Final Project: Is College Worth It? (Tuition VS Salary)

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I. Introduction

Is college worth it? Is college a good investment for your future? If it is, what kind of factors in college would have an impact on career performance?

On one hand, college could be worth it by leading to higher employment rates and higher career performance, in terms of various financial measurements, than people who do not go to college. On the other hand, college tuition is constantly rising and is the same for student loan debt.

In this project, four data sources are acquired from the US Department of Education, the Chronicle of Higher Education, the National Center for Education Statistics, and payscale.com. A final dataset in tidy version is created by conducting a significant amount of data cleansing and data wrangling techniques, so as to retrieve insightful information regarding the relationship between tuition or other factors in college and future career performance of college graduates.

Github Link

(Include several Data in tidy version, Rmd File, Report in PDF File and HTML File)

(https://github.com/Junjie-Dylan-Yang/Data-Wrangling-Project)

II. ETL process: Data Import and Data Cleansing

1,

Import first data: tuition_cost

First data source, tuition_cost, is from "College tuition, Diversity, and Pay" in rfordatascience/tidetuesday/2020-03-10, which is originally acquired from the US Department of Education and the Chronicle of Higher Education.

Data Cleaning for tuition_cost data

In the tuition_cost data, relevant columns are selected (name of the school, state, state code, type of the school, length of the degree). Also, room and board fee and tuition are combined as total tuition and fee.

Below is the snippet of tuition_cost data

```
## # A tibble: 10 x 7
##    name   state state_code type  degree_length in_state_tuitio~ out_of_state_tu~
##    <chr>  <chr> <chr>      <chr> <chr>                    <dbl>            <dbl>
##  1 Aanii~ Mont~ MT         Publ~ 2 Year                    2380             2380
##  2 Abile~ Texas TX         Priv~ 4 Year                   45200            45200
```

```
##  3 Abrah~ Geor~ GA         Publ~ 2 Year                     12602            21024
##  4 Acade~ Minn~ MN         For ~ 2 Year                     17661            17661
##  5 Acade~ Cali~ CA         For ~ 4 Year                     44458            44458
##  6 Adams~ Colo~ CO         Publ~ 4 Year                     18222            29238
##  7 Adelp~ New ~ NY         Priv~ 4 Year                     54690            54690
##  8 Adiro~ New ~ NY         Publ~ 2 Year                     17035            21595
##  9 Adria~ Mich~ MI         Priv~ 4 Year                     48405            48405
## 10 Advan~ Virg~ VA         For ~ 2 Year                     13680            13680
```

2,

Import second data: student_diversity

Second data source, student_diversity by college/university, along with school type, degree length, state, in-state vs out-of-state is from the Chronicle of Higher Education.

Data Cleaning for student_diversity data

In the student_diversity data, the main data cleansing task is to modify name of institution to match the "name" column and "state" column in the tuition_cost data, in order to combine dataset. Several data wrangling steps are applied. First is to change the column name "INSTITUTION" to "name". After that, convert any abbreviation of University from "U." to "University". From the first glance, the name of state is located at the very end of the name of institution. The next step is to extract state from school name with the help of state.name which contains the list of all the state name and column "state" is created. Last but not least, state name inside the name of institution needed to remove. Using str_count to count the letters within state in each observation and str_sub help to keep the name of school only in the "name" column. Str_trim and str_squish are used to remove unnecessary spaces in "name".

Below is the snippet of student_diversity_cleaned data

```
## # A tibble: 10 x 11
##    name  ENROLLMENT  WOMEN `AMERICAN INDIA~ ASIAN BLACK HISPANIC
##    <chr>      <dbl>  <dbl>            <dbl> <dbl> <dbl>    <dbl>
##  1 Univ~     195059 134722              876  1959 31455    13984
##  2 Ivy ~      91179  53476              357  1369 12370     5533
##  3 Libe~      81459  48329              447   856 14751     1186
##  4 Lone~      69395  41268              168  4198 12094    23751
##  5 Miam~      66046  38323               47   655 10722    44870
##  6 Gran~      62304  46647              586  2446 13856     8933
##  7 Texa~      61642  29277              173  3545  1879    11256
##  8 Univ~      60767  33482              120  3343  6400    13108
##  9 Ohio~      58322  28658               76  3339  3108     2049
## 10 Hous~      58276  34007              116  5391 18520    18411
## # ... with 4 more variables: `NATIVE HAWAIIAN / PACIFIC ISLANDER` <dbl>,
## #   WHITE <dbl>, `TOTAL MINORITY` <dbl>, state <chr>
```

Combine tuition_cost and student_diversity data based on "name" and "state"

So far, student_diversity and tuition_cost are modified to share two common column, "name" – name of the school and "state" – the state that the school is located. Thus, student_diversity and tuition_cost datasets are merged for later development. There are a few schools appears in the tuition_cost dataset but not in the student_diversity and results in “NA” value appearance. It is reasonable and schools with “NA” value are removed from the combined dataset. The combined dataset is arranged by state and the name of the school.

Below is the snippet of the combined dataset, tuition_with_diversity

```
## # A tibble: 10 x 16
##    name  state state_code type  degree_length in_state_tuitio~ out_of_state_tu~
##    <chr> <chr> <chr>      <chr> <chr>                    <dbl>            <dbl>
##  1 Alab~ Alab~ AL         Publ~ 2 Year                    4440             8880
##  2 Alab~ Alab~ AL         Publ~ 4 Year                   16490            24818
##  3 Amri~ Alab~ AL         Priv~ 4 Year                    6900             6900
##  4 Athe~ Alab~ AL         Publ~ 4 Year                    6810            12870
##  5 Aubu~ Alab~ AL         Publ~ 4 Year                   24608            43856
##  6 Aubu~ Alab~ AL         Publ~ 4 Year                   17268            29028
##  7 Bevi~ Alab~ AL         Publ~ 2 Year                    6070             9940
##  8 Birm~ Alab~ AL         Priv~ 4 Year                   30000            30000
##  9 Bish~ Alab~ AL         Publ~ 2 Year                    4740             8610
## 10 Calh~ Alab~ AL         Publ~ 2 Year                    4840             8690
## # ... with 9 more variables: ENROLLMENT <dbl>, WOMEN <dbl>, `AMERICAN INDIAN /
## #   ALASKA NATIVE` <dbl>, ASIAN <dbl>, BLACK <dbl>, HISPANIC <dbl>, `NATIVE
## #   HAWAIIAN / PACIFIC ISLANDER` <dbl>, WHITE <dbl>, `TOTAL MINORITY` <dbl>
```

3,

Import third data: Best_School

Third data source, best_school is html data, acquired from the from the payscale.com. It contains all the schools in United States that are arranged by various measurement of career performance, such as “Early Career Pay” and "Mid Career Pay.

Problem encountered When importing html data from https://www.payscale.com/college-salary-report/bachelors, I realized that it only shows the first page of the table and the table only include the data with the top 25 schools in the United States, descending by measurement of career performance. That’s the issue that I am not expecting. Moreover, this is the first page in the web and there are 63 pages in total, which consists all the school data.

Problem resolved Instead of importing data 63 times from different urls to get the entire dataset, one alternative webpage is found by navigating the payscale.com. The page “Best Schools By State” (https://www.payscale.com/college-salary-report/best-schools-by-state) outlays all the best schools ranked by measurement of career performance of all 50 states. Clicking on each state would direct to the schools data within that particular state. In order to import the entire data, I first convert the string format in the list of state.name to match the url format (for example, “New York” to “New-York”). Then, a data frame is created. For-Loop is implemented to import all 50 states data to the R environment and to keep loading data into the data frame to complete the entire dataset of all 50 states, “Best_School”, for data cleansing.

Data Cleaning for Best_School data

First step is to modify the column name “School Name” to “name” and to keep the exact name of school only, in order to match the previous combined tuition_with_diversity dataset for binding. After that, there are several data cleansing steps that are applied to other columns. Only numeric values are extracted from the columns, “Rank”, “Early Career Pay”, “Mid-Career Pay”, “% High Meaning”, “% STEM Degrees”. One lesson learned is that R suggests to use parse_number(), instead of extract_numeric() for extracting numeric value.

Below is the snippet of Best_School_clean data

```
##                                    name Early Career Pay Mid-Career Pay
## 1                    Auburn University             54400         104500
## 2  University of Alabama in Huntsville             57500         103900
## 3            The University of Alabama             52300          97400
## 4                  Tuskegee University             54500          93500
## 5                   Samford University             48400          90500
## 6                  Spring Hill College             46600          89100
## 7           Birmingham Southern College            49100          88300
## 8  University of Alabama at Birmingham             48600          87200
## 9           University of South Alabama            47700          86400
## 10             Alabama A & M University            48700          83500
##    % High Meaning % STEM Degrees
## 1              51             31
## 2              59             45
## 3              50             15
## 4              61             30
## 5              52              3
## 6              53             12
## 7              48             27
## 8              57             17
## 9              56             17
## 10             58             20
```

Combine Best_School_clean data and tuition_with_diversity to form the final data

Finally, Best_School_clean data, which contains different measurements of career performance, merges with tuition_with_diversity data, which contains detailed school information including tuition and race. The column both datasets have in common is “name” and left_join is performed. Similar to the previous merged dataset, schools with “NA” are removed from the dataset.

Create new variables:

Mid_career_pay_paidoff: difference between median salary for alumni with 10+ years experience and out of state tuition and fee:

[Mid Salary(0-5 Years Experience) - Total College Cost]

Early_career_pay_paidoff: difference between median salary for alumni with 0-5 years experience and out of state tuition and fee:

[Early Salary(0-5 Years Experience) - Total College Cost]

Below is the snippet of the Final_data

There are 622 observations in all 50 states in United States and each college or university is a unique observation. This is the tidy version of the final data and it will be stored as a csv file.

Attribute Information

Below information is from payscale.com:

"Early Career Pay" is defined as median salary for alumni with 0-5 years experience.

"Mid-Career Pay" is defined as Median salary for alumni with 10+ years experience.

"% High Meaning" is defined as the percentage of alumni who say their work makes the world a better place.

"% STEM Degrees" is defined as the percentage of degrees awarded in science, technology, engineering or a math subjects.

```
##                                  name Early Career Pay Mid-Career Pay
## 1                   Auburn University            54400         104500
## 2                 Tuskegee University            54500          93500
## 3                   Samford University           48400          90500
## 4                 Spring Hill College            46600          89100
## 5  University of Alabama at Birmingham           48600          87200
## 6         University of South Alabama            47700          86400
## 7                     Troy University            44500          81500
## 8       Jacksonville State University            43800          80000
## 9     Auburn University at Montgomery            45000          79600
## 10                  Huntingdon College           42400          78900
##    % High Meaning % STEM Degrees   state state_code    type degree_length
## 1              51             31 Alabama         AL  Public        4 Year
## 2              61             30 Alabama         AL Private        4 Year
## 3              52              3 Alabama         AL Private        4 Year
## 4              53             12 Alabama         AL Private        4 Year
## 5              57             17 Alabama         AL  Public        4 Year
## 6              56             17 Alabama         AL  Public        4 Year
## 7              60              8 Alabama         AL  Public        4 Year
## 8              61              7 Alabama         AL  Public        4 Year
## 9              61             12 Alabama         AL  Public        4 Year
## 10             69             14 Alabama         AL Private        4 Year
##    in_state_tuition_and_fee out_of_state_tuition_and_fee ENROLLMENT WOMEN
## 1                     24608                        43856      25912 12798
## 2                     31820                        31820       3103  1855
## 3                     42200                        42200       4933  3082
## 4                     52926                        52926       1376   820
## 5                     17110                        31030      18698 11288
## 6                     17490                        27360      15805  9700
## 7                     20645                        31060      19041 11948
## 8                     18525                        28245       8659  4978
## 9                     17268                        29028       5057  3233
## 10                    37150                        37150       1160   572
##    AMERICAN INDIAN / ALASKA NATIVE ASIAN BLACK HISPANIC
## 1                              183   601  1886      599
## 2                                2    26  2345       32
## 3                               17    80   372      218
## 4                               10    16   210       77
## 5                               46   931  3943      496
## 6                              100   539  3285      402
## 7                              143   140  6840      666
## 8                               61    50  2030      110
## 9                               23   104  1633       36
```

```
## 10                              14     9   229       29
##    NATIVE HAWAIIAN / PACIFIC ISLANDER WHITE TOTAL MINORITY
## 1                                0 20855           3269
## 2                                0    52           2405
## 3                                1  4007            738
## 4                                1   947            359
## 5                               14 11840           5993
## 6                               33 10102           4684
## 7                               19  9265           8294
## 8                                7  5934           2258
## 9                                9  2572           1941
## 10                               2   738            313
##    Mid_career_pay_paidoff Early_career_pay_paidoff
## 1                   60644                    10544
## 2                   61680                    22680
## 3                   48300                     6200
## 4                   36174                    -6326
## 5                   56170                    17570
## 6                   59040                    20340
## 7                   50440                    13440
## 8                   51755                    15555
## 9                   50572                    15972
## 10                  41750                     5250
```

The tidy version of the final data, "Final_data" is saved under the name "Tidy_Final_Data.xlsx" local location and committed from Github desktop to Github.com repository (https://github.com/Junjie-Dylan-Yang/Data-Wrangling-Project)

4,

Import fourth data: historical_tuition

The last data source, historical_tuition, is from "College tuition, Diversity, and Pay" in rfordatascience/tidetuesday/2020-03-10, which is originally acquired from the National Center for Education Statistics.(https://nces.ed.gov/fastfacts/display.asp?id=76)

The fourth data, historical_tuition, is tidy and contains the information of the trends in the cost of college education. Therfore, "historical_tuition" is saved under the name of"Tuition_trend.xlsx" in the same location of The tidy version of the final data.

Below is the snippet of tuition_cost data

```
## # A tibble: 10 x 4
##    type             year    tuition_type    tuition_cost
##    <chr>            <chr>   <chr>                  <dbl>
##  1 All Institutions 1985-86 All Constant           10893
##  2 All Institutions 1985-86 4 Year Constant        12274
##  3 All Institutions 1985-86 2 Year Constant         7508
##  4 All Institutions 1985-86 All Current             4885
##  5 All Institutions 1985-86 4 Year Current          5504
##  6 All Institutions 1985-86 2 Year Current          3367
##  7 All Institutions 1995-96 All Constant           13822
```

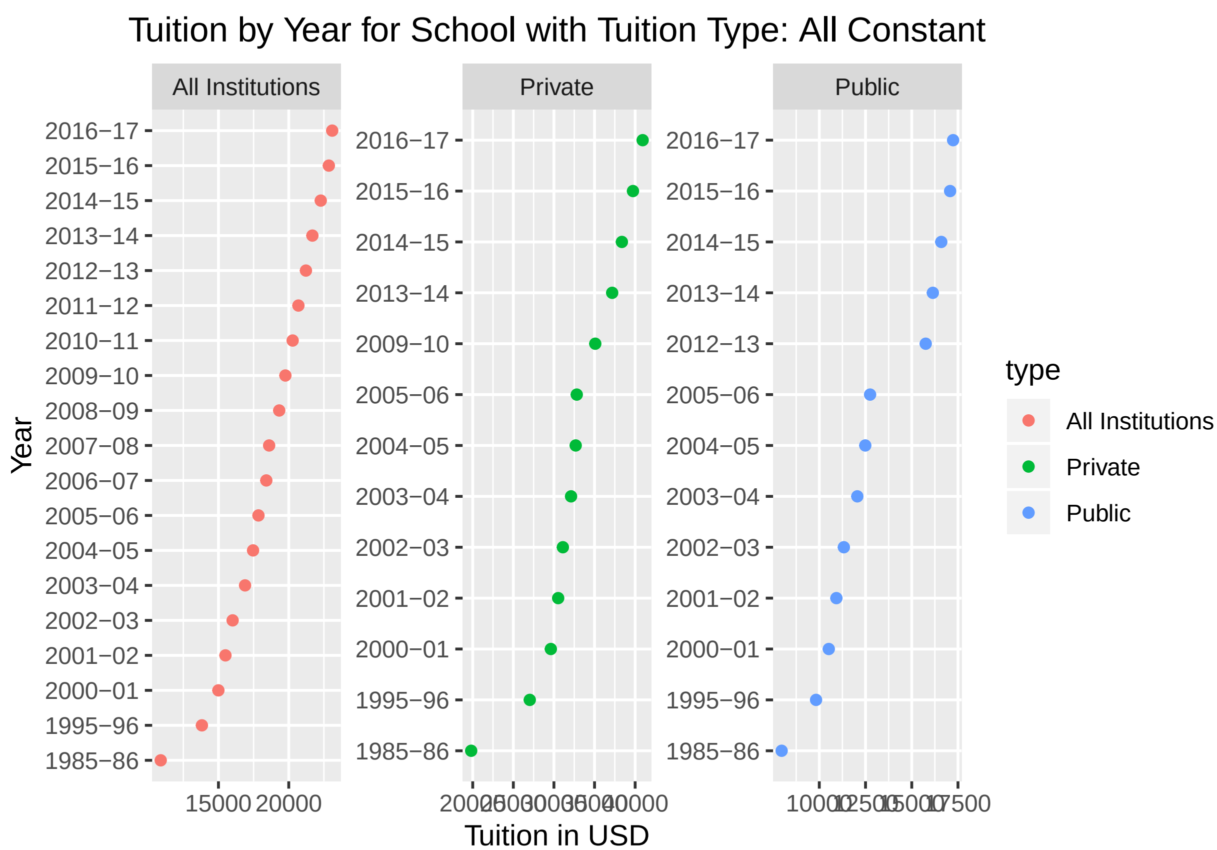
```
##  8 All Institutions 1995-96 4 Year Constant        16224
##  9 All Institutions 1995-96 2 Year Constant         7421
## 10 All Institutions 1995-96 All Current             8800
```

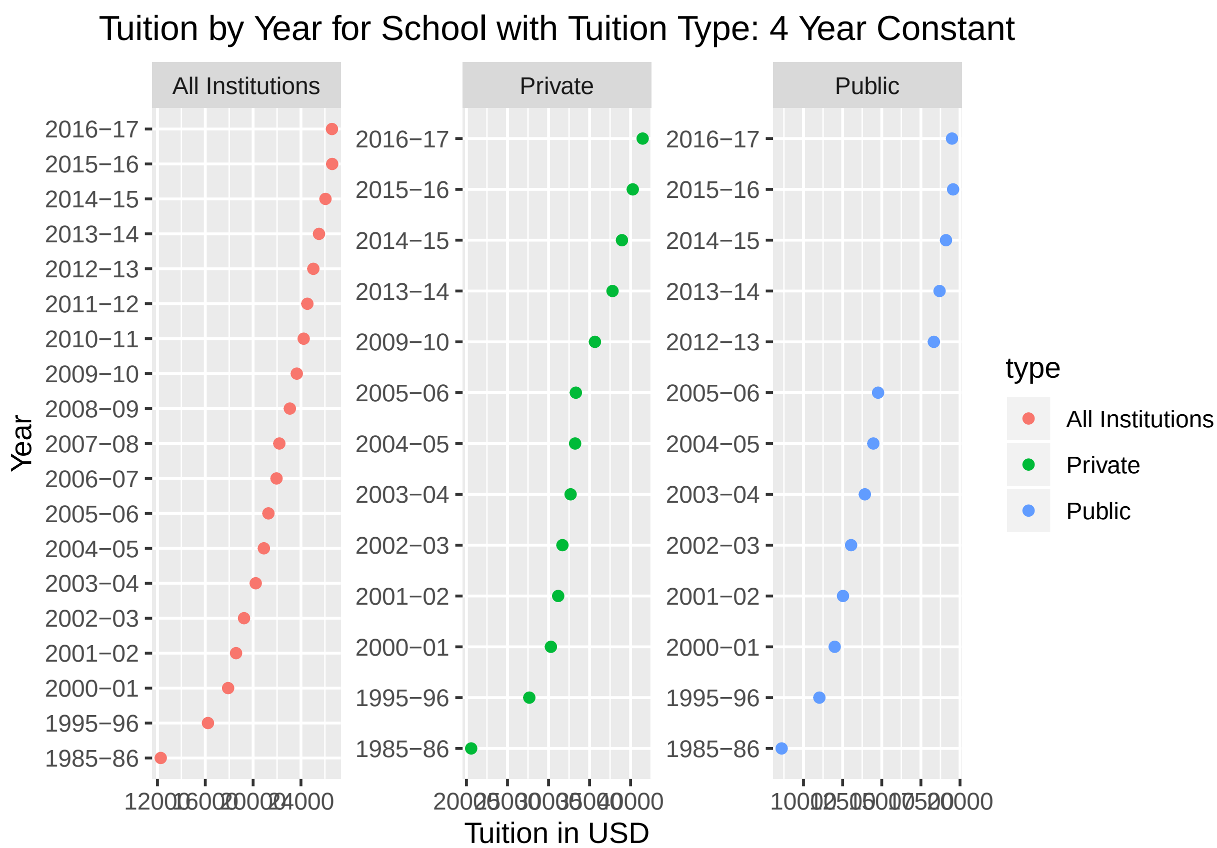
III. Data Analysis by Various Plot and Tables

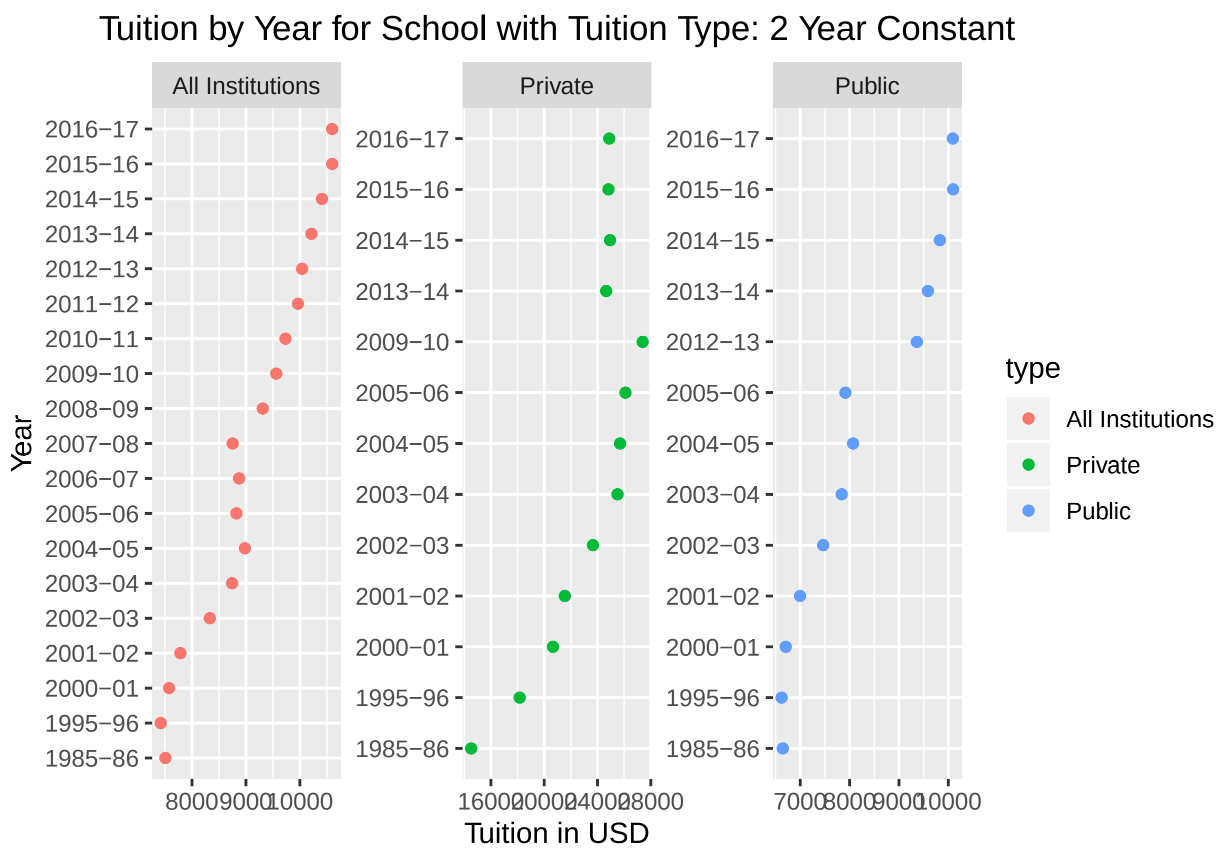
After a series of data wrangling and data cleansing conducted on several data sources from above, final data in tidy version, "Final_data" and "historical_tuition" data are ready to use for data analysis.

1, Tuition Trend: Going upward over time

Split the historical_tuition into 3 subset dataset by tuition type: "All Constant", "4 Year Constant", and "2 Year Constant". From below plots, it clearly shows that, college tuition increases at a rapid rate over time, on schools with all three tuition types.




Tuition by Year for School with Tuition Type: 4 Year Constant
All Institutions
Private
Public
Year
2016−17
2015−16
2014−15
2013−14
2012−13
2011−12
2010−11
2009−10
2008−09
2007−08
2006−07
2005−06
2004−05
2003−04
2002−03
2001−02
2000−01
1995−96
1985−86
Tuition in USD
type
All Institutions
Private
Public

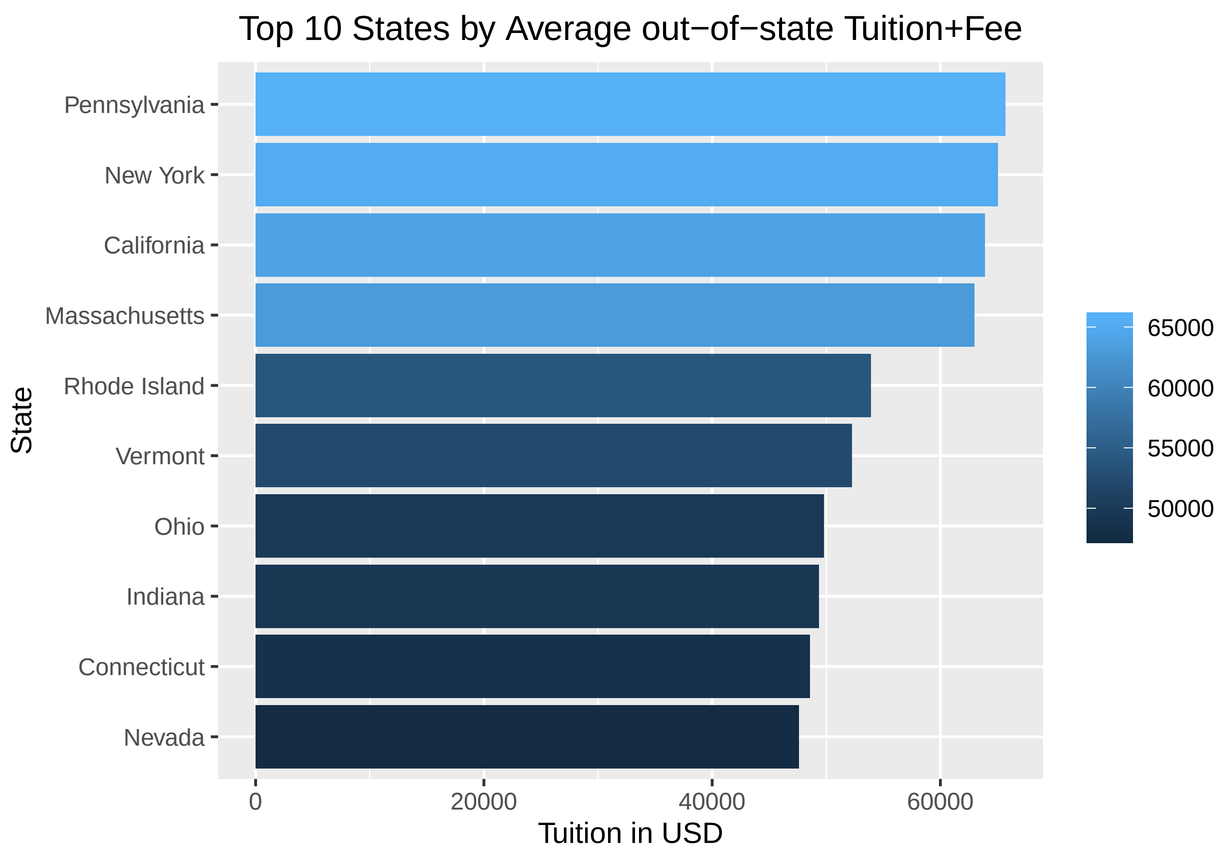


2, Take a look at the final data, "Final_data" at the level of states.

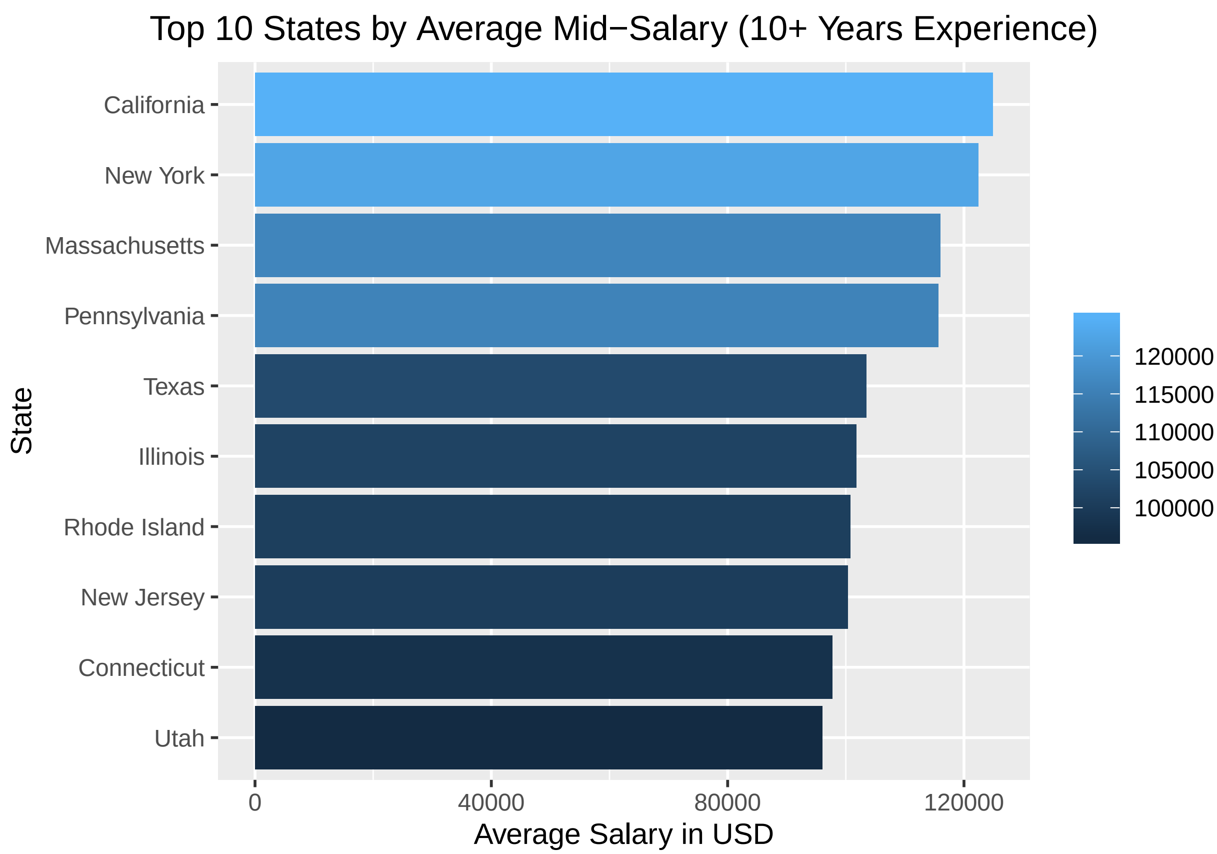
Create another dataset "state_data" at state level from the final data, "Final_data". All numeric values are summarised by taking the average respect to each state. This dataset is also saved under the name "state_data.xlsx", in the same location as the final data.

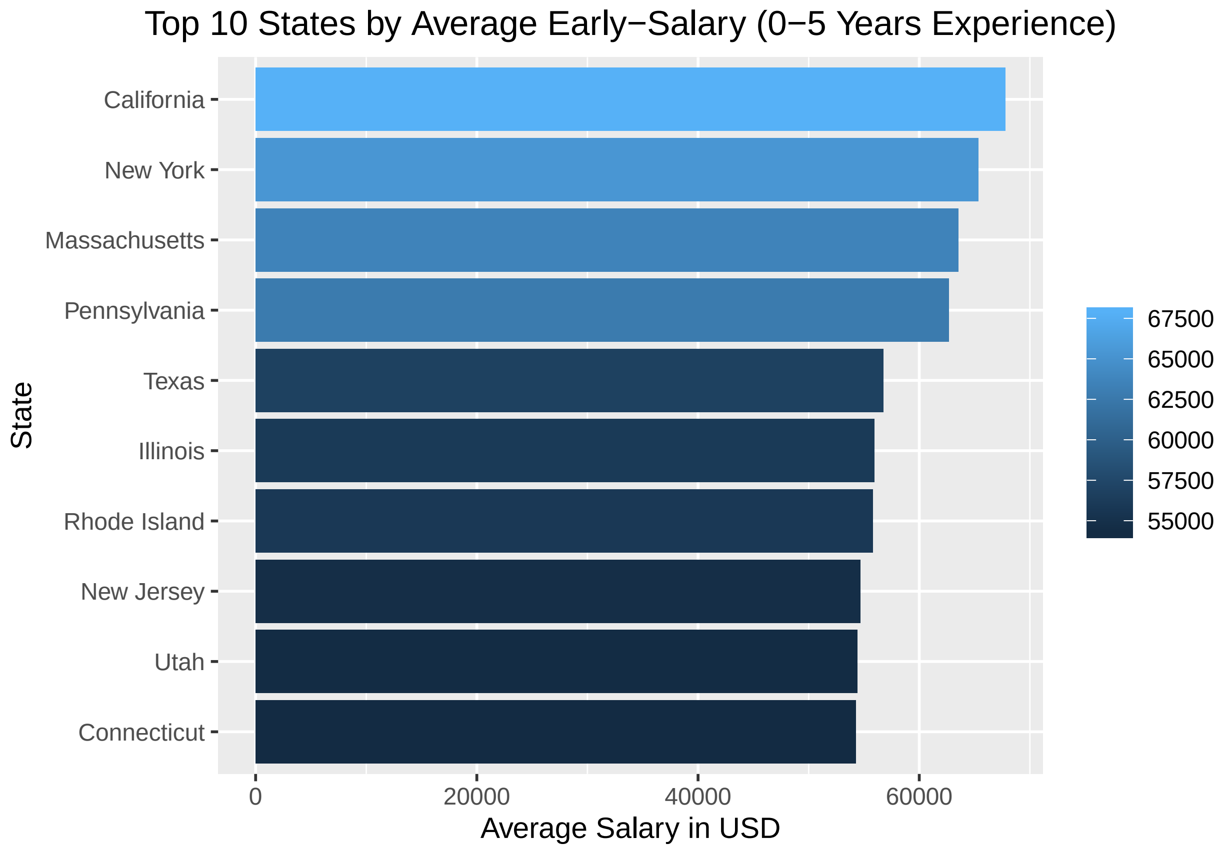
Plots that show insightful information regarding tuition and career performance at the state level

(1) As people expected, schools in big states like Pennsylvania, New York, California, and Massachusetts have the highest average out-of-state college cost because of high income and high levels of consumption rate.



(2) There is no suprise that people graduated from colleges/universities big states like Pennsylvania, New York, Massachusetts, and California would have better career performance in terms of early-salary pay (0-5 year experience) and mid-salary pay (10+ year experience) because schools in those states have the most wide range of education resources.


Top 10 States by Average Mid−Salary (10+ Years Experience)
California
New York
Massachusetts
Pennsylvania
Texas
Illinois
Rhode Island
New Jersey
Connecticut
Utah
State
0
40000
80000
120000
Average Salary in USD
120000
115000
110000
105000
100000



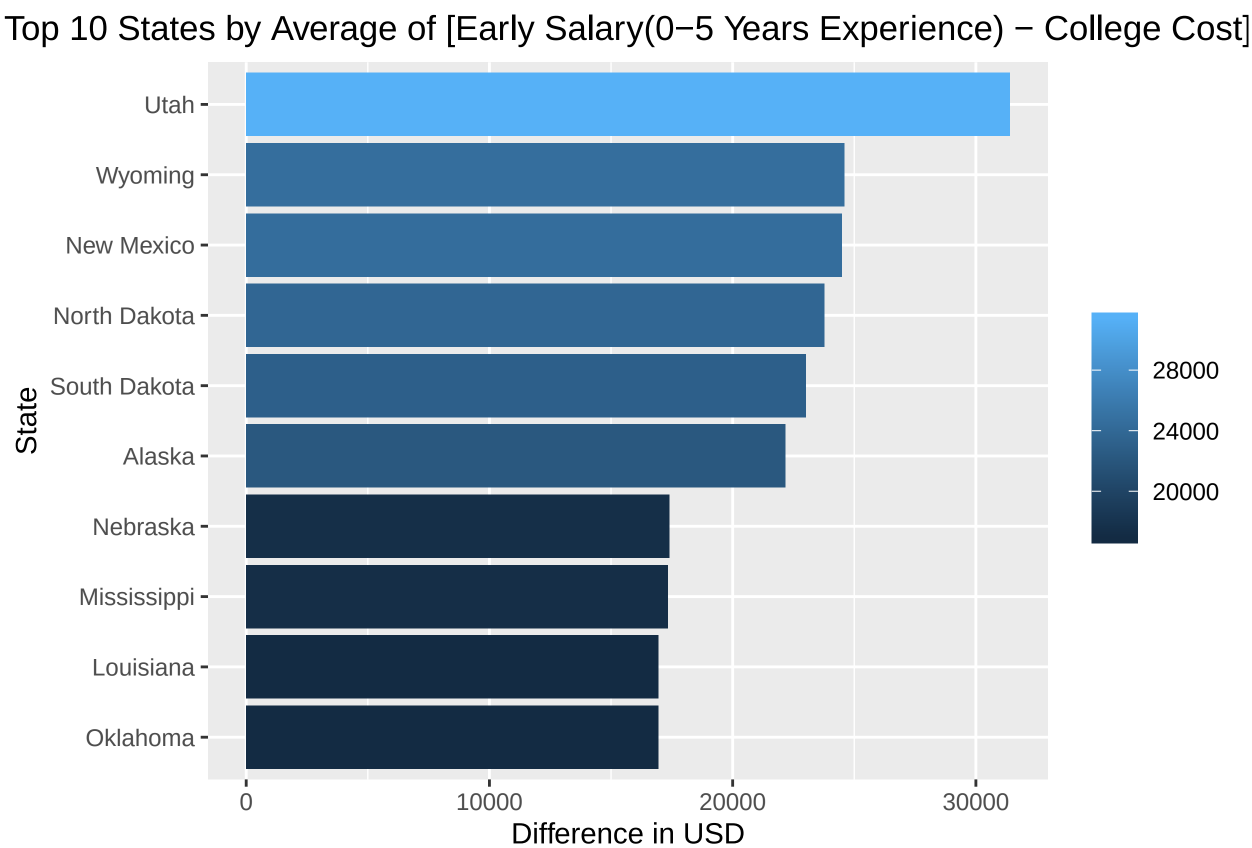
(3) Interesting Finding:

If poeple consider going to college is a good investment and decide to go to the colleges in big states like Pennsylvania, New York, Massachusetts, and California based on the above plots of career performance in terms of salary, they should also take a look at the plots below.

"Mean_early_paidoff" and "Mean_mid_paidoff" are created based on "Early_career_pay_paidoff" and "Mid_career_pay_paidoff" during previous data cleansing steps in Part II.

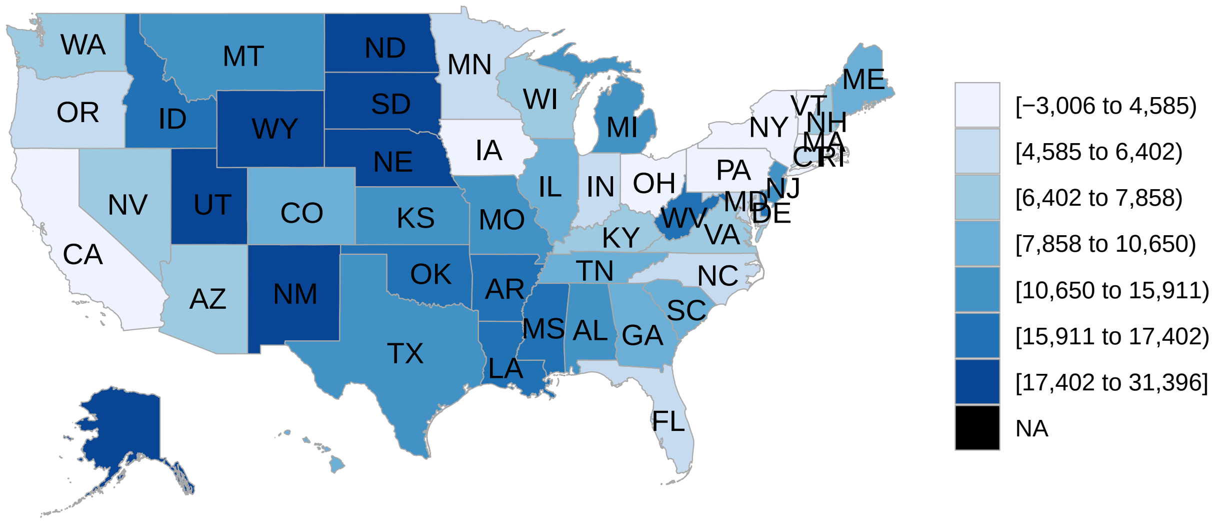
They are defined as the average difference between median salary for alumni with 0-5 and 10+ years experience and out of state tuition and fee in different states.

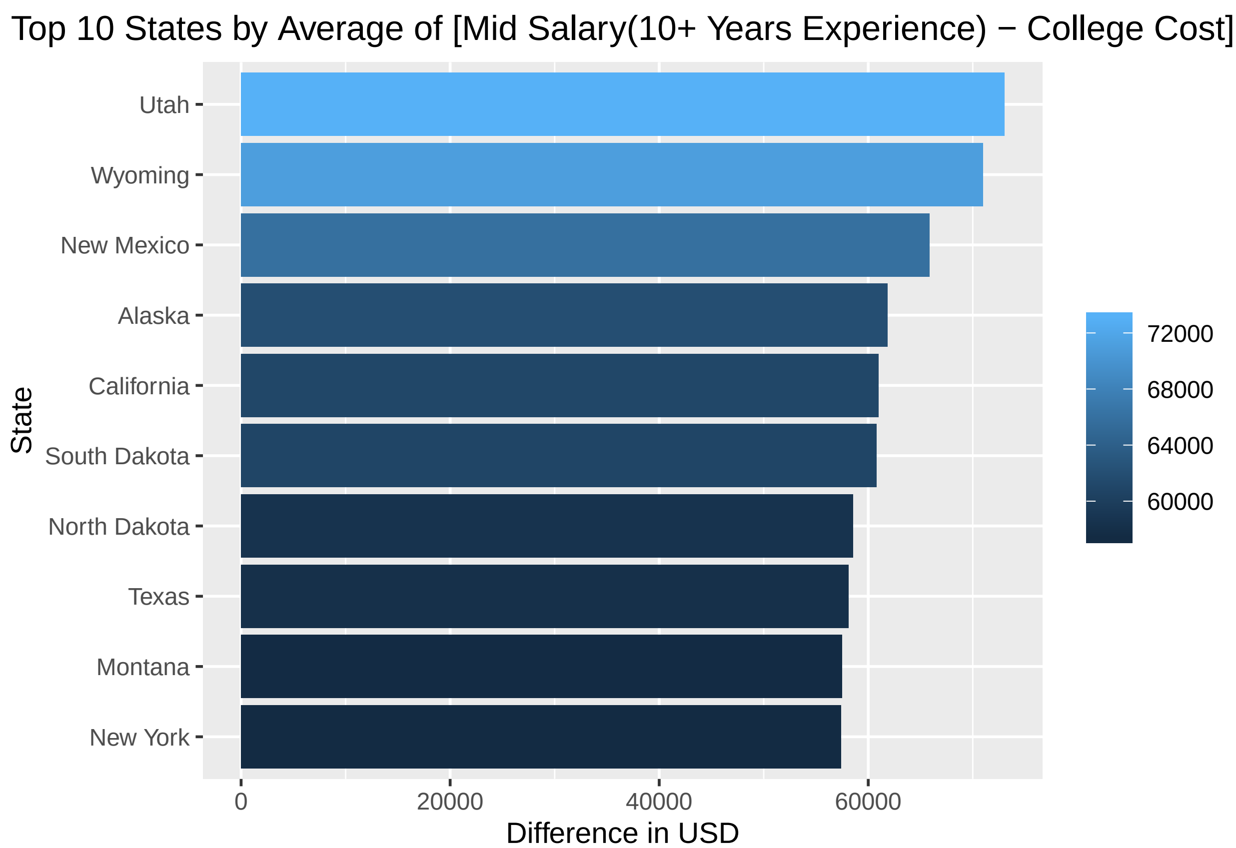
From below plots and maps, the schools in the states that have the best investment value in terms of "Mean_early_paidoff" and "Mean_mid_paidoff" are Ulah, Wyoming, and New Mexico, etc. The school in big states like New York and Pennsylvania are not in the Top-10 list. One reason would be that those schools in the big states have the most wide range of education resources, while at the same time, their college cost is way higher than the schools in other states.



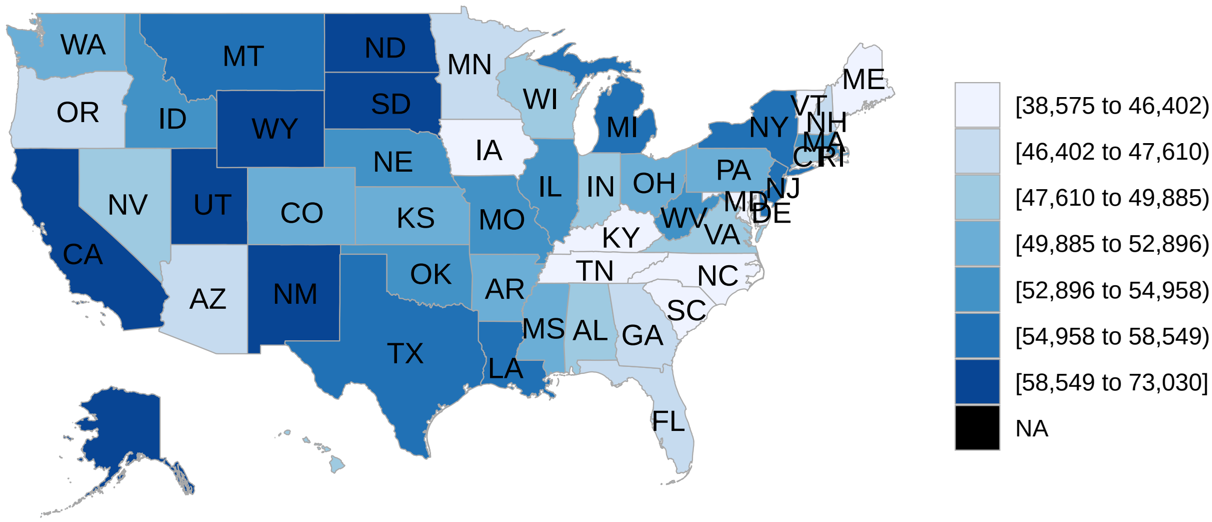
Top 10 States by Average of [Early Salary(0−5 Years Experience) − College Cost]
State
Utah
Wyoming
New Mexico
North Dakota
South Dakota
Alaska
Nebraska
Mississippi
Louisiana
Oklahoma
0
10000
20000
30000
Difference in USD
28000
24000
20000

Average of [Early Salary(0−5 Years Experience) − College Cost] in US




Top 10 States by Average of [Mid Salary(10+ Years Experience) − College Cost]
Utah
Wyoming
New Mexico
Alaska
California
South Dakota
North Dakota
Texas
Montana
New York
State
0
20000
40000
60000
Difference in USD
72000
68000
64000
60000

Average of [Mid Salary(10+ Years Experience) − College Cost] in US



3, Take a look at the final data, "Final_data" at the level of school type (Private vs Public)

New dataset "School_type_data" is created from the final data, "Final_data", by splitting into two group, "Private" and "Public". All numeric values are summarised by taking the average respect to each type of school.

In the average Mid-career Salary(10+ Years Experience) and the average Early-Salary(0-5 Years Experience, private schools outweights public schools in the U.S. However, in the most important career performance matrics that I created, public schools really shows the advantage. Because of lower total college cost, the "Mean_early_paidoff", which represents the average amount of [Early Salary(0-5 Years Experience) - College Cost] for public school is much higher than that in private school.

As a result, if people believe that college is a good investment, public schools should be highly considered.

```
## # A tibble: 2 x 11
##   type  count Mean_Early_Care~ Mean_Mid_Career~ Mean_High_Meani~
##   <chr> <int>            <dbl>            <dbl>            <dbl>
## 1 Priv~   382           52397.           95199.             53
## 2 Publ~   240           48810.           87678.             54.4
## # ... with 6 more variables: Mean_STEM_Degree <dbl>,
## #   Mean_Out_Of_State_Cost <dbl>, Mean_Enrollment <dbl>, Mean_Minority <dbl>,
## #   Mean_early_paidoff <dbl>, Mean_mid_paidoff <dbl>
```

IV. Future Development and Improvement

1, Create a dataset with nested states

Save for future development and improvement, such as creating linear regression model for each states to reveal siginificant impact that each factor might have on the relationship between college cost and career performance.

```
state_nested = Final_data %>%
  group_by(state)%>%
  nest()

# One example for Linear Regression for further data analysis:
state_lm <- function(df){
  lm(Mid_career_pay_paidoff ~ out_of_state_tuition_and_fee, data = df)
}

state_nested_lm <- state_nested$data %>% map(state_lm)
#state_nested_lm[[1]]

# Put the model right back into the nested data frame
state_nested_1 = state_nested%>%
  mutate(lm_fit = map(data, state_lm))

state_nested_1 = state_nested_1%>%
  mutate(lm_glance = map(lm_fit, glance))
```

2, More data needed

When comparing schools with different length of degrees, the comparison could be bias because there are only 2 schools with length of degrees as 2 year.

As for improvement, more schools with 2 year degrees in the U.S. should be added into the dataset.

```
## # A tibble: 2 x 11
##   degree_length count Mean_Early_Care~ Mean_Mid_Career~ Mean_High_Meani~
##   <chr>         <int>            <dbl>            <dbl>            <dbl>
## 1 2 Year            2           43400            76850              61.5
## 2 4 Year          620           51038.           92347.             53.5
## # ... with 6 more variables: Mean_STEM_Degree <dbl>,
## #   Mean_Out_Of_State_Cost <dbl>, Mean_Enrollment <dbl>, Mean_Minority <dbl>,
## #   Mean_early_paidoff <dbl>, Mean_mid_paidoff <dbl>
```