CLUSTERING ASSIGNMENT

DONE BY:
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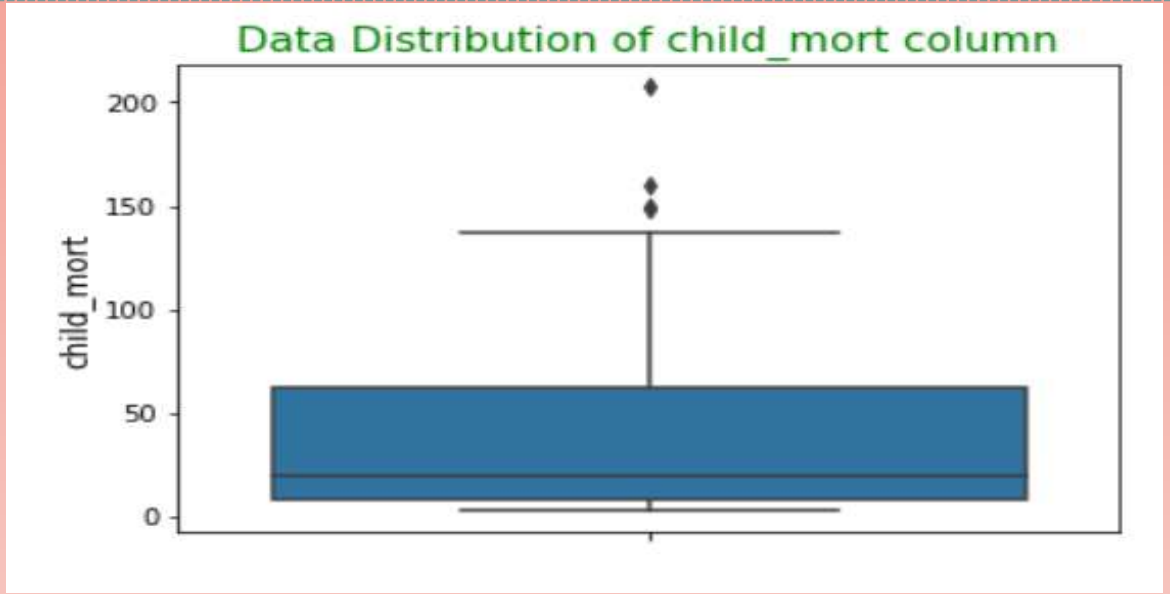
UNIVARIATE ANALYSIS on the Data

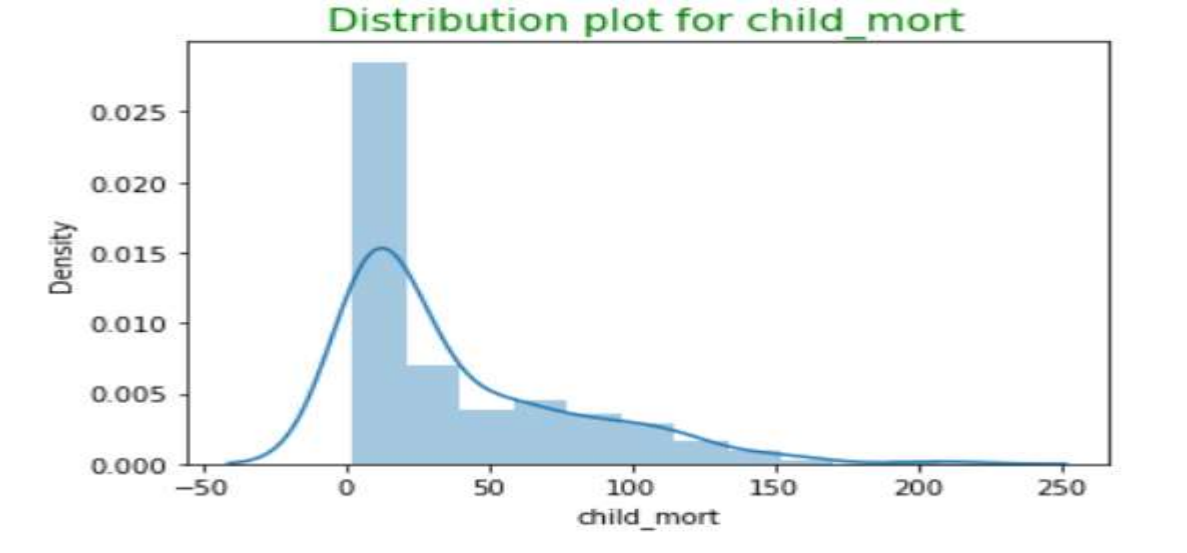
- Categorical Unordered UNIVARIATE analysis
- Categorical ordered UNIVARIATE analysis

UNIVARIATE Analysis helps in fetching insights from single variable which helps in Overall Analysis to identify the distribution of each feature in the data

Distribution on Child_Mortality

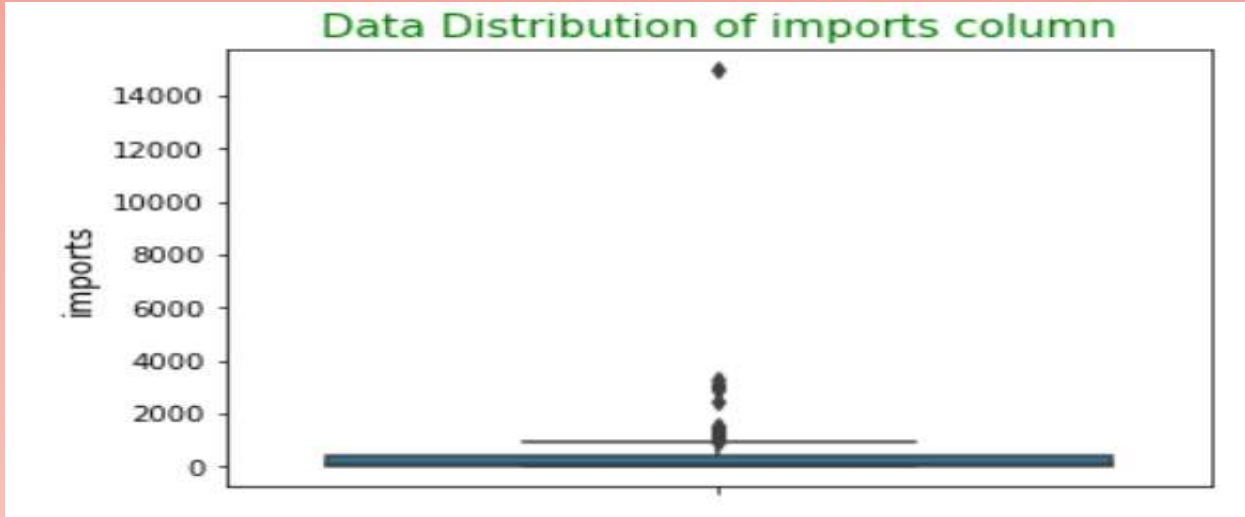
- Child mortality tells us about the count of deaths occurred of children under 5 years of age per 1000 live births in a country
- We have few observations where child mortality rate is greater than 150 which is a serious consideration in our outcome.
- High childmortality indicates countries which may indicate poor countries or less advanced countries to save the children death due to various health problems.
- This feature is strong indicator who are required in aid on priority

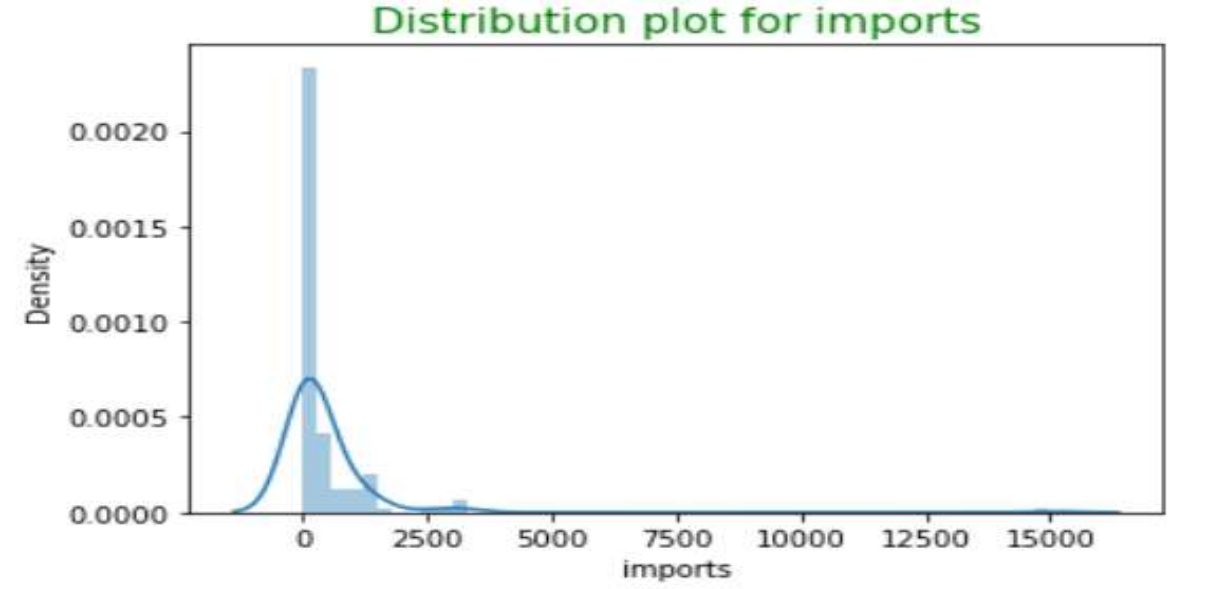




Distribution of Imports Feature

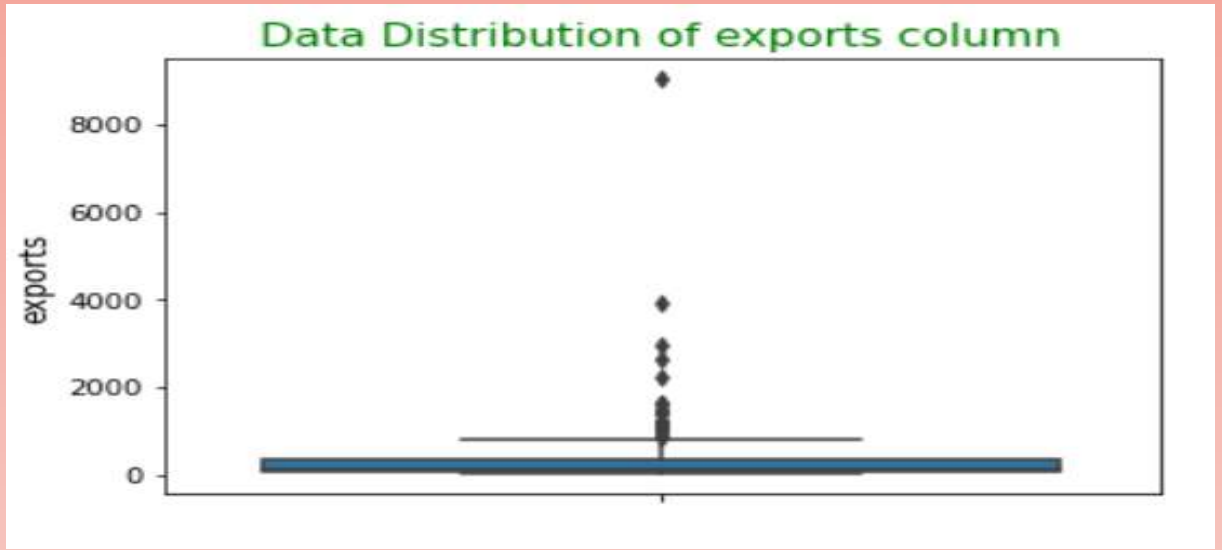
- Import feature says about the Imports of goods and services per capita.
- As shown in the boxplot and distribution of Imports feature we could see data is right skewed. Since some of the countries have higher imports lets treat the right skewed data since it may affect our analysis
- We will cap the outliers since we have very less amount of data.

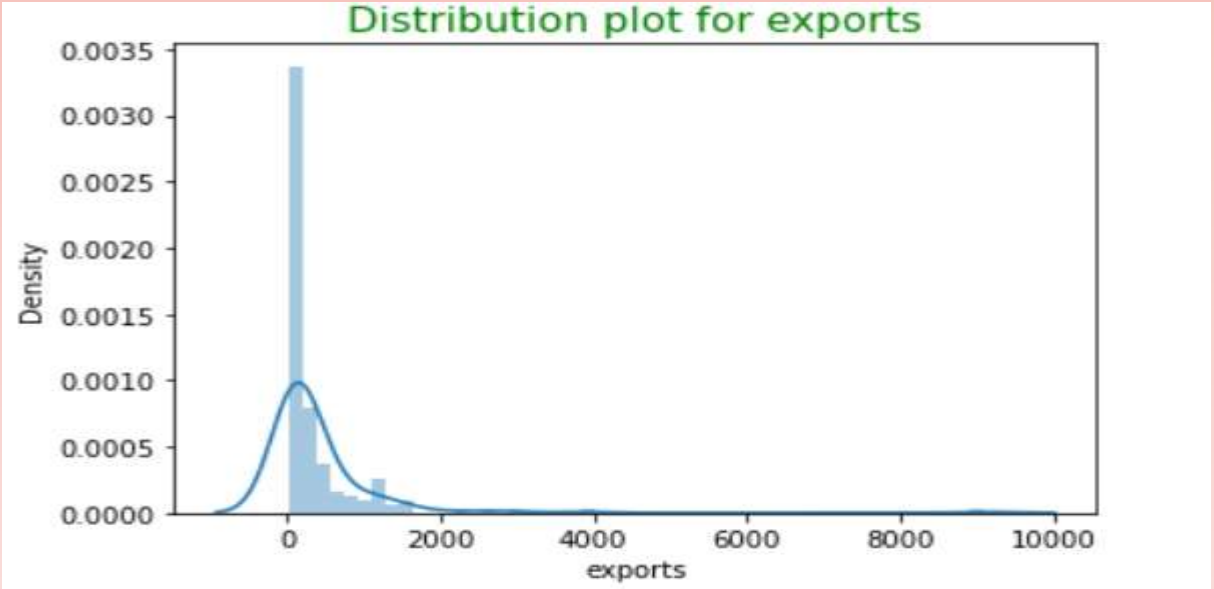




Distribution of Exports Feature

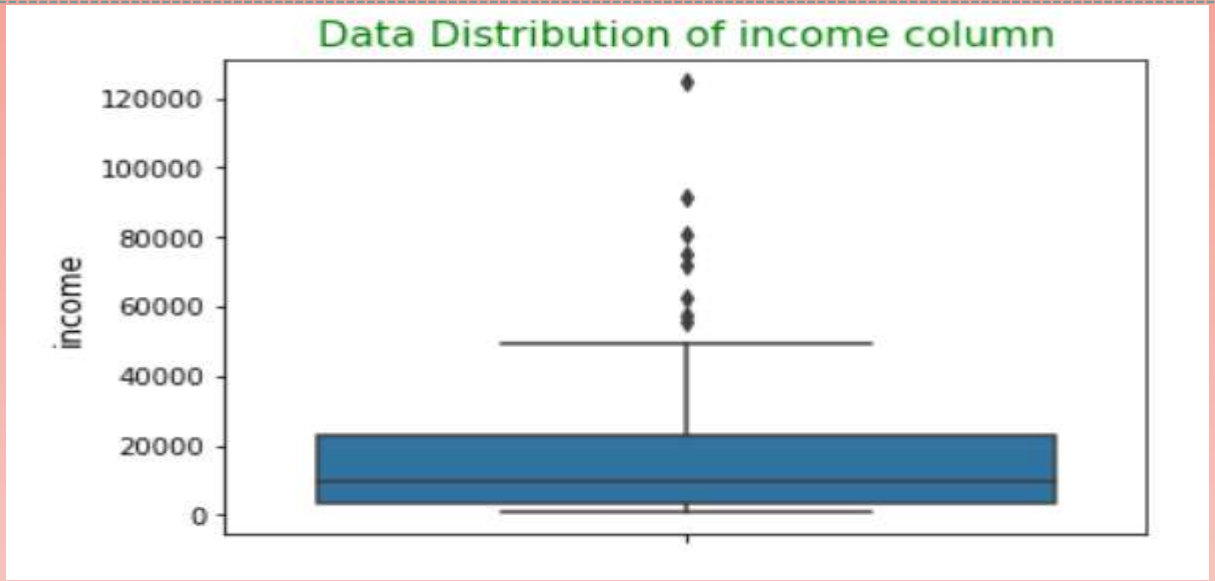
- Export feature says about the exports of goods and services per capita.
- As shown in the boxplot and distribution of exports feature we could see data is right skewed. Since some of the countries have higher exports lets treat the right skewed data since it may affect our analysis
- We will cap the outliers since we have very less amount of data.

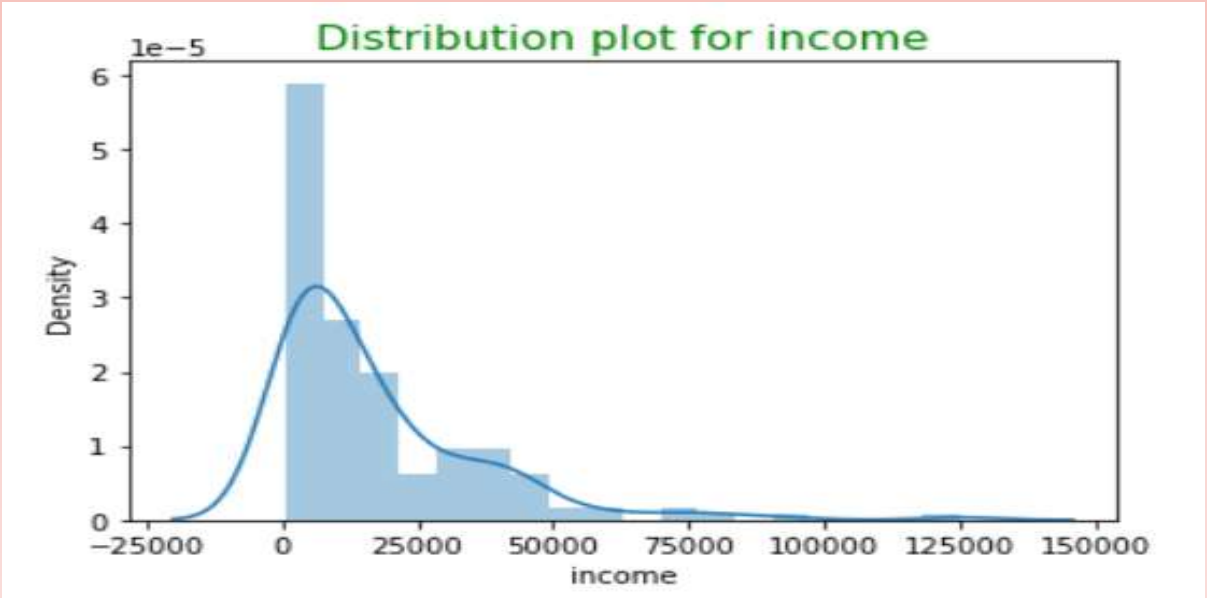




Distribution of income Feature

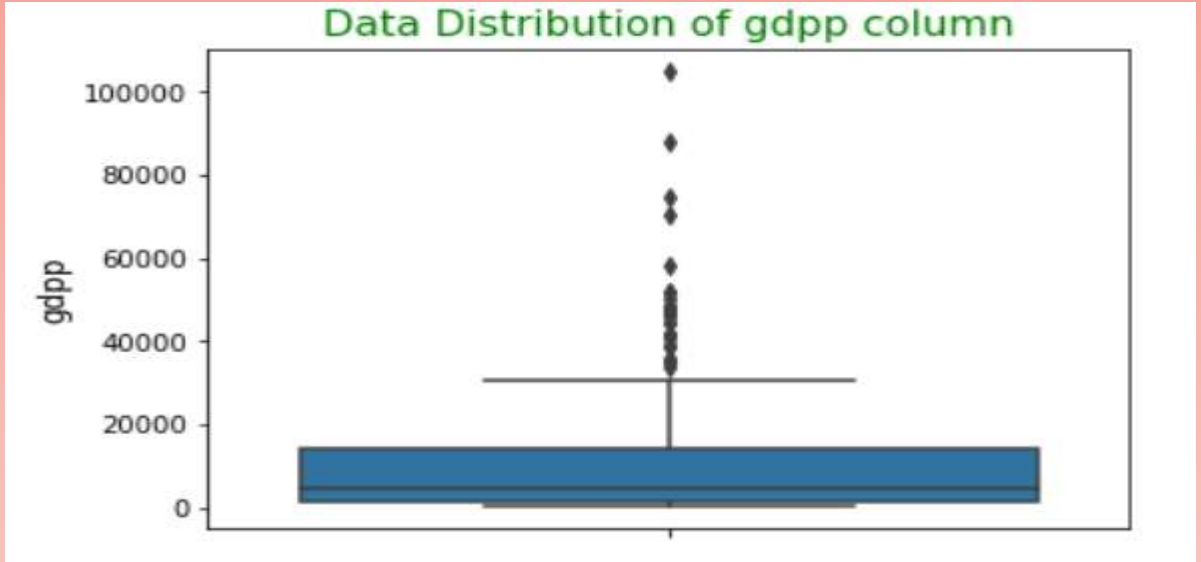
- As observed in the box plot shown income feature has huge set of outliers. Considering this may affect our analysis Lets cap them at 0.95. So the model will not be affected by this skewness
- **Income** has an outlier which looks suspicious at greater than 120000 .We have capped them to avoid skewness of the model.

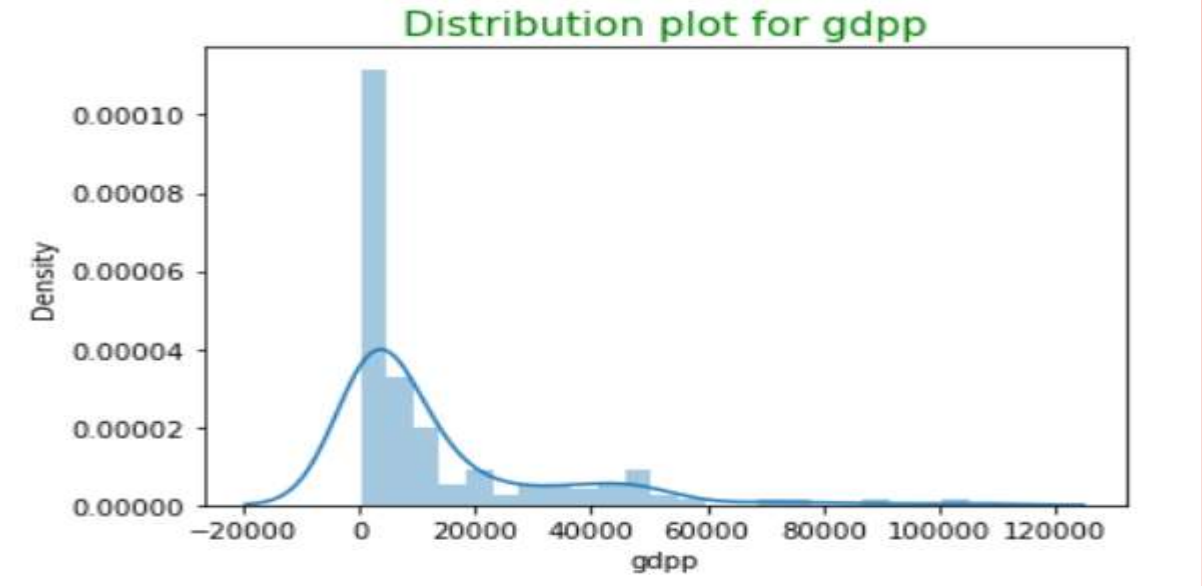




Distribution of GDP Feature

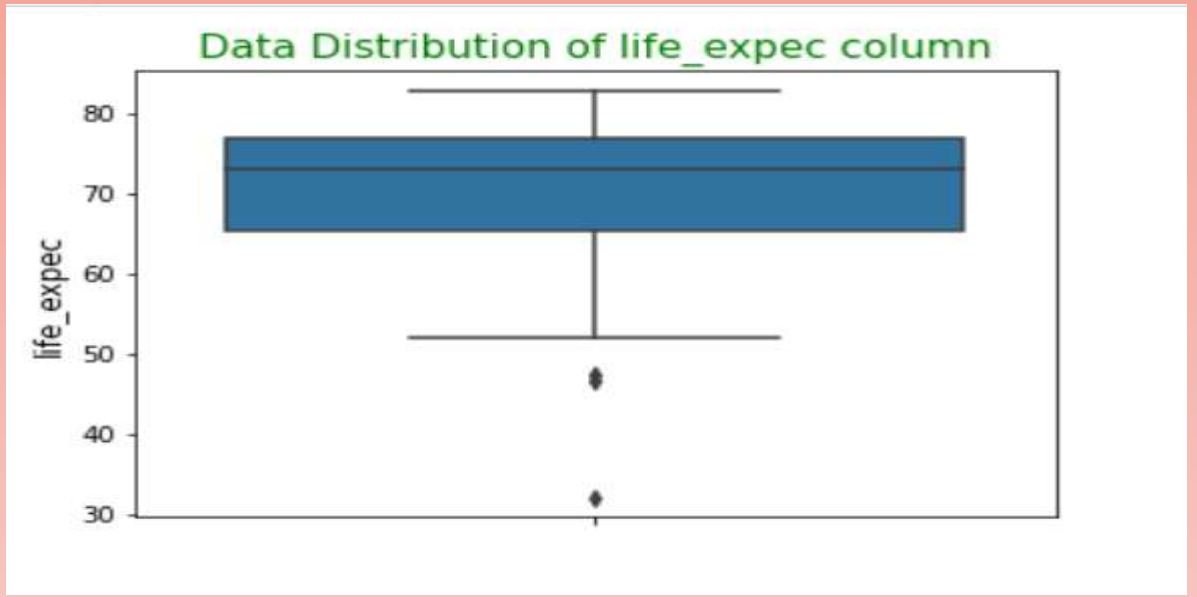
- Gdpp tells about the GDP per capita. Calculated as the Total GDP divided by the total population.
- GDP of the country is one of the criteria in understanding the requirement or identifying the needy people where we can concentrate in funding or helping from **HELP International**
- gdpp feature is having some good amount of outliers. We have capped them since the model will not be affected with the skewness of the feature

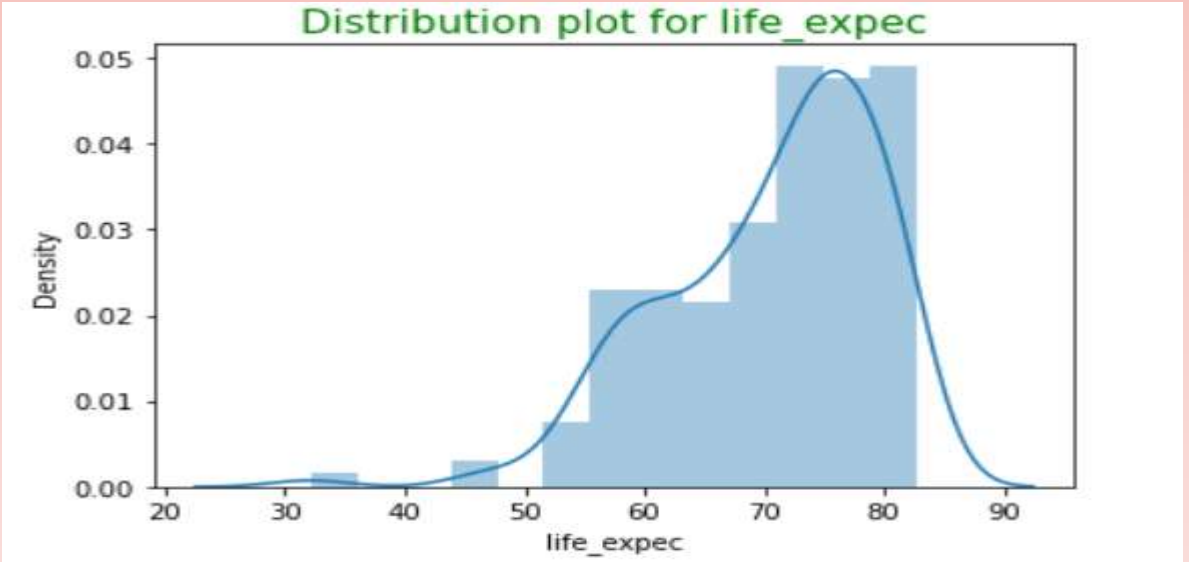




Distribution of life_expec Feature

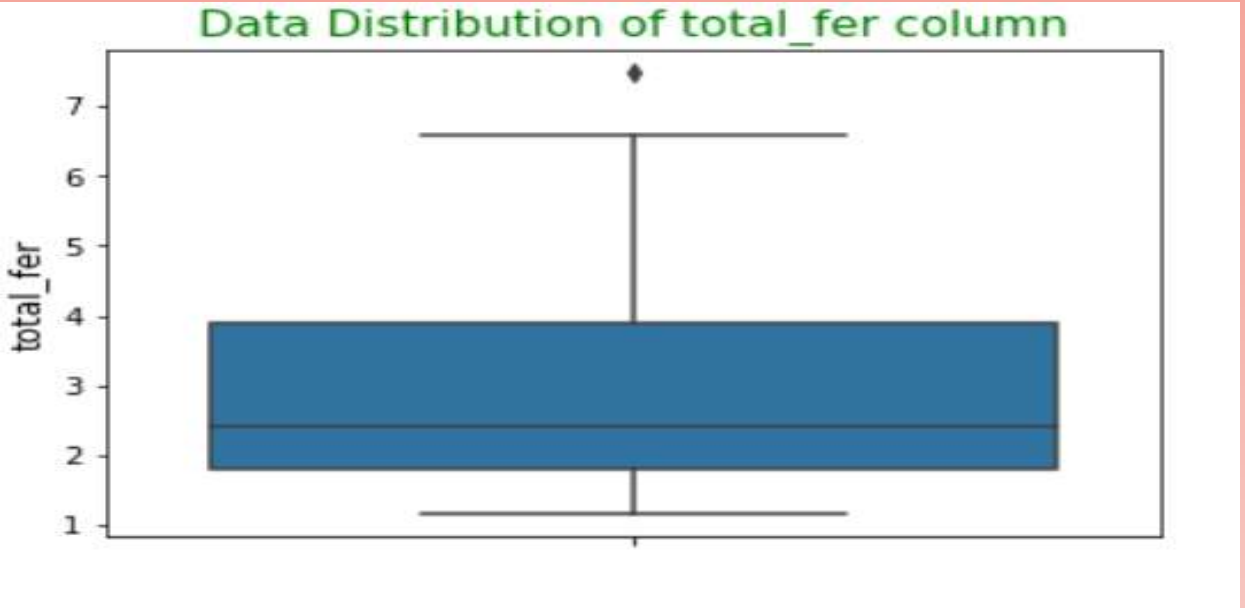
- Life expectancey feature says about the average number of years a new born child would live if the current mortality patterns are to remain the same
- As shown in the plot **life_expec** feature is left skewed. Average human life expectancy for some counries looks weird we need to treat the left skewed data where outliers are present.

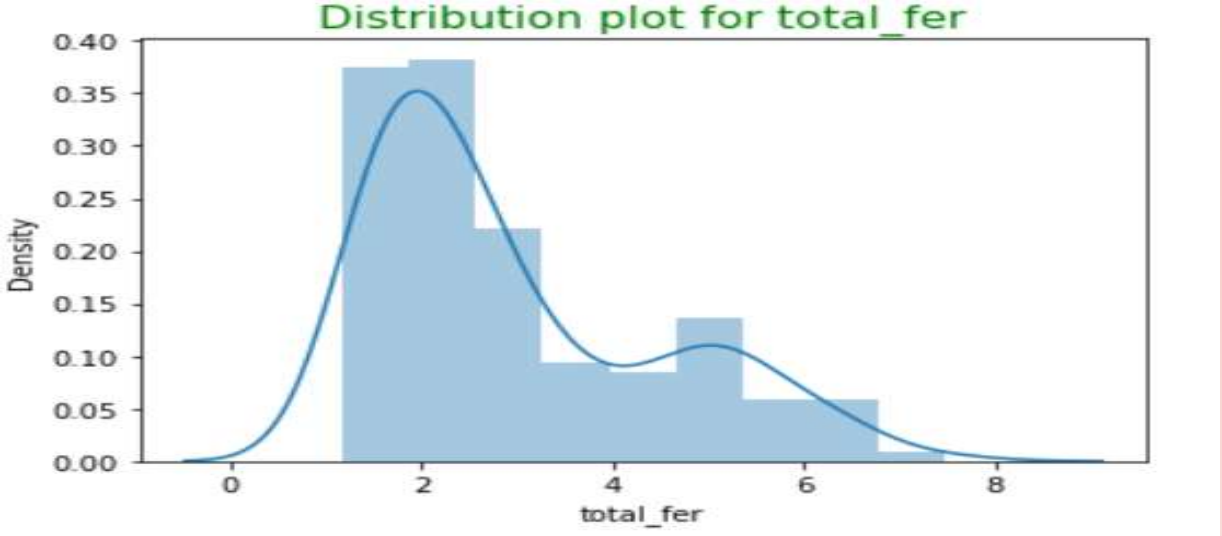




Distribution of total_fertility Feature

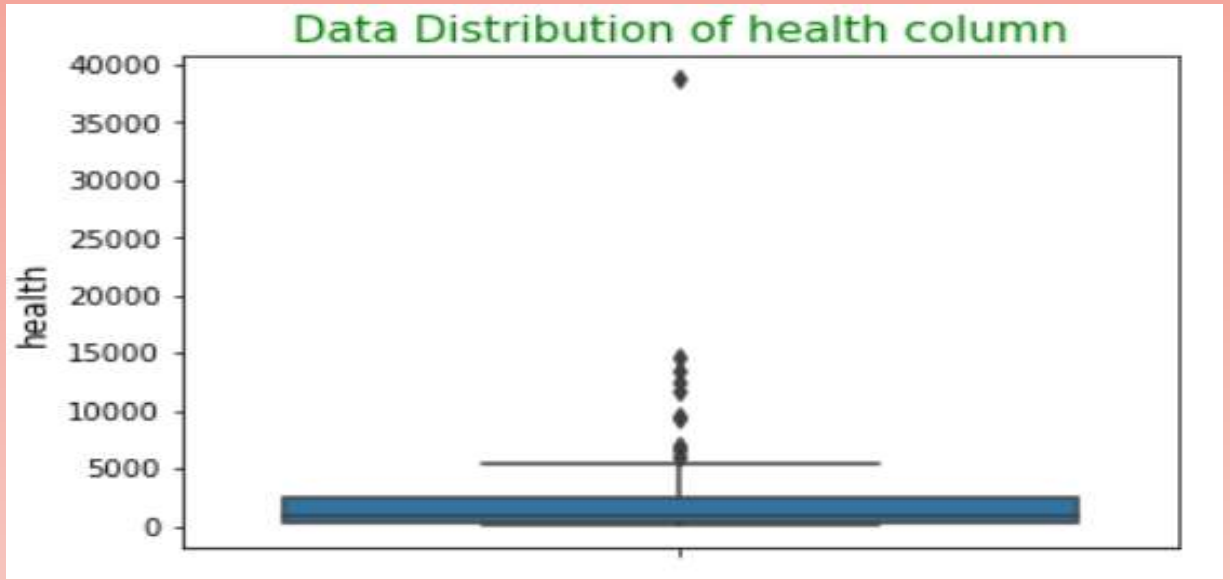
- **total_fer** column tells about the number of children that would be born to each woman if the current age-fertility rates remain the same.
- **total_fert** column has some good spread of data and nothing suspicious other than value near 7.
- Possibility in fertility. so lets understand in further plots to treat if required.

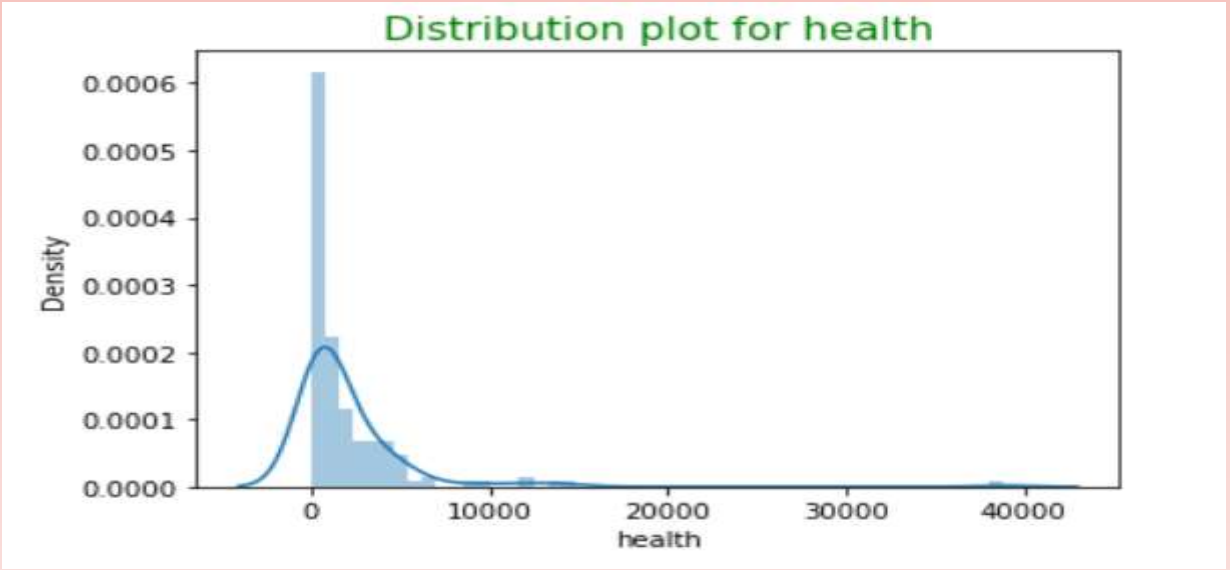




Distribution of health Feature

- **Health** feature is all about the total health spending per capita.
- As shown in the boxplot health feature has outlier at the value near 40000 which look suspicious.
- We could see that distribution of health feature is right skewed Lets cap them at 0.95 percentile in further steps to avoid the model affected by skewness.



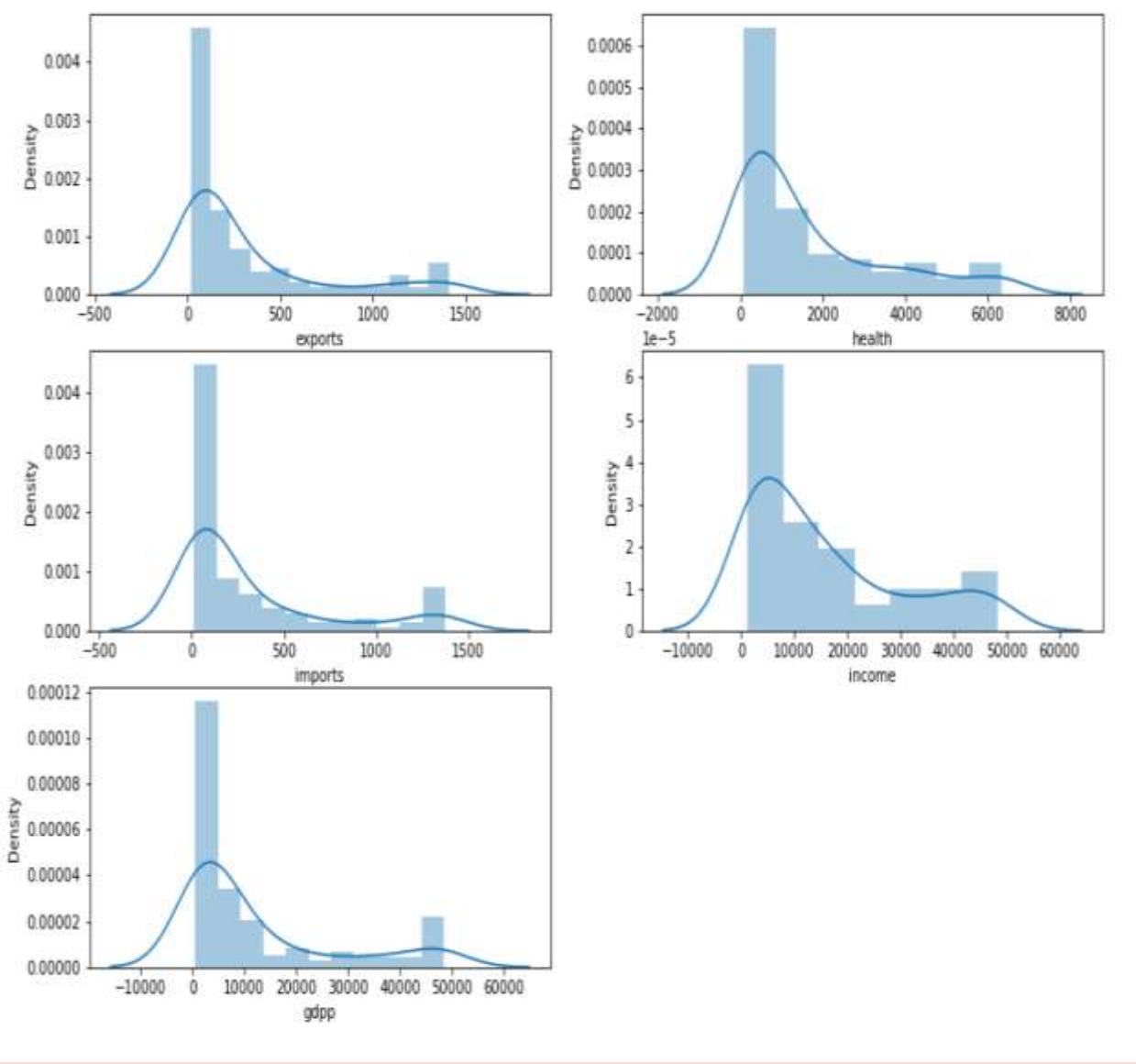


Skewed Data Treatment and Analysing Finding Correlated variables

- Skewness of the data will affect the model's Perfomance. Lets treat them and analyse the high correlated variables

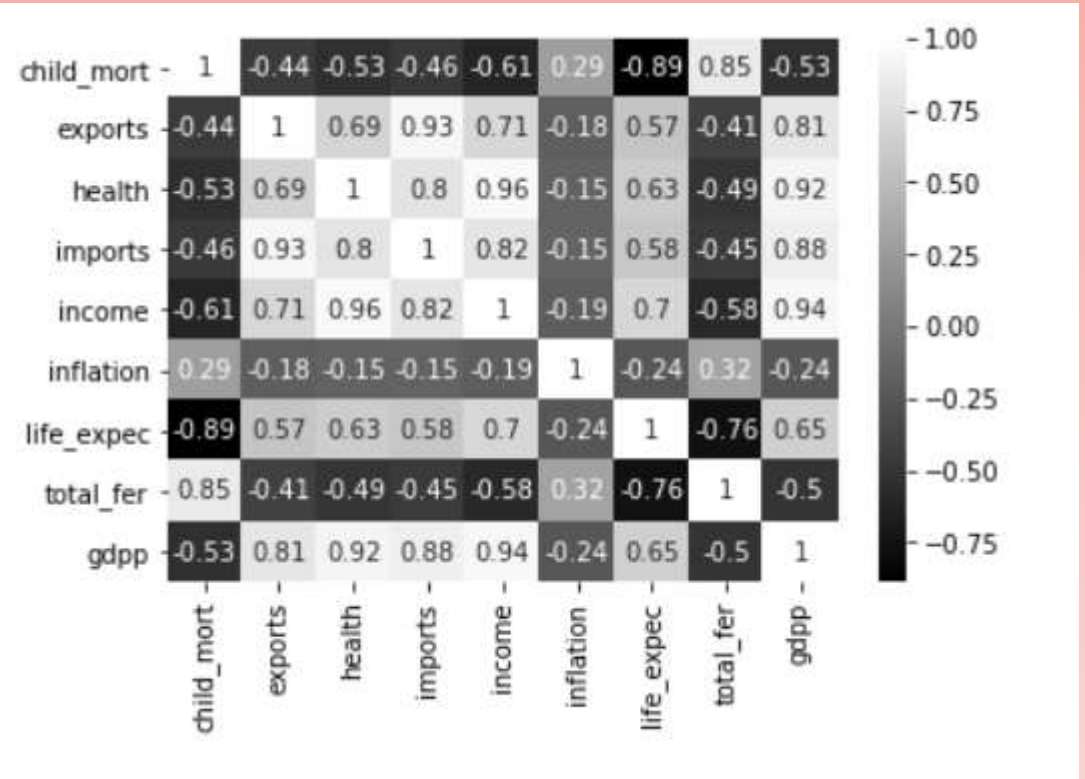
Skewed Data Treatment for feature analysis

- As we observed in previous steps some of the features are skewed towards either positively or negatively skewed. Which will affect the analysis so we treated them and applied clustering on that.
- Image show the data after the skewness which we applied.



Correlation Matrix analysis

- As we can see that health and income are highly correlated variables with 0.96
- Income and gdpp has the correlation value of 0.94
- Imports and exports has the correlation value of 0.93
- Health and gdpp has the correlation value of 0.92
- Child mortality and life expectancy has the correlation value of -0.89
- Using this correlation values business can take decisions further which helps in understanding the correlated variables.



Correlation Matrix analysis

- As we observed in the image we are displaying the highest correlated variables which helps in understanding the variables.
- As we can see that health and income are highly correlated variables with 0.96
- Income and gdpp has the correlation value of 0.94
- Imports and exports has the correlation value of 0.93
- Health and gdpp has the correlation value of 0.92
- Child mortality and life expectancy has the correlation value of -0.89
- Using this correlation values business can take decisions further which helps in understanding the correlated variables.

Top Correlated Variables

income	health	0.958006
health	income	0.958006
income	gdpp	0.941514
gdpp	income	0.941514
imports	exports	0.933897
exports	imports	0.933897
health	gdpp	0.922333
gdpp	health	0.922333
child_mort	life_expec	0.886676
life_expec	child_mort	0.886676
imports	gdpp	0.876639
gdpp	imports	0.876639
child_mort	total_fer	0.848478
total_fer	child_mort	0.848478
imports	income	0.815486
income	imports	0.815486
exports	gdpp	0.809859
gdpp	exports	0.809859
health	imports	0.799945
imports	health	0.799945
total_fer	life_expec	0.760875

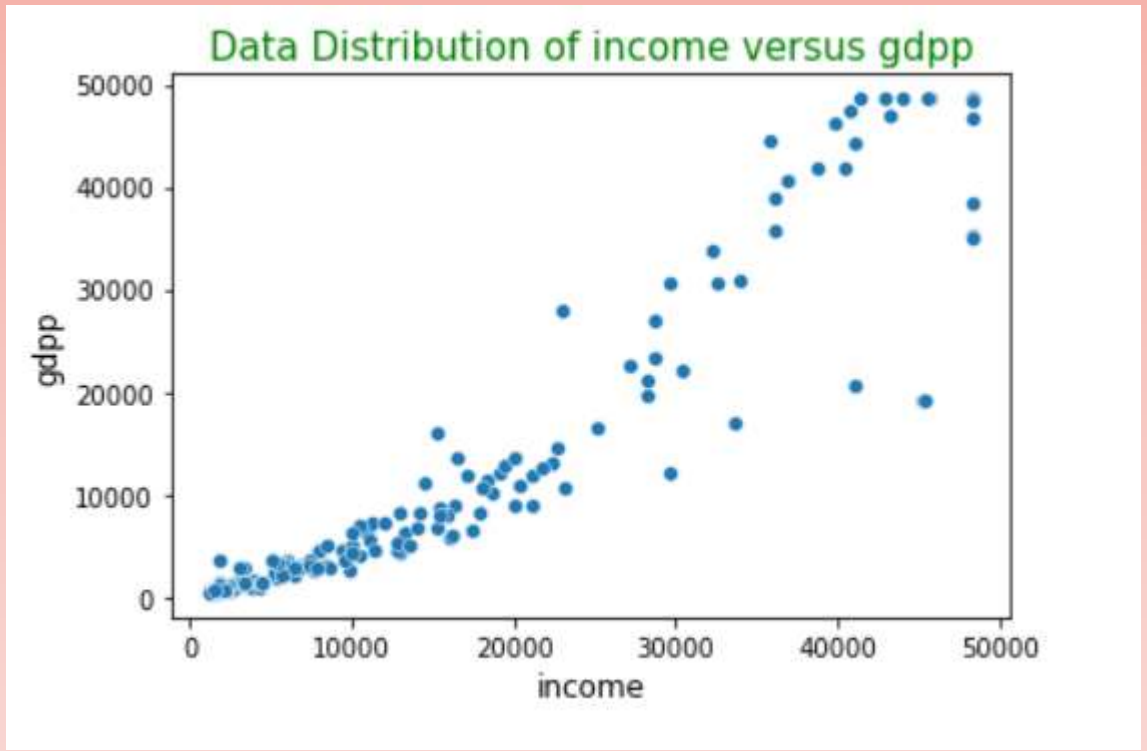
BI-VARIATE ANALYSIS on the country Data

- Numeric – Numeric analysis
- Numerical – Categorical analysis
- Categorical – Categorical analysis

BIVARIATE Analysis helps in fetching insights by looking into multiple variables which helps in gaining Overall Insights from the hidden data

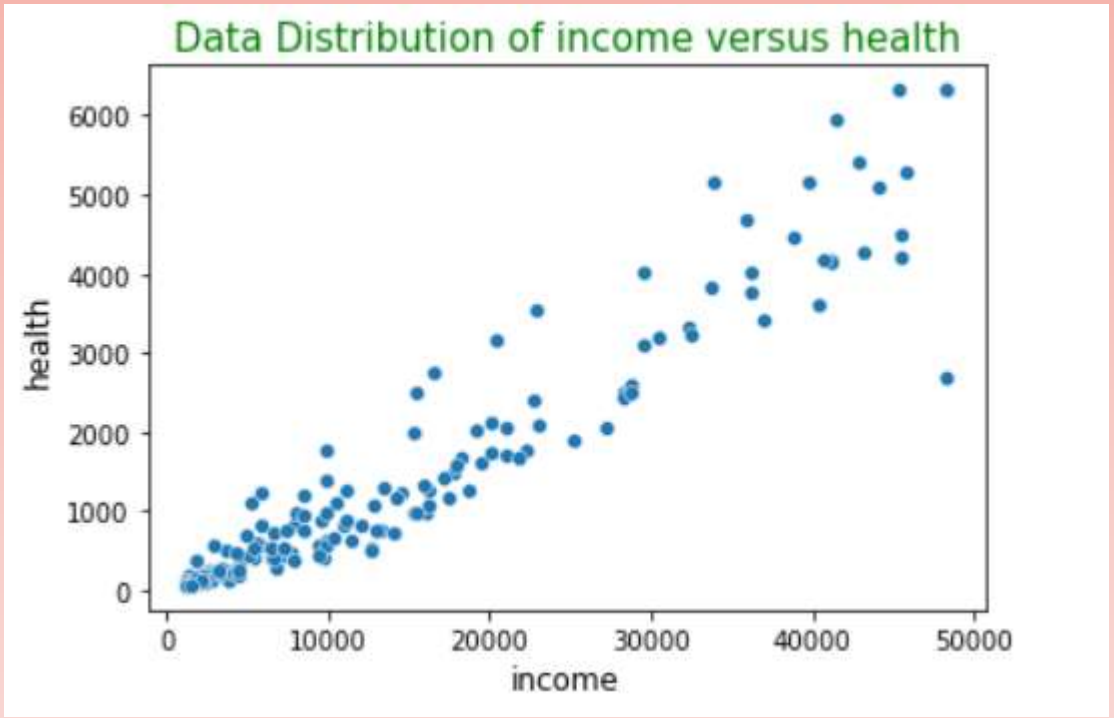
Income *versus* GDP

- Image show the relation between the GDP and net income of the person
- As shown in the plot **GDP** and **income** has highest correlation as the income increases gdpp also increases linearly.
- We can consider GDP in our clustering to understand how the countries gdp helps in identifying our outcome



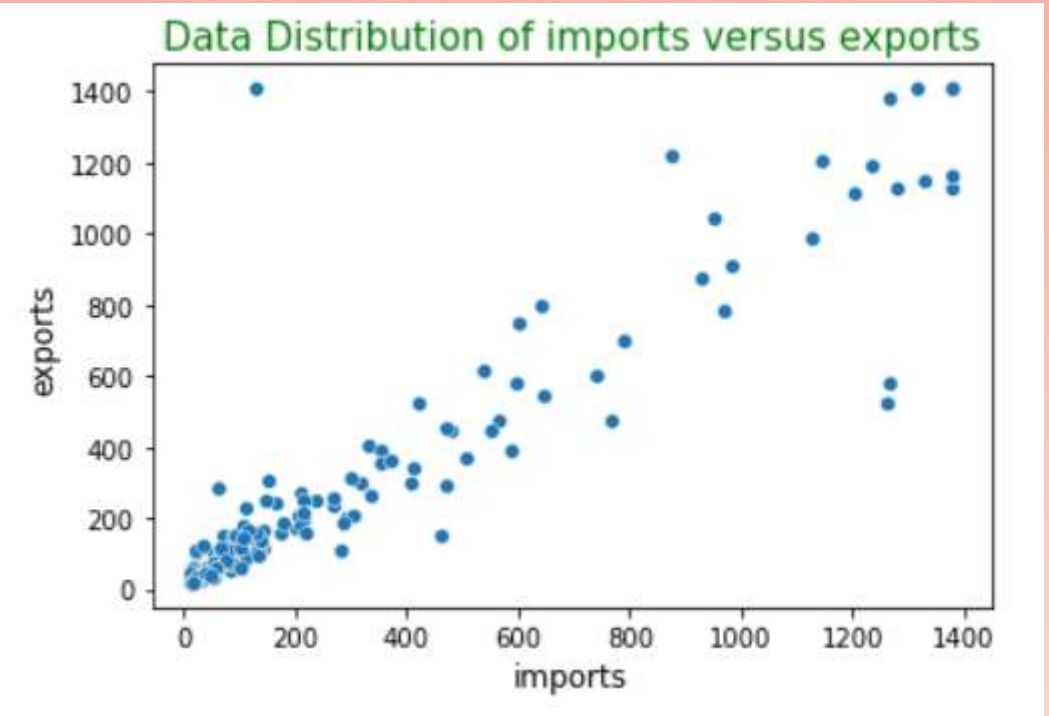
Income *versus* Health

- Image show the relation between the Health nd net income of the person
- As shown in the plot Health and income has the high correlation.
- As shown in the plot GDP and `income` has highest correlation as the income increases GDP also increases linearly.
- We can consider GDP in our clustering to understand how the countries GDP helps in identifying our outcome



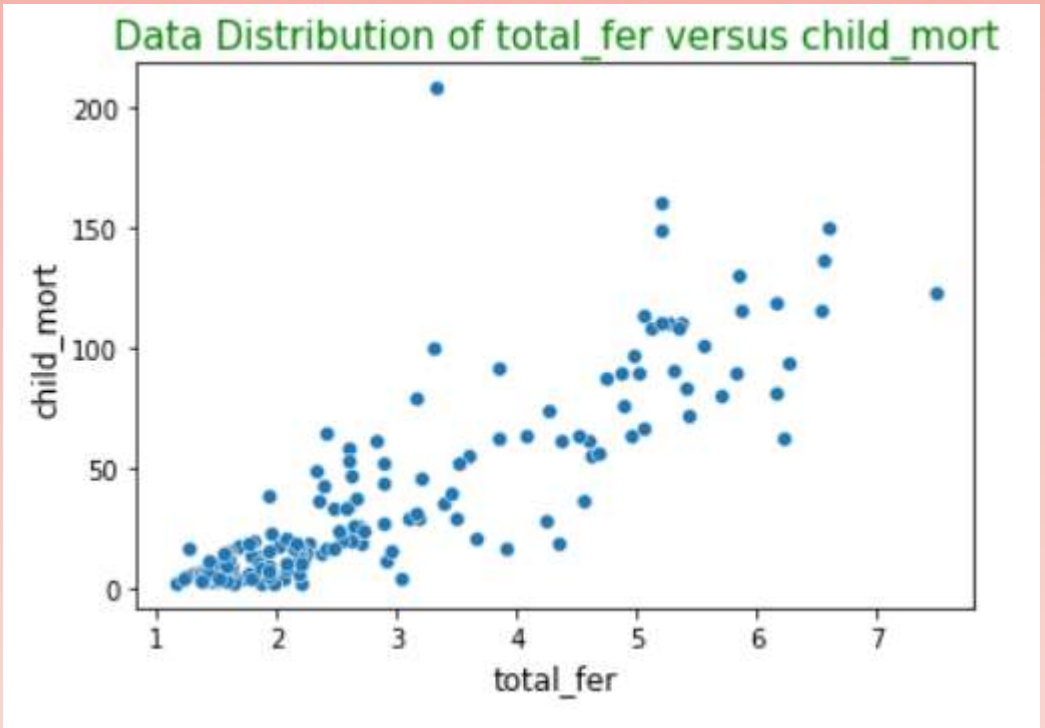
Imports *versus* Exports

- Image show the relation between the Imports and Exports of different countries
- As shown in the plot exports and imports have high correlation.
- As the imports increases Exports also increases but further analysis is required on this
- There is a equal chances for countries to have higher import and export values since all the countries might not be good in all the goods and due to lack of resources there is a goods exchange takes place between countries.



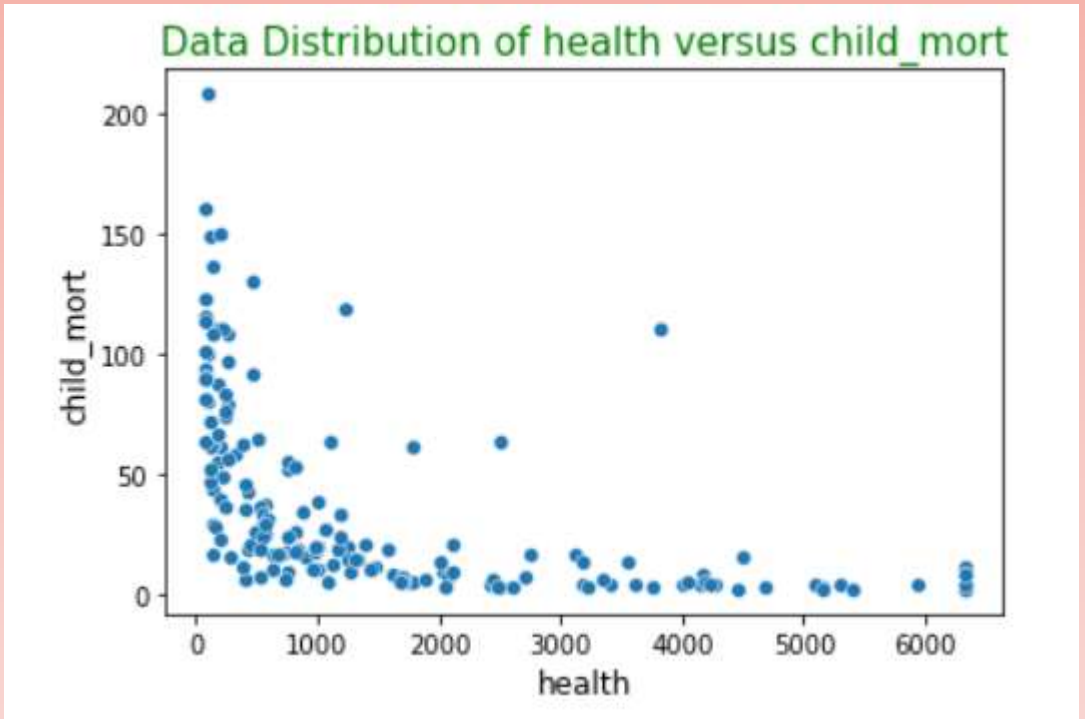
Total Fertility *versus* ChildMortality

- Image show the relation between the total fertility and child mortality
- As shown in the plot total fertility and child mortality have positive correlation.
- **total_fer** tells about the number of children that would be born to each woman if the current age-fertility rates remain the same.
- As the **total_fer** increases **child_mort** increases this is one of the reason where parents are unable to take care of childrens health condition due to which child mortality increases in some countries.



Health *versus* ChildMortality

- Image show the relation between the Health and child mortality
- As shown in the plot we could understand that when the `health`(Total health spending per capita) increase child_mort decreases.
- Less spending of `health` Increase in `child_mort`.
- This is quite obvious when people who are financially week they may don't have health care expenditure due to which child mortality is increasing



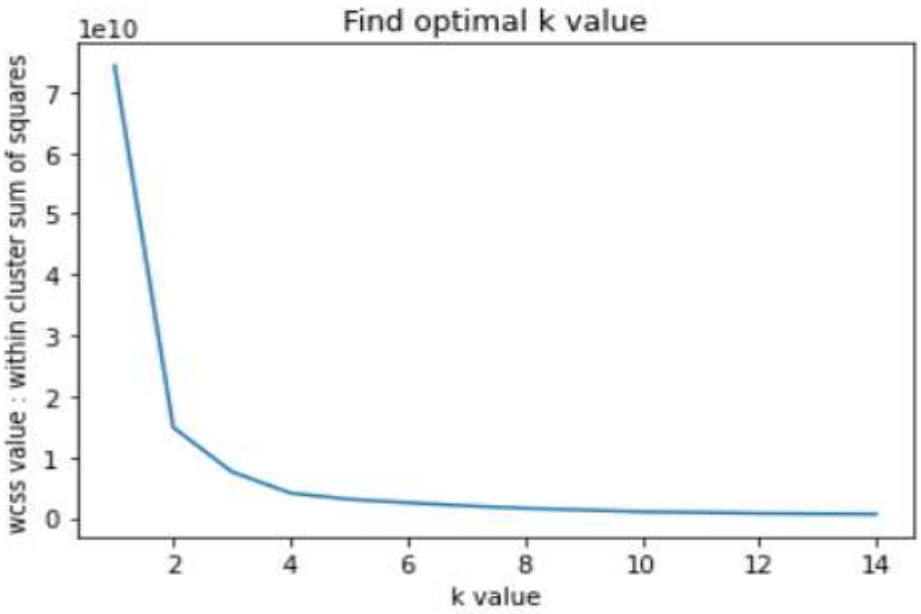
HOPKINS Test

- Hopkins test is done to check how well our data is suitable for Clustering
- Since we want to conduct our clustering on gdpp, child_mort and income features we will do hopkins test on the same
- As shown in the image below we have conducted hopkins test 10 times to make sure that our data is well suited for clustering purpose.
- Every time value is greater than 0.87 which is a good indication for clustering algorithm.

```
# verify hopkins value 10 times/multiple times to make sure our data is well suited for clustering
for i in range(10):
    print(hopkins(data2))
```

```
0.9226991080860142
0.9430939013574527
0.8957223784920787
0.8989539997537725
0.9134025960335941
0.9087716816714866
0.9525939548277452
0.9207562179397881
0.8789436513375259
0.9310128496514376
```

Optimal K value using within cluster sum of squares Method



- Finding the optimal k value using within cluster sum of squares method.
- One among the k value i.e.., k=2 and k=3 can become the optimal values.
- we analysed the data with both the k values and when k=3 data is well explained by the model and we could see some good interpretations or spread of the data.

Optimal K value using Silhouette Method

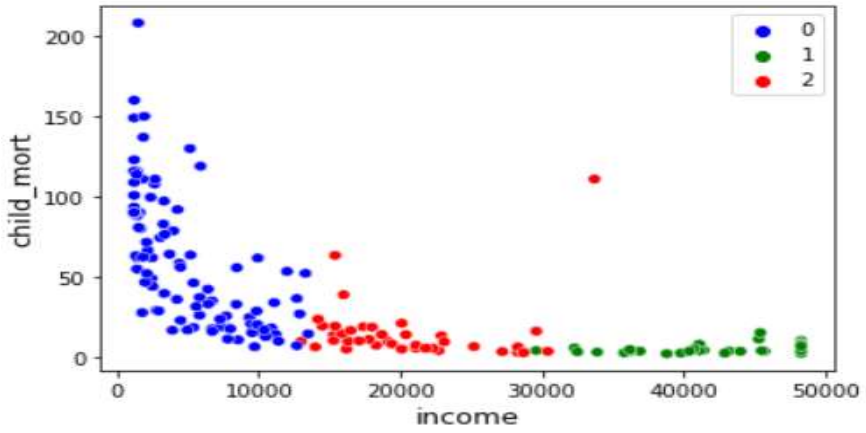
```
#silhoutee_avg=[]
#k=range(1,10)
range_clusters=[2,3,4,5,6,7,8]
for i in range_clusters:
    kmeans=KMeans(i,random_state=42)
    kmeans.fit(data3)
    cluster_labels=kmeans.labels_
    silhouette=silhouette_score(data3,cluster_labels)
    print(silhouette)
```

```
0.6523912889388267
0.5211602226343363
0.5034208079370068
0.47531874441214317
0.47959857878903317
0.48532678651865396
0.4341741125463038
```

- Finding the optimal k value using Silhouette Method.
- As observed in the above analysis we have better silhouette score when k=2: 0.65 and k=3: 0.52
- As we already observed the k value using ssd tells the same analysis but we saw better distribution of clusters when k=3 in the above step. Lets consider k=3 as optimal value and visualise the spread of clusters.

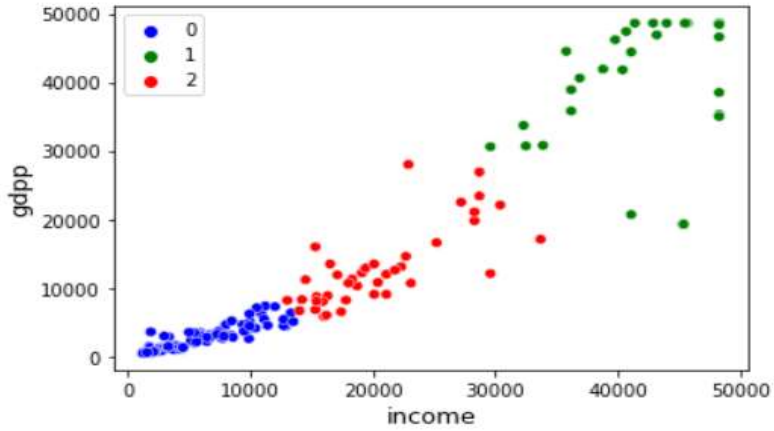
Distribution of Variables when 3 clusters are formed

Plot 1



- As shown in the plot 1 we have created three clusters displaying different income and child_mort values.Now after creation of clusters data is well explained

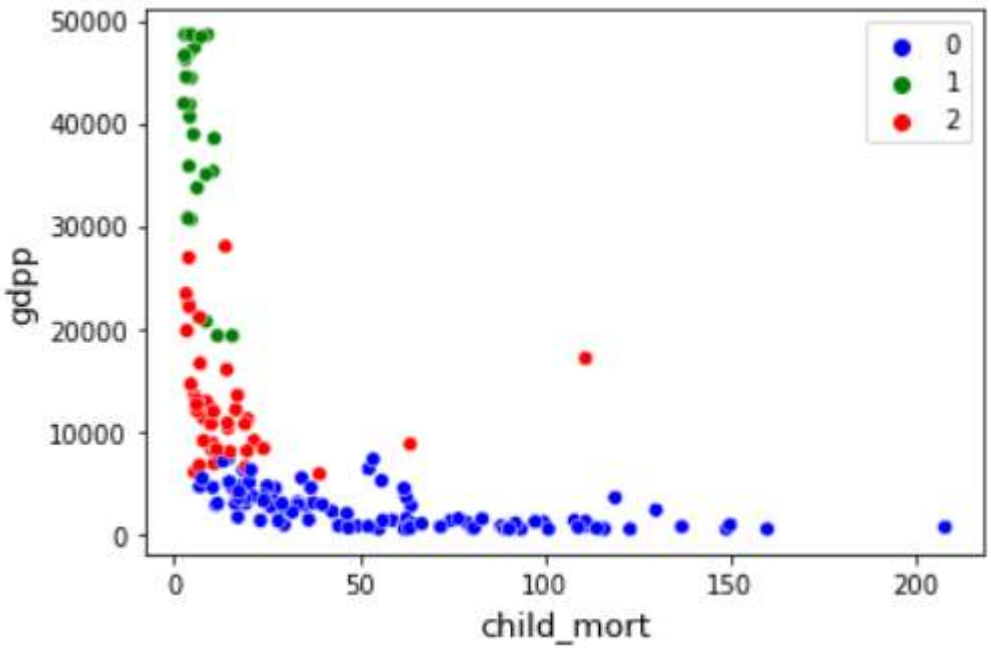
Plot 2



- As shown in the plot 2 we have created three clusters displaying different income and gdpp values. Now after creation of clusters data is well explained

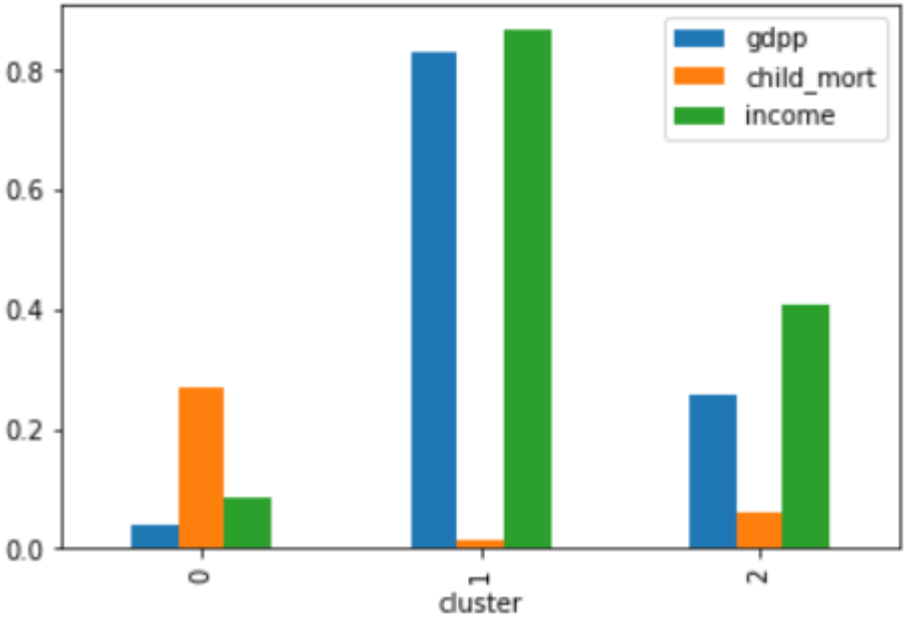
Distribution of Variables when 3 clusters are formed

Plot 3



- As shown in the plot 3 we have created three clusters displaying different gdpp and child_mort values.Now after creation of clusters data is well explained.
- Cluster 0(zero) is where child_mortality is high where we need to concentrate

Distribution of gdpp,child_mort and income across 3 clusters



- As shown in the plot cluster 0 has high child_mortality and less GDP and income. We can concentrate on this countries where we have this properties.

Kmeans: Distribution of gdpp,child_mort and income across 3 clusters and Top 5 countries requires help

PLOT 1

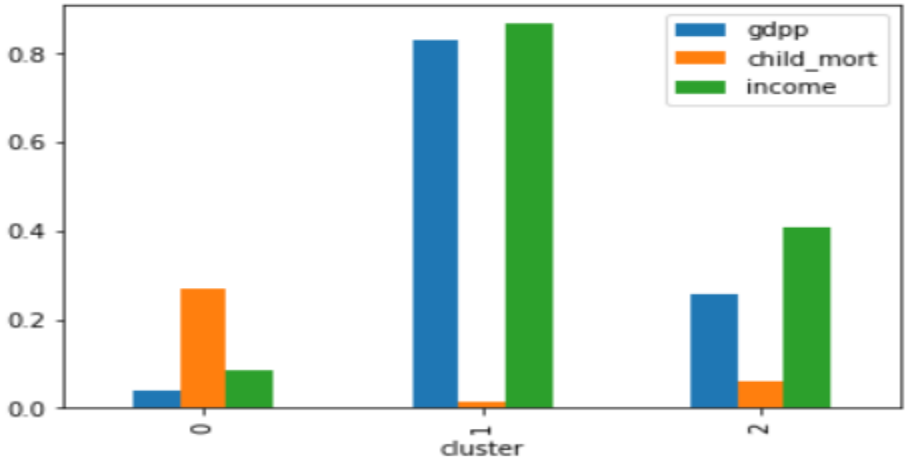


TABLE 1

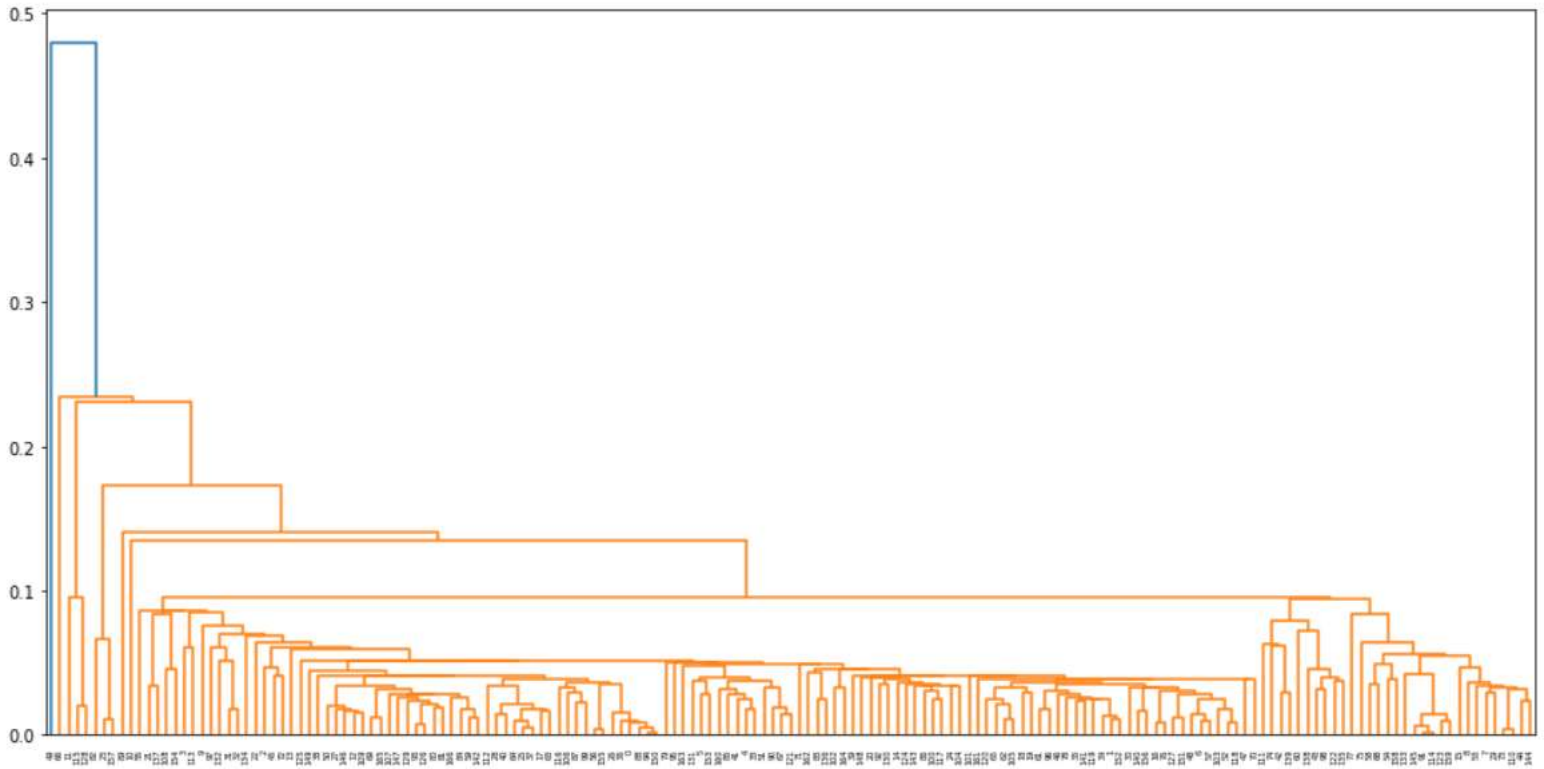
	gdpp	child_mort	income	cluster	country
66	0.004073	1.000000	0.006096	0	Haiti
132	0.000000	0.766310	0.000149	0	Sierra Leone
32	0.008954	0.717624	0.015230	0	Chad
31	0.000000	0.712756	0.000000	0	Central African Republic
97	0.005029	0.654333	0.013956	0	Mali

- As shown in the plot 1 cluster 0(zero) has high child_mortality and less GDP and income. We can concentrate on this countries where we have this properties.
- Table 1 gives the top 5 countries which requires help on priority due to high child_mort,less gdpp and income.
- HELP International can concentrate on this countries on priority.

Agglomerative clustering

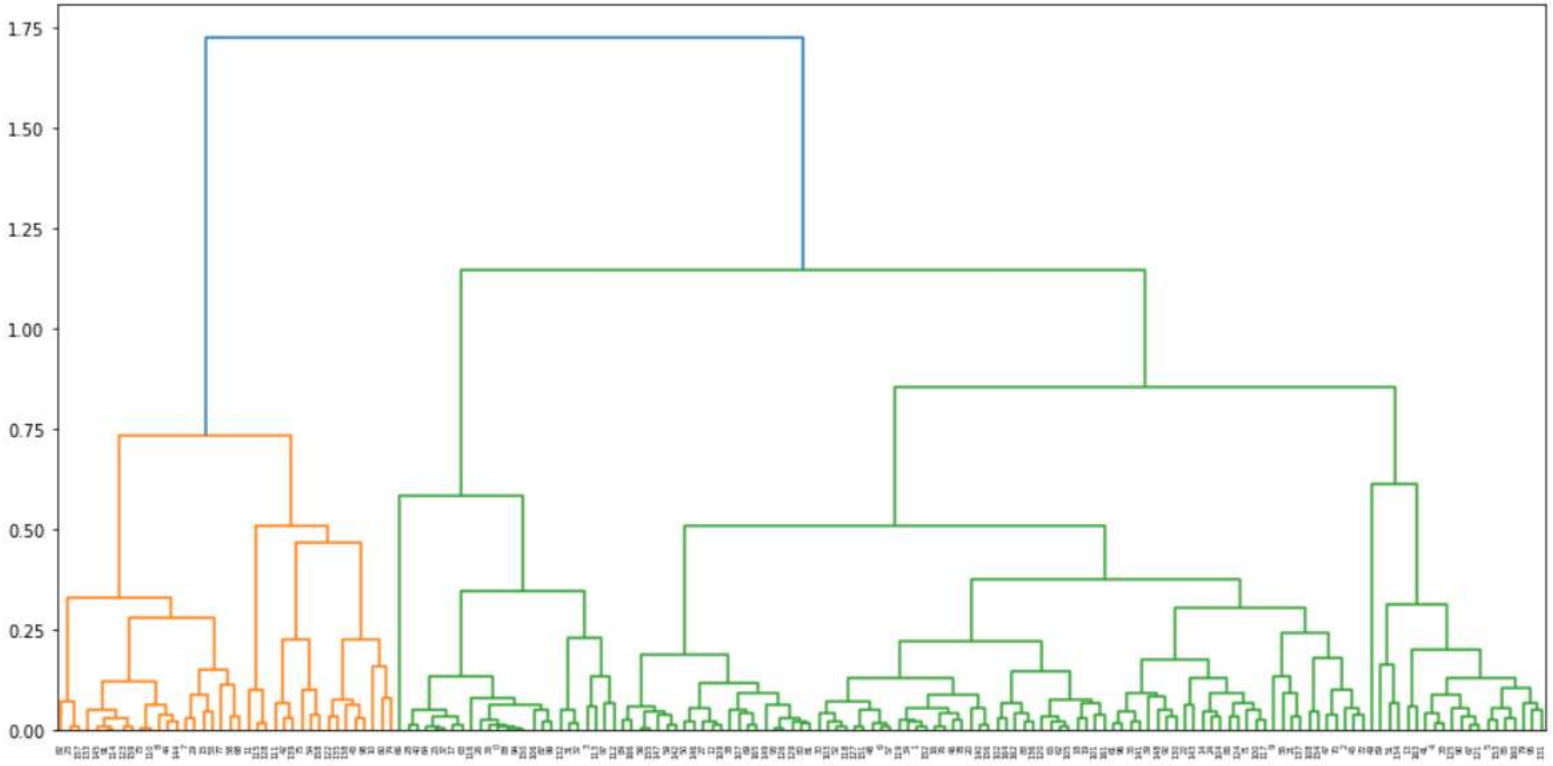
Here we consider each data point as one cluster and we find the distance from each point to the other data points.Then the data points with minimum distance is formed as a cluster resulting in n-1 cluster. This process iterates until all the data points are formed as a single cluster.

Single Linkage



Agglomerative clustering

Complete Linkage



-> When compared with Single and complete Linkage method. Complete linkage explains the data better and some good clusters can be formed which we can understand from the dendograms obtained.

Hierarchical clustering optimal cluster value which is obtained from dendograms

PLOT 1

```
# Verify the count of cluster lables in data3
data3.cluster_labels.value_counts()
```

```
0    129
1     38
Name: cluster_labels, dtype: int64
```

-> As observed in plot 2 we have 96 countries which fall under cluster 0, 31 countries fall under cluster1 and 40 countries fall under cluster 2.

PLOT 2

```
data3.cluster.value_counts()
```

```
0    96
2    40
1    31
Name: cluster, dtype: int64
```

-> As observed in plot 2 we have 96 countries which fall under cluster 0, 31 countries fall under cluster1 and 40 countries fall under cluster 2. Data is well explained in cluster 3 considering GDP,income and child mortality

Hierarchical clustering: Distribution of gdpp,child_mort and income across 3 clusters and Top 5 countries where HELP International can concentrate into

PLOT 1

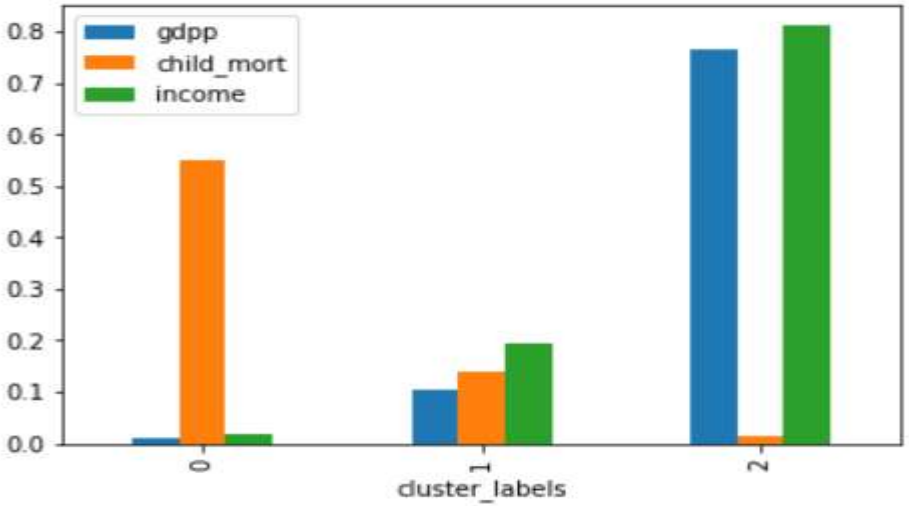


TABLE 1

	gdpp	child_mort	income	country	cluster_labels
66	0.004073	1.000000	0.006096	Haiti	0
132	0.000000	0.766310	0.000149	Sierra Leone	0
32	0.008954	0.717624	0.015230	Chad	0
31	0.000000	0.712756	0.000000	Central African Republic	0
97	0.005029	0.654333	0.013956	Mali	0

- As shown in the plot 1 cluster 0(zero) has high child_mortality and less GDP and income. We can concentrate on this countries where we have this properties.
- Table 1 gives the top 5 countries which requires help on priority due to high child_mort,less gdpp and income.
- HELP International can concentrate on this countries on priority.
- Country list : Haiti,Sierra Leone,Chad,Central African Republic and Mali are the top 5 countries which Help internationcla can concentrate based on the study of data.

CONCLUSION

- HELP International should concentrate on following countries based on the categories we studied:

gdpp	child_mort	income	country	cluster_labels
0.004073	1.000000	0.008098	Haiti	0
0.000000	0.786310	0.000149	Sierra Leone	0
0.008954	0.717624	0.015230	Chad	0
0.000000	0.712756	0.000000	Central African Republic	0
0.005029	0.654333	0.013956	Mali	0
0.038719	0.620263	0.083629	Nigeria	0
0.000000	0.586173	0.000000	Niger	0
0.063644	0.566699	0.099560	Angola	0
0.000000	0.552093	0.000000	Congo, Dem. Rep.	0
0.002286	0.552093	0.004609	Burkina Faso	0
0.001685	0.542356	0.003760	Guinea-Bissau	0
0.006067	0.527751	0.012894	Benin	0
0.015663	0.527751	0.031374	Cote d'Ivoire	0
0.003782	0.518014	0.000000	Guinea	0
0.017533	0.513145	0.030737	Cameroon	0

- Help international can concentrate on the countries like Haiti,Sierra Leone,Chad,Central African Republic and Mali. Which are top 5 countries which require NGO help to save them during difficult times and Natural calamities.
- As per the analysis we did we observed that countries like Nigeria,Niger,Angola,Conga and Burkina Faso are the countries which are in top 10 required NGO help.