

Science of Science Research and Tools

Tutorial #05 of 12

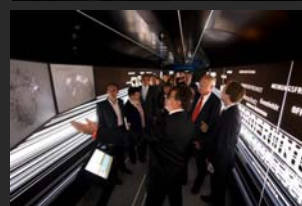
Dr. Katy Börner

Cyberinfrastructure for Network Science Center, Director
Information Visualization Laboratory, Director
School of Library and Information Science
Indiana University, Bloomington, IN
<http://info.slis.indiana.edu/~katy>

With special thanks to Kevin W. Boyack, Micah Linnemeier,
Russell J. Duhon, Patrick Phillips, Joseph Biberstine, Chintan Tank
Nianli Ma, Hanning Guo, Mark A. Price, Angela M. Zoss, and
Scott Weingart

Invited by Robin M. Wagner, Ph.D., M.S.
Chief Reporting Branch, Division of Information Services
Office of Research Information Systems, Office of Extramural Research
Office of the Director, National Institutes of Health

*Suite 4090, 6705 Rockledge Drive, Bethesda, MD 20892
10a-noon, July 13, 2010*



12 Tutorials in 12 Days at NIH—Overview

1. Science of Science Research **1st Week**
2. Information Visualization
3. CISHell Powered Tools: Network Workbench and Science of Science Tool
4. Temporal Analysis—Burst Detection **2nd Week**
5. Geospatial Analysis and Mapping
6. Topical Analysis & Mapping
7. Tree Analysis and Visualization **3rd Week**
8. Network Analysis
9. Large Network Analysis
10. Using the Scholarly Database at IU **4th Week**
11. VIVO National Researcher Networking
12. Future Developments



12 Tutorials in 12 Days at NIH—Overview

[#05] Geospatial Analysis and Mapping

- General Overview
- Designing Effective Geomaps
- Sci2-Geomaps With Circle and Colored Region Annotation
- Sci2-Animations
- Geographic Information Systems (GIS)
- Outlook
- Exercise: Identify Promising Geospatial Analyses of NIH Data

Recommended Reading

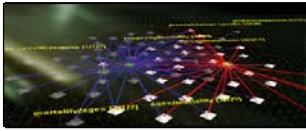
- NWB Team (2009) Network Workbench Tool, User Manual 1.0.0, <http://nwb.slis.indiana.edu/Docs/NWBTool-Manual.pdf>
- Scott Weingart, Hanning Guo, Katy Borner, Kevin W. Boyack, Micah W. Linnemeier, Russell J. Duhon, Patrick A. Phillips, Chintan Tank, and Joseph Biberstine (2010) [Science of Science \(Sci2\) Tool User Manual](#). Cyberinfrastructure for Network Science Center, School of Library and Information Science, Indiana University, Bloomington. http://sci.slis.indiana.edu/registration/docs/Sci2_Tutorial.pdf

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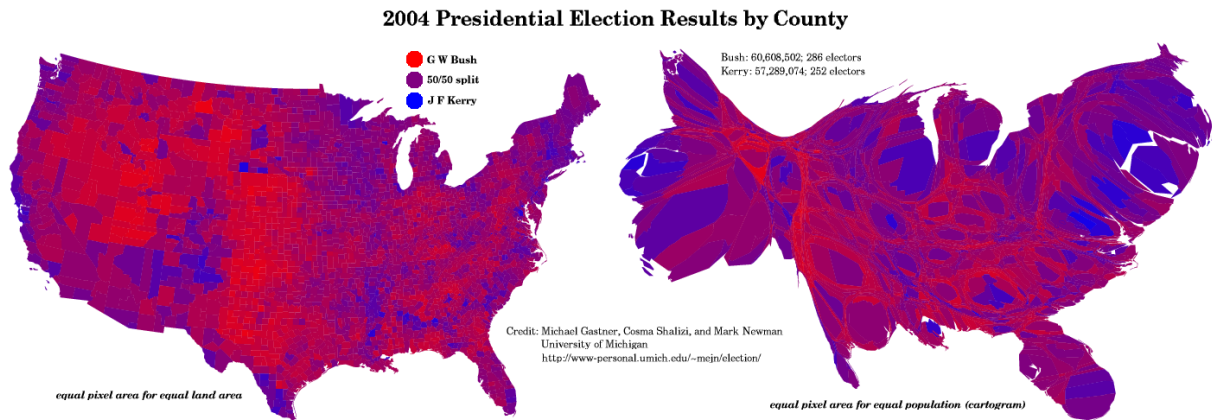
[#05] Geospatial Analysis and Mapping

- **General Overview**
- **Designing Effective Geomaps**
- **Sci2-Geomaps With Circle and Colored Region Annotation**
- **Sci2-Animations**
- **Geographic Information Systems (GIS)**
- **Outlook**
- **Exercise: Identify Promising Geospatial Analyses of NIH Data**

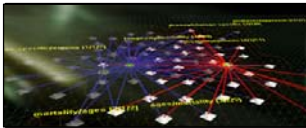
4



Map Substrate & Distortion, Map Attributes



Information Visualization Course, Katy Börner, Indiana University

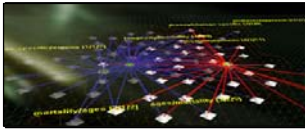


Map Attribute Overlays



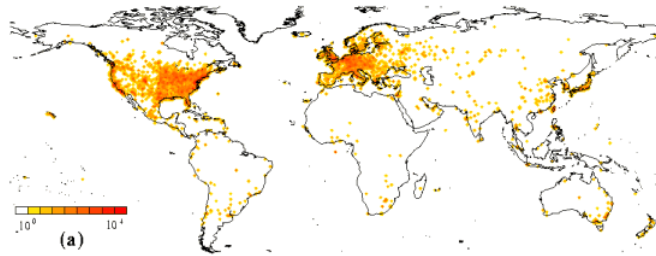
Map of human skin colors based on global ultraviolet radiation intensity and precipitation levels by George Chaplin

Information Visualization Course, Katy Börner, Indiana University

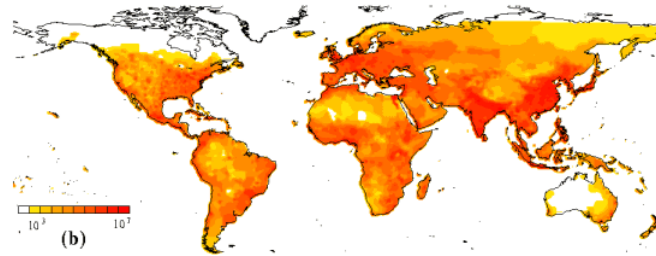


Map Attribute Overlays

Router
density

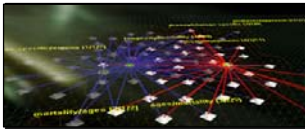


Population
density



http://www.cybergeography.org/atlas/router_distribution_large.png

Information Visualization Course, Katy Börner, Indiana University



Map Attribute Overlays

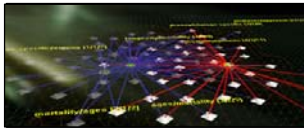
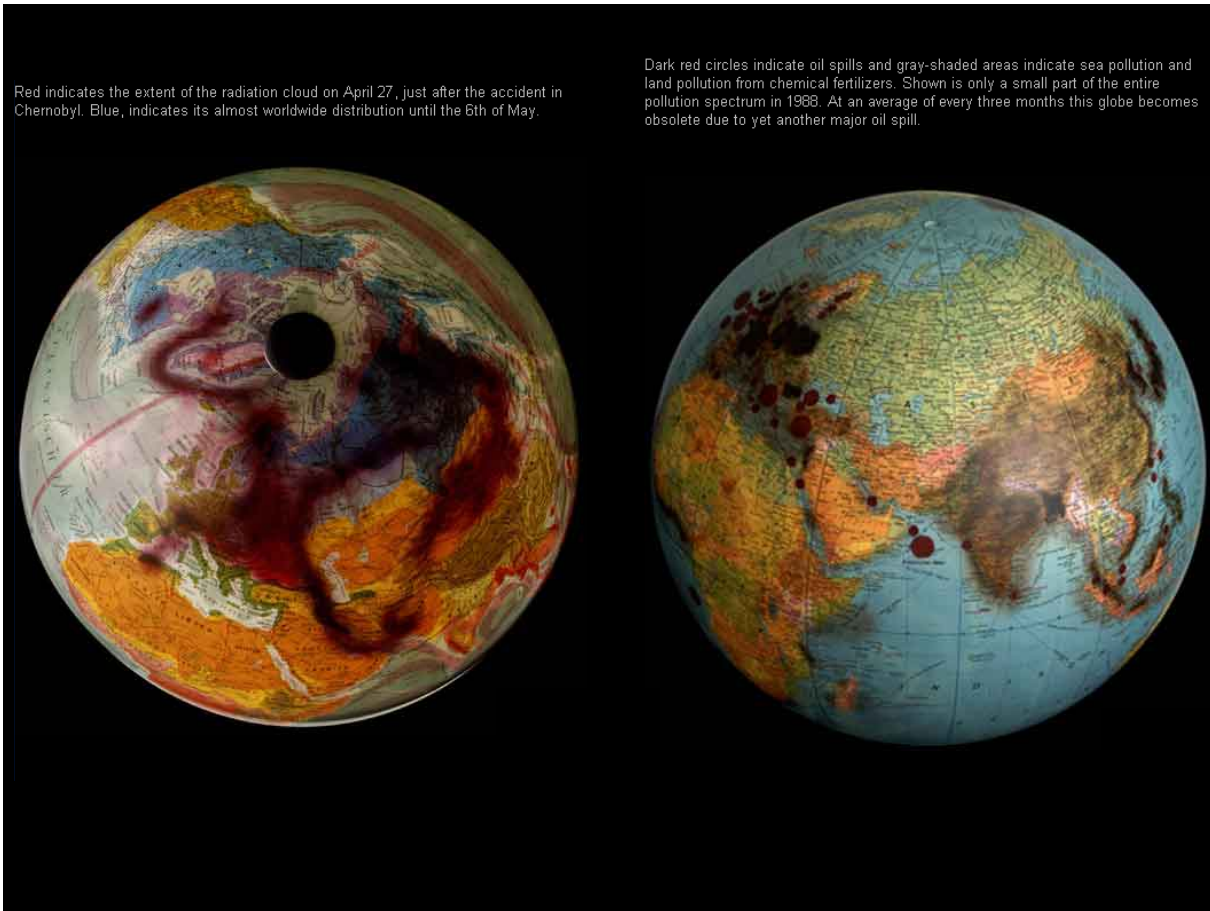


http://worldprocessor.com/index_vis.htm

Information Visualization Course, Katy Börner, Indiana University

Red indicates the extent of the radiation cloud on April 27, just after the accident in Chernobyl. Blue, indicates its almost worldwide distribution until the 6th of May.

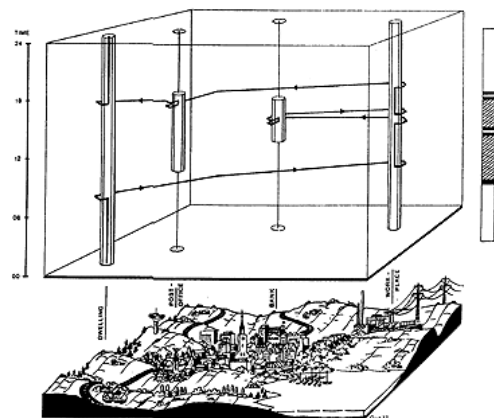
Dark red circles indicate oil spills and gray-shaded areas indicate sea pollution and land pollution from chemical fertilizers. Shown is only a small part of the entire pollution spectrum in 1988. At an average of every three months this globe becomes obsolete due to yet another major oil spill.



Map Attribute Overlays

Lifelines for visualizing Migrations, Transitions and Trajectories

Figure represents the movements of a person over a single day. Individual starts from the home and visits his workplace, a bank, his workplace and finally a post office, before returning home. The shaded bar at the right identifies periods spent traveling (in black) and at work (cross-hatched).



Lenntop's chapter in Carlstein et al.

<http://www.geog.port.ac.uk/lifeline/consult/essay.html>

Spatio-Temporal Information Production and Consumption of Major U.S. Research Institutions

Börner, Katy, Penumarthu, Shashikant, Meiss, Mark and Ke, Weimao. (2006)
Mapping the Diffusion of Scholarly Knowledge Among Major U.S. Research Institutions. Scientometrics. 68(3), pp. 415-426

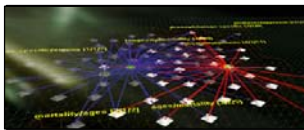
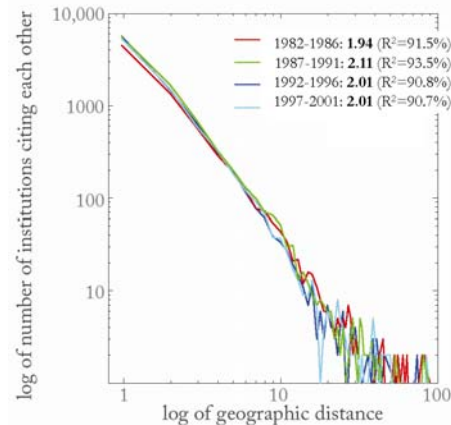
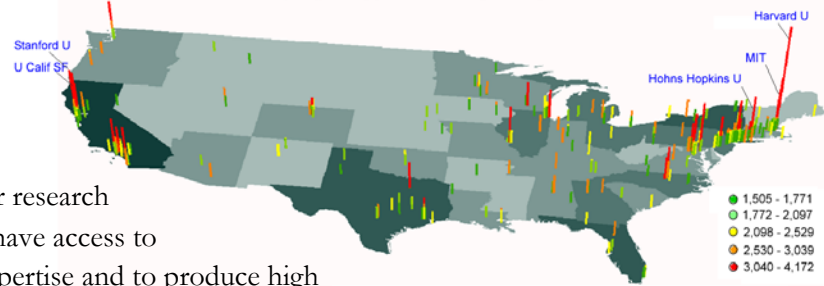


Research questions:

1. Does space still matter in the Internet age?
2. Does one still have to study and work at major research institutions in order to have access to high quality data and expertise and to produce high quality research?
3. Does the Internet lead to more global citation patterns, i.e., more citation links between papers produced at geographically distant research institutions?

Contributions:

- Answer to Qs 1 + 2 is YES.
- Answer to Qs 3 is NO.
- Novel approach to analyzing the dual role of institutions as information producers and consumers and to study and visualize the diffusion of information among them.



Insights from Geography

1. Places have location, direction, and distance with respect to other places
2. Scale is important--places may be large or small
3. A place has both physical structure and cultural content
4. The characteristics of places develop and change over time
5. Places interact with other places
6. The content of places is rationally structured
7. Places may be generalized into regions of similarities and differences

http://www.csiss.org/learning_resources/content/g5/

Suggested Reading

- MacEachren, AM (1995) *How Maps Work..* New York, Guilford. Press.

[#05] Geospatial Analysis and Mapping

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Map Projections - US Map Scope

Eckert IV



Mercator



*Lambert Conformal Conic



Winkel Tripel



*Albers Equal-Area Conic



* recommended

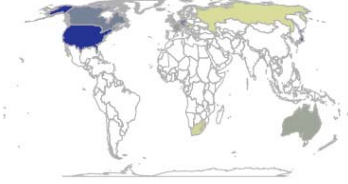
Geo Maps (region coloring)	
Creates a map with colored-region annotations. Regions are colored according to columns in the input table. Values should be log-scaled before processing.	
Map	US States
Projection	Lambert Conformal Conic
Author Name	K. Borner
Region Name	Inst St
Color By	Total Awd Tot \$
Color Scaling	Linear
Color Range	Yellow to Blue

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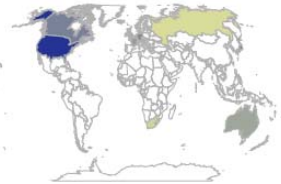


Map Projections - World Map Scope

***Eckert IV**



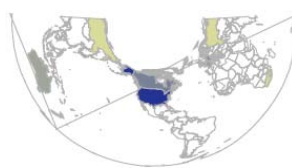
***Winkel Tripel**



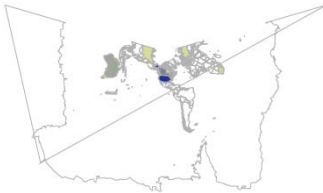
***Mercator**



Albers Equal-Area Conic



Lambert Conformal Conic

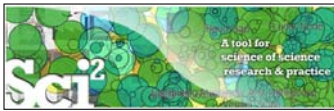


Geo Maps (region coloring)	
Map	Countries
Projection	Lambert Conformal Conic
Author Name	K. Borner
Region Name	Inst St
Color By	Total Awd Tot \$
Color Scaling	Linear
Color Range	Yellow to Blue

Creates a map with colored-region annotations. Regions are colored according to columns in the input table. Values should be log-scaled before processing.

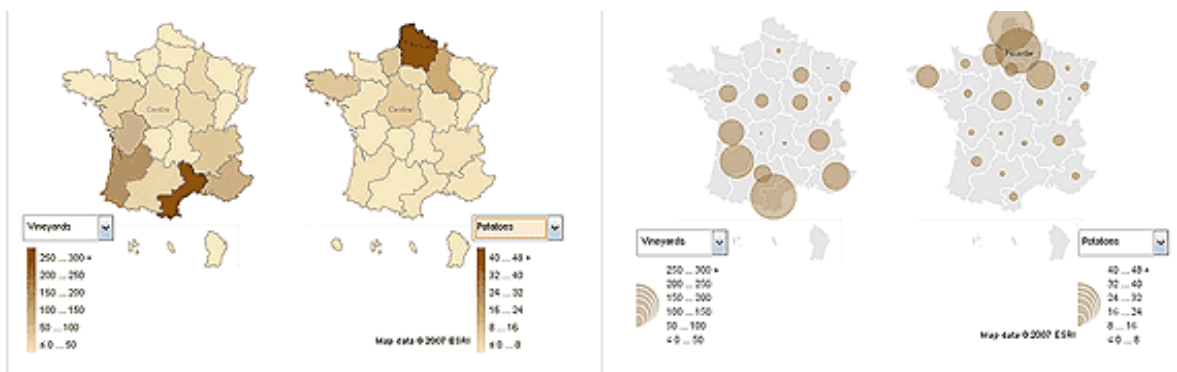
*** recommended**

15



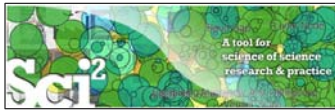
Map Types – Choropleth Maps (left) and Bubble Maps (right)

In Sci2 Tool these are called **Colored Region Annotations** and **Circle Annotations**



Side-by-side comparisons: on the left, two choropleth maps of France are being compared. On the right, the same maps are being compared in "bubble" mode.

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Geospatial Maps – Circle Annotation

The screenshot shows the Sci² Tool interface with several windows open:

- Console:** Displays the message "Geo Map (Circle Annotation Style) was selected. Author(s): Joseph R. Biberstine. Implementer(s): Joseph R. Biberstine. Integrator(s): Joseph R. Biberstine."
- Data Manager:** Shows a CSV file: "C:\Users\User\Desktop\scipolicy\sampladata\geo\usptoInfluenza.csv".
- Microsoft Excel:** Displays a spreadsheet with the following data:

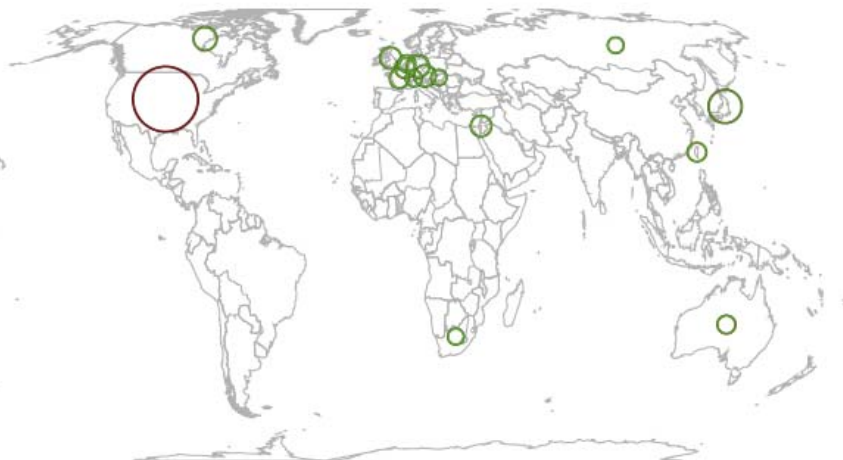
Country	Latitude	Longitude	Patents	Times Cited
1 Hungary	47.16116	19.50496	0.033333	4
2 Belgium	50.50089	4.47677	3.017857	11
4 Germany	51.09084	10.45424	4.783333	4
5 Canada	62.35873	-96.6921	5.539286	21
6 Russia	59.46148	108.8318	0.266667	2
7 Austria	47.69651	13.34577	4.2	17
8 Netherland	52.10809	5.33033	1	2
9 Switzerland	46.81309	8.22414	0.507576	6
10 Taiwan	23.59975	121.0238	2	3
11 Australia	-24.9162	133.3931	1.617857	23
12 United Sta	39.83	-98.58	73.98639	220
13 France	46.71245	1.71832	2.201166	9
14 South Afric	-28.4832	24.67699	0.333333	1
15 Japan	37.4876	139.8383	15.99167	39
16 Israel	31.3893	35.36124	3.5	3
17 United Kin	54.31392	-2.23218	3.85	12
- Geo Maps (circles) dialog:** Shows configuration options for the map, including:
 - Map: Countries
 - Projection: Mercator
 - Author Name: K. Borner
 - Latitude: Latitude
 - Longitude: Longitude
 - Size Circles By: Patents
 - Size Scaling: Linear
 - Color Circle Exteriors By: Times Cited
 - Exterior Color Scaling: Linear
 - Exterior Color Range: Green to Red
 - Color Circle Interiors By: None (no inner color)
 - Interior Color Scaling: Linear
 - Interior Color Range: Yellow to Blue

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USPTP Patent Influenza Data – Geo Map (circle)

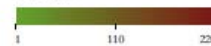
Generated from: _geo(usptoInfluenza.csv)



Geo Map (Circle Annotation Style)
 Eckert IV Projection
 Jul 12, 2010 | 04:30:55 PM
 K. Borner

Exterior Color (Linear)

Times Cited



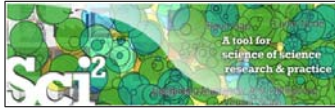
Area (Linear)

Patents



Created with Sci² Tool | Cytoscape extension for Network Science Center (<http://www.cis.upenn.edu/~sc2/>)

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Geospatial Maps – Region Coding

Sci² Tool

File Preprocessing Modeling Analysis Visualization Scientometrics Help

Console

Geo Map (Colored-Region Annotation Style) was selected.
 Author(s): Joseph R. Biberstine
 Implementer(s): Joseph R. Biberstine
 Integrator(s): Joseph R. Biberstine
 Documentation:

Scheduler

Data Manager

CSV file: C:\Users\User\Desktop\scipolicy\sampladata\geo\usptoInfluenza.csv
 PostScript: CSV file: C:\Users\User\Desktop\scipolicy\sampladata\geo\usptoInfluenza.csv
 PostScript: CSV file: C:\Users\User\Desktop\scipolicy\sampladata\geo\usptoInfluenza.csv.2

Microsoft Excel - NWB-Session-xxx-Session-185659073315...

	A	B	C	D	E	F
1	Country	Latitude	Longitude	Patents	Times Cited	
2	Hungary	47.16116	19.50496	0.083333	4	
3	Belgium	50.50099	4.47677	3.017867	11	
4	Germany	51.09084	10.45424	4.783333	4	
5	Canada	62.35873	-96.5821	5.539286	21	
6	Russia	59.46148	100.0316	0.266667	2	
7	Austria	47.83651	13.34577	4.2	17	
8	Netherlands	52.10809	5.33033	1	2	
9	Switzerland	46.81309	8.22414	0.507576	6	
10	Taiwan	23.59975	121.0238	2	3	
11	Australia	-24.9162	133.3931	1.617867	23	
12	United Sta	39.83	-98.58	73.99839	220	
13	France	46.71245	1.71832	2.201166	9	
14	South Afric	-28.4832	24.67699	0.333333	1	
15	Japan	37.4876	139.8383	15.99167	39	
16	Israel	31.3893	35.36124	3.5	3	
17	United Kin	54.31392	-2.23218	3.85	12	
18						
19						

Geo Maps (region coloring)

Creates a map with colored-region annotations. Regions are identified and colored according to columns in the input table. The table data can be log-scaled before processing.

Map: Countries
 Projection: Mercator
 Author Name: Katy Borner
 Region Name: Country
 Color By: Patents
 Color Scaling: Linear
 Color Range: Green to Red

Geo Maps (region coloring)

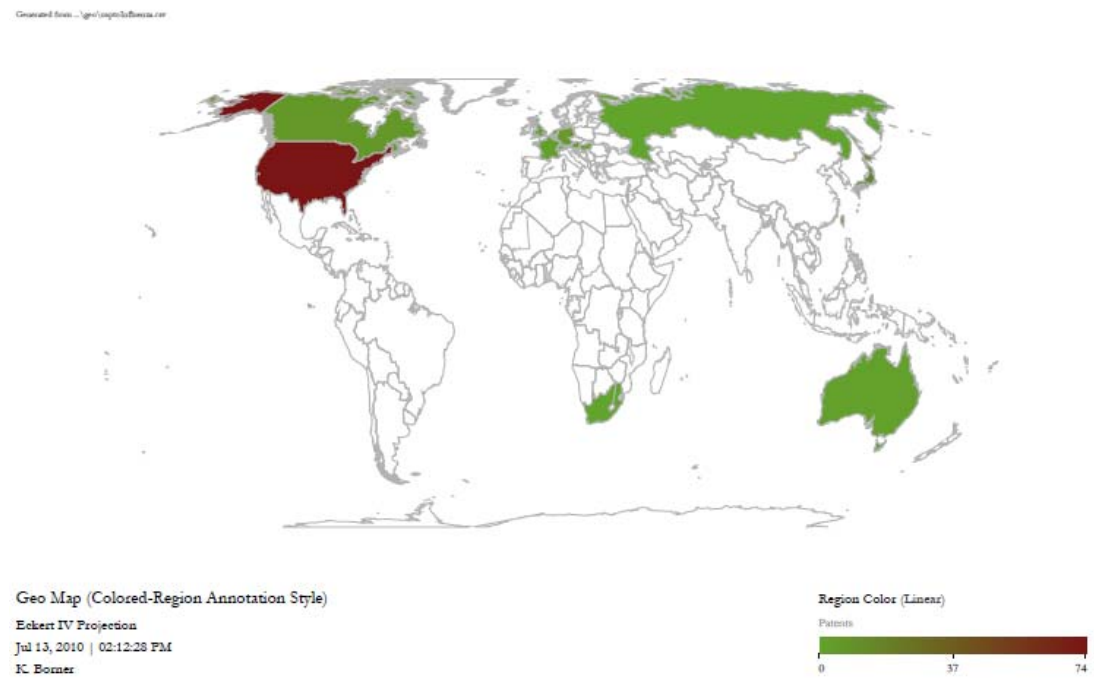
Creates a map with colored-region annotations. Regions are identified and colored according to columns in the input table. The table data can be log-scaled before processing.

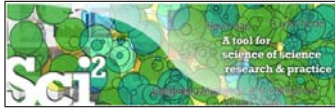
Map: Countries
 Projection: Mercator
 Author Name: Katy Borner
 Region Name: Country
 Color By: Times Cited
 Color Scaling: Logarithmic
 Color Range: Green to Red

OK Cancel



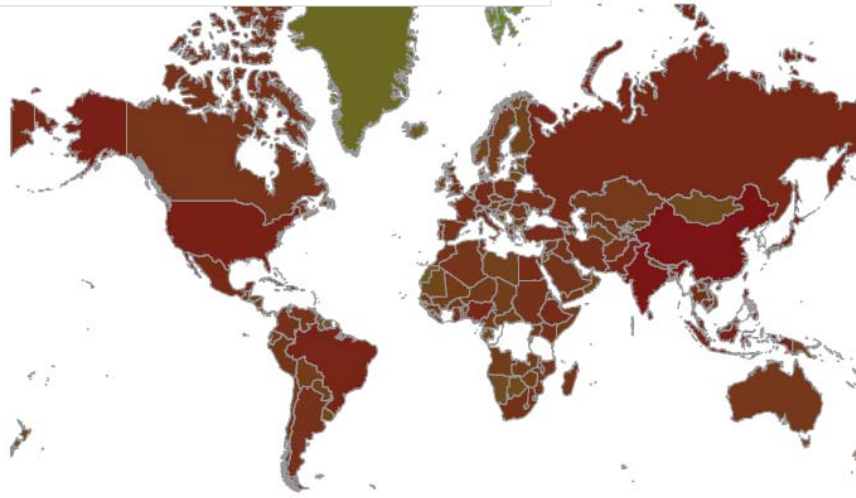
USPTP Patent Influenza Data – Geo Map (region)





World Population Data – Geo Map (region)

Generated from Prefuse CSV file: C:\Users\Uster\Desktop\Sci2-Tool-NICO\sampladata\sci2statistics\geo\worldfactbook.csv



Geo Map (Colored-Region Annotation Style)

Mercator Projection

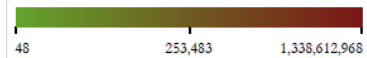
Sep 03, 2009 | 12:35:50 AM

K. Borner

Created with Sci2 Tool | Cyberinfrastructure for Network Science Center (<http://cns.sis.indiana.edu>)

Region Color (logarithmic)

Population



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Geo Mapping: US Map, Data Aggregated Over States

MIDAS PI locations, use file NIH-MIDAS-Grants-Aggregated4GeoState.csv

Area color coding



Geo Map (Colored-Region Annotation Style)

Lambert Conformal Conic Projection

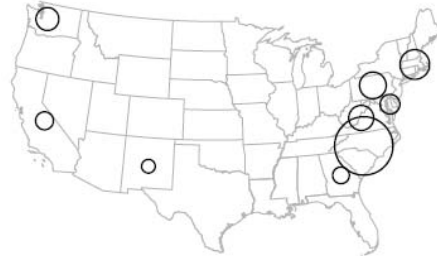
Oct 14, 2009 | 06:29:35 PM

Joseph Biberstine

Region Color (Linear)



Circle coding



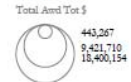
Geo Map (Circle Annotation Style)

Albers Equal-Area Conic Projection

Oct 14, 2009 | 06:24:56 PM

Joseph Biberstine

Area (Linear)



Inst St	Total Awd Tot \$
New Mexico	443267
Georgia	960093
California	1193465
Maryland	1587622
Washington	2332220
Virginia	2880362
Pennsylvania	3370739

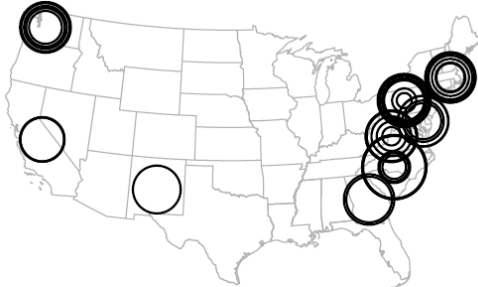
22



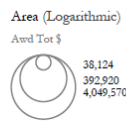
Geo Mapping: US Map, State Level Data

MIDAS PI locations

Circle coding (Logarithmic)



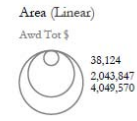
Geo Map (Circle Annotation Style)
Albers Equal-Area Conic Projection
Oct 15, 2009 | 05:31:47 PM
K. Borner



Circle coding (Linear)



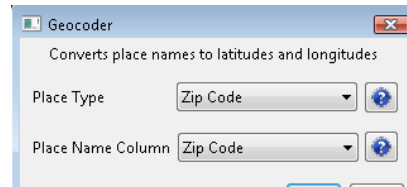
Geo Map (Circle Annotation Style)
Albers Equal-Area Conic Projection
Oct 15, 2009 | 05:30:59 PM
K. Borner



To convert US ZIP codes into Latitude/Longitude run

Label	ZIP Code
J. Smith	47405

Analysis > Geospatial > Geocoder with parameter values:



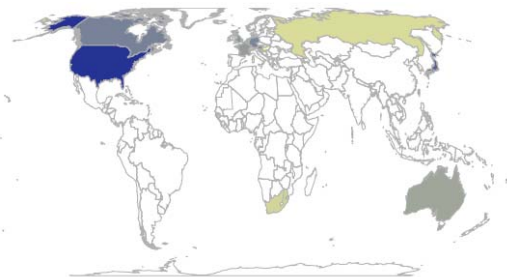
23



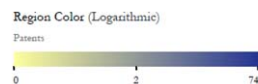
Geo Mapping: World Map, Aggregated per Country

Medline 2008 first author locations

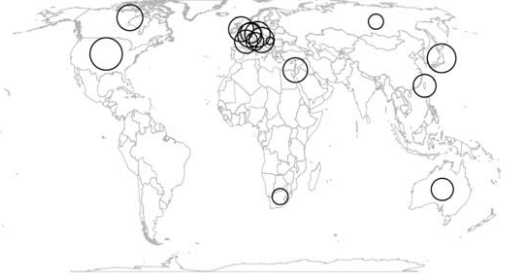
Area color coding



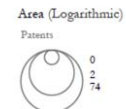
Geo Map (Colored-Region Annotation Style)
Eckert IV Projection
Oct 15, 2009 | 05:04:50 PM
K. Borner



Circle coding



Geo Map (Circle Annotation Style)
Eckert IV Projection
Oct 15, 2009 | 05:30:49 PM
K. Borner



Use

- Area size coding when exactly one variable needs to be encoded.
- Circle coding when 100,000 of zip codes. Can encode 2 variables via area size and ring color.

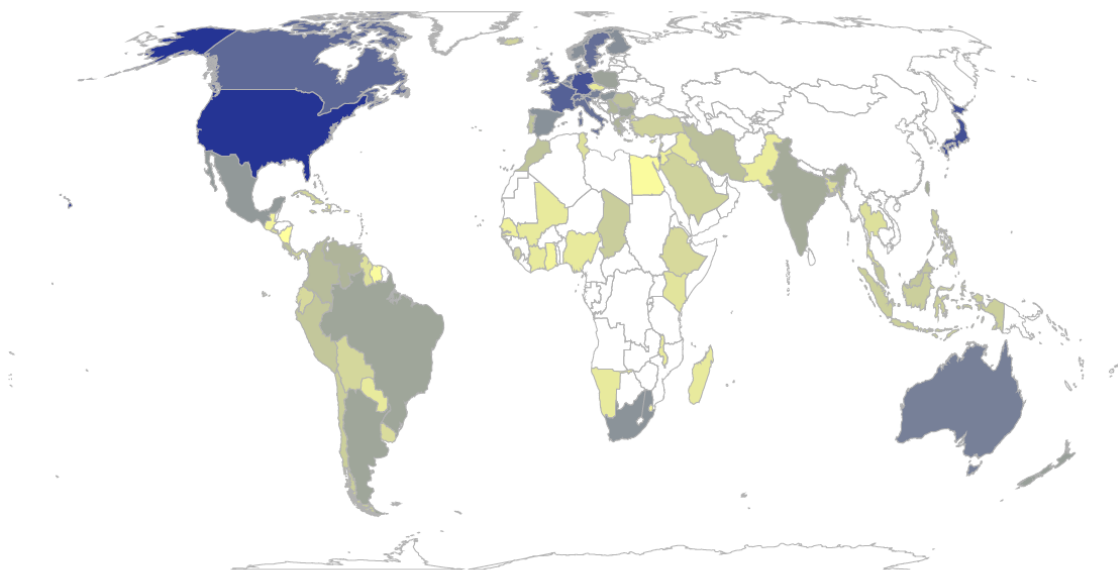
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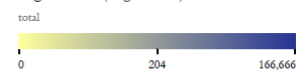
Presented from Prefire Table: C:\Documents and Settings\jhiberst\Desktop\ainal-10-16-12\uspto_country_f_76-79.csv



Geo Map (Colored-Region Annotation Style)

Eckert IV Projection
Oct 16, 2009 | 03:03:32 PM
Joseph Biberstine

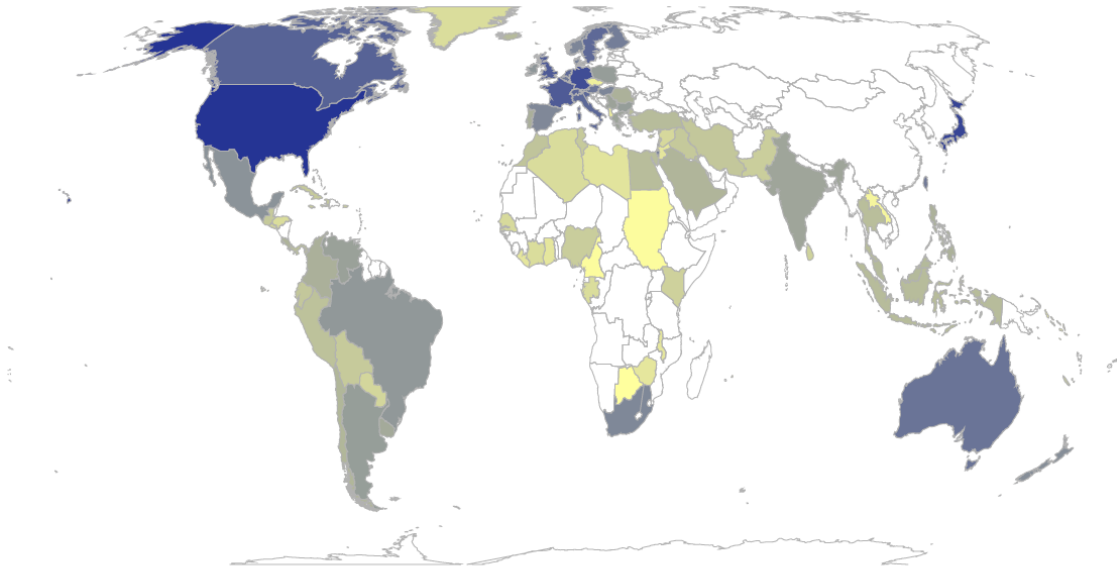
Region Color (Logarithmic)



Created with Sci2 Tool | Cyberinfrastructure for Network Science Center (<http://cns.siu.edu>)

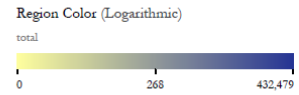
USPTO Patents published in 1976-1979
18 countries not found

26

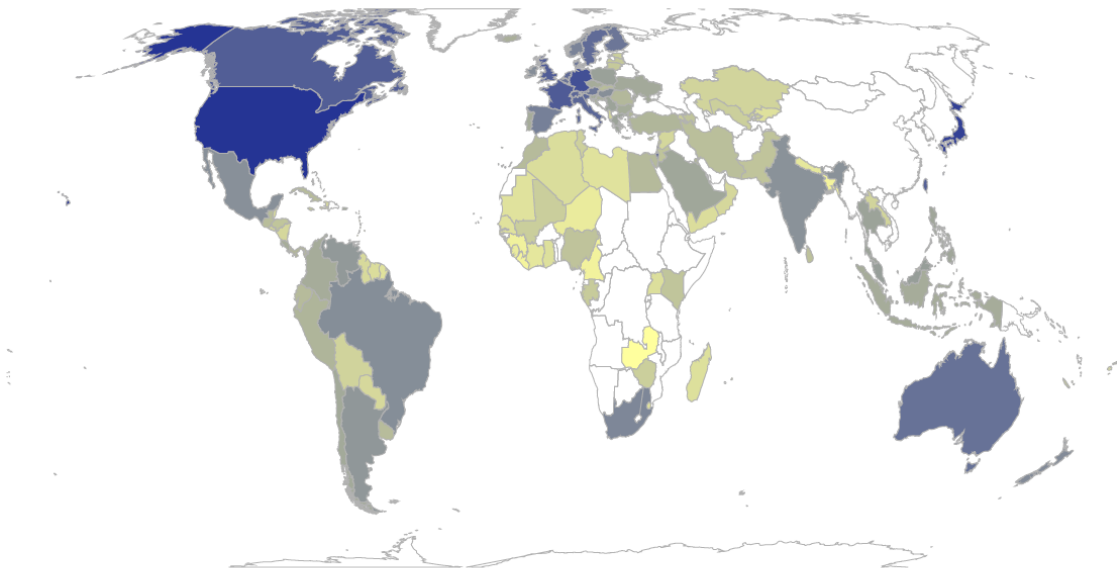


Geo Map (Colored-Region Annotation Style)

Eckert IV Projection
Oct 16, 2009 | 03:05:16 PM
Joseph Biberstine

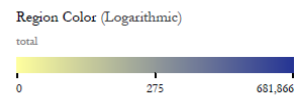


USPTO Patents published in 1980-1989
20 countries not found

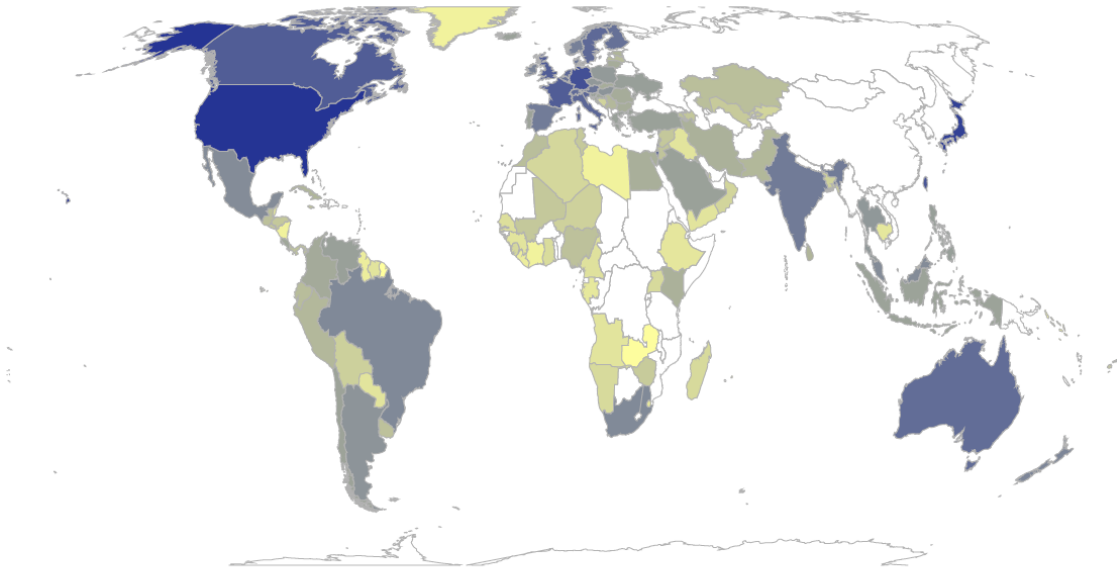


Geo Map (Colored-Region Annotation Style)

Eckert IV Projection
Oct 16, 2009 | 03:06:00 PM
Joseph Biberstine

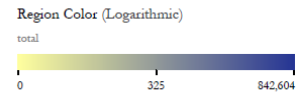


USPTO Patents published in 1990-1999
36 countries not found



Geo Map (Colored-Region Annotation Style)

Eckert IV Projection
Oct 16, 2009 | 03:06:44 PM
Joseph Biberstine



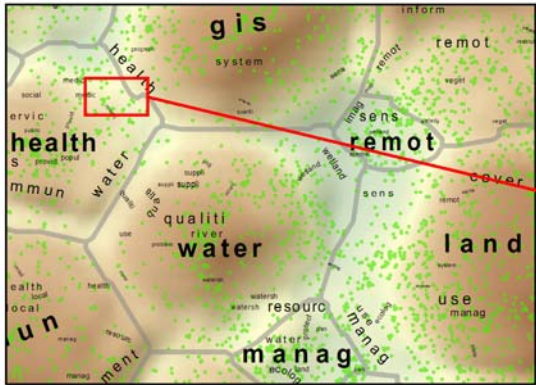
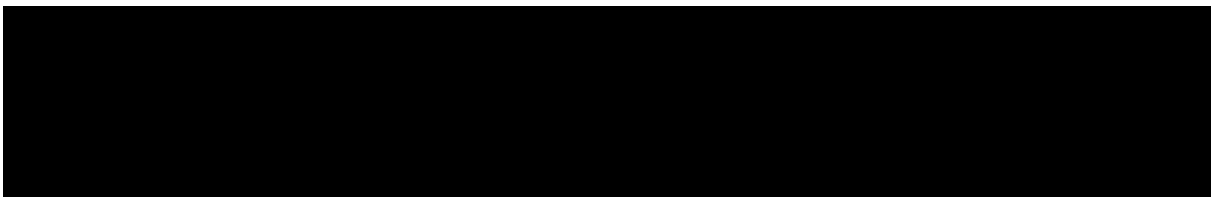
Created with Sci2 Tool | Cyberinfrastructure for Network Science Center (<http://cin.ilo.indiana.edu>)

USPTO Patents published in 2000-2008
33 countries not found

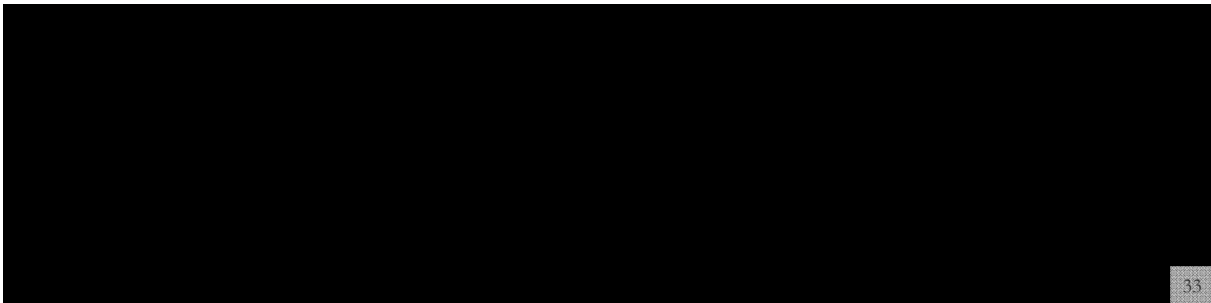
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[#05] Geospatial Analysis and Mapping

- General Overview
- Designing Effective Geomaps
- Sci2-Geomaps With Circle and Colored Region Annotation
- Sci2-Animations
- **Geographic Information Systems (GIS)**
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Effects on Weighted Regression. Hospitalizations in Victoria, BC.	Barriers to Childcare Access in Boone County, Missouri.	GIS Studies at the Centers for Disease Control and Prevention (CDC and Agency for Toxic Substances and Disease Registry (ATSDR).
Hospital Service Delivery Trends in Metropolitan Ohio: 1980 to Present.	Linking Health Facility and Population Level Data Using GIS: A Comparison of Case Studies from Bangladesh and Kenya.	Mixing Methodologies: Using GIS to Frame Qualitative Research.
Location Analysis of Mental Health Facilities Using Geographic Information Systems.	Regional Variation in Rural Infant Mortality Distributions: in the United States, 1985-1987.	Tick-Borne Occupational Hazards of Soldiering in the Conterminous United States. Accuracy Assessment for Locational Information of Toxic Facilities.
Geography and Regional Variation in Rural Infant Mortality Distributions: in the United States, 1985-1987.	Towards the Development of Zone Design Methods of Physicians in Guwanese	Modeling the Number of Physicians in Lead Sour Reported Lea



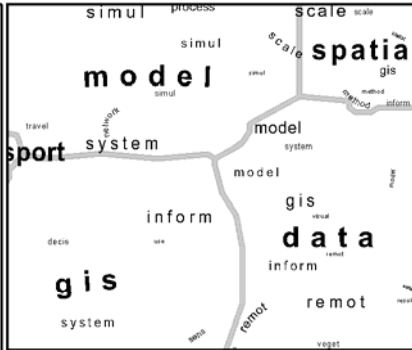
M.F. Goodchild and D.C. Ford (1971) Analysis of scallop patterns under controlled conditions. *Journal of Geology* 52-62.

M.F. Goodchild and B.H. Massam (1971) Some least-cost models of spatial administrative systems in Southern Ontario. In R.L. Gentilcore, editor, *Geographical Approaches to Canadian Problems*. Prentice-Hall, Canada, Ltd., 220-228.

...

D.R. Fesenmaier, M.F. Goodchild and S. Morrison (1979) The spatial structure of the rural urban fringe. *Canadian Geographer* 23: 255-265.

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M.F. Goodchild and P.J. Booth (1976) Modelling human spatial behaviour in urban recreation facility site location. In *Research Program: Impact of the Public Sector on Local Economies*, Discussion Paper 7. London, Ontario: University of Western Ontario, Department of Economics

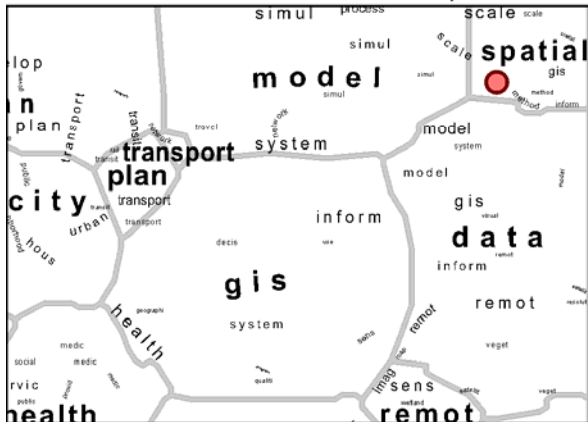
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R. Averack and M.F. Goodchild (1984) Methods and algorithms for boundary definition. In D.F. Marble, editor, *Proceedings of the International Symposium on Spatial Data Handling, Zurich*, 1: 238-250.

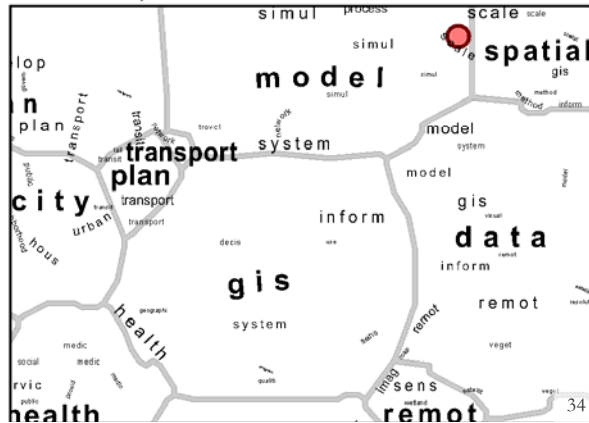
M.F. Goodchild and A.W. Grandfield (1984) Spatial aggregation and intransitivity in U.S. migration streams. *Modeling and Simulation (Proceedings of the 15th Annual Pittsburgh Conference)* 15: 501-505.

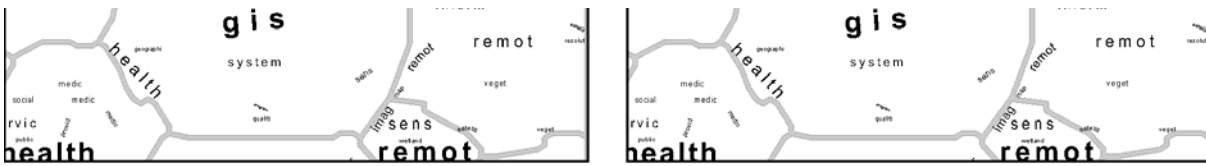
Base Map

Author Location 1970-1979

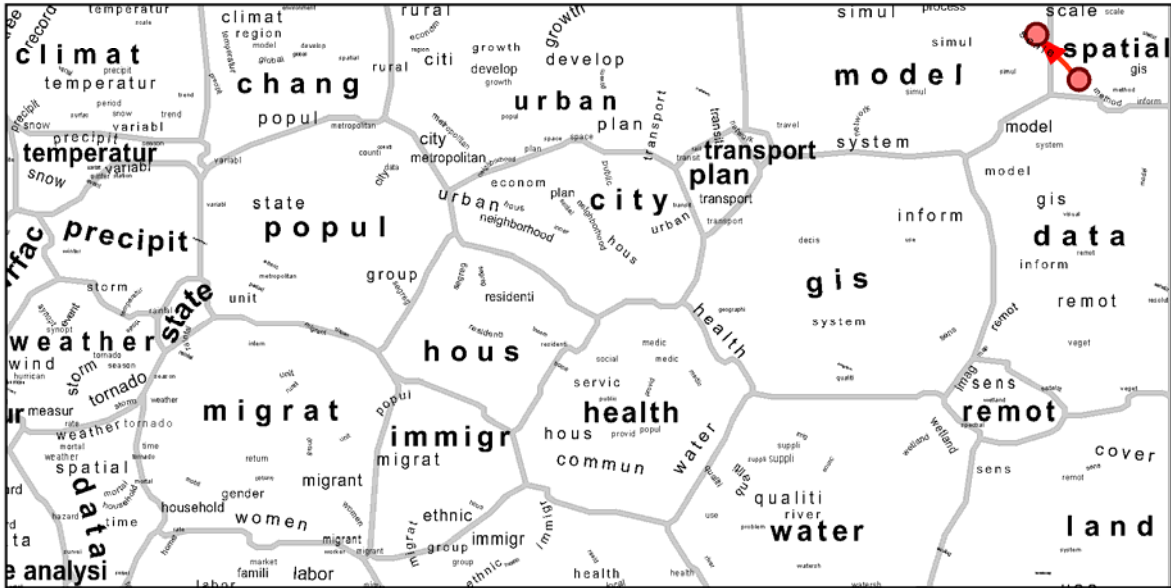


Author Location 1975-1984





Author Change Trajectory from 1970-79 to 1975-84



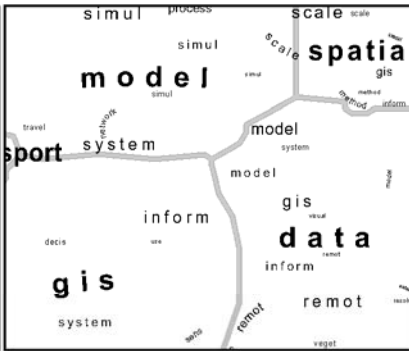
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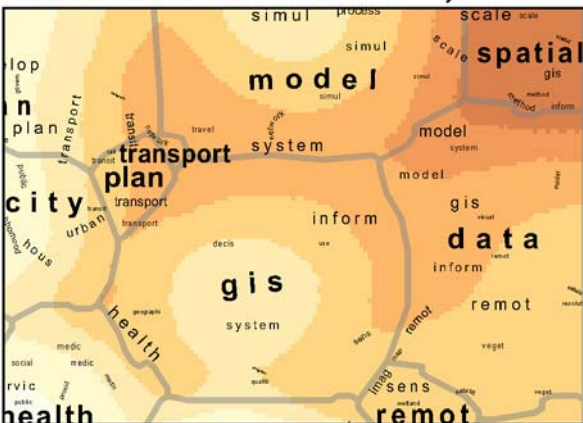
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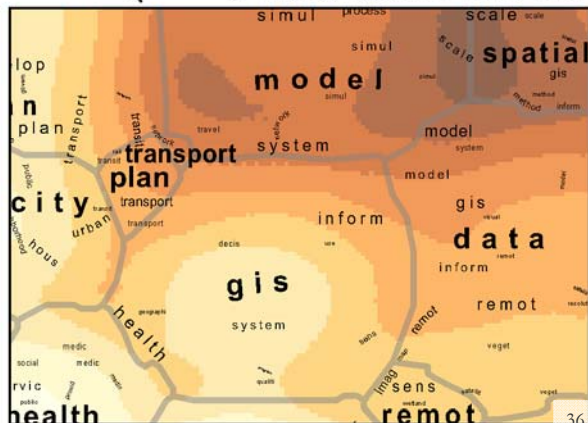
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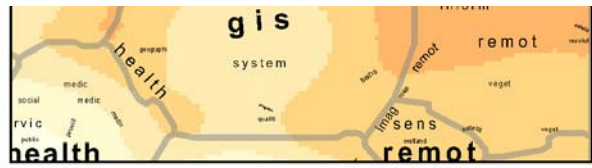
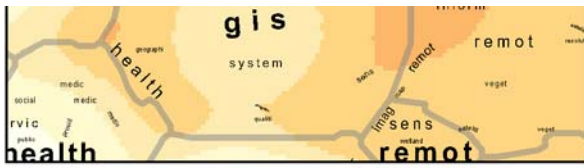
Base Map

Author Location 1970-1979

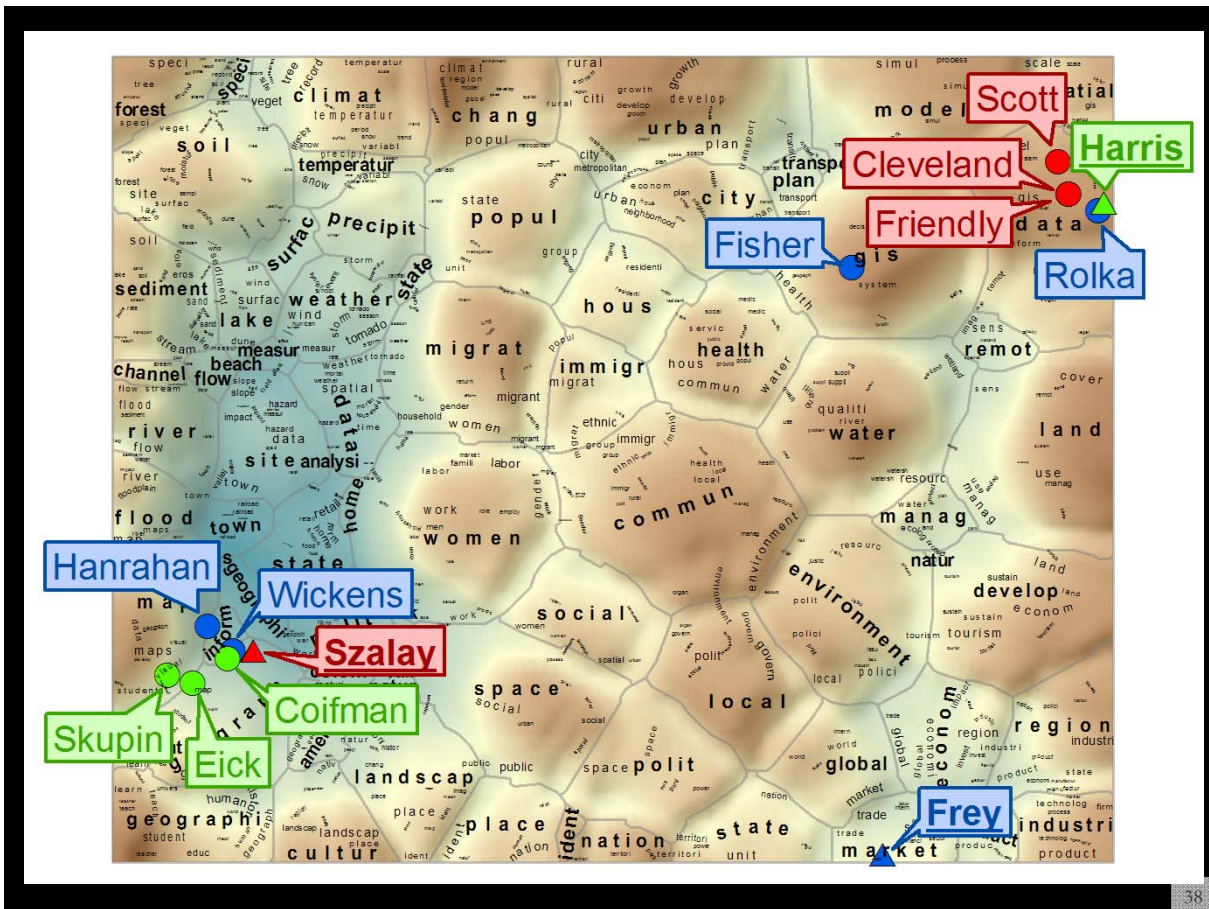
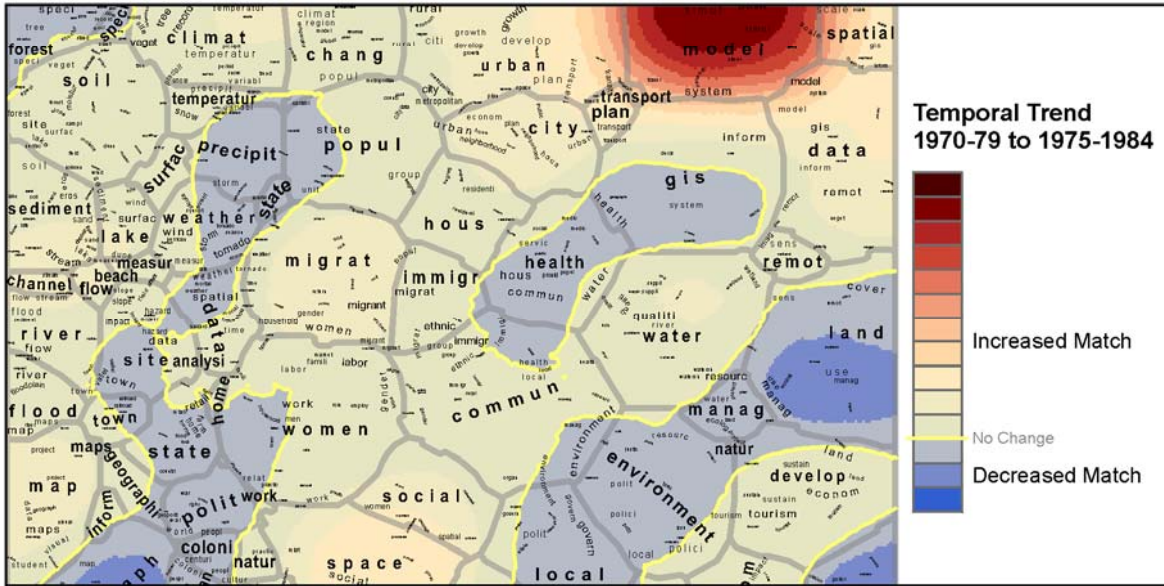


Author Location 1975-1984





Author Change Surface from 1970-79 to 1975-84



A Semantic Landscape of the Last.fm Music Folksonomy using a Self-Organizing Map

Joseph Biberstine, Russell J. Dubon, Katy Börner, Elisha Hardy, CNS and André Skupin, San Diego State University
 Sunbelt SNA Conference, 2010. http://cns.slis.indiana.edu/research/InTermsOfMusic_5Levels_Masked_a9.pdf

A Semantic Landscape of the Last.fm Music Folksonomy using a Self-Organizing Map

Joseph Biberstine, Russell J. Dubon, Katy Börner, Elisha Hardy, CyberInfrastructure for Network Science Center, School of Library and Information Science, Indiana University, Bloomington, and André Skupin, San Diego State University

Data

Last.fm is an Internet radio site where users discover new music based on their listening history. They can annotate musical items such as artists and songs with arbitrary tags, ranging from "rock" or "jazz" to "seen five" or "songs I absolutely love".

The original data set, collected during the first half of 2009, was sampled by removing all but the 1,000 most frequently used tags (out of 281,818 total), then discarding items not annotated with one of those tags. This reduces the number of items from 1,393,559 to 1,088,761. After sampling, the average item has 6.8 tags (3.8 unique tags).

Top 10 Tags

rock
 electronic
 soon live
 indie
 alternative
 pop
 female vocals
 jazz
 classic rock
 experimental



Self-Organizing Maps

A self-organizing map (SOM) is a form of artificial neural network that generates a low-dimensional geometric model from high-dimensional data. It transforms nearness in the input space to nearness in the map space. The map is a landscape made up of a grid of small neurons, each having some level of association with each of the tags in the tag space. The map is randomly seeded and then trained on a collection of data by repeatedly (1) finding the most similar neuron for a piece of training data and (2) pulling each neuron's tag associations closer to the matched piece of training data. Early in the training, the pull extends across most of the map. By the end, it affects only a tiny range around the most similar neuron.



Project

The landscape is a 180 by 180 grid of hexagonal neurons.

Regions on the landscape are labeled by the tags with which their constituent neurons associate most strongly.

Purple borders separate regions defined by each neuron's single strongest tag association; those regions are marked with purple tags.

Orange tags identify regions defined by the second-strongest association of each neuron, and so on, as shown in the legend below.

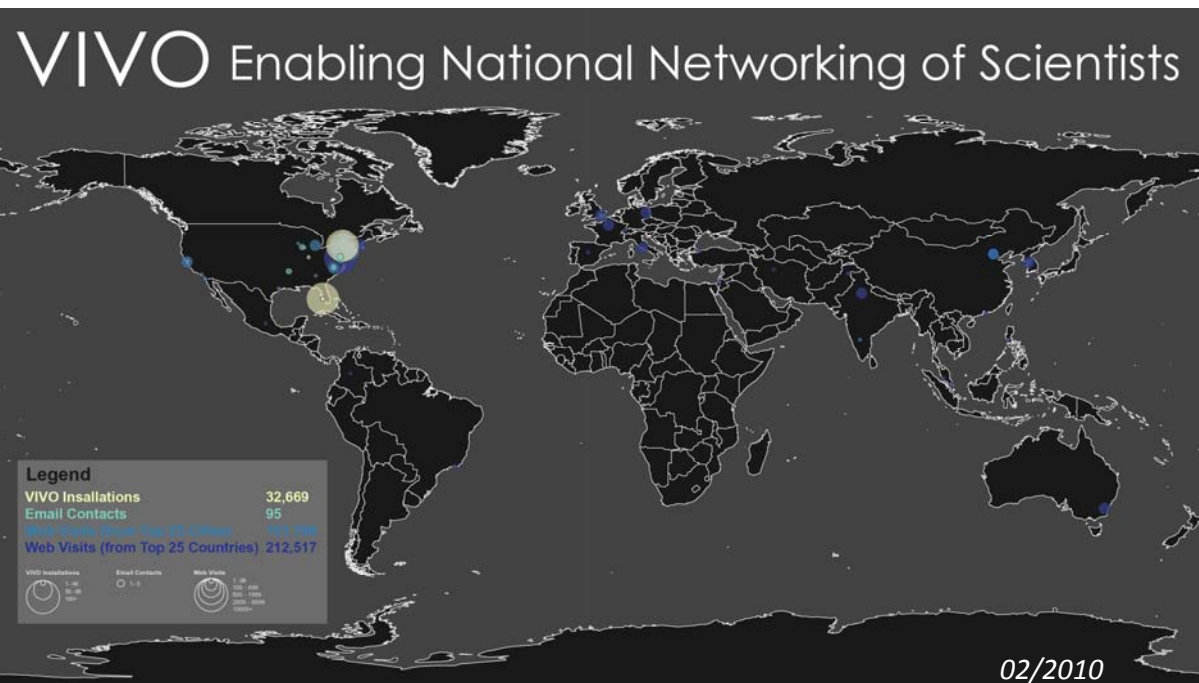


The size and shape of each tag roughly reflects the extent of its region. The actual size and shape are somewhat flexible to guard against label overlap.

Note that tags can appear in multiple locations, especially if they have strong associations with multiple terms that are not themselves strongly associated. For instance, "alternative" shows up as a second-level region within "seen five", but also exists as a top-level region elsewhere on the map.

Acknowledgments

Thanks to the following individuals and organizations for their support and contributions to this project: [Logos for funding agencies and institutions]

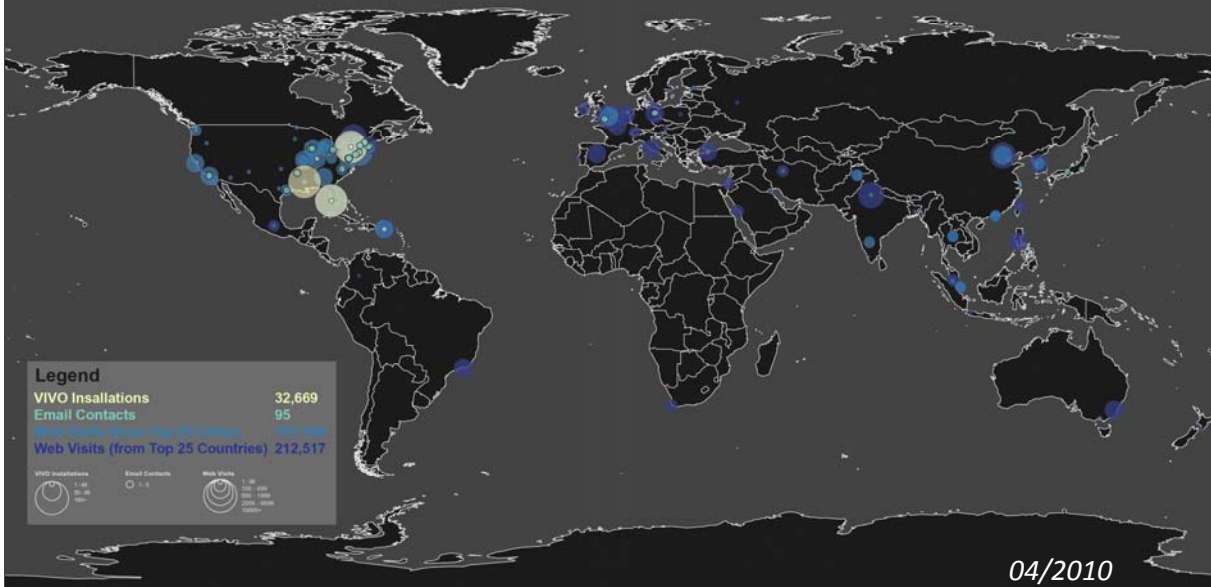


Visualization created by: Katy Börner (concept), Jeni Coffey (design), Kaveh Ekbia (ArcGIS) and Justin Peters (ArcGIS).

The National Research Network: VIVO: Enabling National Networking of Scientists NIH U24RR029822
 Start: Sept 2009
 PI: Michael Conlon, University of Florida
 Award amount: \$12,300,000

DRAFT

VIVO Enabling National Networking of Scientists



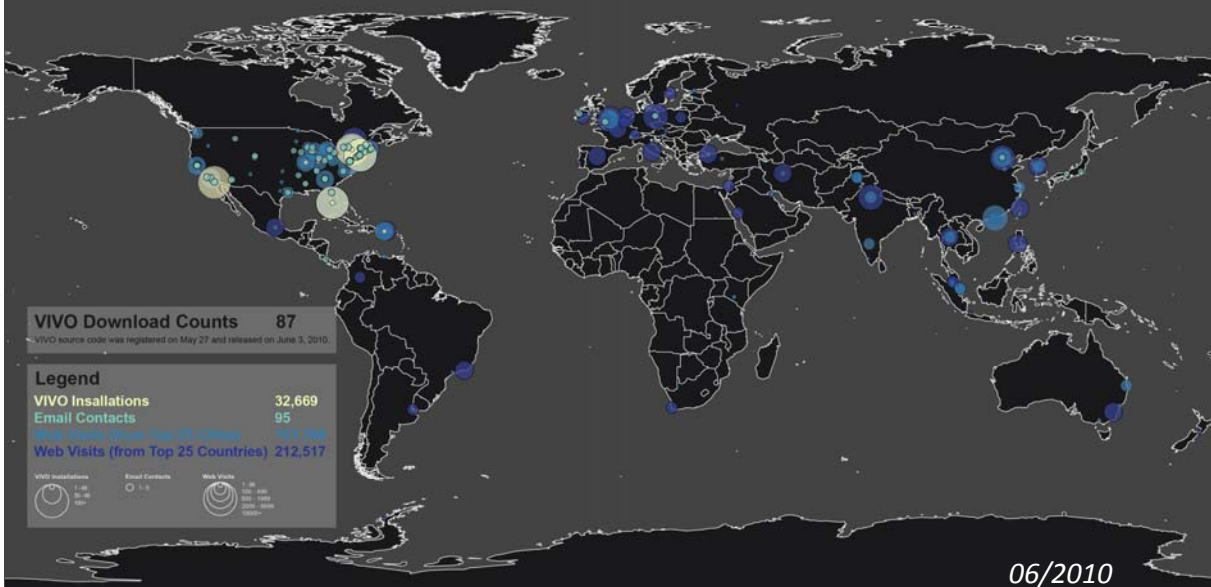
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DRAFT

Shown are the number of people profiles in the 7 different installation sites.
Email contacts by data and service providers as well as institutions interested to adopt VIVO.
The number of visitors on <http://vivoweb.org>

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VIVO Enabling National Networking of Scientists



Visualization created by: Katy Börner (concept), Jeni Coffey (design), Kaveh Ekbia (ArcGIS) and Justin Peters (ArcGIS).

DRAFT

VIVO 1.0 source code was publicly released on April 14, 2010
87 Downloads by June 11, 2010
The more institutions adopt VIVO, the more high quality data will be available to understand, navigate, manage, utilize, and communicate progress in science and technology.

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Outlook

Planned extensions of Sci2 Tool:

- (Flowmap) network overlays for geo maps and science maps.
- Easy means to render maps online.



Research Collaborations by the Chinese Academy of Sciences

By Weixia (Bonnie) Huang, Russell J. Dubon, Elisha F. Hardy, Katy Börner, Indiana University, USA

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Interactive World and Science Map of S&T Jobs

Angela Zoss, Michael Conover, Katy Börner (2010).



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Interactive World and Science Map of S&T Jobs

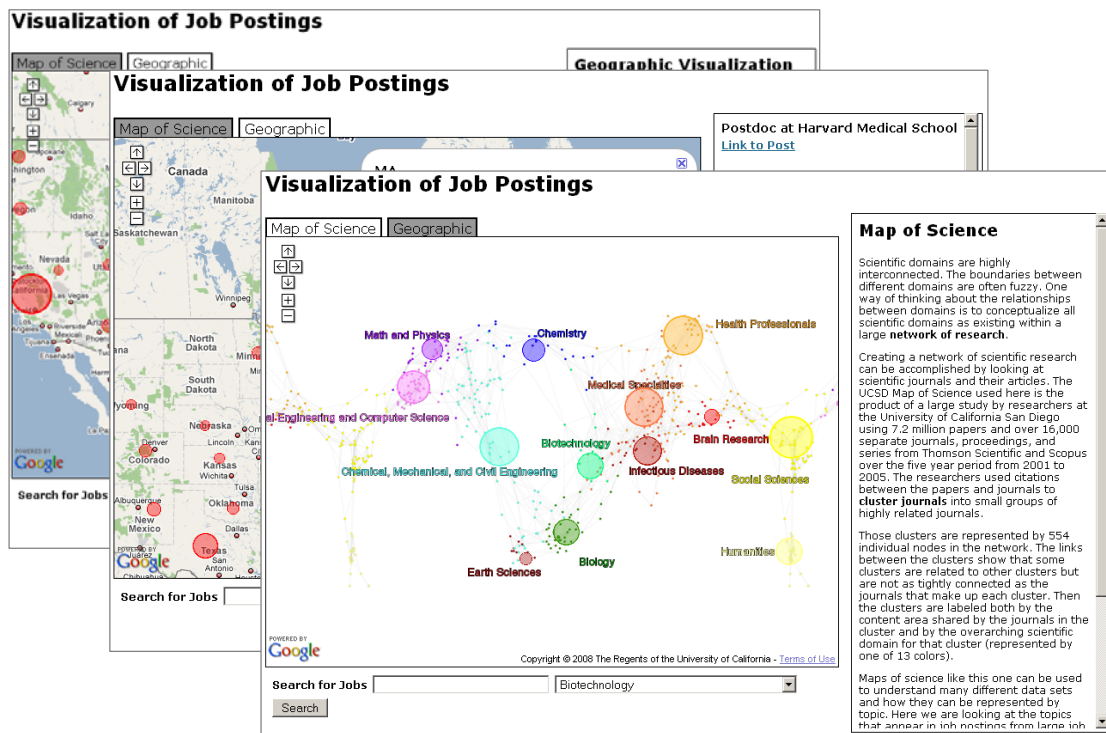
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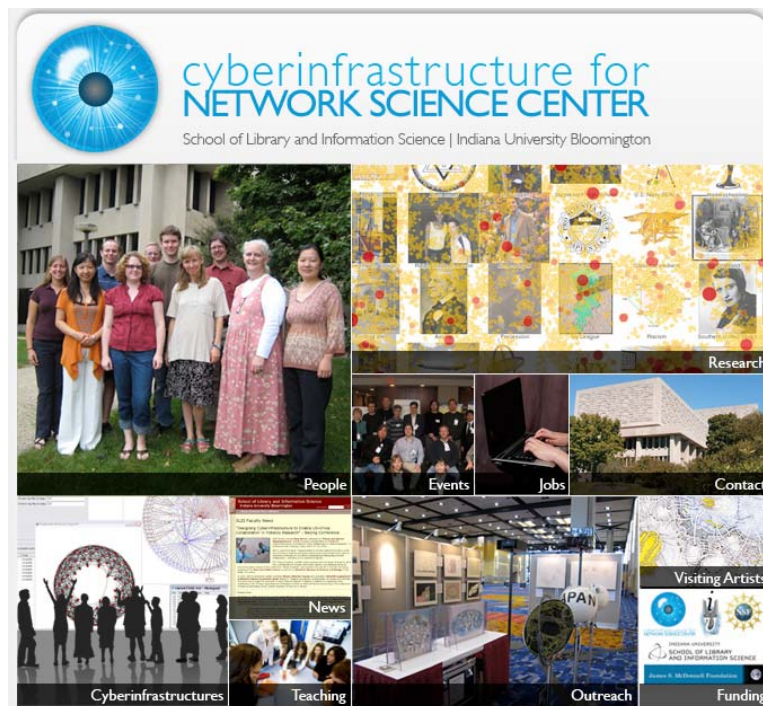
Exercise

Please identify a promising geospatial analysis of NIH data.

Document it by listing

- Project title
- User, i.e., who would be most interested in the result?
- Insight need addressed, i.e., what would you/user like to understand?
- Data used, be as specific as possible.
- Analysis algorithms used.
- Visualization generated. Please make a sketch with legend.

49



All papers, maps, cyberinfrastructures, talks, press are linked from <http://cns.slis.indiana.edu>

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