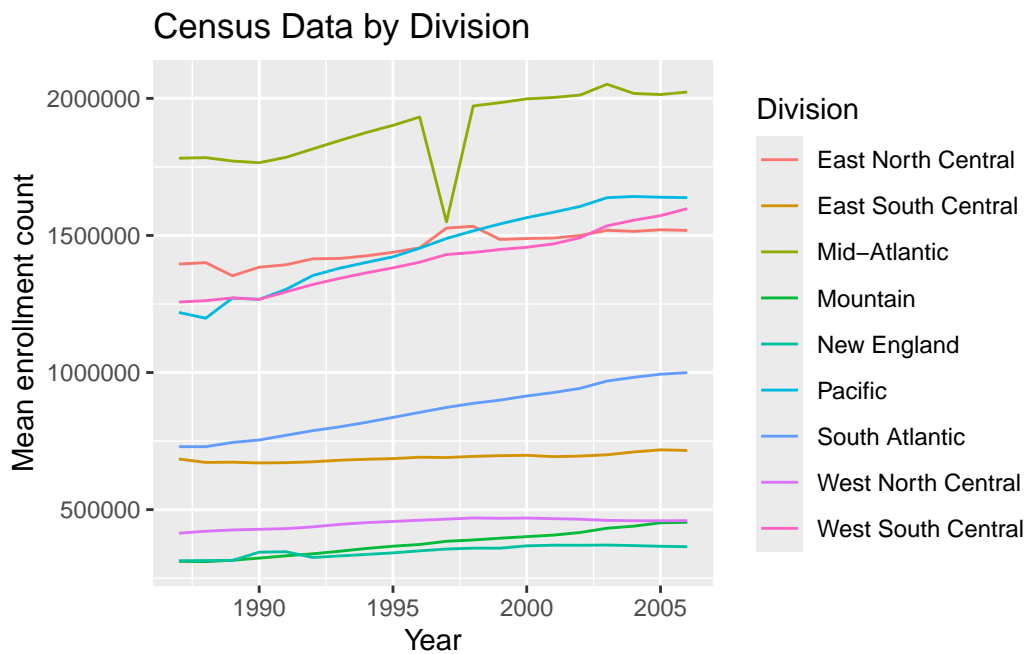
```
#indexing to display the last 15 values of the state data to avoid `ERROR` in `division`
census[[2]] |>
  tail(n=15)
```

```
# A tibble: 15 x 6
  area_name STCOU survey_ID enrollment_count year division
  <chr>      <int> <chr>          <int> <dbl> <chr>
1 WISCONSIN 55000 EDU0102          879361 2002 East North Central
2 WISCONSIN 55000 EDU0152          880031 2003 East North Central
3 WISCONSIN 55000 EDU0152          864652 2004 East North Central
4 WISCONSIN 55000 EDU0152          875174 2005 East North Central
```

5	WISCONSIN	55000	EDU0152	876700	2006	East North Central
6	WYOMING	56000	EDU0101	99058	1997	Mountain
7	WYOMING	56000	EDU0101	97115	1998	Mountain
8	WYOMING	56000	EDU0101	94988	1999	Mountain
9	WYOMING	56000	EDU0102	92283	2000	Mountain
10	WYOMING	56000	EDU0102	89940	2001	Mountain
11	WYOMING	56000	EDU0102	87897	2002	Mountain
12	WYOMING	56000	EDU0152	87462	2003	Mountain
13	WYOMING	56000	EDU0152	84733	2004	Mountain
14	WYOMING	56000	EDU0152	86420	2005	Mountain
15	WYOMING	56000	EDU0152	85193	2006	Mountain

Next we are going to test out our plotting function for the state data frame.

```
plot.state(census[[2]], var_name = "enrollment_count")
```

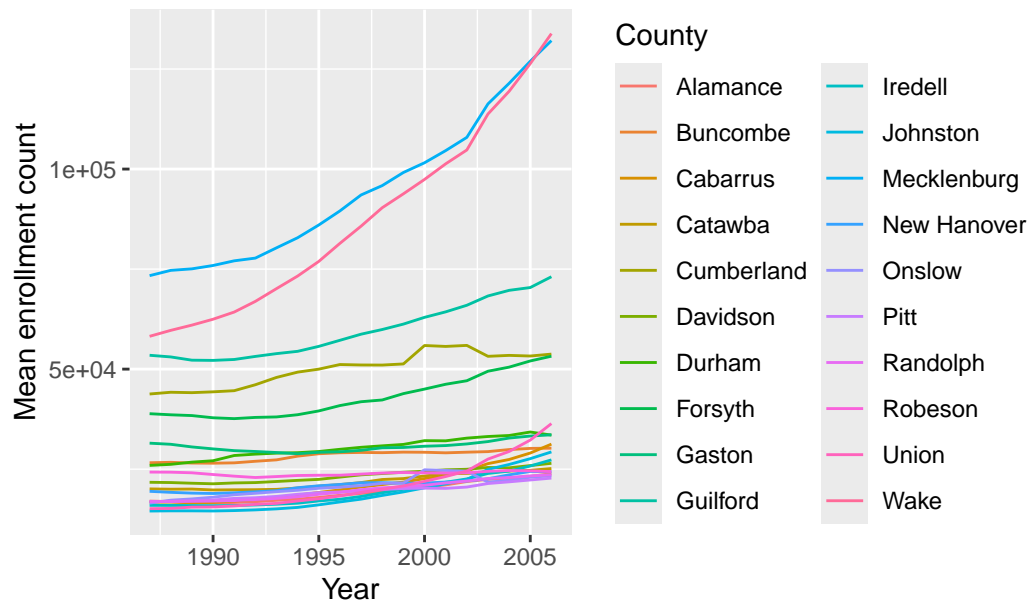


Finally, let's test out multiple inputs using our county data.

1. Let's look at the state of "NC" and the top 20 counties for enrollment data

```
plot.county(census[[1]], var_name = "enrollment_count",
             state.name="NC",
             top_bottom = "top",
             n_counties = 20)
```

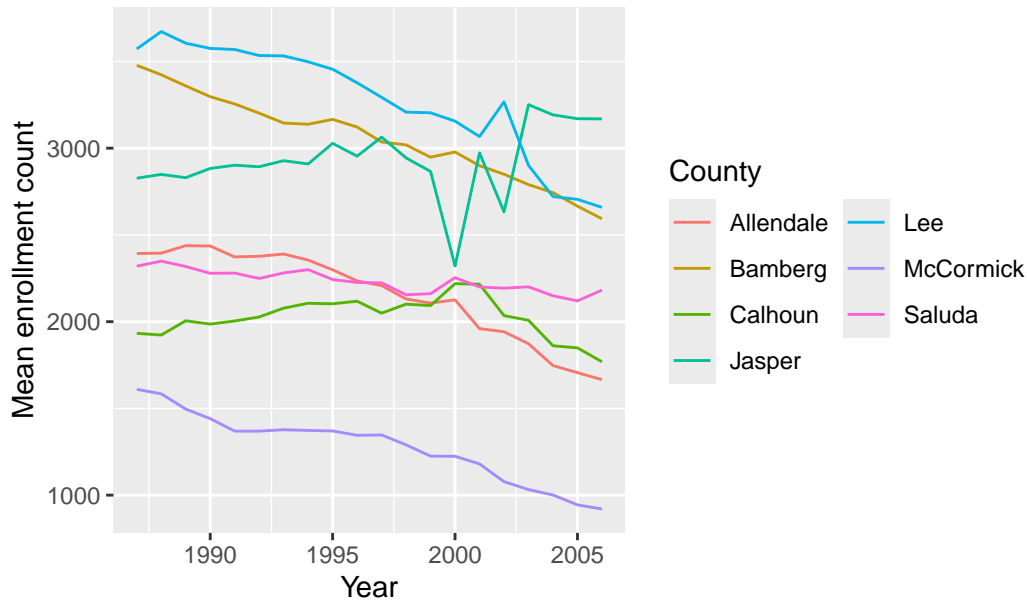

Census Data from top 20 Counties in NC



2. Let's look at the state of "SC" and the bottom 7 counties for enrollment data

```
plot.county(census[[1]], var_name = "enrollment_count",
             state.name="SC",
             top_bottom = "bottom",
             n_counties = 7)
```

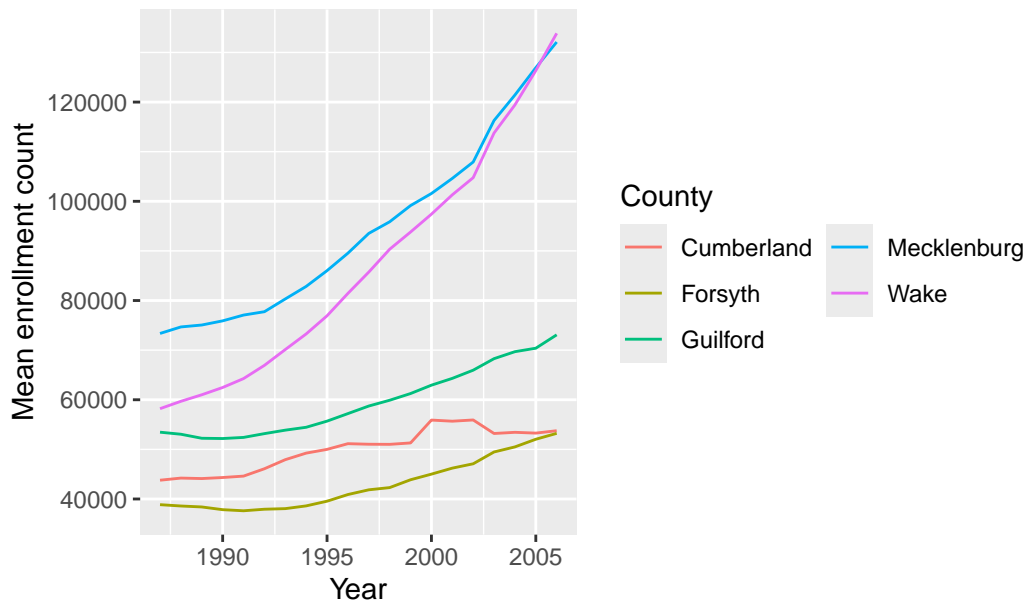
Census Data from bottom 7 Counties in SC



3. Let's now look at whether our defaults are working. To reference back, we chose a default state of "NC" with the top 5 counties

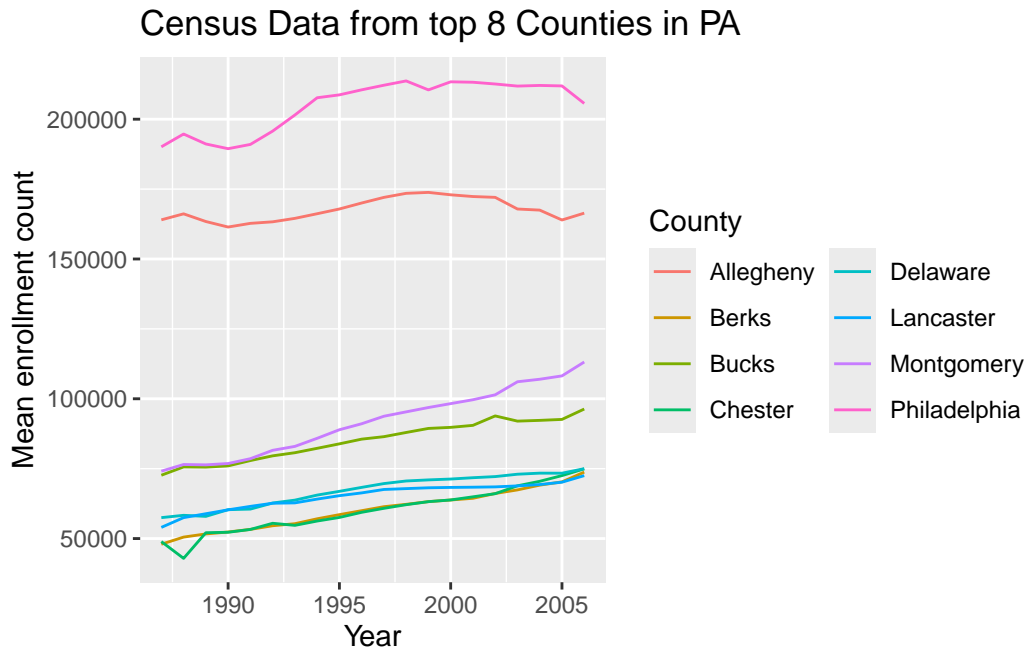
```
plot.county(census[[1]])
```

Census Data from top 5 Counties in NC



4. Finally, let's look at the state of "PA" and the top 8 counties for enrollment data

```
plot.county(census[[1]], var_name = "enrollment_count",
             state.name="PA",
             top_bottom = "top",
             n_counties = 8)
```



Looks like so far our functions are performing as desired!

Now let's utilize different data sets to apply our functions.

```
#run the data processing function for each dataset
data_pst01a <- process_census_data(url = "http://www4.stat.ncsu.edu/~online/datasets/PST01a.")
data_pst01b <- process_census_data(url = "http://www4.stat.ncsu.edu/~online/datasets/PST01b.")
data_pst01c <- process_census_data(url = "http://www4.stat.ncsu.edu/~online/datasets/PST01c.")
data_pst01d <- process_census_data(url = "http://www4.stat.ncsu.edu/~online/datasets/PST01d.")

#now we need to run our data combining function 3 times to get our desired list that contains
#tibbles, 1 for county data and 1 for state data
```

```

census_pst_ab <- combine_census_data(data_pst01a, data_pst01b)

census_pst_abc <- combine_census_data(census_pst_ab, data_pst01c)

census_pst_abcd <- combine_census_data(census_pst_abc, data_pst01d)

#indexing to display the first 15 values of the county data
census_pst_abcd[[1]] |>
  head(n=15)

```

```

# A tibble: 15 x 6
  county state STCOU survey_ID enrollment_count year
  <chr>   <chr> <int> <chr>          <int> <dbl>
1 Autauga AL      1001 PST0151          25508 1971
2 Autauga AL      1001 PST0151          27166 1972
3 Autauga AL      1001 PST0151          28463 1973
4 Autauga AL      1001 PST0151          29266 1974
5 Autauga AL      1001 PST0151          29718 1975
6 Autauga AL      1001 PST0151          29896 1976
7 Autauga AL      1001 PST0151          30462 1977
8 Autauga AL      1001 PST0151          30882 1978
9 Autauga AL      1001 PST0151          32055 1979
10 Autauga AL      1001 PST0251          31985 1981
11 Baldwin AL     1003 PST0151          60141 1971
12 Baldwin AL     1003 PST0151          62435 1972
13 Baldwin AL     1003 PST0151          64195 1973
14 Baldwin AL     1003 PST0151          66071 1974
15 Baldwin AL     1003 PST0151          67860 1975

```

```

#indexing to display the last 15 values of the state data to avoid `ERROR` in `division`
census_pst_abcd[[2]] |>
  tail(n=15)

```

```

# A tibble: 15 x 6
  area_name STCOU survey_ID enrollment_count year division
  <chr>     <int> <chr>          <int> <dbl> <chr>
1 WISCONSIN 55000 PST0452          5541443 2005 East North Central
2 WISCONSIN 55000 PST0452          5571680 2006 East North Central
3 WISCONSIN 55000 PST0452          5601571 2007 East North Central
4 WISCONSIN 55000 PST0452          5627610 2008 East North Central
5 WISCONSIN 55000 PST0452          5654774 2009 East North Central

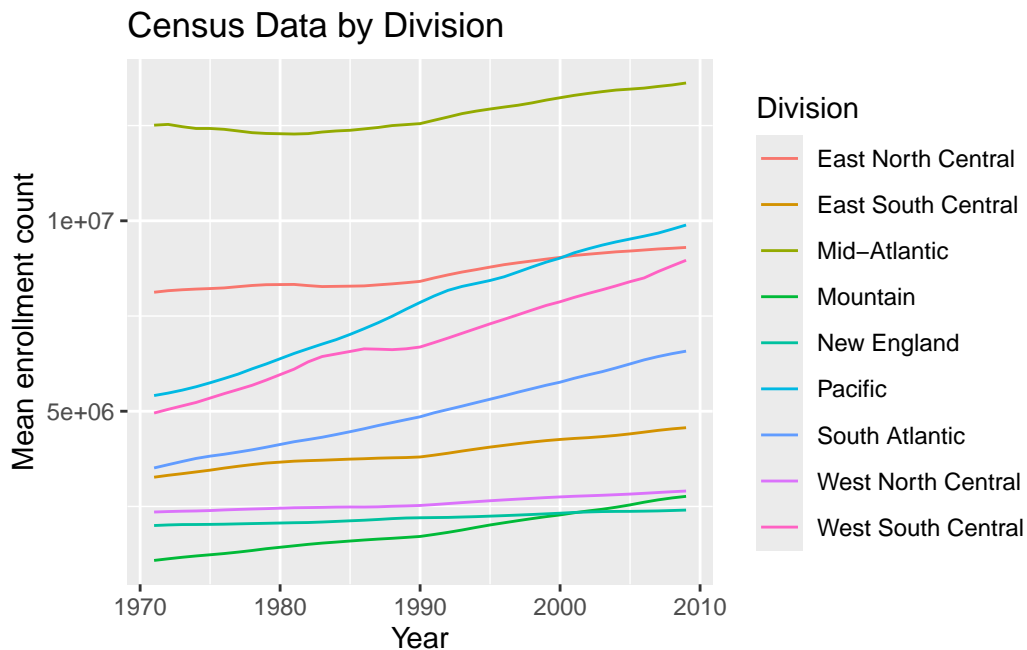
```

6	WYOMING	56000	PST0452	493958	2000	Mountain
7	WYOMING	56000	PST0452	492982	2001	Mountain
8	WYOMING	56000	PST0452	497069	2002	Mountain
9	WYOMING	56000	PST0452	499189	2003	Mountain
10	WYOMING	56000	PST0452	502988	2004	Mountain
11	WYOMING	56000	PST0452	506242	2005	Mountain
12	WYOMING	56000	PST0452	512841	2006	Mountain
13	WYOMING	56000	PST0452	523414	2007	Mountain
14	WYOMING	56000	PST0452	532981	2008	Mountain
15	WYOMING	56000	PST0452	544270	2009	Mountain

It looks like this data is older than our previous data. The year of the surveys ranges from 1971 to 2009. Additionally, this is from a different survey, with a prefix of PST. Now that we read in the 4 data sets and combined them, separating out the `county` and `state` data, let's make some plots.

Our first plot will contain our data from our `state` data.

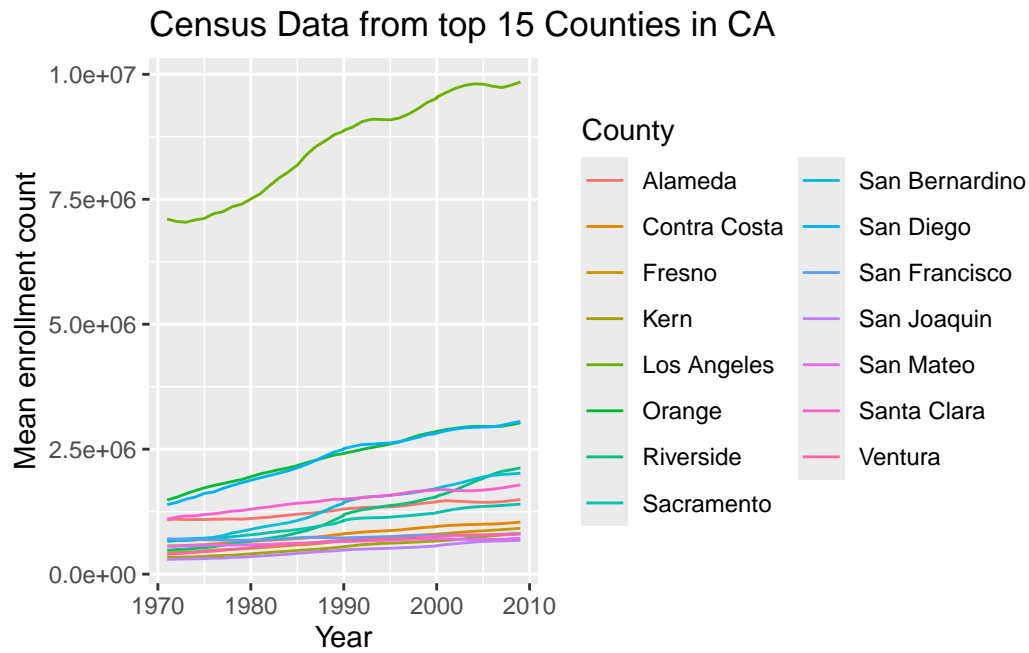
```
plot.state(census_pst_abcd[[2]],var_name = "enrollment_count")
```



Now we are going to run some plots utilizing our `county` data

1. Here is the data from California with the top 15 counties of enrollment means

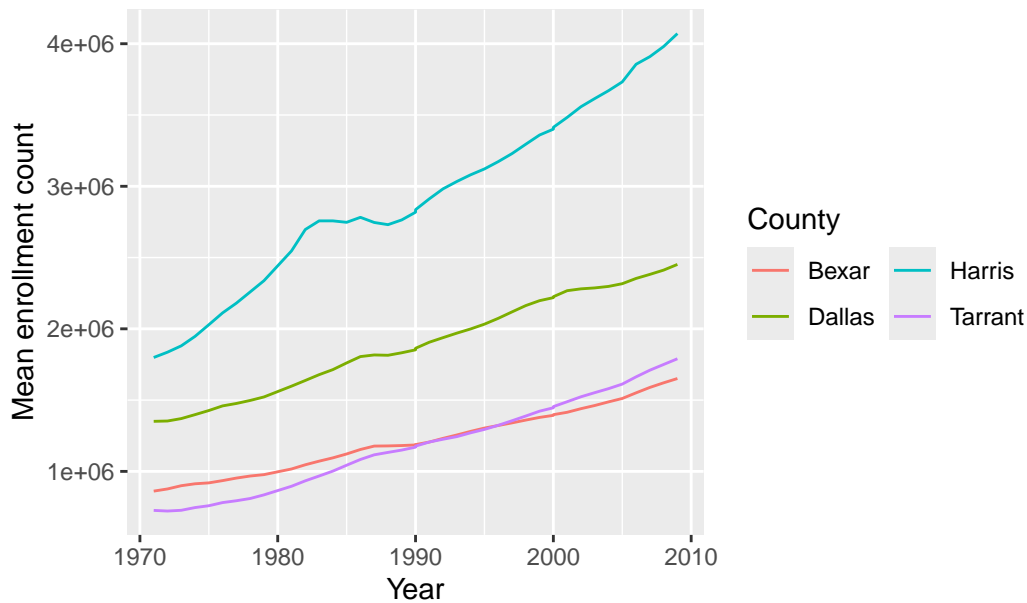
```
plot.county(census_pst_abcd[[1]],var_name = "enrollment_count",
            state.name="CA",
            top_bottom = "top",
            n_counties = 15)
```



2. Next, let's look at the top 4 counties from Texas

```
plot.county(census_pst_abcd[[1]],var_name = "enrollment_count",
            state.name="TX",
            top_bottom = "top",
            n_counties = 4)
```

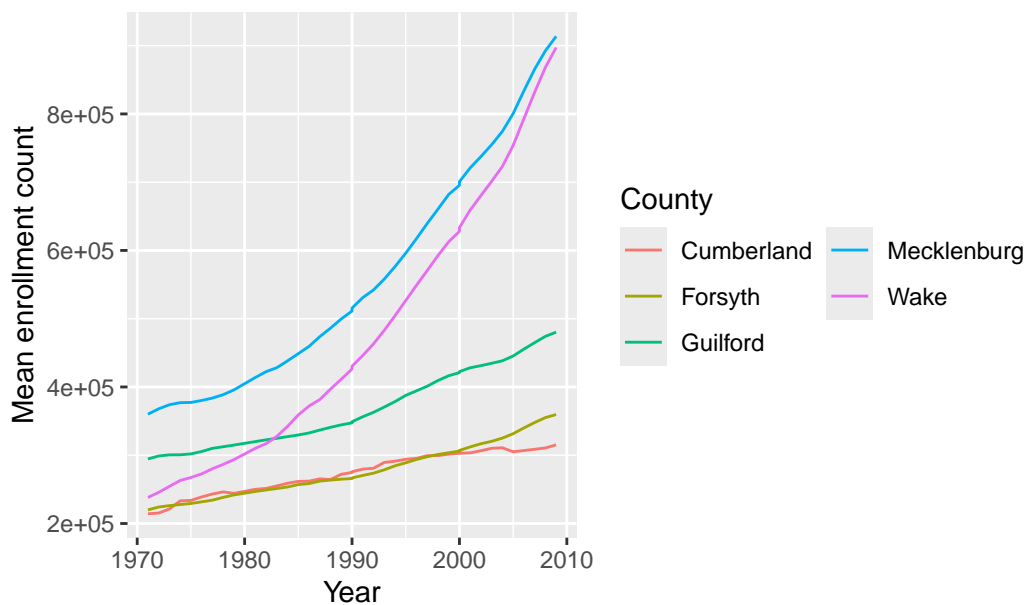
Census Data from top 4 Counties in TX



3. Here is the plot using our defaults in our plotting function. To reference back, we chose a default state of “NC” with the top 5 counties

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

Census Data from top 5 Counties in NC



4. Finally, we are going to look at the top 10 counties, based on enrollment mean, from New York

```
plot.county(census_pst_abcd[[1]], var_name = "enrollment_count",  
            state.name="NY",  
            top_bottom = "top",  
            n_counties = 10)
```

