

# OurCS: Augmented Reality Visualizations of IoT

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School of Informatics, Computing and Engineering  
Indiana University, USA

*OurCS Event at Indiana University*

*Oct 26-28, 2018*



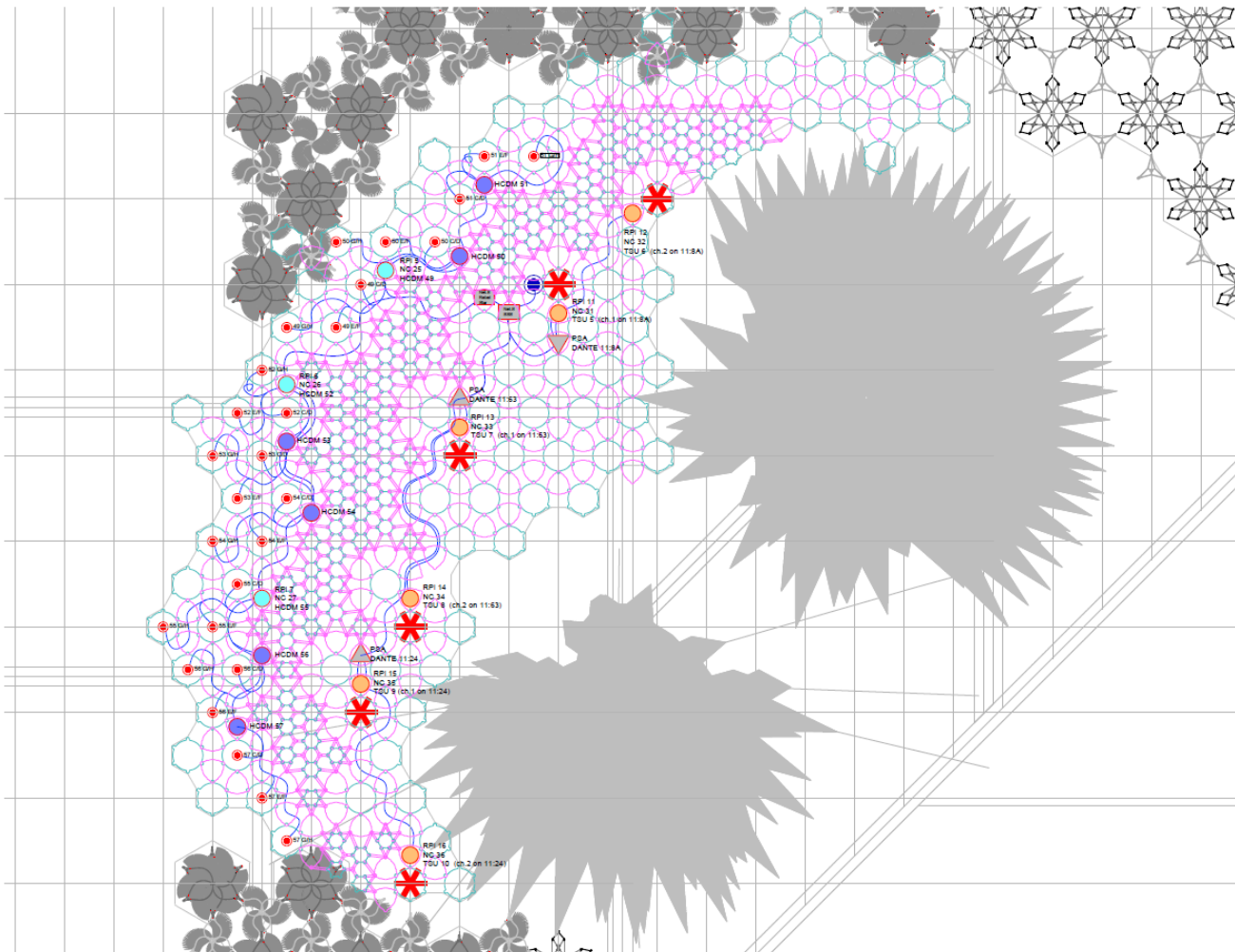
**Using Big Data for Visualizing Living Architectures.** International Research Partnership Grant, University of Waterloo, Canada (Philip Beesley, Dana Kulic, Katy Börner) Feb 17 - Jan 18.



AMATRIA  
Sentient Architecture



<https://cns.iu.edu/amatria.html>



PBAI / LASG

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 web: livingarchitecturesystems.com  
 tel: 416 766 8284

By	Date	Status	Rev By	Rev Date
JP	18/04/02	As-Built	TB	18/06/13

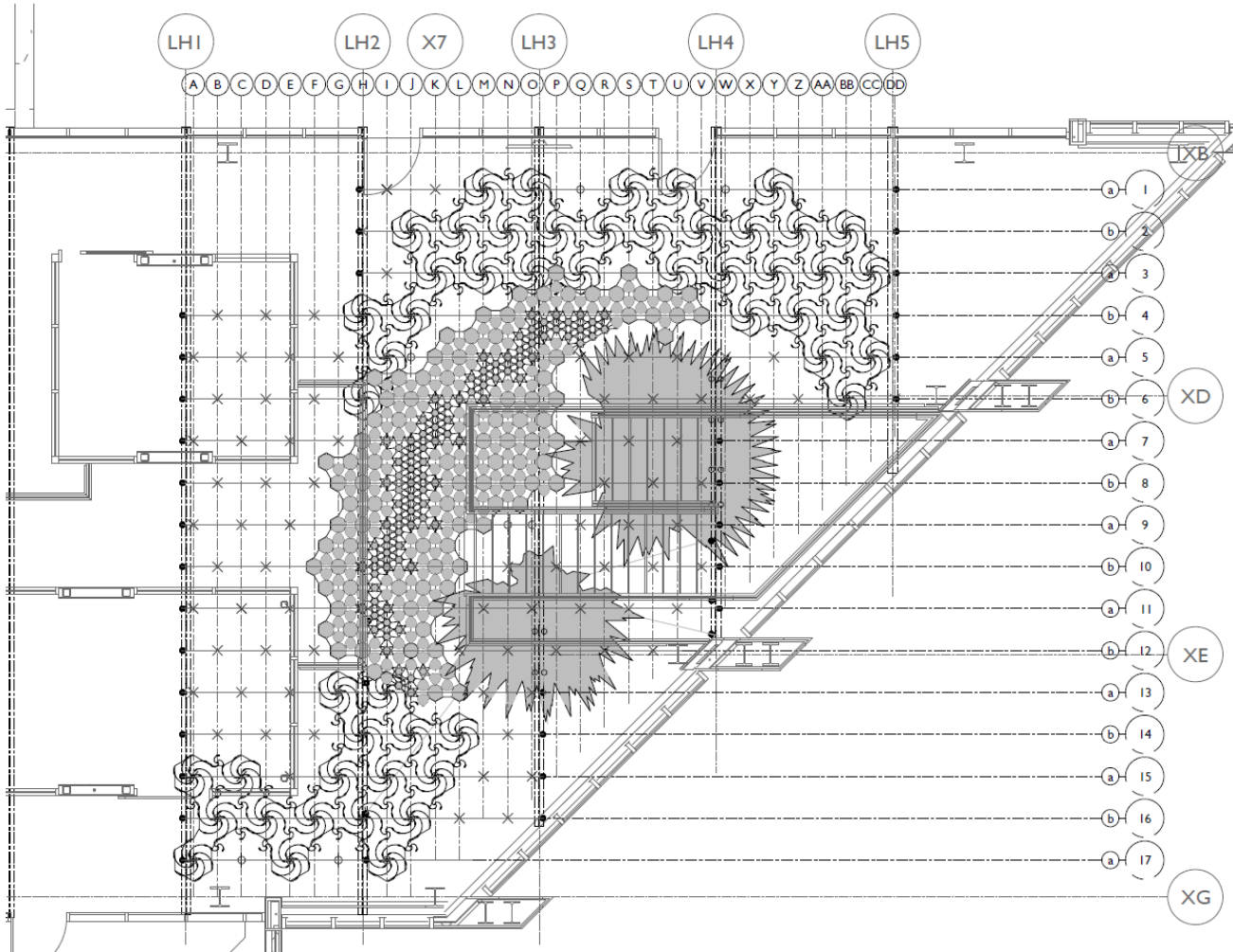
Notes

Phase  
 Maintenance Manual

Project  
 17540 Luddy Hall - Amatria

Drawing Title  
 Device Locator - Springfield Canopy

Sheet  
 M102



Living Architecture  
Systems Group/  
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By	Date	Status	Rev By	Rev Date
TB	18/02/09	DRAFT	MF	18/02/09
TB	18/02/13	DRAFT	VF	18/02/13
TB	18/02/16	DRAFT	PB	18/02/16

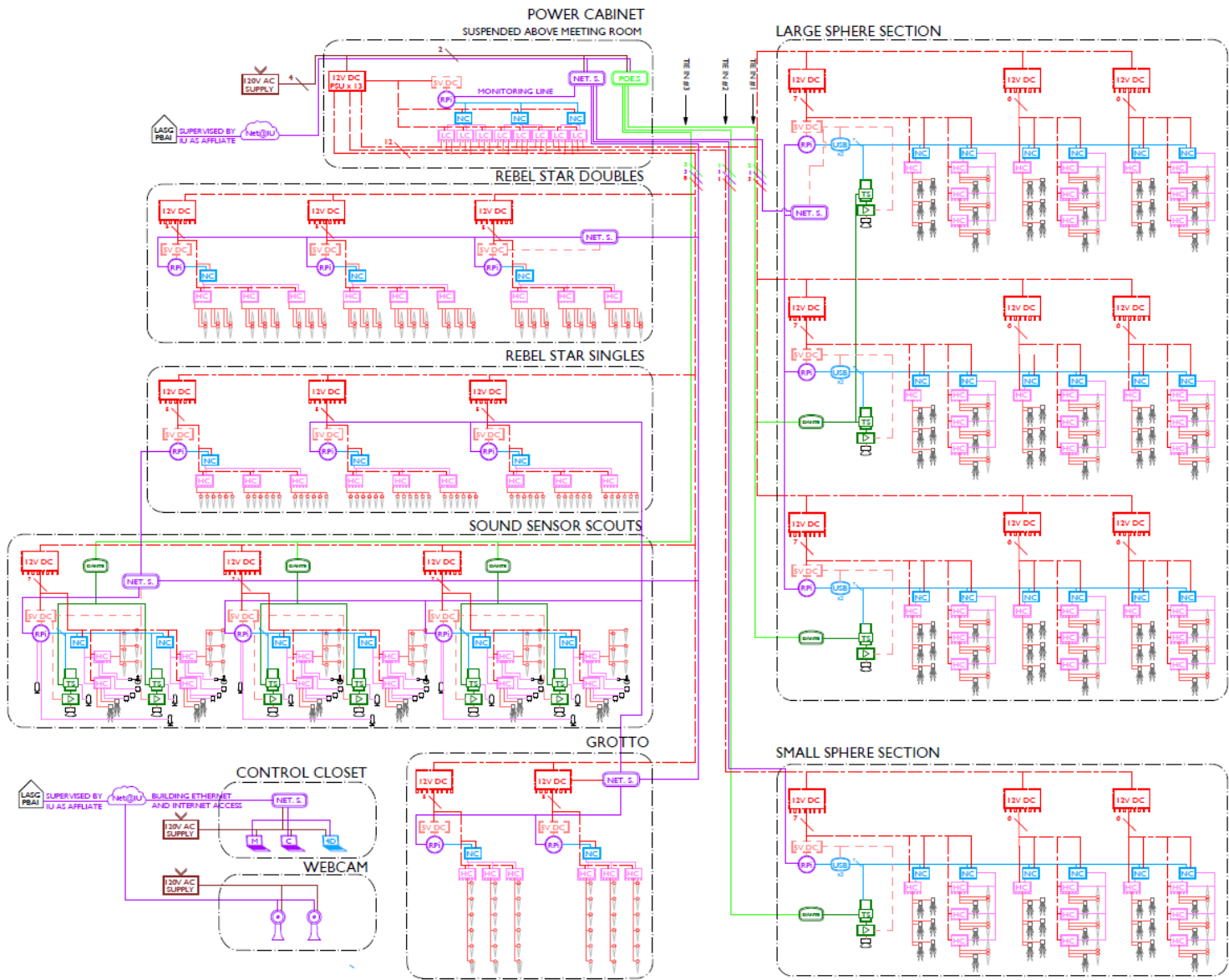
Notes

Phase  
Schematic Design

Project  
17540 Luddy Hall

Drawing Title  
Sculpture Master Plan

Sheet  
A102



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By	Date	Status	Rev By	Rev Date
MH	01/03/08	Draft		

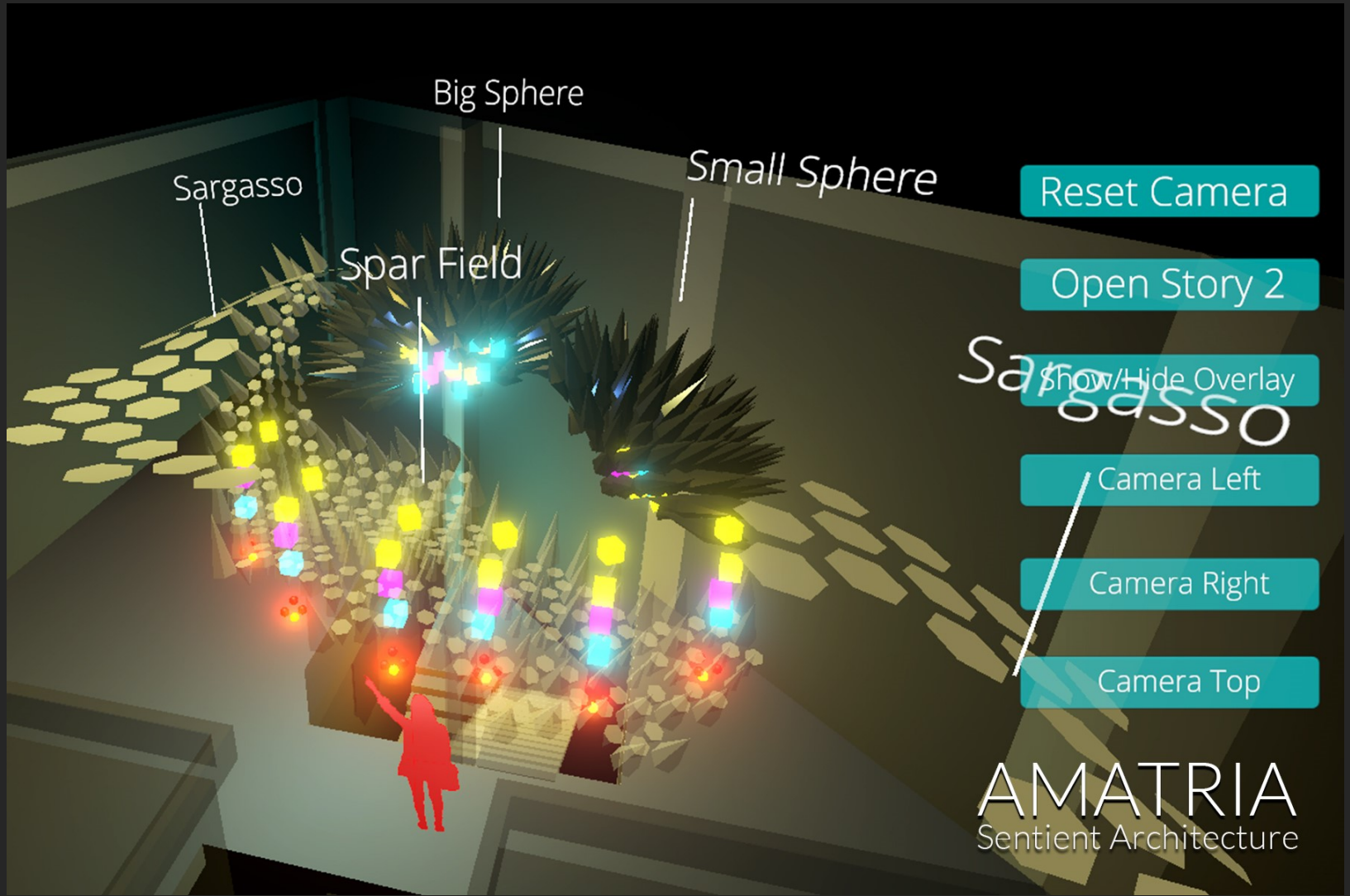
DRAWING LEGEND


Phase  
Design  
Development

Project  
17540 Luddy Hall

Drawing Title  
Electronic Schematic

Sheet  
IS10-



Big Sphere

Sargasso

Small Sphere

Spar Field

Reset Camera

Open Story 2

Sargasso  
Show/Hide Overlay

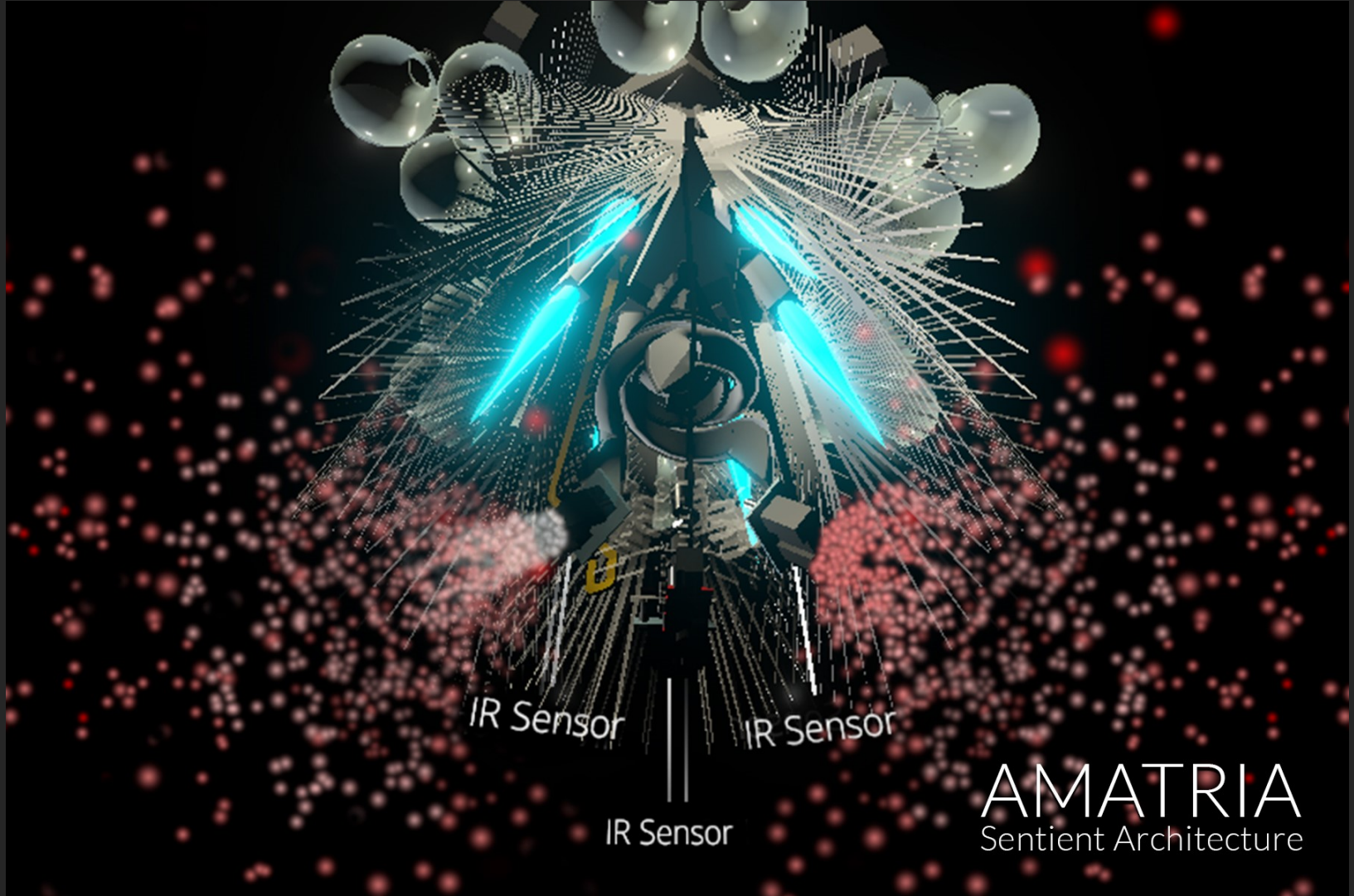
Camera Left

Camera Right

Camera Top

AMATRIA  
Sentient Architecture





IR Sensor

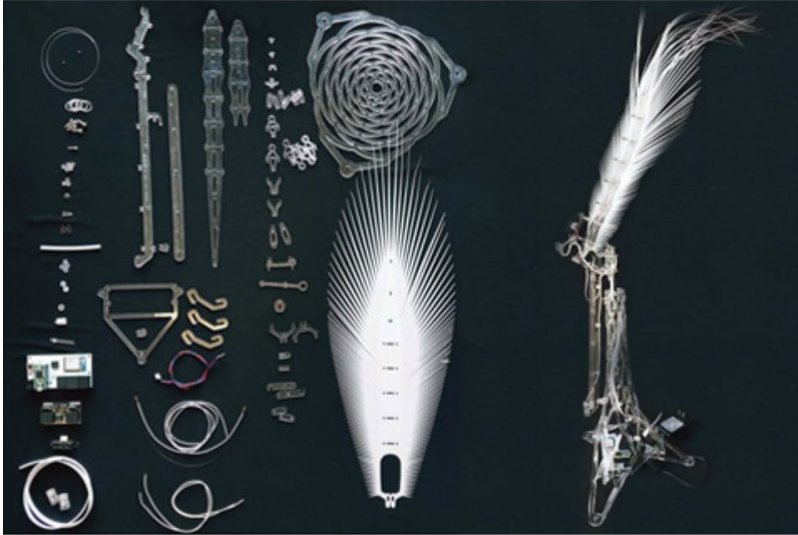
IR Sensor

IR Sensor

AMATRIA  
Sentient Architecture

## Amatria Dendrite

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*Amatria* Dendrites, on display in the Luddy Hall Visualization Lab (room 4012), are pieces of living architecture. Each comprises one light sensor (the eye) and actuators such as lights and a strand of shape memory alloy that makes the sculpture move. Software controls the sensor and actuators. Dendrite fields were built in the 2017 ISE Summer camp. See below for events and activities where you can build or view dendrites.

Resources: [Amatria Dendrite Manual](#) | [Code on GitHub](#)

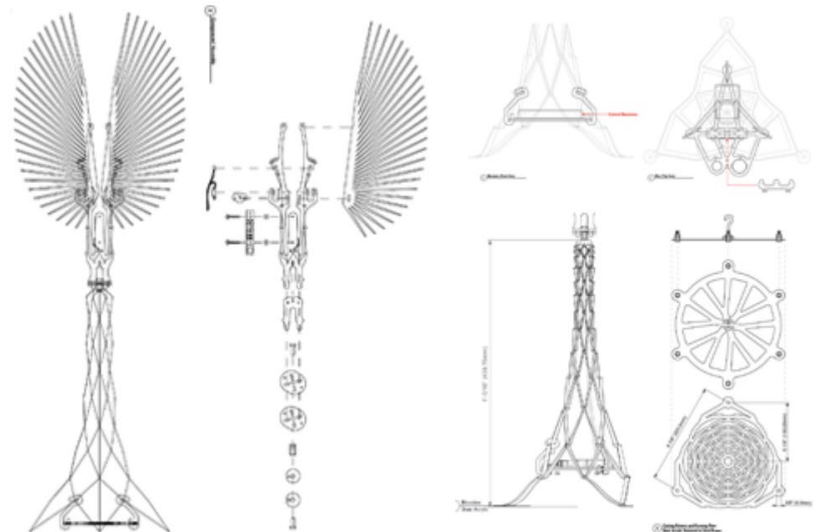
## Amatria Moth

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*Amatria* Moths, on display in the Luddy Hall Visualization Lab (room 4012), are the newest generation of *Amatria*-related architectural elements. For a limited time you can purchase a moth kit and build one yourself. Kits are \$25 and can be ordered at [go.iu.edu/moth](https://go.iu.edu/moth). See below for additional events and activities where you can build or view moths.

Resources: [Amatria Moth Manual](#)

<https://cns.iu.edu/amatria.html>



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By	Date	Status	Rel By	Rel Date
LC	082418			

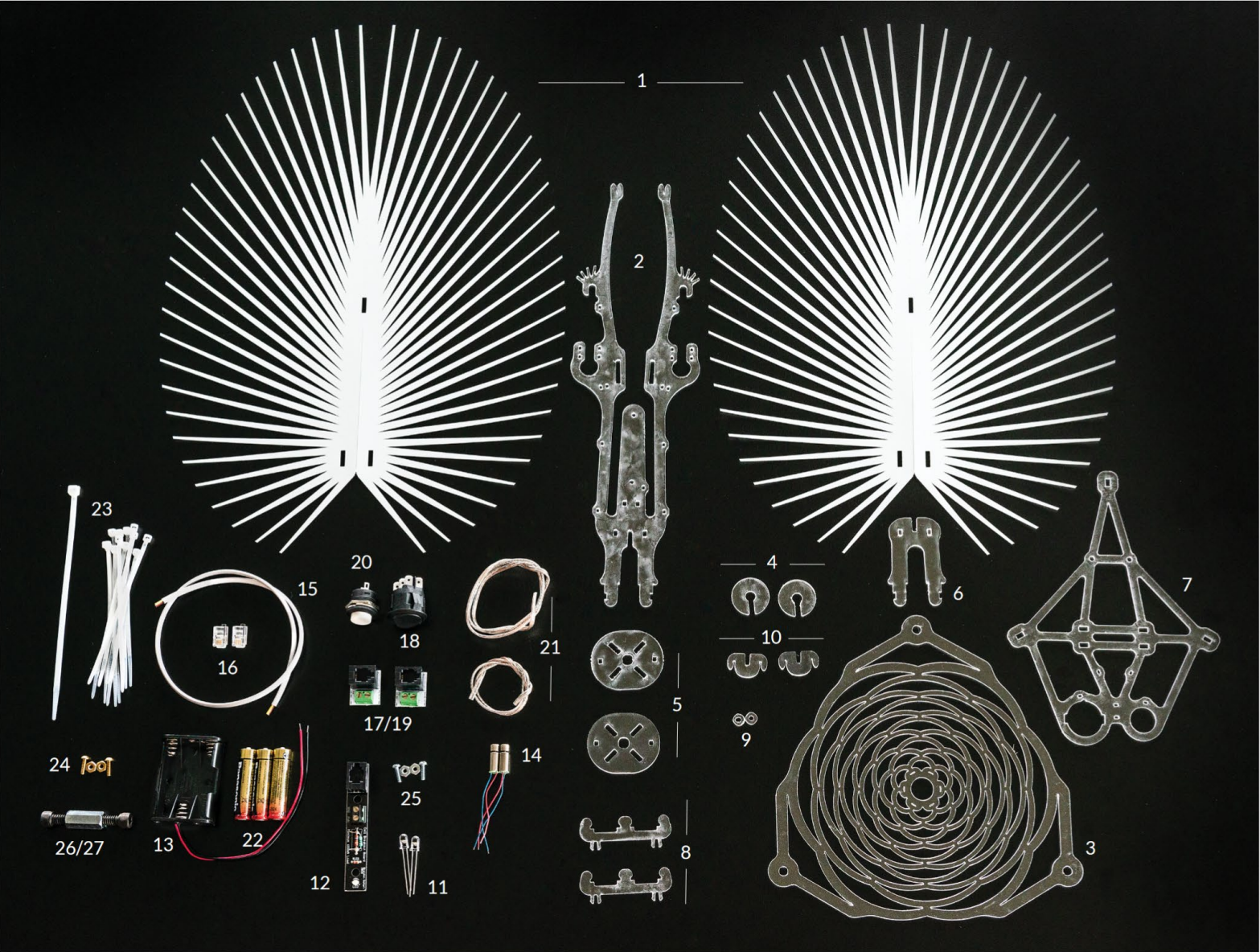
Notes

Legend

- 1. Frond (2)
- 2. Moth sled (1)
- 3. Spar (1)
- 4. Moth sled fastening (2)
- 5. Moth sled fastening plate (2)
- 6. Moth sled holder (1)
- 7. Electronics sled (1)
- 8. Electronics sled fastener (2)
- 9. Acrylic washer (2)
- 10. Frond fastener (2)
- 11. LED lightbulb (2)
- 12. Jack plate (1)
- 13. Battery pack (1)
- 14. DC motor (2)
- 15. Flat 4P short cable (47cm) (1)
- 16. Modular plug end (2)
- 17. Moth breakout board (2)
- 18. DPDT switch (2)
- 19. 4P4C jack (2)
- 20. Momentary button (1)
- 21. 24AWG speaker wire (2)
- 22. AAA battery (3)
- 23. Zipties (12 sm, 1 lg)
- 24. Screw & washers for battery pack (2 ea)
- 25. Screw & washer for moth sled (2 ea)
- 26. Large plastic screw (2)
- 27. Metal sleeve for large plastic screw (1)

Project  
**Amatria Moth**

Title  
**Amatria Moth Parts**





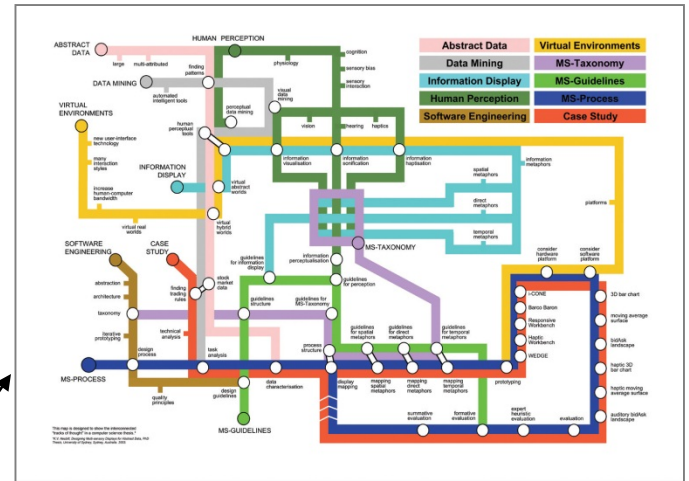
Register for free: <http://ivmooc.cns.iu.edu>.

# Different Question Types



Terabytes of data

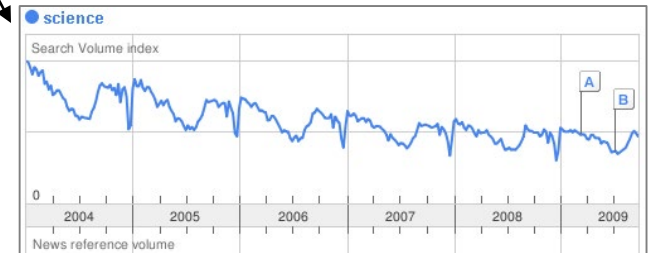
Descriptive & Predictive Models



Find your way



Find collaborators, friends

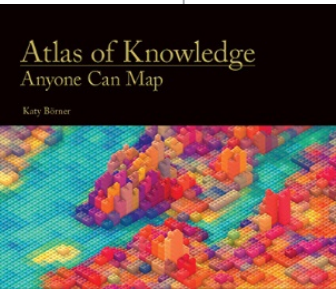


Identify trends

# Tasks

## LEVELS

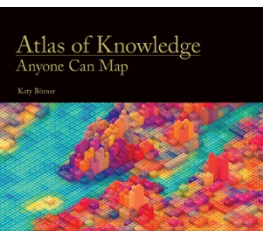
	<b>MICRO: Individual Level</b> about 1–1,000 records page 6	<b>MESO: Local Level</b> about 1,001–100,000 records page 8	<b>MACRO: Global Level</b> more than 100,000 records page 10
<b>TYPES</b>			
<b>Statistical Analysis</b> page 44	 Knowledge Cartography page 135	 Productivity of Russian life sciences research teams page 105	 Science and Society in Equilibrium Number of scientists versus population and R&D costs versus GNP. page 103
<b>WHEN: Temporal Analysis</b> page 48	 Visualizing decision-making processes page 95	 Key events in the development of the video tape recorder page 85	 Increased travel and communication speeds page 83
<b>WHERE: Geospatial Analysis</b> page 52	 Cell phone usage in Milan, Italy page 109	 Victorian poetry in Europe page 137	 Ecological footprint of countries page 99
<b>WHAT: Topical Analysis</b> page 56	 Evolving patent holdings of Apple Computer, Inc. and Jerome Lemelson page 89	 Evolving journal networks in nanotechnology page 139	 Product space showing co-export patterns of countries page 93
<b>WITH WHOM: Network Analysis</b> page 60	 World Finance Corporation network page 87	 Electronic and new media art networks page 133	 World-wide scholarly collaboration networks page 157



See *Atlas of Science: Anyone Can Map*, page 5

# Visualization Framework

Insight Need Types page 26	Data Scale Types page 28	Visualization Types page 30	Graphic Symbol Types page 32	Graphic Variable Types page 34	Interaction Types page 26
<ul style="list-style-type: none"><li>• categorize/cluster</li><li>• order/rank/sort</li><li>• distributions (also outliers, gaps)</li><li>• comparisons</li><li>• trends (process and time)</li><li>• geospatial</li><li>• compositions (also of text)</li><li>• correlations/relationships</li></ul>	<ul style="list-style-type: none"><li>• nominal</li><li>• ordinal</li><li>• interval</li><li>• ratio</li></ul>	<ul style="list-style-type: none"><li>• table</li><li>• chart</li><li>• graph</li><li>• map</li><li>• network layout</li></ul>	<ul style="list-style-type: none"><li>• geometric symbols<ul style="list-style-type: none"><li>point</li><li>line</li><li>area</li><li>surface</li><li>volume</li></ul></li><li>• linguistic symbols<ul style="list-style-type: none"><li>text</li><li>numerals</li><li>punctuation marks</li></ul></li><li>• pictorial symbols<ul style="list-style-type: none"><li>images</li><li>icons</li><li>statistical glyphs</li></ul></li></ul>	<ul style="list-style-type: none"><li>• spatial<ul style="list-style-type: none"><li>position</li></ul></li><li>• retinal<ul style="list-style-type: none"><li>form</li><li>color</li><li>optics</li><li>motion</li></ul></li></ul>	<ul style="list-style-type: none"><li>• overview</li><li>• zoom</li><li>• search and locate</li><li>• filter</li><li>• details-on-demand</li><li>• history</li><li>• extract</li><li>• link and brush</li><li>• projection</li><li>• distortion</li></ul>



See page 24

# Graphic Variable Types Versus Graphic Symbol Types

			Geometric Symbols					
			Point		Line		Area	
Spatial	x	quantitative						
	y	quantitative						
	z	quantitative						
Retinal	Form	Size	quantitative	NA (Not Applicable)				
		Shape	qualitative	NA				
		Rotation	quantitative	NA				
		Curvature	quantitative	NA				
		Angle	quantitative	NA				
		Closure	quantitative	NA				
	Color	Value	quantitative					
Hue		qualitative						
Saturation		quantitative						

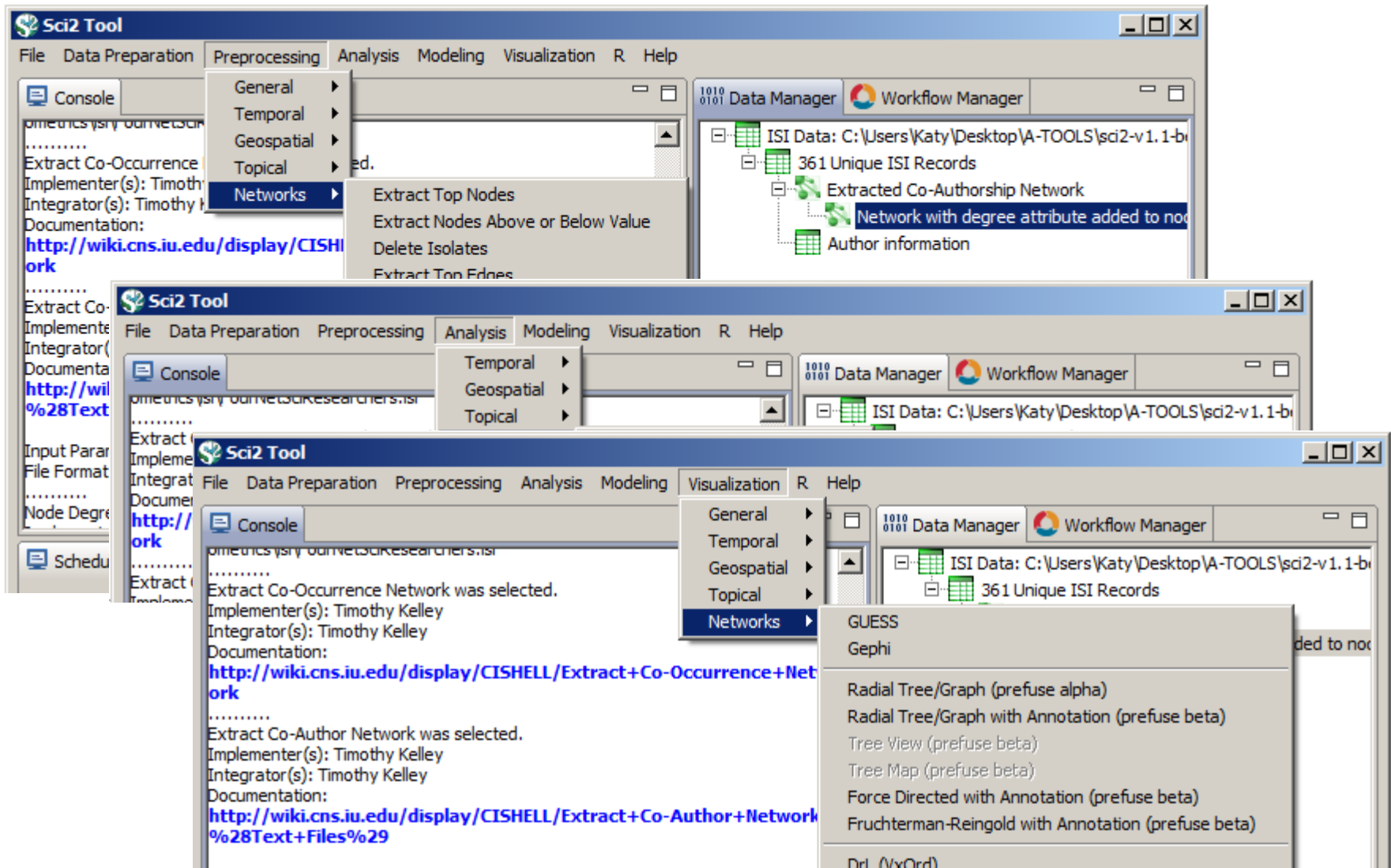


# Graphic Variable Types Versus Graphic Symbol Types

		Geometric Symbols					Linguistic Symbols Text, Numerals, Punctuation Marks		Pictorial Symbols Images, Icons, Statistical Glyphs	
		point	line	area	surface	volume				
Symbol	1									
	2									
	3									
Form	size	NA (Not applicable)								
	shape	NA								
	orientation	NA								
	curvature	NA								
	angle	NA								
	closure	NA								
	value									
	hue									
	saturation									
Texture	spacing									
	complexity									
	pattern									
	orientation	NA								
	accent									
	blur									
	transparency									
	shading									
	stereoscopic depth	Point in foreground - background	Line in foreground - background	Area in foreground - background	Surface in foreground - background	Volume in foreground - background	Text in foreground - background	Text in foreground - background	Image in foreground - background	Image in foreground - background
	speed									
Motion	velocity									
	rhythm	Blinking point slow - fast	Blinking line slow - fast	Blinking area slow - fast	Blinking surface slow - fast	Blinking volume slow - fast	Blinking text slow - fast	Blinking text slow - fast	Blinking icons slow - fast	Blinking icons slow - fast

# Sci2 Tool Interface Components Implement Vis Framework

Download tool for free at <http://sci2.cns.iu.edu>



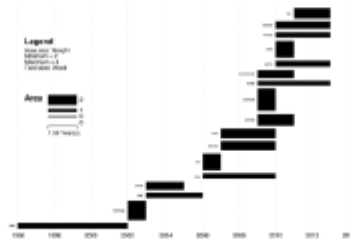
# Load **One** File and Run **Many** Analyses and Visualizations

Times Cited	Publication Year	City of Publisher	Country	Journal Title (Full)	Title	Subject Category	Authors
12	2011	NEW YORK	USA	COMMUNICATIONS OF THE ACM	Plug-and-Play Microscopes	Computer Science	Borner, K
18	2010	MALDEN	USA	CTS-CLINICAL AND TRANSLATIONAL SCIENCE	Advancing the Science of Team Science	Research & Experimental Medicine	Falk-Krzesinski, HJ Borner, K Contractor, N Fiore, SM Hall, KL Keyton, J Spring, B Stokols, D Trochim, W Uzzi, B
13	2010	WASHINGTON	USA	SCIENCE TRANSLATIONAL MEDICINE	A Multi-Level Systems Perspective for the Science of Team Science	Cell Biology   Research & Experimental Medicine	Borner, K Contractor, N Falk-Krzesinski, HJ Fiore, SM Hall, KL Keyton, J Spring, B Stokols, D Trochim, W Uzzi, B

Statistical Analysis—p. 44

Location	Count	# Citations
Netherlands	13	292
United States	9	318
Germany	11	36
United Kingdom	1	2

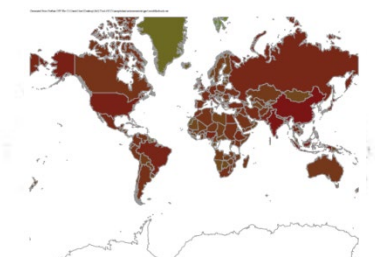
Temporal Burst Analysis—p. 48



Geospatial Analysis—p. 52



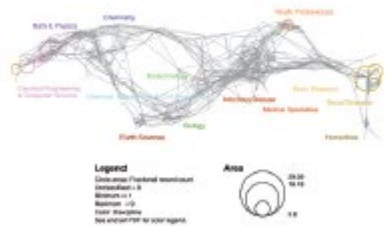
Geospatial Analysis—p. 52



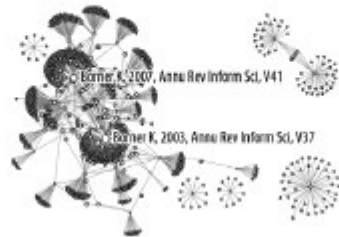
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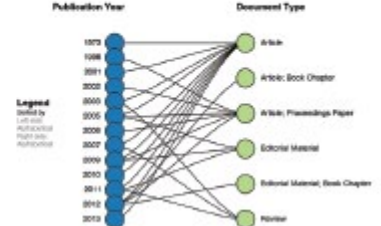
Topical Analysis—p. 56



Paper Citation Network—p. 60

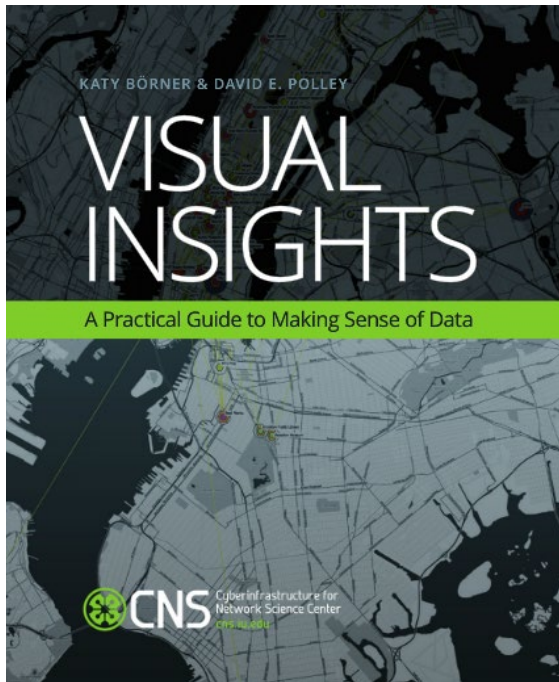


Bi-Modal Network—p. 60



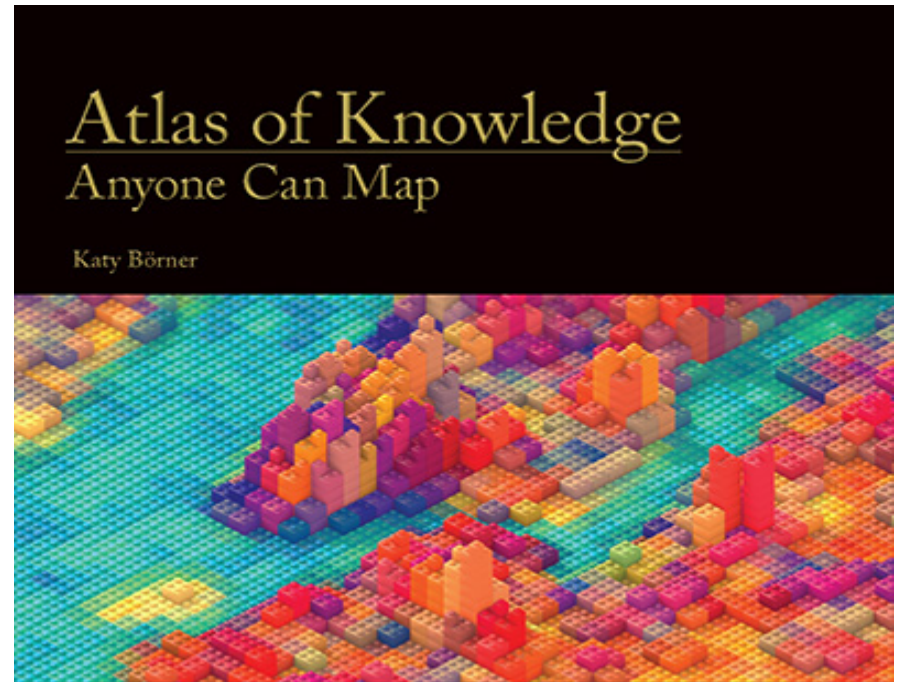
Co-author and many other bi-modal networks.

# Books Used in the IVMOOC



**Teaches timely knowledge:**

Advanced algorithms, tools, and hands-on workflows.



**Teaches timeless knowledge:**

Visualization framework—exemplified using generic visualization examples and pioneering visualizations.

# S637/E583/IVMOOC

# Information Visualization

Spring 2019

*Learn to Harness the Power of Data*

CNS launched the inaugural Information Visualization MOOC (IVMOOC) in January 2013, attracting participants from more than 100 countries. The course provides an overview about the state of the art in information visualization, emphasizing a user-needs-driven process. Anyone interested in generating visualizations would benefit from the course, and there are also opportunities to work with real-world clients on a variety of data visualization projects.



Type of Analysis vs. Level of Analysis

	Micro/Individual (1-100 records)	Meso/Local (101-10,000 records)	Macro/Global (10,000+ records)
Statistical Analysis/Profiling	Individual person and their expertise profiles	Larger labs, centers, universities, research organizations, states	All of NOE, all of science
Temporal Analysis (When)			
Geospatial Analysis (Where)			
Topical Analysis (What)			
Network Analysis (With Whom?)			

Needs-Driven Workflow Design



ENGR-E484/E584 | **Fall 2019**

# Scientific Visualization

Instructor: William R. Sherman, shermanw@indiana.edu

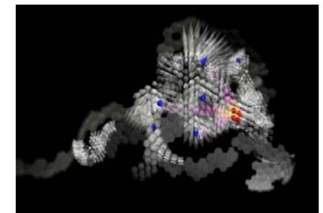
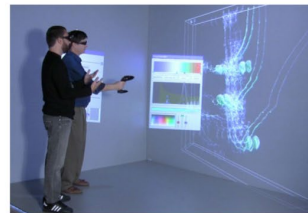
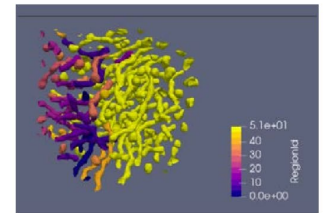
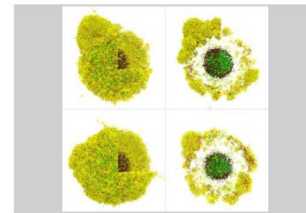
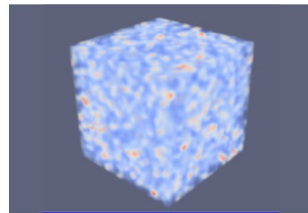
Monday/Wednesday 4:00–5:15 p.m.

Visualization Lab, Luddy Hall 4012

This 3-credit course teaches basic principles of human cognition and perception; techniques and algorithms for designing and critiquing scientific visualizations in different domains (neuro, nano, bio-medicine, IoT, smart cities); hands-on experience using modern tools for designing scientific visualizations that provide novel and/or actionable insights; 3D printing and augmented reality deployment; and teamwork/project management expertise.

## Topics covered:

- Scientific visualization: Past, present, and future trends
- Human cognition and perception
- Techniques and algorithms for neurological sciences, nanotechnologies, bio-medicine, IoT, etc.
- Virtual and augmented reality visualizations
- 3D printing deployment
- Choosing and working with clients
- User and task analysis
- Client-oriented projects



# OurCS Goes Moth

Day	Time	Activity	Location	Who	Needed
<b>Fri Oct 26</b>	11a-12.30p	Self-introductions Intro to Sentient Architecture (Katy), Amatria tour (Andreas), Dendrite Moth Field Array, show videos Q&A	VIS/Fab Lab	Katy, Mike, Andreas	<ul style="list-style-type: none"> <li>- 15 handouts of Dendrite instructions</li> <li>- 15 handouts of Moth instructions</li> <li>- Printouts of Amatria schematics and plans</li> </ul>
	2.15-3.30p	Moth building part 1, build base for electronics	VIS/Fab Lab	Mike	15 kits, spargate, crazy long screwdriver
	4-5.45p	Moth building p2, extruding, assemble frond + actuators	VIS/Fab Lab	Mike	
<b>Sat Oct 27</b>	9-10.30a	Intro to laser-cutting, also cut Chevrons	VIS/Fab	Mike	Cut for 30(?) more Moths? How many laser-cutters do we have? Precut elements? Minimize waiting times
	11-12.30p	Manual writing, figure out what to capture in what way	VIS/Fab Lab	Katy	Camera setup for this.
	<b>3.15-3.30p</b>	<b>Group picture!</b>		<b>Andreas</b>	
	4-6p	Manual writing, p. 2 Kit construction, impacted by	VIS/Fab Lab	Mike	






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▶ Research

 Open Data and Open Code for Big Science of Science Studies


▶ Latest News

 Put your money where your citations are: a proposal for a new funding system (website accessed 9/05/13)


▶ Upcoming Events

- OCT 1** Katy Börner attends PIUG 2013 Northeast Conference
- 10.13** Katy Börner presents Mapping Science Exhibit at WSSF
- 10.15** Ted Polley & Google Team present IVMOOC at EDUCAUSE
- 10.22** Katy Börner presents at the SciELO 15 Years Conference


▶ Development

 Behind the scenes of the design and development of *AcademyScope*


▶ Outreach

 See some of the most fascinating data visualizations in the world.


▶ Videos

 Watch Katy Börner's full presentation from TEDxBloomington

▶ Teaching

 Successful IVMOOC will be offered again in January of 2014

▶ Our Products

 We work closely with clients to provide custom-made data, visualization, and software solutions

All papers, maps, tools, talks, press are linked from <http://cns.iu.edu>

These slides will soon be at <http://cns.iu.edu/presentations.html>

CNS Facebook: <http://www.facebook.com/cnscenter>

Mapping Science Exhibit Facebook: <http://www.facebook.com/mappingscience>