Mapping Globalization

Using Heatmaps to Explore Trade Networks

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Exploring Networks Without a Map

Patterns of trade among dyads often visualized using maps

Map based displays usually constrain amount of data we can plot & absorb

And hard to show direction of trade

Or make comparisons across years or transaction types

Alternative: move away from physical space

Plot a grid showing every country’s trade with every other country

This type of plot is known as an image plot
Questions raised by image plots of trade data

How do we select the countries to plot?

How do we order the countries in rows and columns?

What data are we plotting exactly?

How do we turn those data into color (selecting bins)?
How do we select the countries to plot?

Lots of options

Need not choose the same countries for rows and columns

Examples here: $N$ largest importers and $M$ largest exporters
Dyadic strength of trade relations

Region color codes

East Asia
India Subcontinent
Middle East
Oceania
Europe
Latin America
North America
Southeast Asia

Dyadic intensity of trade

3.97e−09 to 0.000348
0.000348 to 0.00218
0.00218 to 0.00563
0.00563 to 0.00988
0.00988 to 0.0135
0.0135 to 0.0189
0.0189 to 0.173
How do we order the countries?

Perhaps the key step

Alpha or random order will tend to hide interesting patterns

Solution: Plot “similar” rows and columns close to each other

Reveals clusters of traders and outliers from prevailing patterns of trade

We use cluster analysis to find which rows and columns cluster together

Heatmap: An image plot with rows & columns ordered by cluster analysis
What data are we plotting exactly?

How do we measure trading relationships?

Total dollars of trade between two countries?

Two problems with this:

1. Trade data is directional
   
   US imports from China $\neq$ US exports to China

2. Big countries have much higher absolute levels of trade

   $\rightarrow$ Graphs will tend to highlight well-known relationships only
What data are we plotting exactly?

Option 1:

Measure trade from country $i$ to $j$ as a % of world trade

\[
\text{Global Intensity of Trade}_{i \rightarrow j} = \frac{\text{Imports}_{i \rightarrow j}}{\text{Imports}_{\bullet \rightarrow \bullet}}
\]

This gives us two complementary measures for any pair of countries.

Solves problem 1 (directionality), not problem 2 (big countries dominate).
What data are we plotting exactly?

Option 2:

Measure trade as a % of imports (by the importer) and exports (by the exporter)

Gives greater weight as dyads become more “exclusive”

\[
\text{Dyadic Intensity of Trade}_{i \rightarrow j} = \left( \frac{\text{Imports}_{i \rightarrow j}}{\text{Imports}_{\bullet ightarrow j}} \right) \times \left( \frac{\text{Imports}_{i \rightarrow j}}{\text{Imports}_{i \rightarrow \bullet}} \right)
\]

Solves problem 1; \textit{partially} solves problem 2 (bigger countries have more “partners”)

# An example

<table>
<thead>
<tr>
<th>World Trade</th>
</tr>
</thead>
<tbody>
<tr>
<td>&quot;= $1000 million&quot;</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th></th>
<th>Amount of Trade</th>
<th>Global Intensity of Trade</th>
<th>Sender’s Total Exports</th>
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<th>Dyadic Intensity of Trade</th>
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<tbody>
<tr>
<td>Mexico → US</td>
<td>$100 m</td>
<td>0.1</td>
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<td></td>
<td></td>
</tr>
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<td>Sweden → Finland</td>
<td>$1 m</td>
<td>0.001</td>
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<td></td>
<td></td>
</tr>
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World Trade 
"= $1000 million"
How do we turn those data into colors?

We have our transformed trade data by dyad.

To plot it on a heatmap, we need to discretize it, or place it in “bins”

Choosing the cutpoints between bins affects what patterns will emerge from the data

Our dyadic trade data is strongly skewed:
Distribution of Dyadic Trade Intensity, 2001

Dyadic Trade Intensity

Frequency

0.00 0.05 0.10 0.15

0 50 100 150 200 250

Dyadic Trade Intensity
How do we turn those data into colors?

Choosing equally spaced bins will thus submerge most of the variation, and highlight the small handful of strong relationships

Alternatively, we could choose bins based on quantiles, e.g.,

Bin 1  50th percentile and below  
Bin 2  75th percentile down to 50th  
Bin 3  85th percentile down to 75th  
Bin 4  90th percentile down to 85th  
Bin 5  95th percentile down to 90th  
Bin 6  97.5th percentile down to 95th  
Bin 7  100th percentile down to 97.5th

which is what we’ve been using for all our previous plots. . .
Dyadic intensity of trade

Region color codes

-0.000173 to 0.0191
0.0191 to 0.0383
0.0383 to 0.0576
0.0576 to 0.0768
0.0768 to 0.096
0.096 to 0.115
0.115 to 0.135
0.135 to 0.154

Dyadic strength of trade relations

Exporter

Importer
More advanced features for heatmaps

Color coded nodes:
I’ve used region here, but could be any variable, categorical or continuous

Change the axes:
To explore the evolution of a single exporter’s trading partners,
replace the exporter dimension with time, or with different categories of trade

Parquet plots:
Split the square to show change over time, or differences across traded goods
Future extensions

Interface directly with SQL database

Create a web version (currently an R package)