FINAL TERM PROJECT - FALL (2022-23)

PROJECT TITLE: WEB SCRAPPING

COURSE: INTRODUCTION TO DATA SCIENCE

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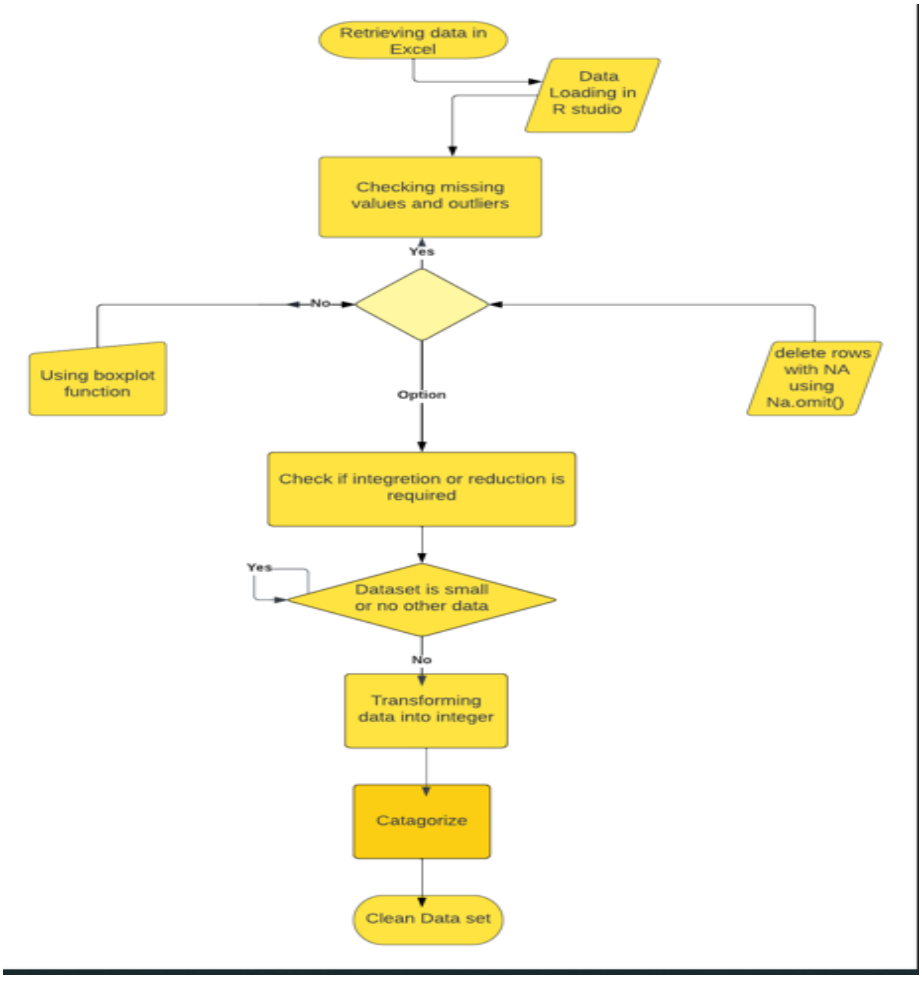
Project Overview:

In this project I have worked on web-scrapping, Data pre-processing, Descriptive statistics and Data visualization. So, first of all I have scrapped a data table from a website by using regarding R codes on R studio. Then I have loaded this data table as in csv format. After that I have used Data Cleaning methods to process those data and to clean them. Then I have calculated different statistics values for different variables. Finally, I have graphed bar charts to do Data Visualization. For those process I have to install several libraries.

Project Design:



Web Scrapping:

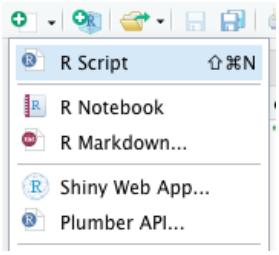
Web scraping is an automatic method to obtain large amounts of data from websites. Most of this data is unstructured data in an HTML format which is then converted into structured data in a spreadsheet or a database so that it can be used in various applications. There are many different ways to perform web scraping to obtain data from websites. These include using online services, particular API's or even creating your code for web scraping from scratch. Many large websites, like Google, Twitter, Facebook, Stack Overflow, etc. have API's that allow to access their data in a structured format. This is the best option, but there are other sites that don't allow users to access large amounts of data in a structured form or they are simply not that technologically advanced. In that situation, it's best to use Web Scraping to scrape the website for data.

Scraping tabular data is one of the most powerful skills data scientists can have to gather relevant information at scale. Nowadays, almost every set of data shown on the internet uses HTML tables to organize and display complex set of data in a more understandable format.

Here I'm going to use the Rvest package to extract data from HTML tables and send it to a data frame for further analysis, and import it to a CSV file.

Step 1: Set Up Your Development Environment

The first thing I need to do is creating a new directory for our project. Open RStudio and click on "create a project". Inside the new folder, click on "new file" and create a new R Script. Let's named Scrapping_5 (it'll automatically save it as a. R file).



On our new file, we'll install the Rvest, Dply, xml2, tidyverse packages using the following commands:

```
install.packages('rvest')
install.packages('dplyr')
installed.packages('xml2')
install.packages("tidyverse")

library(rvest)
library(dplyr)
library(xml2)
library(tidyverse)
```

Rvest: rvest helps to scrape information from web pages.
Dplyr: dplyr is a grammar of data manipulation, providing a consistent set of verbs that help you solve the most common data manipulation.
Xml: helps to read files.

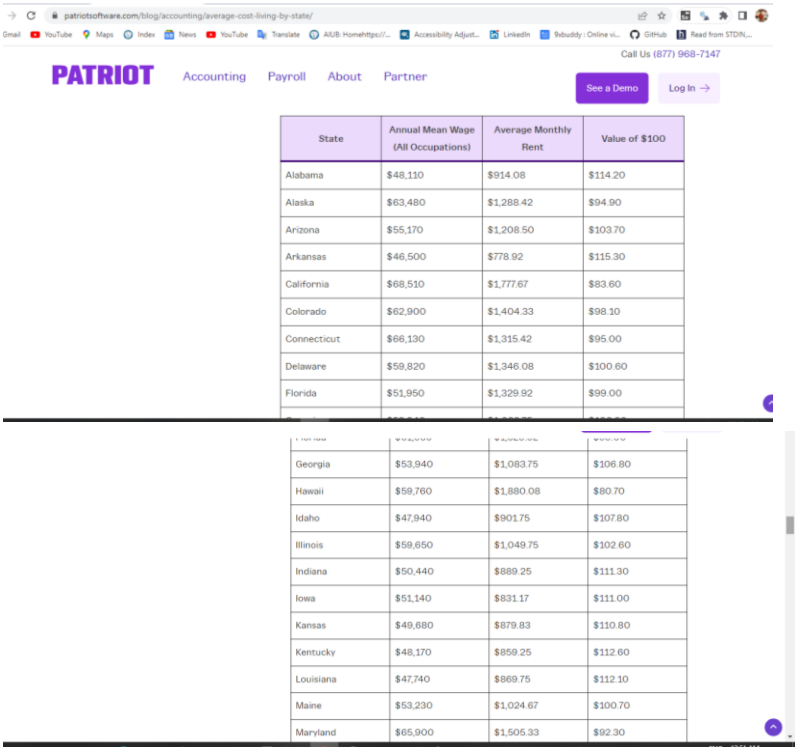
It can take a couple of minutes to install, but with this last step, we're ready to create our scraper.

Step 2: Select the website and send initial request to the web

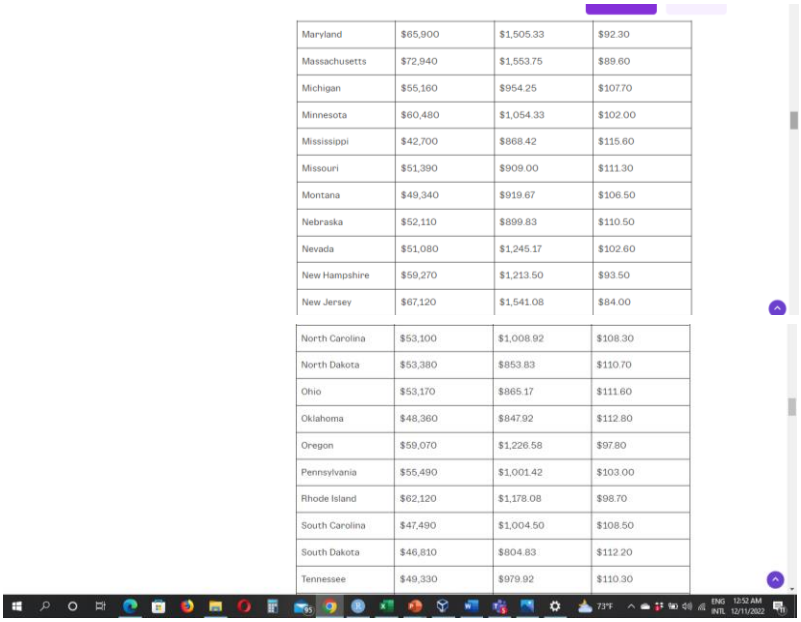
So first, let's take a look at our target site:

I have selected my target website and its URL is: https://www.patriotsoftware.com . Now, I have chosen a Data Table named "U.S. cost of living comparison by state" from this website.

Here is Data Table which I have selected for scraping.



State	Annual Mean Wage (All Occupations)	Average Monthly Rent	Value of $100
Alabama	$48,110	$914.08	$114.20
Alaska	$63,480	$1,288.42	$94.90
Arizona	$55,170	$1,208.50	$103.70
Arkansas	$46,500	$778.92	$115.30
California	$68,510	$1,777.67	$83.60
Colorado	$62,900	$1,404.33	$98.10
Connecticut	$66,130	$1,315.42	$95.00
Delaware	$59,820	$1,346.08	$100.60
Florida	$51,950	$1,329.92	$99.00
Georgia	$53,940	$1,083.75	$106.80
Hawaii	$59,760	$1,880.08	$80.70
Idaho	$47,940	$901.75	$107.80
Illinois	$59,650	$1,049.75	$102.60
Indiana	$50,440	$889.25	$111.30
Iowa	$51,140	$831.17	$111.00
Kansas	$49,680	$879.83	$110.80
Kentucky	$48,170	$859.25	$112.60
Louisiana	$47,740	$869.75	$112.10
Maine	$53,230	$1,024.67	$100.70
Maryland	$65,900	$1,505.33	$92.30



Maryland	$65,900	$1,505.33	$92.30
Massachusetts	$72,940	$1,553.75	$89.60
Michigan	$55,160	$954.25	$107.70
Minnesota	$60,480	$1,054.33	$102.00
Mississippi	$42,700	$868.42	$115.60
Missouri	$51,390	$909.00	$111.30
Montana	$49,340	$919.67	$106.50
Nebraska	$52,110	$899.83	$110.50
Nevada	$51,080	$1,245.17	$102.60
New Hampshire	$59,270	$1,213.50	$93.50
New Jersey	$67,120	$1,541.08	$84.00
North Carolina	$53,100	$1,008.92	$108.30
North Dakota	$53,380	$853.83	$110.70
Ohio	$53,170	$865.17	$111.60
Oklahoma	$48,360	$847.92	$112.80
Oregon	$59,070	$1,226.58	$97.80
Pennsylvania	$55,490	$1,001.42	$103.00
Rhode Island	$62,120	$1,178.08	$98.70
South Carolina	$47,490	$1,004.50	$108.50
South Dakota	$46,810	$804.83	$112.20
Tennessee	$49,330	$979.92	$110.30

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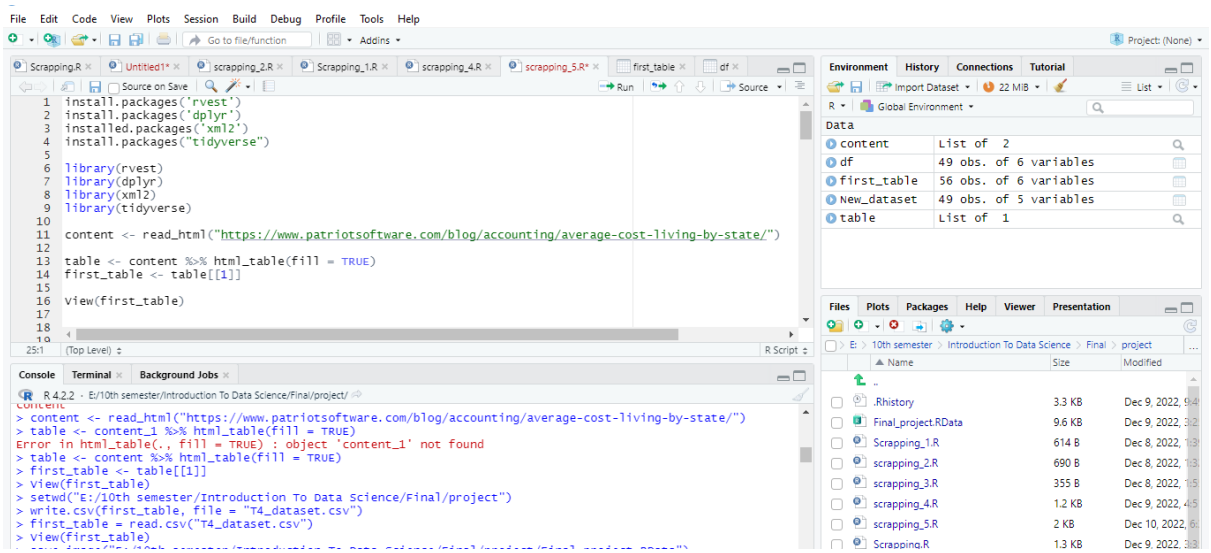
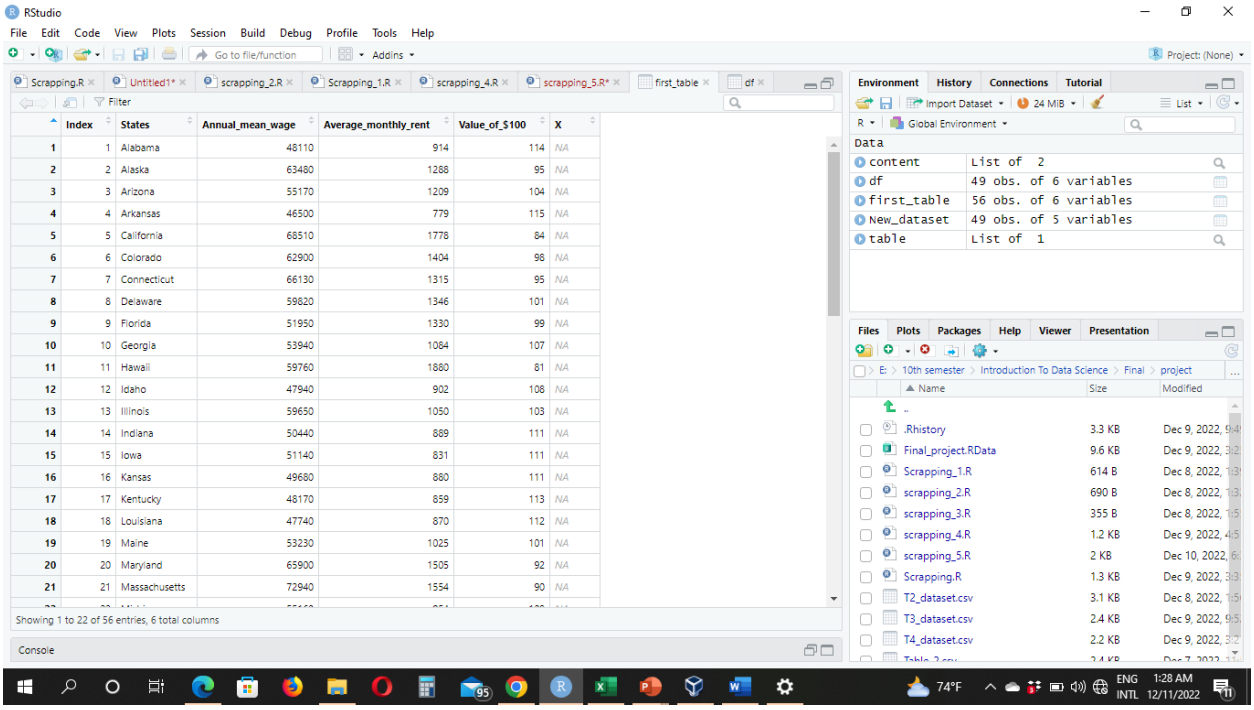
Tennessee	$49,330	$979.92	$110.30
Texas	$54,230	$1,090.83	$103.50
Utah	$53,400	$1,171.08	$103.50
Vermont	$55,450	*Not provided*	$96.90
Virginia	$62,330	$1,351.33	$98.70
Washington	$68,740	$1,487.58	$91.60
West Virginia	$46,490	$786.83	$112.90
Wisconsin	$53,120	$943.58	$108.10
Wyoming	$52,110	$876.92	$107.20

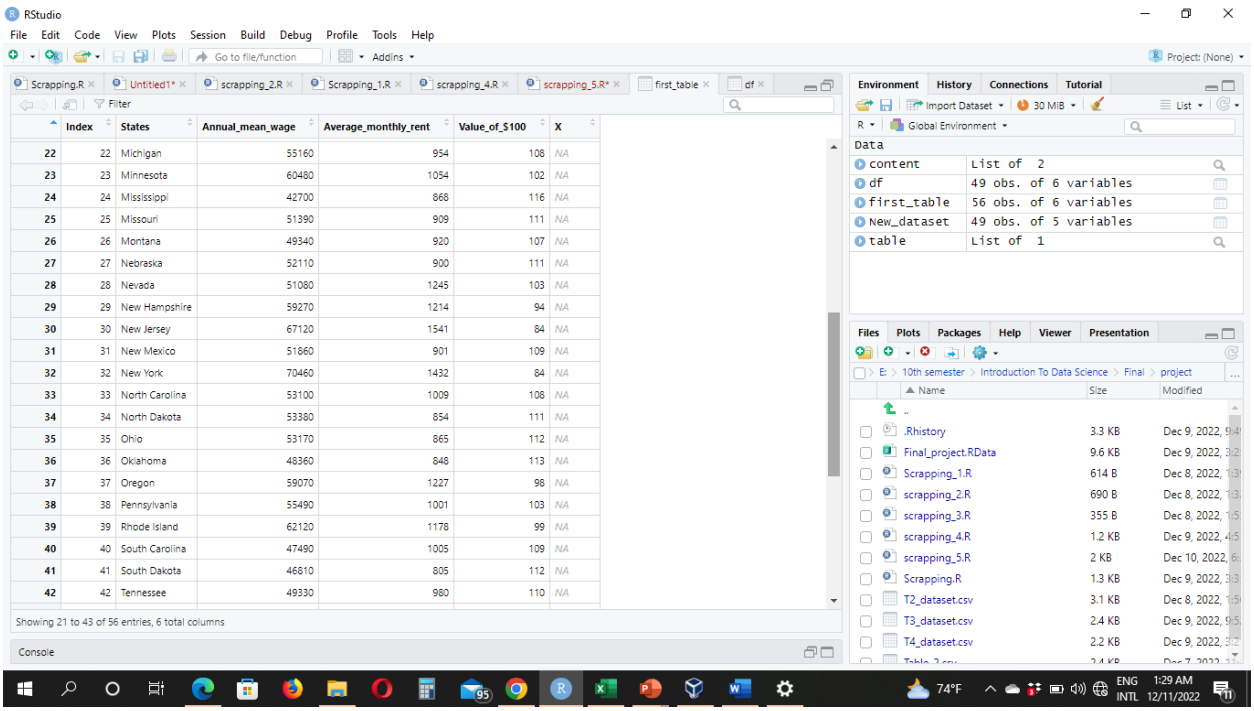
So now for retrieving this table first I need to copy the URL link and send it through read_html() function and also store it on a variable. Then, by using html_table() function I have store the link in a new variable table. After that I have pointed that as I'm going to retrieve table number 1 and store it in first_table variable. And now I have viewed that table.

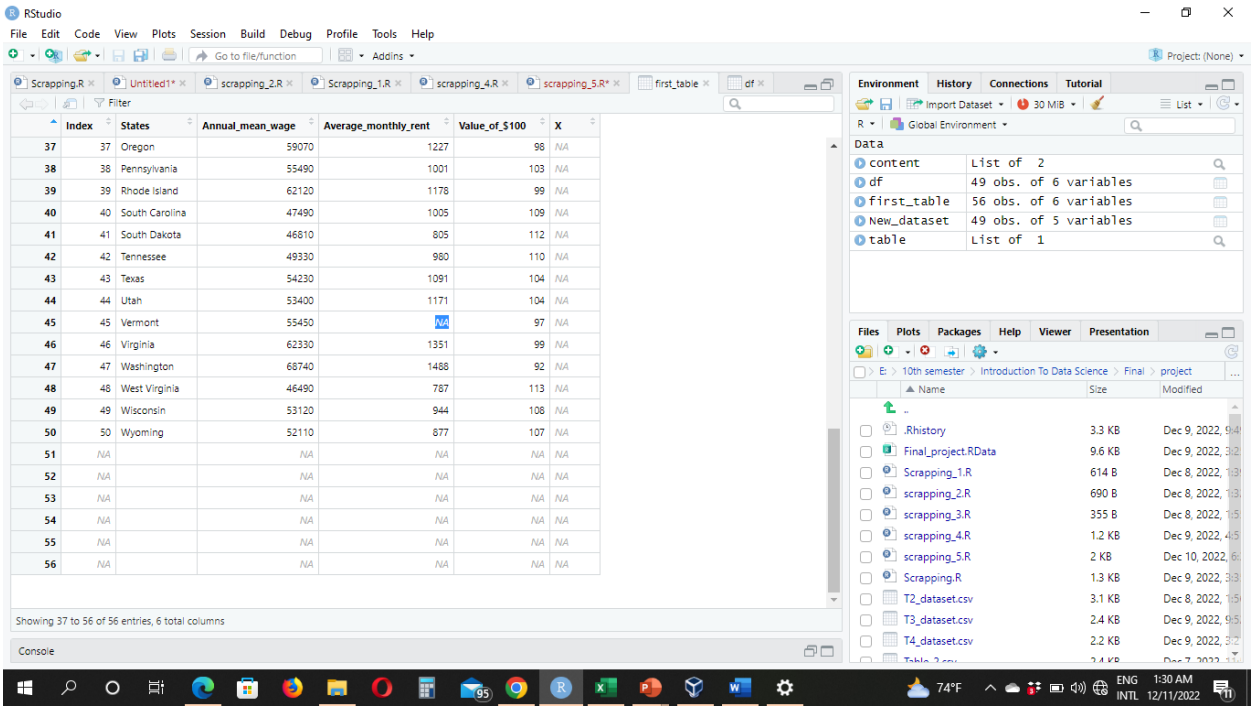
```
content <- read_html("https://www.patriotsoftware.com/blog/accounting/average-cost-living-by-state/")

table <- content %>% html_table(fill = TRUE)

first_table <- table[[1]]

View(first_table)
```



Retrived table with lots of NA (Not Available) or missing values.







Step 3:

Now it's time for save the scrapped table or the dataset in Csv format. I have set directory first and named the csv file as T5_dataset.csv

```
write.csv(first_table, file = "T5_dataset.csv")
```

```
first_table = read.csv("T5_dataset.csv")
```

Data Preprocessing

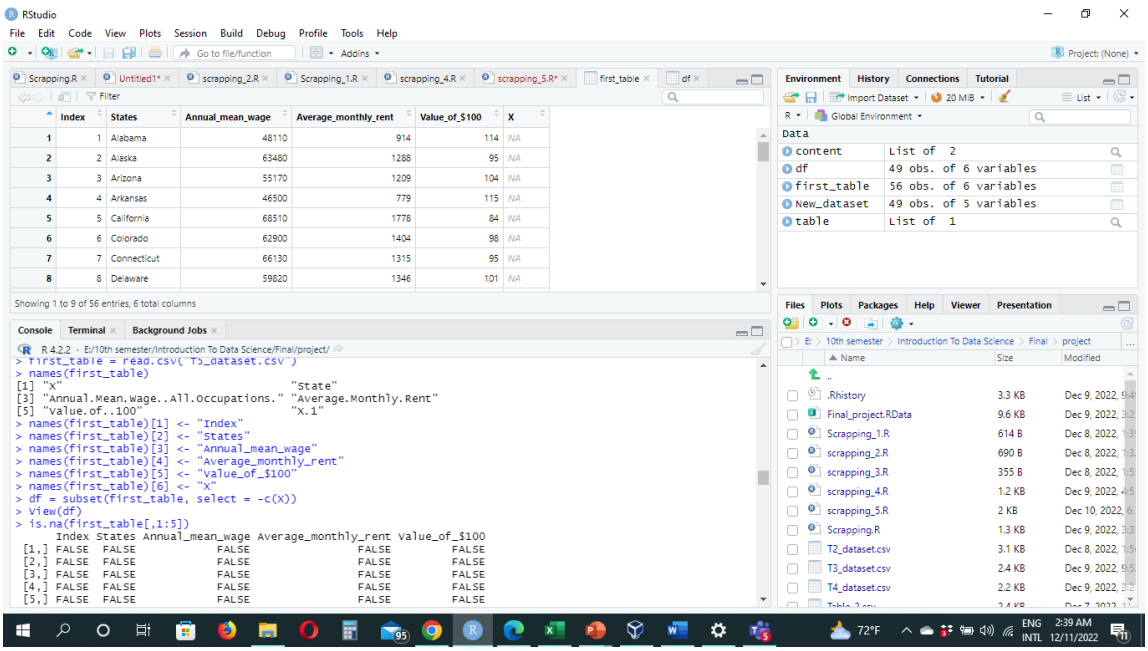
Data in the real world is often dirty; that is it is in need of being cleaned up before it can be used for a desired purpose. This is often called data pre-processing.

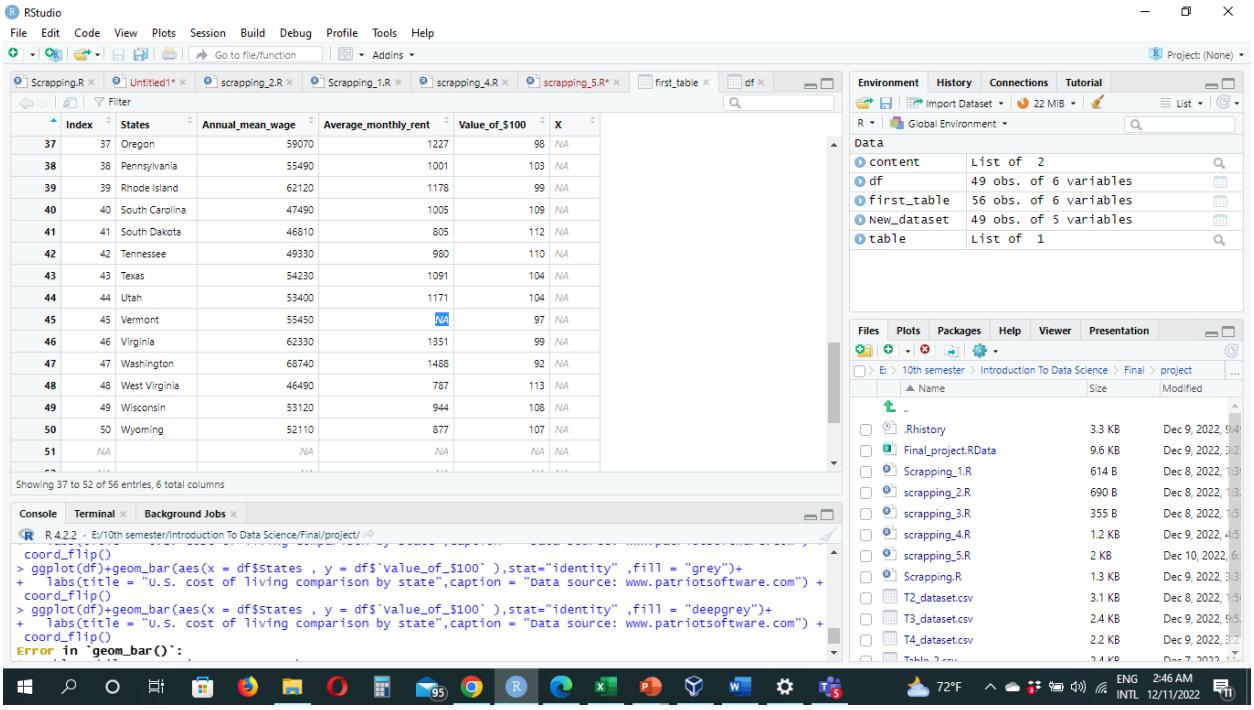
There some process for it:

1. Data cleaning:
    a. Smooth Noisy Data
    b. Handling Missing Data
    c. Data Wrangling or Munging
2. Data Integration
3. Data Transformation
4. Data Reduction
5. Data Discretization

First of all I have renamed all column names.

```
#renaming tables
names(first_table)
names(first_table)[1] <- "Index"
names(first_table)[2] <- "States"
names(first_table)[3] <- "Annual_mean_wage"
names(first_table)[4] <- "Average_monthly_rent"
names(first_table)[5] <- "Value_of_$100"
names(first_table)[6] <- "X"
```





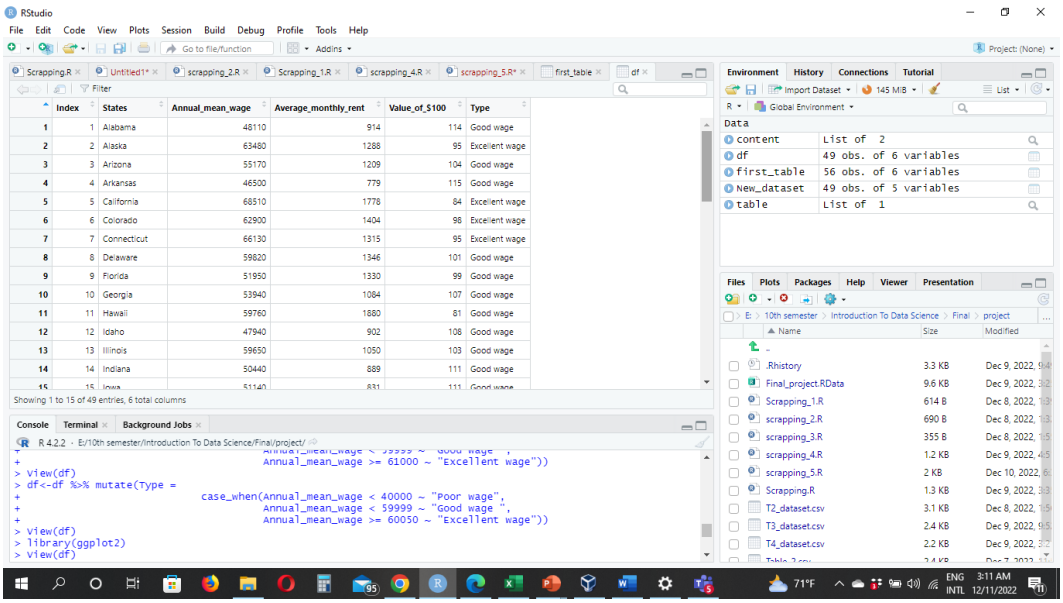
Handling missing data:

Then started data cleaning process. By using is.Na() I have found out which columns and rows have NA values. I saw that “X” named column had full of NA values. So, I have used subset function to remove this entire column. And then I have used NA.omit() to delete an entire row having NA value.

```
#delete column with NA value
df = subset(first_table, select = -c(X))
is.na(df[,1:5])

#delete NA row
df <- na.omit(df)
```

As my dataset values are already in integer format so I didn't have to perform data integration, data transformation and reduction here. All I need to categorize the values of dataset. So, I have set Annual mean wage (all occupations) into three categories.

```
library(dplyr)
df<-df %>% mutate(Type =
                    case_when(Annual_mean_wage < 40000 ~ "Poor wage",
                              Annual_mean_wage < 59999 ~ "Good wage ",
                              Annual_mean_wage >= 60050 ~ "Excellent wage"))
View(df)
```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Index States Annual_mean_wage Average_monthly_rent Value_of_$100 Type
1 1 Alabama 48110 914 114 Good wage
2 2 Alaska 63480 1288 95 Excellent wage
3 3 Arizona 55170 1209 104 Good wage
4 4 Arkansas 46500 779 115 Good wage
5 5 California 68510 1778 84 Excellent wage
6 6 Colorado 62900 1404 98 Excellent wage
7 7 Connecticut 66130 1315 95 Excellent wage
8 8 Delaware 59820 1346 101 Good wage
9 9 Florida 51950 1330 99 Good wage
10 10 Georgia 53940 1084 107 Good wage
11 11 Hawaii 59760 1880 81 Good wage
12 12 Idaho 47940 902 108 Good wage
13 13 Illinois 59650 1050 103 Good wage
14 14 Indiana 50440 889 111 Good wage
Showing 1 to 15 of 49 entries, 6 total columns
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Annual_mean_wage >= 61000 ~ "Excellent wage"))
> view(df)
> df<-df %>% mutate(Type =
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+ Annual_mean_wage < 59999 ~ "Good wage ",
+ Annual_mean_wage >= 60050 ~ "Excellent wage"))
> view(df)
> library(ggplot2)
> view(df)
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content List of 2
df 49 obs. of 6 variables
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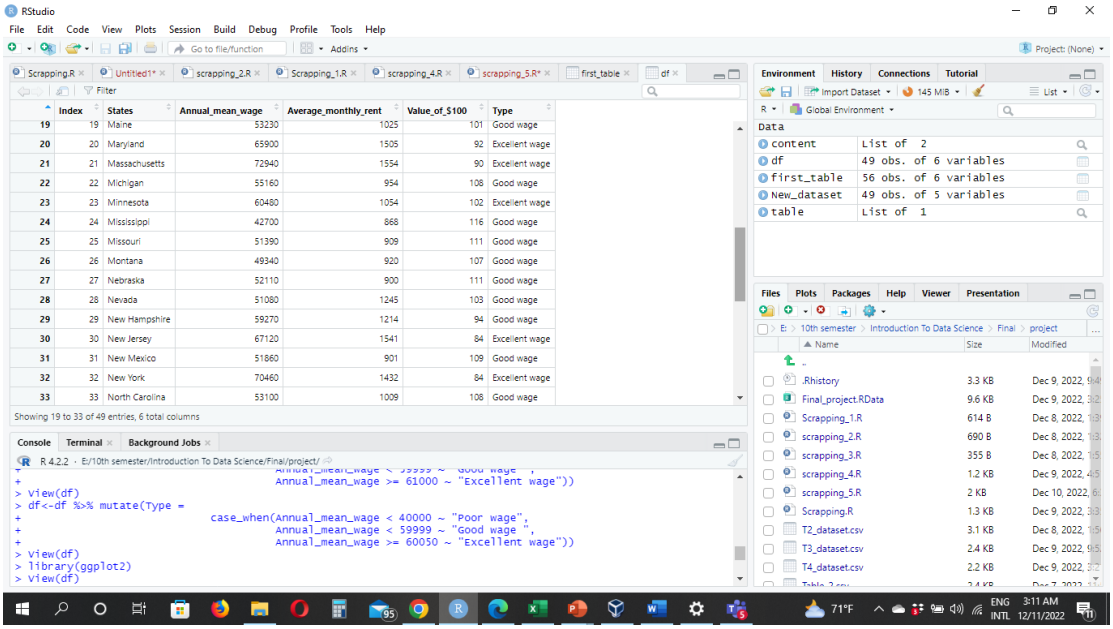
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Scrapping.R Untitled1* scrapping_2.R Scrapping_1.R scrapping_4.R scrapping_5.R* first_table df
Filter
Index States Annual_mean_wage Average_monthly_rent Value_of_$100 Type
19 19 Maine 53230 1025 101 Good wage
20 20 Maryland 65900 1505 92 Excellent wage
21 21 Massachusetts 72940 1554 90 Excellent wage
22 22 Michigan 55160 954 108 Good wage
23 23 Minnesota 60460 1054 102 Excellent wage
24 24 Mississippi 42700 868 116 Good wage
25 25 Missouri 51390 909 111 Good wage
26 26 Montana 49340 920 107 Good wage
27 27 Nebraska 52110 900 111 Good wage
28 28 Nevada 51080 1245 103 Good wage
29 29 New Hampshire 59270 1214 94 Good wage
30 30 New Jersey 67120 1541 84 Excellent wage
31 31 New Mexico 51860 901 109 Good wage
32 32 New York 70460 1432 84 Excellent wage
33 33 North Carolina 53100 1009 108 Good wage
Showing 19 to 33 of 49 entries, 6 total columns
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Annual_mean_wage >= 61000 ~ "Excellent wage"))
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+ Annual_mean_wage >= 60050 ~ "Excellent wage"))
> view(df)
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> view(df)
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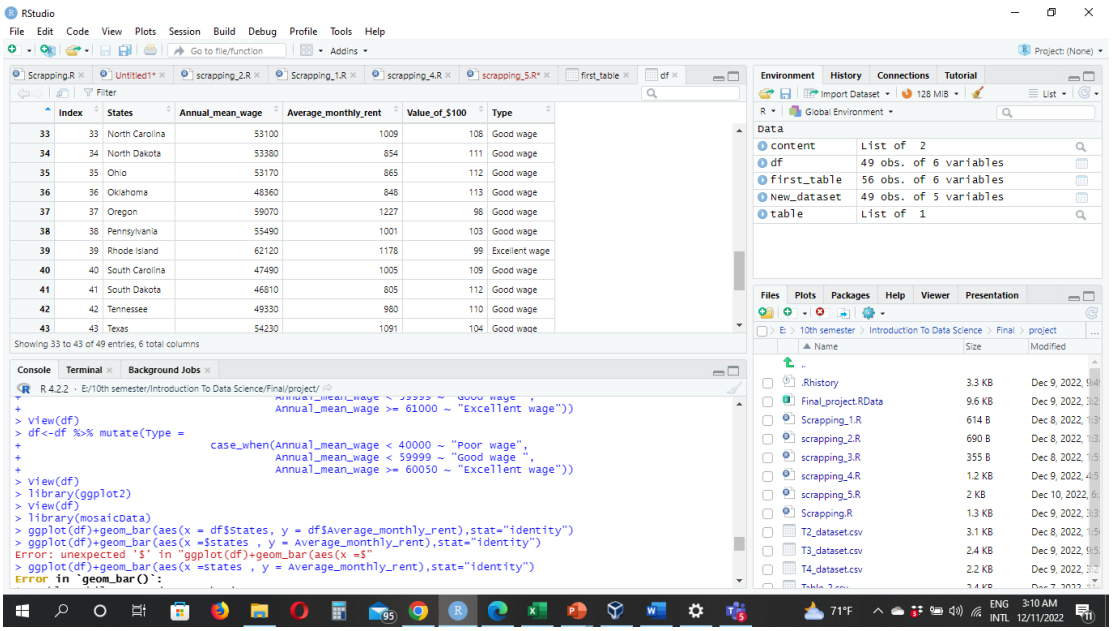
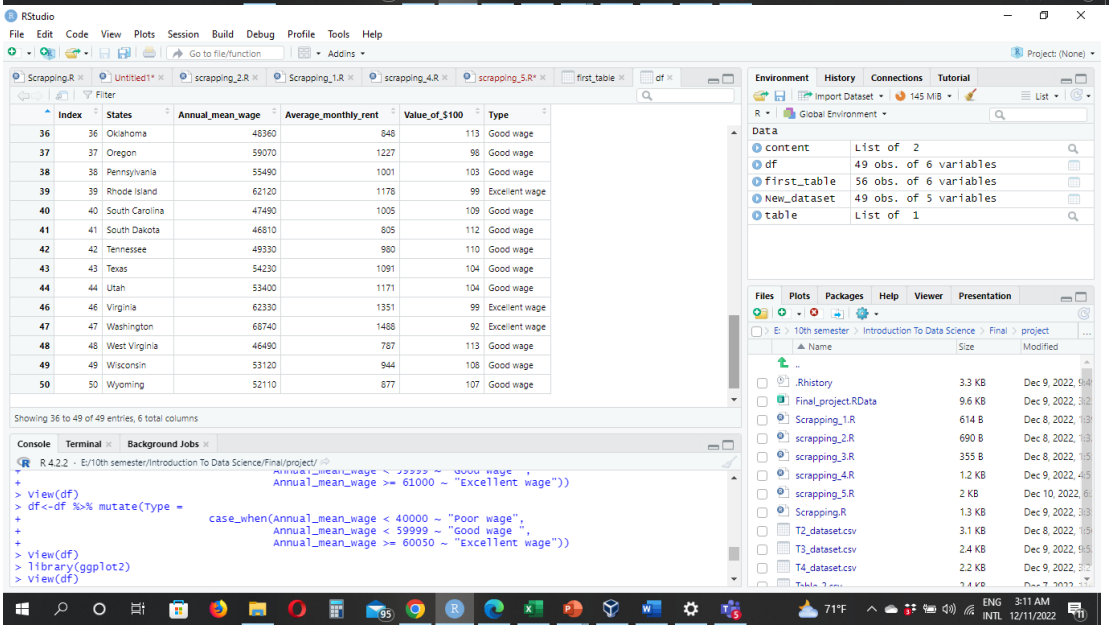




So, This Dataset df is clean now.

Descriptive Statistics:

Mean:

The mean (technically the arithmetic mean), is a measure of central tendency that is calculated by adding together all of the observations and dividing by the number of observations. I had to use mean() to determine mean.

Annual mean wage (for all occupation) = $55,363.5

Average monthly rent (mean) = $1104.306

Value Of $100(for different states) =$103.5918

```
#coding part

mean(df$Annual_mean_wage)

mean(df$Average_monthly_rent)

mean(df$`Value_of_$100`)
```

Median:

The median is another measure of central tendency but one that cannot be directly calculated. Instead, you make a sorted list of all of the observations in the sample and then go halfway up that list.

• Whatever the value of the observation is at the halfway point, that is the median.

• So, the median is the middle value in a data set ordered from low to high.

Median value for Annual mean wage (for all occupations) = 53230

Median value Average monthly rent (mean) = 1009

Median value Value Of $100(for different states) = 107

```
#Coding part

median(df$Annual_mean_wage)

median(df$Average_monthly_rent)

median(df$`Value_of_$100`)
```

Range:

The range is a measure of dispersion—how spread out a bunch of numbers in a sample are—calculated by subtracting the lowest value from the highest value. The range can only be calculated for numerical data. I Have to Use the R min() and max() functions to find the range.

The Range of Annual mean wage (for all occupations) = 30240

The Range of Average monthly rent (mean) = 1101

The Range of Value of $100(for different states) = 35

```
#Coding Part

max(df$Annual_mean_wage)-min(df$Annual_mean_wage)

max(df$Average_monthly_rent)-min(df$Average_monthly_rent)

max(df$`Value_of_$100`)-min(df$`Value_of_$100`)
```

Variance:

- The variance is a measure of dispersion.
- Like the range, the variance describes how spread out a sample of numbers is.
- Unlike the range, though, which uses just two numbers to calculate dispersion, the variance is obtained from all of the numbers through a simple calculation that compares each number to the mean.
- Steps to calculate variance:
  - A) Find the mean of the attribute you want to calculate the variance.
  - B) For Each Value of the attribute - Find the Difference from the Mean.
  - C) For Each Difference - Find the Square Value.
  - D) The Variance is the Average Number of These Squared Values.

The variance value of Annual mean wage (for all occupations) = 53329

The variance value of Average monthly rent (mean) = 72567.47

The variance of Value of $100(for different states) = 81.45493

```
#Coding Part

var(df$Annual_mean_wage)

var(df$Average_monthly_rent)
```

var(df$`Value_of_$100`)

Standard Deviation:

The standard deviation is simply the square root of the variance. Standard deviation measures how far a 'typical' observation is from the average of the data.

The Standard Deviation value of Annual mean wage (for all occupations) = 7302.711

The Standard Deviation value of Average monthly rent (mean) = 269.3835

The Standard Deviation value of Value of $100(for different states) = 9.025239

#Coding Part

sd(df$Annual_mean_wage)

sd(df$Average_monthly_rent)

sd(df$`Value_of_$100`)

Quartiles:

• Quartiles are values that separate the data into four equal parts.

• The quartiles (Q0, Q1, Q2, Q3, Q4) are the values that separate each quarter.

- Q0 is the smallest value in the data.
- Q1 is the value separating the first quarter from the second quarter of the data.
- Q2 is the middle value (median), separating the bottom from the top half.
- Q3 is the value separating the third quarter from the fourth quarter
- Q4 is the largest value in the data

• Using the R quantile() function I have to find the Quartiles of the values.

Quartile of Annual mean wage (for all occupations):

```
> quantile(df$Annual_mean_wage)
   0%   25%   50%   75%  100%
42700 49680 53230 59820 72940
>
```

Quartile of value of Average monthly rent (mean):

```
> quantile(df$Average_monthly_rent)
  0%  25%  50%  75% 100%
 779  889 1009 1288 1880
```

Quartile of Value of $100(for different states):

```
> quantile(df$`value_of_$100`)
  0%  25%  50%  75% 100%
  81   99  107  111  116
```

#Coding Part

quantile(df$Annual_mean_wage)

quantile(df$Average_monthly_rent)

quantile(df$`Value_of_$100`)

Interquartile:

• Interquartile range is the difference between the first and third quartiles (Q1 and Q3).

• The 'middle half' of the data is between the first and third quartile.

• The first quartile is the value in the data that separates the bottom 25% of values from the top 75%.

• The third quartile is the value in the data that separates the bottom 75% of the values from the top 25%.

Interquartile value of Annual mean wage (for all occupations) = 10140

Interquartile value of Average monthly rent (mean) = 399

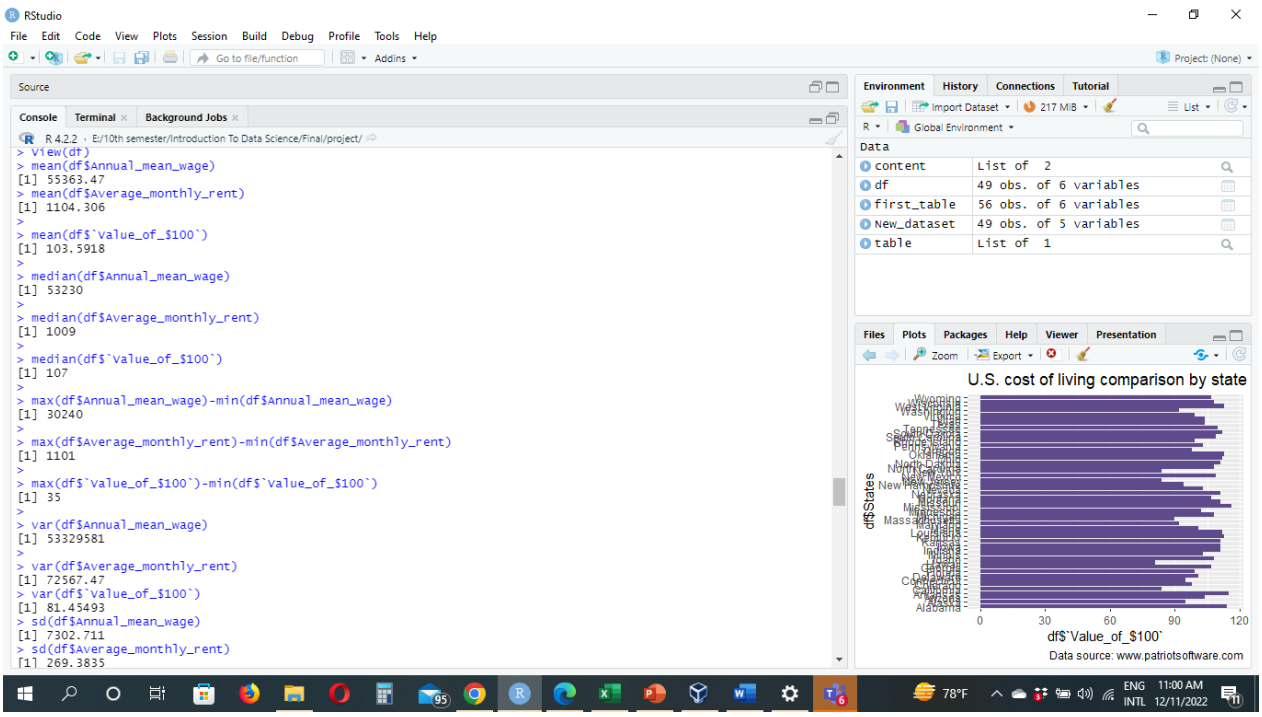
Interquartile value of Value of $100(for different states) =12

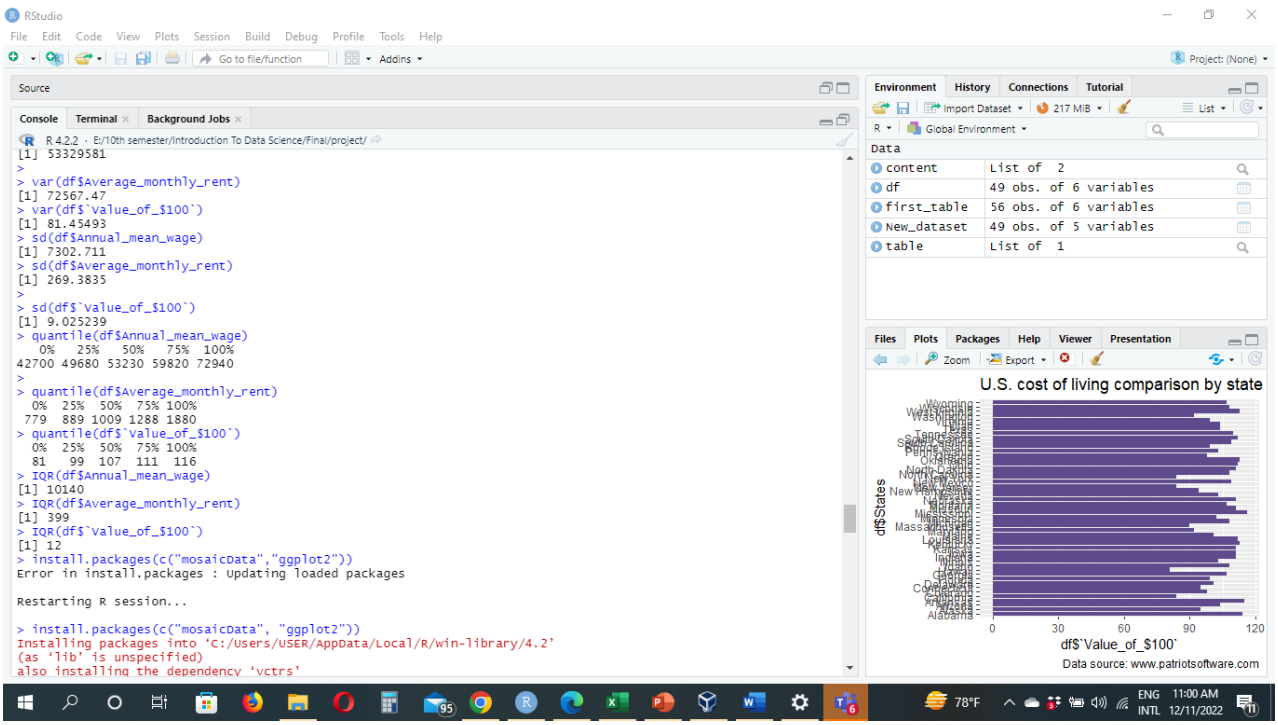
#Coding Part

IQR(df$Annual_mean_wage)

IQR(df$Average_monthly_rent)

IQR(df$`Value_of_$100`)





Data Visualization

The main goal of data visualization is to make it easier to identify patterns, trends and outliers in large data sets. The term is often used interchangeably with others, including information graphics, information visualization and statistical graphics.

Data visualization is one of the steps of the data science process, which states that after data has been collected, processed and modeled, it must be visualized for conclusions to be made. Data visualization is also an element of the broader data presentation architecture (DPA) discipline, which aims to identify, locate, manipulate, format and deliver data in the most efficient way possible.

Bar chart: Data visualization is one of the steps of the data science process, which states that after data has been collected, processed and modeled, it must be visualized for conclusions to be made. Data visualization is also an element of the broader data presentation architecture (DPA) discipline, which aims to identify, locate, manipulate, format and deliver data in the most efficient way possible**.**

When to Use a Bar Chart

1)When I need to compare a large set of categorical values.

2)When required to compare multiple categories or sub-categories simultaneously

3) When you need to visualize two data sets on a single chart

4) When you need to gather insights on deviations in data

Here I'm going to use bar chart for data visualization.

First, I have installed required packages and libraries.

```
install.packages(c("mosaicData","ggplot2"))
```

```
library(ggplot2)
```

```
library(mosaicData)
```

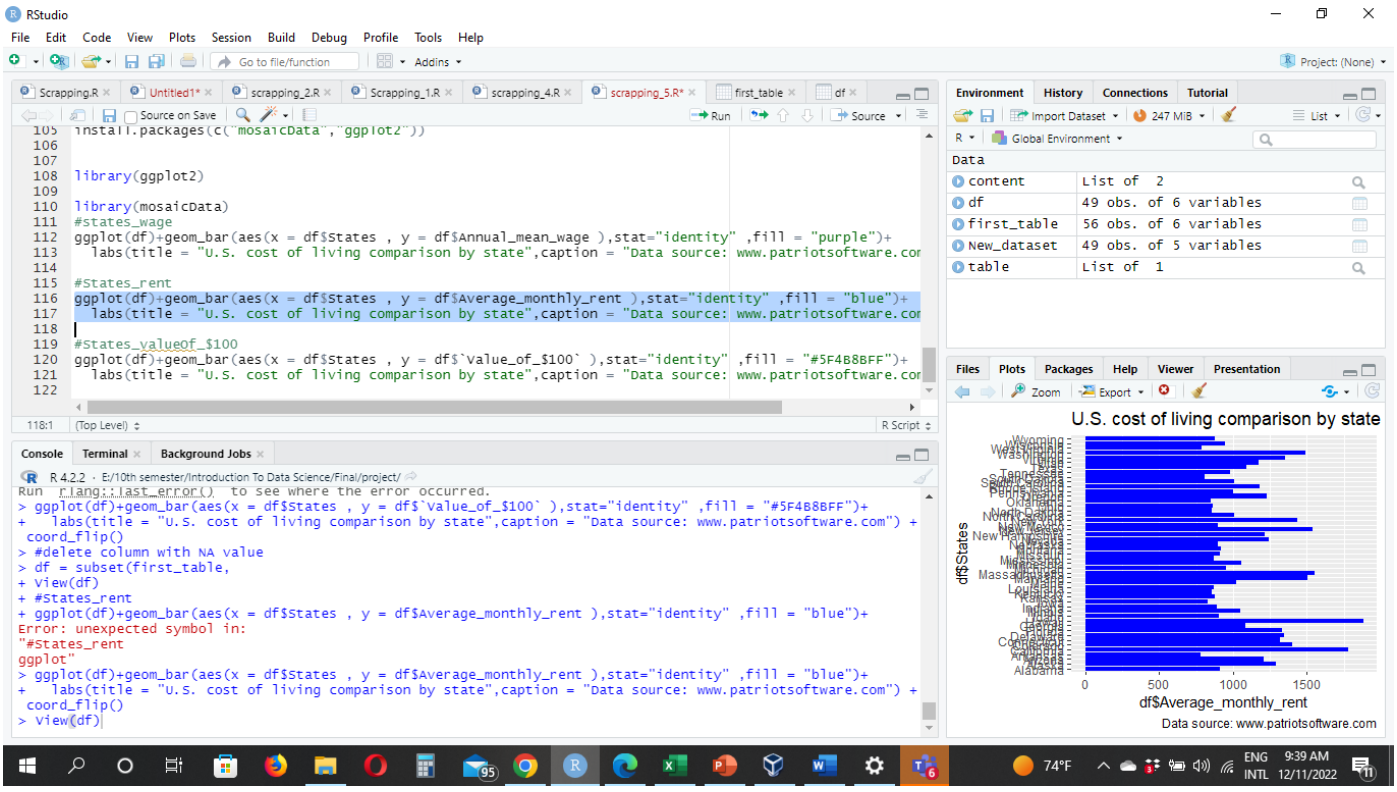
*Graph plotting for Annual mean wage(all occupations) on different states:

Then I have called ggplot function and set df dataset there. Then called goembar function for using bar chart and set x axis as States variable and Y axis as Annual_mean_wage variable. Then set the color as purple. Then used labs() function to set a suitable title for the graph and caption to mention source. Finally I have used coord_flip() function to flip the bar chart and to plot the data as a horizontal bar chart.

#Coding Part

ggplot(df)+geom_bar(aes(x = df$States , y = df$Annual_mean_wage),stat="identity" ,fill = "purple")+

labs(title = "U.S. cost of living comparison by state",caption = "Data source: www.patriotsoftware.com") + coord_flip()



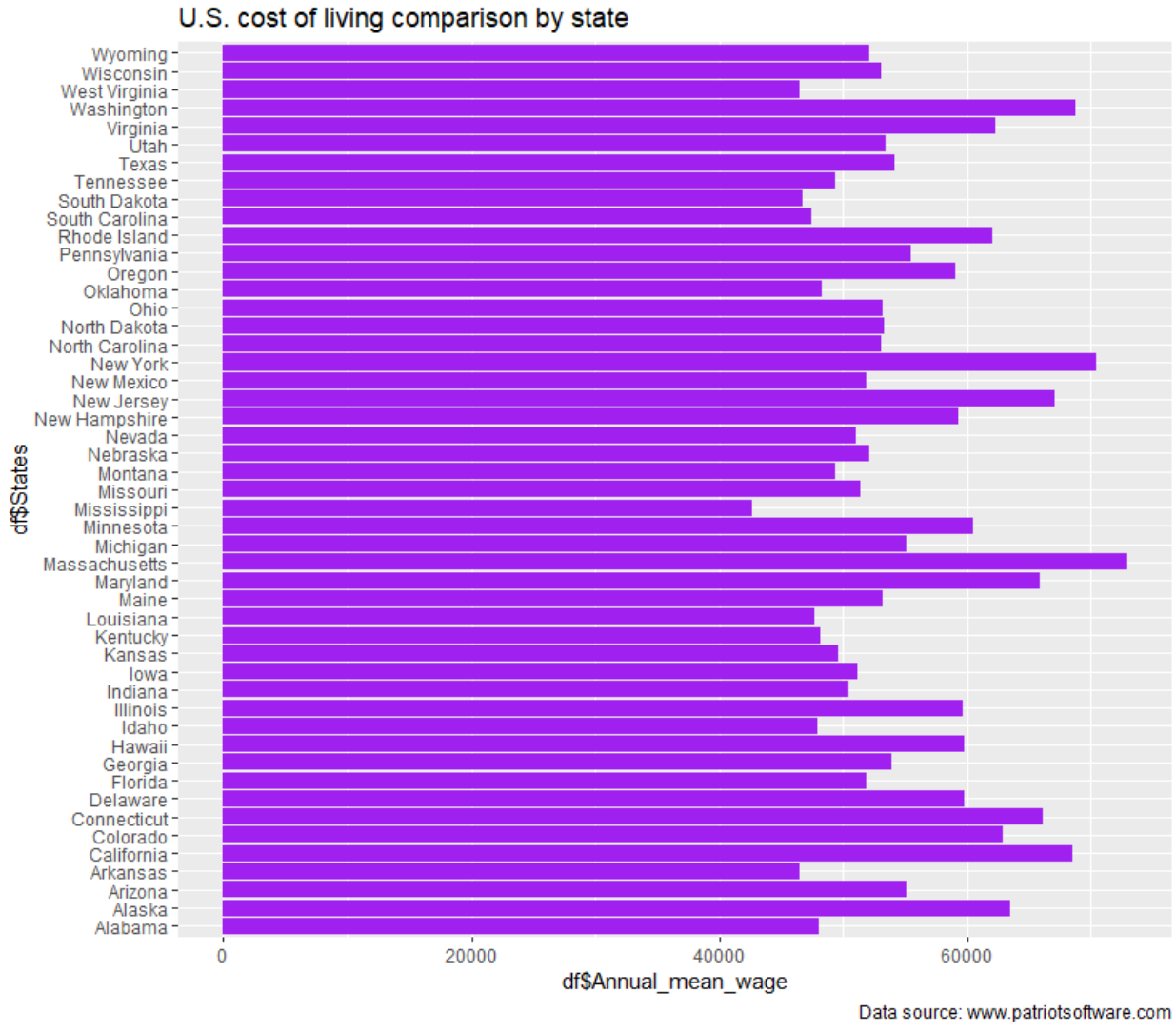


Figure 1:Bar_Chart diagram over Annual_mean_wage for different states

From this bar chart we can see the highest Annual mean wage is on Massachusetts and the lowest Annual mean wage for Mississippi.

*Graph plotting for Average monthly rent on different states:

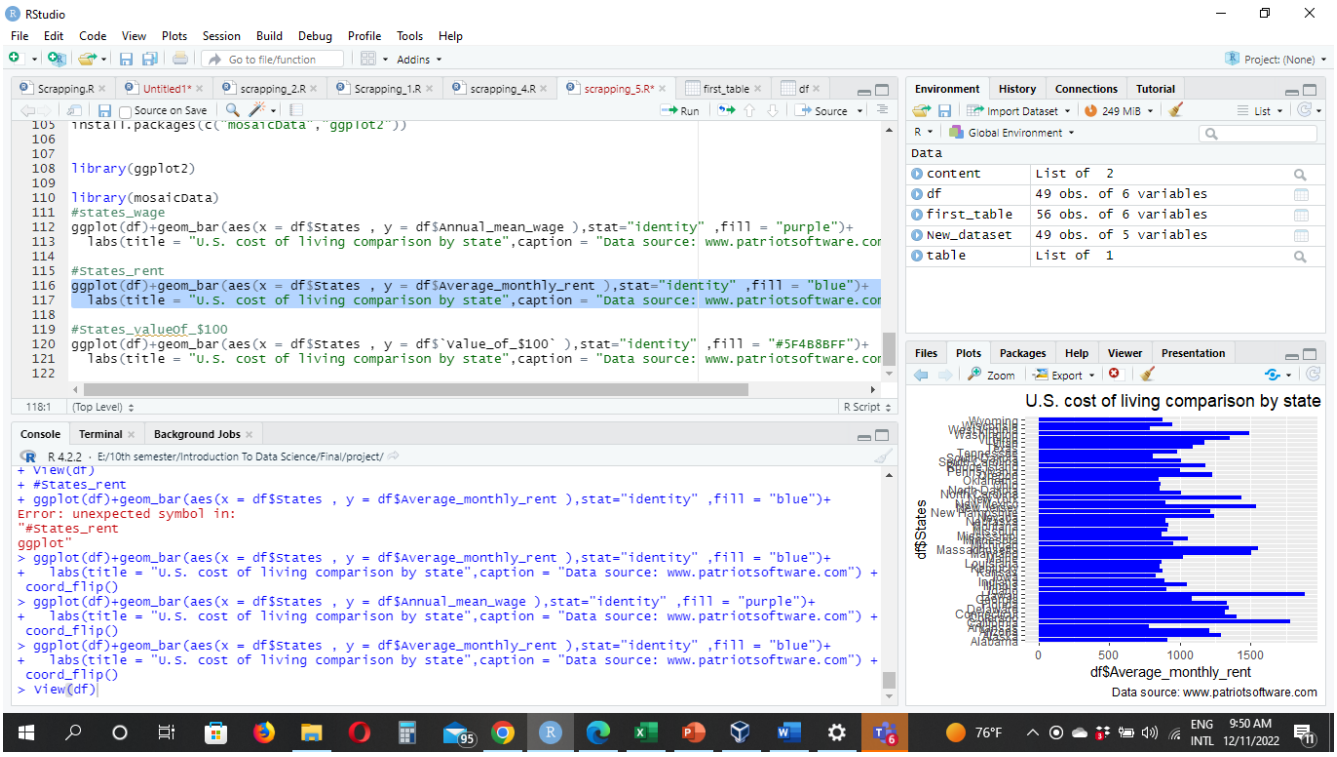
Again we have plotted the graph for Average monthly rent on different states. So, I have to call ggplot function and set df dataset there. Then called goembar function for using bar chart and set x axis as States variable and Y axis as Average monthly rent variable. Then set the color as blue.

Then used labs() function to set a suitable title for the graph and caption to mention source. Finally I have used coord_flip() function to flip the bar chart and to plot the data as a horizontal bar chart.

#Coding Part

```
ggplot(df)+geom_bar(aes(x = df$States , y = df$Average_monthly_rent ),stat="identity" ,fill = "blue")+

  labs(title = "U.S. cost of living comparison by state",caption = "Data source: www.patriotsoftware.com") + coord_flip()
```



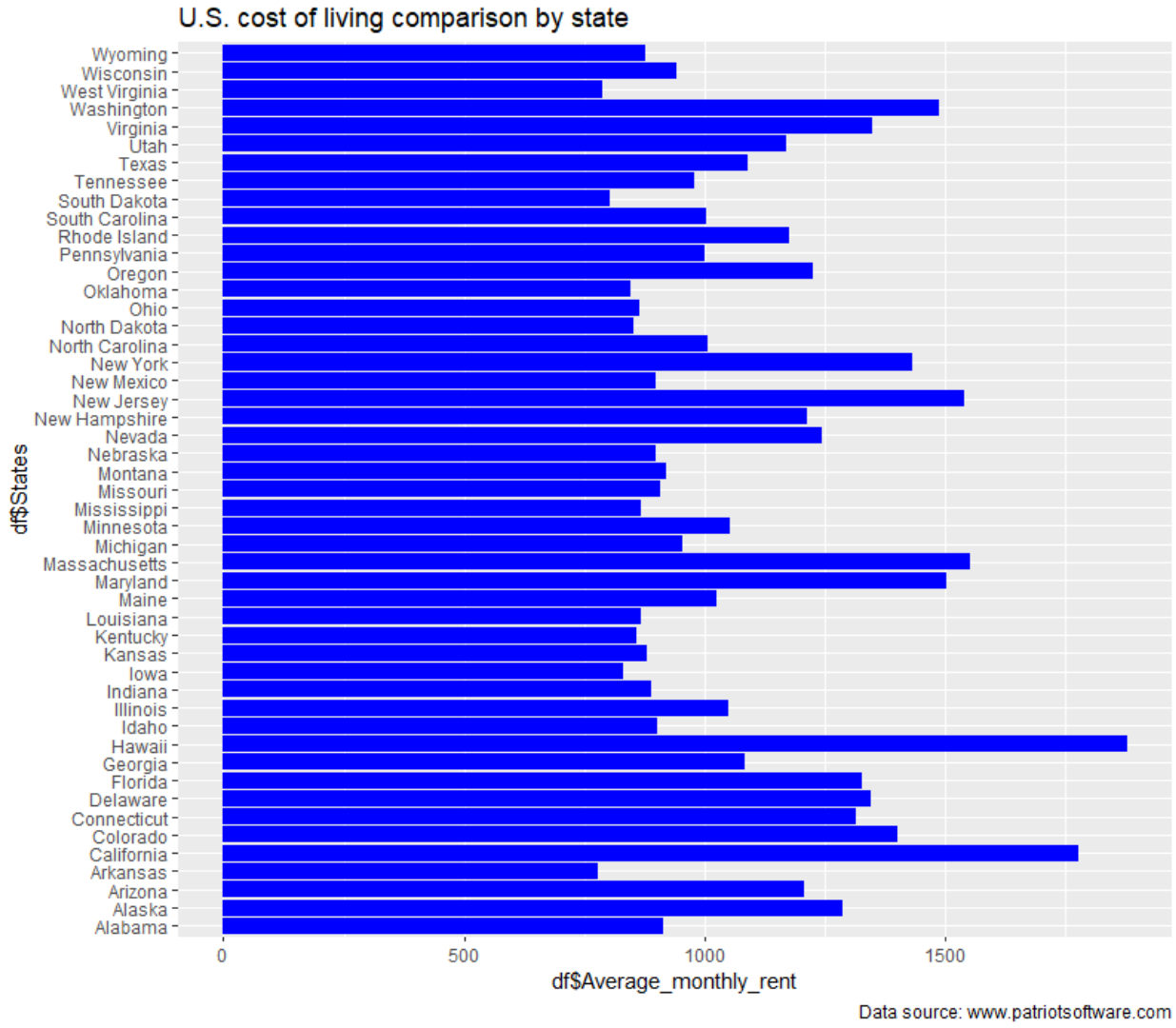


Figure 2: Monthly average rent on different states

From this bar chart we can see the highest Average monthly rent is on Hawaii and the lowest Annual mean wage for Arkansas alongside West Virginia.

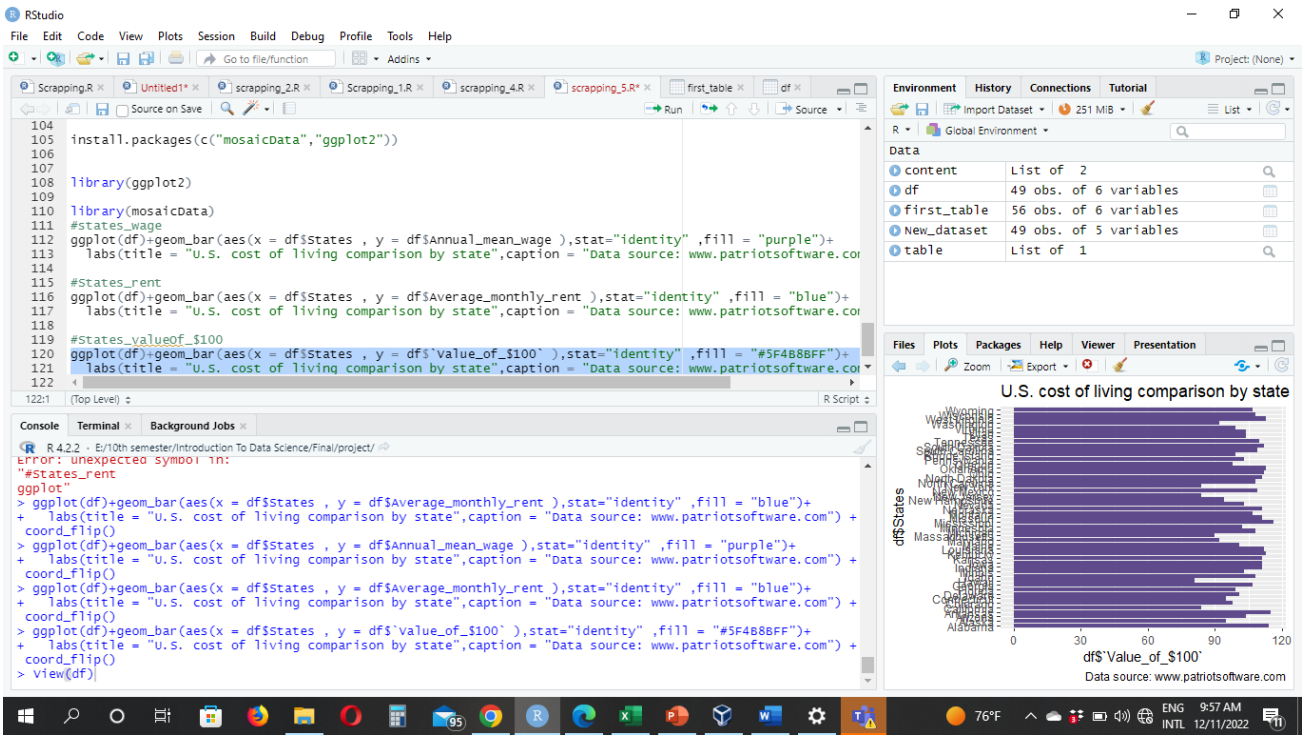
*Graph plotting for Value of $100 on different states:

Again, we have plotted the graph for Value of $100 rent on different states. So, I have to call ggplot function and set df dataset there. Then called goembar() function for using bar chart and

set x axis as States variable and Y axis as Value of $100 variable. Then set the color as "5F4B8BFF". Then used labs() function to set a suitable title for the graph and caption to mention source. Finally I have used coord_flip() function to flip the bar chart and to plot the data as a horizontal bar chart.

#Coding Part

```
ggplot(df)+geom_bar(aes(x = df$States , y = df$`Value_of_$100` ),stat="identity" ,fill = "#5F4B8BFF")+
  labs(title = "U.S. cost of living comparison by state",caption = "Data source: www.patriotsoftware.com") + coord_flip()
```



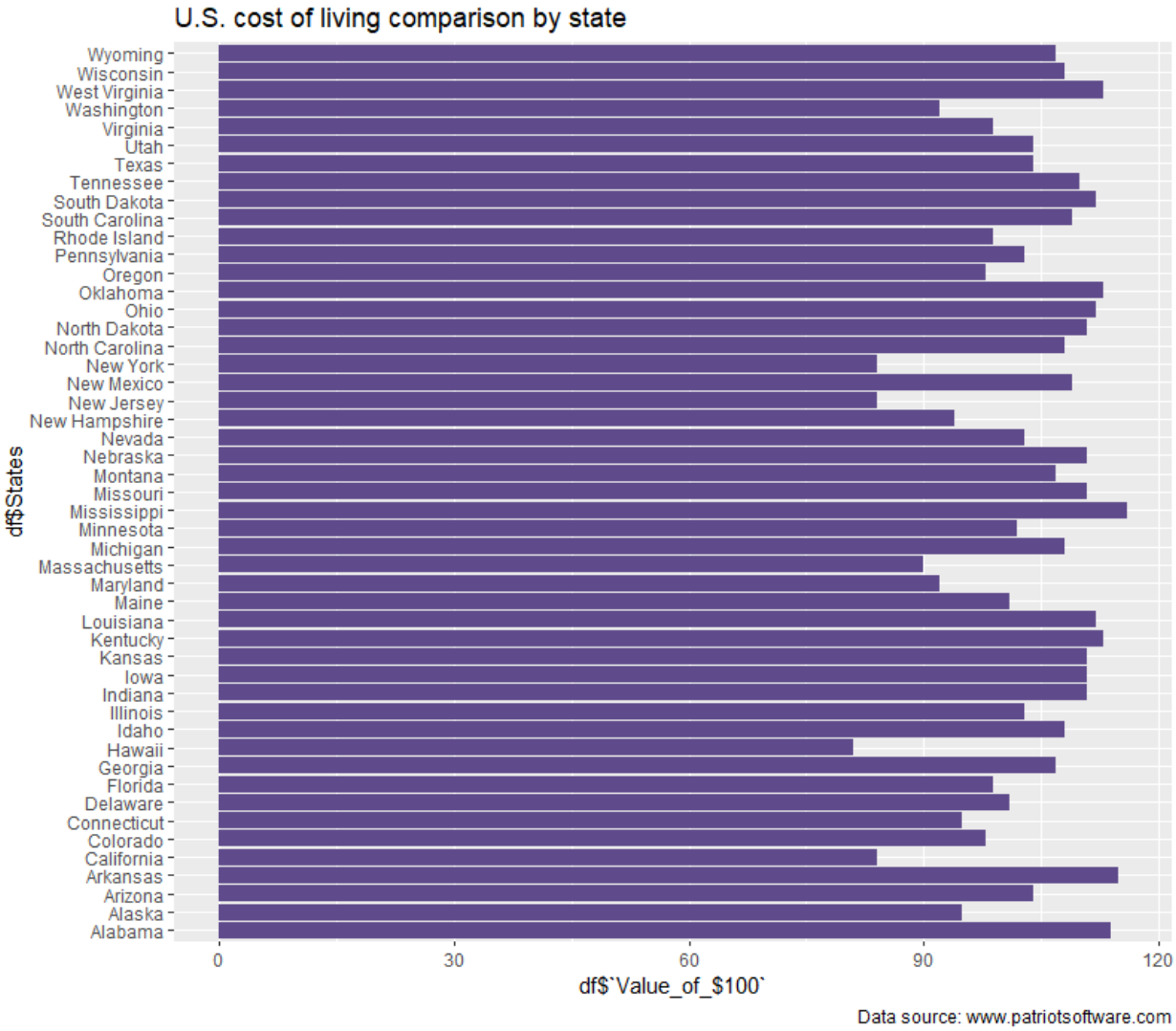


Figure 3: Value Of $100 on different states

From this bar chart we can see the state where $100 is most valuable is Mississippi and also to close states are Arkansas, West Virginia. Now, the less valuable place is Hawaii.

Discussion & Conclusion:

In this project, I have worked on scrapping, Data-Preprocessing, Descriptive Statistics and Data Visualization. For this I have Scrapped a table from this URL: https://www.patriotsoftware.com/blog/accounting/average-cost-living-by-state/ and this table is based on Cost of living in each state of U.S.A.

Cost of living in each state data can vary depending on what factors are analyzed (e.g., housing) and who conducts the study. So, for cost-of-living comparison by state, this dataset having with the following critical information:

- Annual mean wage for all occupations
- Average monthly rent
- Value of $100

The mean wages represent the average wages employees working in the state earn per year. This data is from May 2021. Also, I can to divide the annual mean wage by 12 to find the monthly wage amount.

Average monthly rent shows the average overall value of rent in the state (for all unit sizes). This data was compiled by GoBankingRates in 2021.

The value of $100 captures how much 100 George Washingtons are worth in the state. If the value of a dollar drops below $100, then it does not go as far in that state. This data was compiled in February 2022.

By looking at the chart, we have to keep in mind that states with a higher mean wage, higher monthly rent, and lower value of a dollar tend to have a higher cost of living.

So, from bar charts we can easily see that there is highest Annual mean wage for Massachusetts which is $72940, highest Average monthly rent is for Hawaii is $1880 and highest value of $100 is for Mississippi with $116.

Now, coming to lowest. From bar charts we can see there is lowest Annual mean wage for Mississippi which is $42700, lowest Average monthly rent is for Arkansas which is $779 and lowest value of $100 is for Hawaii with $81.

So, by analyzing those data we can say that Mississippi is the most affordable state by considering its highest value of $100 and lowest Annual mean wage.

And, Hawaii is most expensive state by considering its highest Average monthly rent and lowest value of $100.

- **Cost of living per state: Lowest to highest list**

  By considering on values from graph and dataset I tried organize those states from most affordable to most expensive order. Here is the list:

1. Mississippi
2. Arkansas
3. Missouri
4. Michigan
5. Tennessee
6. Ohio
7. Kentucky
8. Oklahoma
9. Georgia
10. Alabama
11. Indiana
12. North Carolina
13. West Virginia
14. Texas
15. Louisiana
16. Kansas
17. Iowa
18. South Carolina
19. Illinois
20. Wisconsin
21. Nebraska
22. Idaho
23. South Dakota
24. New Mexico
25. Florida
26. Pennsylvania

27. Arizona
28. Minnesota
29. Montana
30. Virginia
31. Utah
32. Wyoming
33. North Dakota
34. Delaware
35. Nevada
36. Colorado
37. New York
38. Washington
39. Maine
40. Oregon
41. Vermont
42. New Jersey
43. New Hampshire
44. Maryland
45. Rhode Island
46. Connecticut
47. Massachusetts
48. Alaska
49. California
50. Hawaii

Through this list anyone could easily get valuable idea about affordable or expensive states in U.S.A.