

CS171 Process Book

Project 3

Visualizing U.S. Foreign Trade from 1992-2012

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TF: Blake Walsh, CS171

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Initial TF Meeting

The initial meeting with our TF, Blake, occurred on 4/18/2013. During this meeting, we presented the following:

- Proposed Scope of Improvement:
 - We proposed technical improvements to the functionality of our visualization including the animation of the bar chart, adding additional chart features, and adding chronological ‘playing’ transitions.
 - We presented two new alternative sketches for our new data ideas, which are attached at the end of this processbook in the appendix.
- Proposed scope of storytelling:
 - **Topic:** Show the progression of globalization through changing patterns of trade with the United States
 - **Opening:** Introduction to the visualization, including an introduction to the significance of international trade and a walkthrough guide of the visualization features.
 - **Middle:** ‘Playing’ the visualization from start to finish chronologically.
 - **End:** Exploring the map and charts data in detail, revealing the extent to which the U.S has increased trading ties with its partners. We hope to allow users to draw their own conclusions based on what they have seen from ‘playing’ the visualization.
- Proposed Implementation Plan:
 - See ‘Timeline’ for details. We use technology that we used in Project 2, including jVectorMap, which we modified to extend its functionality, and the D3.js library.

Feedback (from Blake)

- Proposed Scope of Improvement
 - The proposed features seem appropriate, given the large amount of work completed for Project 2. Blake mentioned changing the color choice of the pie charts so they don’t give a false impression of a gradient, which we plan to do if we keep them.
- Proposed Scope of Storytelling
 - In our discussions, we discussed the use of features to ‘walk through’ our visualization as being useful in providing a form of narrative, which may be difficult given the separate compartments of our visualization.
- Proposed Scope of Implementation
 - Blake approved of the general scope we aim to implement. While we do build on our previous project, we do propose the use of new data and features to create a substantive set of new work to be completed.

Timeline of Project Completion

Features to be implemented, by priority:

1. A slider that allows viewing of month-by-month (or year-by-year, depending on the availability) data
2. Optimizing the lines on the visualization to show trade data with the United States
3. A guided walkthrough and explanatory paragraphs to introduce the data, its historical context, and its significance (a more infographic appeal).
 - a. This feature could be potentially implemented with bootstro.js. ([link](#))
4. Line chart (either below the visualization or an overlay) with more country-specific chronological data
5. A 'play' button for the timeline that automatically changes the view of the chronological data in sequence

Features that would be 'nice-to-have':

6. Animations for the lines optimized for the sliders
7. Convert the pie charts from Project 2 into bar charts (if necessary)
8. Allow drill-down capability for the bar charts
9. Historical trade agreement tooltips that pop up on either the map or line chart
 - a. Historical happenings that help explain spikes

Project Proposal

Project title: Visualizing World Trade Data 1992-2012

Project members:

- Kevin Sun (ksun01@college)
- Albert Young (ayoung01@college)

Research questions and hypotheses:

- To what extent does the United States trade with each country? Which countries are the United States' most significant trading partners, and how has this list changed over time?
- Has the mix or sector distribution of United States trade changed significantly over time? Are there countries which specialize in certain sectors? (electronics to China, for example).
- How has the direction and/or volume of international trade changed over time?
- How has the balance between imports and exports changed over time and what are the causes?
- Hypothesis: We expect from preliminary data exploration that we will see a dramatic increase of trade to and from the United States. This increase will serve at the focus of the 'story' we wish to tell: the United States as an integrated node in an international network of trade.

Motivation:

- Our research questions provide a platform to examine international trade data and educate the public about the increasingly global nature of the societies in which we live. In that regard, we are motivated to visualize trade data because we believe doing so can create a noble sense of cosmopolitan global community and a useful perspective in discussing economic issues, especially those pertaining to international trade policy.
- More specifically, we postulate that having a means to visualize international trade could lead to smarter decisions with regards to formulating mutually beneficial international trade agreements.

Data:

- The data that we will be using will be from the following resources both of which offer downloadable files of aid funding numbers that will be directly visualized by the project:
 - The United States Census Bureau Foreign Trade Division (FTD) ([link](#))
 - This information is the “official source for U.S. export and import statistics and responsible for issuing regulations governing the reporting of all export shipments from the United States.”
 - World Trade Organization ([link](#))
 - This website contains trade and tariff profiles of each member country, as well as detailed information about infrastructure services.

Visualization:

We would like to display our data to facilitate comparison between times and illustrate the dramatic development of international trade in the last two centuries. Our past project 2 already included the implementation which effectively included filtering, country-to-country flows, and brushing/linking. Building on the past work of our project, we aim to implement a number of new features which allow us to tell a coherent and compelling chronological story.

The list of features we aim to implement can be found in the previous section, ‘Timeline of Project Completion.’

Sketches:

In this file we have attached the following two sketches:

1. **Left/Right Design:** This design builds most closely on our previous design, using a dynamically updated ‘sparkline’ chart to update export and import figures to visualize trade differences along with a prominently featured map feature. The design also includes a chronological ‘player’ on the bottom and a dynamically updated top trading partners bar chart list.
2. **Map and Chart Design:** The design places less focus on the map design and also includes a large chart on the bottom of the map. The map, as above, is dynamic and includes a chronological player. However, this design also incorporates (or aims to incorporate) interactive scrolling such that users scroll down and view the

line chart on the bottom. On the side are bar charts to visualize top trading partners.

Project Development

Data Collection and Refinement:

Data Source:

- The data was downloaded in Excel format from the U.S. Census Bureau [website](#). This included ‘Exports, Imports, and Trade Balance by Country, Monthly Totals, 1985-present’, ‘Export of Goods by Principal End-Use Category (seasonally adjusted)’, and ‘Import of Goods by Principal End-Use Category (seasonally adjusted)’.

Data Refinement:

- The files were converted from Excel format into CSV format and formatted manually. The Net Balance data was calculated for each row in the ‘Exports, Imports, and Trade Balance by Country, Monthly Totals, 1985-present’ dataset using Excel formulas. Rows with substantial missing data were manually removed.

JSON Conversion:

- The CSVs were converted into JSON files using a python script and loaded into index.html via an external javascript file (since the [same origin policy](#) prevented the loading of local JSON files). It was a challenge to format the JSON data so that it would be easily accessible for the visualizations.
- For the map, the data is needed to be accessed both by year and by country. In the end, we decided on a structure that was indexed by time, then country, then by data type.
- The letter “B,” “E,” and “I” were chosen to represent trade balance, exports, and imports.
- The bar chart data was sorted by year and month

Figure 1: Representation of the data used in our map shading visualization.

```

> data
▼ Object {1985: Object, 1986: Object, 1987: Object, 1988: Object, 1989: Object, 1990: Object, 1991: Object, 1992: Object, 1993: Object, 1994: Object, 1995: Object, 1996: Object, 1997: Object, 1998: Object, 1999: Object, 2000: Object, 2001: Object, 2002: Object, 2003: Object, 2004: Object, 2011: Object, 2012: Object, 2013: Object} ⓘ
  ▼ 1985: Object
    ▼ APR: Object
      ▼ AE: Object
        B: -3.3
        E: 45.6
        I: 48.9
      ► __proto__: Object
    ► AO: Object

```

Visualizing Data

Technology:

- We used **jVectorMap** Javascript package (<http://jvectormap.com/>) to provide a basic map framework. We chose jVectorMap over other candidates like Google Maps and DataMaps.js for several reasons:
 - jVectorMap natively supports features such as panning and zooming, tooltips, highlighting of countries upon mouseover, and color-coding of countries based on data input.
 - jVectorMap has offers a detailed documentation of its methods, which helped when we had to make changes to certain library functions.
 - We did not use Google Maps because it does not not integrate as well with data and is too detail-rich for our purposes.
 - We did not use DataMaps.js because it offered fewer features than jVectorMap (in particular zooming and panning, which is essential for drilling down to smaller countries).
- We used the visualization library **NVD3.js** (<http://nvd3.org/>) to construct the bar chart and line chart in our visualization because we had prior experience with D3.js from class and it offered simple tools for creating and manipulating chart elements in the DOM.
- We used **Bootstrap.js** (<http://clu3.github.io/bootstrap.js/>) to provide a walkthrough demo of our visualization.

Map Shading:

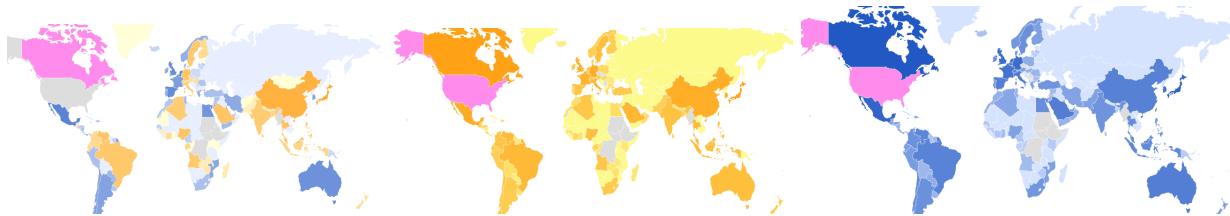
The map shading scale used for our visualization proved to be nontrivial because of the two datasets we had to encode in the color of the map (positive donor information and negative recipient information). We followed these steps:

- Because jVectorMap only accepts one dataset as shading information, we combine the dataset, multiplying all recipient values by negative 1.
- The jVectorMap color scaling process only uses one color scale, which would be

problematic when we needed to encode values along two different color schemes.

- To solve this problem, we modified the jVectorMap numeric scale library and hardcoded in the appropriate minimum maximum values such that there were two distinct datasets [0, maxdonor] and [0, maxrecipient].
 - Balance range: [-29376, 2264]
 - Import range: [0,40290]
 - Export range: [0,26297]
- The data we received was highly skewed, so we decided to encode in shading not our actual data values, **but logarithmic values**:
 - Effectively this creates a logarithmic scale which increases the displayed variety.
 - This was accomplished by using `Math.log` on values prior to encoding.
 - For negative and values less than e, the value was to 0.
- **Different color schemes:**
 - For visualizing trade balance, countries with positive trade balance were encoded in blue, and negative trade balance in yellow/orange.
 - For exports, we used varying shades of blue.
 - For imports, we used varying shades of yellow/orange.

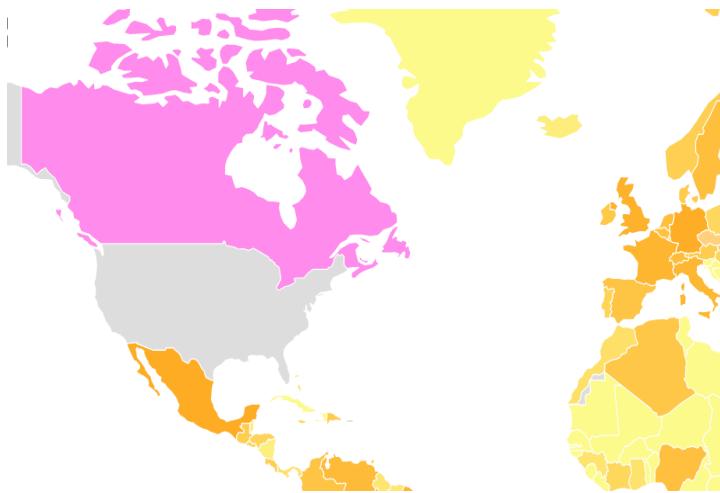
Figure 2: Display of differing color schemes used in our visualization



Country Selection

- Incorporating country selection allows for **details-on-demand**.
- Country selection allows for the user to view a more detailed line chart of trade data.
- The map was modified to allow for the selection of **one** region at a time by clicking.
 - This selection was achieved by modifying 'regionsSelectableOne' of the jVectorMap framework.
- The default country selection when the visualization loads is Canada, in order to load data into the line chart.
- The selected country appears in bright pink, and also controls the line chart being displayed.

Figure 3: Zoomed-in Visualization with ‘Canada’ selected:



Dynamic Tooltips

- The use of tooltips in our visualization incorporates details-on-demand and go beyond just a simple display of data. Depending on the radio menu selection, the tool tips can either display the export, import, or trade balance data for the particular country.
 - Upon mouseover of any country, the tooltip displays the appropriate value between the U.S. and that country for the selected time period.
 - For countries that are missing data for the specified time period, the tooltip displays 'No data on trade balance available'.

Figure 4: Different Tooltips used in our Visualization

Saudi Arabia Net imports with Saudi Arabia: \$889.4 mil USD	Italy Net trade balance with Italy: \$-85.1 mil USD	Iraq Net exports with Iraq: \$0.3 mil USD
----------------------------------------------------------------	--------------------------------------------------------	----------------------------------------------

Country Table Listing

- Following our country selection, we decided to highlight top countries that the U.S trades with to further support **linking & brushing**.
 - The table is sorted by the trade type currently selected.
 - In addition, the data changes with the current slider time.
 - The table can be reverse-sorted or sorted alphabetically by clicking on the table headers. We used the jQuery Animated Table Sorter (<http://www.matanhershberg.com/plugins/jquery-animated-table-sorter/>) plugin and CSS from Smashing Magazine (<http://coding.smashingmagazine.com/2008/08/13/top-10-css-table-designs/>).

- The table is linked to the time slider used throughout our visualization, as well as the ‘data type’ selection: when the map is displaying imports, so will the table (etc.)

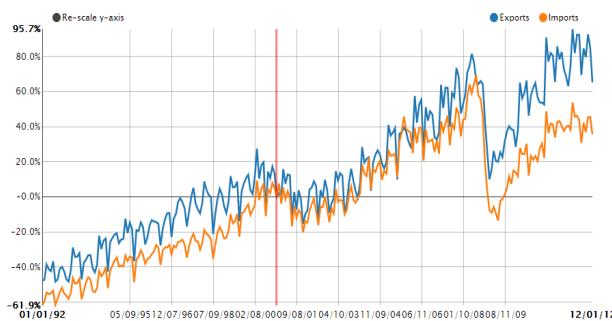
Figure 5: Country Table in our Visualization

Rank	Country	Exports
1	Canada	\$6922 mil USD
2	Japan	\$3651 mil USD
3	Mexico	\$3061 mil USD
4	United Kingdom	\$1787 mil USD
5	Germany	\$1761 mil USD
6	South Korea	\$1463 mil USD
7	France	\$1191 mil USD
8	Netherlands	\$1172 mil USD
9	Taiwan	\$1025 mil USD
10	Italy	\$774 mil USD

Line Chart

- To show the relative change over time in trade, we implemented a line chart with a y-axis of relative percent. The line chart thus rescales with the currently selected time, another example of linking and brushing.
 - The trade data being visualized is encoded by a line for exports and one for imports.
 - In addition, the data scales with the the slider time, allowing for the comparison of relative changes over time.

Figure 6:Line Chart in our Visualization



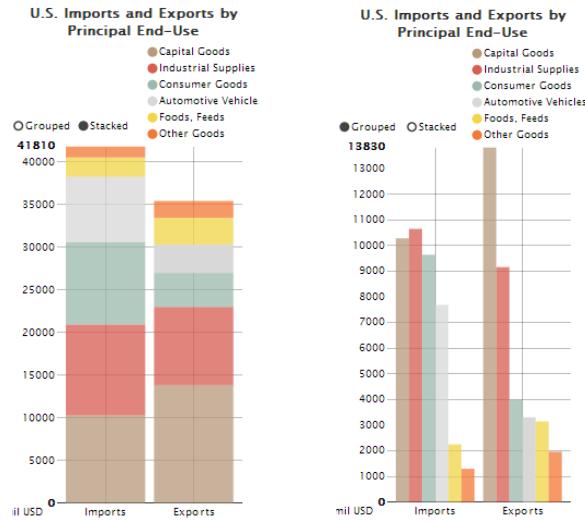
Bar Charts:

- We incorporate **linking & brushing** and **details-on-demand** with the bar charts, which display data in a separate visualization based on the current time.
 - For different years, the sector breakdown changes per year.
- Clicking on the legend categories allows you to change which sectors are being

visualized.

- In addition, the visualization provides the option of choosing between stacked and grouped bar charts, with an animated transition between the two.

Figure 7: Bar Chart used in our Visualization (Both Stacked/Grouped)



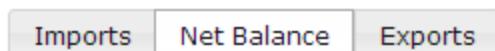
Animating Data

- Bar Chart
 - Animations were included by default in the NVD3.js example we used and help make the transition clear between the stacked and group views of the bar chart. We shortened the duration of the transition slightly.
- Line Chart
 - Animations were included by default in the NVD3.js example and we saw no need for modifications.
- Table
 - Animations were included for sorting table values, to show movement between countries along the table rankings.

Filtering Data:

- Radio Buttons
 - The main filtering mechanism of the visualization is whether to show trade balance, exports, or imports. The radio buttons were styled with the assistance of jQuery UI:

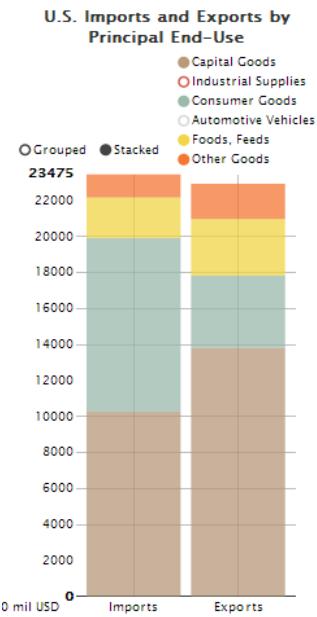
Figure 8: Filter Buttons



- Through this selection, the visualization information is effectively 'filtered' down to

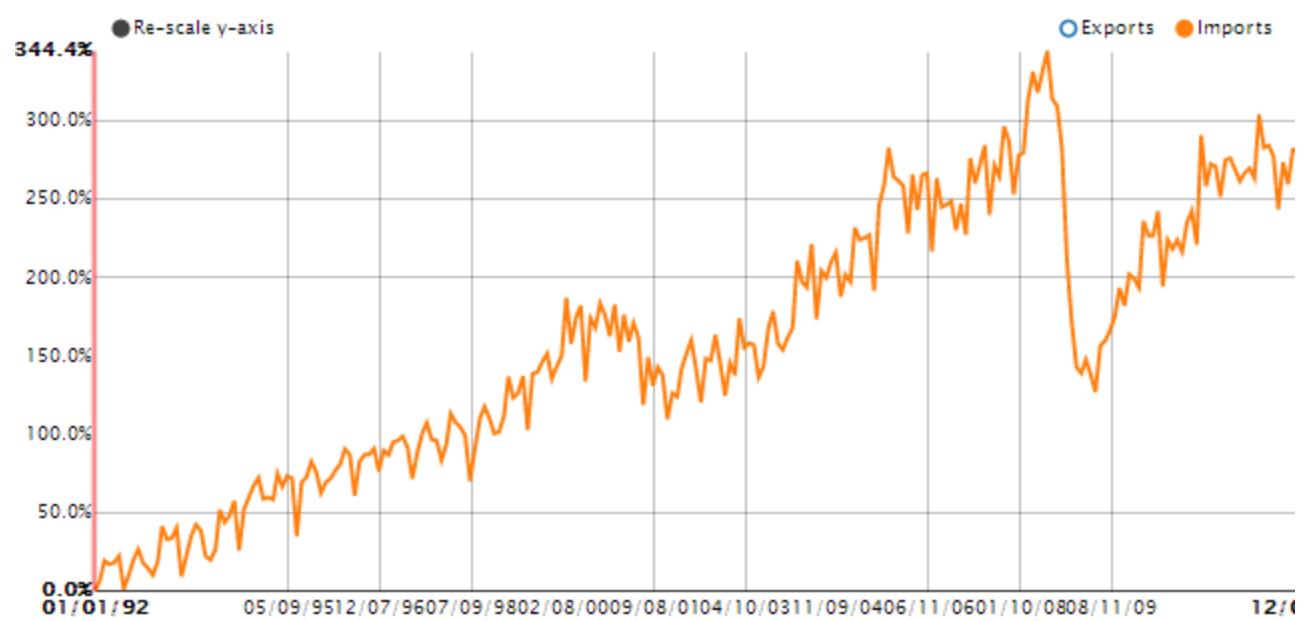
- one particular data type (from three possible). This filtering mechanism mainly applies for the map shading and the table, not the line/bar chart. T
- However, the filter buttons *do affect* the table, which displays its the top countries of the particular data type selected (ex, the top 10 export or import trading partners)
 - The fact that the filter can be applied to more than one part of the dashboard reflects our goal of achieved centralized control linked together.
 - Bar Chart - Category Legend
 - The different items on the bar chart legend can be selected or deselected to filter for the categories of interest. Note how the deselected categories become hollow circles, indicating they are no longer being visualized.

Figure 9: Bar Chart Legend Filter



- Line Chart
 - The line chart legend can be manipulated such that the chart only displays only imports, only exports, or both.

Figure 10: Line Chart Legend Filter



Design Justifications:

Mockup Selection:

- We decided to select the second sketch concept as the basis for our visualization design. As in the sketch, we ended up using a separate display panel for the 'U.S. Imports and Exports by Principal End-Use Category' data but allowed for switching between group and stacked views for the bar chart.
- The first sketch concept, which had a different map view to optimize the distribution of flow lines, was abandoned because we removed flow lines and decreased the focus of our visualization on the map (instead, making the charts more prominent).

Project 2 Modifications:

- We decided to remove flow lines because the lines obscured the map, encoded redundant information (since the width of the flow lines would be better shown as color variation in the countries), and could only be drawn for the U.S.
- The pie charts encoding categorical data in Project 2 were replaced by bar charts that could switch between stacked and grouped views. This change allows comparison to be made between the total import and export values (stacked view) and each individual category (grouped view).
- We removed the 'Reset View' and 'Focus on Current Country' buttons because they are unnecessary as our Project 3 visualization focuses less on the exploration of the map.

Color Scheme:

- Background:
 - We used white for the background color of the page in order to contrast with the brighter elements of the page--the data being highlighted.
- Map:
 - Shading:
 - For the balance of trade, countries with which the U.S. had a negative trade balance were filled with shades of orange, and those with which the U.S. had a positive trade balance were filled with shades of blue. Blue and orange are complementary colors that allow the countries to be easily categorized by color.
 - Countries that were missing data were rendered in gray. The user should be accustomed to associating this neutral color with missing data values.
 - Selection:
 - When a country is selected, its color changes to a bright pink, which gives it the most contrast against the background and other countries, allowing the user to easily identify the current selection.
 - Mouseover:
 - Upon mouseover, the tint of a country's fill changes to provide feedback to the user that a new country is being moused over. This is the

unmodified default state of the jVectorMap example we built off of.

- Stacked Bar Chart:
 - The stacked bar chart uses colors that are easily distinguishable and aesthetically complement those found on the map.
- Line Chart:
 - Imports were encoded with blue and exports with orange to match the color encoding of the map. Blue and orange are complementary colors that allow the lines to be easily distinguished on the chart.
- Tooltips:
 - Tooltips have a dark gray background with a white stroke, a default feature of the jVectorMap example, which we found easy to read and unnecessary to modify.

Page Layout:

- Resolution:
 - We decided to use a 1366 x 768 size for our visualization because it is now the most popular screen resolution for the web and was appropriate for our layout(<http://techcrunch.com/2012/04/11/move-over-1024x768-the-most-popular-screen-resolution-on-the-web-is-now-1366x768/>).
- Layout:
 - We placed the line graph underneath the map and allowed it to span the width of the page in order to show the most detail. Unfortunately the line chart and map could not be kept in the same view, whether we chose to create a lightbox over the map or require the user to scroll.

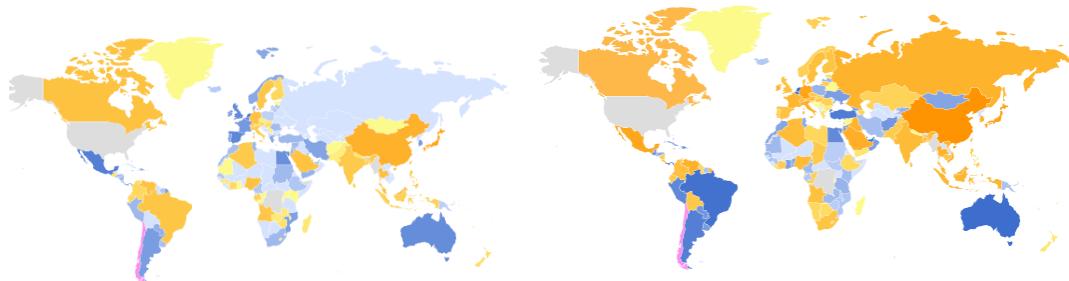
Data Analysis and Discussion

Magnitude of Imports and Exports:

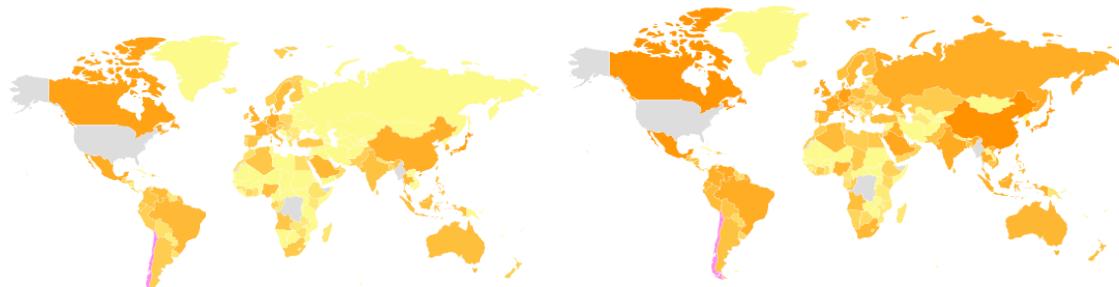
- By playing the 'Import' and 'Export' components of the visualization, it is immediately apparent that the quantity of foreign trade increased significantly between 1992-2012.

Figure 11: A Comparison of Trade Data from 1992 and 2012.

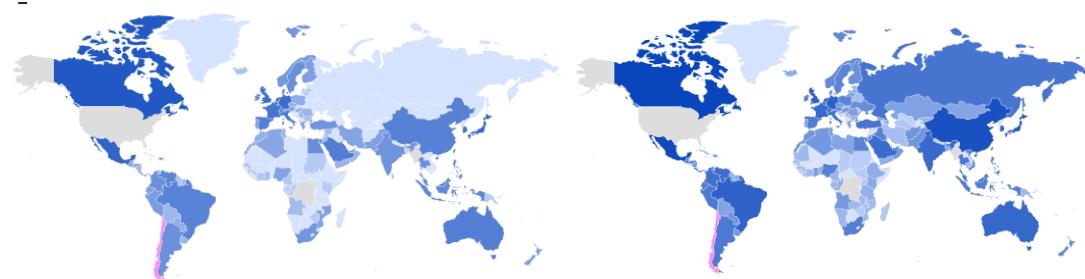
Balance:



Imports:



Exports:



In all figures the shading of the maps indicate an increase in the total volume of trade. Thus the finding of this visualization, broadly speaking, is increasingly globalized state of our world.

Net Trade Balance:

- By playing the 'Net Balance' component of the visualization, some interesting trends emerge:
 - The U.S. has a consistent and increasingly negative trade balance with China.
 - The U.S. has a consistent and increasingly positive trade balance with Australia.

- The U.S. goes from having a negative trade balance with Brazil to a strongly positive trade balance.
- The U.S. goes from having a positive trade balance with Mexico to a strongly negative balance.
- The balance of trade with various countries resembles a mosaic and fluctuates between positive and negative depending on the month.

Imports:

- By playing the ‘Imports’ component of the visualization, some interesting trends emerge:
 - Overall, U.S. imports from every country increases, with dramatic differences in China, Russia, and India.
 - The U.S. has fewest imports from Africa and growth in imports there has been lower than other continents.

Exports:

- By playing the ‘Exports’ component of the visualization, some interesting trends emerge:
 - Overall, U.S. imports from every country increases, with dramatic differences in China, Russia, Brazil, and India.
 - The U.S. has lowest quantity of exports to Africa but growth in exports is fast, particularly in Nigeria and in North and East Africa.

Historical Events:

- By playing the ‘Exports’ component of the visualization, some interesting trends emerge:

Project Summary and Evaluation:

In our final project, we produced a comprehensive dashboard to visualize complex trade data. Our project includes **multiple, coordinated views**, by including a map view, two chart views, and tabular display of the selected country. In addition, our map view has **significant complexity**, because it supports the animation of not only changes in data, but changes through time.

Of the major visualization features in class, our visualization excels in providing several ways to interact with data. **Linking** is supported on several levels from the selection of a single country to the traversal of time. A selection of the single country creates a unique chart display while changes the time changes the stacked chart, map shading, and line chart marker. Finally, our visualization also includes **details-on-demand** through the dynamic tooltip which changes between exports, imports, and trade balance

Sources Used:

Data:

U.S. Census Bureau, *Foreign Trade*, 2013. Accessed on 4/20/13 from <http://www.census.gov/foreign-trade/>

Libraries:

Bootstrap (Otto, Mike; 2013). Used for Bootstro.js functionality under the CC BY 3.0 license. Accessed on 4/29/2013 at <http://twitter.github.io/bootstrap/>.

Bootstro.js (Tran, Steve; 2013). Used for visualization 'demo.' under the MIT license. Accessed on 4/29/2013 at <https://github.com/clus3/bootstro.js/blob/master/README.md>.

d3.js (Bostock, Mike; 2013). Used for NVD3.js functionality under the BSD license. Accessed on 4/5/2013 at <http://d3js.org/>.

jQuery (Resig, John; 2013). Used for general assistance, jQuery UI/ATS functionality under the MIT license. Accessed on 4/1/2013 at <http://jquery.com/>.

jQuery Animated Table Sorter (Hershberg, Matan; 2012). Used for table animations and sorting under the MIT license. Accessed on 4/28/2013 at www.matanhershberg.com/plugins/jquery-animated-table-sorter/.

jQuery UI (González, Scott; 2013). Used for slider and radio buttons under the MIT license. Accessed on 4/4/2013 at <http://jqueryui.com/>.

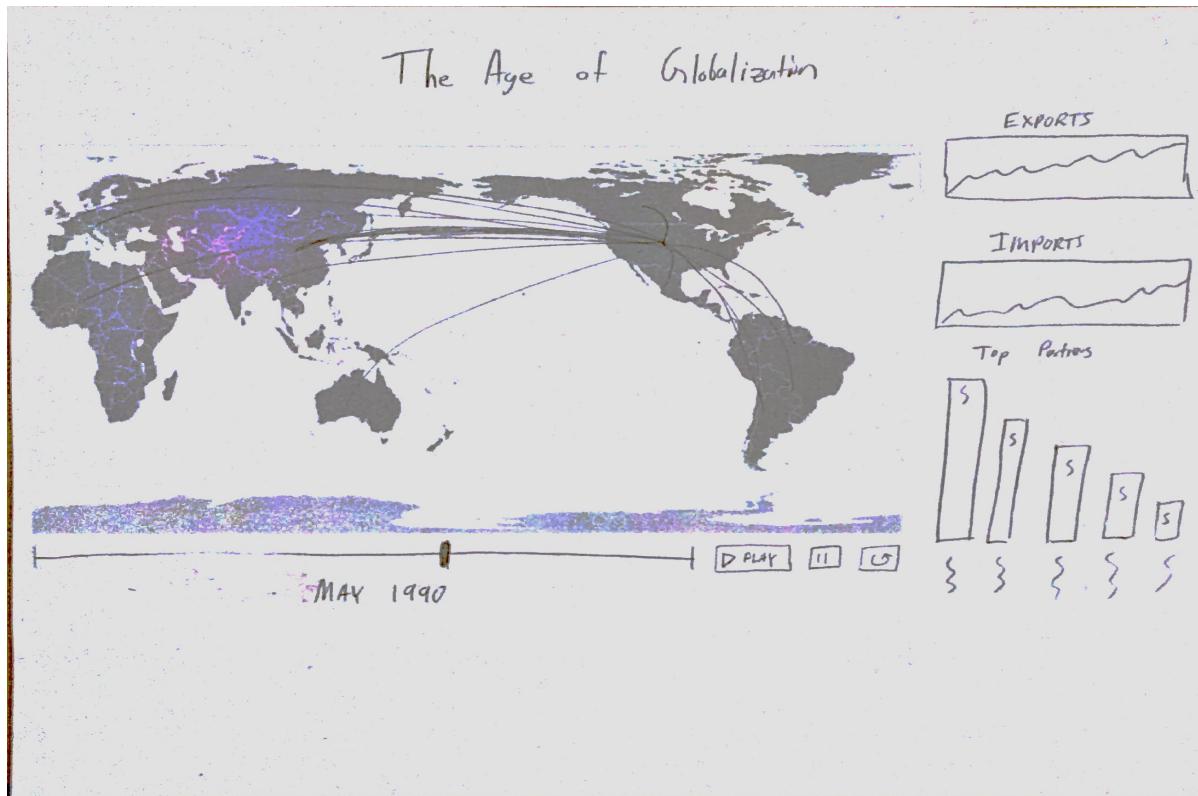
jvectorMap (Lebedev, Kirill; 2012). Used for map view under the MIT license. Accessed on 4/1/2013 at <http://jvectormap.com/>.

NVD3.js (Novus Partners; 2012). Used for line and bar charts under the CC-wiki license. Accessed on 4/30/2013 at <http://nvd3.org/>.

PrettyPhoto (Carone, Stephane ; 2012). Used for video overlay lightbox under the GPL v2 / CC 2.5 license. Accessed on 5/1/2013 at <http://www.no-margin-for-errors.com/projects/prettyphoto-jquery-lightbox-clone/>.

Appendix: Sketches for Project 3

Sketch 1: Left/Right Division



Sketch 2: 'Map and Chart' Design

