

CARTOGRAPHY LAB

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Story Map: COVID-19 and World Trade

Technical Report



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1 Introduction

Since the outbreak of the coronavirus disease of 2019 (COVID-19), the pandemic has impacted the world largely. People experienced the lockdown, gradually got used to the health restrictions and started to receive vaccination. For the world, COVID-19 becomes a new challenge after the Global Financial Crisis in 2008. Much longer period can be expected for the globe to recover from the pandemic.

During the COVID-19 period, more than 1 million people have lost their lives due to the virus, and the global economy is expected to contract by a staggering 4.3% in 2020. Millions of jobs have already been lost, millions of livelihoods are at risk, and an estimated additional 130 million people will be living in extreme poverty if the crisis persists.

The strike of the pandemic to the world economy is even harder than the global financial crisis, according to the United Nations Conference on Trade and Development (UNCTAD). International trade plunged as the disease spread, due to widespread border closures, travel restrictions and shelter-in-place policies. The cross-border supply value chains have been disrupted.

Though most countries are affected in 2020 and expect a slow recovery from 2021, there are several countries seeing more positive prospects - in the second half of 2020, China experienced the growth of imports and exports of goods compared to the same period in the previous year.

It would be valuable to comprehend the world economy and trading during COVID-19 and to learn from the particular region about why it achieved high speed in economic and trading recovery.

2 Objectives

2.1 Thematic Objectives

The project aims to give users an overview of the global economy and trade trends under the COVID-19 pandemic by web-based visualization methods. Through the interactive visualization of economic and trading-related data, users may understand how the global trade and economy is affected from the pre-COVID period to now.

The realization of the project is a web-based story map, with multimedia, interactive charts and maps. We set the project at global scale, but the trade trend and trading-related policies in China is the case study in the story map.

In the story map, we firstly introduced the development of COVID-19 and its impact on the world. Then we elaborated the global economy during COVID-19, especially comparing it with the Global Financial Crisis in 2008. In the next section, the global trade trend was explained. We also showed the divergent trade trend across countries - some countries (e.g., China) performed better in the trading recovery. Later, China was as a case study to show the details of its trade structure during COVID-19. Setting the origin country as China, we visualized the trade flow and the composite of its imports and exports of goods in 2020. The visualization of such data could be a tool to help users explore the reason why China became an exception under the downturns of trade markets. We further introduced the trading-related policies and measurements taken by China to deal with the pandemic. Finally, we gave an outlook to the post-pandemic period.

We assume the target groups as citizens who can get knowledge of how the world trade was impacted by COVID-19. The product could tell a simple but clear story about the world economy and trading during the pandemic.

2.2 Technical Objectives

Developing web-based story map is a chance for us to learn the user-friendly interactive map design. We explored interactive 2D Map, 3D Map and map animations. Besides, there is a large amount of high-dimensional data. For example the trading-related data is often categorized by countries and commodity types. There is often another time dimension to such data set. Thus, it is a great lesson for us to learn how to interpret the data by proper maps and charts.

We deployed several front-end design frameworks and web-based visualization libraries. In the project, we could improve the programming skills in web-based visualization of geographical data.

3 Raw data

- Raw data for base map:
 - Administration boundaries of regions and countries
- Raw data for thematic content:
 - GDP of all countries in the world in 2020, and the change percent from 2019.
 - The trade volume of imports and exports of all countries in the world from 2005 to 2020.
 - China's trade flow (imports and exports partners) from 2016 to 2020.
 - Trade flow by commodity types of China in 2020.
 - Global weekly port calls from 2019 to 2020.
- Additional data sources:
 - Trade themed pictures and videos
 - OECD Economic Outlook video

Detailed description of the data can be found in Table 2.

4 Technical equipment

To develop the web-based story map, we utilized several frameworks and packages, which are listed in Table 1.

5 Project steps and implementation

5.1 Initial draft of map

We made three maps in the story map, which are drafted as sketches in Figure 1. We will explain the key designs and functions in the map design section 5.4.

5.2 Data preparation

5.2.1 Data cleaning

The collected raw data needs to be cleaned for subsequent use. For the base map data, we manually check whether there are some errors in the boundary division of administrative regions. For the thematic data, we delete unnecessary fields and records. The empty value is replaced by a special and uniform value so that it can be easily processed later.

Table 1: Frameworks and libraries

	Library	Description	URL
Data Processing	Pandas	Process tabular data in python;	https://pandas.pydata.org/
	GeoPandas	Process geodata in python;	https://geopandas.org/
	QGIS	Process geodata in a GUI;	https://qgis.org/en/site/
Front-end Design	VUE	JavaScript framework for web development	https://vuejs.org/
	Quasar	Front-end design framework	https://quasar.dev/
	anime.js	JavaScript animation engine	https://animejs.com/
Interactive Map	Mapbox.gl	JavaScript library that uses WebGL to render interactive maps from vector tiles and Mapbox styles	https://docs.mapbox.com/mapbox-gl-js/api/
	Globe.gl	UI component for Data Visualization using ThreeJS/WebGL	https://www.npmjs.com/package/globe.gl
	Flourish	Library for data visualization and storytelling	https://flourish.studio/
Interactive Chart	D3.js	JavaScript library for manipulating documents based on data	https://d3js.org/
	Apache ECharts	An open source JavaScript visualization library	https://echarts.apache.org/en/index.html

5.2.2 Merging base map data with thematic data

The collected base map data (world administrative boundaries) is in GeoJSON format while the collected thematic data (e.g. GDP, exports and imports values of each country) is in CSV format. As each country has a unique ISO3 code, we first add the ISO3 code column to the CSV file if it doesn't exist. Then we merge the base map data with the thematic data based on the ISO3 code using Python script. The output GeoJSON includes both geographic information and thematic data, which can then be directly processed by the cartographic tools, such as Mapbox.gl and Globe.gl.

5.2.3 Thematic data in interactive charts

The cleaned thematic data is formatted according to the input format for each interactive chart. They are in JSON format. Thus, we used Python scripts to transform the tabular thematic data into tree-based JSON format.

5.3 Data modelling

To process the data efficiently, we wrote the Python scripts. The catalog of such scripts can be found in Appendix B Table 3.

5.4 Map design

The key designs are marked as numbers in Figure 1. We will explain them in details.

Figure 1(a) shows the 3D globe to visualize global GDP changes between 2009 and 2020. It is actually a world map in 3D globe overlaid by a Choropleth map layer. There are four major designs. The index below is consistent with the marked number in the map draft.

1. The 3D globe is auto rotating to show the data of all countries;
2. The GDP change rate is colored by a diverging color scheme. Countries with positive change rate are colored in a positive gradient color. While countries with negative change rate are colored in a gradient color scheme with negative sense. The legend bar is drawn accordingly.
3. When the mouse hover on a polygon of a country, the polygon is highlighted with different color and a tooltip is triggered.
4. The tooltip triggered by mouse hover event is shown in the draft. The circle is the place to show the national flag of the country. The detailed information including country name, GDP value and GDP change rate is also shown in the tooltip.

Figure 1(b) shows the 2D world map to visualize the trading volume per country. We utilized a world country map as the base map, and overlaid a Choropleth map layer on it. The key designs are listed below:

1. We fixed the zooming level of the world map to avoid infinite zooming-in or zooming-out by users.
2. We overlaid an information box over the map, which contains the map title, legends and other UI tools.
3. In the information box, we added two radio buttons. Users can change the visualized map between export volume by countries and import volume by countries.
4. We added the map legend in the information box.
5. There is a slider to show the year of the current visualized data. Users may slide from year to year to find the changing in trade volume across countries.
6. The toolbar contains functions of zoom-in, zoom-out and compass.
7. When the mouse hover on a polygon of a country, a tooltip is triggered to show detailed data of the country.

Figure 1(c) shows another 3D globe. We aimed to show the trading flow between China and the other countries. Thus, we overlaid the flow map over the globe. The width of flow reflects the volume of trading between the two connected countries. The key designs are listed below:

1. The information box section contains the map title and several UI components to realize the map interaction.
2. User can pan, zoom and rotate the 3D globe by mouse to explore in the map.
3. In the spinner, user can select either to show the import flows of China or to show the export flow.

4. User may click the "start" button to watch the animated flow maps over the years. They can also slide on the timeline to show the flow map at a certain time epoch.
5. When the timeline changes, the top 10 countries that China trades with are also updated respectively.
6. Flows in the map are rendered according to the volume of trade flow - the larger trading volume between the two countries, the wider the flow is shown.
7. The mouse hover event is triggered when user's mouse goes through a flow. Then a tooltip is shown to give users further detailed data.

5.5 Map publishing

As we are developing a web-based story map, we finally publish the map on a website server so that it can be easily accessed by the public through Internet. The URL of the online map is <https://covid-trade.github.io/>.

6 Results and personal learning experience

6.1 Final result

The screenshots of the final story map can be found in Appendix A. The story map is finally structured into five sections, namely Econ in COVID-19, Global Trading, China, Policies & Measurements, and Outlook.

- Econ in COVID-19: In this section, we first use a timeline to introduce readers to how the world fights against the virus. Then, the strike of the pandemic to the world economy is demonstrated by a line chart (Figure 2), in which we compare COVID-19 and the 2008 global economic crisis. A 3D globe map (Figure 3) is used to show the difference in the GDP change percent in different countries.
- Global Trading: This section begins with a line chart (Figure 4) to show the sharp decline in world trade volume in 2020. Since 80% of global trade in goods are carried by sea, we compare global weekly port calls exports in 2019 and 2020 (Figure 6) to show the impact of the pandemic on trade in finer temporal resolution. Then a global map (Figure 5) is used to show the import and export situation of different countries and regions. Users can drag the time bar in the lower left corner to view the trade situation in different years. We then compare the trade volume of major economies and find China's imports and exports have increased in the second half of 2020.
- China: We go deep into China's trade flow in this section. First, a trade flow map (Figure 7) is used to show the flow of China's imports and exports. Then detailed commodity composition is shown in a tree map and their flow is shown in a pie chart (Figure 8). The pie chart on the right will update if a product category on the tree map is selected.
- Policies & Measurements: Since China has successfully responded to the impact of COVID19 on trade, we explore the measures China has taken in response to COVID-19. Three interactive cards are used to show China's three main strategies.

- Outlook: Finally, in this section we have a outlook towards to the post-epidemic era. A video from the Organization for Economic Co-operation and Development (OECD) is used for users to read further. Some suggestions are provided to the government for reference to better recover trade from COVID-19.

There is still potential for further improvement. First, the Policies & Measurements section only focuses on China. A comparison of trade policies between different countries may provide readers more insights. Second, the story map can be extended to include the trade flow of more countries.

6.2 Further use of the story map

The story map can be used to convey knowledge about the world economy and trade under the pandemic to the public. In addition, governments and international organizations can use this story map to understand world trade conditions and propose more effective strategies to recover the economy.

6.3 Challenges

6.3.1 Interactive storytelling

It is challenging to create an inspiring, immersive story by combining text, interactive maps, and other multimedia content. We need to organize these contents in a logical way and grab readers' attention. To achieve this, we try to make the maps and charts interactive through mouse clicking, scrolling and hovering. At the same time, we must avoid conflicts between these interactions. For example, the mouse wheel is usually used to zoom the map, but this will contradict the user swiping down the web page. To solve this conflict, we add a toolbar to the upper right corner of the 2D world map (Figure 1(b)) to control zoom in/out instead of using scrolling.

6.3.2 Compatibility of different devices

Because our map is web-based, users may access our story map through different devices with different screen sizes. We must ensure that the content of the web page can be properly displayed on all devices to make a good user experience. For example, when the size of the user's screen changes, the charts should also be automatically resized. To solve this challenge, we use window event listener and media query techniques to adjust the size of the contents. In addition, we try to use Qusar UI components, which automatically adjust the layout to be compatible with different devices.

6.4 Learning experiences

6.4.1 How to tell a good story

We learned that user experience plays an important role in storytelling. First, the user interface should be attractive and the interaction should be as simple as possible. Second, the color scheme of maps and charts should be intuitive. For example, we should use red to indicate the degree of GDP reduction, and blue to indicate the degree of GDP growth, since red usually implies something negative. Finally, proper animation can help attract readers' attention. For example, a rotating globe can make users more interested and motivate users to interact.

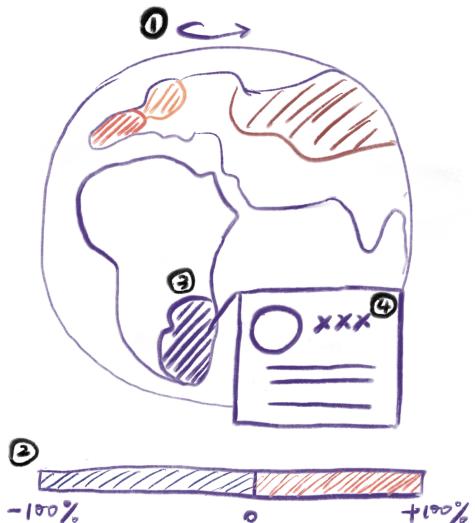
6.4.2 Efficient project management

As this project is based on web development and carried out as a group work, it is important to share source code in a timely manner among team members. The Github platform has proven to be very helpful. Any changes made by other team members can be integrated into their own local code repository easily. Using this tool makes the project under version control and proceed more efficiently.

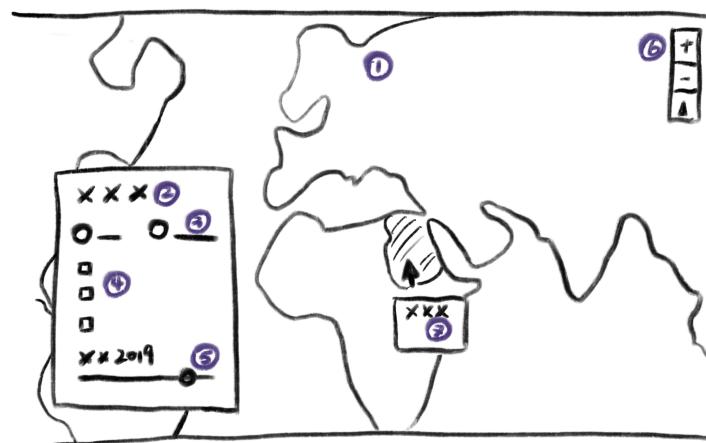
7 Reference and sources

Table 2: Reference and sources

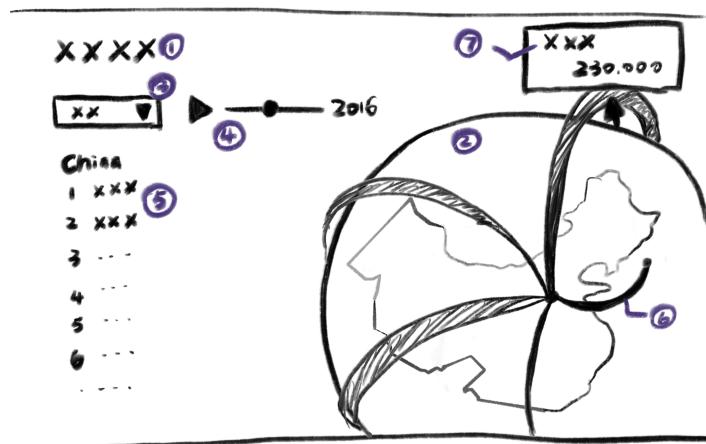
Data Source	Description	URL
Opendatasoft	World Administrative Boundaries - Countries and Territories	https://public.opendatasoft.com/explore/dataset/world-administrative-boundaries/export/
World Economic Outlook Database	GDP and change percent of countries in the world	https://www.imf.org/external/pubs/ft/weo/disclaim.htm
UNCTAD STAT	Change of trade volume of major trading economies	https://unctadstat.unctad.org/wds/ReportFolders/reportFolders.aspx
UN Comtrade Database	Types and total amount of goods imported and exported by China	https://comtrade.un.org/data
AIS: Weekly Port Calls	Weekly port calls from around 1200 ports based on AIS datasets available at the UN Global Platform	https://marketplace.officialstatistics.org/ais-weekly-port-calls
Flaticon	Free vector icons & stickers	https://www.flaticon.com/
Unsplash	Trade themed images	https://unsplash.com/
Pexels	Trade themed images and videos	https://www.pexels.com/
OCED	Economic outlook video	https://www.oecd.org/economic-outlook/



(a)



(b)



(c)

Figure 1: Map drafts in sketches. (a) 3D globe. (b) 2D world map. (c) 3D global flow map with animation.

Appendix A. Story map screenshots

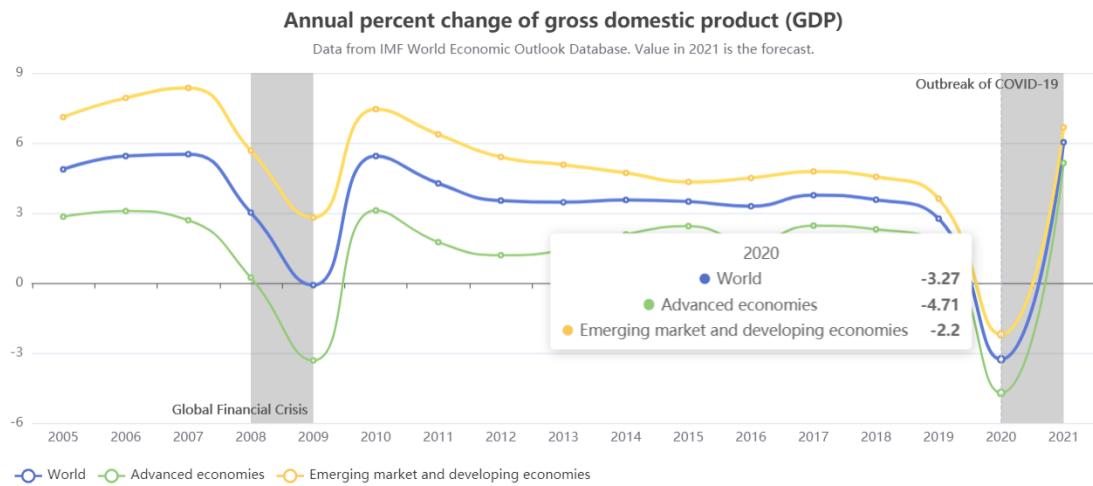


Figure 2: Annual percent change of world GDP

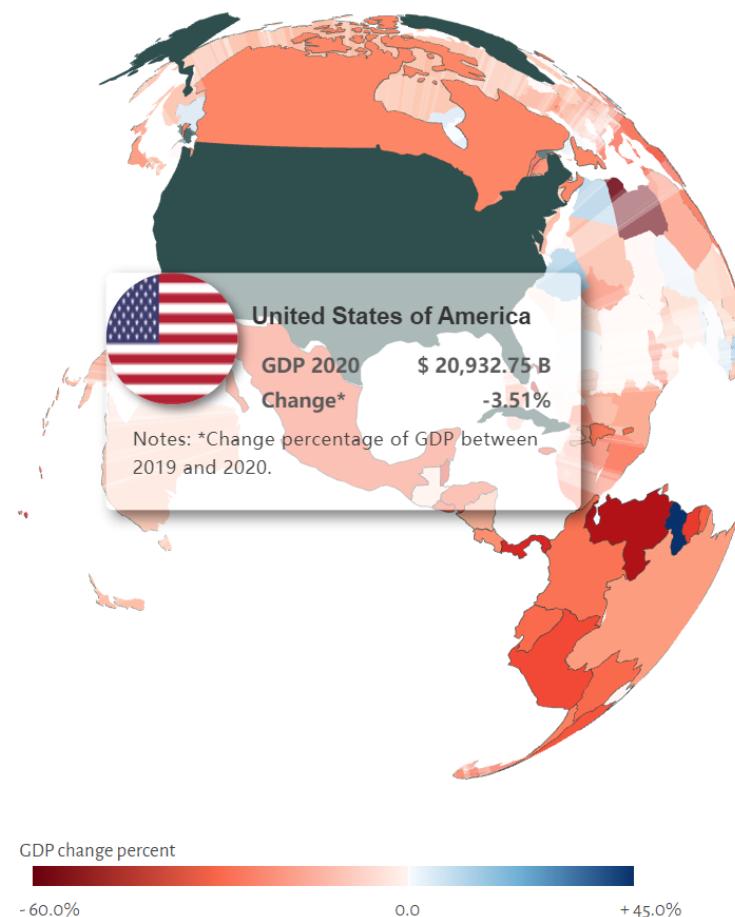


Figure 3: World GDP change percent map

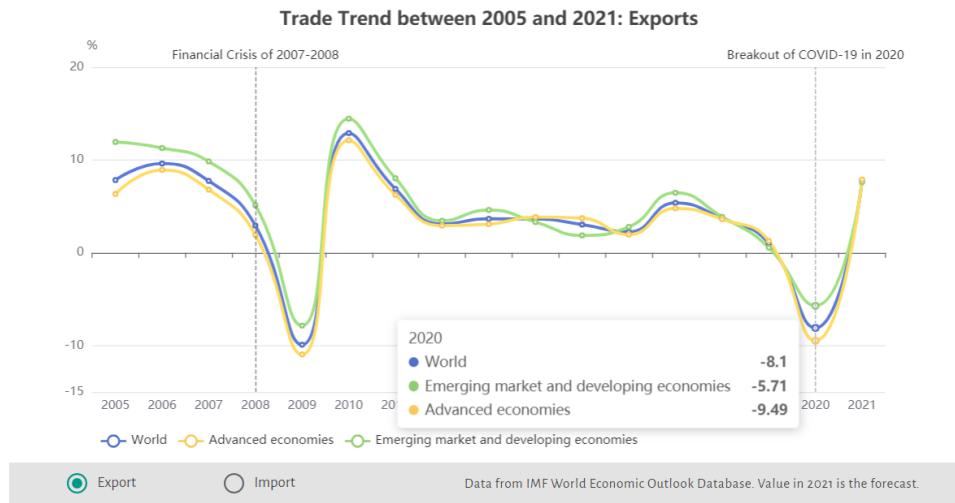


Figure 4: World trade volume from 2005 to 2021

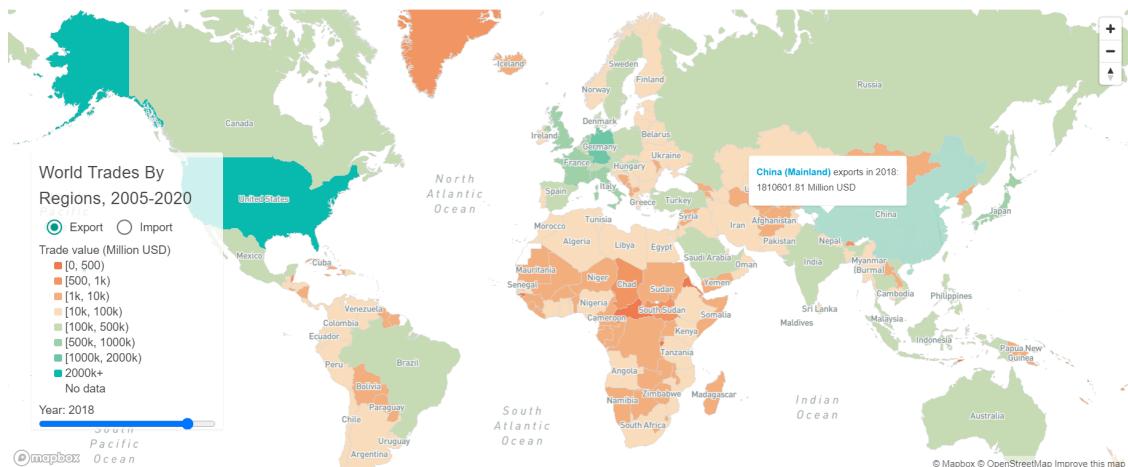


Figure 5: World imports and exports map

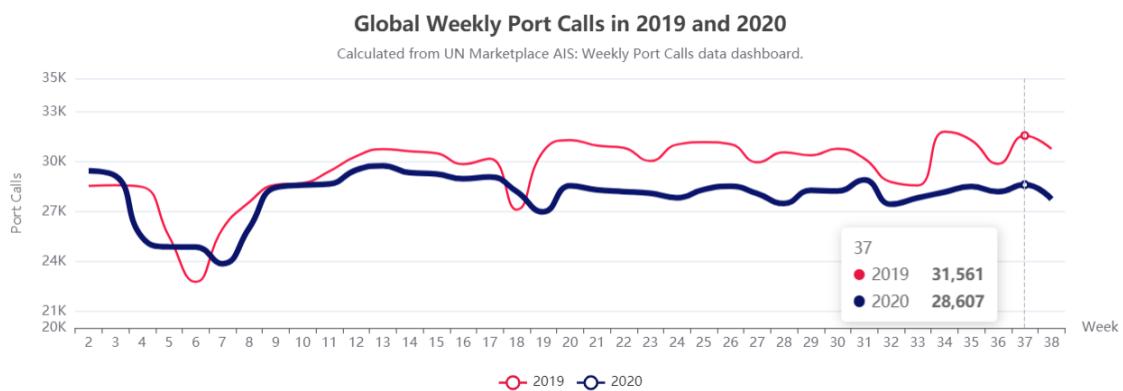


Figure 6: Global weekly port calls in 2019 and 2020

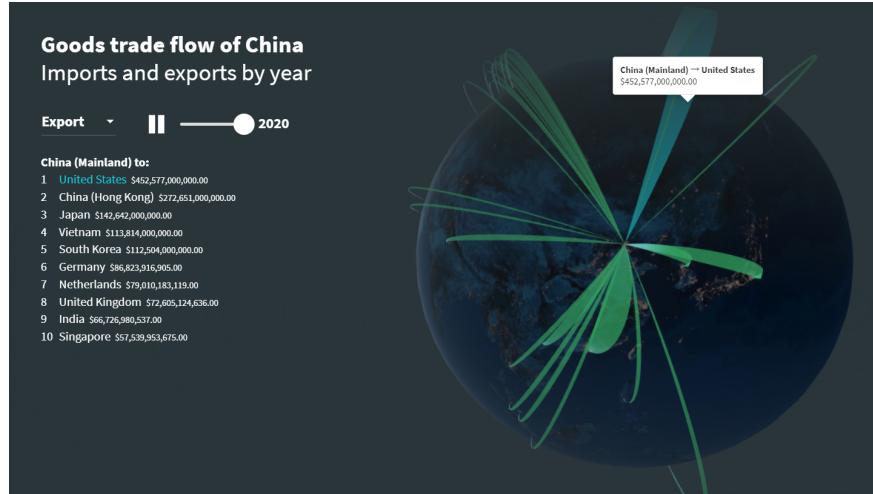


Figure 7: China trade flow map

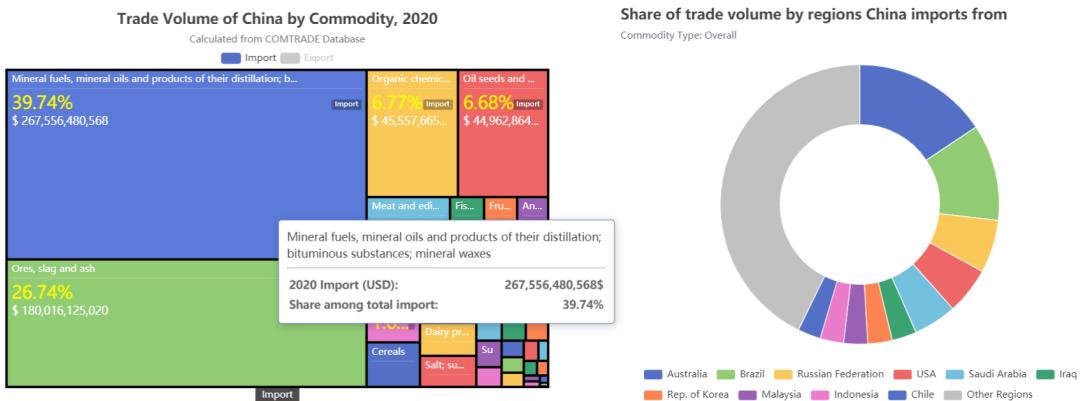


Figure 8: Trade volume of China by commodity

Appendix B. Additional Tables

Table 3: Attachment List

Attachment	Directory	Description
Initial Concept	initialConcept.pdf	Initial concept of the project.
Raw data, codes for data processing	./Data	Raw data downloaded from the source stated in Table 2, and the codes for preprocessing. Please refer to ./Data/readme.md for the details of the catalog for raw data and python scripts.
Codes	./Code	Source code of the story map.
Declaration of originality	declaration.pdf	-