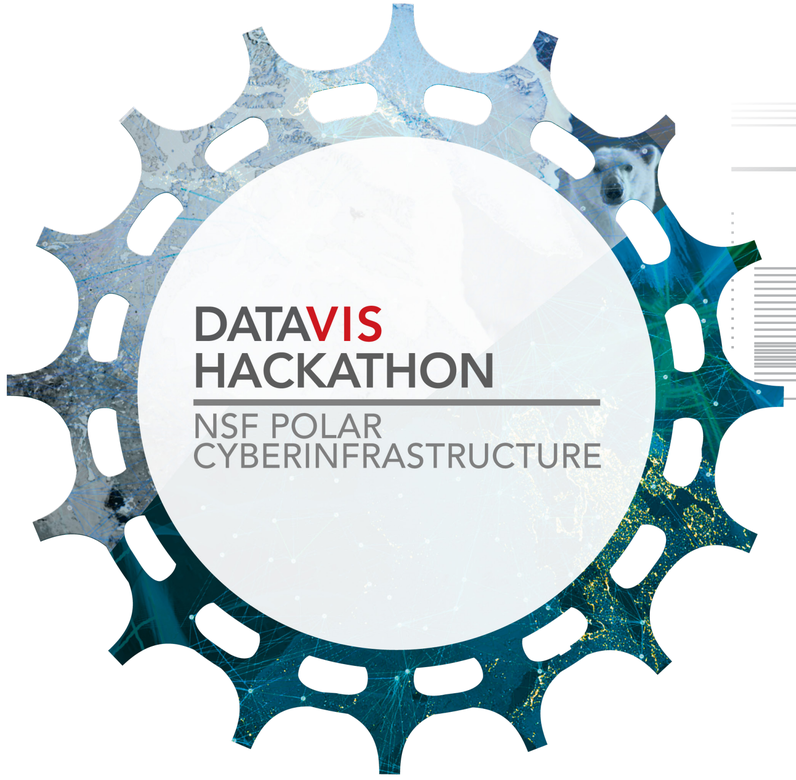


WELCOME!

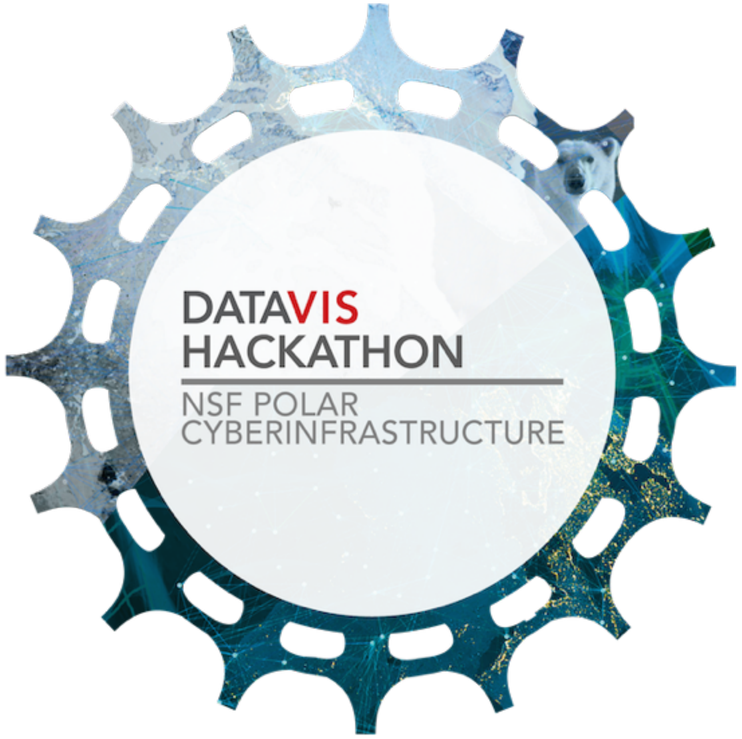
During your visit to the historical Orozco room, please do not touch the murals, move chairs or tables against them or post anything on the walls.

Thank you for your cooperation.

SPONSORS

HOSTS

CONTRIBUTORS



Data Visualization and Immersive Interfaces

Curtis Lisle, Ph.D.
CEO, KnowledgeVis, LLC,
Maitland, FL
curtislisle@knowledgevis.com

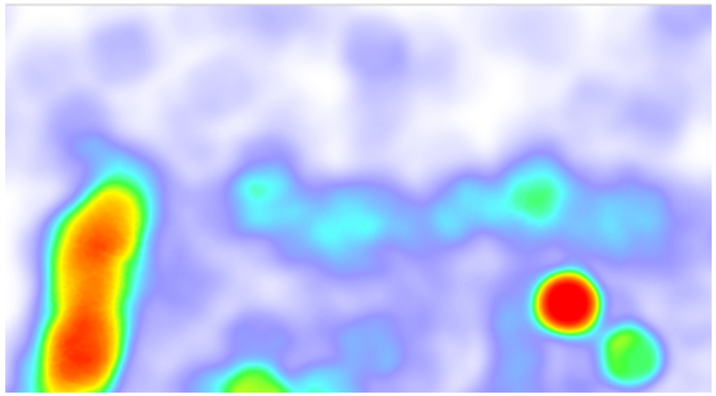
My Background and Thanks

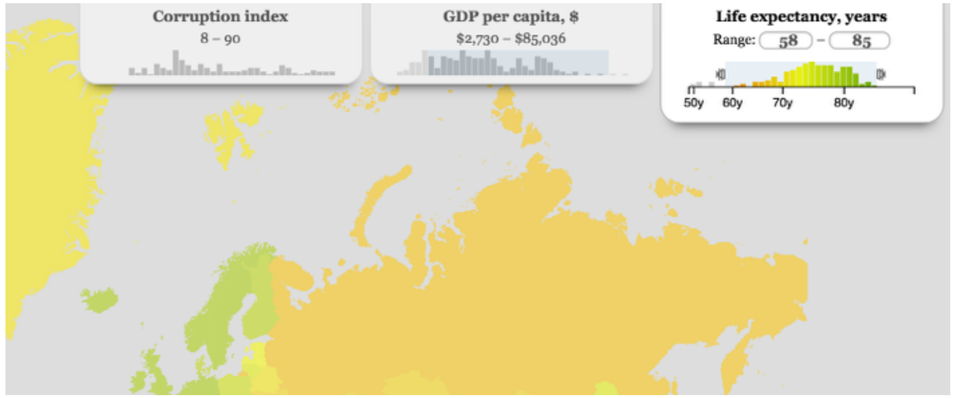
- Thanks to NSF, JPL, and the New School for organizing
- My background in EE and CS was focused in graphics hardware and algorithms as a GPU designer
- Cartography experience researching flight simulator databases (remote sensing imagery, DEMs, polygonization for real-time displays)
- Now that graphics hardware (and the web) is very capable, it is more about what interactive interfaces are now possible

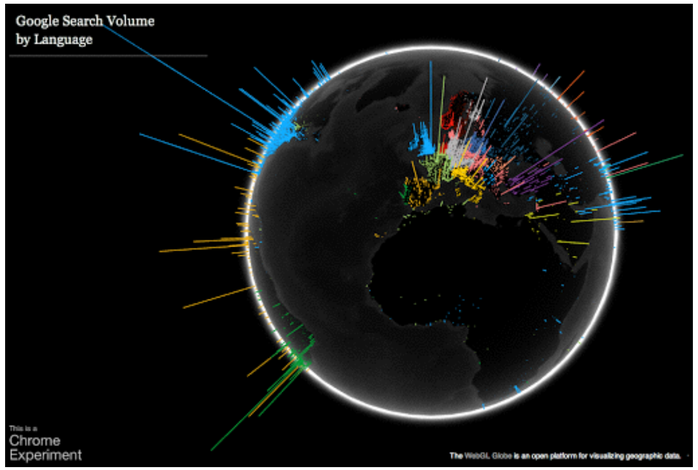
Exciting Time for Visualization

- Visualization technologies are developing rapidly (WebGL, interactive web pages, OpenGL on mobile platforms)
- Open-source alternatives to proprietary data processing products (QGIS, GDAL)
- Data scientists have better ways to analyze and convey discoveries to colleagues and to the public

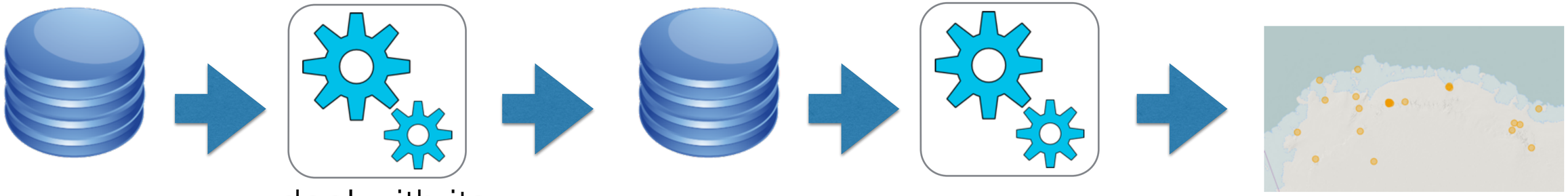
- Lets do a tour of the data visualization process to illustrate…







The “Viz" Process



take some raw data

deal with its peculiarities (well, some of them)

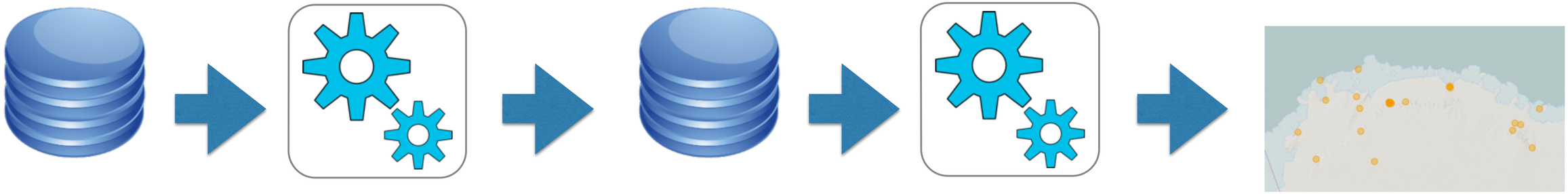
“clean” data

transform for rendering (address more peculiarities)

visualize! (finally)

- many times there are different experts for each part of the pipeline
- So what happens **inside the arrows,** anyway?

Fortunately, Big Pieces are Available



raw data

clean and fix

data wrangler

openRefine

QGIS

GDAL

…

“clean” data

transform for rendering

faceted views (Solr)

aggregation (mongo)

datacubes

geopandas

…

visualize!

OpenGL, webGL

d3, vega

bokeh, tangelo

ggplot, ggvis

…

Processes by Polar Datatype

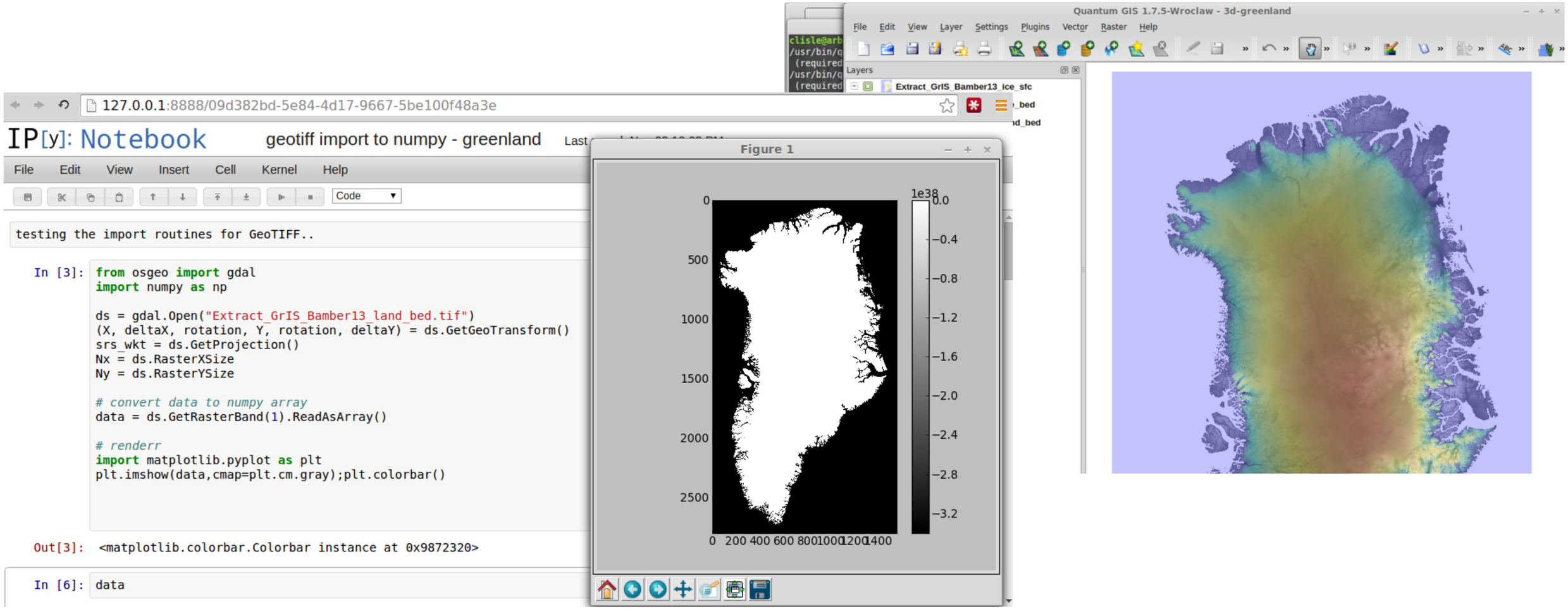
Datatype	Conditioning	Transform	Render
Geospatial Imagery	orthorectify,camera model, stitch together	map projection, tile set generation	image maps (Google Earth)
Time Sequence Data (climate conditions)	fill in missing, extrapolate, normalize	adjust for time zone, derived data (calc averages, std. dev)	plots, pie, line, bar charts, choropleth
DEMs (digital elevation)	smooth, resample, hole fill, stitch together	map projection, TIN (triangulate),	perspective rendering, 3D printing
cartographic features	downsample	project to different coord. system	layers on “slippy" maps (Gmap)
analytical model output (n-dimenions)		dimension reduction, classification	cluster rendering (2D or 3D), plots

Solutions by Polar Datatype

Datatype	Conditioning	Transform	Render
Geospatial Imagery	GDAL, OSSIM, QGIS	mapnik (tiling), QGIS	image maps, Google Earth, World Wind, oculus, osg
Time Sequence Data (climate conditions)	R libraries, openRefine, GMT	faceting, aggregation,	d3, vega, ggplot, raphael, tangelo
DEMs (digital elevation)	VTK, vterrain.org, GMT	map projection, TIN (triangulate),	scene graphs, Cesium, three.js
cartographic features	downsample, project	QGIS, SAGA GIS, etc.	layers on “slippy" maps (Gmap)
analytical model output (n-dimenions)	custom coding (R, python, java, Hadoop)	dimension reduction, classification, scipy	NanoCubes, clustering, vtkweb…

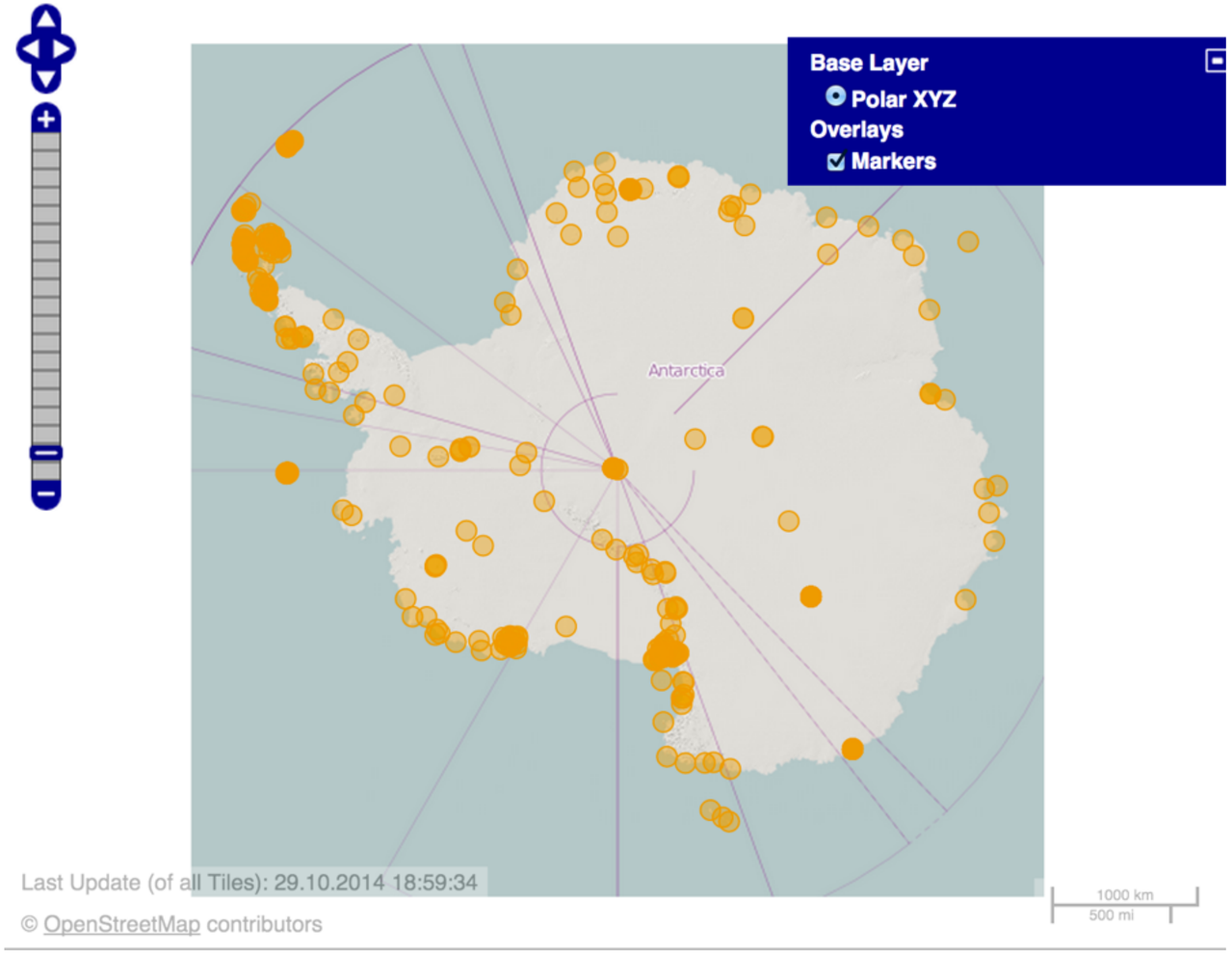
Digital Elevation Example

- Reading the 3D greenland dataset from github using iPython and QGIS



Projections for polar regions

- polar regions require special mapping projections
- Some graphics and viz people don't understand projections & cartography; check out your CS collaborators carefully :-)
- openLayer Antarctica solution example polar.openstreetmap.de



Web is replacing (has replaced?) native apps

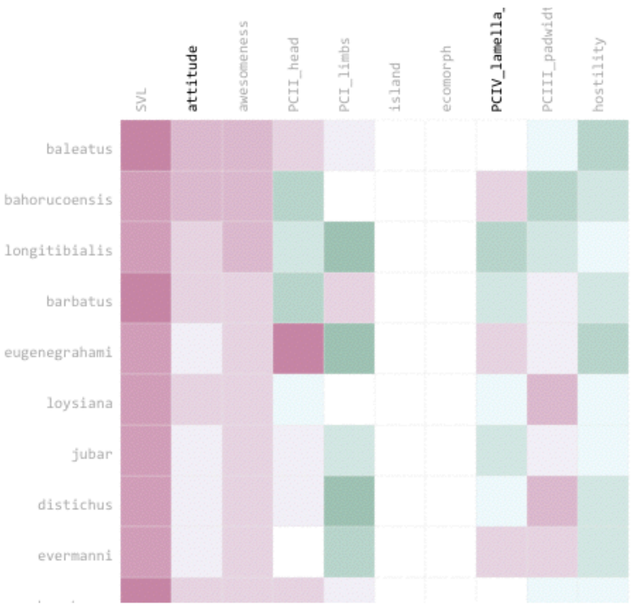
- For me, it happened quickly about 18 months ago with an NIH client:
  - Everything new is web-based development instead of native apps

- **Benefits**: DOM is powerful and interactive; URL references to local/remote resources; HTML5 is powerful; good debugging/runtime environments in modern browsers; broadly available to users, collaborators, and the public

- **Missing**: OpenGL performance, native file system access; until recently, web UIs had less widget support

Good days for web visualization

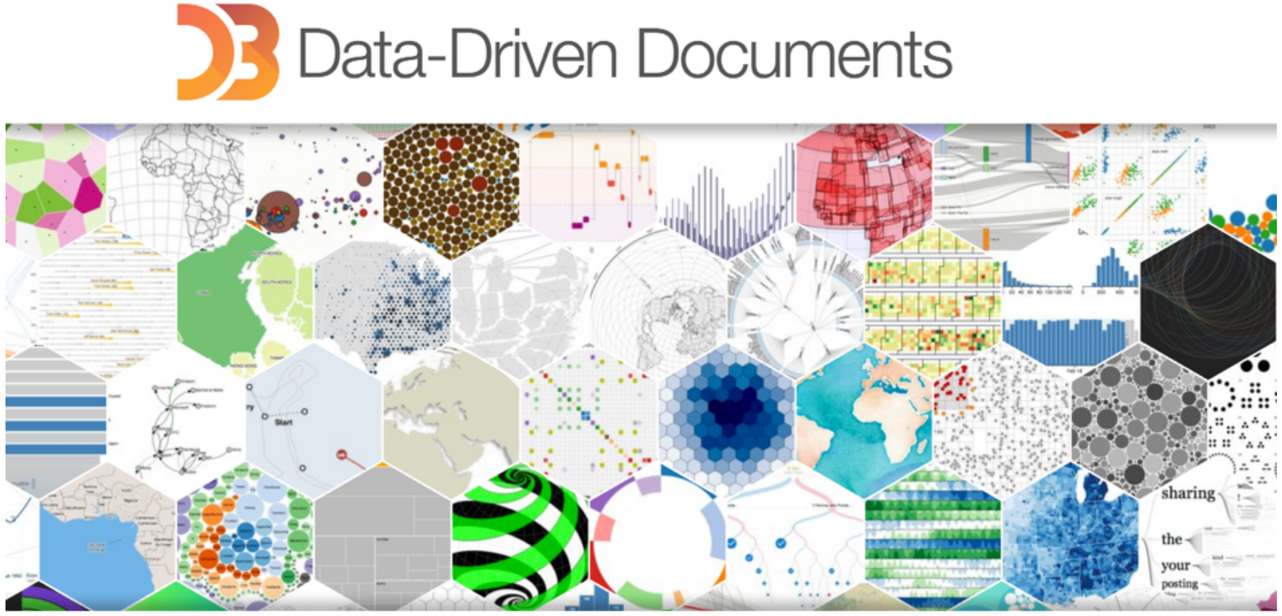
- Exciting technologies are now available for interactive web visualization
- **D3** - (d3js.org) data-driven documents; this is quite popular currently and becoming one of the most popular libraries of all time
- **Vega** - (http://trifacta.github.io/vega/) declarative definition for a visualization; dynamic connection to data
  - try to make it easier to do d3-like things
  - still be low-level enough to embed in a product or web page
- **webGL** - OpenGL running in the browser (threejs.org)



interactive heatmap with d3

D3 - data driven documents (d3js.org)

- extremely popular low-level javascript library for generating interactive visualizations embedded in web pages.
- overview - D3 creates and maintains a binding between data items and corresponding elements in the browser's DOM (document object model). Dynamic creation/modification/ deletion of visual elements
- D3 supports many cartographic projections

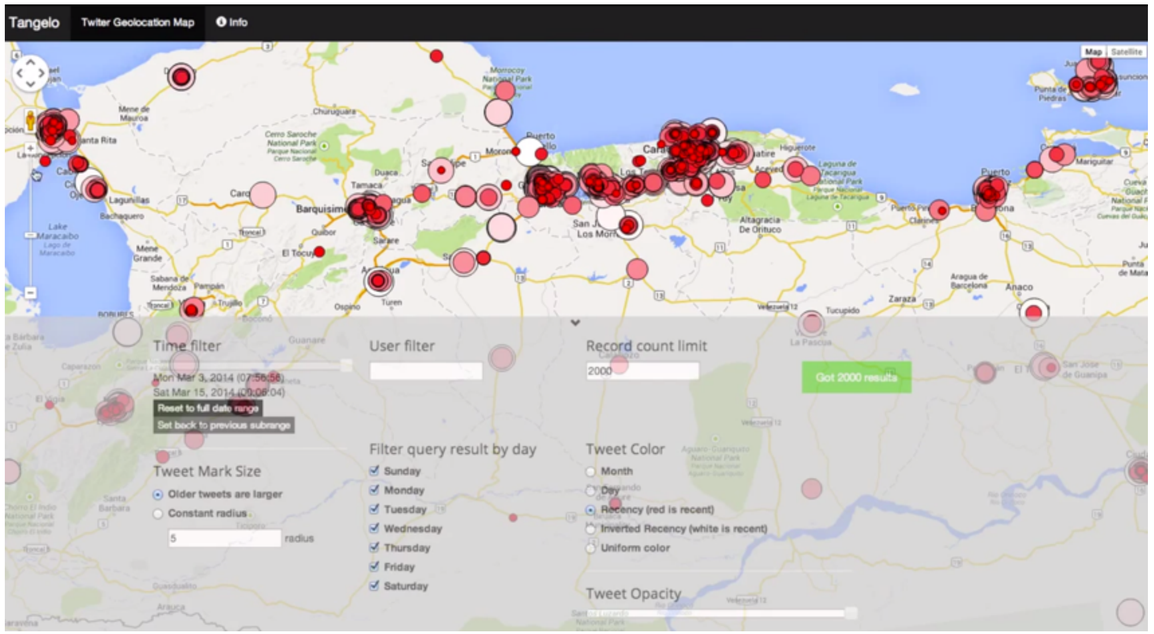


A Recent D3 example

- georeferenced tweets are pulled dynamically from mongoDB and plotted; users browse the marks, read full text, and change search criteria; (geocoded time sequence data)

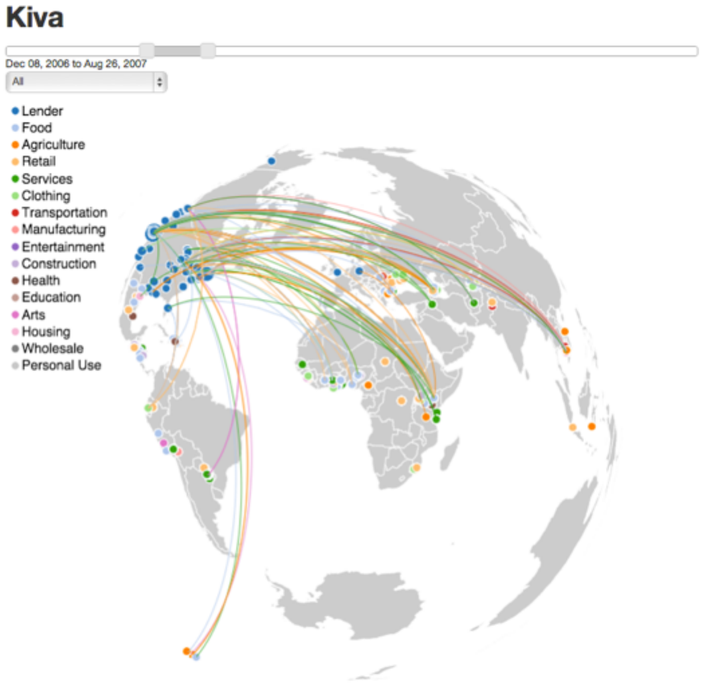
- A network of related individuals is inferred through analysis of tweeters who mention others by name in the tweet text. Local history of search results maintained.

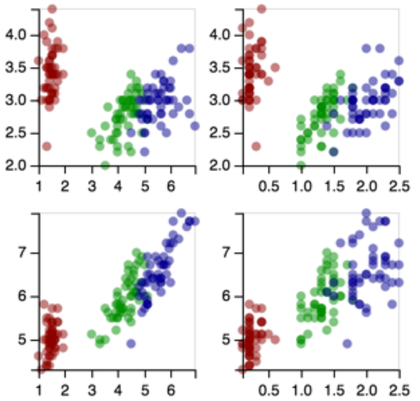
- check out my YouTube channel: https://www.youtube.com/channel/UCyME5r9zgkmI6ApRrKFu_pA

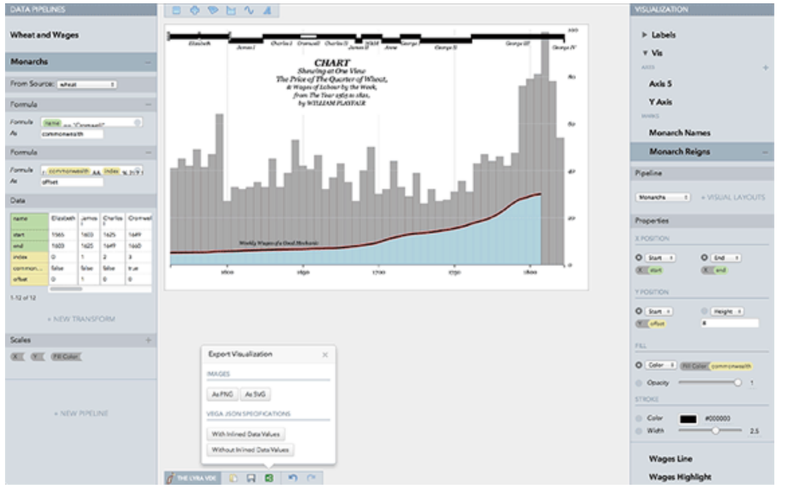


Vega (trifacta.github.io/vega)

- Declarative technology for mapping data to rendering
- Abstraction above D3, but still a low-level type of “grammer of graphics”
- Vega used as engine for ggvis (R)
- ‘Reactive Vega’ in development to improve interactivity; extending the grammar
- Lyra (interactive interface for generating Vega specs

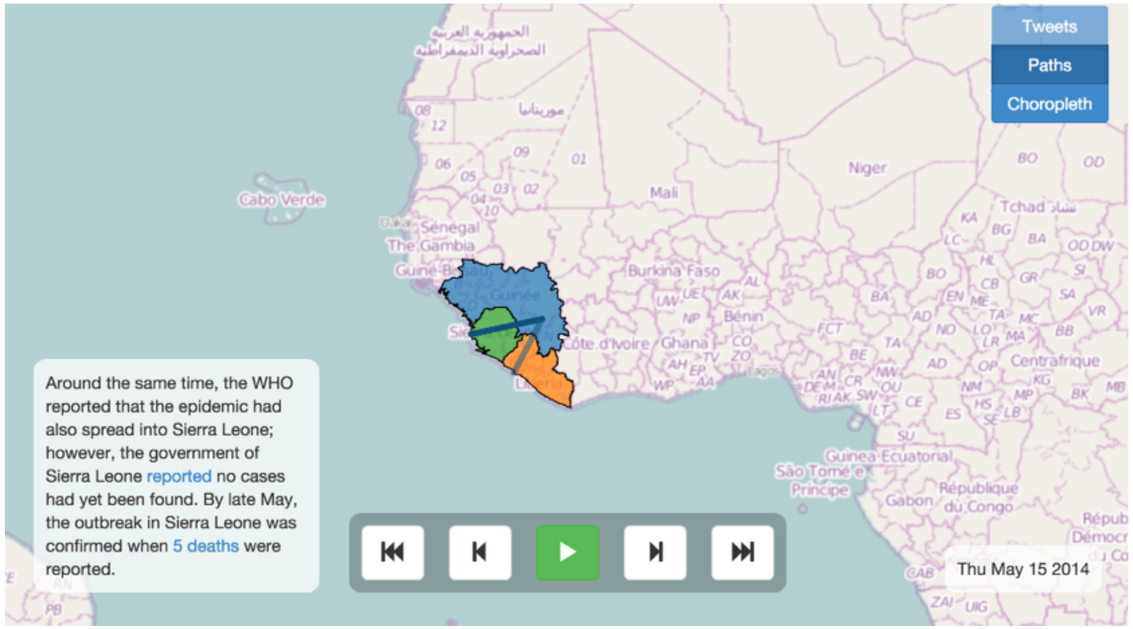






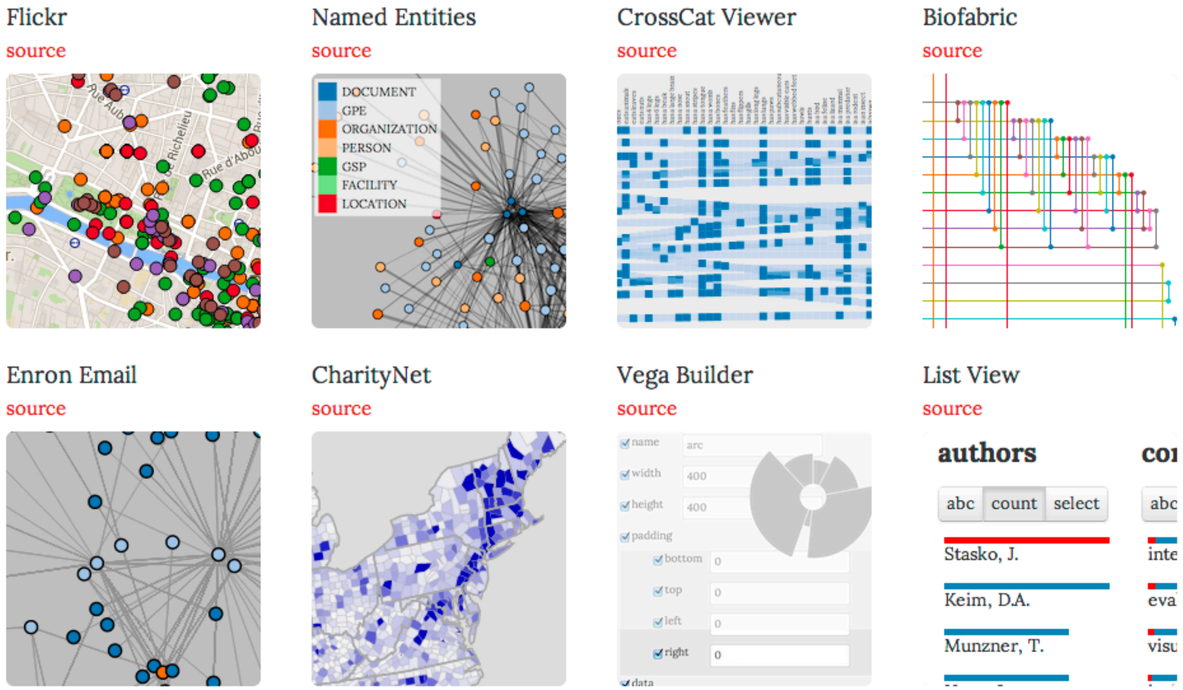
Geojs

- Open source multilayer map designed to combine imagery, openLayers tiled layers, and animated features together in an interactive map.
- WebGL used for rendering option results in better performance
- Configurability of renderers; each layer can have its own renderer (D3, webGL, etc.).
- github.com/OpenGeoscience/geojs



Tangelo (TAN-jə-loh) *n.* a rapid, powerful, visual web

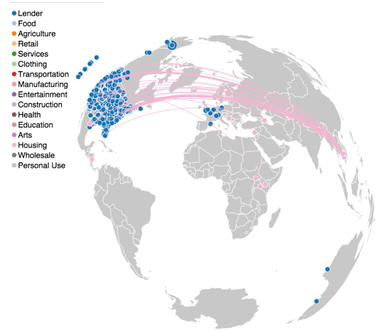
- A lightweight framework for creating interactive web applications over big data
- mongoDB is the the primary input data connector
- Computation is done is Python, page layout and interaction in jQuery/ JavaScript
- Developed by collaborator, Kitware, Inc.
- http://kitware.github.io/tangelo/



Tangelo example gallery

Tangelo (TAN-jə-loh) *n.* a rapid, powerful, visual web

User-interface (HTML/jQuery) →



AJAX calls from Javascript to custom Python-based services →

App UI Logic (JS)

Computationally-expensive processing is implemented in Python services →

Services (Python)

Python queries mongoDB through pymongo →

mongoDB or REST endpoint serves data →

mongoDB

REST APIs

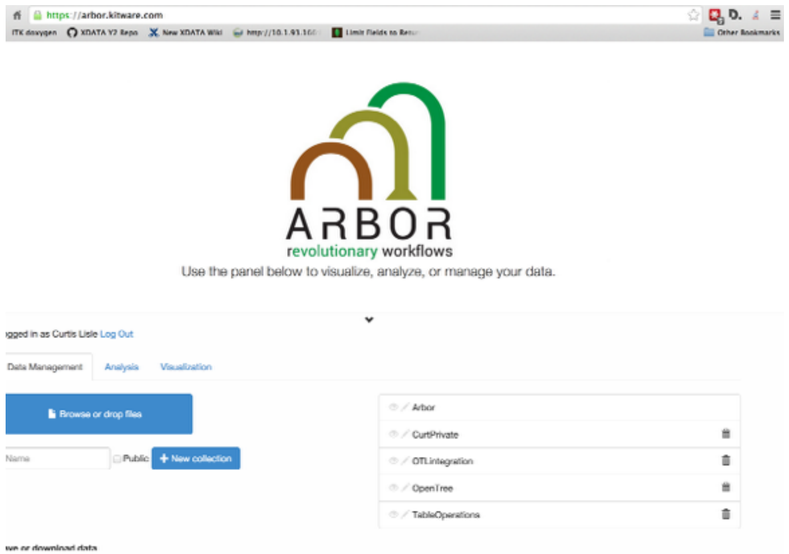
Workflow processing: Arbor / Tangelo-Hub

- In collaboration with Kitware, I am building Arbor, a web-hosted, multistep workflow system for scientific analysis
- This NSF funded Biology application is the first full application built on this technology.
- A non-programming biologist recently used it successfully in a hackathon setting

click for Arbor Demonstration Videos

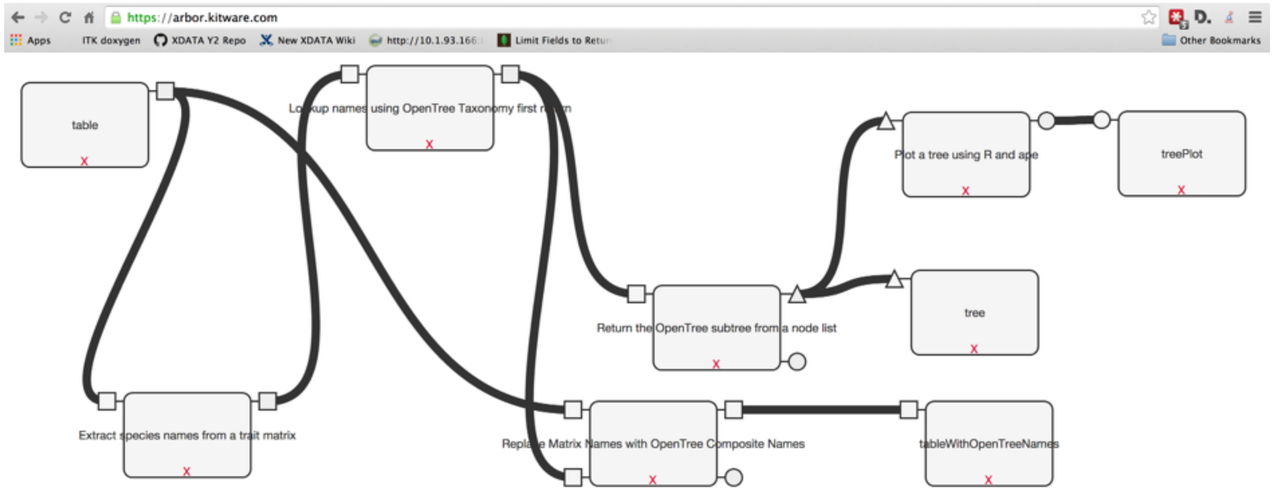
http://arborworkflows.com

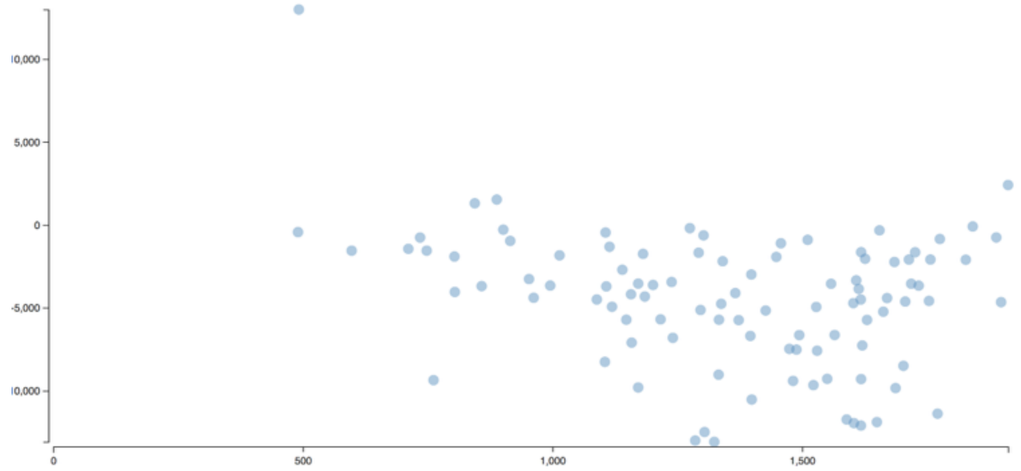
http://arbor.kitware.com



Tangelo-hub: Create and Edit Workflows

- Define and run R or python work steps interactively through the web UI
- simple plotting is supported through the interface



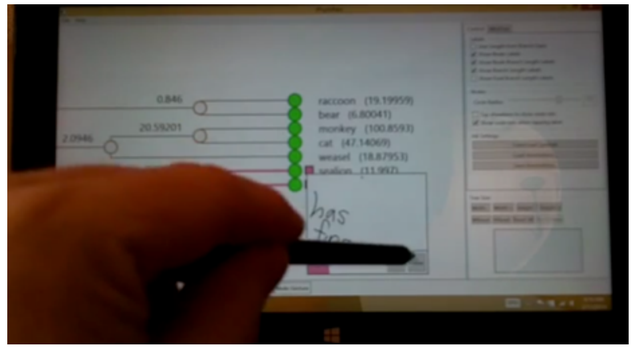


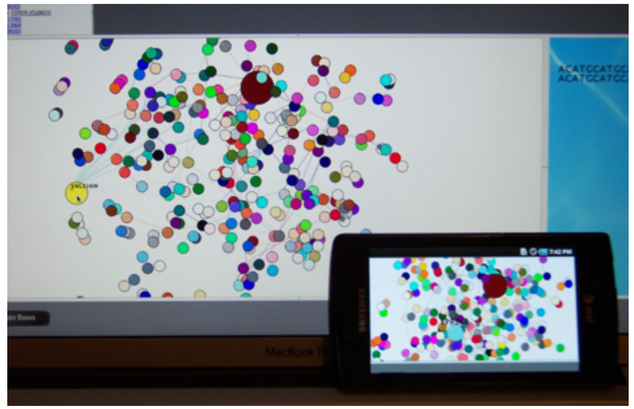
https://github.com/tangelo-hub

http://arborworkflows.com

Future Trends

- multitouch (maybe even stylus) interfaces are on the rise
  - hierarchy tree demo video by a UCF student, Anthony Wehrer (see at right)
- I believe many future apps will develop voice command interfaces
- mobile will become the prevalent interface device
  - apps will be augmented by hardware accelerated OpenGL running natively. Mobile devices will be like first-class workstations with native rendering
  - Use a multi-platform approach to support web and mobile





demo

stationName	stationNumber	stationLat	stationLng	stationElevation	time	temp	pressure	wind_speed	wind_direction	humidity	delta_t
Baldrick	9116	82.46S	13.03W	1968	0	-42.2	775.9	7.5	72	53.8	444
Baldrick	9116	82.46S	13.03W	1968	3	-42.8	776.1	7.9	76	53	444
Baldrick	9116	82.46S	13.03W	1968	6	-41.4	776.3	8.6	75	54.4	444
Baldrick	9116	82.46S	13.03W	1968	9	-40.6	776.7	7.8	76	55.4	444
Baldrick	9116	82.46S	13.03W	1968	12	-40	776.9	8.6	76	56.1	444
Baldrick	9116	82.46S	13.03W	1968	15	-41.3	776.6	7.8	82	54.8	444
Baldrick	9116	82.46S	13.03W	1968	18	-42.3	776.8	7.1	82	53.6	444
Baldrick	9116	82.46S	13.03W	1968	21	-42.5	776.6	9.8	87	53.3	444
Baldrick	9116	82.46S	13.03W	1968	24	-43.1	776.4	10.1	84	52.6	444
Baldrick	9116	82.46S	13.03W	1968	27	-43.7	776.2	10.5	82	51.9	444
Baldrick	9116	82.46S	13.03W	1968	30	-43.6	775.6	11.8	79	51.9	444
Baldrick	9116	82.46S	13.03W	1968	33	-44.2	775.7	10.4	81	51.3	444
Baldrick	9116	82.46S	13.03W	1968	36	-44.9	775.6	10.7	83	50.5	444

Logged in as Girder Admin Log Out

Data Management Analysis Visualization

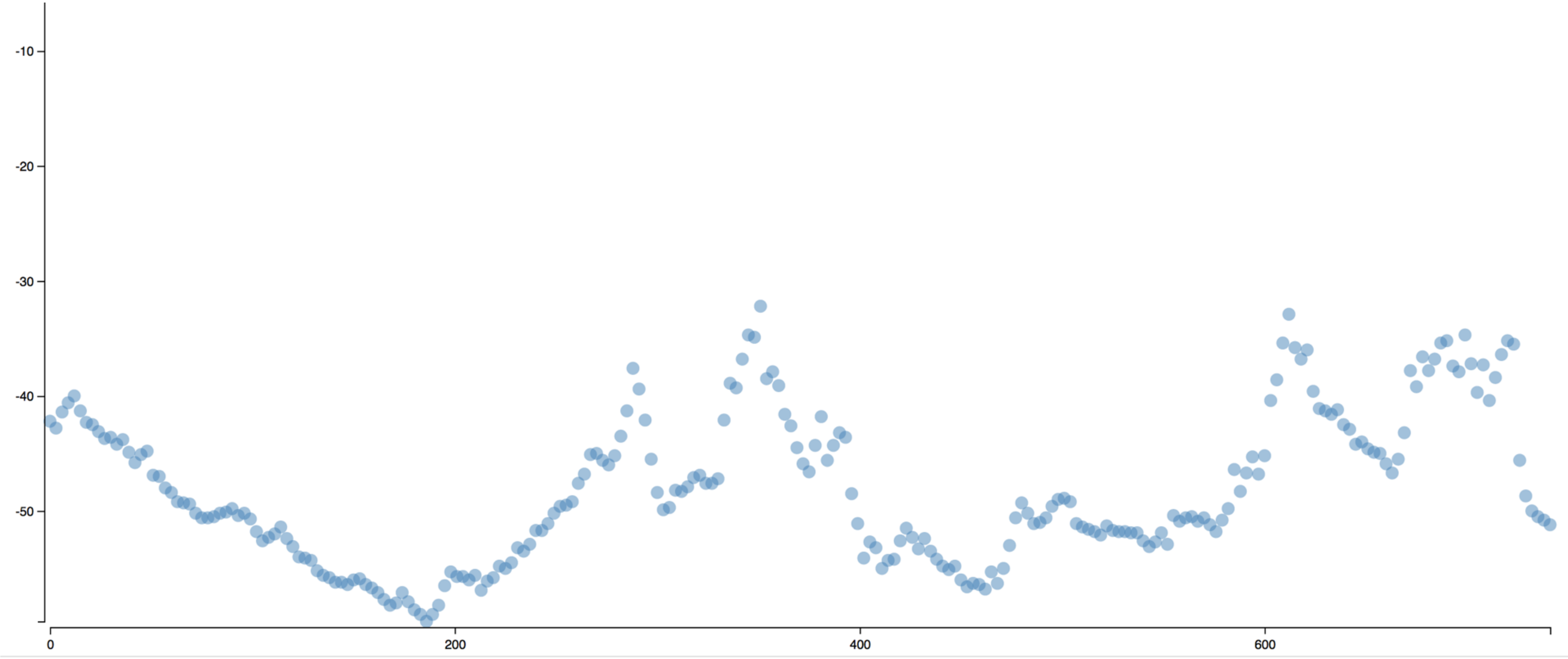
Select visualization

table

data

9116-0514.csv (Polar)

Update


-10
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-30
-40
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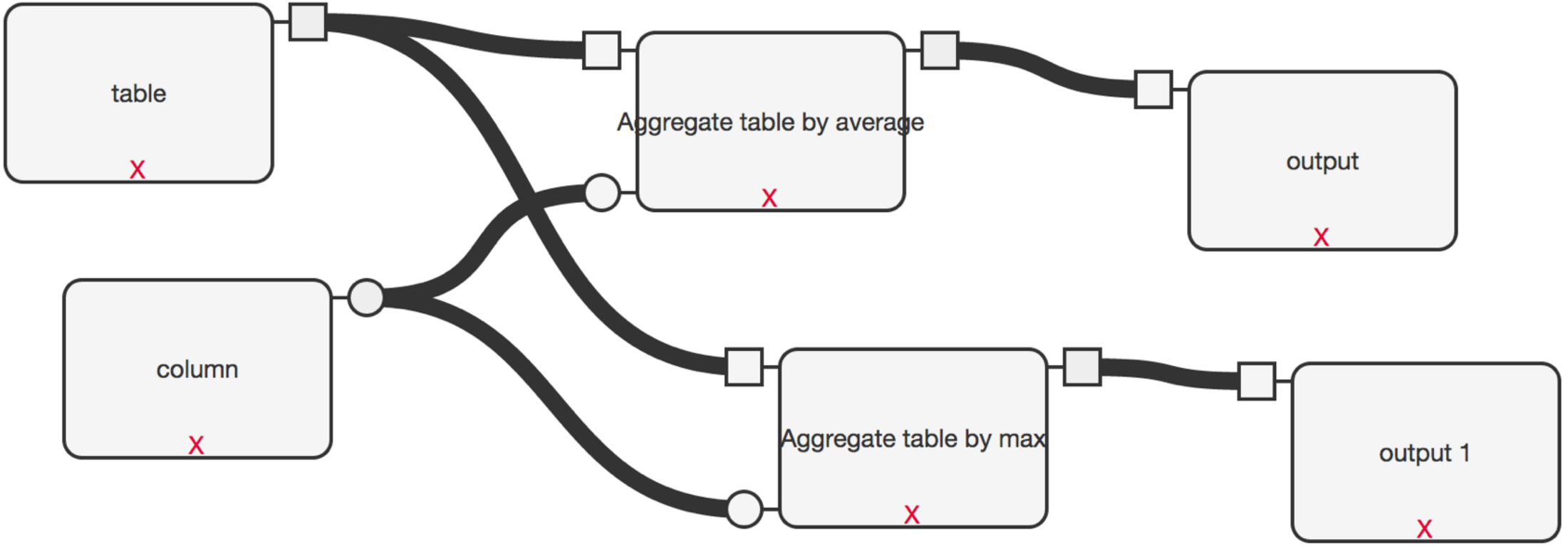
table
X
Aggregate table by average
X
output
X
column
X
Aggregate table by max
X
output 1
X

stationName	stationNumber	stationLat	stationLng	stationElevation	time	temp	pressure	wind_speed	wind_direction	humidity	delta_t
Baldrick	9116	82.46S	13.03W	1968	741	-32.2	784.2	444	444	64.9	444
Dome	-9e+50	82.33S	75.99E	4027	741	444	999.9	444	444	444	444
Vito	8695	78.47S	-9e+50	50	741	-12.9	999.7	444	444	444	444
Eric	8697	81.50S	-9e+50	45	741	444	999.6	444	444	444	444
Harry	8900	83.00S	-9e+50	945	741	-10	885.5	444	444	444	444
Byrd	8903	80.01S	-9e+50	1530	741	-16.2	821.4	444	444	85	444
Dome	8904	77.31S	39.71E	3810	741	-47.8	612.7	444	444	-50	10.8
Manuela	8905	77.44S	-9e+50	78	741	-9.9	995.8	36.3	307	85	444
Marble	8906	77.44S	-9e+50	108	741	-4.5	991.8	14.9	357	444	444
Marlene	8908	83.65S	-9e+50	82	741	-10.1	994.3	24	329	93	444
Margaret	8910	80.00S	-9e+50	67	741	-13.2	993.5	444	444	90	444
Gill	8911	79.88S	-9e+50	53	741	-16.9	995.8	444	444	82	444
D-85	8912	70.43S	-9e+50	2651	741	444	712.7	444	444	444	444

Logged in as Girder Admin Log Out

Data Management | Analysis | Visualization

Select visualization

table

data

workflow_aggregation output 1

Update

Thank you!