

3D to 3D: New Dimensions of Data Representation

VISUAL ANALYTICS LABORATORY

Dr. Sara Diamond, OCAD University

ISS, Immersive Visualization



OCAD UNIVERSITY



The University of the Imagination

140 years old.

The largest and most comprehensive art, design and media university in Canada and 3rd largest in North America. 4700 UG and graduate students.

Grounded in historical focus on art, design, media, and cultural and social theory.



R & D activities focus on four main areas

- **Visual Design:** Developing new ways to tell stories with data through unique visual representations is the key research focus of the lab. Depiction of complex patterns and relationships through appealing visuals enables better information delivery.
- **Analytic Methods:** VAL's researchers design software and methods that guide users in exploring and gaining valuable information from visual representations. By these visualizations, users can create and test hypotheses, communicate results, and challenge assumptions.
- **Natural User Interactions:** At VAL, the team explores emerging multimodal techniques and hardware for developing natural interfaces that brings users closer to their data than ever before. The team creates new interactive visual environments for the web, mobile devices, and desktop applications.
- **User Experience:** The ultimate goal of VAL is to help people work with information. The user-centered design approach used in the lab includes collaborating closely with users to understand their problems, test solutions, and deliver usable and useful software products.



Visual Analytics Lab

Team Members

Director:

Dr. Sara Diamond

Research Faculty:

Dr. Isabel Meirelles

Dr. Martha Ladly

Dr. Patricio Davila

Greg Van Alstyne

Jeremy Bowes

Dr. Peter Coppin

Karin Von Ompstead

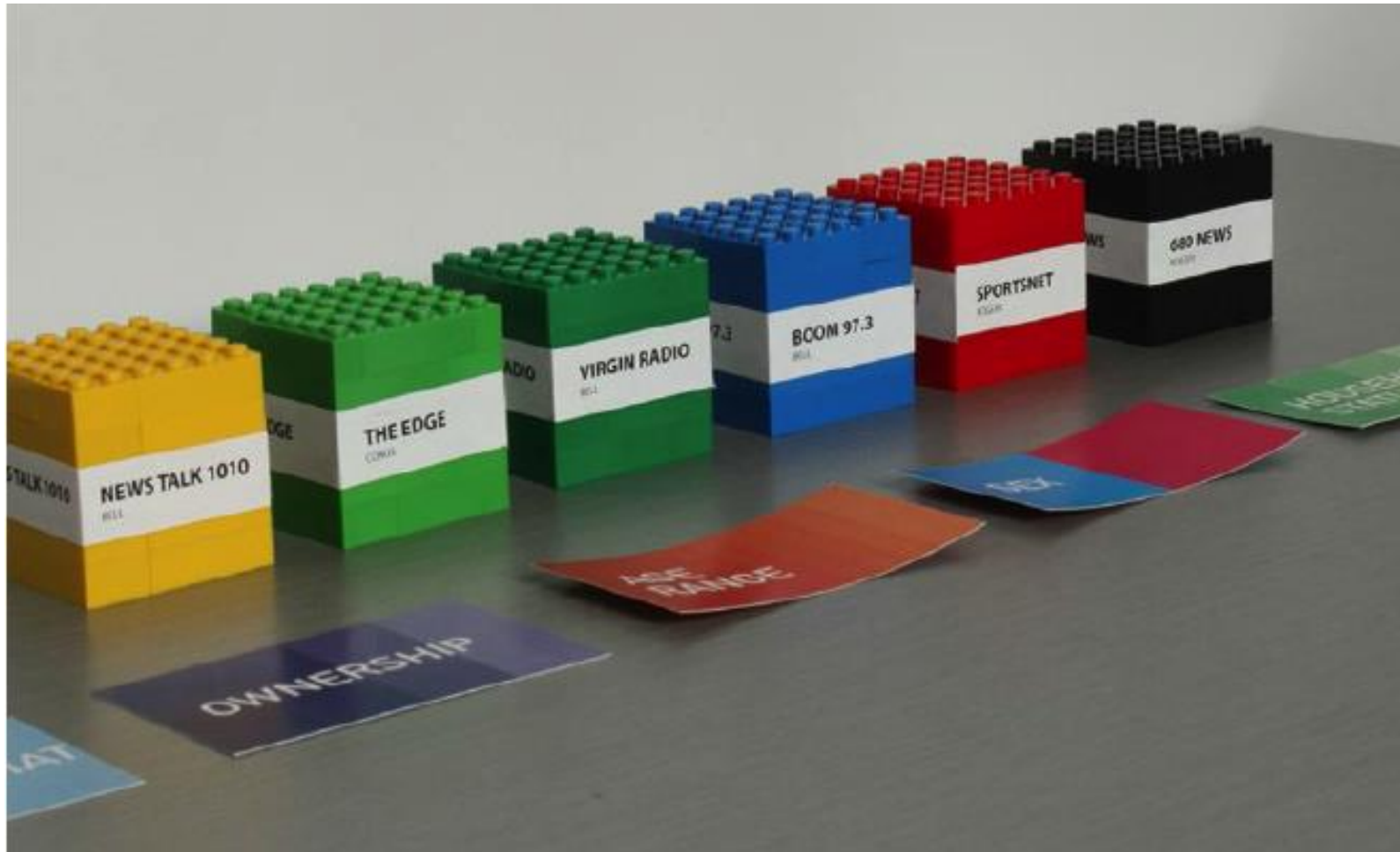
Francis Le Bouthillier

Research Fellows:

Dr. Steve Szigeti

Dr. Ana Jofre

Dr. Carl Skelton



Szigeti, S., Stevens, A., Tu, R., Jofre, A., Gebhardt, A., Chevalier, F., Lee, J. & Diamond, S. (2014) Output to Input: Concepts for Physical Data Representations and Tactile User Interfaces. Proceedings of CHI14 Works-in-Progress (Toronto, ON).

Users generate graphs of radio station data by placing objects onto a table. Objects control which radio station we view as well as how the data is broken down.

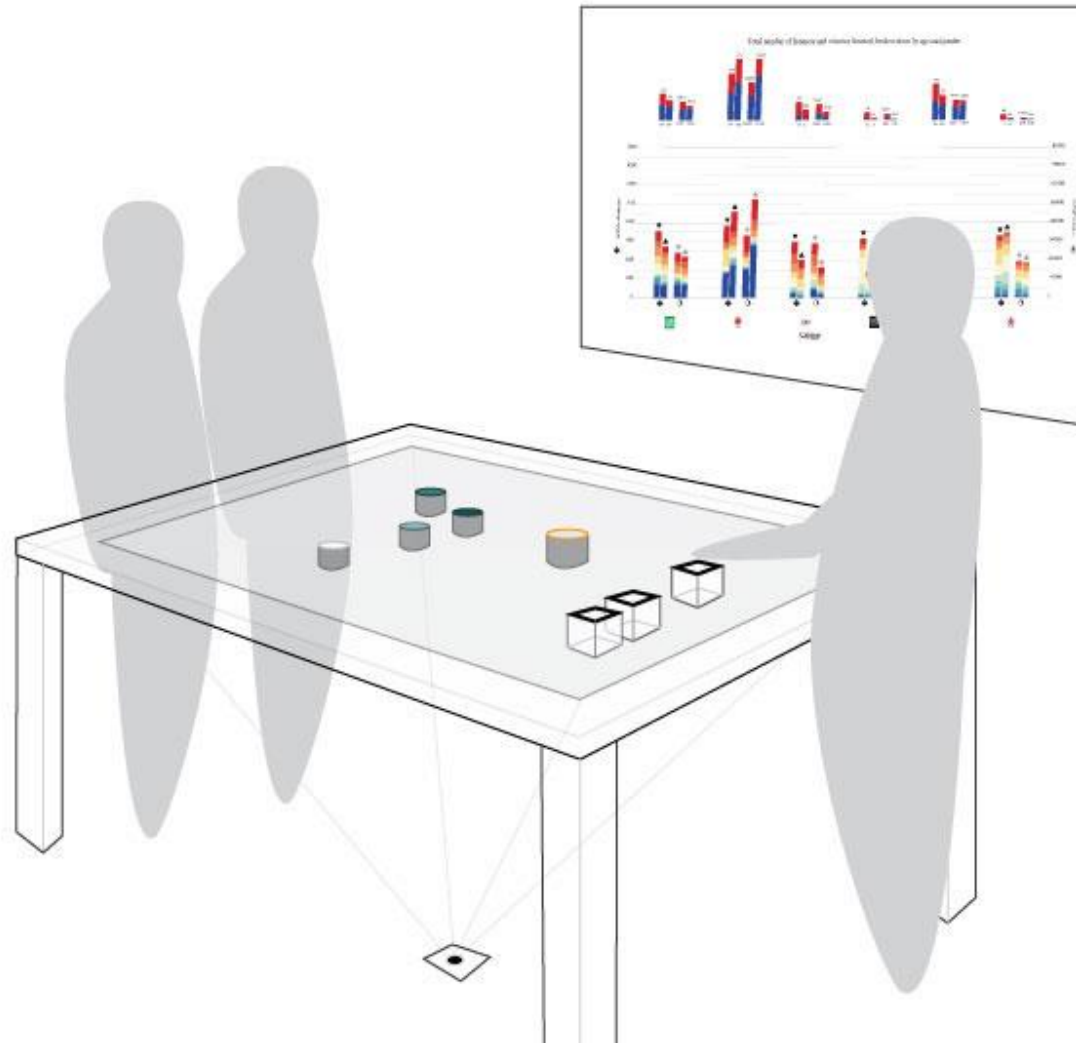


Users generate graphs of radio station data by placing objects onto a table. In this test, the data is embedded into the tangible interface, as the size of each representative radio station block is related to how many listeners it has and the amount of minutes listened.



Jofre, A. Szigeti, S., Tiefenbach-Keller, S., Dong, L.-X., Tomé, F., Czarnowski, D., Diamond, S. (2015) "A Tangible User Interface for Interactive Data Visualization" Proceedings of the 2015 Conference of the Center for Advanced Studies on Collaborative Research. IBM Corp., CASCON2015, November 2-4, 2015, Toronto, Ontario.

Users generate graphs of radio station data by placing objects onto a table – 2nd prototype. Objects control which radio station we view as well as whether to view the station's number of listeners or minutes listened or both. The data can further be broken down by age and gender by placing each of the representative objects on the table.

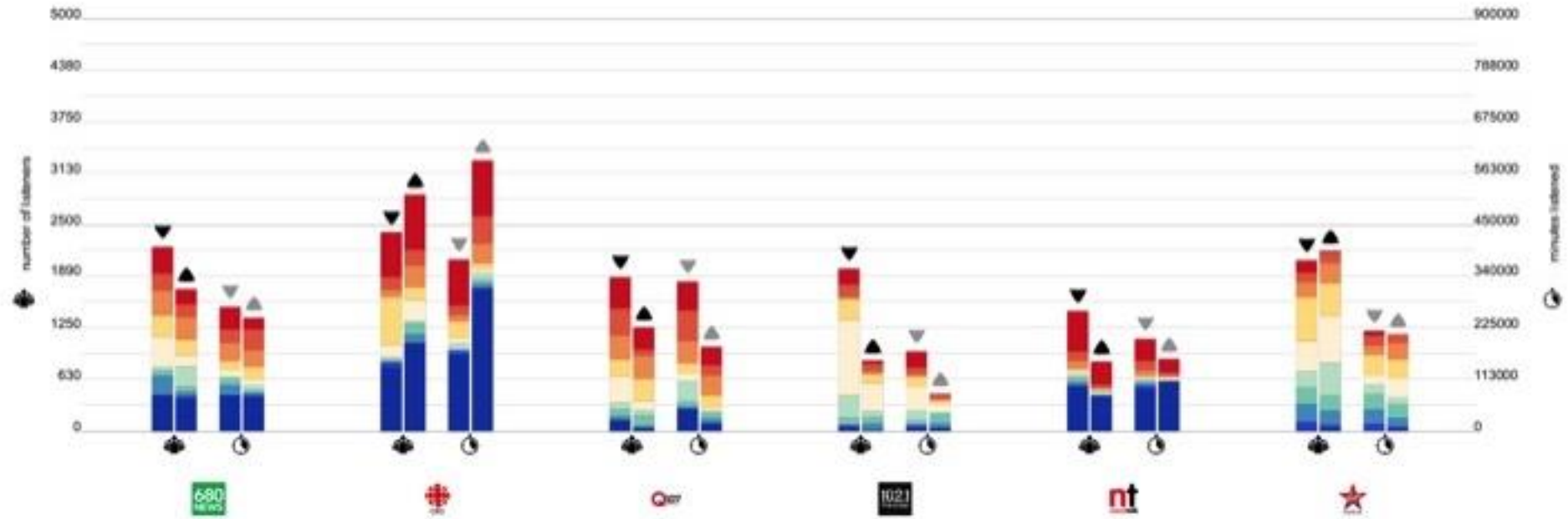


Users generate graphs of radio station data by placing objects onto a table. Objects control which radio station we view as well as whether to view the station's number of listeners or minutes listened or both. The data can further be broken down by age and gender.



Fully functional prototype of the tangible interface presented at CHI Interactivity 2016 (San Jose May 7-12, 2016).

Jofre, A., Szigeti, S., Tiefenbach-Keller, S., Dong, L.-X., Diamond, S. "Manipulating Tabletop Objects to Interactively Query a Database" (2016) CHI'16 Extended Abstracts (Chi 2016 San Jose May 7-12)



Our tangible user interface has applications in education contexts.

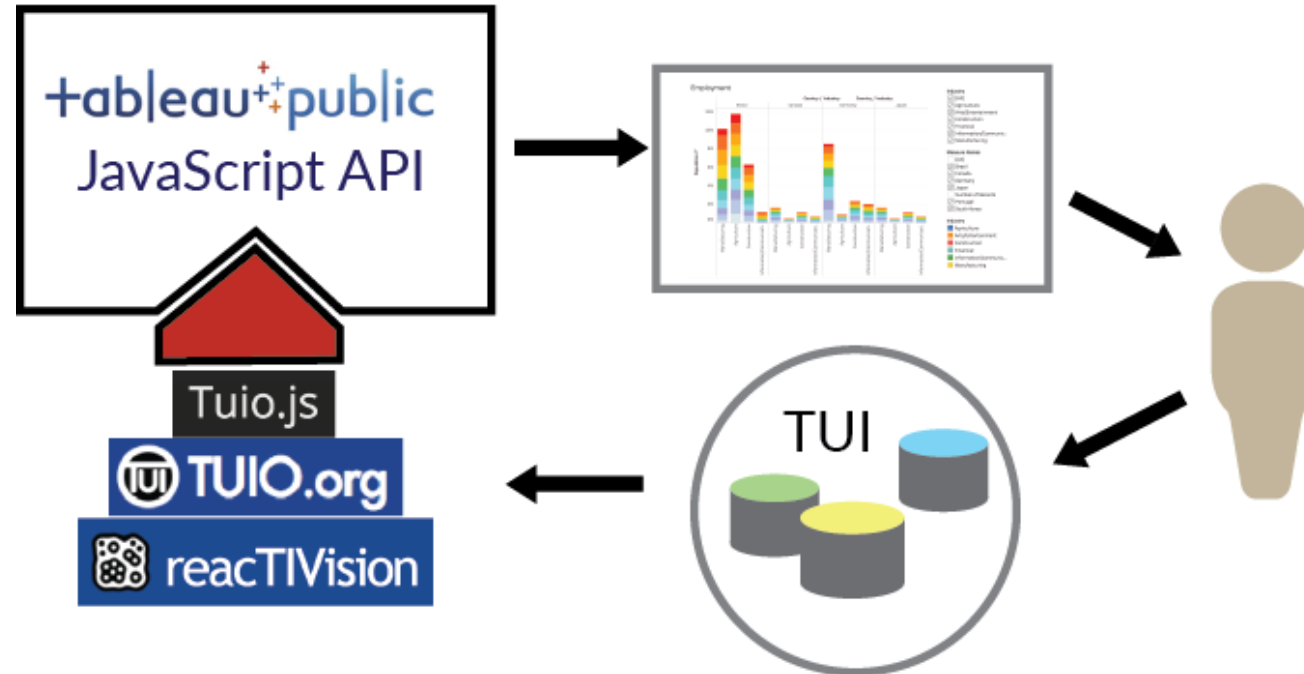
Jofre, A., Szigeti, S., Diamond, S. "Citizen engagement through tangible data representation" Foro de Educación (January-June 2016) vol. 14, n. 20

Generic Tangible Front-End for Manipulating Visualizations on a Browser

Ana Jofre, Stephen Teifenbach-Keller, Lan-Xi Dong, Steve Szigeti, Sara Diamond

Part 1:

b) TUIO protocol for Javascript and Tableau



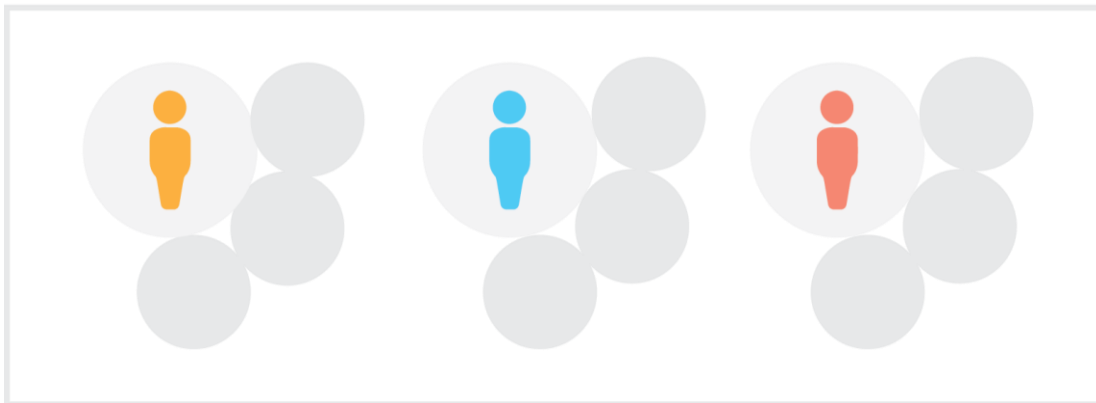
<http://protium-labs.co/Tuio.js/>

file:///Users/ajofre/Desktop/TUIOTableau_Visualization-CHI.html

Part 2: Presentation Models for NLOGIC Data The 'Persona' Model

Use the attributes to build a persona.

Visualize the data for each persona.



Personas



Listener 1



Listener 2



Listener 3

Gender

Male

Female

Age

2-6

7-11

12-17

18-24

25-34

35-44

45-49

50-54

55-64

64+

Occupation

1

2

3

4

5

6

7

8

Education

1

2

3

4

5

6

Female

x

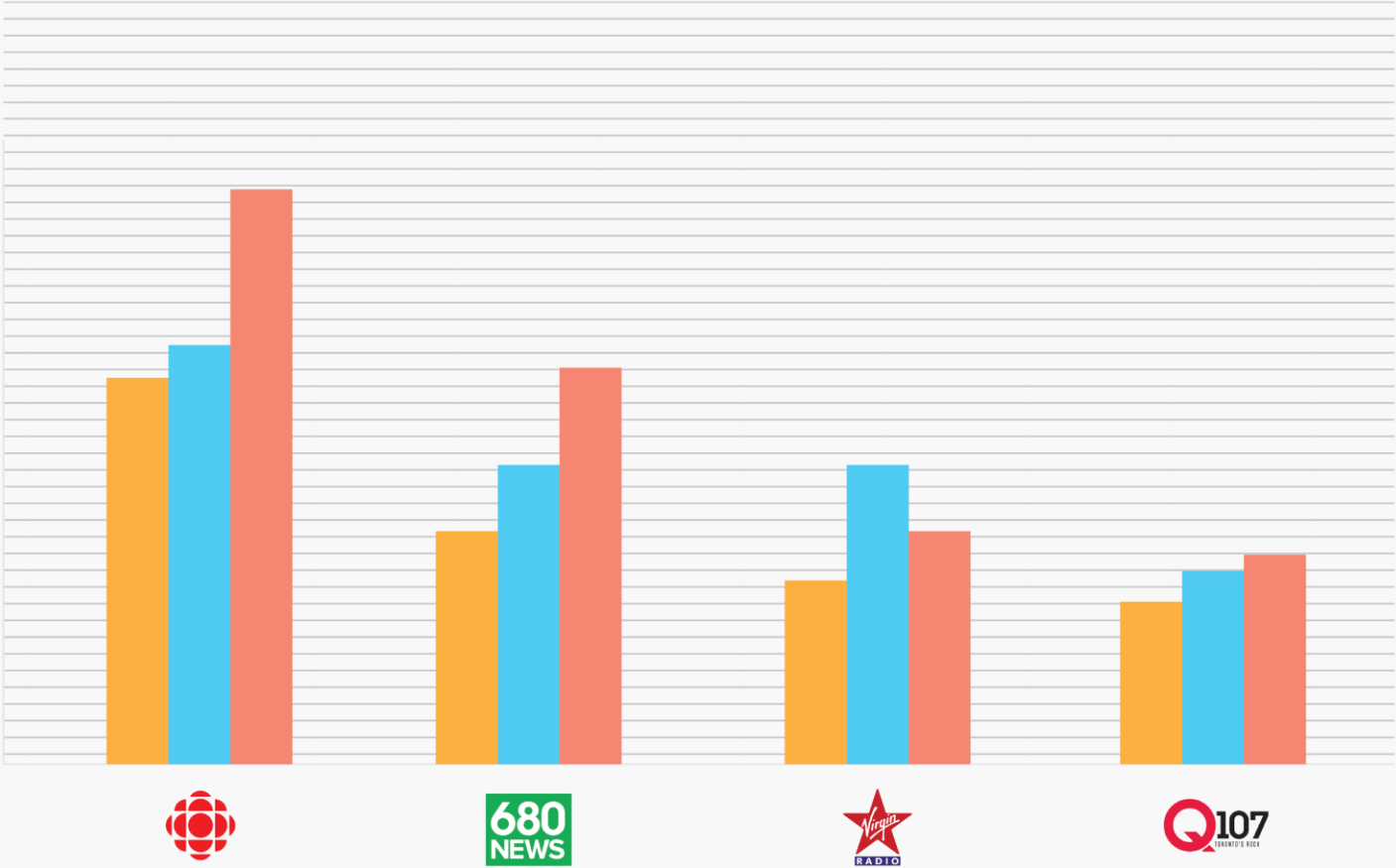
Age 55-64

x

Occupation 5

x

NUMBER OF LISTENERS



Personas



Female x Age 55-64 x

Occupation 5 x



Male x Age 18-24 x

Occupation 3 x

Occupation 6 x



Male x

Age 35-44 x

Age 45-49 x

Gender

Age

Occupation

Education

2-6

7-11

12-17

18-24

25-34

35-44

45-49

50-54

55-64

64+

Filters

Stations

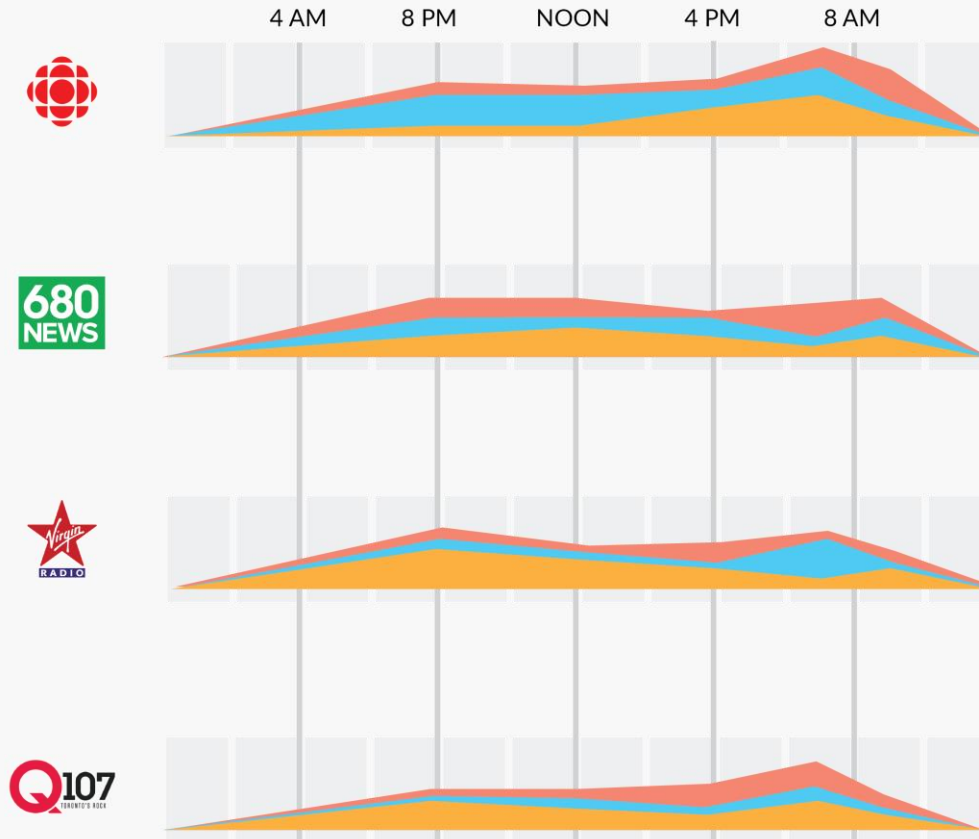
All

Regions

Toronto/Hamilton

TIME

When should I advertise?



Personas



Female x Age 55-64 x
Occupation 5 x



Male x Age 18-24 x
Occupation 3 x Occupation 6 x



Male x Age 35-44 x Age 45-49 x

Gender Age Occupation Education

2-6 7-11 12-17 18-24 25-34
35-44 45-49 50-54 55-64 64+

Filters

Stations

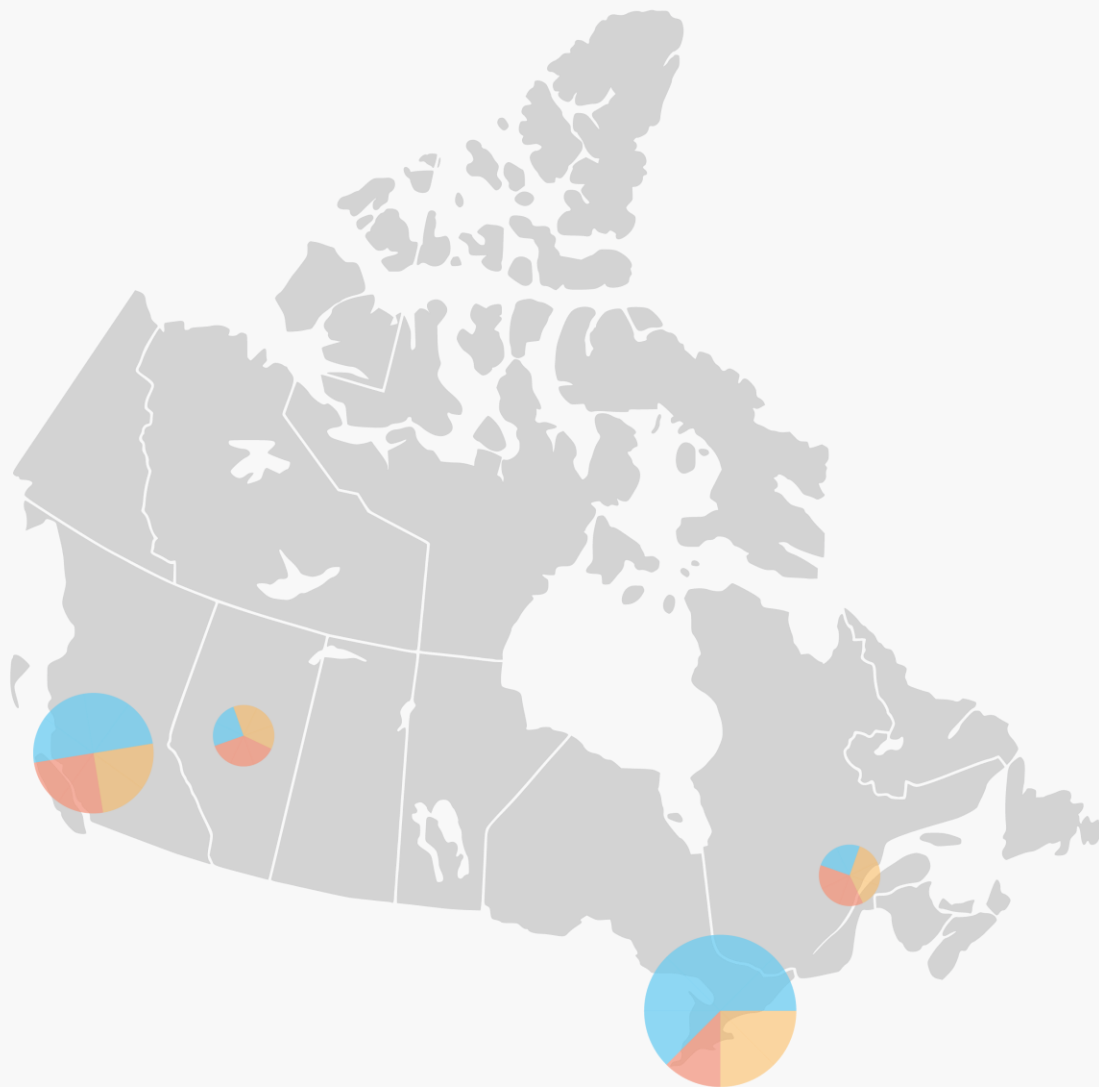
All

Regions

Toronto/Hamilton

REGION

Where should I advertise?



Personas



Female x Age 55-64 x
Occupation 5 x



Male x Age 18-24 x
Occupation 3 x Occupation 6 x



Male x Age 35-44 x Age 45-49 x

Gender

Age

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Education

2-6

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Filters

Stations

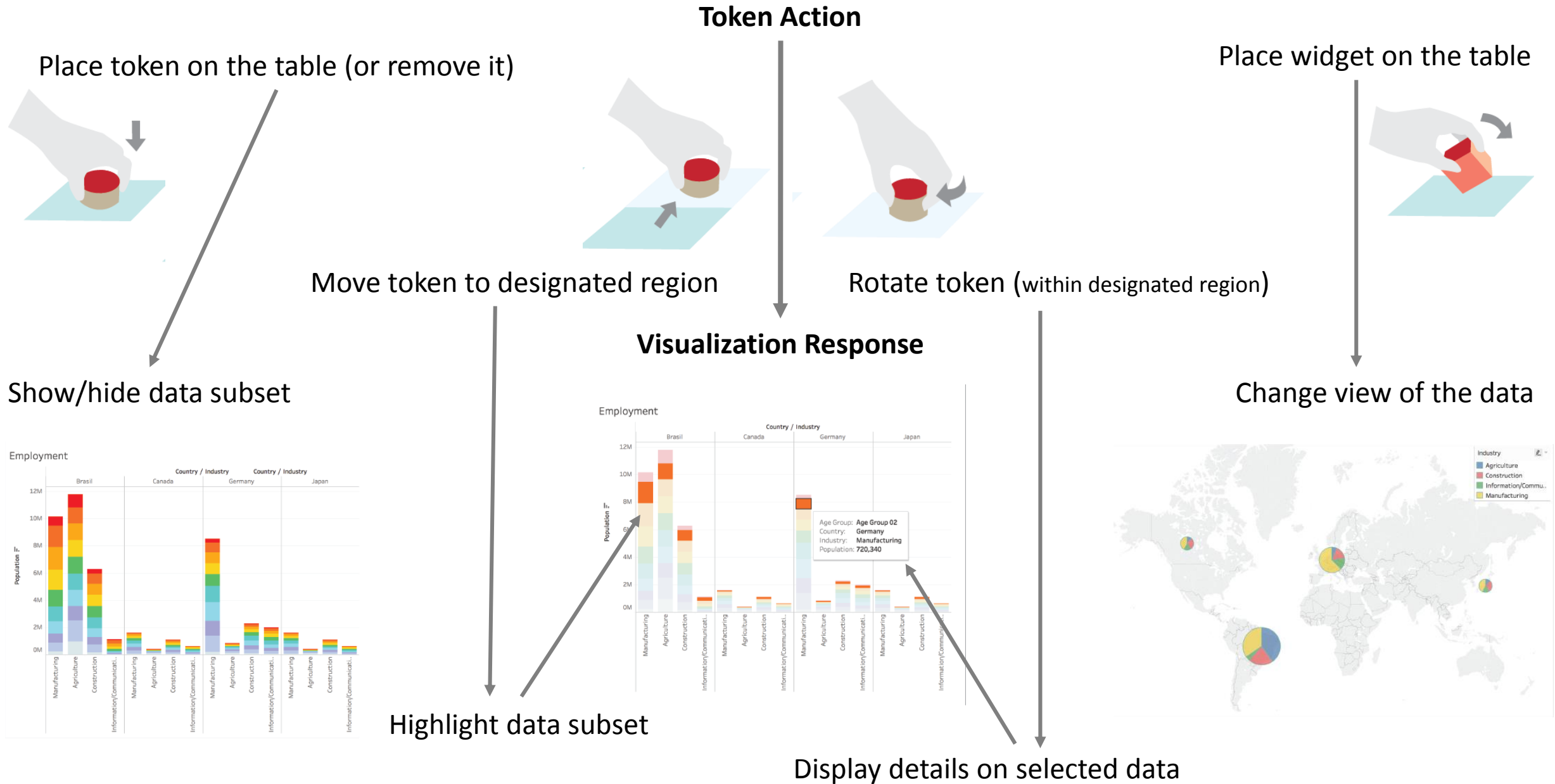


Regions



Part 1:

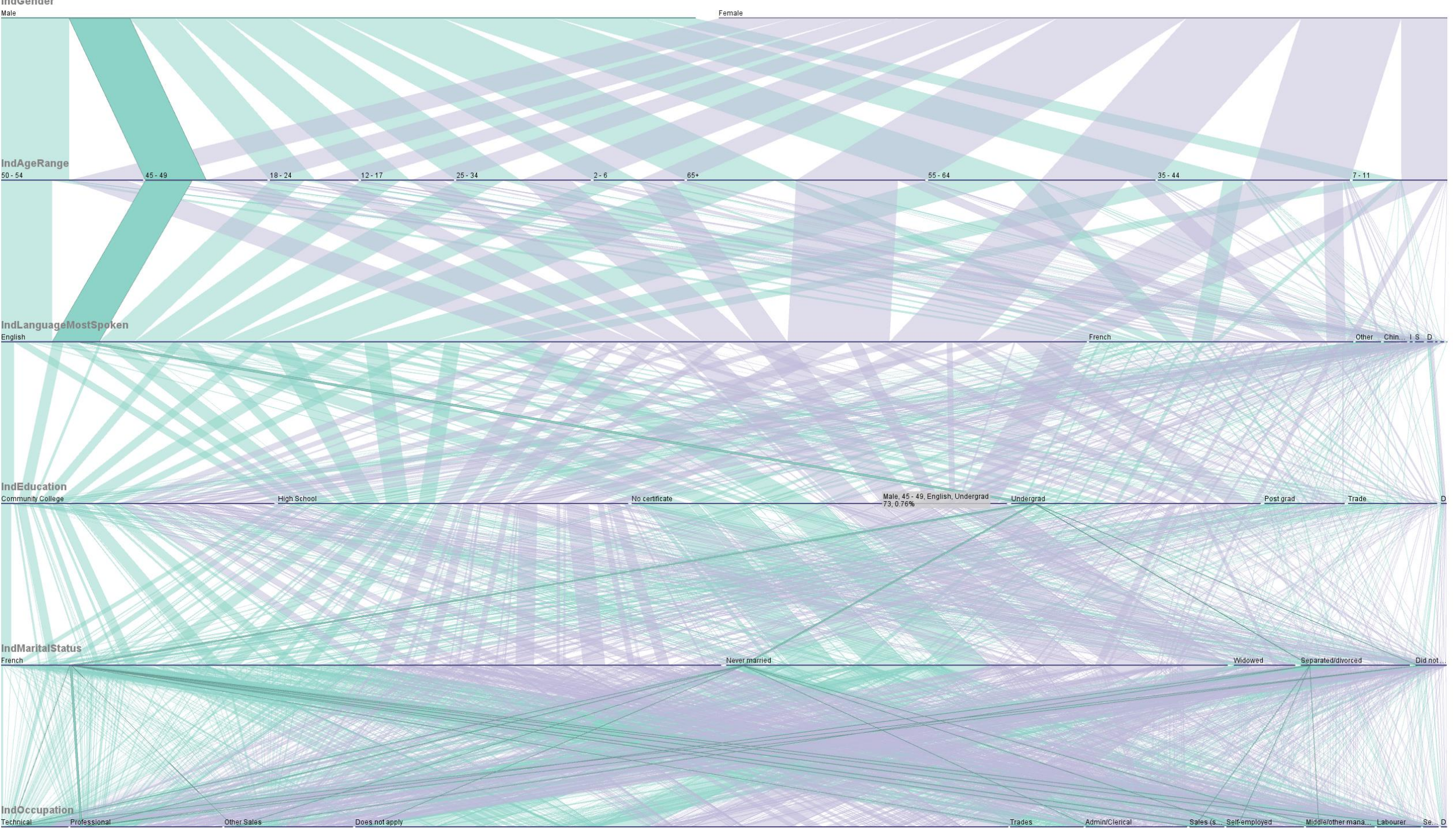
a) tangible 'language' – some translation with Tableau's interface



Visually filtering high-dimensional data

Ana Jofre, Lan-Xi Dong, Stephen Teifenbach-Keller, Steve Szigeti, Sara Diamond
(OCAD University)

Omar Grant, Matthew Kyan (York University)





Visual Analytics Lab

iCity

iCity: Urban Informatics for Sustainable Metropolitan Growth

*A 4-year Translational Research Initiative
Supported by The Ontario Research Excellence
Fund Round 7*



UNIVERSITY OF
WATERLOO

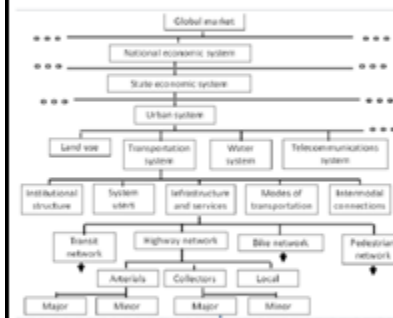


UNIVERSITY OF TORONTO
FACULTY OF APPLIED SCIENCE & ENGINEERING
Transportation Research Institute



iCity concept of city systems as nested structures

Figure 2: Hierarchical Approach to Urban Systems



Meyer & Miller (2013)

Each system decomposes into sub-systems; E.g., “the” transportation system consists of:

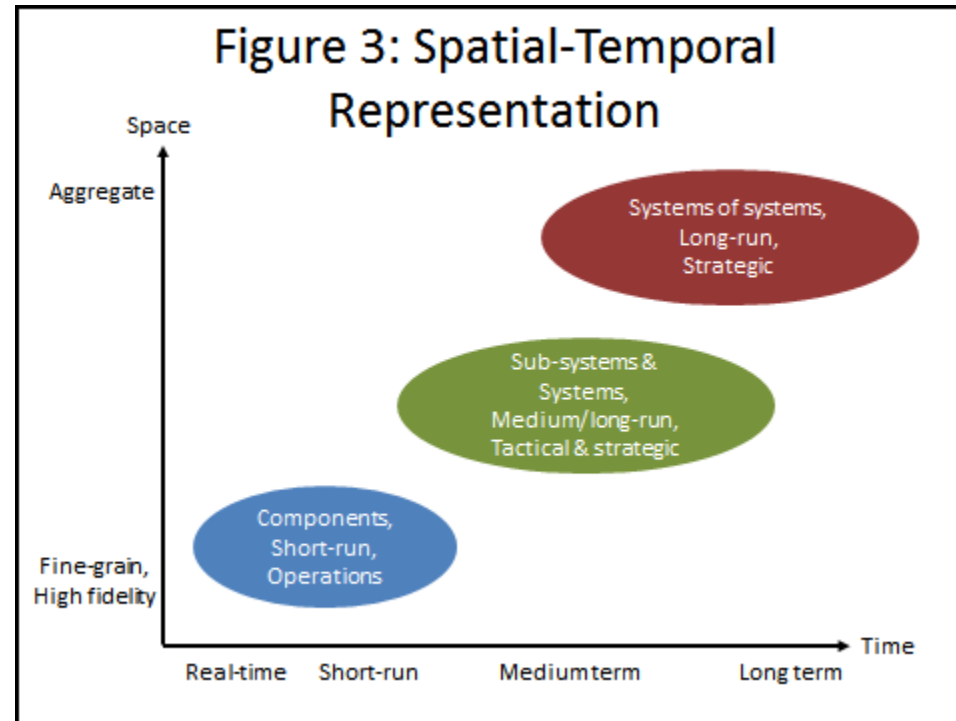
- The road system
- Transit system
- Active transportation system
- Operating agencies
-

Each “system” interconnects & interacts with other systems



Cities (urban regions) are “systems of systems”.

Modeling systems relationships



Betaville and Story Facets visualization tools

- *Design Approach*
 - Communication Centered
 - Collaboration- Minded
- *Visual Data/Model Integration*
 - Able to link qualitative data
 - Real-time “what-ifs”
 - Changing/historical data and data ontologies
 - Provenance

Betaville and StoryFacets

- *Visualization Techniques*
 - Interactive Computing
 - Overview + Detail
 - Geospatial Visualization
 - Info vis
 - Comparative Visualization
- *White Boxes*
 - Ontology
 - Models – transparency
 - Provenance - retrievability

Betaville = Experiential + Data



Urban Development Process

BETA VILLE SELECTION Statue of Liberty Ferry Terminal <http://www.url.org>

Got a proposal, base? new proposal

PROPOSAL TITLE
PROPOSAL DESCRIPTION
ADDRESS (optional)
WEBSITE URL (optional)

new version of existing design

[Click on the model you want to update]

VERSION DESCRIPTION

next

No Title
Move Speed: 1
Rotation: 0
Move North Move South Move Up Cancel

Performance
Frames Per Second: 30
Triangles in Scene: 349k
Triangles in Selected: 81k
✓ Round FPS ✓ Round Triangle Count

PROPOSALS **VERSIONS**

Maglev Station (1) Bud Griffiths
Liberty Piers (3) B-Ville Crew

Liberty Piers Version 2
a (very) mixed-use development
by: B-Ville Crew
June 2, 2010 SHOW

Liberty Piers Version 3
a (very) mixed-use development,
with much-needed flora
by: B-Ville Crew
June 3, 2010 HIDE

1 City nade

SHOW

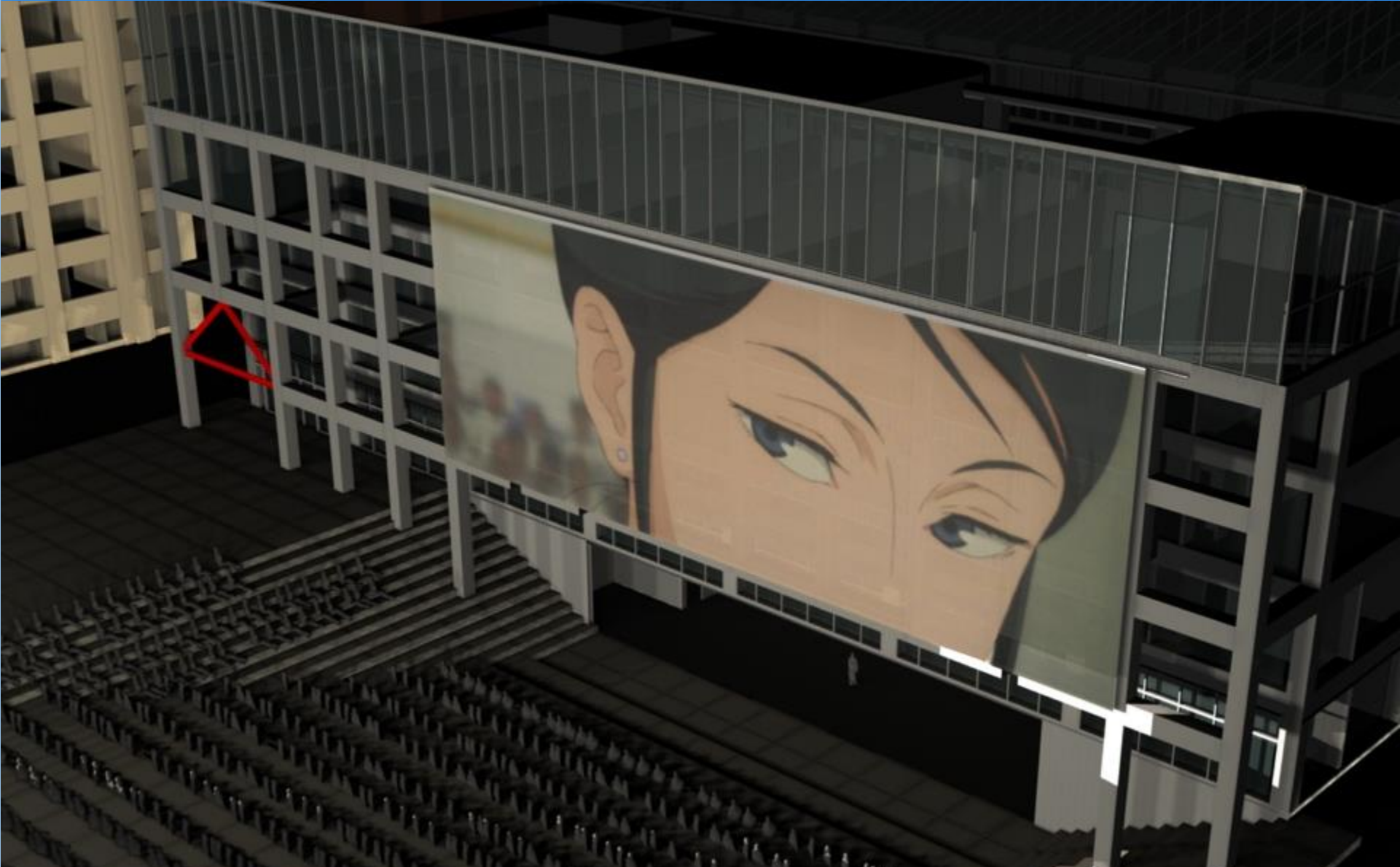
Compare Photo View...



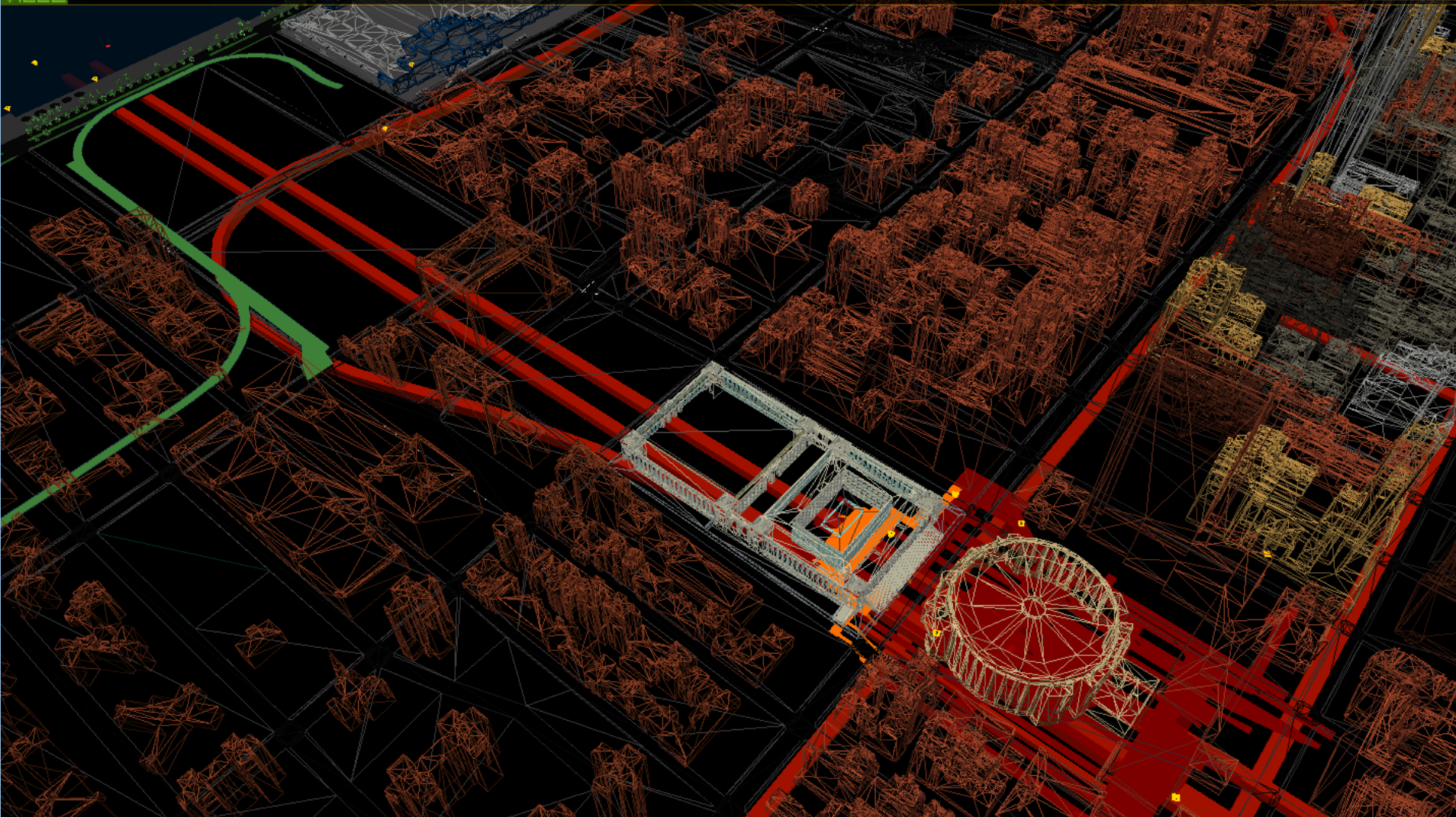
...With the Betaville View



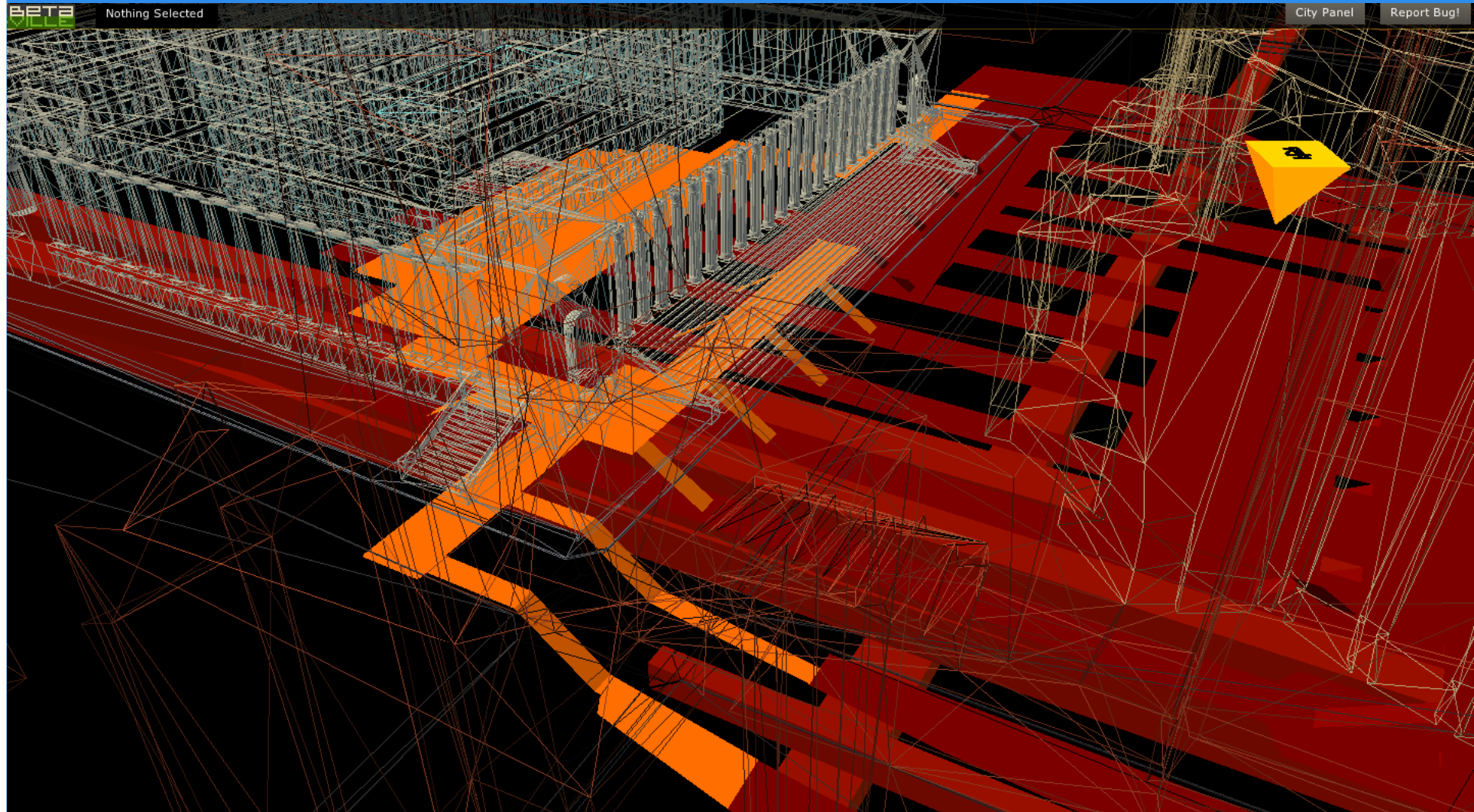
...Including the Future!



See Above and Below Grade



Navigate Inside and Out



Betaville: City 3D + City Data



BETA VILLE M95_B90_L7501 <http://www.jr.com>

INFORMATION

Name
M95_B90_L15

Address
15 Park Row

Description
Mixed Residential & Commercial
built 1896, replacing a two-
storey cigar shop

URL
<http://www.jr.com>

Zoning Units
C5-5 2 Res., 3 Comm.

G. Floor Area As-of-right
336,447 sf. 450,000 sf.

#6 Oil Multi-Fuel Conv. Due
YES NO 08-21-2015

Average KWH./sq.ft./year this zip
R 12,567 C 23,434 M 31,765

[Update](#) [More Sources](#)

Betaville: New WebGL Client Runs in Any HTML5 Browser



ESRI CityEngine: Open City 3D



Betaville + CityEngine: Building Experiences of the Future, Now

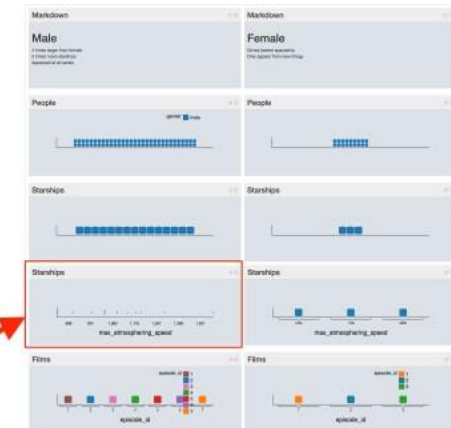


StoryFacets

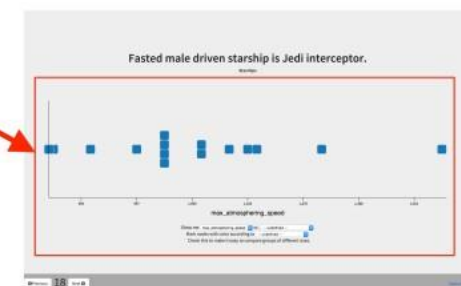
Overview



(a) Trail Facet



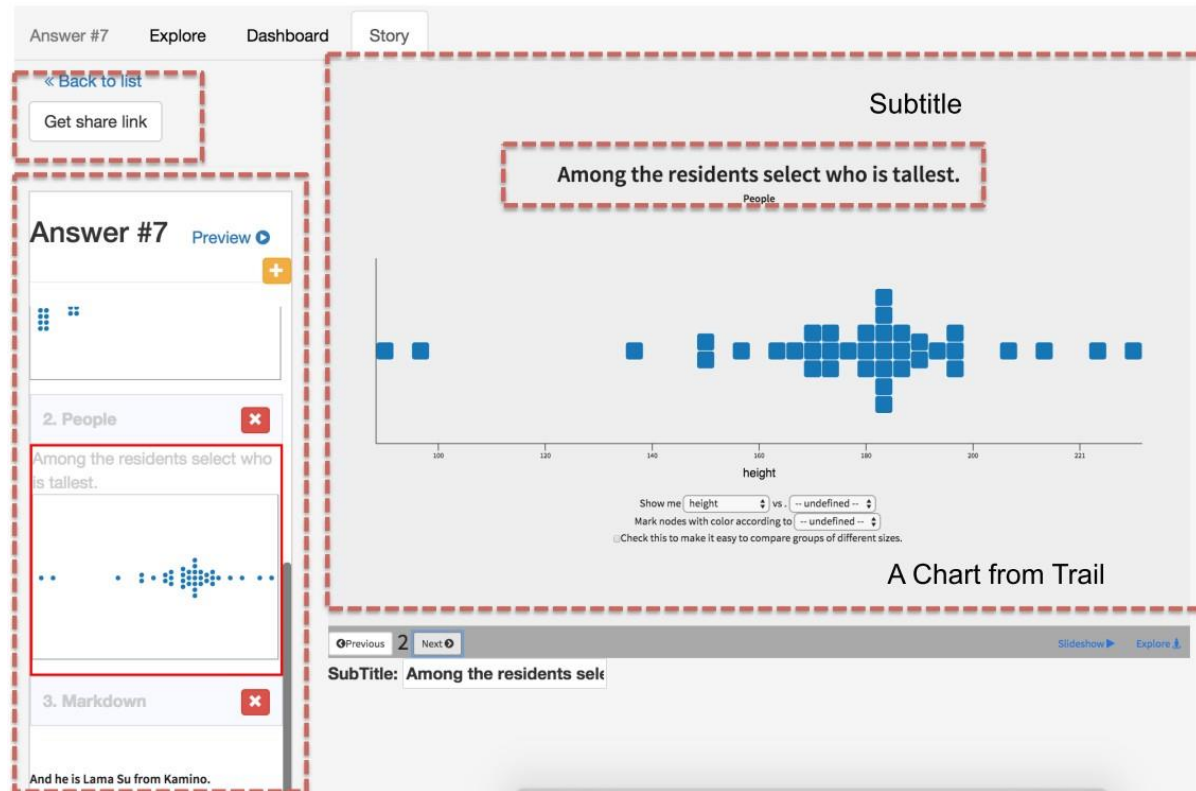
(b) Dashboards or Info Graphics Facet



(c) Story Facet

StoryFacets

Story (slideshow) [Link for sharing](#) Wars character height



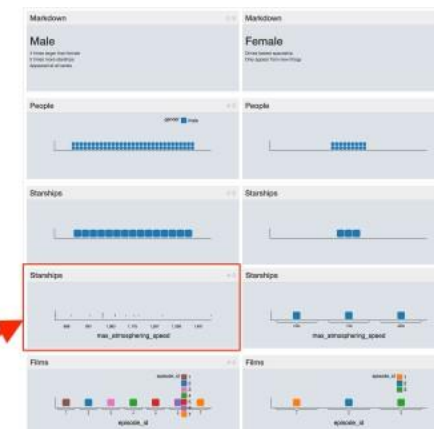
Slides Preview

StoryFacets

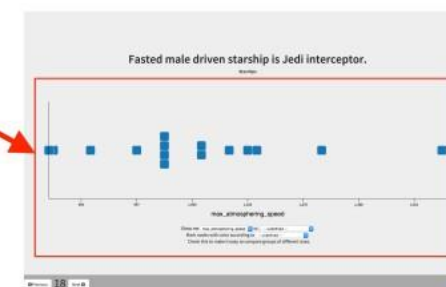
Linked back to trail facet



(a) Trail Facet



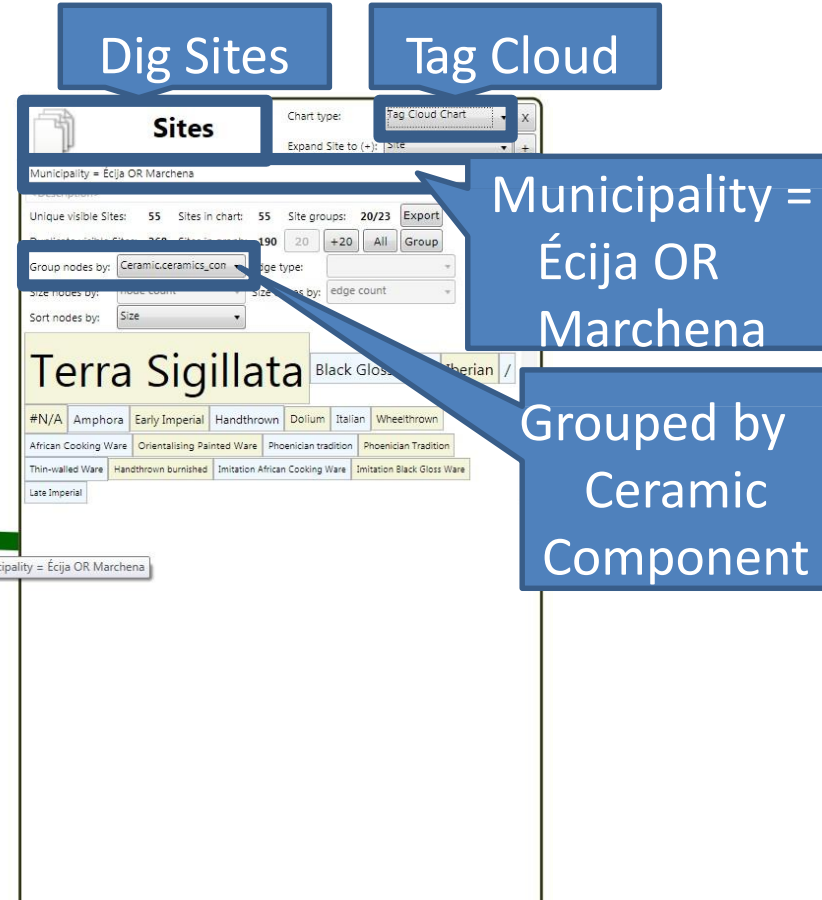
(b) Dashboards or Info Graphics Facet



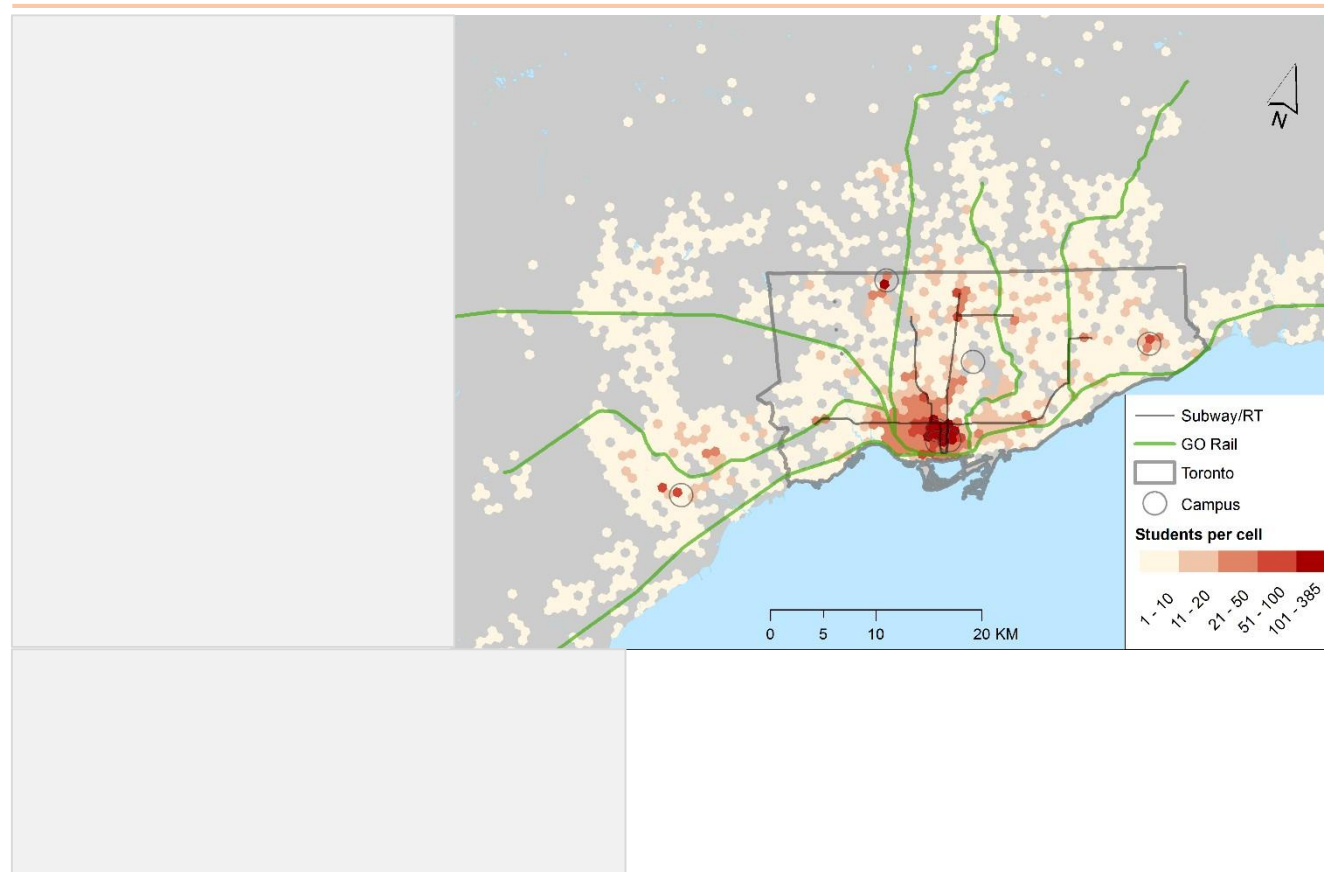
(c) Story Facet

GraphTrail

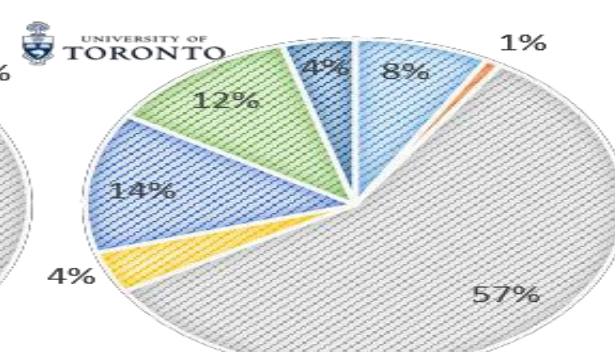
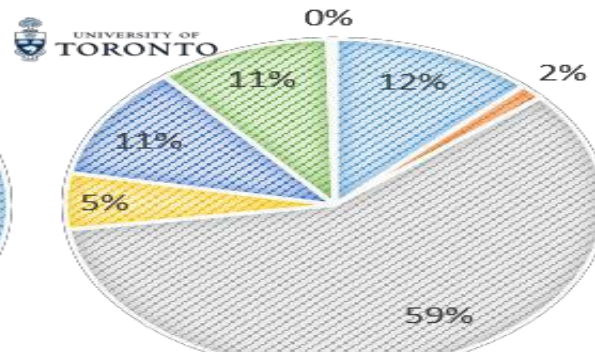
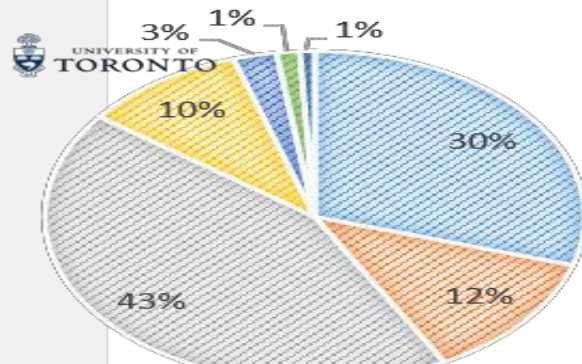
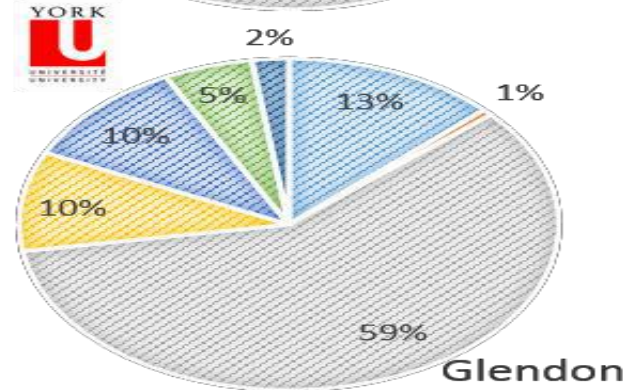
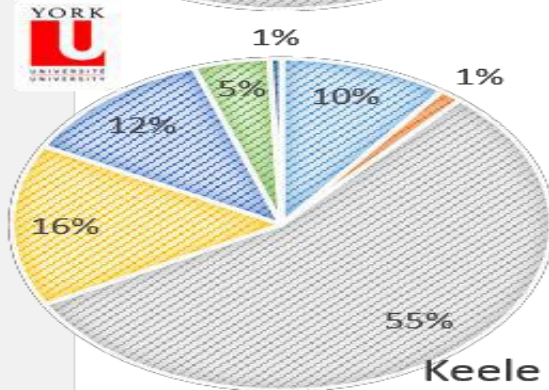
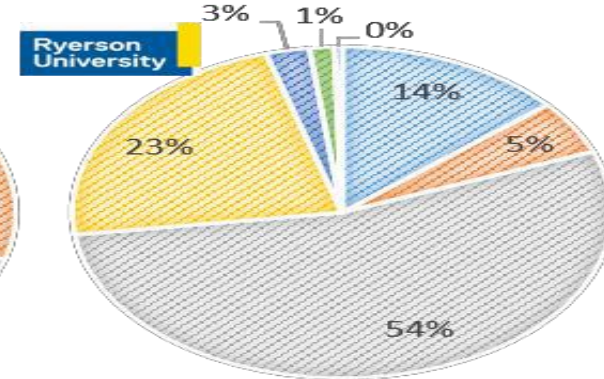
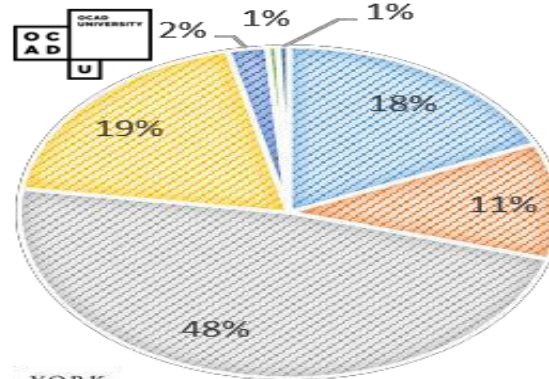
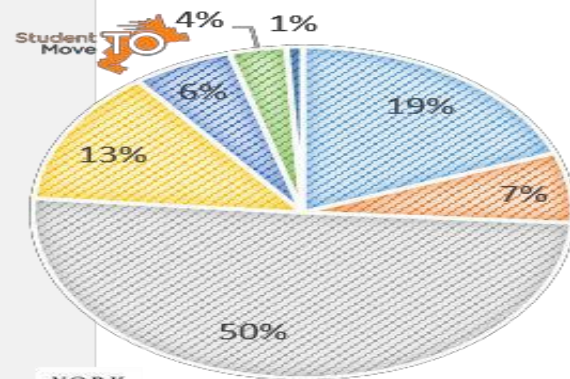
Provenance & chart parameterization



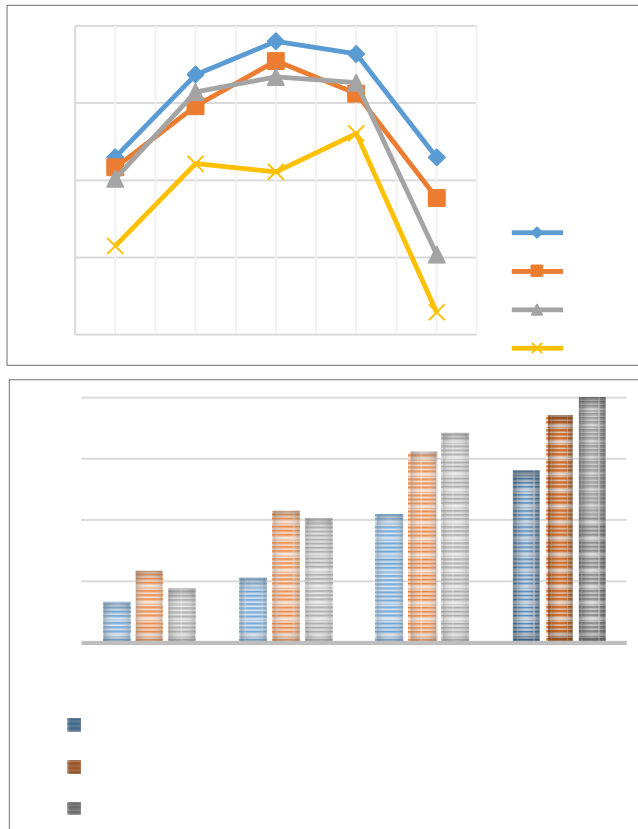
Home Location of Respondents



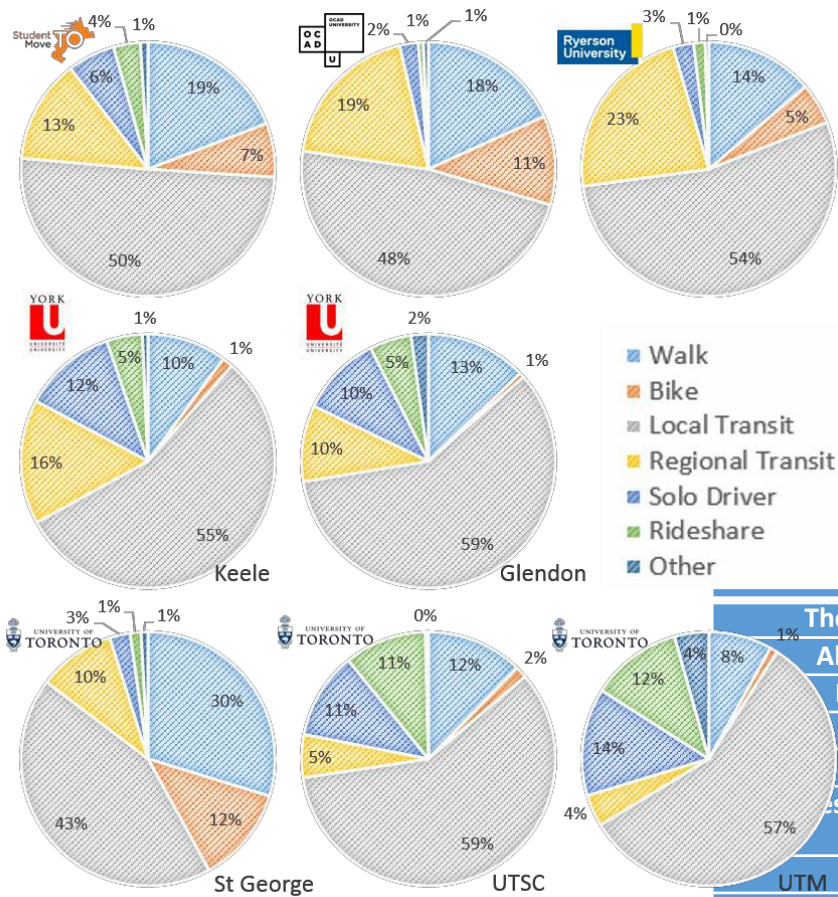
StudentMove TO



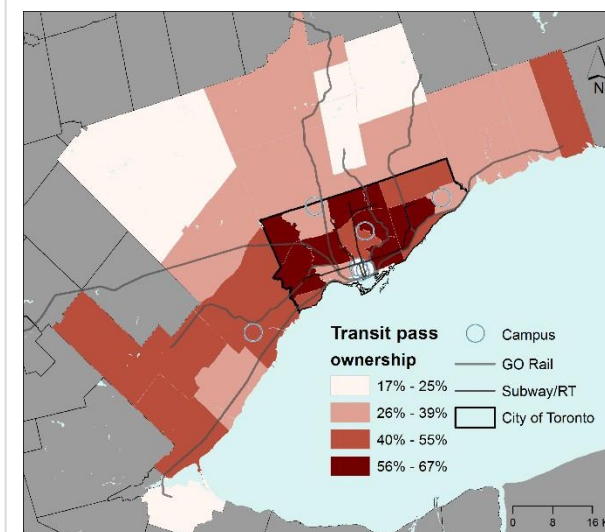
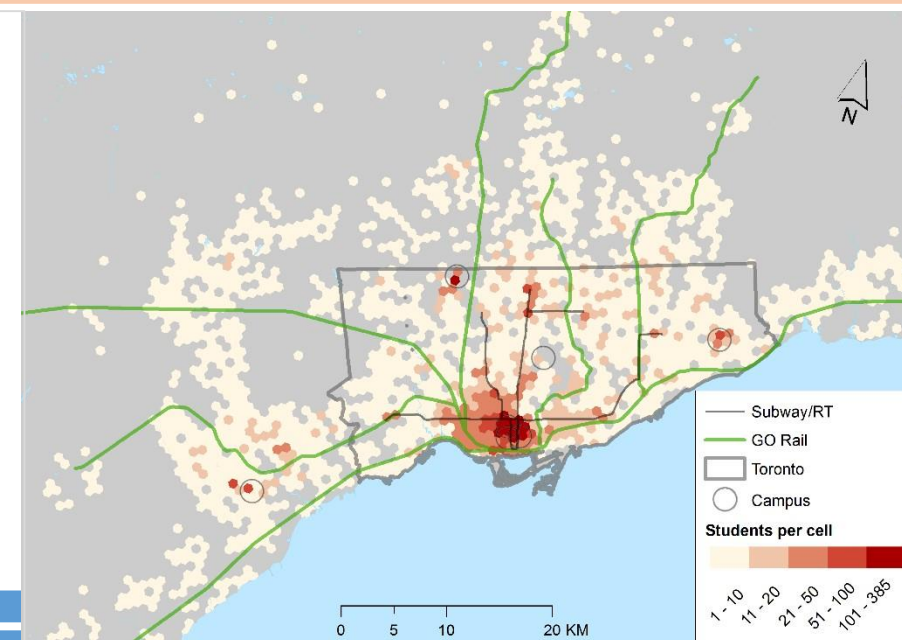
Relationships commute time and school engagement



- Percentage coming to campus daily by distance of commute
- One way commute and involvement in school: pick courses by commute time, commute discourages coming to campus, commute discourages extracurricular activity



- Cost of housing
- The decision was out of my control
- Ability to walk or bike to campus
- Housing qualities (space, yard, ...)
- Proximity to public transit
- Being near friends and family
- Features of neighbourhood (shops, parks, houses, ...)
- Other
- Walkability of neighbourhood
- Crime and safety



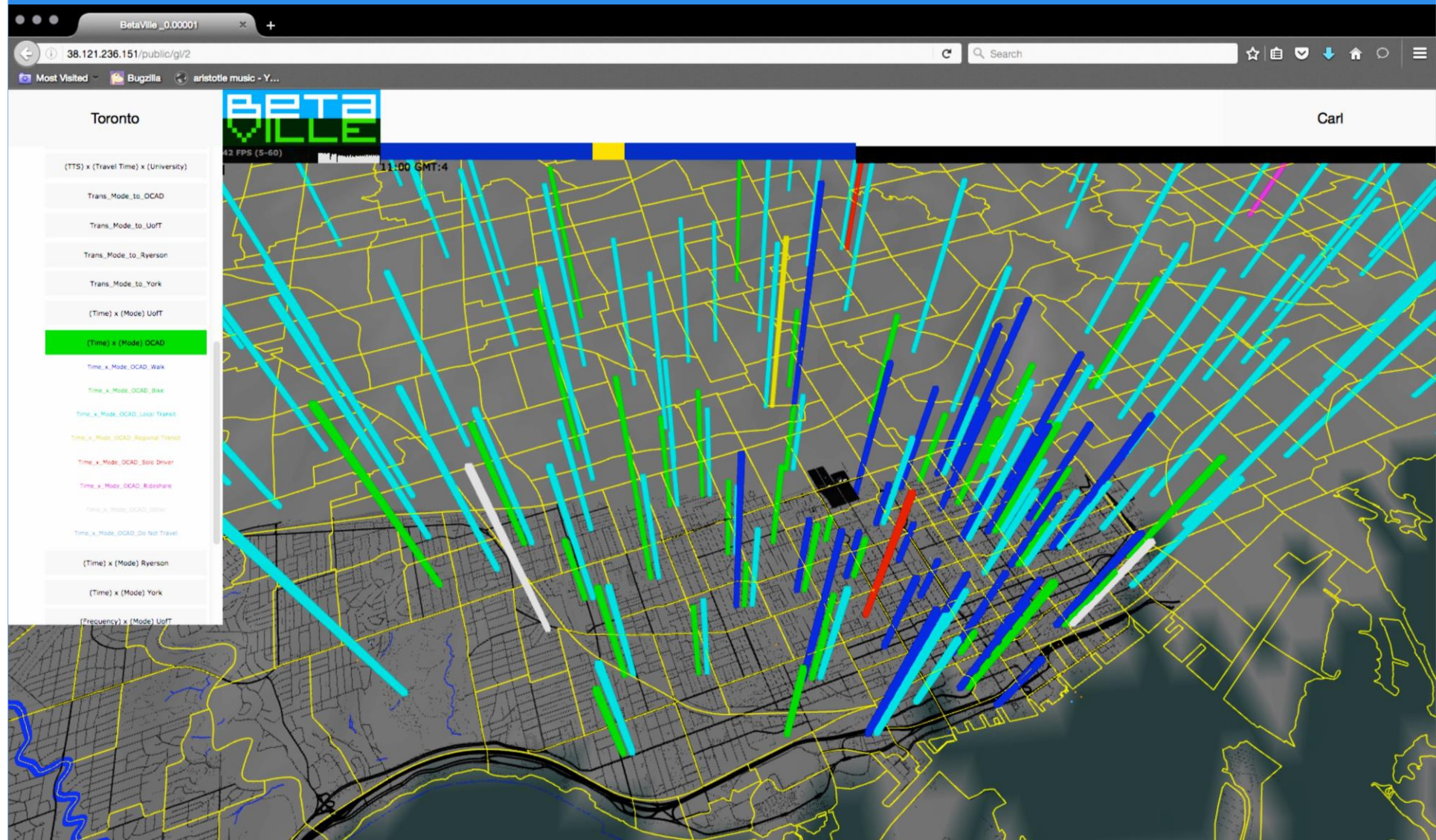
Video Student MoveTO

- Betaville – where are students located and what is their destiny?
- StoryFacets – factors in considering a new home...

Student MoveTO: Data We Need to Understand

#	id	hhszgegru	hissingqeh	hissingqeh	hhnumdex	hhcamub	hhcamub	hhcamub	hhbuildingt	hhbuildingt	hhcmpldr	hhcmpldr	hhcmpldr	hhcmpldr	hhownersh	hhownersh	hhlivingstu	hhcmptc	hhcmptc	hhresphou	hhcmprsp	hhcmprsp	hhcmprsp	HmCuid	HmTTS20C	HmSAZ01	HmPD
7	2	5_persons	5 persons	<	0	More than <	4	1	1_vehicles	1 vehicle	Semi-detac building_ty	2	Semi-detac semi_detac	1	Owner	Live with fa Two-parent	4	1	1	Residential yes	5350193.0f	261	M3C				
2	2	persons	2 persons	0	0	0_vehicle	0 vehicle	0	0	0_vehicle	0 vehicle	Apartment building_ty	4	Apartment apartment_	0	Tenant	Live with p; Two person	2	0	2	No resident no	5350091.0f	71	M5R			
4	4	persons	4 persons	0	0	More than <	0	1	1_vehicles	1 vehicle	Semi-detac building_ty	2	Semi-detac semi_detac	1	Owner	Live with fa Two-parent	4	1	1	Residential yes	5350516.2f	3714	L5M				
4	4	persons	4 persons	0	0	0	0_vehicle	0 vehicle	0	0_vehicle	0 vehicle	Apartment building_ty	4	Apartment apartment_	0	Tenant	Live with rc Other hous	5	0	2	No resident no	5350059.0f	74	M5S			
2	2	persons	2 persons	0	0	More than <	0	0	0_vehicle	0 vehicle	Apartment building_ty	4	Apartment apartment_	0	Tenant	Live with p; Two person	2	1	1	Residential yes	5350091.0f	71	M5R				
3	3	persons	3 persons	0	0	More than <	0	0	0_vehicle	0 vehicle	Apartment building_ty	4	Apartment apartment_	0	Tenant	Live with rc Other hous	5	0	2	No resident no	5350092.0f	72	M5R				
5	5	persons	5 persons	<	0	More than <	0	2	2_vehicles	2 vehicles	Semi-detac building_ty	2	Semi-detac semi_detac	1	Owner	Live with fa Two-parent	4	0	2	No resident no	5350377.0f	600	M1V				
5	5	persons	5 persons	<	0	More than <	0	2	2_vehicles	2 vehicles	Detached h building_ty	1	Single deta single_deta	1	Owner	Live with fa Two-parent	4	1	1	Residential yes	5350576.2f	3420	L6R				
2	2	persons	2 persons	0	0	More than <	0	1	1_vehicles	1 vehicle	Apartment building_ty	4	Apartment apartment_	0	Tenant	Live with p; Two person	2	0	2	No resident no	5350049.0f	113	M6R				
2	2	persons	2 persons	0	0	More than <	0	1	1_vehicles	1 vehicle	Apartment building_ty	4	Apartment apartment_	0	Tenant	Live with p; Two person	2	0	2	No resident no	5350804.0f	1031	L1X				
3	3	persons	3 persons	0	0	More than <	0	1	1_vehicles	1 vehicle	Apartment building_ty	4	Apartment apartment_	0	Tenant	Live with fa Two-parent	4	1	1	Residential yes	5350267.0f	237	M3B				
2	2	persons	2 persons	0	0	More than <	0	0	0_vehicle	0 vehicle	Apartment building_ty	4	Apartment apartment_	0	Tenant	Live with p; Two person	2	0	2	No resident no	5350062.0f	46	M4Y				
4	4	persons	4 persons	0	0	More than one-person household	1	2	2_vehicles	2 vehicles	Semi-detac building_ty	2	Semi-detac semi_detac	1	Owner	Live with fa Two-parent	4	1	1	Residential yes	5350324.0f	472	L3R				
4	4	persons	4 persons	0	0	More than <	0	1	1_vehicles	1 vehicle	Apartment building_ty	4	Apartment apartment_	1	Owner	Live with p; Two person	2	0	2	No resident no	5350035.0f	50	M5B				
2	2	persons	2 persons	0	0	More than <	0	1	1_vehicles	1 vehicle	Apartment building_ty	4	Apartment apartment_	1	Owner	Live with p; Two person	2	1	1	Residential yes	5350064.0f	21	M4Y				
2	2	persons	2 persons	0	0	More than <	0	0	0_vehicle	0 vehicle	Apartment building_ty	4	Apartment apartment_	0	Tenant	Live with p; Two person	2	0	2	No resident no	5350128.0f	209	M4S				
5	5	persons	5 persons	<	0	More than <	3	5	3_vehicles	3 vehicles	Detached h building_ty	1	Single deta single_deta	1	Owner	Live with fa Two-parent	4	1	1	Residential yes			N1A				
2	2	persons	2 persons	0	0	More than <	0	0	0_vehicle	0 vehicle	Apartment building_ty	4	Apartment apartment_	1	Owner	Live with rc Two person	2	0	2	No resident no	5350066.0f	22	M4X				
5	5	persons	5 persons	<	0	More than <	0	2	2_vehicles	2 vehicles	Apartment building_ty	4	Apartment apartment_	1	Owner	Live with fa Two-parent	4	1	1	Residential yes	5350331.0f	554	M1E				
2	2	persons	2 persons	0	0	More than <	0	0	0_vehicle	0 vehicle	Apartment building_ty	4	Apartment apartment_	0	Tenant	Live with rc Two person	2	0	2	No resident no	5350034.0f	38	M5B				
5	5	persons	5 persons	<	0	More than <	0	1	1_vehicles	1 vehicle	Row house building_ty	3	Row/Town/ row_house	0	Tenant	Live with fa Two-parent	4	1	1	Residential yes	5350516.0f	3868	L5L				
1	1	person	1 person	1	1	One-person household	0	0_vehicle	0 vehicle	Apartment building_ty	4	Apartment apartment_	0	Tenant	Live alone Single Pers	1	0	2	No resident no	5350036.0f	67	M5G					
5	5	persons	5 persons	<	0	More than <	0	1	1_vehicles	1 vehicle	Semi-detac building_ty	2	Semi-detac semi_detac	1	Owner	Live with fa Other hous	5	1	1	Residential yes	5350804.1f	1042	L1V				
3	3	persons	3 persons	0	0	More than <	1	2	2_vehicles	2 vehicles	Semi-detac building_ty	2	Semi-detac semi_detac	1	Owner	Live with fa Two-parent	4	1	1	Residential yes	5350411.0f	2081	L4K				
4	4	persons	4 persons	0	0	More than <	0	1	1_vehicles	1 vehicle	Apartment building_ty	4	Apartment apartment_	1	Owner	Live with fa Two-parent	4	1	1	Residential yes	5350302.0f	480	M2J				
3	3	persons	3 persons	0	0	More than <	1	1	1_vehicles	1 vehicle	Detached h building_ty	1	Single deta single_deta	1	Owner	Live with fa Two-parent	4	0	2	No resident no	5350295.0f	413	M3M				
1	1	person	1 person	1	1	One-person household	0	0_vehicle	0 vehicle	Detached h building_ty	1	Single deta single_deta	0	Tenant	Live alone Single Pers	1	0	2	No resident no	5350338.0f	542	M1N					
2	2	persons	2 persons	0	0	More than <	0	0	0_vehicle	0 vehicle	Apartment building_ty	4	Apartment apartment_	0	Tenant	Live with rc Two person	2	0	2	No resident no	5350035.0f	51	M5G				
2	2	persons	2 persons	0	0	More than <	0	0	0_vehicle	0 vehicle	Apartment building_ty	4	Apartment apartment_	0	Tenant	Live with rc Two person	2	0	2	No resident no	5350091.0f	71	M5R				
5	5	persons	5 persons	<	0	More than <	3	1	1_vehicles	1 vehicle	Apartment building_ty	4	Apartment apartment_	0	Tenant	Live with p; Other hous	5	1	1	Residential yes	5350520.0f	3664	L5C				
2	2	persons	2 persons	0	0	More than <	0	0	0_vehicle	0 vehicle	Apartment building_ty	4	Apartment apartment_	0	Tenant	Live with rc Two person	2	0	2	No resident no	5350036.0f	67	M5G				
3	3	persons	3 persons	0	0	More than <	0	0	0_vehicle	0 vehicle	On-campus building_ty	5	Student Re student_res	0	Tenant	Live with rc Other hous	5	0	2	No resident no	5350061.0f	70	M5S				
1	1	person	1 person	1	1	One-person household	1	1_vehicles	1 vehicle	Apartment building_ty	4	Apartment apartment_condo	Unknown	Unknown	Live alone Single Pers	1	1	1	Residential yes	5350035.0f	50	M5G					
3	3	persons	3 persons	0	0	More than <	0	0	0_vehicle	0 vehicle	Row house building_ty	3	Row/Town/ row_house	0	Tenant	Live with fa Single pers	3	1	1	Residential yes	5350361.0f	569	M1C				
3	3	persons	3 persons	0	0	More than <	0	2	2_vehicles	2 vehicles	Detached h building_ty	1	Single deta single_deta	1	Owner	Live with fa Two-parent	4	1	1	Residential yes	5350805.1f	1062	L1T				
5	5	persons	5 persons	<	0	More than <	0	1	1_vehicles	1 vehicle	Detached h building_ty	1	Single deta single_deta	1	Owner	Live with fa Other hous	5	1	1	Residential yes	5350237.0f	352	M9R				
2	2	persons	2 persons	0	0	More than <	0	0	0_vehicle	0 vehicle	Apartment building_ty	4	Apartment apartment_	0	Tenant	Live with rc Two person	2	0	2	No resident no	5350035.0f	50	M5G				
6	5	persons	5 persons	<	0	More than <	0	0	0_vehicle	0 vehicle	On-campus building_ty	5	Student Re student_res	0	Tenant	Live with rc Other hous	5	0	2	No resident no	5350061.0f	70	M5S				
2	2	persons	2 persons	0	0	More than <	0	2	2_vehicles	2 vehicles	Row house building_ty	3	Row/Town/ row_house	0	Tenant	Live with p; Two person	2	0	2	No resident no	5370201.0f	4052	L7T				
2	2	persons	2 persons	0	0	More than <	0	0	0_vehicle	0 vehicle	Apartment building_ty	4	Apartment apartment_	0	Tenant	Live with rc Two person	2	0	2	No resident no	5350063.0f	40	M4Y				
2	2	persons	2 persons	0	0	More than <	0	0	0_vehicle	0 vehicle	Apartment building_ty	4	Apartment apartment_	1	Owner	Live with p; Two person	2	0	2	No resident no	5350062.0f	49	M5G				
5	5	persons	5 persons	<	0	More than <	0	0	0_vehicle	0 vehicle	Semi-detac building_ty	2	Semi-detac semi_detac	0	Tenant	Live with fa Two-parent	4	0	2	No resident no	5350029.0f	271	M4M				
1	1	person	1 person	1	1	One-person household	0	0_vehicle	0 vehicle	Semi-detac building_ty	2	Semi-detac semi_detac	0	Tenant	Live alone Single Pers	1	0	2	No resident no	5350516.1f	3663	L5L					
4	4	persons	4 persons	0	0	More than <	1	2	2_vehicles	2 vehicles	Semi-detac building_ty	2	Semi-detac semi_detac	1	Owner	Live with fa Other hous	5	1	1	Residential yes	5350369.0f	510	M1P				
3	3	persons	3 persons	0	0	More than <	0	2	2_vehicles	2 vehicles	Apartment building_ty	4	Apartment apartment_	0	Tenant	Live with fa Two-parent	4	1	1	Residential yes	5350354.0f	521	M1H				
3	3	persons	3 persons	0	0	More than <	0	0	0_vehicle	0 vehicle	Apartment building_ty	4	Apartment apartment_	0	Tenant	Live with rc Other hous	5	0	2	No resident no	5350060.0f	73	M5S				
1	1	person	1 person	1	1	One-person household	1	1_vehicles	1 vehicle	Apartment building_ty	4	Apartment apartment_	0	Tenant	Live alone Single Pers	1	0	Unknown	Unknown	5350122.0f	202	M4V					
4	4	persons	4 persons	0	0	More than <	0	2	2_vehicles	2 vehicles	Detached h building_ty	1	Single deta single_deta	1	Owner	Live with fa Two-parent	4	1	1	Residential yes	5350352.0f	509	M1P				
1	1	person	1 person	1	1	One-person household	0	0_vehicle	0 vehicle	Detached h building_ty	1	Single deta single_deta	0	Tenant	Live with rc Single Pers	1	0	2	No resident no	5350297.0f	427	M3H					
6	5	persons	5 persons	<	0	More than <	0	2	2_vehicles	2 vehicles	Detached h building_ty	1	Single deta single_deta	1	Owner	Live with fa Two-parent	4	1	1	Residential yes	5350411.2f	2078	L6A				
3	3	persons	3 persons	0	0	More than <	0	0	0_vehicle	0 vehicle	Apartment building_ty	4	Apartment apartment_	0	Tenant	Live with fa Other hous	5	0	2	No resident no	5350063.0f	41	M4Y				
4	4	persons	4 persons	0	0	More than <	0	2	2_vehicles	2 vehicles	Semi-detac building_ty	2	Semi-detac semi_detac	1	Owner	Live with rc Two-parent	4	1	1	Residential yes	5350519.0f	3814	L5C				
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1	1	person	1 person	1	1	One-person household	0	0_vehicle	0 vehicle	Detached h building_ty	1	Single deta single_deta	0	Tenant	Live alone Single Pers	1	0	Unknown	Unknown	5350084.0f	280	M4K					
5	5	persons	5 persons	<	0	More than <	0	3	3_vehicles	3 vehicles	Detached h building_ty	1	Single deta single_deta	1	Owner	Live with fa Other hous	5	1	1	Residential yes	5350400.2f	2448	L3S				
5	5	persons	5 persons	<	0	More than <	3	1	1_vehicles	1 vehicle	Semi-detac building_ty	2	Semi-detac semi_detac	1	Owner	Live with fa Two-parent	4	1	1	Residential yes	5350422.0f	2257	L4S				
4	4	persons	4 persons	0	0	More than <	0	0	0_vehicle	0 vehicle	On-campus building_ty	5	Student Re student_res	0	Tenant	Live with rc Other hous	5	0	2	No resident no	5350061.0f	70	M5S				
4	4	persons	4 persons	0	0	More than <	0	0	0_vehicle	0 vehicle	On-campus building_ty	5	Student Re student_res	0	Tenant	Live with rc Other hous	5	0	2	No resident no	5350061.0f	70	M5S				
6	5	persons	5 persons	<	0	More than <	0	1	1_vehicles	1 vehicle	Apartment building_ty	4	Apartment apartment_	1	Owner	Live with fa Other hous	5	1	1	Residential yes	5350355.0f	518	M1J				
5	5	persons	5 persons	<	0	More than <	3	2	2_vehicles	2 vehicles	Detached h building_ty	1	Single deta single_deta	1	Owner	Live with fa Two-parent	4	1	1	Residential yes	5350365.0f	496	M1G				
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5	5	persons	5 persons	<	0	More than <	0	2	2_vehicles	2 vehicles	Detached h building_ty	1	Single deta single_deta	1	Owner												

2.5D Models: Data <> Mapping



Partner Suite: Data Visualization + Fusion = StoryFacets

Explore

Dashboard

Story



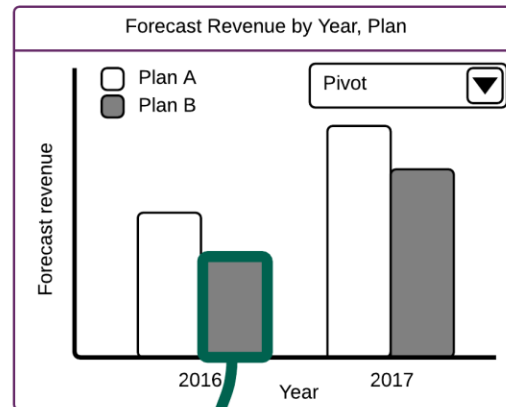
Cody Dunne

Controls

Chart Type ▼

- Choropleth map
- Globe
- Node-link
- Matrix
- Parallel coordinate
- Bar**
- Scatter
- GatherPlot
- Tag cloud

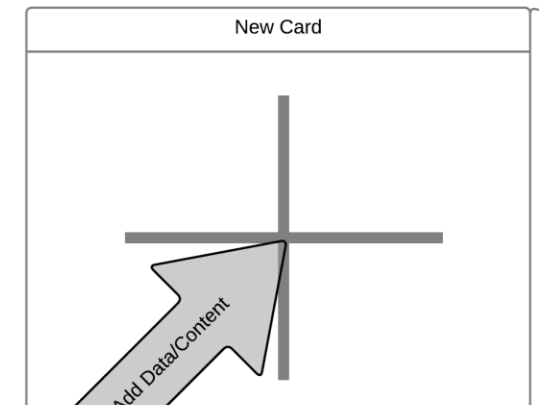
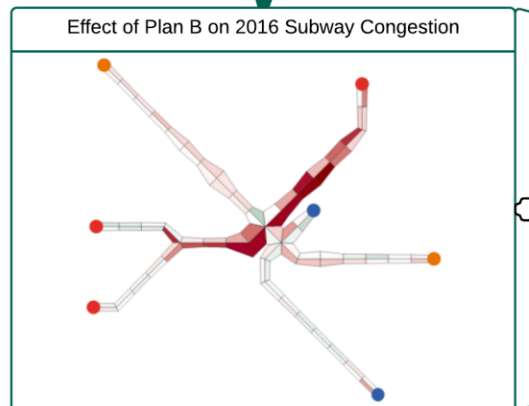
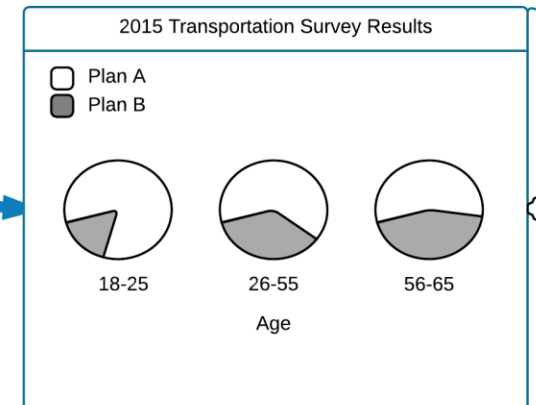
...



Both plans are good, but the revenue forecast for Plan A is much better!

Check out the latest survey results.

Plan B has less revenue, but look what lack of repair can do to our city!



AR: See It On Location



VR: Bringing Game Tech to Real Stakes





Visual Analytics Lab

Team Members

Research Questions

Urban Analytics Systems

3D visualization of data (Betaville)

ESRI – AR/VR applications

Presentation and Analytics – StoryFacets (GraphTrails)

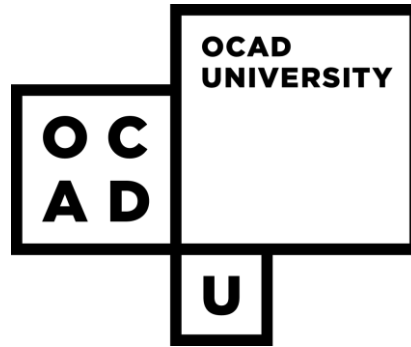
StudentMoveTO – comparative use of visualization

Big Data Research, Analytics and Information Network (BRAIN)

Subproject title: Interactive Visualization of Large Data Sets



Database framework



Visualizations



Data and Applications

Research Goal for December 2016:

Create a prototype of an interactive visualization tool that:

- 1) couples to Skydive's existing system, and
- 2) fulfills a need for the brain research community.

Skydive

Ana Jofre, Steve Szigeti, Sara Diamond (OCAD University)

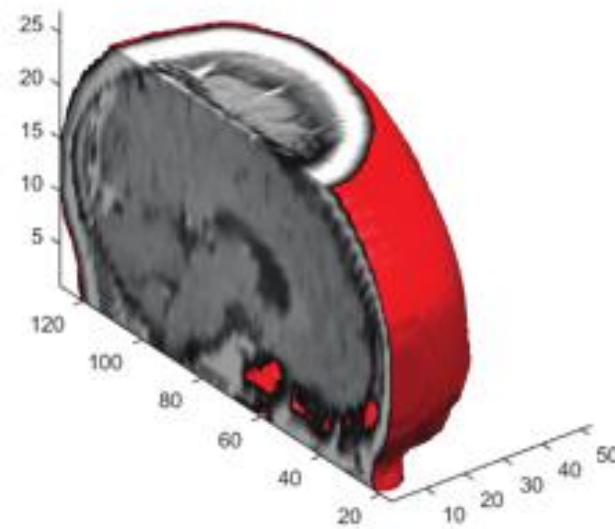
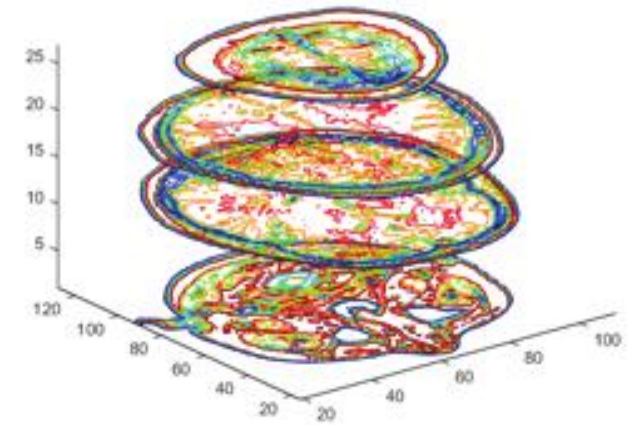
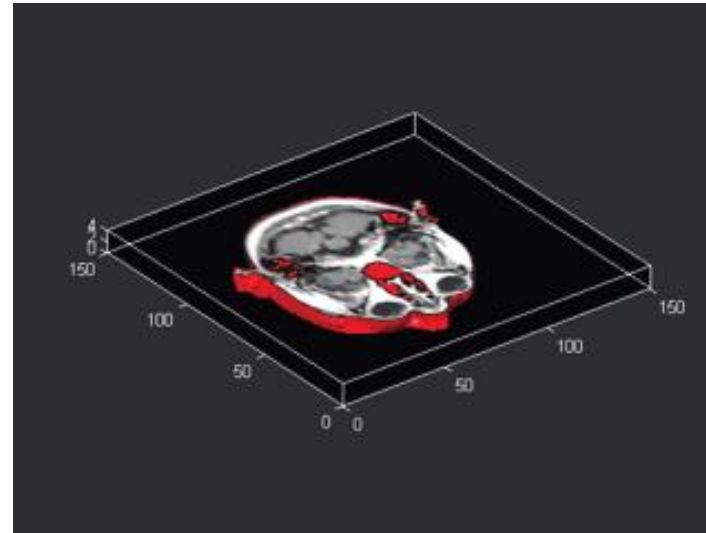
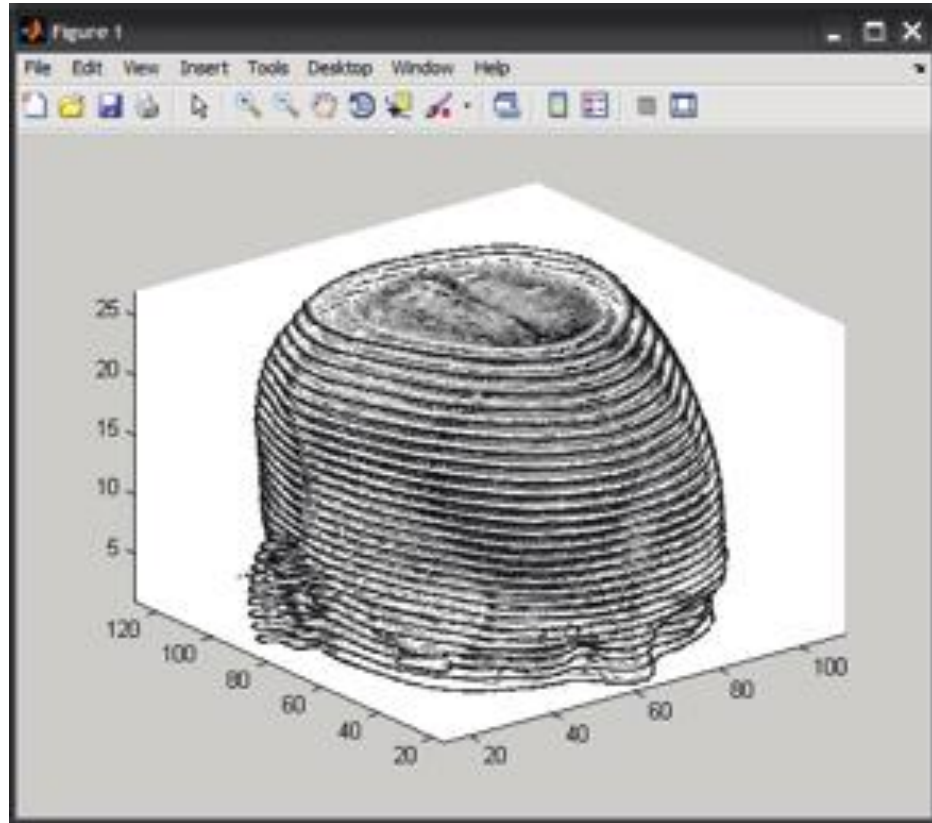
Piotr Lasek, Nasim Rasavi, Parke Godfrey (York University)

Identify needs of brain research community:

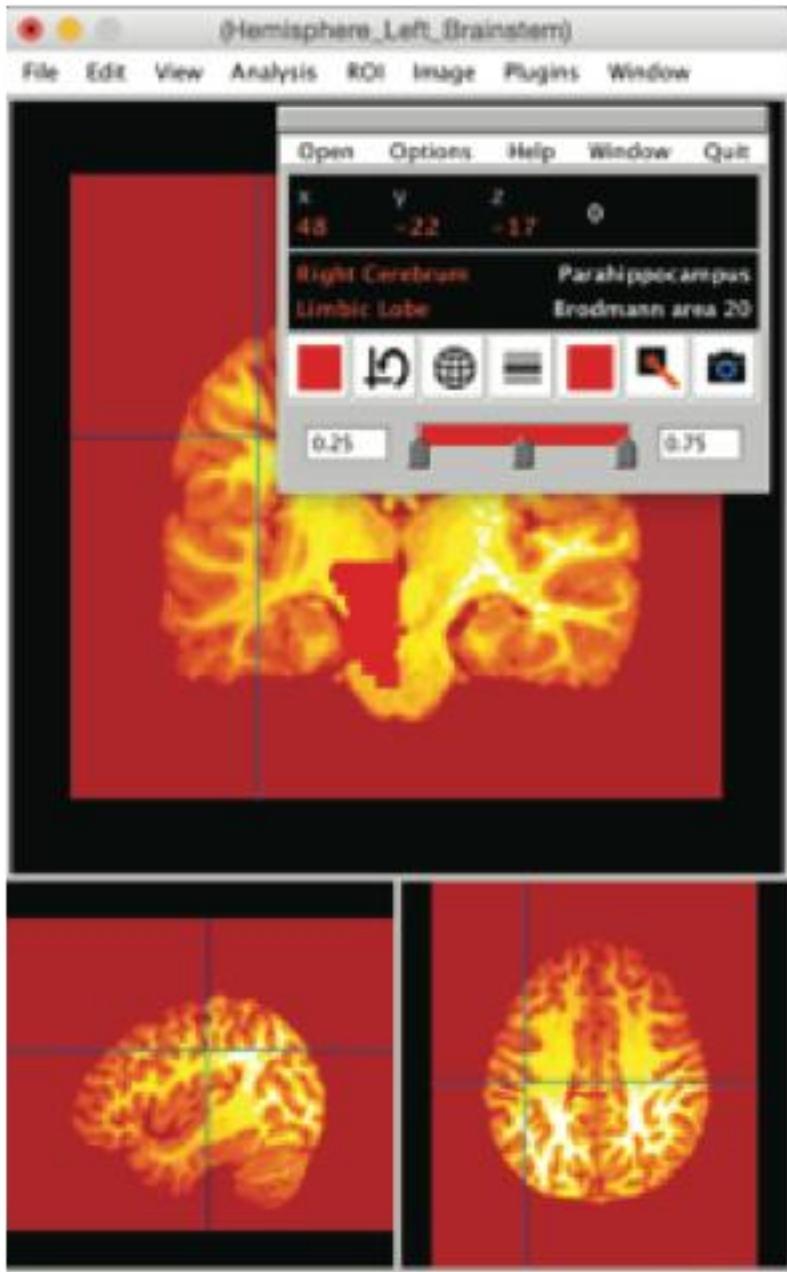
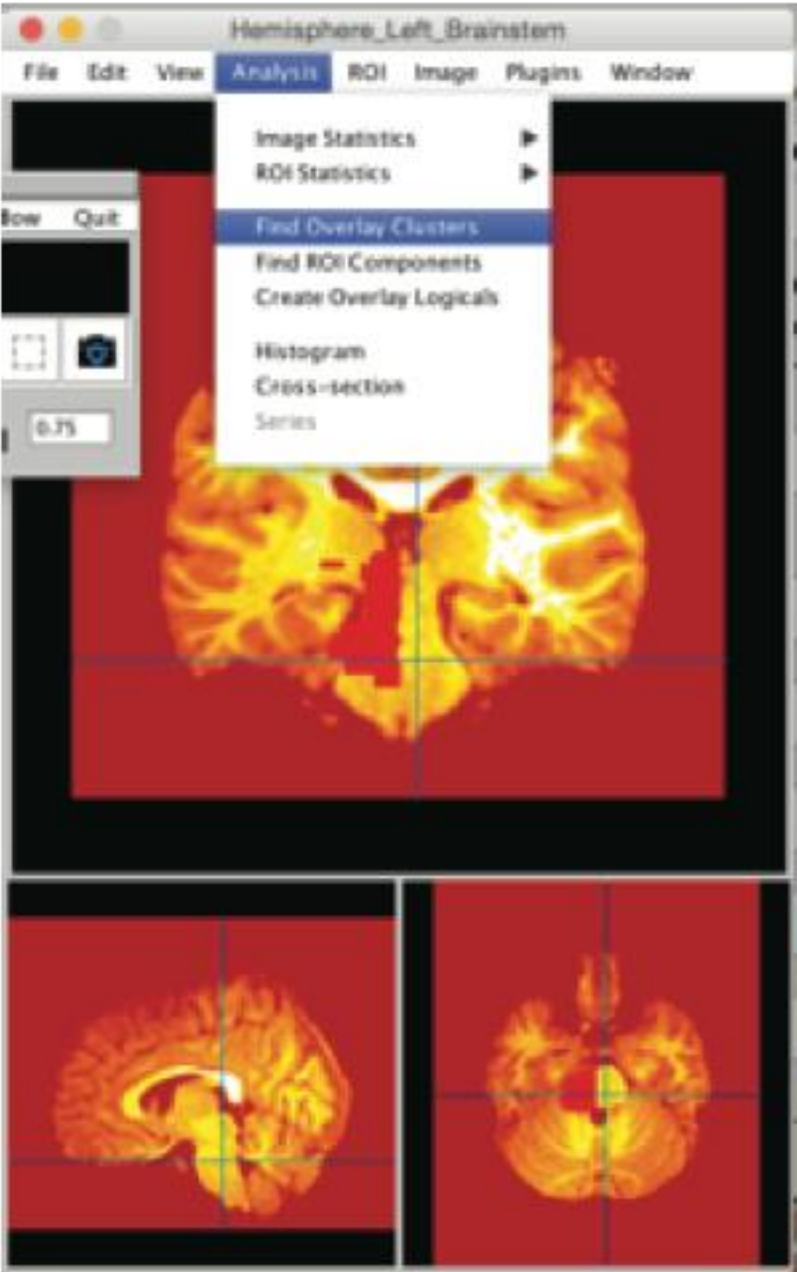
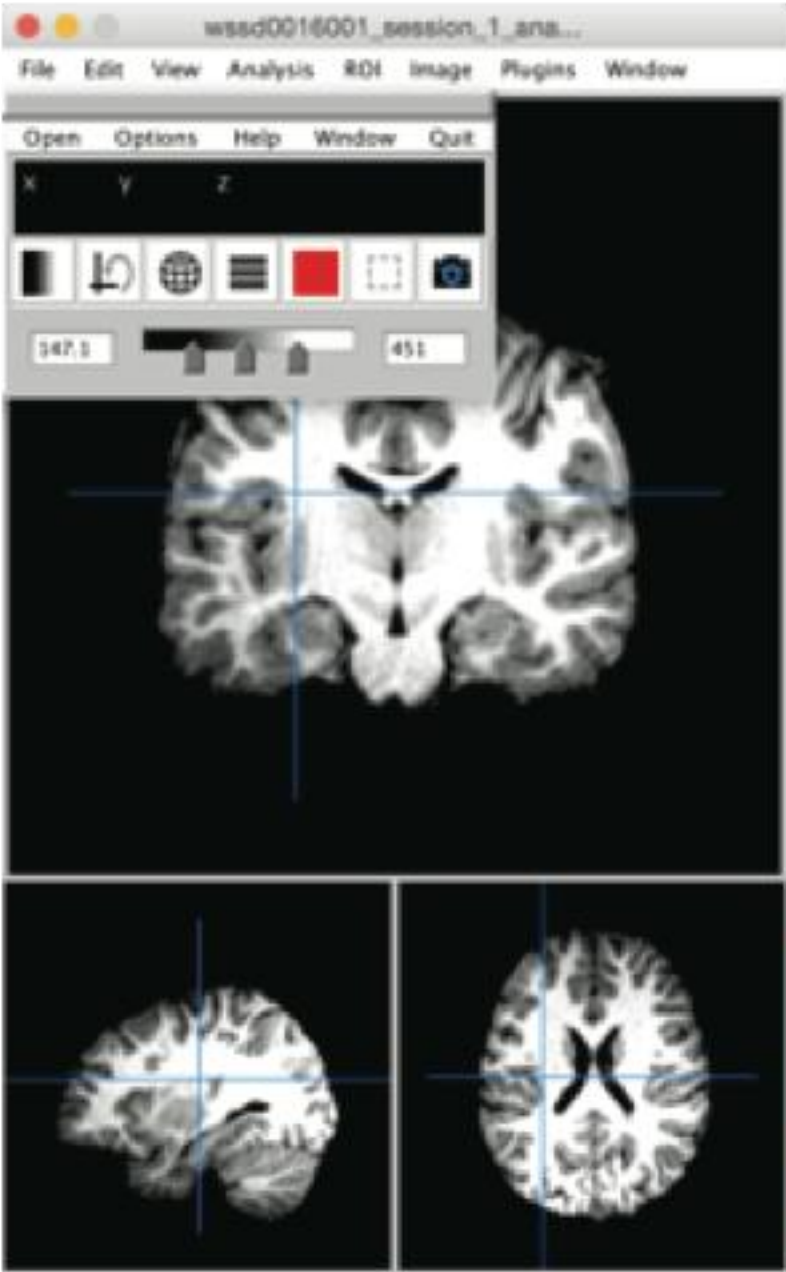
- Survey current software technologies in the field: what is lacking?
- Establish contact and relationship with researchers at Baycrest.
- Idea iteration

Survey of existing software for Brain Image analysis

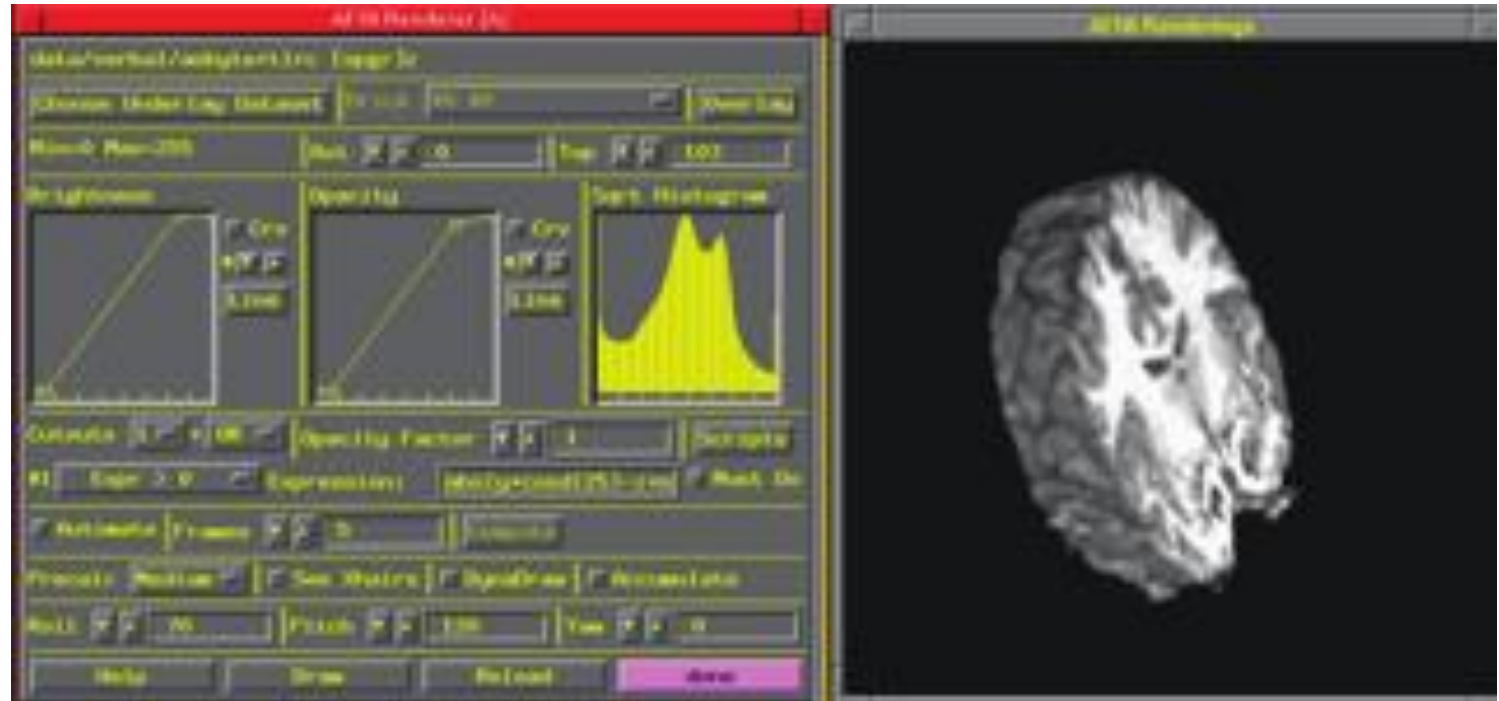
1) Matlab ISOCAPS



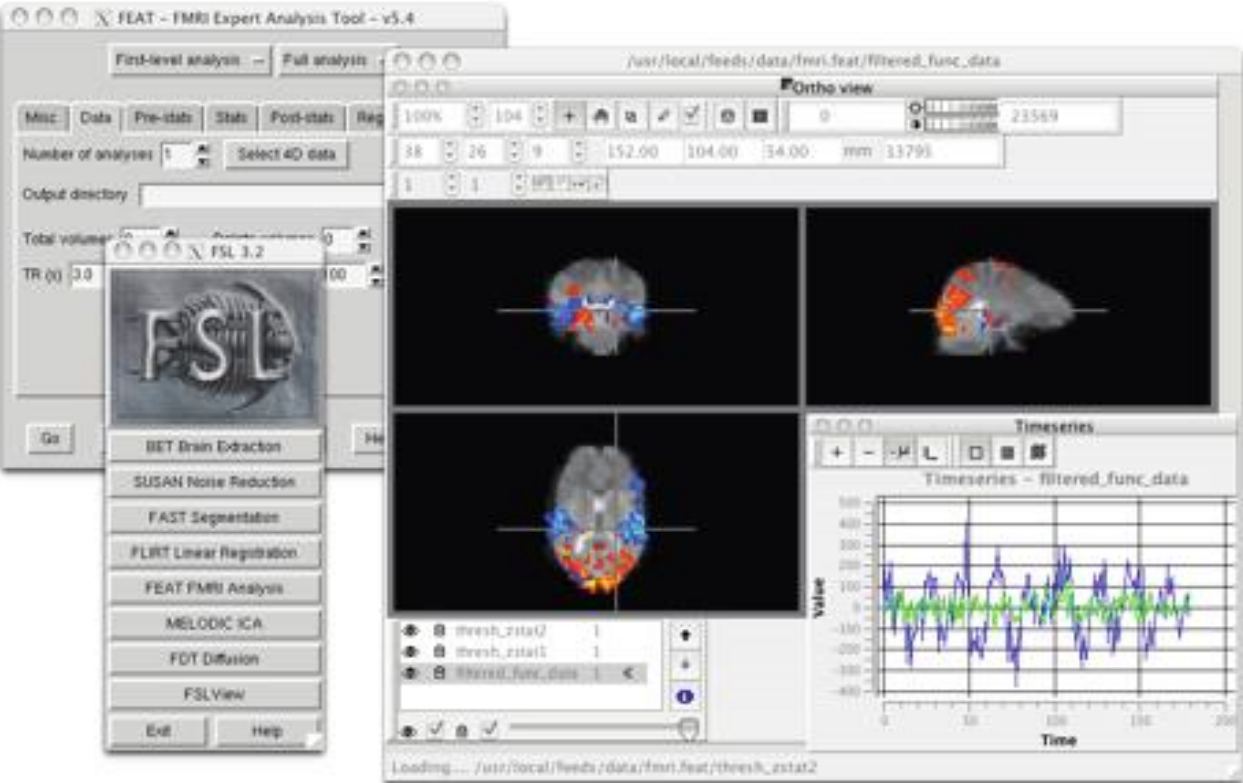
2) MANGO



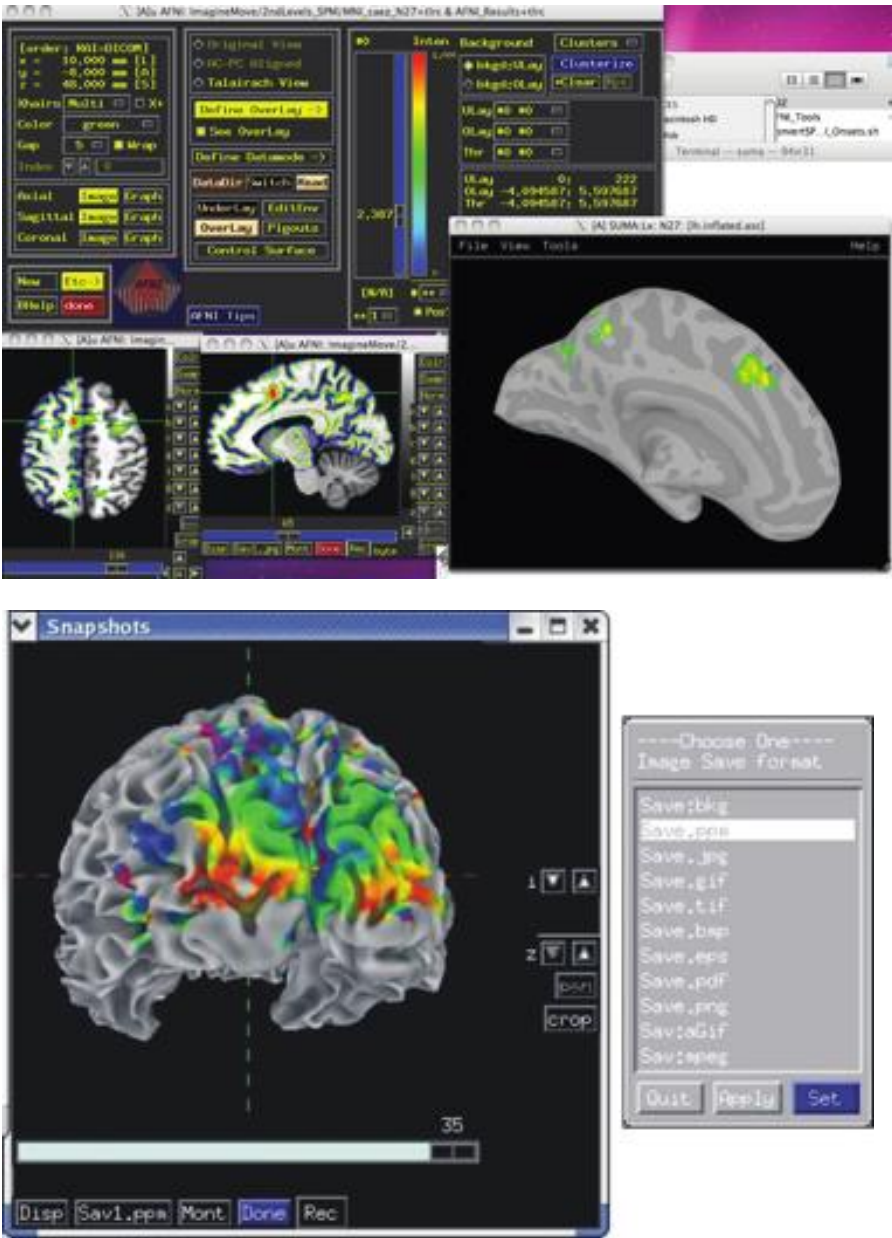
3) AFNI



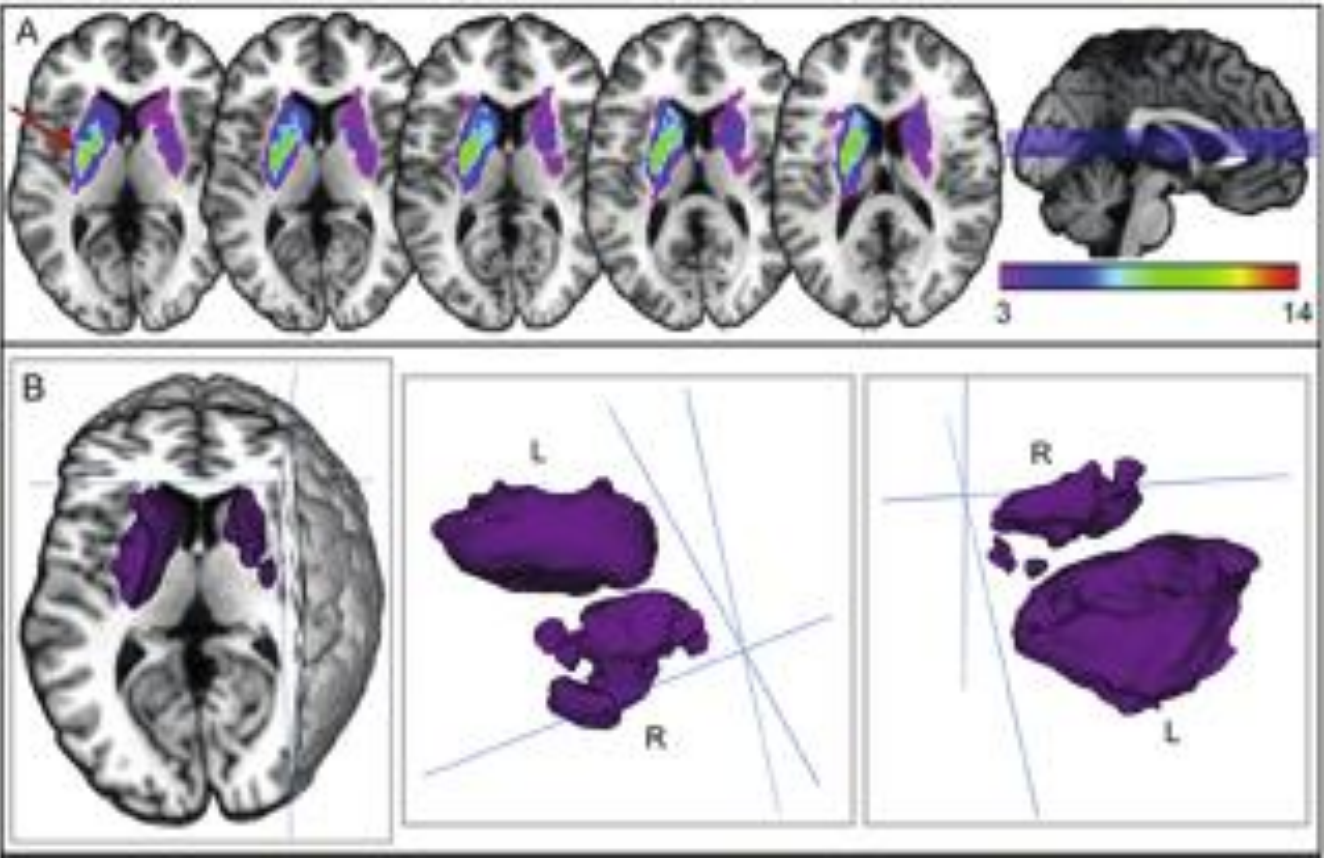
4) FSL



5) SUMA



6) MRICron



Given what is out there, what can we contribute?

We have explored two possible directions:

1. Create a visualization that allows users to view many brains (overview and pan), which still allows users to view detail on a single brain (zoom).
2. Create visualizations for abstracted brain data (Connectome network diagrams).

1. Create a visualization that allows users to view many brains.

What can we add?

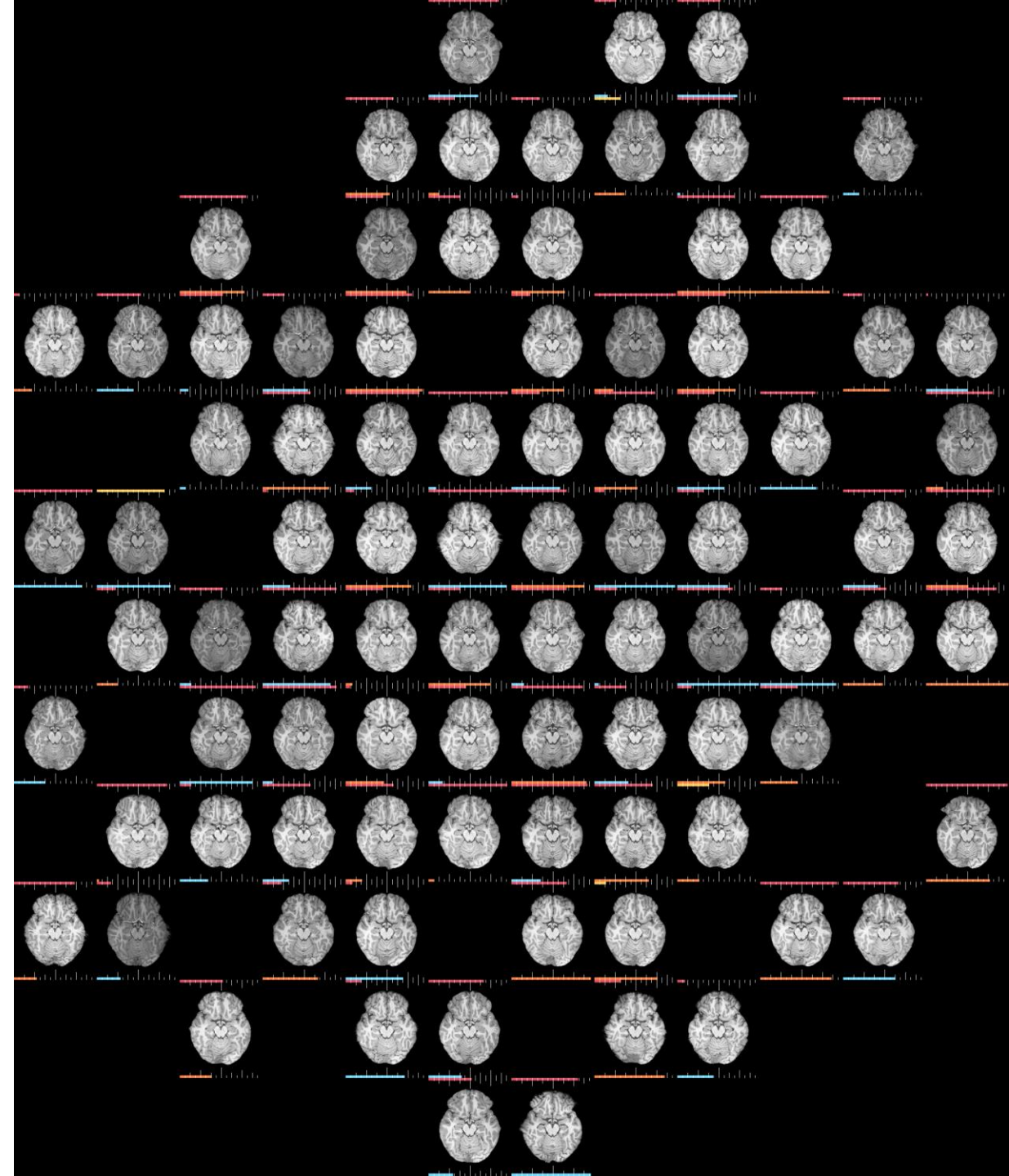
- Skydive lends the ability to rapidly pan and zoom over a large database
- Our visualization can include algorithms that sort the data by visual features.
This could be useful for technicians reviewing the scans.

Example:

Using Python's OpenCV library, images can be sorted by Histogram of Gradients (HOG) features.

Problems:

- Leads to software that is too specialized – not generalizable
- Matching computer-perceived features to human-perceived features is a difficult machine learning problem.



2. Convert fMRI data to connectome data

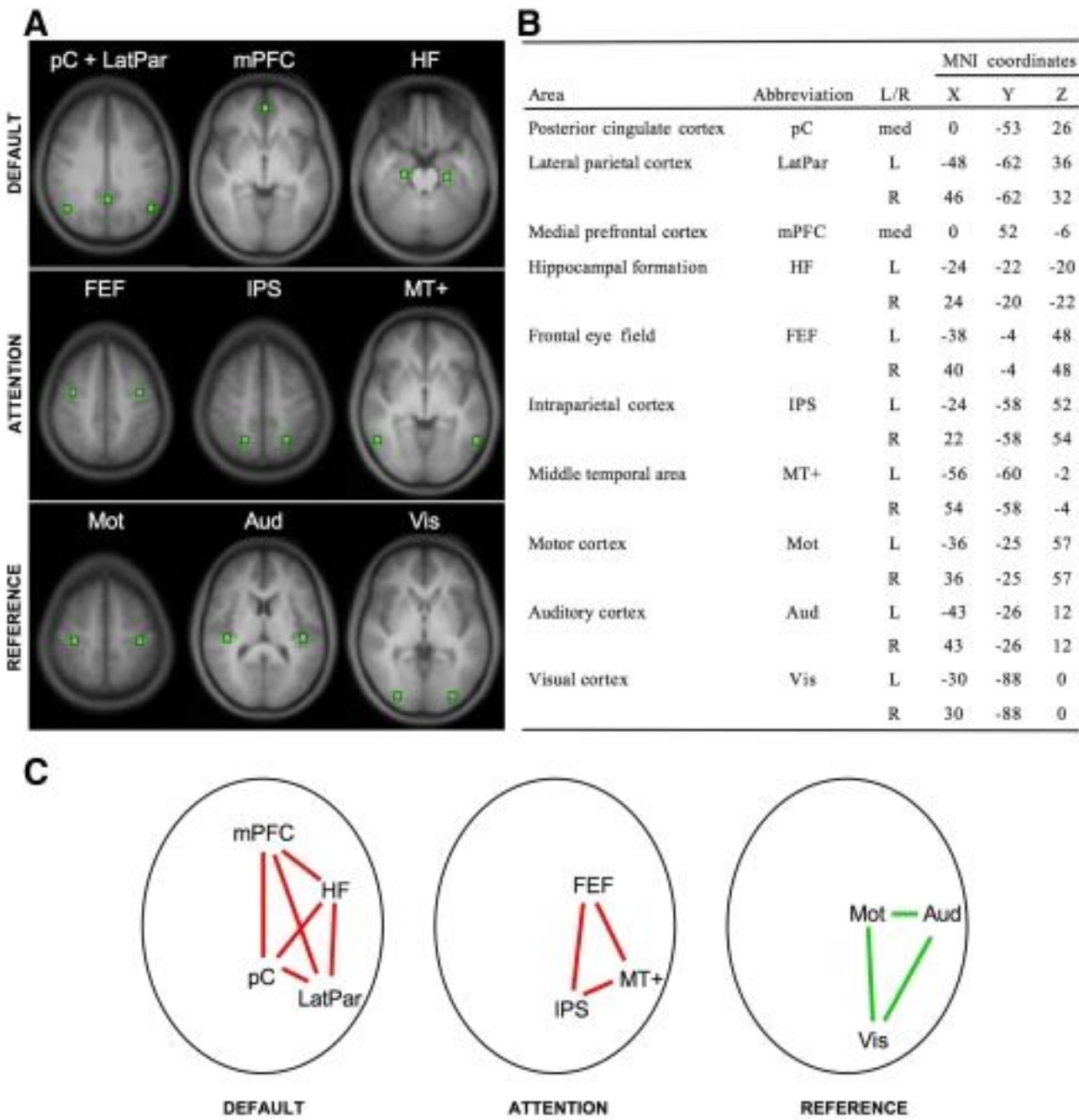
Problem is transformed into a network visualization problem.

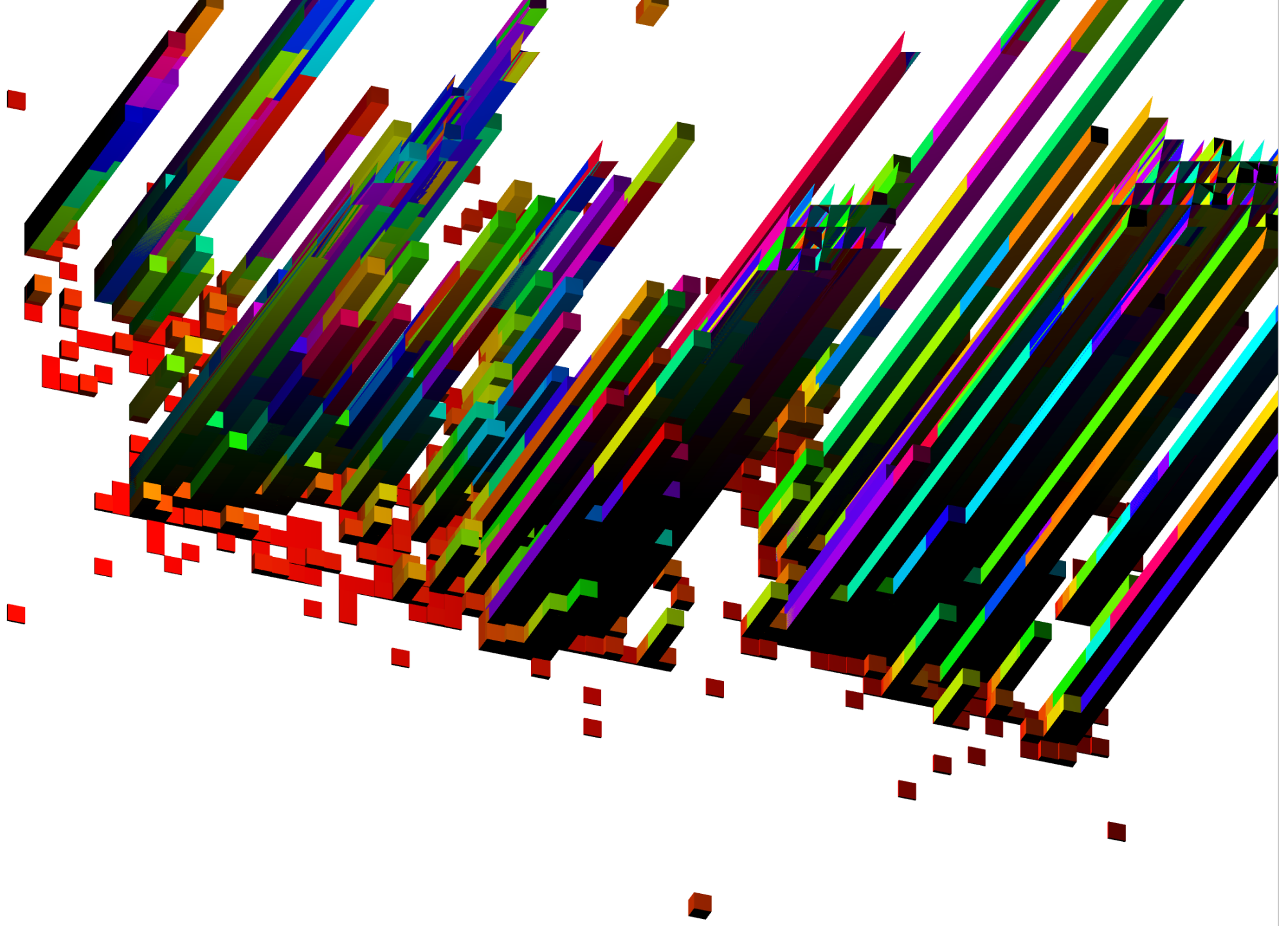
Some Advantages:

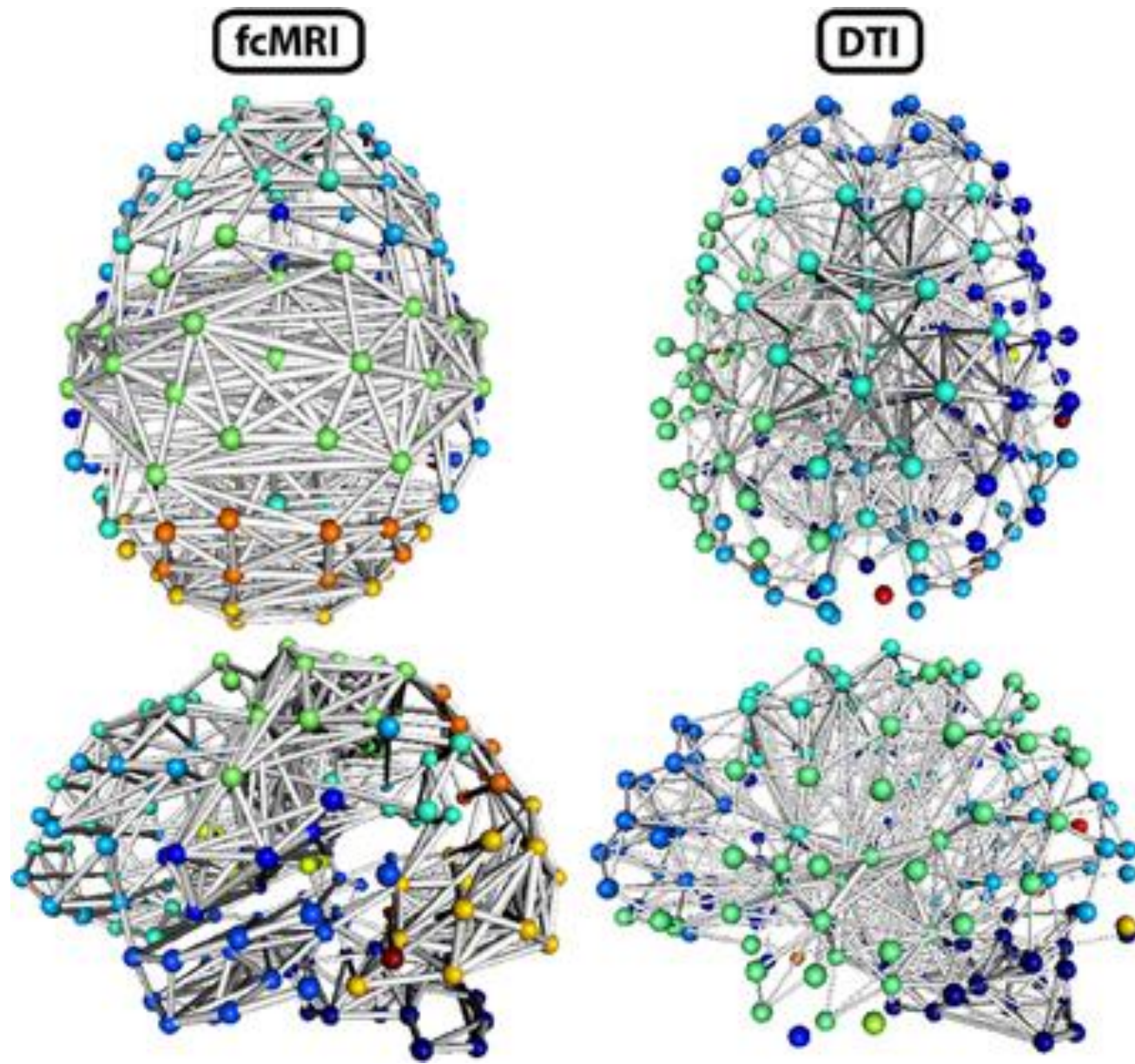
- Network visualizations are applicable and of interest across disciplines: solution can be applied across domains.
- Taps into a hot research topic

Image from:

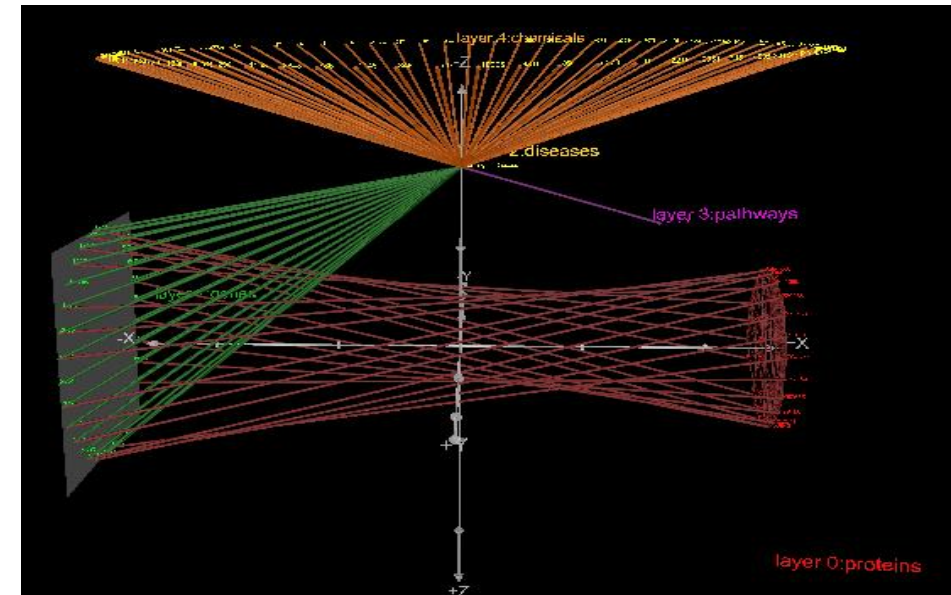
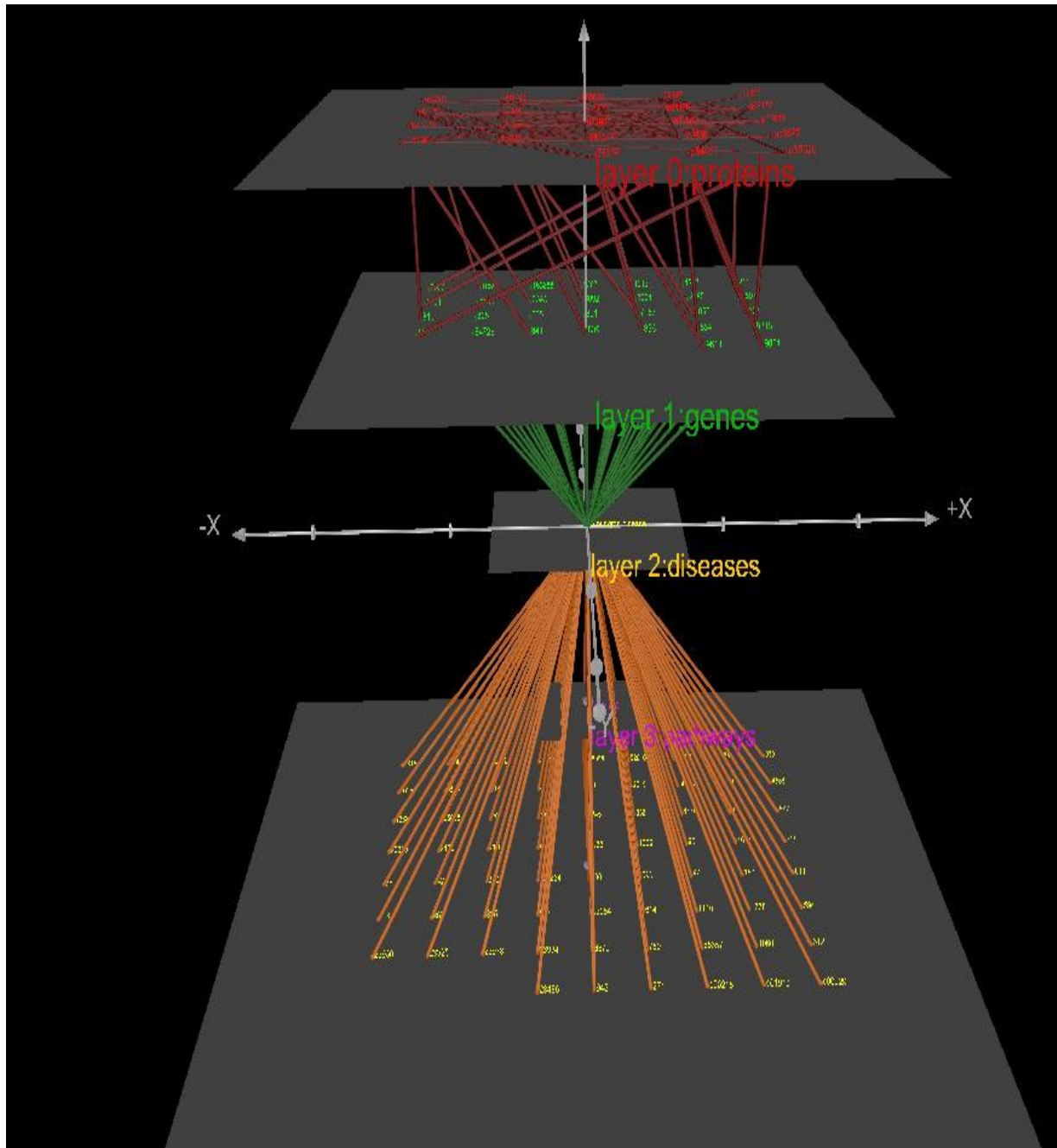
[J Neurophysiol](#). 2010 Jan; 103(1): 297–321.
Published online 2009 Nov 4. doi: [10.1152/jn.00783.2009](https://doi.org/10.1152/jn.00783.2009)







Existing Software for Imaging 3d bio networks: ARENA 3D



What can we add to this?

- Skydive capabilities (explore large networks)
- Calculate connectivity while visualizing the network:
 - Currently, connectivity is first calculated separately, then resulting network is viewed. Maybe we can build a system that bundles these steps?
 - Raw data is similar in structure to urban taxi pick up and drop off data, already demonstrated in Skydive.



This data sculpture changes according to how much energy is being consumed in the building. The most energy is being used when the sculpture is closest to the floor.



This data sculpture changes according to how much energy is being consumed in the building. The cloud becomes greyer as more energy is consumed.



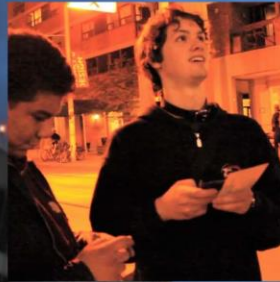
This data sculpture proposal changes according to how much energy is being consumed in the building. The electrical outlets express concern when too much energy is being consumed.



This data sculpture proposal changes according to how much energy is being consumed in the building. The battery symbol becomes fully charged when energy use is high.

E-Tower

*CN Tower light system shows activity of over 5000 mobile phone users during Nuit Blanche event
(Patricio Davila & Dave Colangelo with
CN Tower and Rogers Communication, 2010)*



SEND e-
TOWER
YOUR e-
NERGY,
TEXT
“energy”
AND YOUR
COM-
MENTS TO
667242



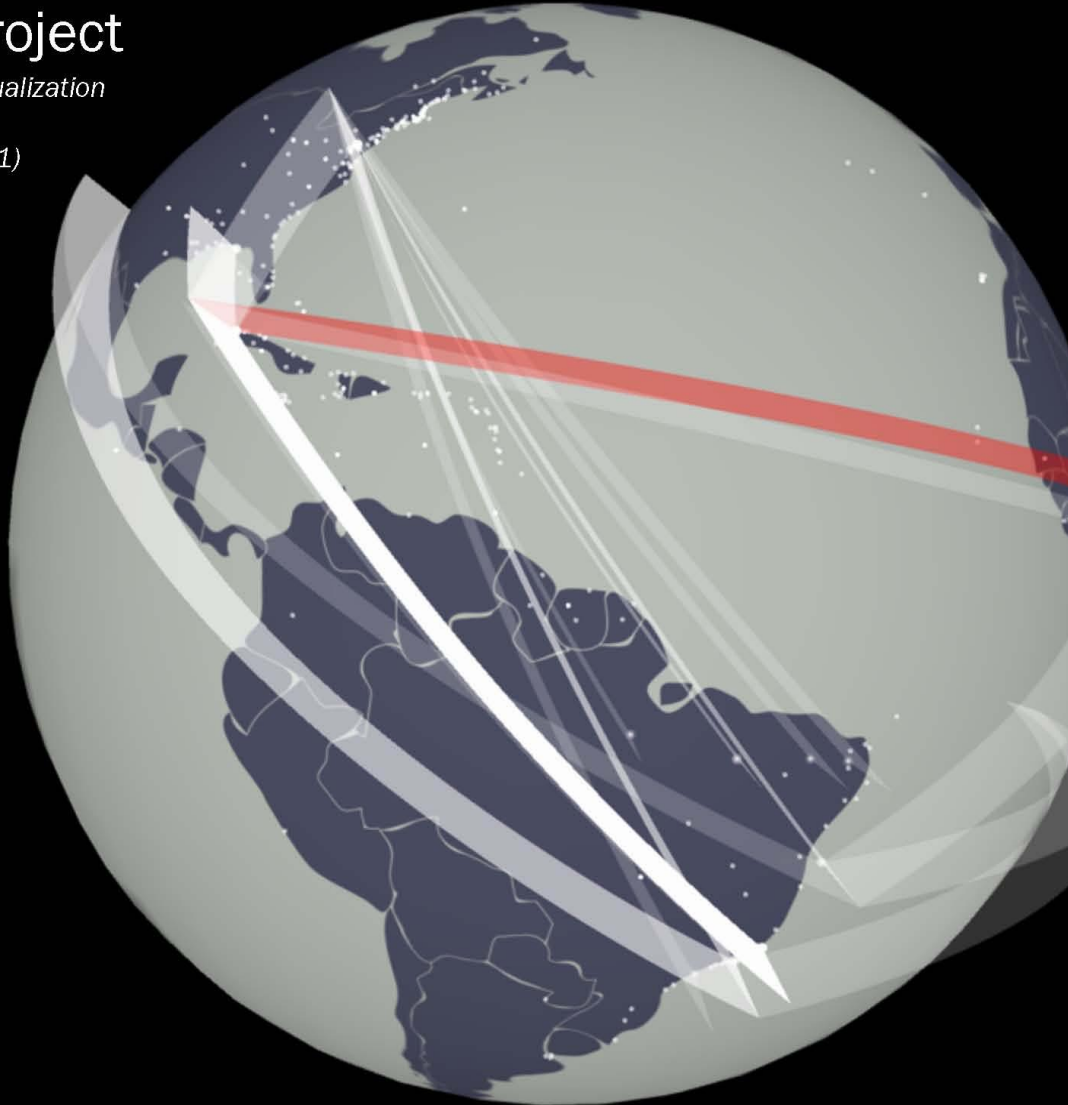
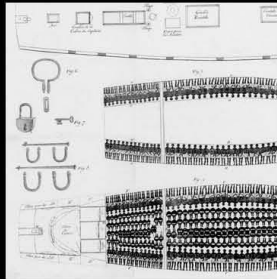
Parkdale Versions

*Community-based geo-located mapping and 3D modelling
project with public interaction installation
(Patricio Davila and Dan McCafferty with Toronto Public Library, 2011)*



African Diaspora Project

*Prototype for immersive and tablet visualization
of African Slave Voyage Database
(Patricio Davila and Caitlin Fisher, 2011)*



every(all at(toge(forever)ther)once)thing

*Flocking bits trace paths over bp nichol poetry;
21-channel HD video installation at
Sony Centre of the Performing Arts for Digifest 2011
(Patricio Davila and Justin Stephenson, 2011)*





The CBC Newsworld Holodeck is an interactive video installation that allows users to browse and search a massive digitized “big data” collection of 24-hour news from the CBC, Canada’s national broadcaster, which spans a 24-year period from 1989-2013.



MAKING DIGITAL MATTER

SURGICAL TRAINING FETUS

Surgeons require expert skills prior to performing high-risk surgical procedures in utero and on newborns. Highly representational 3D fetal models, with lifelike physical properties, do not exist. The goal of **Making Digital Matter—Surgical Training Fetus** is to create a series of accurate and responsive models to help surgeons visualize the complex physiology of a newly developing fetus and their associated pathologies. These models will provide surgeons with the tangible and tactile information necessary to confidently implement highly complicated in utero surgical procedures.

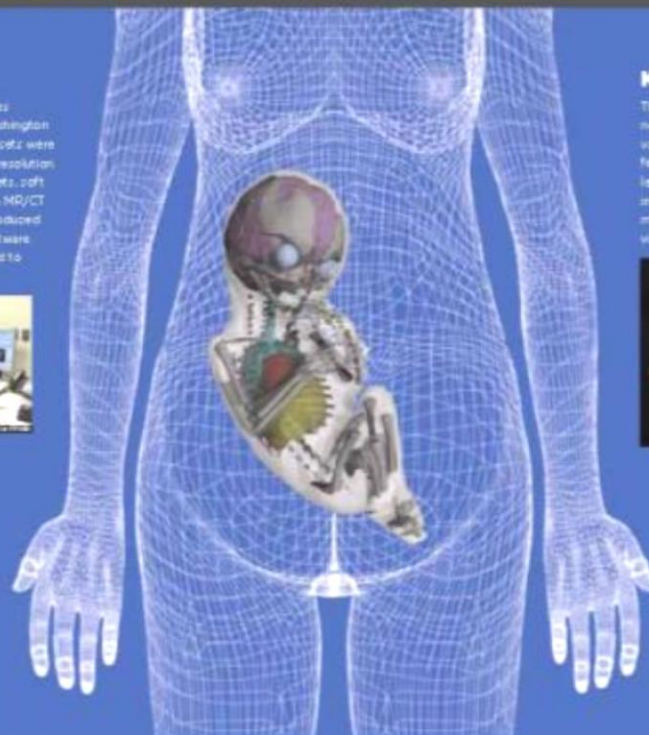
Professor Francis LeBouthillier, AOCA, MFA

METHOD

In order to produce models, we acquired data from numerous sources including the Human Developmental Anatomy Center (HDAC) in Washington and the Virtual Human Embryo Project. We found that existing data sets were not comprehensive enough and we needed to acquire our own high-resolution data sets for the desired outcome in order to represent vital organ sets, soft tissue and skeletal structures. Newly acquired data was derived from MR/CT scans of fetal specimens produced at STTARR. The MR/CT scans produced cross-sections and were analyzed using AMIRA medical imaging software. The soft tissue and skeletal structures were identified and segmented to produce comprehensive 3D data sets.



Data sets were resolved using a variety of mesh mending software (MeshLab) to make the data usable in a 3D modeling environment. Then these data sets were sculpted using digital software (Hudon and Rhin) and 3D printed using the Connex500 Objet 3D printer at Javelin Technologies. These digitally 3D printed forms were employed in a complex moulding system to produce a 3D plastic model containing vital organs, skeletal and soft tissue structures that have tactile and lifelike characteristics.



KEY FINDINGS

The current prototype model has been developed to reflect a healthy fetus. It is now ready for the research team to generate a series of modules that contain various fetal pathologies. These modules will be integrated into the standardized fetus (healthy fetus). The resulting fetal models will be designed to simulate a laparoscopic and ultrasound guided in utero surgical procedures and interventions on newborns. The continued refinement and development of the material properties of these models will enable surgical teams to use crucial visualization tools (MR scans) to guide in vivo perinatal surgeries.



IMPACT

The premise of the project is to continue to assist in the facilitation of in utero surgeries that can address a number of fetal and/or debilitating pathologies such as:

- Congenital Diaphragmatic Hernia (FETO) fetal endobronchial occlusion
- Fetal Oral Teratoma (laparoscopic removal of tumor)
- Fetal Bladder Obstructions (laparoscopic incision of tube into fetal bladder)
- Aortic or Pulmonary Valvuloplasty (opening the aortic or pulmonary fetal heart valves to allow blood flow)
- Atrial Septostomy (opening the inter-atrial septum of the fetal heart to allow unobstructed blood flow between the atria)
- Critical Aortic Stenosis (enlarging of the main output valve of the left ventricle)
- Spina Bifida (laparoscopic closure of the malformation)

Can we equip surgeons with an accurate and responsive fetal models that have been developed from MR/CT scans to affect devastating fetal development?

