Final Report

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Motivation

Death by suicide is an extremely complex issue that causes pain to hundreds of thousands of people every year around the world. Globally, close to 800,000 people die from suicide every year. This makes it one of the leading causes of death globally which is in the top 15 list. In this project, with a joint dataset from United Nations Development Program, World Bank, Kaggle, and World Health Organization, we examined current trend of Suicide Commitments.

Initial questions

1. What's the general trend of suicide rate globally across the time.
2. Is there any gender difference in suicide rate across the time.
3. Is there any age difference in suicide rate across the time.
4. The relationship between the development of a country (GDP) and suicide rate across time.

Data

The main dataset for our project is a combined dataset from summary datasets made by United Nations Development Program, World Bank, Kaggle, and World Health Organization. It can be access at https://www.kaggle.com/russellyates88/suicide-rates-overview-1985-to-2016. This dataset has a range from 1985 to 2016. However, since there are very few data in 2016, we will only keep the range from 1985 to 2015.

The raw dataset has a size of 27660 observations and 8 features. Basic features we are interested in include:

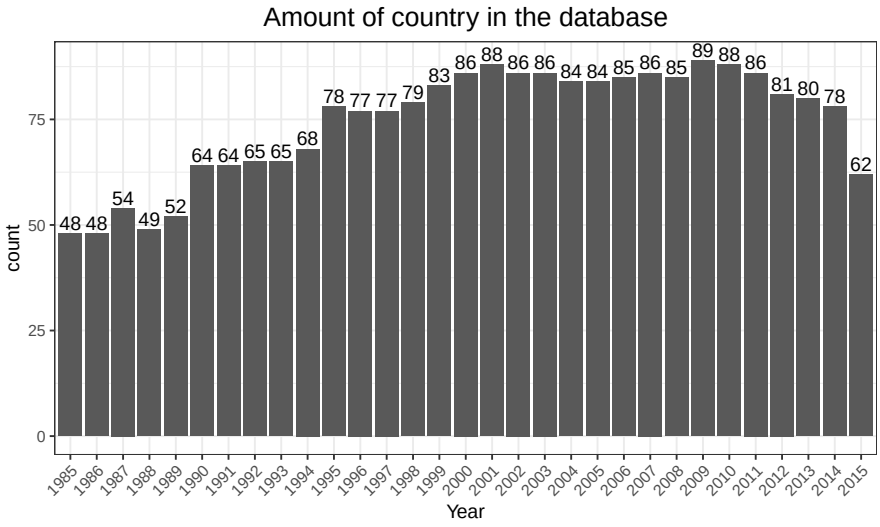
- **Country**
- **Year**: Year of the records
- **Sex**
- **Age**: Age groups including "5-14", "15-24", "25-34", "35-54", "55-74", and "75+".
- **GDP per capita**
- **Suicides_no**: Amount of suicides

Besides those, we will derive our main interested variable, **Suicides Per 100K** as **Suicides_no** divided by **Population** and multiplied by 100,000.

Exploratory data analysis

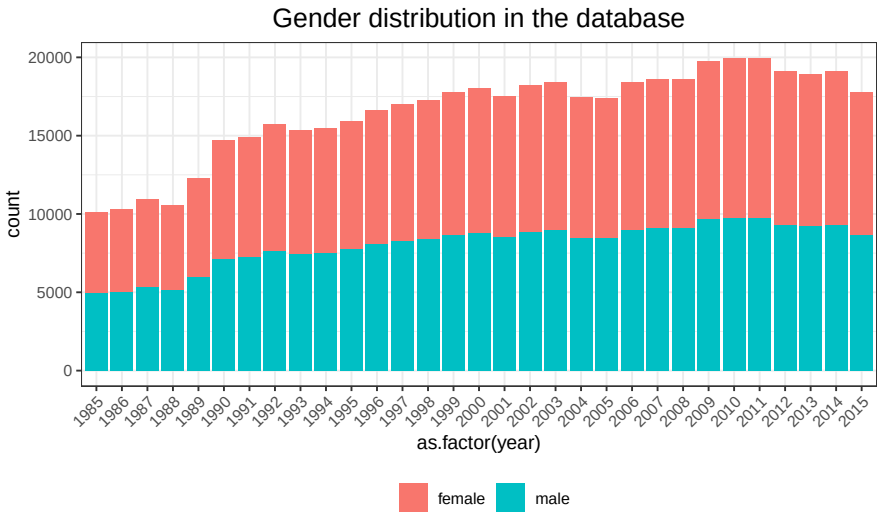
Country

There are average 74.3548387 countries in the dataset across each year. Graph below shows the distribution. Although there are less countries before 1995, the amount of countries for each year is stable around 80.



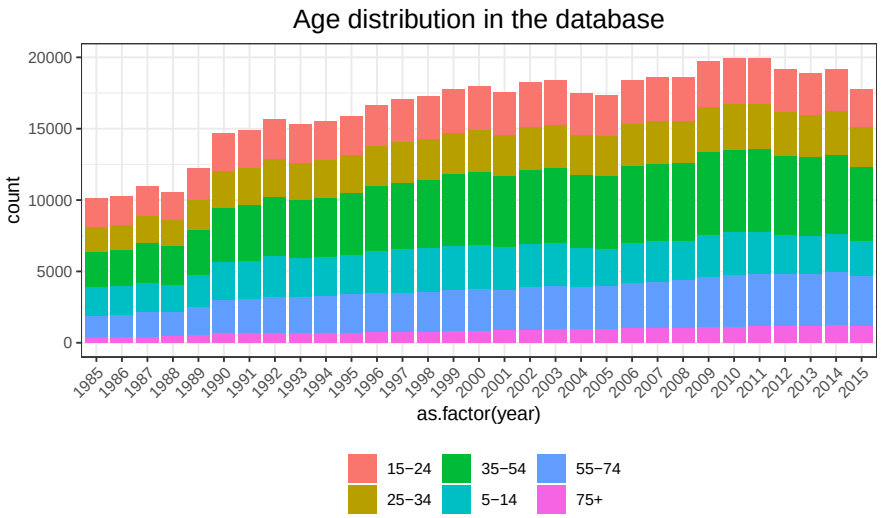
Sex

Graph below shows that sex for each year is also evenly distributed.



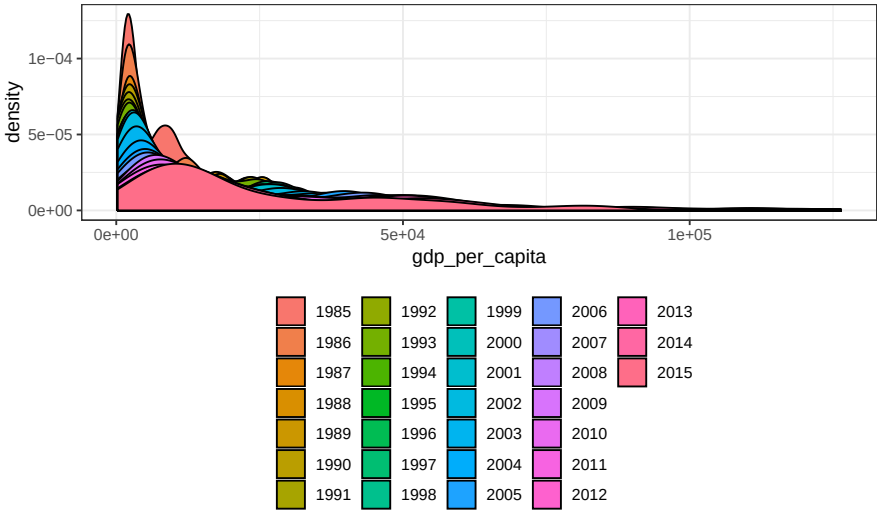
Age group

Although there are some variations between groups, the ratios between amounts of people in different age groups are consistent across years.



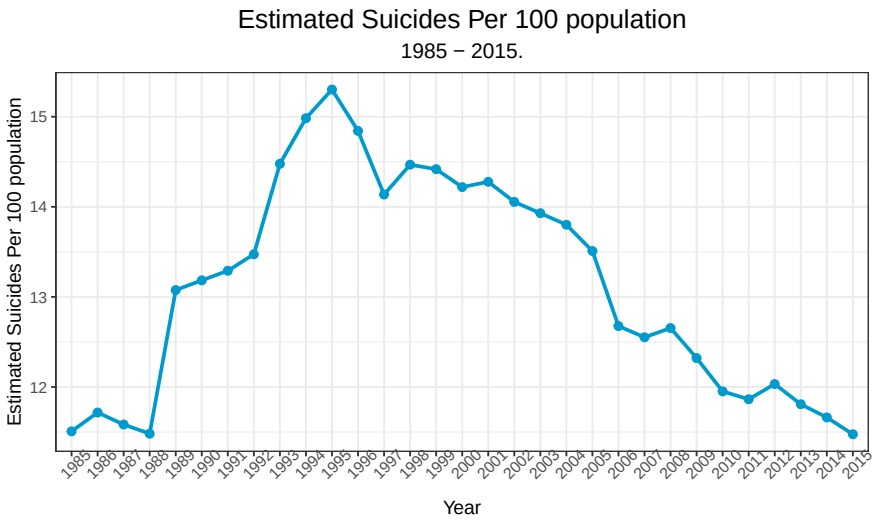
GDP per capita

The distribution of GDP per capita is skewed to the right. As the year goes on, we can see that the distribution becomes flatter, relatively.



Suicides Per 100K

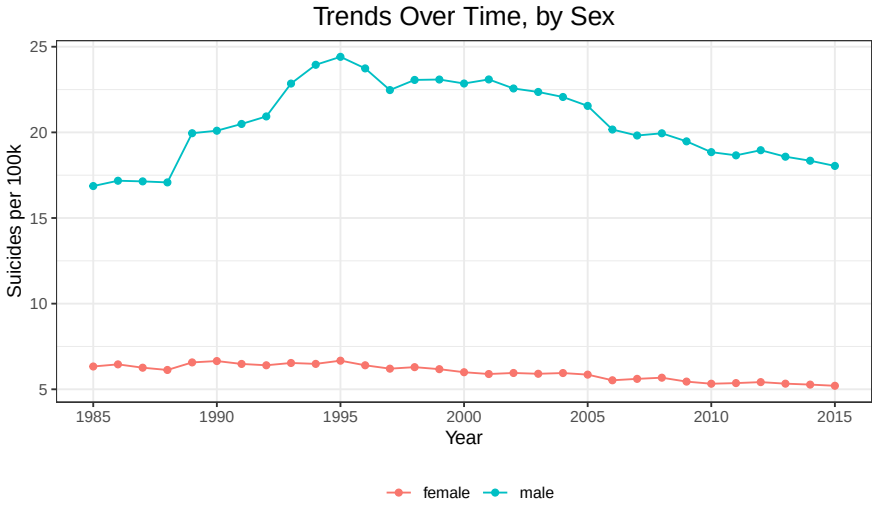
As we mentioned above, we can derive our main interested variable, **Suicides Per 100K**, as **Suicides_no** divided by **Population** and multiplied by 100,000. The trend is shown as below. As we can see, in recent years, the estimated suicides rates are decreasing.



Visualization

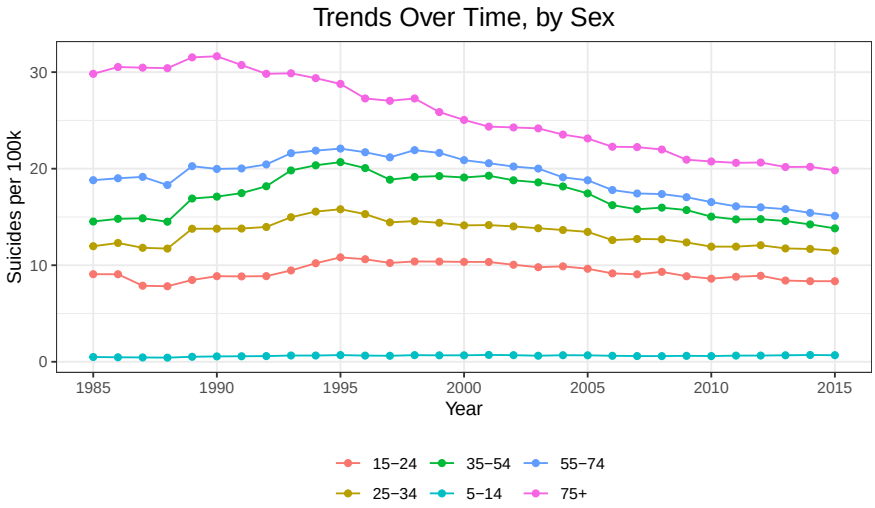
Global Trend of Suicide Per 100k Population by gender over time

We found that surprisingly, male has higher rate of suicide than female since 1985. Female suicide rate had a very stable trend throughout the history, while the male suicide rate had dramatic changes. As mentioned in the other graph, there is a peak in 1995 for the suicide rate.



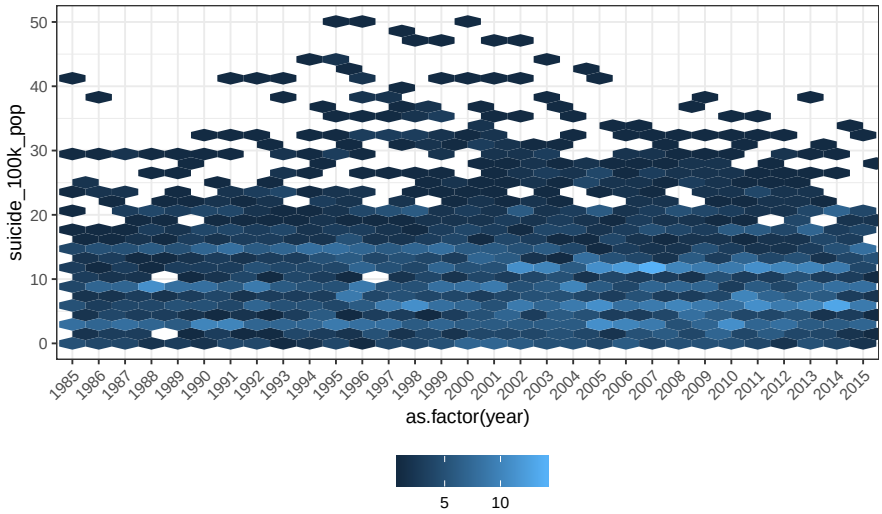
Global Trend of Suicide Per 100k Population by age over time

Suicide rates for the youngest age group are nearly constant and low over time. As the graph shown, elder groups have had higher suicide rate since 1985, and surprisingly such trend has not changed once. Age groups 25-34, 35-54 and 55-74 had similar trends over those 30 years.



Suicide Rate by Country GDP

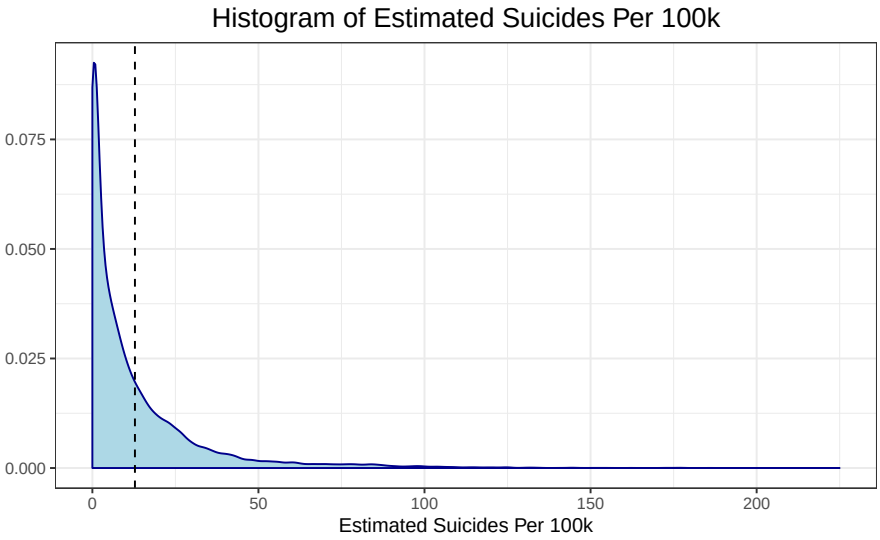
GDP has been viewed as a good measure about the development of a country. In the graph below, each color represents one country at a given year. However, the graph below shows that there is no obvious trend between GDP and suicide rate across 30-year period. We can see that although GDP's across the world have been shifted toward the right which indicates an increasing trend, the estimated suicides in 100k people have only slight decrease.



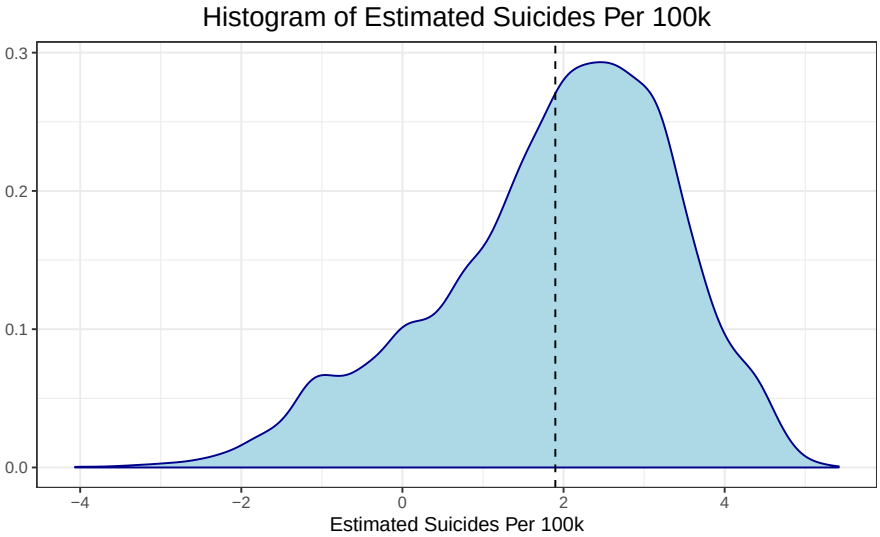
Statistical Analysis

Visualization will be used to examine the global general trend. We will detect the group difference by sex, age, and GDP per capita by doing regression analysis. The interaction terms between age group and sex are also considered since it's possible that sex can have different suicide trend regarding to different age groups. For example, women in menopause might have higher suicide rate because of the hormonal fluctuation. Lastly, although it is out of our primary interest, we will fit a regression model to see whether there is a sign of national-specific trend.

Following is the distribution of suicide_100k_pop, we can see that we need to transform it to satisfy the assumptions of the linear model.



We used log transformation and changed 0's to 0.01 for further calculations. Following graphs show that after the transformation, the distribution had been much more normal than the previous one.



Results

Based on transformation above, the model we are going to fit is:

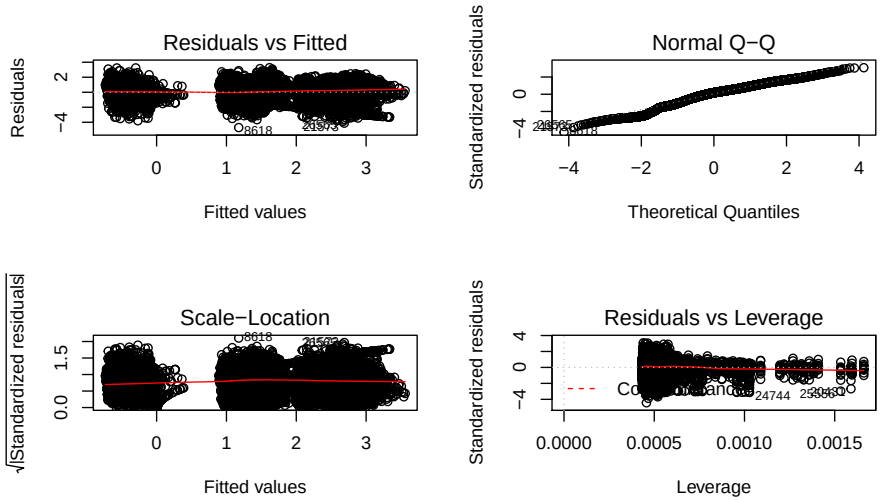
$$log(suicideper100k) = \beta_0 + \beta_1 year + \beta_2 sex + \beta_3 age + \beta_4 age * sex + \beta_5 gdppercapita$$

	Estimate	Std. Error	t value	Pr(>|t|)
(Intercept)	20.4128030	1.6138338	12.648641	0.0000000
year	-0.0096925	0.0008074	-12.004703	0.0000000
sexmale	1.0971519	0.0313288	35.020566	0.0000000
age25-34	0.0827020	0.0313288	2.639807	0.0083000
age35-54	0.2699173	0.0313288	8.615630	0.0000000
age5-14	-1.6251063	0.0313288	-51.872616	0.0000000
age55-74	0.3531358	0.0313288	11.271926	0.0000000
age75+	0.4404010	0.0313288	14.057388	0.0000000
gdp_per_capita	0.0000067	0.0000004	18.529951	0.0000000
sexmale:age25-34	0.2767489	0.0443056	6.246365	0.0000000
sexmale:age35-54	0.2562206	0.0443056	5.783030	0.0000000
sexmale:age5-14	-0.8449252	0.0443056	-19.070394	0.0000000
sexmale:age55-74	0.1647189	0.0443056	3.717790	0.0002014
sexmale:age75+	0.2615484	0.0443056	5.903282	0.0000000

Based on the summary, we can see that all our main effects and the interaction term are statistically significant. This indicates that there indeed are group differences by age, gender, and GDP per capita. As we proposed, sex can have different suicide trends regarding to different age groups.

The F-statistics is 2221.3144029. It's obvious that the model is statistically significant under any reasonable critical value. It also has a R^2 value of 0.5108901, which indicated chosen variables together are able to explain 51.09% of observed variation.

To ensure accuracy, we also examined the assumptions of our model. The Residuals vs Fitted and Scale-Location value plot show that the model is nearly homostaticity. Normality assumption is examined by the Q-Q plot, which is satisfied. Lastly, the Residuals vs Leverage plot indicates that although there are about 3 potential outliers in our dataset, none of them is close enough to the contour of cook's distance to be considered as influential observations.



In addition, we fitted another model by adding country and population into previous model.

$$log(suicideper100k) = \beta_0 + \beta_1 year + \beta_2 sex + \beta_3 age + \beta_4 age * sex + \beta_5 gdppercapita + \beta_6 Country$$

The anova result indicates that at least one of the countries and population variable is statistically significant. This means that a more micro studies such as national level suicide trend analysis can be a topic for future research questions.

```
## Analysis of Variance Table
##
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```
## Model 1: log_suicide ~ country + sex + age + gdp_per_capita + sex * age
## Model 2: log_suicide ~ year + sex * age + gdp_per_capita
##   Res.Df   RSS  Df Sum of Sq      F    Pr(>F)
## 1  27548 16220
## 2  27646 31272 -98    -15052 260.86 < 2.2e-16 ***
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
```

Conclusion

Our regression model indicates that all our main effects (i.e. age_group, sex, GDP per capita) and the interaction term between age_group and sex are statistically significant. This indicates that there indeed are group difference by age and gender. As we proposed, gender can have different impacts on amount of suicides regarding to different age groups. An interesting finding is that although there is no obvious trend between amount of suicides and GDP per capita based on the graph, the regression output shows that GDP per capita does have a statistically significant effect on amount of suicides.

Discussion

A strength of this study is that the study is a longitudinal study with a time spin of 30 years, which gives us more chance to explore the justifications and the trends behind the data. Meanwhile, there are many limitations that future researchers need to be aware of. First of all, there are only few variables that may be related to suicide rate. However, there are other factors or latent factors that may be reflected by suicide rate such as alcoholic use. Secondly, since we had done a global trend analysis, we need data from all over the world. However, this particular data set is lack of the suicide information from Asia(especially China and North Korea) and Africa. Lastly, the data is not individual-leveled which may intervene with our analysis for prediction purposes.

Contribution

Yingxi Ji and Wurongyan Zhang were mainly responsible for the Data cleaning, EDA, Regression, Model Selection and analyses. Yiling Yang was mainly responsible for further data visualization such as the animation of the plots of the trend and the organization of the whole report and website. Yeqing Ji was mainly responsible for the shiny app part including interactive map and data exploration by users. We wrote the final report and recorded the videos together and we evenly distributed the amount of the work.