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R for Data Analysts – C997

BOM1 TASK 1: ESTIMATING POPULATION SIZE

Packages

Directly copy and paste the following to ensure that the necessary packages are present to load the code:

install.packages("dplyr")
install.packages("tibble")
install.packages("tidyverse")
install.packages("ggpubr")

Introduction

The United States collects and analyzes demographic data from the U.S. population. The U.S. Census Bureau provides annual estimates of the population size of each U.S. state and region. Many important decisions are made using the estimated population dynamics, including the investments in new infrastructure, such as schools and hospitals; establishing new job training centers; opening or closing schools and senior centers; and adjusting the emergency services to the size and characteristics of the demographics of metropolitan and other areas, states, or the country as a whole. The census data and estimates are publicly available on the U.S. census website. Data analysts use a variety of tools to create models for predictions, including models of population dynamics of a state of a region. For this project, you will use R to create a linear regression model of the population dynamics of your state and predict the size of its population.

Importing the Data

For this project the data can be found from the U.S. Census Bureau at WWW.census.org. For our purposes I've decided to use the "City and Town Population Totals: 2010-2019" for Texas. This data can be found at https://www.census.gov/data/datasets/time-series/demo/popest/2010s-total-cities-and-towns.html#ds. My first step of this project was to import the data into a dataframe in R.

```
population <- read.csv("https://www2.census.gov/programs-surveys/popest/datasets/2010-2019/cities/totals/sub-est2019_48.csv", stringsAsFactors = FALSE)
```

Cleaning and Prepping the Data

For this project a linear regression will be created using the total population estimate for each year from 2010 to 2019. Therefore, in order to simplify and improve the readability of the data I will be removing any unnecessary columns and/or rows.

```
df <- subset(population, select = -c(SUMLEV, STATE, COUNTY, PLACE, COUSUB, CO
NCIT, PRIMGEO_FLAG, FUNCSTAT))
```

- The cleaned data has been put into a new data frame named “df”. Specifically, a subset of the original data without the columns SUMLEV, STATE, COUNTY, PLACE, COUSUB, CONCIT, PRIMGEO_FLAG, and FUNCSTAT has been put into a dataframe named “df”

Now that the data has each unnecessary column removed, it can be further manipulated. For the purpose of estimating the total population of Texas only the first row or the “State Total” is need. Thus, we can pull that data out using the head() function and put it into a new dataframe.From there the data needs to be transposed to invert the X and Y columns so that a column for all of the years and a separate column for the population estimates can be created.

```
library(dplyr)

total <- head(df, n=1)
total <- as.data.frame(t(total))
total <- tibble::rownames_to_column(total, "Year")
colnames(total)[2] <- "Population_Estimates"
head(total)
```

```
##                Year Population_Estimates
## 1              NAME                Texas
## 2            STNAME                Texas
## 3     CENSUS2010POP             25145561
## 4 ESTIMATESBASE2010             25146091
## 5   POPESTIMATE2010             25241971
## 6   POPESTIMATE2011             25645629
```

The next step to prepping the data for the linear regression is removing the first 4 rows, “NAME”, “STNAME”, “CENSUS2010POP” and “ESTIMATESBASE2010” as they are unnecessary. In addition each row in the column “Year” will be renamed in order to convert the data type to a numeric type and remove the “POPESTIMATE” text before the year.

```
total <- total[-c(1,2,3,4),]
total$Year <-c(2010, 2011, 2012, 2013, 2014, 2015, 2016, 2017, 2018, 2019)

head(total)
```

```
##    Year Population_Estimates
## 5  2010             25241971
## 6  2011             25645629
## 7  2012             26084481
## 8  2013             26480266
## 9  2014             26964333
## 10 2015             27470056
```

The last thing to do is change the data type for the column “Population_Estimates”. Using the str() function it can be seen that "Population_Estimates is a character data type.

```
str(total)
```

```
## 'data.frame':    10 obs. of  2 variables:
##  $ Year                : num  2010 2011 2012 2013 2014 ...
##  $ Population_Estimates: chr  "25241971" "25645629" "26084481" "26480266"
...
```

For the current scenario it is necessary to convert “Population_Estimates” to an integer data type.

```
total$Population_Estimates <-as.integer(as.character(total$Population_Estimat
es))
str(total)
```

```
## 'data.frame':    10 obs. of  2 variables:
##  $ Year                : num  2010 2011 2012 2013 2014 ...
##  $ Population_Estimates: int  25241971 25645629 26084481 26480266 26964333
27470056 27914410 28295273 28628666 28995881
```

The data has now been cleaned and manipulated in order to easily create a linear regression with “Year” as the predictor or independent variable and “Population_Estimates” as the dependent variable.

Creating a Linear Regression

In order to predict the future population size for the state of Texas a linear regression model named “lmPop” will be created using the lm() function.

```
lmPop <-lm(Population_Estimates~Year, data = total)
lmPop
```

```
## Call:
## lm(formula = Population_Estimates ~ Year, data = total)
##
## Coefficients:
## (Intercept)         Year
##  -833917553       427446
```

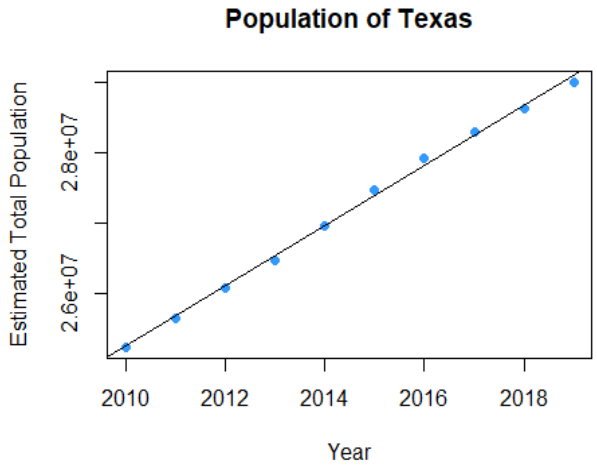
The linear regression equation for the data is Y = Year(X) + Intercept or Y = 427,446(X) + -833,917,553.

A graph of the data points and the linear regression line can be seen below:

```
plot(total$Year, total$Population_Estimates,
     main = "Population of Texas",
     xlab = "Year",
```

```
     ylab = "Estimated Total Population",
     pch = 19,
     col = "#3399FF")

abline(lmPop)
```



Statisitcal Description of The Model Using summary()

The summary() function can be used to provide statistical information about the linear model.

```
summary(lmPop)

##
## Call:
## lm(formula = Population_Estimates ~ Year, data = total)
##
## Residuals:
##    Min     1Q Median     3Q    Max
## -99722 -37220 -12810  42411 101145
##
## Coefficients:
##               Estimate Std. Error t value Pr(>|t|)
## (Intercept) -833917553   14823968  -56.26 1.11e-11 ***
## Year            427446       7359   58.09 8.57e-12 ***
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
##
## Residual standard error: 66840 on 8 degrees of freedom
## Multiple R-squared:  0.9976, Adjusted R-squared:  0.9973
## F-statistic:  3374 on 1 and 8 DF,  p-value: 8.567e-12
```

Looking at the summary we can see that the model is a good fit to the data. The multiple R-squared value is very close to 1 and the 3-stars for the variable "Year" indicate a low p-value close to 0 which then indicates a high significance level.

Predicting Future Population

In order to predict the future population for the state of Texas a data frame needs to be created with one column for the years to be predicted and another column to hold the future predicted values.

```
future_df <- data.frame("Year" = 2020:2030, "Population_Estimates" = 0)
head(future_df)
```

```
##    Year Population_Estimates
## 1  2020                    0
## 2  2021                    0
## 3  2022                    0
## 4  2023                    0
## 5  2024                    0
## 6  2025                    0
```

Now that the data frame holding future year values has been created it is now possible to use the predict() function to predict the population for future years.

```
predictions <- predict(lmPop, newdata = future_df)

future_df$Population_Estimates <- predictions
future_df
```

```
##    Year Population_Estimates
## 1  2020             29523049
## 2  2021             29950495
## 3  2022             30377940
## 4  2023             30805386
## 5  2024             31232832
## 6  2025             31660278
## 7  2026             32087724
## 8  2027             32515170
## 9  2028             32942615
## 10 2029             33370061
## 11 2030             33797507
```

Looking at the table above we can see that the total population of Texas in 2025 is predicted to be 31,660,278.