Visualization of Student Migration Data Using Google Charts Sankey Diagrams

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• Goals
  o To learn the basics of Sankey diagrams
  o To gain an understanding of how Sankey diagrams can be used in Institutional Research
  o To be able to create a basic Sankey diagram in Google Charts, using Excel data
  o To review an example of a Sankey diagram created to visualize student migration at Stony Brook
• Introduction to Sankey diagrams

• Sankey Diagrams and Institutional Research

• Building an Example Sankey
  o Discuss the process behind collecting data and creating a basic Sankey diagram
  o Look further into how a more complex diagram is created

• Google Charts for Institutional Research
  o Other charts available
  o Dashboards in Google Charts
WHAT IS A SANKEY DIAGRAM?

- Originally created to show efficiency of a steam engine by Captain Matthew Henry Phineas Riall Sankey in 1898 (Source: Wikipedia)
- Flow diagram
- Used to visualize flow of a system, transfer of items, movement of goods…
- Thickness of line represents magnitude of flow
EXAMPLES OF SANKEY DIAGRAMS

Simple Sankey Diagram of a Lightbulb

- Electrical energy: 100 J
- Light energy: 10 J
- Heat energy: 90 J

Multi Level Sankey Energy Diagram
**Nodes:** Represent sources and destinations of flows
- Cities, Universities, Academic Departments, Accounts

**Links:** Links indicate that there exists flow between the nodes it connects

**Weight:** Also known as the thickness. The higher the weight of the link, the thicker it is
• Useful where there is movement
• Student transitions
  o Major changes, Time to degree, Transfer destinations
• Transactional data
  o Finance, Student Financial Aid, Research Expenditures, HR Data
• Example: Tracking a cohort (Fall 2010 SBU FTFT to their 4th Fall)
SANKEY EXAMPLE: IPEDS SFA

- 2013 – 14 IPEDS SFA Data from Stony Brook
- Total financial aid
- Scholarships/Grants vs Loans
- Aid source
MAJOR CHANGES AT STONY BROOK UNIVERSITY

• Closer look at Stony Brook University FTFT 2010 students
  • Looking by Major groupings
• Looking for retention/graduation interventions: undeclared?
• For now, look at one year change (Fall to Fall)
• Immediate observations
  o Majority do not leave
• Questions about those not returning:
  o In line with other majors?

Example 1.1
MAJOR CHANGES AT STONY BROOK UNIVERSITY

- To answer this question, let’s look at students who don’t return

- Observations
  - Not out of line with other majors

- Benefits
  - Not a list of numbers and percentages
  - Easy to visualize

Example 1.2
• Add major groupings to initial cohort tracking example (Example 1)
What does the Sankey help to show us? What does it show decision makers?

- Helps to show complexity to decision makers and those making requests
- Demonstrate trends in flow, or “currents”
- Highlight problem areas: high transfer out, high attrition,…
- Can also show successes
- Prompt further investigation into previously unnoticed subgroups or trends

SBU case specific examples

- SOMAS – High out, low in
- CEAS – AMS in, engineering out
- Undeclared students persist, do not leave at as significantly different rates as thought
- Major alone will not give us a target
Several options for creating Sankey diagrams (some others listed at end)

Sankey diagram included as part of Google Charts
  - Clean, straightforward, and does not require a background in coding (*I am not a programmer!*)
  - Replicable and easily editable to accommodate data changes or new project
  - Can be combined to create dashboards with other Google Charts

https://developers.google.com/chart/interactive/docs/gallery/sankey

We will examine the code behind some simple Sankey diagrams
  - Creating the diagram only involves changing *one* section of the code provided by Google
  - Users can modify more if they like
THE CODE FOR EXAMPLE 1.2

```html
<html>
  <head>
    <script type="text/javascript" src="https://www.gstatic.com/charts/loader.js"></script>
    <script type="text/javascript" id="sankey-basic-charts">
        google.load("visualization", "1.1", {packages:["sankey"]});
        google.setOnLoadCallback(drawChart);

        function drawChart() {
            var data = new google.visualization.DataTable();
            data.addColumn('string', 'From');
            data.addColumn('string', 'To');
            data.addColumn('number', 'Weight');
            data.addRows([['Business (F10)', 'DID NOT RETURN (F11)', 15], ['CA3: Biological Sciences (F10)', 'DID NOT RETURN (F11)', 42], ['Undeclared Students (F10)', 'DID NOT RETURN (F11)', 38], ['CA3: Health (F10)', 'DID NOT RETURN (F11)', 20], ['CA3: Humanities and Fine Arts (F10)', 'DID NOT RETURN (F11)', 17], ['CA3: Physical Sciences & Math (F10)', 'DID NOT RETURN (F11)', 17], ['CA3: Social and Behavioral Sciences (F10)', 'DID NOT RETURN (F11)', 24], ['Engineering & Applied Sciences (F10)', 'DID NOT RETURN (F11)', 32], ['Journalism (F10)', 'DID NOT RETURN (F11)', 4], ['Marine Sciences (F10)', 'DID NOT RETURN (F11)', 19], ['Provostial Area (F10)', 'DID NOT RETURN (F11)', 2]]);
            var options = {
                height: 600,
                width: 750,
                sankey: { nodePadding: 40, label: {fontName: 'Arial', fontSize: 12, bold: true, color: 'black' } }
            }
            var chart = new google.visualization.Sankey(document.getElementById('sankey_basic'));
            chart.draw(data, options);
        }
    </script>
  </head>
  <body>
    <div id="sankey_basic" style="width: 900px; height: 900px;"></div>
  </body>
</html>
```
Creating your own Sankey diagram

This is the only section that needs to change: **The links and weights**

Some example code can be found on Google's webpage

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<html>
<head>
    <script type="text/javascript" src="https://www.gstatic.com/sankey"></script>
    <script type="text/javascript">
        google.load("visualization", "1.1", {packages: ["sankey"]});
        google.setLoadCallback(drawChart);

        function drawChart() {
            var data = new google.visualization.DataTable();
            data.addColumn('string', 'From');
            data.addColumn('string', 'To');
            data.addColumn('number', 'Weight');
            data.addRows(["Business (F10), 'DID NOT RETURN (F11)', 15],
                          ['CAS:Biological Sciences (F10), 'DID NOT RETURN (F11)', 42],
                          ['Undeclared Students (F10), 'DID NOT RETURN (F11)', 38],
                          ['CAS:Health (F10), 'DID NOT RETURN (F11)', 20],
                          ['CAS:Humanities and Fine Arts (F10), 'DID NOT RETURN (F11)', 17],
                          ['CAS:Physical Sciences & Math (F10), 'DID NOT RETURN (F11)', 17],
                          ['CAS:Social and Behavioral Sciences (F10), 'DID NOT RETURN (F11)', 24],
                          ['Engineering & Applied Sciences (F10), 'DID NOT RETURN (F11)', 32],
                          ['Journalism (F10), 'DID NOT RETURN (F11)', 4],
                          ['Marine Sciences (F10), 'DID NOT RETURN (F11)', 13],
                          ['Provostial Area (F10), 'DID NOT RETURN (F11)', 2]);

            var options = {
                height: 600,
                width: 750,
                sankey: { node: { nodePadding: 40, label: {fontName: 'Arial', fontSize: 12, bold: true, color: 'black'} } };
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    </script>
</head>
<body>
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</body>
</html>
```
HOW TO CREATE YOUR OWN SANKEY DIAGRAM

• Basic Steps
  1. Define nodes, links, and weights
  2. Gather data (enrollments for this example)
  3. Create code for nodes and links using data
  4. Insert the code, replacing old nodes and links
  5. Run code in HTML editor, you’re done!

• Going Further
  o Edit Google chart options
  o Edit HTML options (*not covered in this presentation*)

• Let’s try it
• Build the Major Migration Sankey from Example 1.2

• The following structure is used
  - Nodes: Major groups by fall terms (Ex: Engineering Fall 2010)
  - Links: Links represent movement between the two major groups they connect (the year of the movement is also specified by which nodes are connected – we limit to one year movements)
  - Weights: Denotes the amount of students moving between the two program groups in the represented time frame

• Not all definitions will be the same. Ensure you will be able to demonstrate what you are trying to show
  - Initial attempts at this example led to adding a year component to the node labeling
  - Initial cohort node – helps with start distribution
• Need enrollment data, stored in a spreadsheet
  
  o Pulled from enrollment records

• Create a panel that shows enrollment in one fall and then subsequent fall enrollment
  
  o For SBU, data stored on major, school/college, graduation status, college/division (local grouping of majors to reduce number of links)

• Summary sheet for total changes: will use to create code
  
  o Pivot table
BASIC STEPS: CREATE CODE

• “Rows” create nodes, links, and their relationship

• Columns inside each row are:
  o Source – Where does the flow start?
  o Destination – Where does the flow go?
  o Value – How much flow?

• Row code format: ['Source', 'Destination', Value],

  o [ 'Source', 'Destination', Value ]
  Note: ORDER MATTERS

  Must start and end with open bracket: [

  Include single quotes around node names: ‘’

  Separate source, destination and value with commas. Also, separate EACH row entry with a comma (except for the final entry): ,

• Use a concatenate formula in your spreadsheet to create rows in this format
• Copy basic example code from Google Sankey page or code from a previous diagram you created
• Place in editor (Notepad, Notepad++, HTML online editor, JSFiddle…)
• Leave the first and last lines
  o data.addRow([  
  o ]);
• Remove links in between these lines, and add your links
  o Make sure last link does NOT end with a comma, the code will not work

This sample is from example 1.2. You can use any previous Sankey code to start.
BASIC STEPS: RUN CODE

- Notepad
  - Save as .htm, open file with internet browser

- Notepad++
  - Save file, use run option to run in a browser

- HTML editor
  - [http://htmledit.squarefree.com/](http://htmledit.squarefree.com/) - updates in real time

- JS Fiddle
  - [https://jsfiddle.net/](https://jsfiddle.net/) - need some HTML experience, since Javascript and HTML is separated by this editor
GOING FURTHER: OPTIONS

• Options are entered with the following format
  o Example: var options = {node: {label: {bold: true, font: ‘Arial’} …} …}
  
  Declare the options variable
  Open the node options
  Open label category within node options
  Make label font bold
  Set label font to Arial
  Close the node and label sections

• Available option categories
  o Sankey (Node, Link, and Iterations subcategories – Node and Link are shown on next page)
  o Height
  o Width
  o forceFrame
  o Tooltips (can be used to change hover effect)
GOING FURTHER: OPTIONS

sankey: {
  link: {
    color: {
      fill: '#efd', // Color of the link.
      fillOpacity: 0.8, // Transparency of the link.
      stroke: 'black' // Color of the link border.
      strokeWidth: 1 // Thickness of the link border (default 0).
    }
  }
}

sankey: {
  node: {
    label: {
      fontName: 'Times-Roman',
      fontSize: 12,
      color: '#000',
      bold: true,
      italic: false
    },
    labelPadding: 6, // Horizontal distance between the label and the node.
    nodePadding: 10, // Vertical distance between nodes.
    width: 5 // Thickness of the node.
  }
}

• Sankey
  • Link
    • Color
      • Fill
      • FillOpacity
    • Stroke
    • StrokeWidth

• Sankey
  • Node
    • Label
      • FontName
      • FontSize
    • Color
    • Bold
    • Italic
    • LabelPadding
    • NodePadding
    • Width
Multi level Sankey Diagrams are coded in the same manner
  - Keep adding links
  - Logical flow (Example, F10 to F11, F11 to F12, …)
  - Add in order for organization, Google will add them in best fit

SBU migration has hundreds of links
  - Still created in the same manner
  - Pivot tables and concatenate in Excel

Options will be key for Visualization
  - Use node padding and sizing, label padding and sizing
  - Change chart size
## OTHER CHARTS AVAILABLE FROM GOOGLE CHARTS

<table>
<thead>
<tr>
<th>Traditional Graphs</th>
<th>Diagrams</th>
</tr>
</thead>
<tbody>
<tr>
<td>Area Charts (Traditional and Stepped)</td>
<td>Bubble Charts</td>
</tr>
<tr>
<td>Bar Charts</td>
<td>Box and Whisker Plots (Candlestick Charts)</td>
</tr>
<tr>
<td>Column Charts</td>
<td>Calendar Charts</td>
</tr>
<tr>
<td>Combo Charts</td>
<td>Gauge Charts</td>
</tr>
<tr>
<td>Histograms</td>
<td>Geographic Charts</td>
</tr>
<tr>
<td>Intervals</td>
<td>Organizational Charts</td>
</tr>
<tr>
<td>Line Charts</td>
<td>Tables</td>
</tr>
<tr>
<td>Pie Charts</td>
<td>Timelines</td>
</tr>
<tr>
<td>Scatter Charts</td>
<td>Tree Map Charts</td>
</tr>
<tr>
<td>Time Series (Annotated)</td>
<td>Word Trees</td>
</tr>
<tr>
<td>Trend lines</td>
<td><strong>User created community charts are also available</strong></td>
</tr>
</tbody>
</table>
Dashboards allow combination of charts and controls

Controls act as filters
  - Category (Pick from available), String (Search), ChartRange, DateRange, NumberRange
  - Customizable filter options (Examples: starting states, allow one choice only…)

Can use same data source across multiple charts and filters, or multiple data sources

Can control one or many charts with filter; can use multiple filters per chart
Undergraduate Student Degree Outcomes and Major Migration Fall-to-Fall

These charts depict the degree outcomes and major migration of undergraduate students from the census date of a fall semester to the census date of the following fall semester. The charts in part answer the question “where are these students one year later?” Pull-down menus allow for selection of a given year, a specific major/department, and a specific student academic level: U0 (Non-matriculated), U1 (Freshman) 0-23 credits earned, U2 (Sophomore) 24-56 credits earned, U3 (Junior) 57-84 credits earned, U4 (Senior) 85+ credits earned. The bottom chart shows a university comparison for a given year and academic level. It is important to observe that various academic and departmental policies, the distribution of student across academic levels, and time frames will affect these figures and major-to-major comparisons are not valid in many cases.
Department Category Filter set to Applied Math
Year Category Filter set 2013-14

Second pie chart set to only change with “Level” Category Filter
Connecting to Data

- Google charts allows connection to your database with php and a .json file
  - [https://developers.google.com/chart/interactive/docs/php_example](https://developers.google.com/chart/interactive/docs/php_example)

Other Resources for Creating Sankey Diagrams

- D3.js
  - Javascript Visualization library
  - Powerful, with more options than Google Charts
  - More complex
  - [http://d3js.org/](http://d3js.org/)

- Tableau
  - Requires manipulation
  - Not flexible, very complicated
• Thank you!

• Examples will be posted on our Webpage within the next week
  o http://www.stonybrook.edu/commcms/irpe/dashboards/viz.html

• Contact information
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