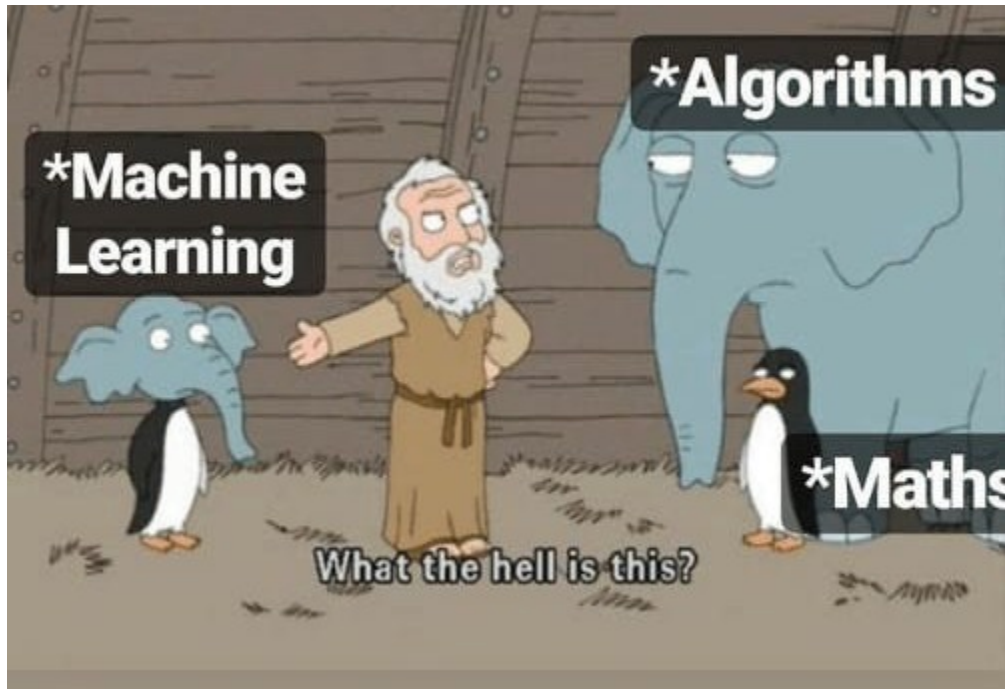


**DDW DESIGN THINKING PROJECT III:**  
**Modelling Uncertainty 2D Report**

**SC06 GROUP 5**



```
def get_authors(self):  
    return { 'Davis_chun' : '1005936',  
            'Varun_Teja' : '1005965',  
            'Darren_Lee' : '1006331',  
            'Xing_Rui' : '1006026',  
            'Vanya_Jalan' : '1006190' }
```

**Background:**

Looking at how drastically the food security of many countries were affected by the war in Ukraine, we wanted to explore more on how conflict affected the food security of a certain country. We looked at the case on El Salvador which has been plagued in civil war and conflict for a long time and this caused their food security to be particularly low but we deduced this would be a pretty obvious cause and effect relationship, hence we decided to delve deeper and see if crime of a certain country would affect the food security of the country and if so which crimes and how they affect it. Therefore, we decided to frame our problem statement based on this train of thought.

**Problem Statement:**

How might we investigate the effect of crime indicators like corruption, violence, theft, etc on the food security of a country over a span of 7 years(2014 - 2021).

**Exploratory Analysis:****Why we chose to focus on food distribution:**

There are five pillars under food security which are availability, access, utilisation, stability, agency and sustainability. We chose to focus on food distribution which falls under availability as we believed that one of the major reasons there is a lack of food security due to poor distribution of food among the world and other than the lack of infrastructure which would have an obvious solution to build better infrastructure.

The other major factor that affects distribution would be crime and conflict in the region of choice. Hence, by choosing crime as the predictor variable we are able to figure out whether there is any correlation between crime and food security and hence figure out which areas of crime and conflict in general can be improved upon in countries around the world so as to improve the food security of the country. That would be the end goal of the modelling of this data.

**Relation between chosen indicator and food security:**

We believe crime is closely linked to food insecurity due to 2 reasons:

- People that have limited access to food (minimal resources in terms of money or poor infrastructure of the country) will resort to crime to survive. They will be more inclined to commit crimes such as kidnapping, burglary for monetary gains to afford food. This can even include stealing of food (theft).
- In a country with poor security in general, the food security is likely to be low as the food supply infrastructures will be severely affected by crimes. For example, food hoarding due to corruption leads to shortage of food for some, this in turn, would lead to them resorting to other crimes like theft, violence, fraud, kidnapping, etc in order to meet their basic food requirements.

**Thought process in finding predictor variables:****Corruption/Fraud:**

In a country where corruption is evident, the politicians and corporations collude with each other to drive up prices so as to maximise profits which denies food to a large sum of the population. This is just one way corruption could affect the food security of the country hence it should be a predictor variable. This is further backed by a study done by the National Library of Medicine.

**Burglary/Theft/Robbery:**

Burglary, or stealing of food is also a major predictor variable linking to food security because All these crimes just affect the overall infrastructure and security in the country. People would resort to these measures when they do not have enough for their survival.

**Intentional Homicide/Serious Assault:**

Poverty leads to an inability to effectively maintain a strong quality of life. A lower quality of life leads to more civil unrest within a country and civil unrest usually leads to higher levels of violence. Frequent assaults and homicides suggest that the level of security in a country is low. Food infrastructures will be affected. Farmers may be extorted, marts may be robbed. This is further backed by this study which concludes that violence leads to greater food insecurity.

**Persons Convicted/Persons Convicted:**

A country with a high incarceration rate leads to more people being food insecure as those that are incarcerated and coming out from prison tend to have a very high barrier to food security due to many factors such as difficulty of employment and access to food. It also indicates a low level of security in the country due to the very high incarceration rate.

**Kidnapping:**

This can again be linked to food security in the manner that kidnappers resort to kidnapping due to desperation for money, demanding a lot of money as ransom in order to procure food for themselves. This is another example of a violent crime affecting the food security of a country.

**Processing and Cleaning data-**

Our target data is the number of moderately or severely food insecure people (in millions) from FAOstat. The data set was first narrowed down to countries, excluding regions such as "Africa" or "World". Some values were missing or indicated as >0.1 (i.e. less than 100,000 food insecure people). Rows with missing values were removed and >0.1 was rounded up to 0.1 to allow for linear regression.

Values for our target data were three year averages, however our predictor data, crime data, was for individual years from 2014 to 2021. Thus predictor data that matched country and year (within the year range) present in our target data was extracted. Three year averages were calculated and matched with the corresponding target data. The averages were only calculated if data was available for all three years, if one or more was missing, it would be left blank.

Outliers were then removed from our predictor data, defined as more than 1.5 IQR above or below the 3rd or 1st quartile respectively. Our target data was available in two metrics, counts and per 100,000 population. The above average was calculated for both metrics and outliers were removed using per 100,000 population metric. This was a more accurate indicator of crime rate as compared to raw count as population could cause much higher counts despite normal rates, e.g. USA. However raw count will be used for linear regression analysis as our target data is also in total count and thus similarly affected by population.

## Linear Regression Analysis

We will be using adjusted R-Squared value to compare the performance of our predictor data in order to compare the effects of adding a new predictor variable. Unlike the R-squared value which ends to increase as the number of variables is increased, adjusted R-squared only increases if the new variables increase the accuracy of the model.

Linear regression analysis was conducted using Excel's Data Analysis ToolPak and our process is as follows:

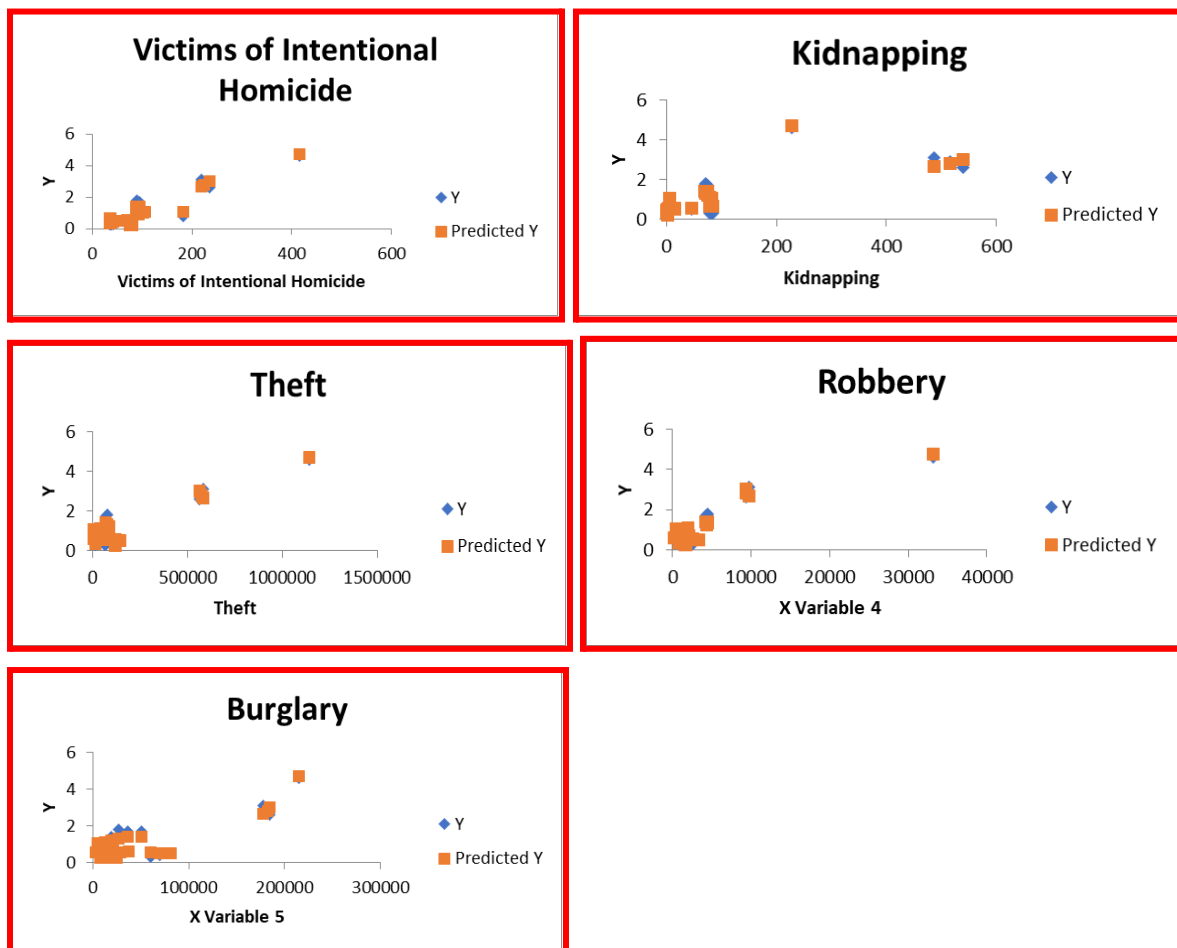
- 1) Analyse the target data against each predictor variable.
- 2) Record the adjusted R-squared value and number of observations.
- 3) Identify highest adjusted R-squared value (improvement)
- 4) Fix this predictor variable and repeat the above steps.

For example: if corruption showed the highest adjusted R-squared value at first, we then analyse the target data against corruption and another predictor variable. If robbery shows the largest improvement, we then analyse the target data against corruption, robbery and a new predictor variables and so on.

This process continues until either none of the comparisons show any further improvements or the number of observation drops below 30.

### Derived Model

Chosen Predictors: Kidnapping, Victims of Intentional Homicide, Theft, Robbery, Burglary. Final Adjusted R-squared value: 0.93907, final number of observations: 32

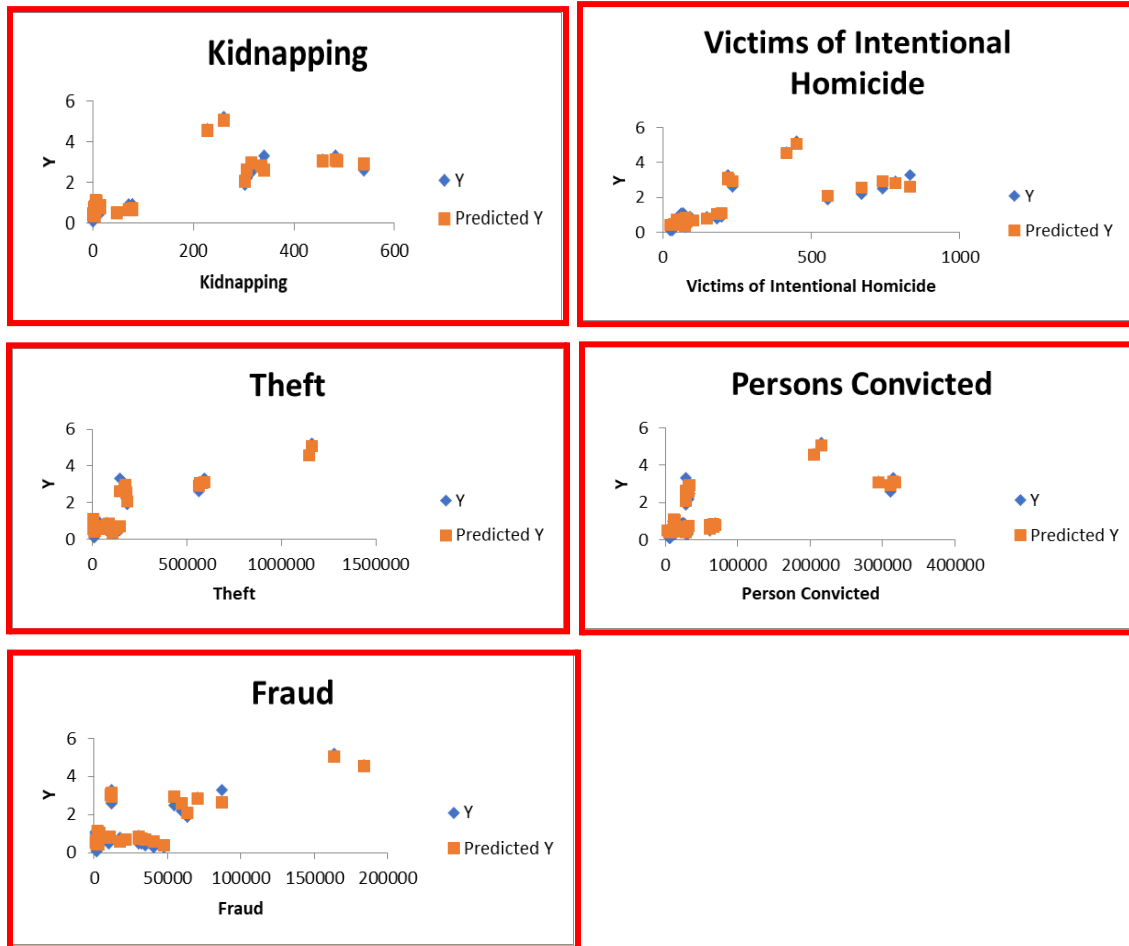


## Improving The Model

We explored additional models by “branching off”. At various number of predictor /variables (number of cycles of the above steps), we would add the predictor variable with the next highest adjusted R-squared value instead and explored from there.

## Final Model

Chosen Predictors: Kidnapping, Victims of Intentional Homicide, Theft, Persons Convicted, Fraud. Final Adjusted R-squared value: 0.94292, final number of observations: 37



## Analysis:

Our initial model indicates that kidnapping, homicide, theft, robbery and burglary can be used to predict food insecurity. Theft, robbery and burglary are likely to occur either due to food insecurity or economic reasons that also result in food insecurity. Kidnapping and homicide are more extreme among the crime indicators we considered, they are indicators of general security, a lack of which can negatively impact food security. They also indicate desperation, showing that some situations might cause people to resort to such desperate measures.

In our improved model, however we learnt that the persons convicted and the cases of fraud are better predictors of the food insecurity of a country as they give a better adjusted r squared value so all final 5 variables best predict the food insecurity of a country and can be used in future modelling to determine the food security of a country based on these specific predictors.

The reason why fraud and persons convicted are better predictors could be because victims of fraud and criminals convicted have their food security directly affected by the respective indicators. For example, victims of fraud could lose a large amount of their life savings while criminals convicted when released from jail could face a harder time to land jobs, causing them to have less economic access to food.

However, it is unexpected that the indicator of corruption does not heavily predict the food security of the country as it would be expected that the fundamental distribution of food in a country would easily be influenced if there was a high corruption rate. Our models predict otherwise which indicate either that corruption is not a good predictor of food security of a country or that corruption indexes are not very accurate in depicting the true corruption in a country.

### Insights, predictions or recommendations -

From our final model we are able to deduce the indicators that give us the best adjusted r squared value and hence the best prediction of the food security of a specific country. Hence, the United Nations and the World Health Organisation can use these predictor variable to accurately(to a certain extent) predict the food security of the country and the governments of countries with poor food security can tackle these specific crime indicators to achieve better food security for their country making our model useful in improving food security around the world.

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