CSC110 Project Proposal: Global Wealth Gap

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Problem Description and Research Question

Research conducted by economists shows the wealth gap widened during the industrial revolution (Rychbosh, 2015). Before the industrial revolution, the richest countries were 3 times as rich as the poorest countries. Today, this difference widens to more than 100-fold. The wealth gap deserves attention as poorer countries are more susceptible to social problems like poverty, terrorism and subpar living condition (Krieger, 2016; "Standard of Living", n.d.).

Two ideas come to mind when considering how COVID-19 and the global wealth gap interact:

1. COVID-19 has varying degrees of impact on different industries. For instance, in 2020, global tourism lost $935 billion, a 10.5% reduction compared to 2019's revenue (Madden, 2021). Relatively, the impact on manufacturing sector is lesser where production declined 7% globally in 2020 (Todorov, 2020).

   Moreover, countries differ in economic structures. Using the three-sector model, the economies of developed nations are mostly made up of tertiary sector (services) and secondary sector (manufacturing), while undeveloped nations depend on secondary sector and primary sector (extraction and agriculture).

   Thus, it is interesting to understand the magnitude of impact COVID-19 exerts on different nations of different economic structures.

2. Research shows 60% of people in high-income countries receive a first dose vaccine while this number is only 1% in low-income countries ("Vaccine inequality", 2021). This disparity is attributable to different levels of wealth and healthcare networks which affects countries' ability to respond to COVID-19.

   We predict that quicker response of wealthier nations resulted in less impact on their workforce and economy, thus widening the wealth gap. We hope to examine this prediction using datasets we find.

The 2 ideas lead us to question **how COVID-19 impacts the global wealth gap**. Since gross domestic product (GDP) is a widely accepted economic metric to measure a nation's output and income, we will analyze GDP by sector, GDP and unemployment rate to assess the magnitude of impact COVID-19 exerts on countries of different stages of development (idea 1). We also consider non-economic metrics like death rate and vaccination rate to understand how nations' varying capabilities to respond to COVID-19 influence their economic performance (idea 2).

Overall, these findings will uncover the impact COVID-19 exerts on countries from economic and social perspectives. The results may help policy makers at national and international levels (e.g. World Bank) better understand the vulnerability of economies of different nations. Appropriate recommendations can be made to reduce the wealth gap, thus better preparing for future pandemics.

Dataset Description

1. **Mortality**
   (a) **Source**: World Happiness Report
   (b) **Format**: CSV
   (c) **Relevant Column Headers**: Country name, COVID-19 deaths per 100,000 population in 2020
   (d) **Dimensions**: 167 rows and 4 columns
   (e) **Additional Notes**: None
2. **Annual GDP**
   (a) **Source**: World Bank
   (b) **Format**: CSV
   (c) **Relevant Column Headers**: Country Name, 2016 GDP, 2017 GDP, 2018 GDP, 2019 GDP, 2020 GDP
   (d) **Dimensions**: 271 rows and 65 columns
   (e) **Additional Notes**: Monetary values are recorded in USD.
3. **Country Income Quartile**
   (a) **Source**: World Bank
   (b) **Format**: CSV
   (c) **Relevant Column Headers**: Country Code, Income Group
   (d) **Dimensions**: 273 rows and 5 columns
   (e) **Additional Notes**: Income group is separated into 4 quartiles (high, upper middle, lower middle, low).
4. **GDP By Sector**
   (a) **Source**: World Bank
   (b) **Format**: CSV
   (c) **Relevant Column Headers**: Country Name, 2016 Manufacturing Value Added, 2016 Services Value Added, 2016 Industry Value Added, 2016 Agriculture, Forestry and Fishing Value Added (same format for 2017, 2018, 2019, 2020)
   (d) **Dimensions**: 272 rows and 22 columns
   (e) **Additional Notes**: Monetary values are recorded in USD.
5. **Unemployment Rate**
   (a) **Source**: World Bank
   (b) **Format**: CSV
   (c) **Relevant Column Headers**: Country Name, 2016 Unemployment as % of Workforce, 2017 Unemployment as % of Workforce, 2018 Unemployment as % of Workforce, 2019 Unemployment as % of Workforce, 2020 Unemployment as % of Workforce
   (d) **Dimensions**: 271 rows and 65 columns
   (e) **Additional Notes**: None
6. **Vaccination**
   (a) **Source**: Our World In Data
   (b) **Format**: CSV
   (c) **Relevant Column Headers**: Total Vaccinations as a Percentage of the Population
   (d) **Dimensions**: 226 rows and 65 columns
   (e) **Additional Notes**: None

Computational Plan

Data Processing

1. Create a `Country` class that bundles data in different CSV files together. Instance attributes include country, 2016 - 2020 GDP, 2016 - 2020 GDP by sector, income quartile, 2016 - 2020 unemployment rate, COVID-19 mortality rate and vaccination rate.
2. Create a dictionary that maps a country name to a `Country` instance with attributes initialized as `None`.
3. Extract necessary fields from each CSV file and assign them to the appropriate country's instance attributes.
4. The dictionary now maps a country's name to its `Country` instance containing the attributes required for computation. We refer to this dictionary as `country_dict`.

Required Libraries

1. **Plotly**: Plotly plots data into interactive graphs. Plotly will be used to plot line graphs for chronological data, bar charts for qualitative data and scatter plots and trendlines to verify metrics' correlation.
2. **Geopandas**: Geopandas helps work with geospatial data. Geopandas will be used to plot choropleth maps which are coloured maps where the colour of a country is determined by a numeric value.

Computations By Metrics

1. **GDP % Change**
   (a) **Formula**: Year n GDP % Change $= \frac{\text{GDP}_n - \text{GDP}_{n-1}}{\text{GDP}_{n-1}} \times 100$
   (b) **Computation**: For years 2016 to 2020, iterate over all countries in `country_dict` and apply the formula for pairs of consecutive years.
   (c) **Visualization**: Generate a chloropleth map from % change in GDP by year (e.g. green represents high GDP growth) using `Geopandas`. Plot GDP % change over time as line graphs using `Plotly`.
2. **GDP as a % of Global GDP**
   (a) **Formula**: GDP of Country as % of Global GDP $= \frac{\text{National GDP}}{\text{Global GDP}} \times 100$
   (b) **Computation**: For years 2016 to 2020, iterate over countries in `country_dict` to aggregate GDP to find global GDP. Iterate through all the countries in `country_dict` again to use the country's GDP and the global GDP and apply the formula.
   (c) **Visualization**: Generate a chloropleth map using difference in GDP as % of global GDP between 2016 and 2020 (e.g. green represents increase in GDP as % of global GDP) using `Geopandas`.
3. **Unemployment Rate % Change**
   (a) **Formula**: Year n Unemployment Rate % Change $= \frac{\text{Unemployment Rate}_n - \text{Unemployment Rate}_{n-1}}{\text{Unemployment Rate}_{n-1}} \times 100$
   (b) **Computation**: Iterate over all countries in `country_dict` and apply the formula for pairs of consecutive years from 2016 to 2020.
   (c) **Visualization**: Similar to `GDP % Change`.
4. **Aggregate Sector GDP as a % of Aggregate GDP Grouped by National Income Quartile**
   (a) **Formula**: Aggregate Sector GDP as % of Aggregate GDP $= \frac{\text{Aggregate Sector GDP}}{\text{Aggregate GDP}} \times 100$
   (b) **Computation**: Iterate over `country_dict` and aggregate national GDP of all countries in the desired quartile to calculate aggregate GDP. Aggregate sector GDP for nations in the desired quartile to calculate aggregate sector GDP. Apply the formula with the values calculated.
   (c) **Visualization**: Generate a bar chart using `Plotly` for the four sectors (from dataset). For each sector, plot aggregate sector GDP as a % of aggregate GDP for each income quartile.

5. **COVID-19 related deaths as a predictor of National GDP**

   (a) **Formula**: GDP = $\beta_0 + \beta_1 \times$ COVID-19 deaths per 100,000 population in 2020 + ϵ_i

   (b) **Computation**: Using linear regression, compute the fitted linear regression line and regression coefficients to determine an equation that predicts national GDP given the COVID-19 deaths per 100,000 population in 2020 of a country.

   (c) **Visualization**: Create a scatter plot with each point representing a country on an x-axis of COVID-19 deaths per 100,000 population in 2020 and a y-axis of national GDP and plot the fitted linear regression line using `Plotly`.

6. **Total Vaccinations as a Percentage of the Population as a predictor of National GDP**

   (a) **Formula**: GDP = $\beta_0 + \beta_1 \times$ Total Vaccinations as a Percentage of the Population + ϵ_i

   (b) **Computation**: Similar to `COVID-19 related deaths as a predictor of National GDP`.

   (c) **Visualization**: Similar to `COVID-19 related deaths as a predictor of National GDP`.

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