

# Complex Studies of a Complex Subject: Data Visualization and Visitors

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Science Museum of Minnesota: Zdanna Tranby, Marjorie Bequette

New York Hall of Science: Steven Uzzo

Visitor Studies Association

July 2015

# Pathways

## Sense-Making of Big Data

The project examined the data visualization literacy of over 900 youth and adult visitors across five US science museums. The New York Hall of Science and Science Museum of Minnesota are both involved as partner institutions, providing financial support, facilities, and collaborative research. Data collection took place at the New York Hall of Science, the Marian Koshland Science Museum, COSI in Columbus Ohio, and Wonderlab Museum in Bloomington, IN.



Pathways: Sense-Making of Big Data. NSF ISE DRL-1223698 Award (Katy Börner, Adam V. Maltese, Joe E. Heimlich, Stephen Miles Uzzo, Paul Martin, and Sasha Palmquist, \$250,000) 2012.07.01 - 2015.06.30.



Participants from the November 2013 Pathways Workshop at the Science Museum of Minnesota



Jax and the Big Data Beanstalk, a Science Museum of Minnesota theater piece funded by the NSF, introduces museum visitors to big data visualizations and science maps

# CNS Macroscopes are used by hundreds of thousands around the globe



Our mission is to advance datasets, tools, and services for the study of biomedical, social and behavioral science, physics, and other networks. A specific focus is research on the structure and evolution of science and technology (S&T) and the communication of results via static and interactive maps of science. Learn more at [cns.iu.edu](https://cns.iu.edu).

# Places & Spaces Exhibit

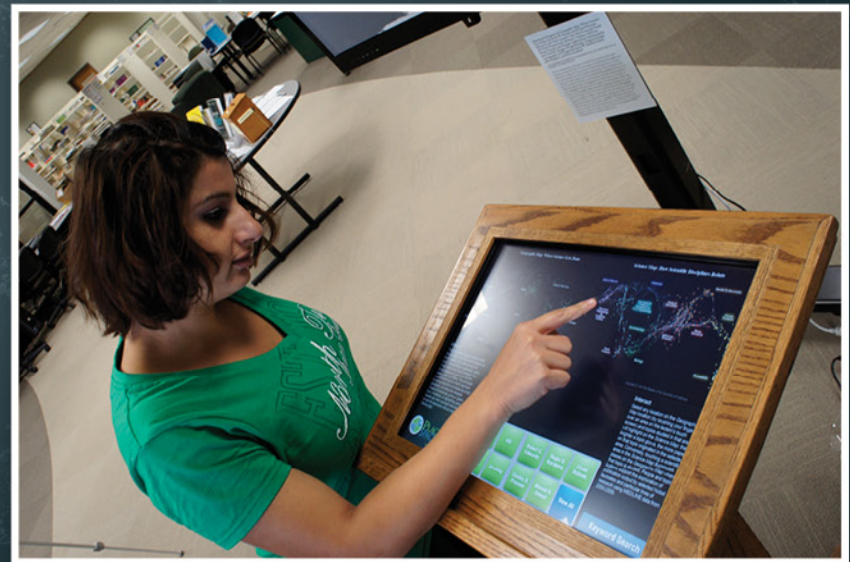
This exhibit aims to demonstrate the power of maps to navigate and make sense of physical places and abstract topic spaces.

Phase 2, which is just getting underway, is designed to bring “Macroscopic Tools” to public places to help exhibit visitors not only learn how to *read* science maps but how to *make* them.

See all the maps and more at the new [scimaps.org](http://scimaps.org).



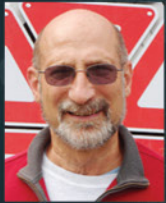
# Places & Spaces Hands-On Elements



# Places & Spaces On Display



# Meet the international advisory board that helps select the maps that make up the exhibit



Gary  
Berg-Cross



Bob  
Bishop



Kevin W.  
Boyack



Donna J.  
Cox



Bonnie  
DeVarco



Sara Irina  
Fabrikant



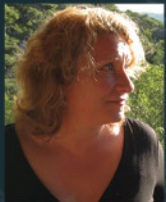
Marjorie M.K.  
Hlava



Peter A.  
Hook



Manuel  
Lima



Deborah  
MacPherson



Lev  
Manovich



Carlo  
Ratti



Eric  
Rodenbeck



André  
Skupin



Moritz  
Stefaner



Stephen  
Uzzo



Caroline  
Wagner



Benjamin  
Wiederkehr

The process of selecting the exhibit's pieces begins each year with a call for maps corresponding to a particular theme or addressing the needs of a particular audience. Once the submissions have been gathered, a team of international reviewers and exhibit advisors select the ten most articulate and innovative maps for entry into *Places & Spaces*.

# The *Places & Spaces* Exhibit Ambassadors



These men and women from around the globe work selflessly to make the exhibit a success. Their intellectual guidance and commitment to promoting science mapping are what has made *Places & Spaces* the vital exhibit it is today.





AcademyScope, an interactive visualization of National Academies Press publications created by the CNS Center in partnership with the National Academy of Sciences.

# IVMOOC

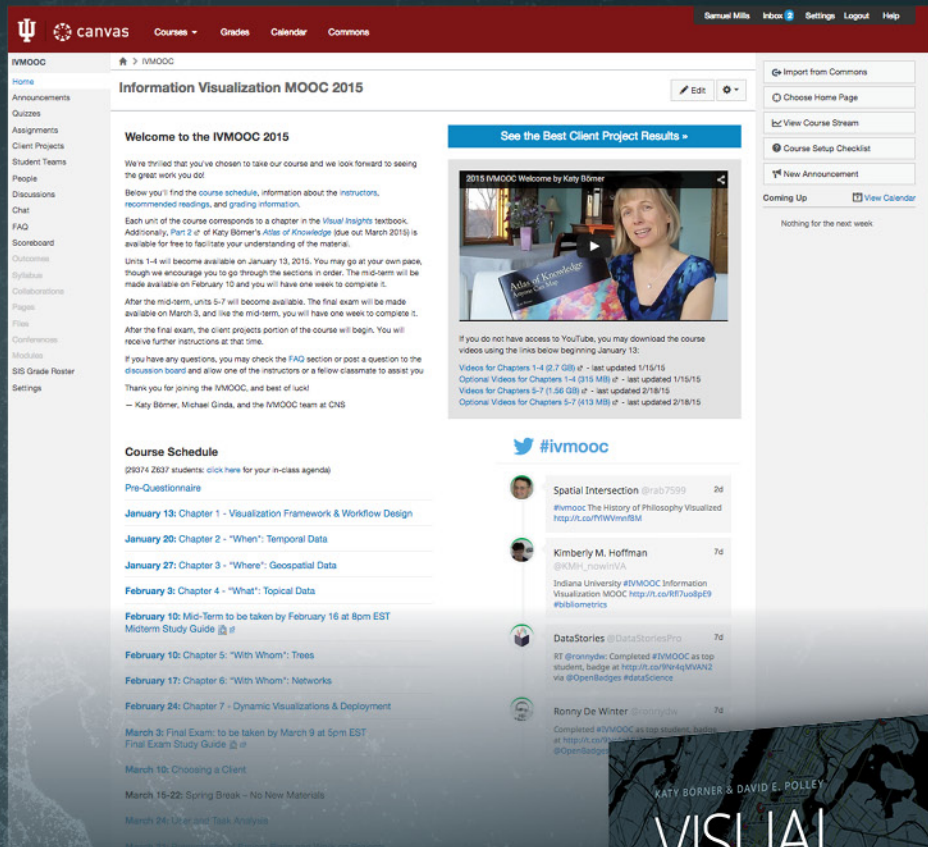
## Information Visualization MOOC

The Information Visualization MOOC provides an overview about the state of the art in information visualization, teaching the process of producing effective visualizations that take the needs of users into account.

The inaugural IVMOOC, which launched in January 2013, attracted participants from more than 100 countries. It is one of the first MOOCs offered by IU and the first to offer an opportunity for students to work in teams with real clients. All registrants gain free access to the Scholarly Database and the Sci2 Tool.

The course can be taken for three Indiana University credits as part of the Online Data Science Program offered by the School of Informatics and Computing.

The course will return in January 2016. Learn more at [ivmooc.cns.iu.edu](http://ivmooc.cns.iu.edu).



**Information Visualization MOOC 2015**

Welcome to the IVMOOC 2015

We're thrilled that you've chosen to take our course and we look forward to seeing the great work you do!

Below you'll find the course schedule, information about the instructors, recommended readings, and grading information.

Each unit of the course corresponds to a chapter in the *Visual Insights* textbook. Additionally, Part 2 of Katy Börner's *Atlas of Knowledge* (due out March 2015) is available for free to facilitate your understanding of the material.

Units 1-4 will become available on January 13, 2015. You may go at your own pace, though we encourage you to go through the sections in order. The mid-term will be made available on February 10 and you will have one week to complete it.

After the mid-term, units 5-7 will become available. The final exam will be made available on March 3, and like the mid-term, you will have one week to complete it.

After the final exam, the client projects portion of the course will begin. You will receive further instructions at that time.

If you have any questions, you may check the FAQ section or post a question to the discussion board and allow one of the instructors or a fellow classmate to assist you. Thank you for joining the IVMOOC, and best of luck!

— Katy Börner, Michael Gindl, and the IVMOOC team at CNS

**Course Schedule**

29374 Z037 students: [click here for your in-class agenda!](#)

**Pre-Questionnaire**

**January 13:** Chapter 1 - Visualization Framework & Workflow Design

**January 20:** Chapter 2 - "When": Temporal Data

**January 27:** Chapter 3 - "Where": Geospatial Data

**February 3:** Chapter 4 - "What": Topical Data

**February 10:** Mid-Term to be taken by February 16 at 8pm EST  
Midterm Study Guide [📄](#)

**February 10:** Chapter 5 - "With Whom": Trees

**February 17:** Chapter 6 - "With Whom": Networks

**February 24:** Chapter 7 - Dynamic Visualizations & Deployment

**March 3:** Final Exam: to be taken by March 9 at 5pm EST  
Final Exam Study Guide [📄](#)

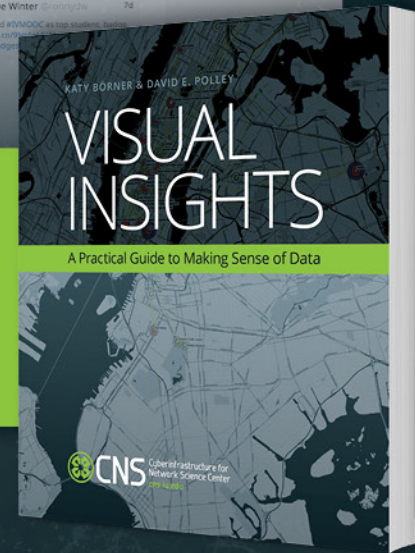
**March 10:** Choosing a Client

**March 15-22:** Spring Break - No New Materials

**March 29:** Up and Level: Task Analysis

**March 30:** Final Exam: Final Review and a Welcome to the Future

This IVMOOC companion textbook offers a gentle introduction to the design of insightful visualizations. It seamlessly blends theory and practice, giving readers both the theoretical foundation and the practical skills necessary to render data into insights.

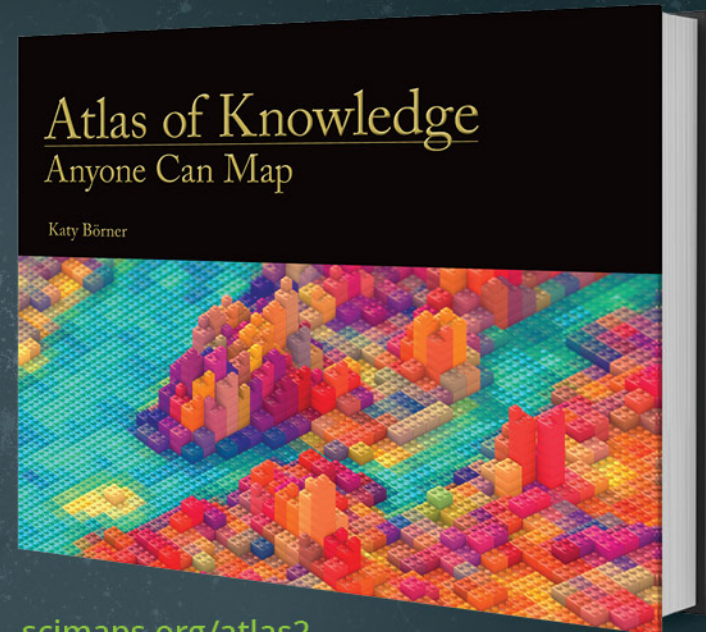


# Enjoy the first two books in Katy Börner's 3-Part *Atlas* series



[scimaps.org/atlas1](http://scimaps.org/atlas1)

*Atlas of Science*, featuring more than thirty full-page science maps, fifty data charts, a timeline of science-mapping milestones, and 500 color images, serves as a sumptuous visual index to the evolution of modern science and as an introduction to “the science of science”—charting the trajectory from scientific concept to published results.



[scimaps.org/atlas2](http://scimaps.org/atlas2)

The *Atlas of Knowledge* introduces a theoretical visualization framework meant to empower anyone to systematically render data into insights. It aims to teach “timeless” knowledge that holds true over a lifetime while referring to an extensive set of references for “timely” advice on what tool and workflow is currently the best for answering a specific question.



[facebook.com/cnscenter](https://facebook.com/cnscenter)



[@cnscenter](https://twitter.com/cnscenter)

# What is Big Data?

More than two-thirds of visitors interviewed said that they had not previously heard the phrase “Big Data.”

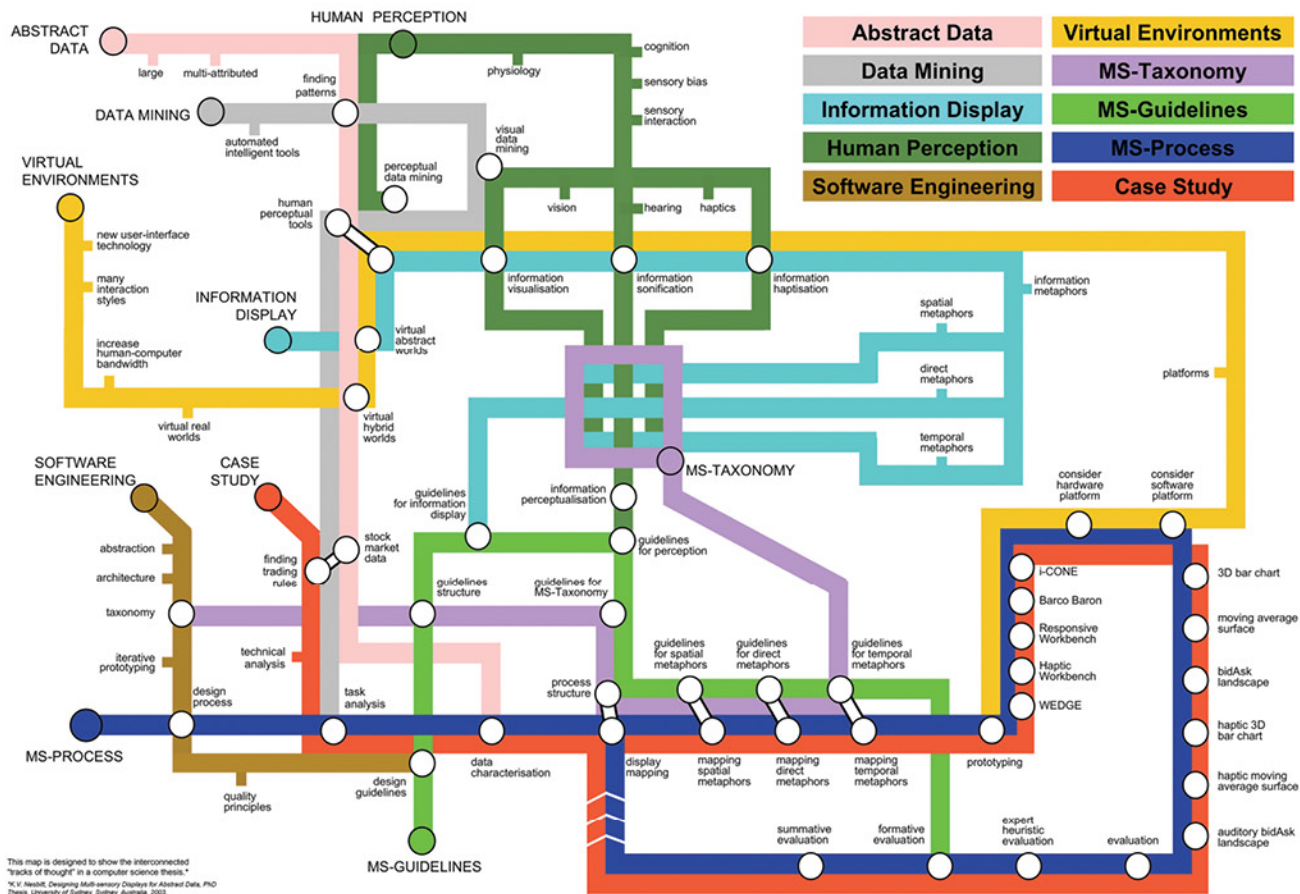
—Sense Making of Big Data, Heimlich, Tranby, Wojton 2014

“Important information. Something everybody relates to, but doesn’t understand.”

—Project participant

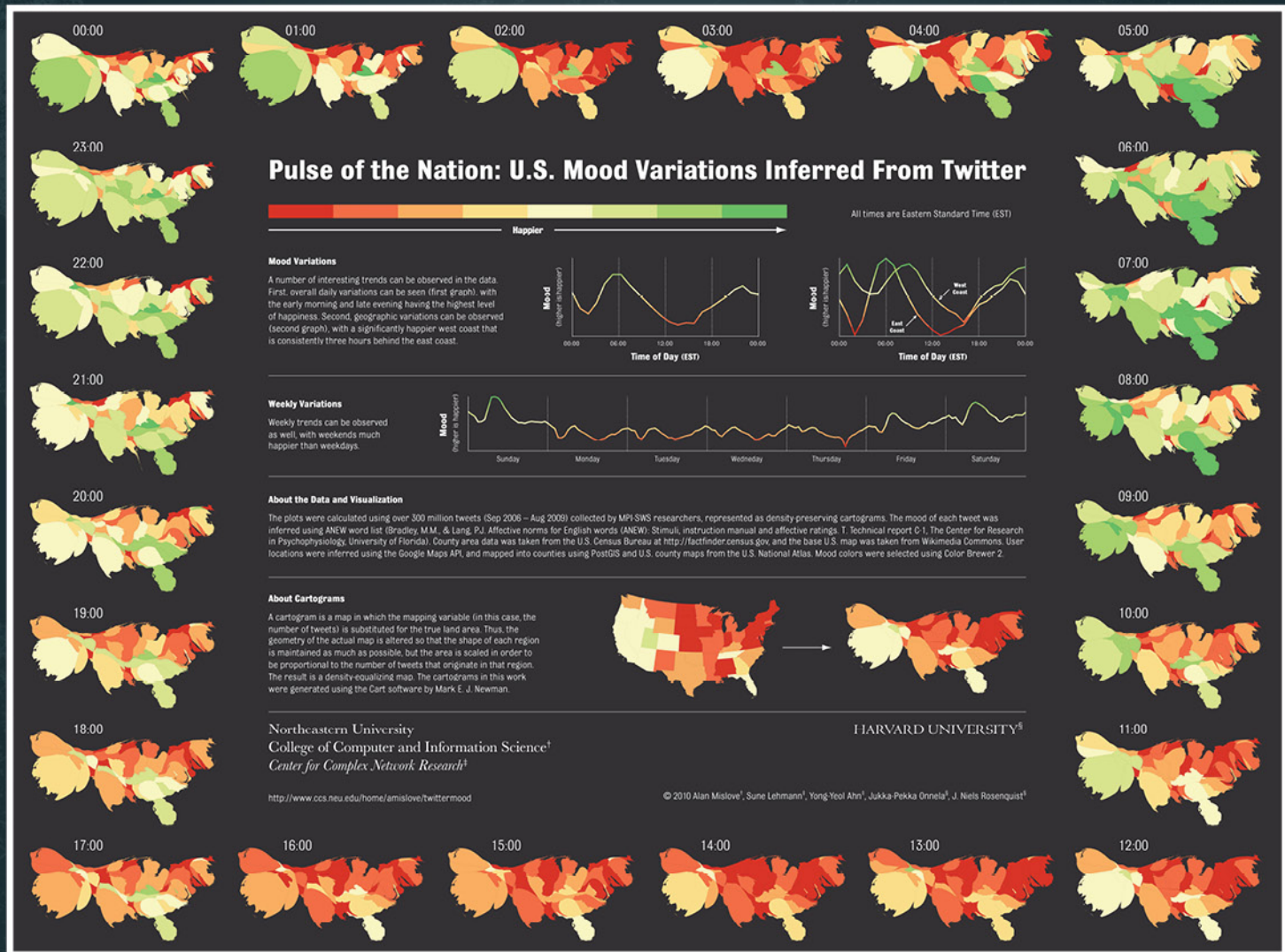
“[It] gives me anxiety. I don’t know and I don’t like it.”

—Project participant



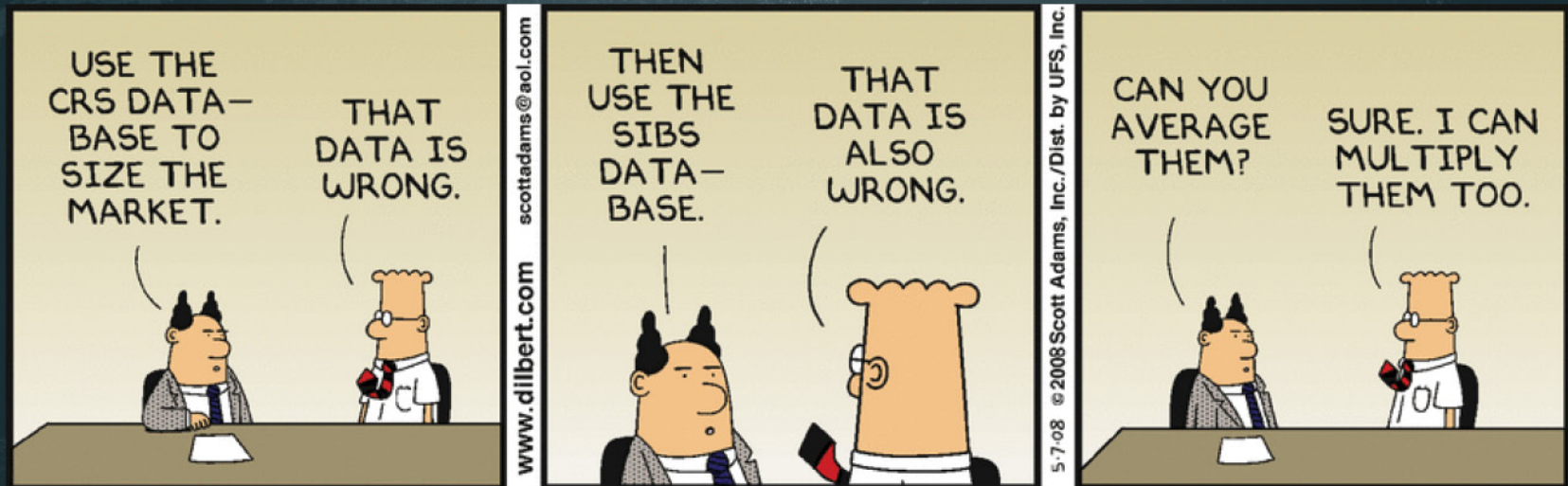
Ph.D. Thesis Map, by Keith V. Nesbitt

Could you convey the collective “mood” of Twitter users with just text? Maybe—but it would take pages and pages to convey the same insights this map does in seconds.



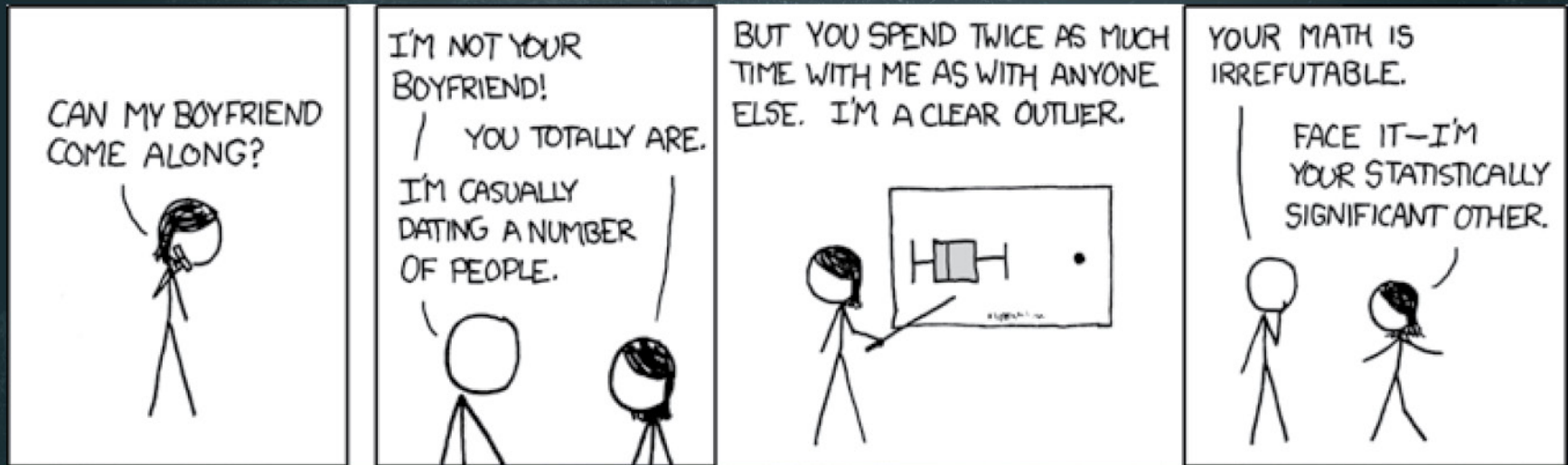
*Pulse of the Nation*, by Alan Mislove, Sune Lehmann, Yong-Yeol Ahn, Jukka-Pekka Onnela, and James Niels Rosenquist

# How we analyze and use data matters.



“We need to be able to make sense of data to improve personal and collective daily decision making.”

—Katy Börner, *Atlas of Knowledge*





# HEWLETT FOUNDATION FUNDING

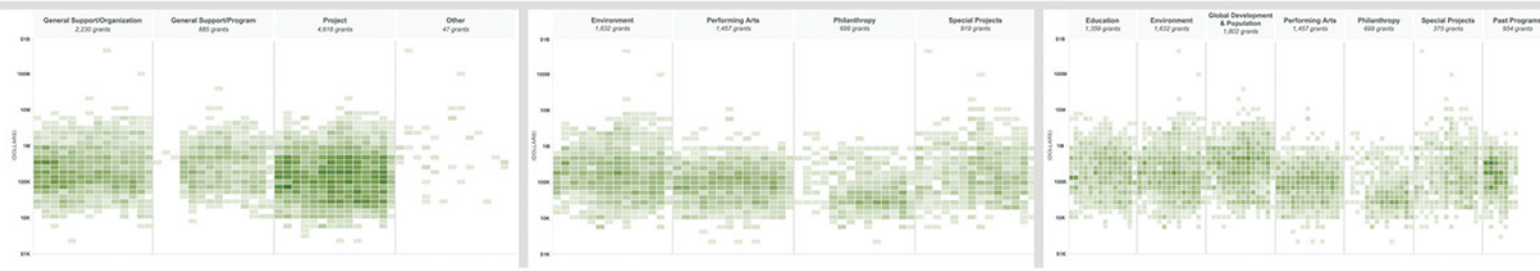
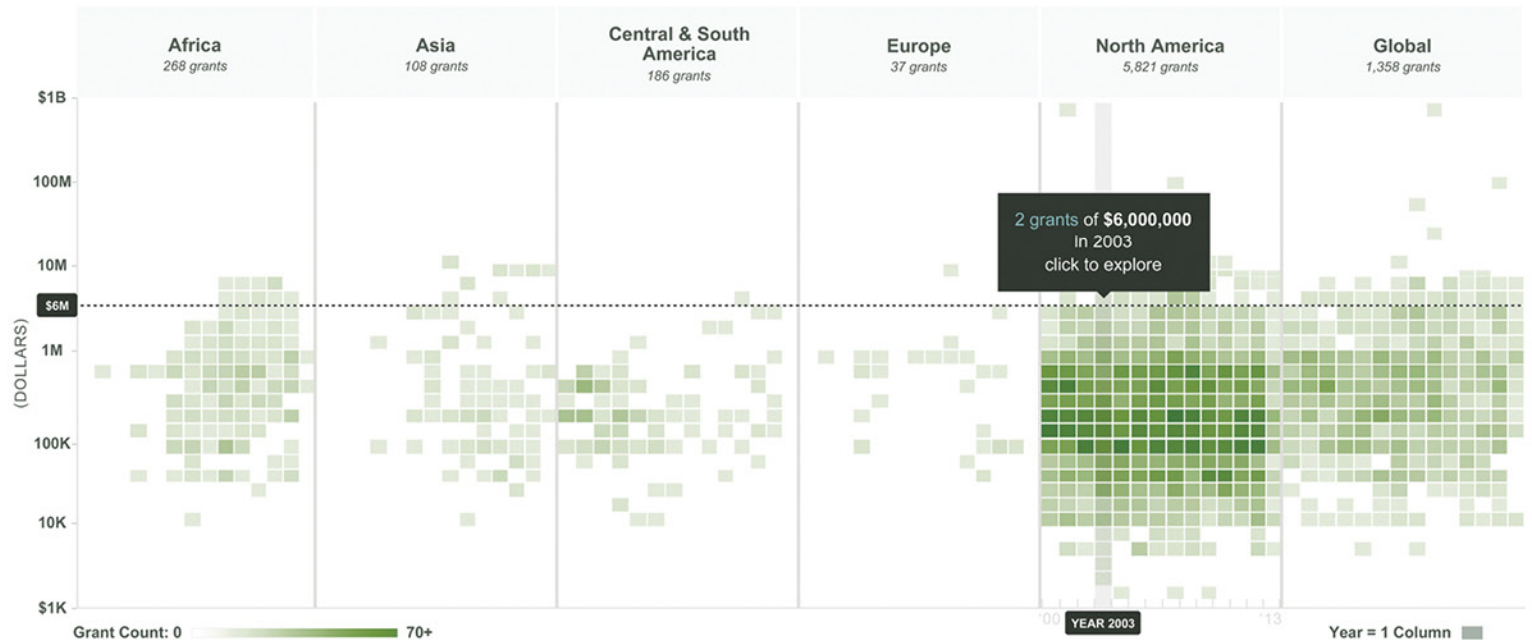
We've made  
**7,778**  
grants

**YEARS**  
viewing  
(2000-2013)

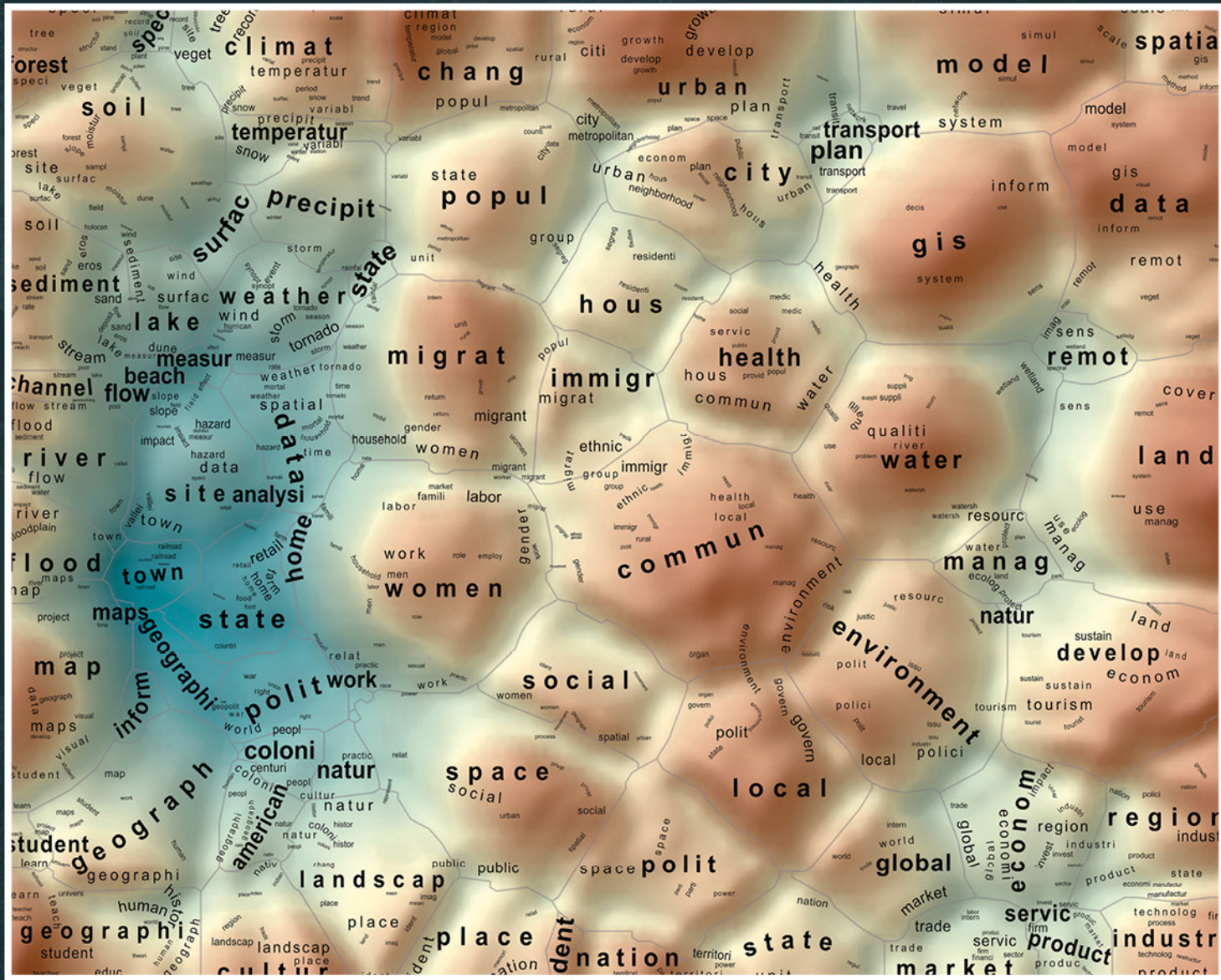
**AMOUNT**  
viewing  
(\$1K-\$1B)

**FILTERS**  
viewing  
(ALL)

for a total of  
**\$4.01B**  
during 2000-2013

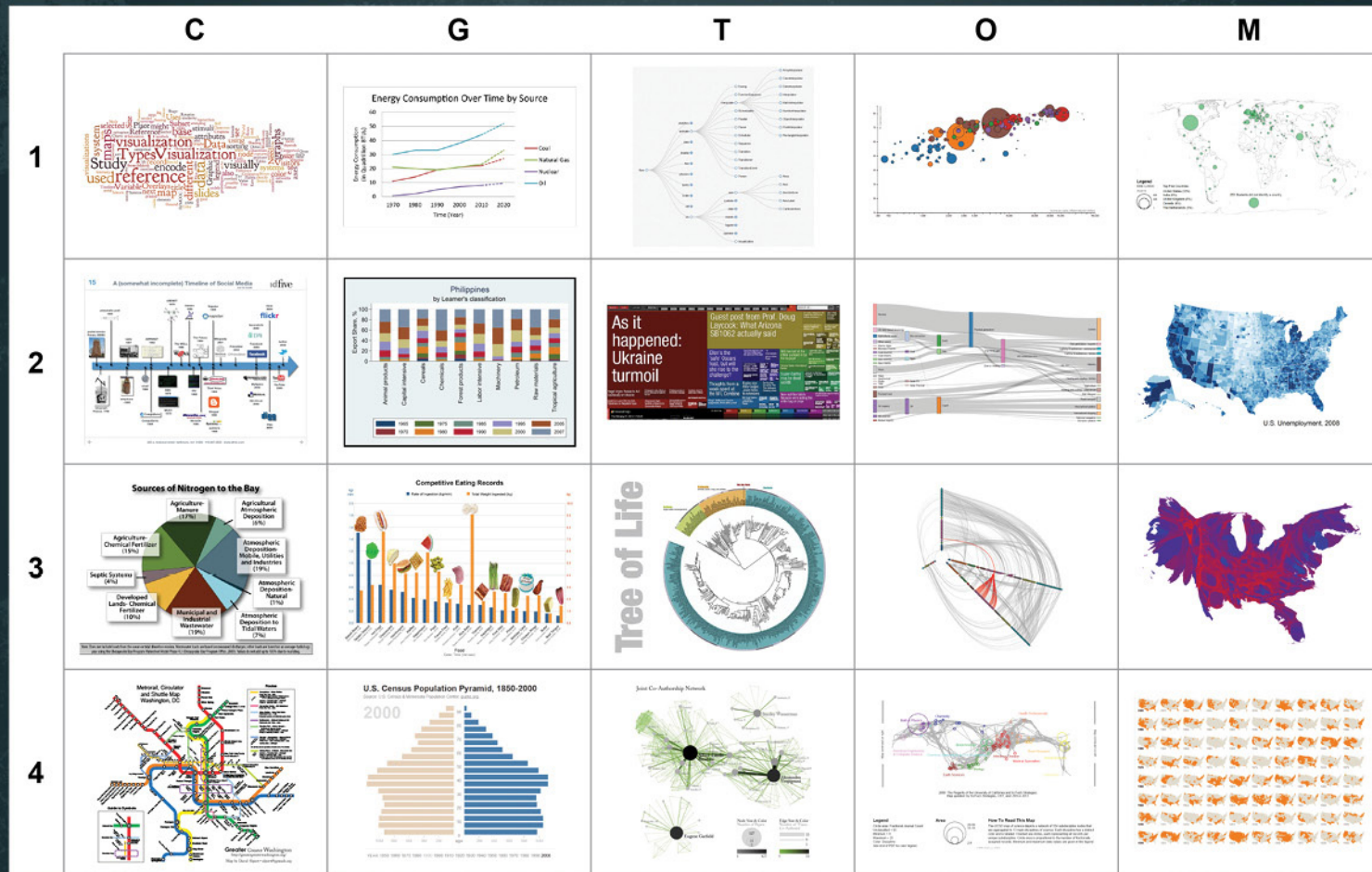


The Hewlett Foundation Grant Visualizer, by Dino Citraro, Kim Rees, Jacob O'Brien, Brett Johnson, Andrew Winterman, and Andrew Witherspoon



In Terms of Geography, by André Skupin

# Data Visualization Literacy: Can 273 Science Museum Visitors Read 20 Information Visualizations?



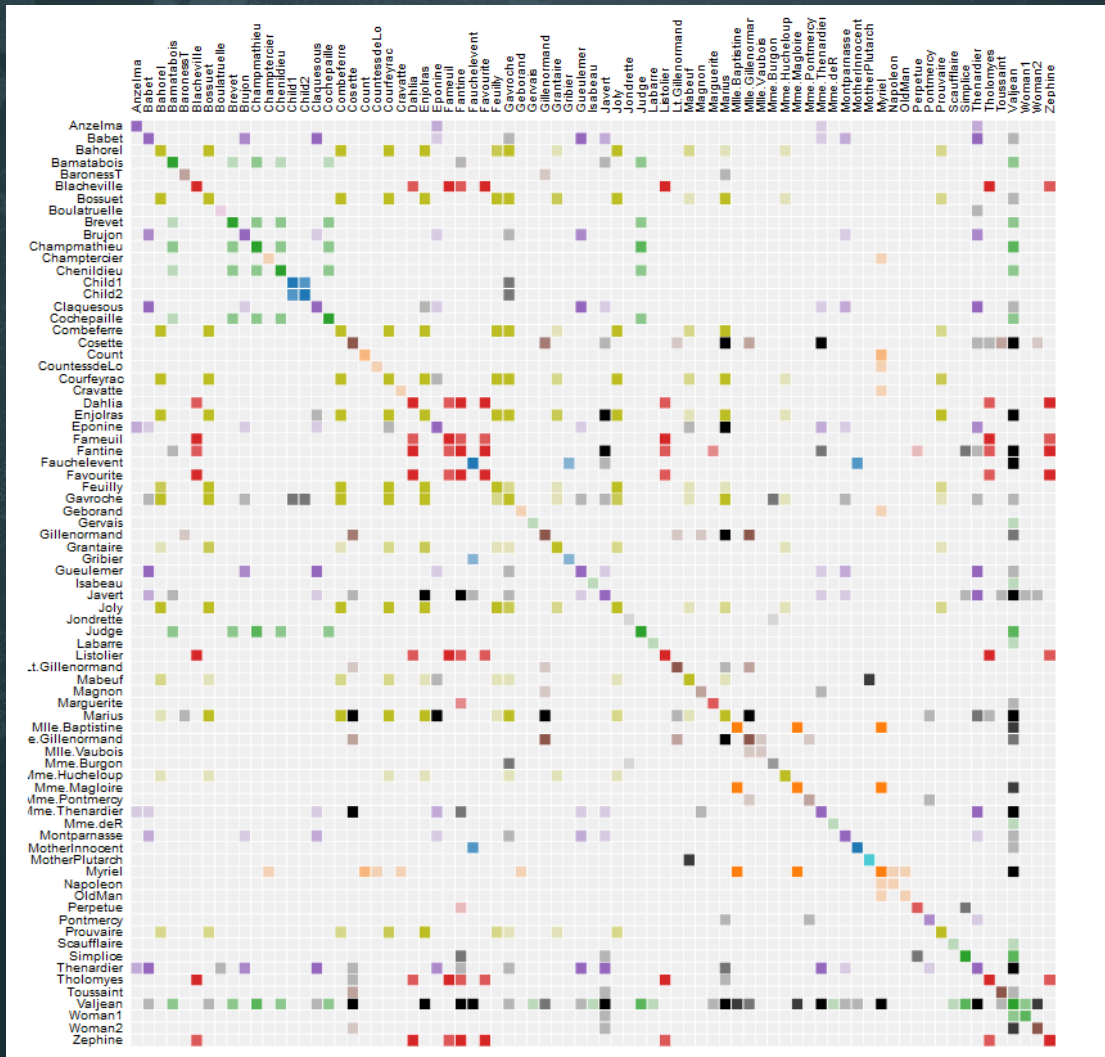
Börner, Katy, Joe E. Heimlich, Russell Balliet, and Adam V. Maltese. (Submitted). "Investigating Aspects of Data Visualization Literacy Using 20 Information Visualizations and 273 Science Museum Visitors". Information Visualization.

# Research Questions

How do visitors to museums and science centers react to conceptual science maps?

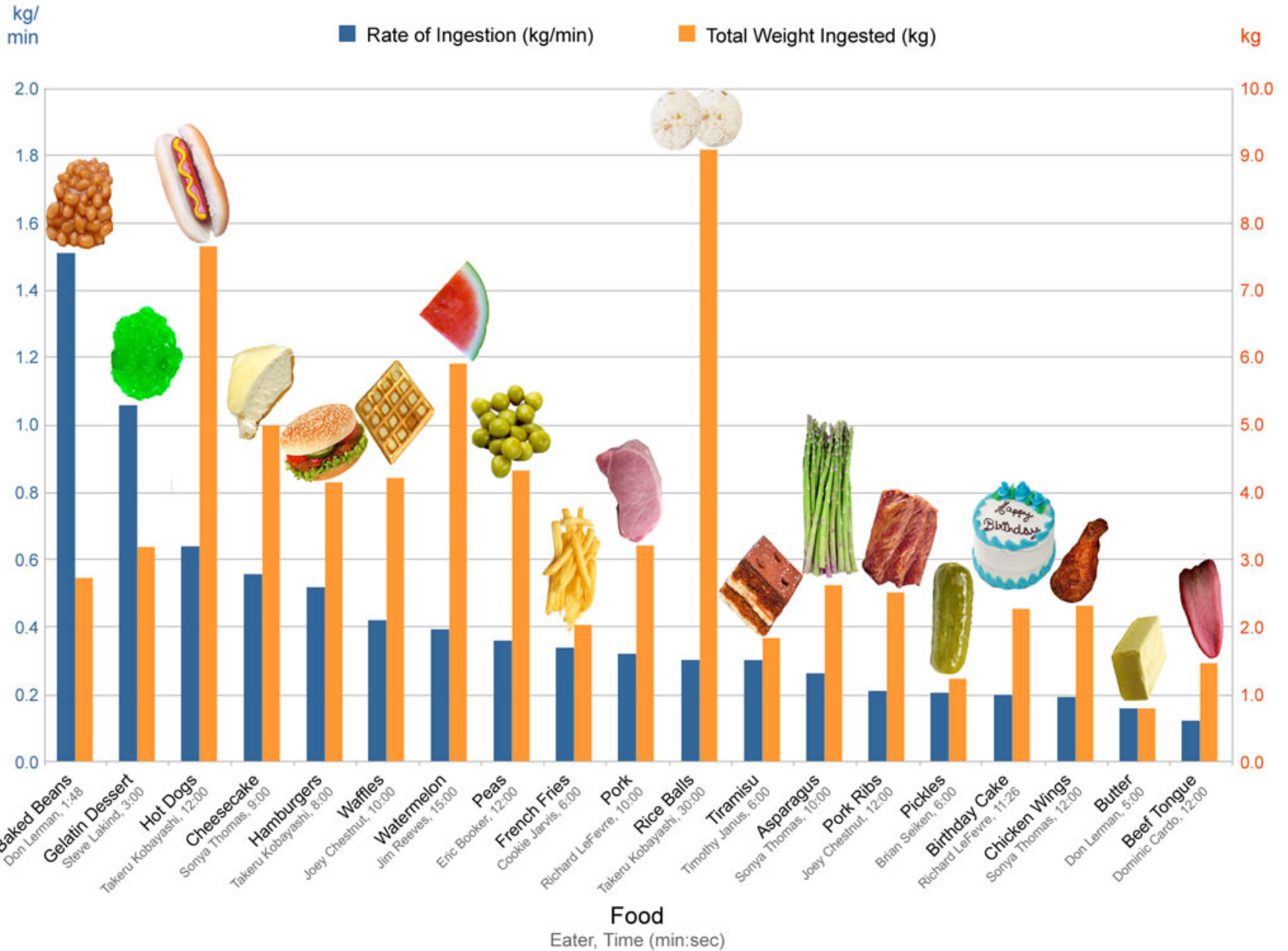
How do people engage with and understand reference systems?

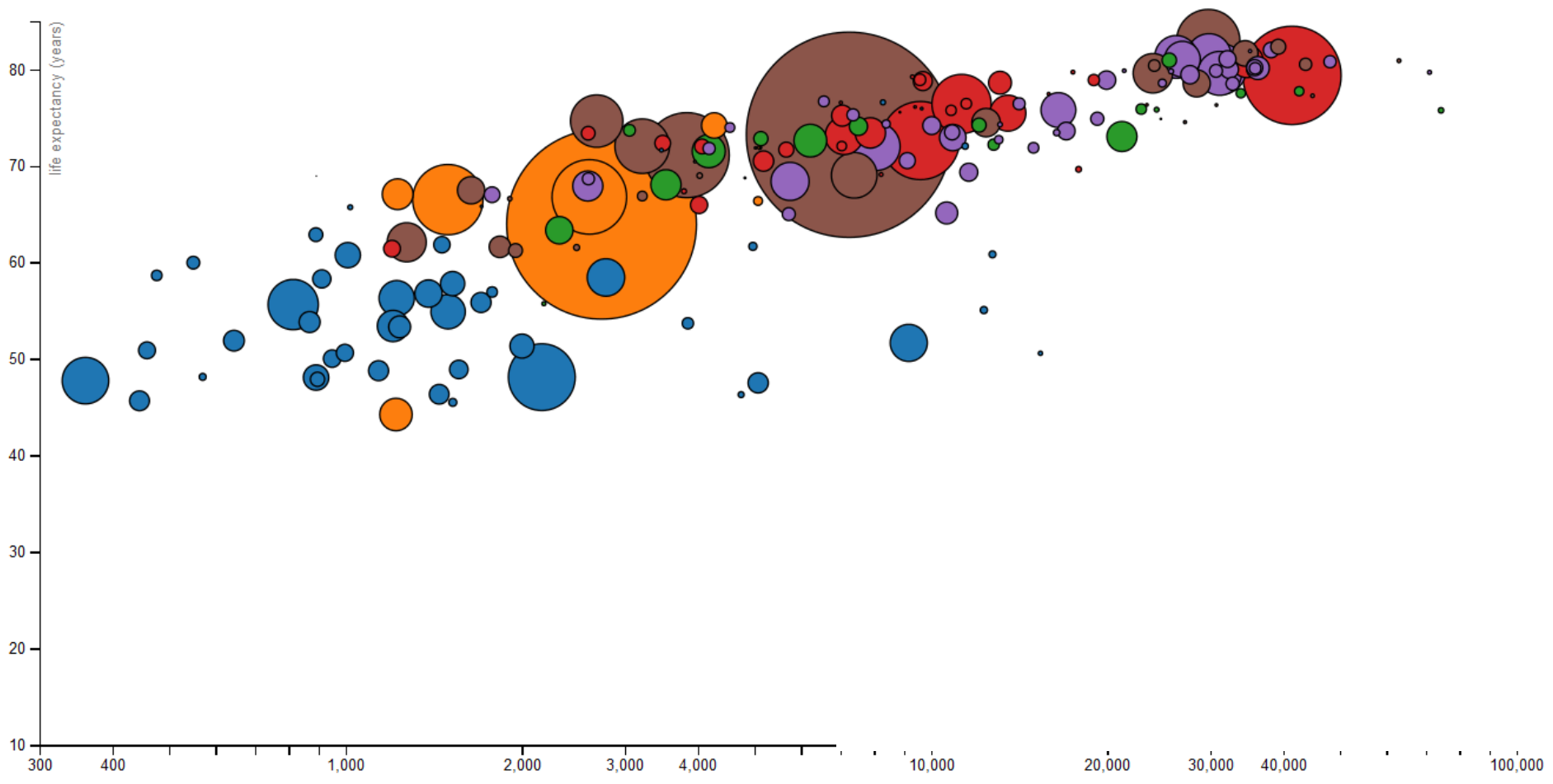
# Visualization Recognition & Meaning Making





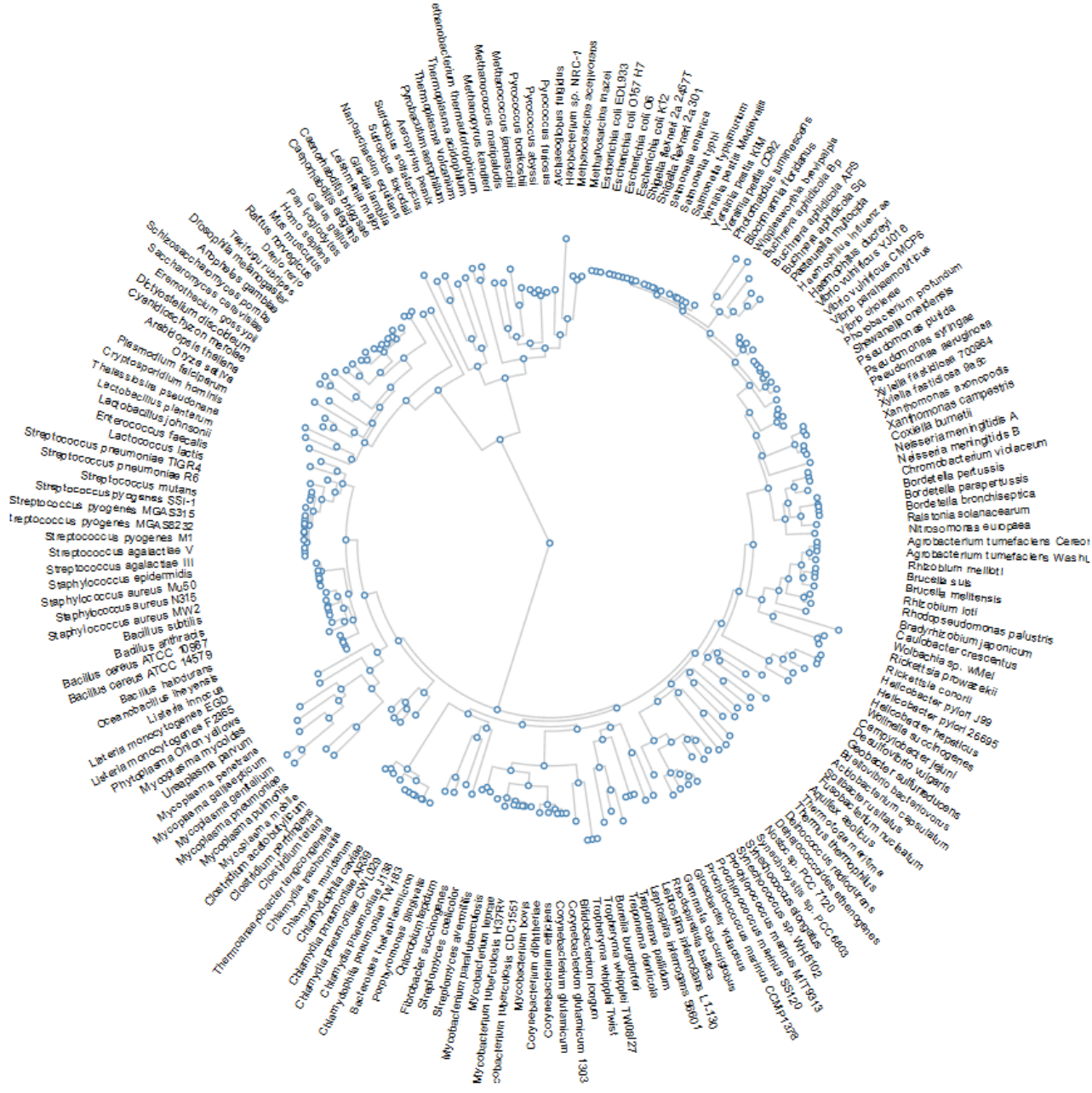
# Competitive Eating Records

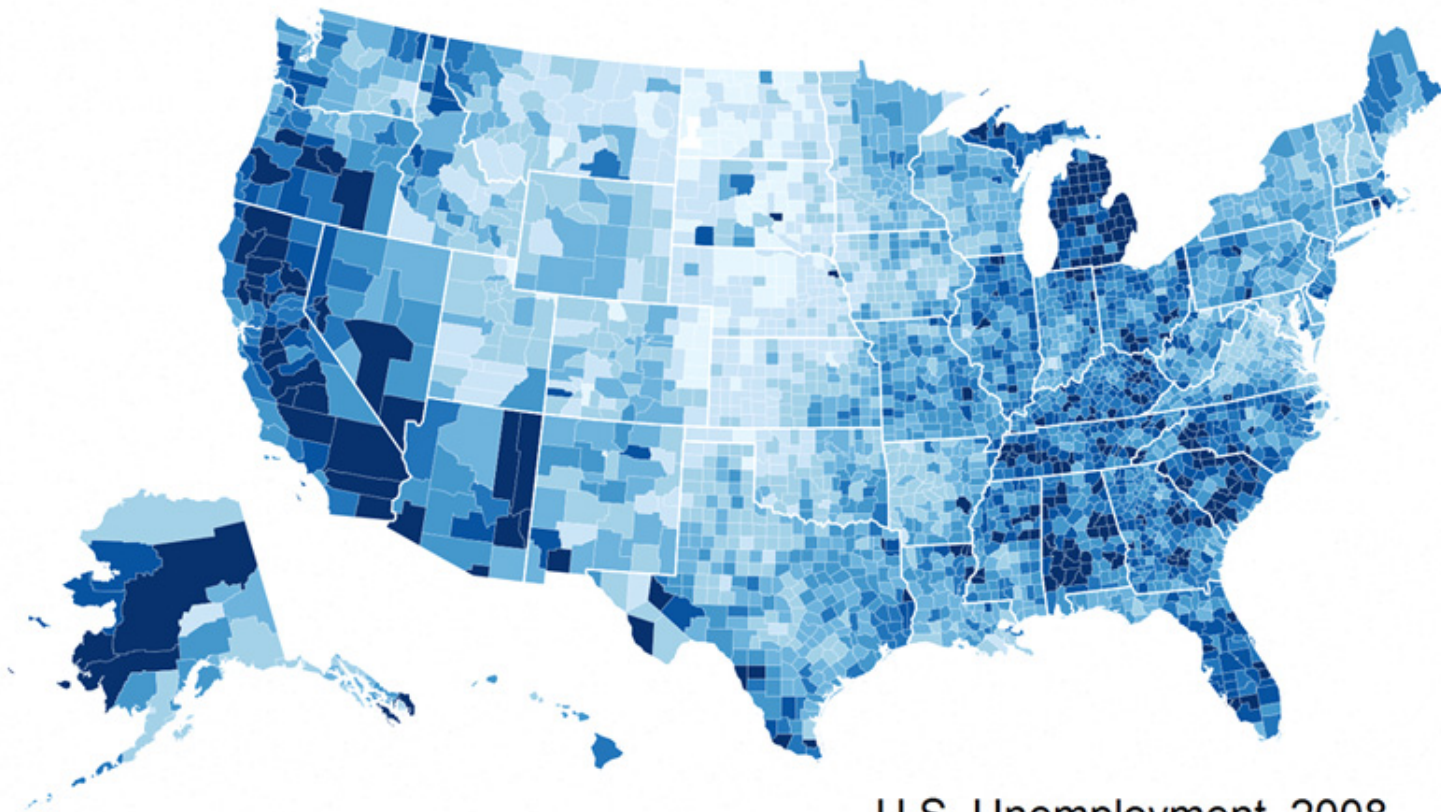






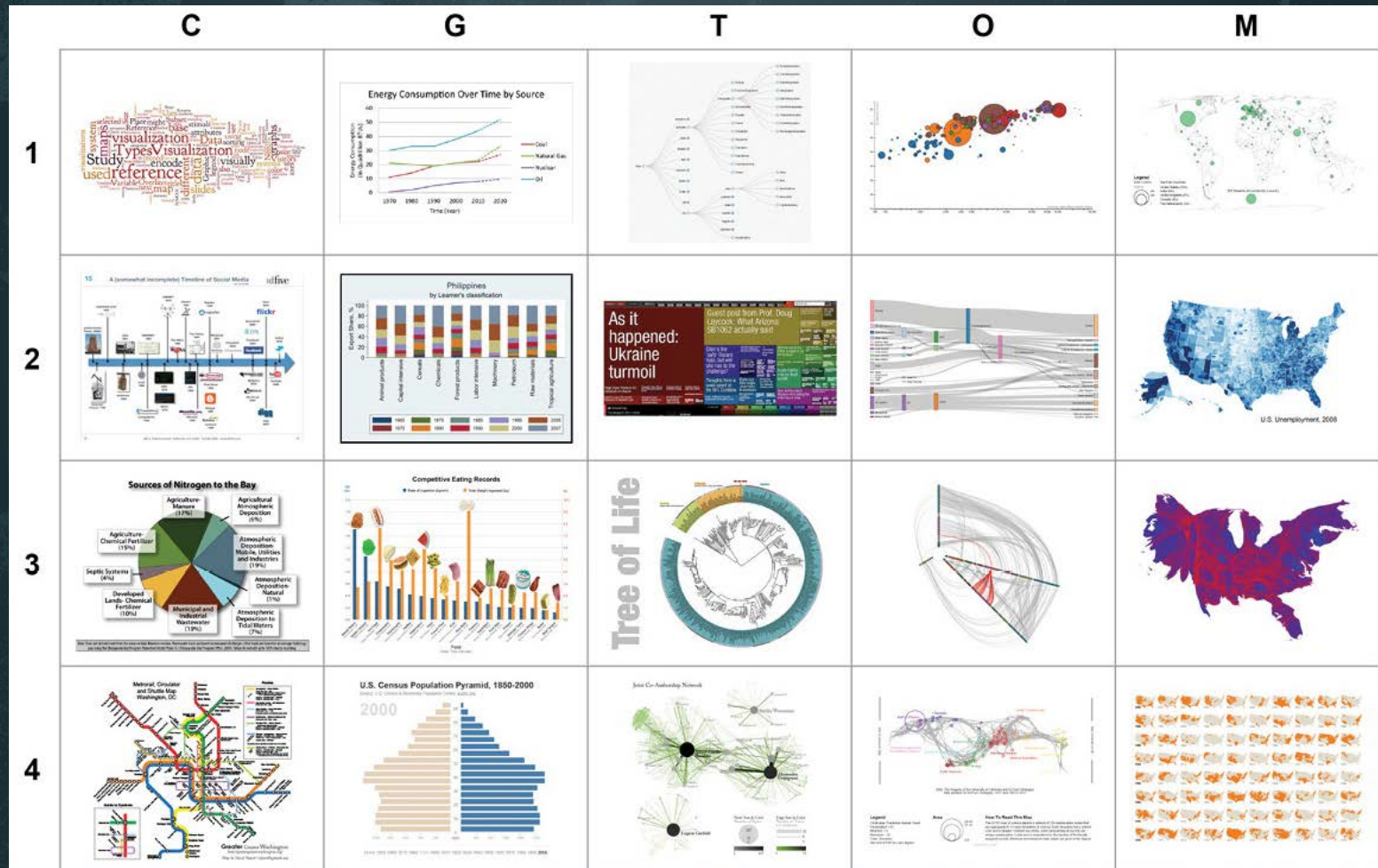
# Phylogenetic Tree of Life





U.S. Unemployment, 2008

# Visualization Recognition & Meaning Making



# Design

Does this type of data presentation look at all familiar?

How do you think you read this type of data presentation?

What would you call this type of data presentation?

What types of data do you think would makes sense for this type of presentation?

In addition, each individual/group was asked to rank the five visualizations based on “ease of readability”.

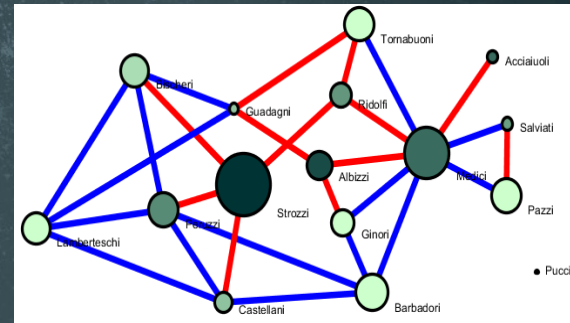
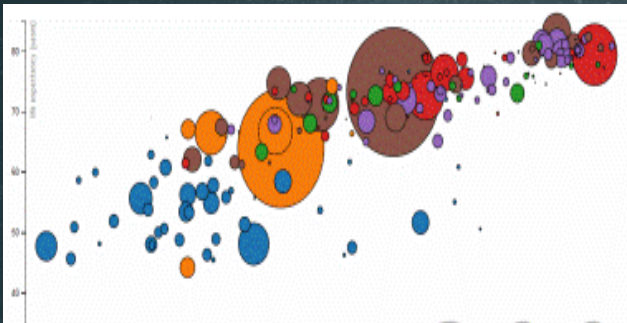
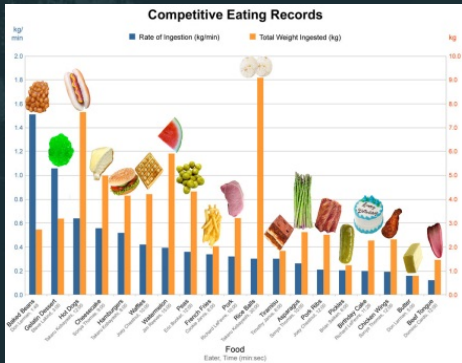
# Findings

- Participants were unable to accurately describe the meanings of many of the reference systems
- Participants' tended to prefer those visuals that had a familiarity in terms of the reference system.

# Findings

- Topics do matter in terms of which visuals people prefer
- Color and visual appeal are important and for some people these factors drive preference.

# Construction and Deconstruction

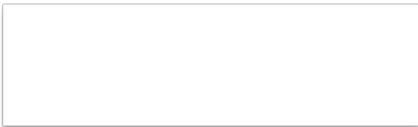
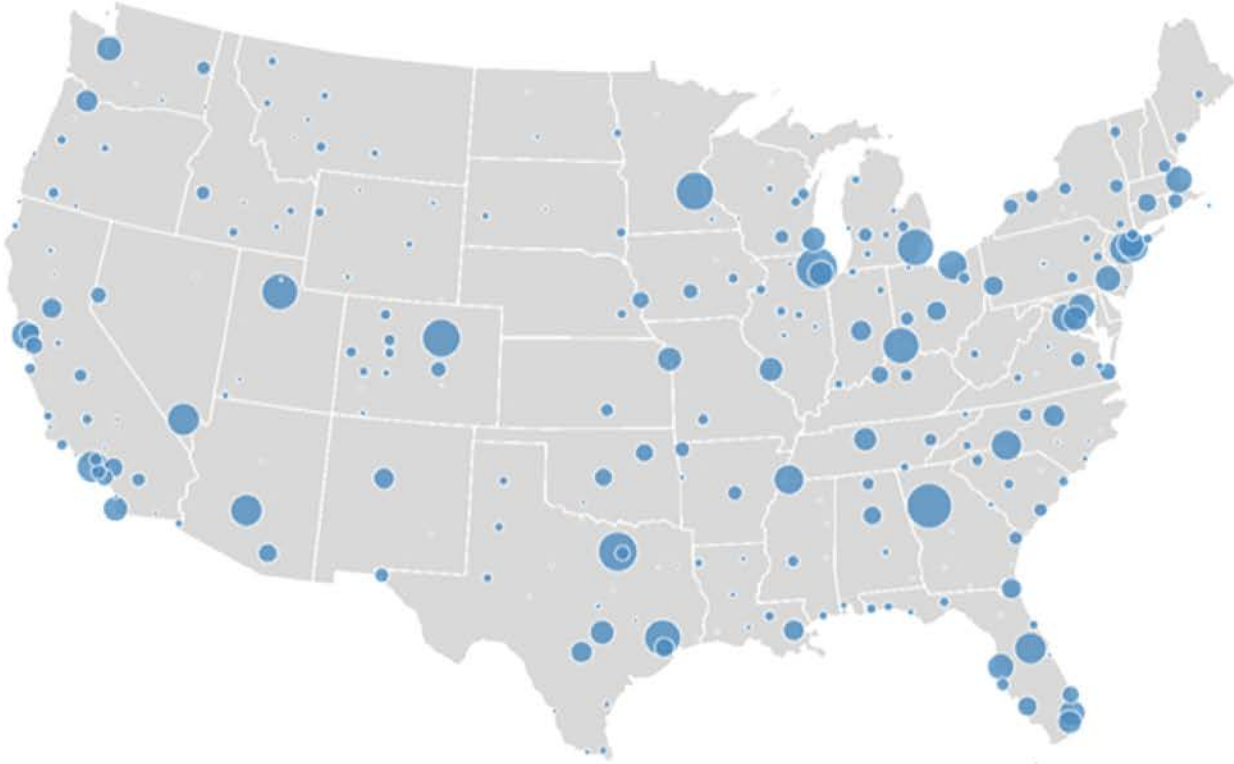


***Participating Museums:  
COSI, Koshland, New York Hall of  
Science, and Wonder Lab***

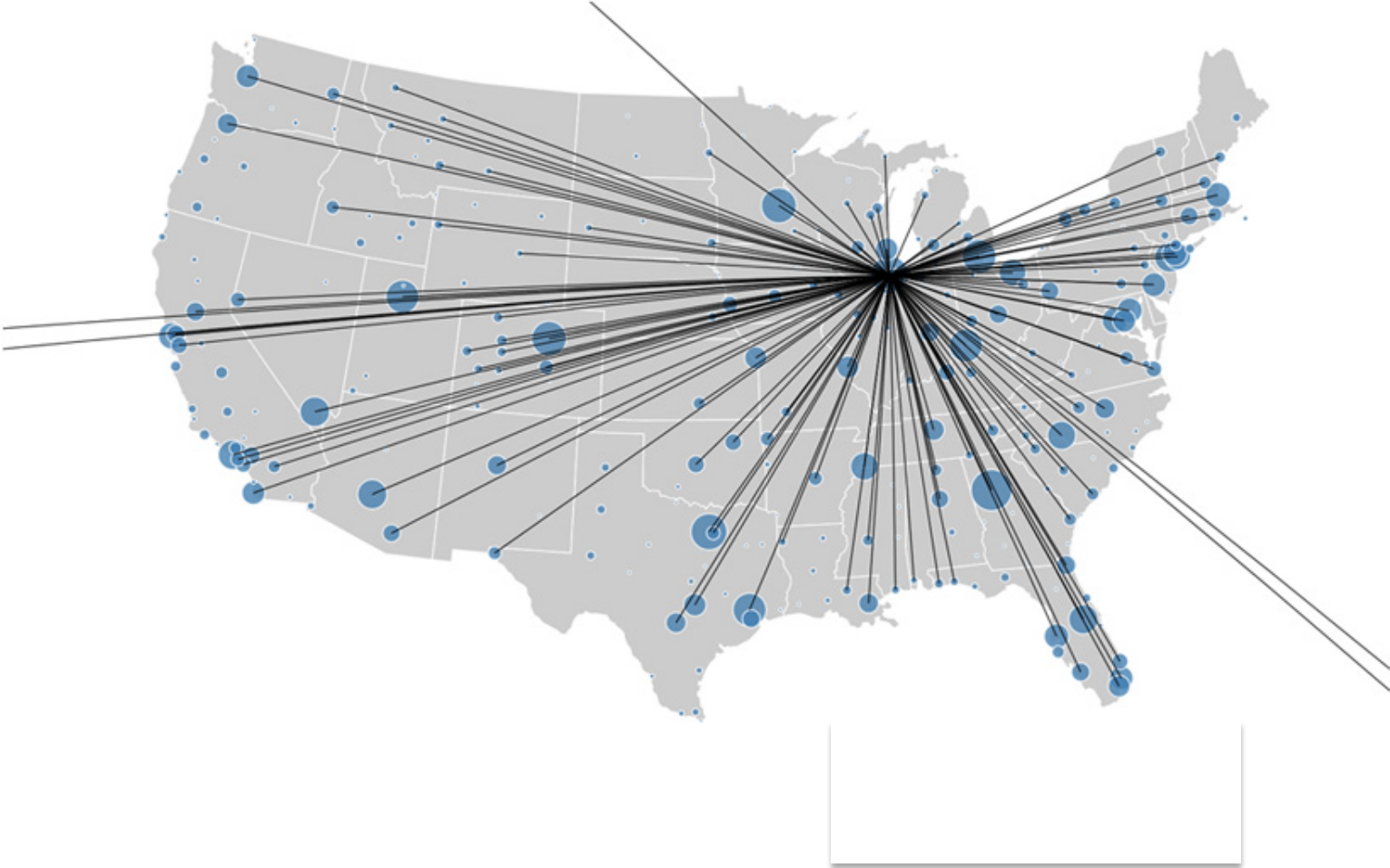




Circle size equals number of flights per day.

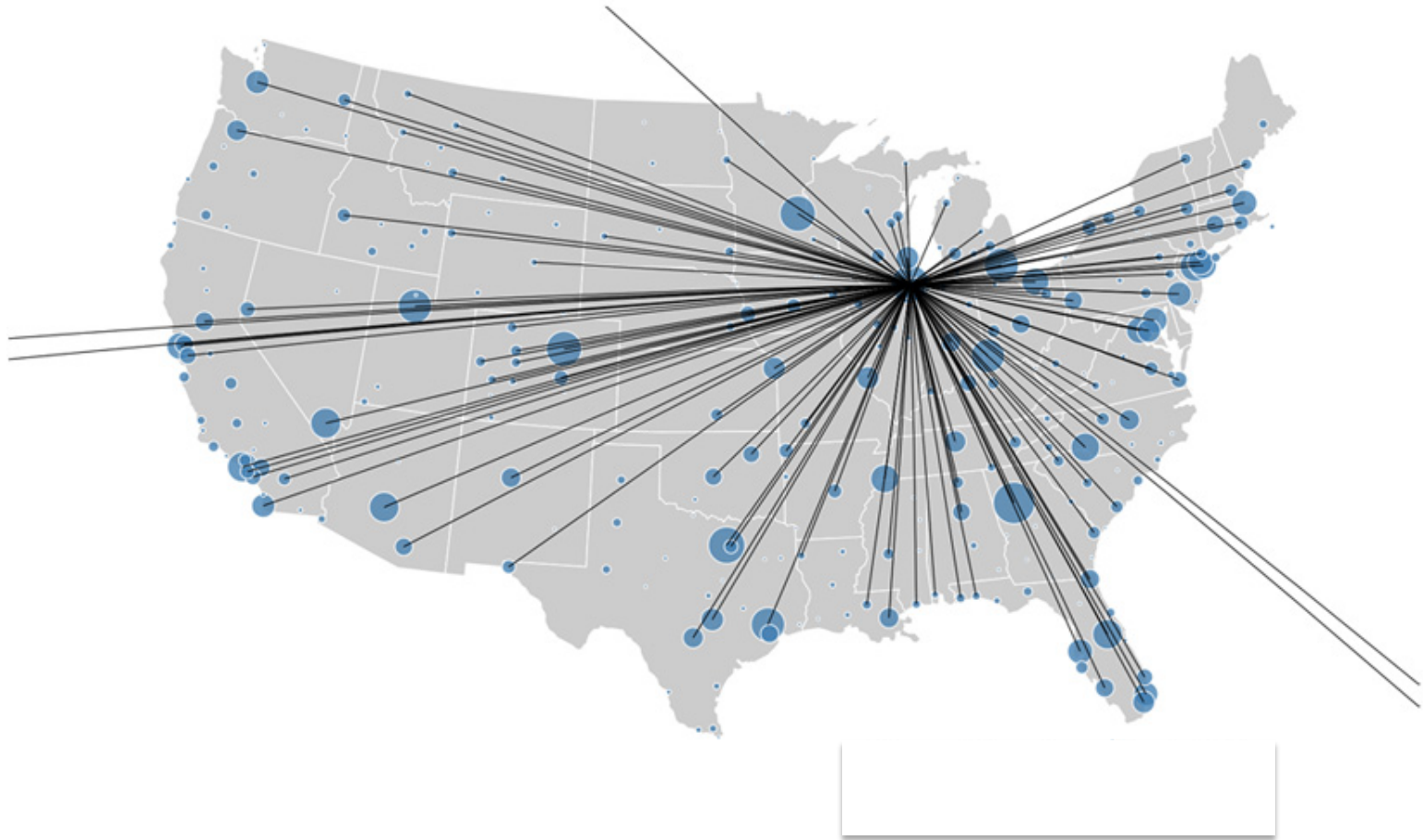


Links represent flight connections.



# Airports reachable from Chicago O'Hare International Airport in 2008

Circle size equals number of flights per day.

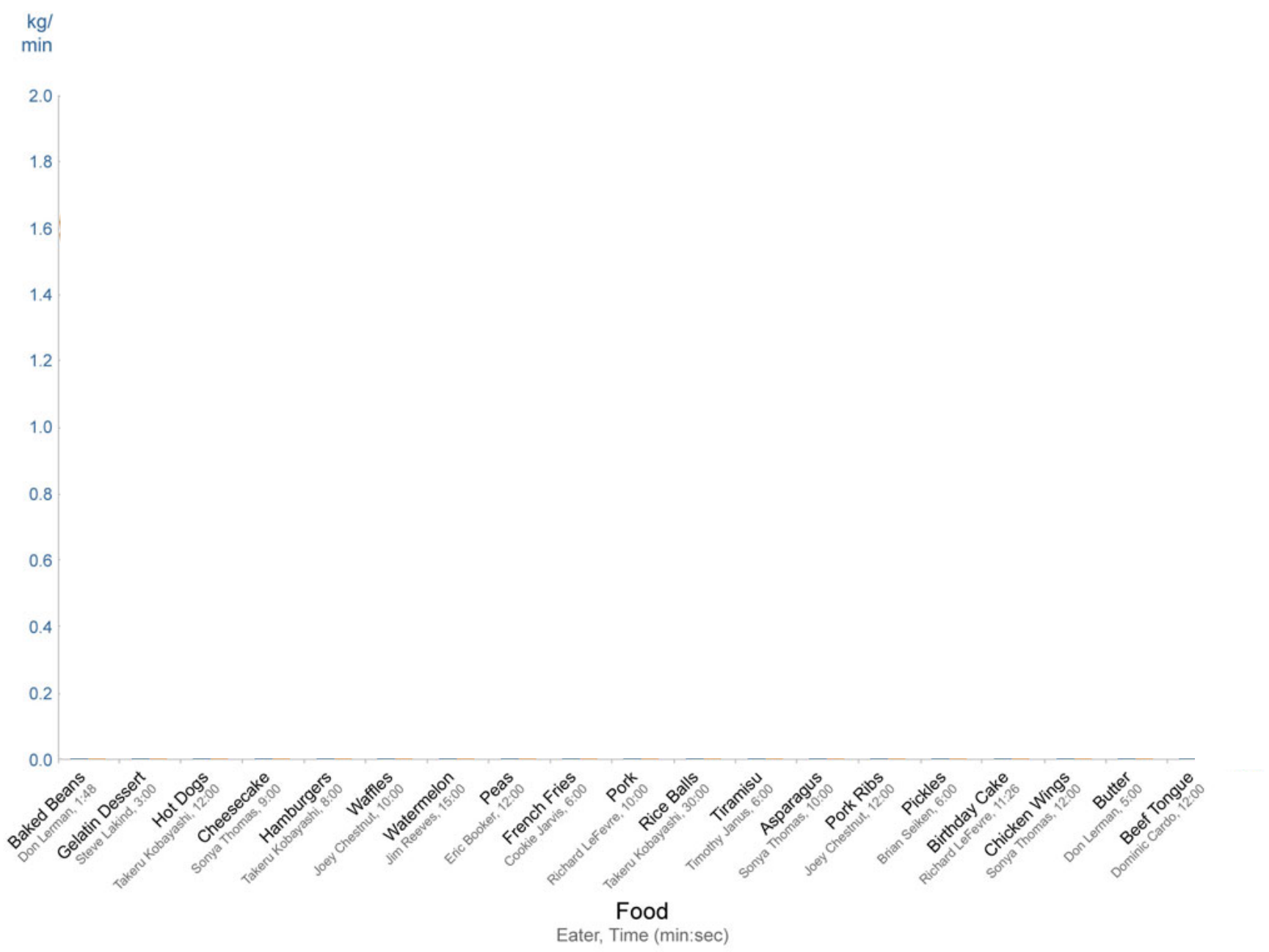


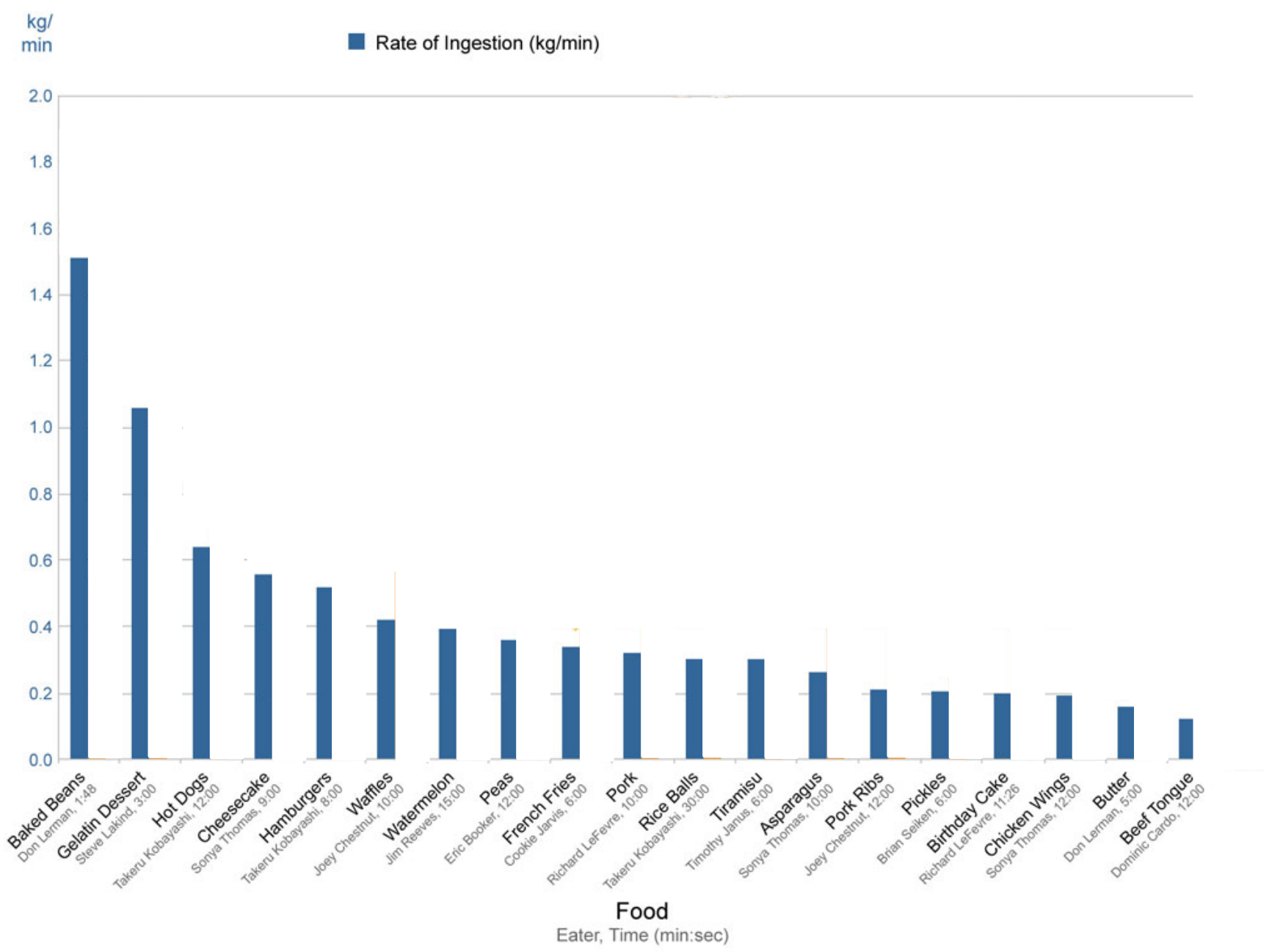
# O'Hare Flight Map

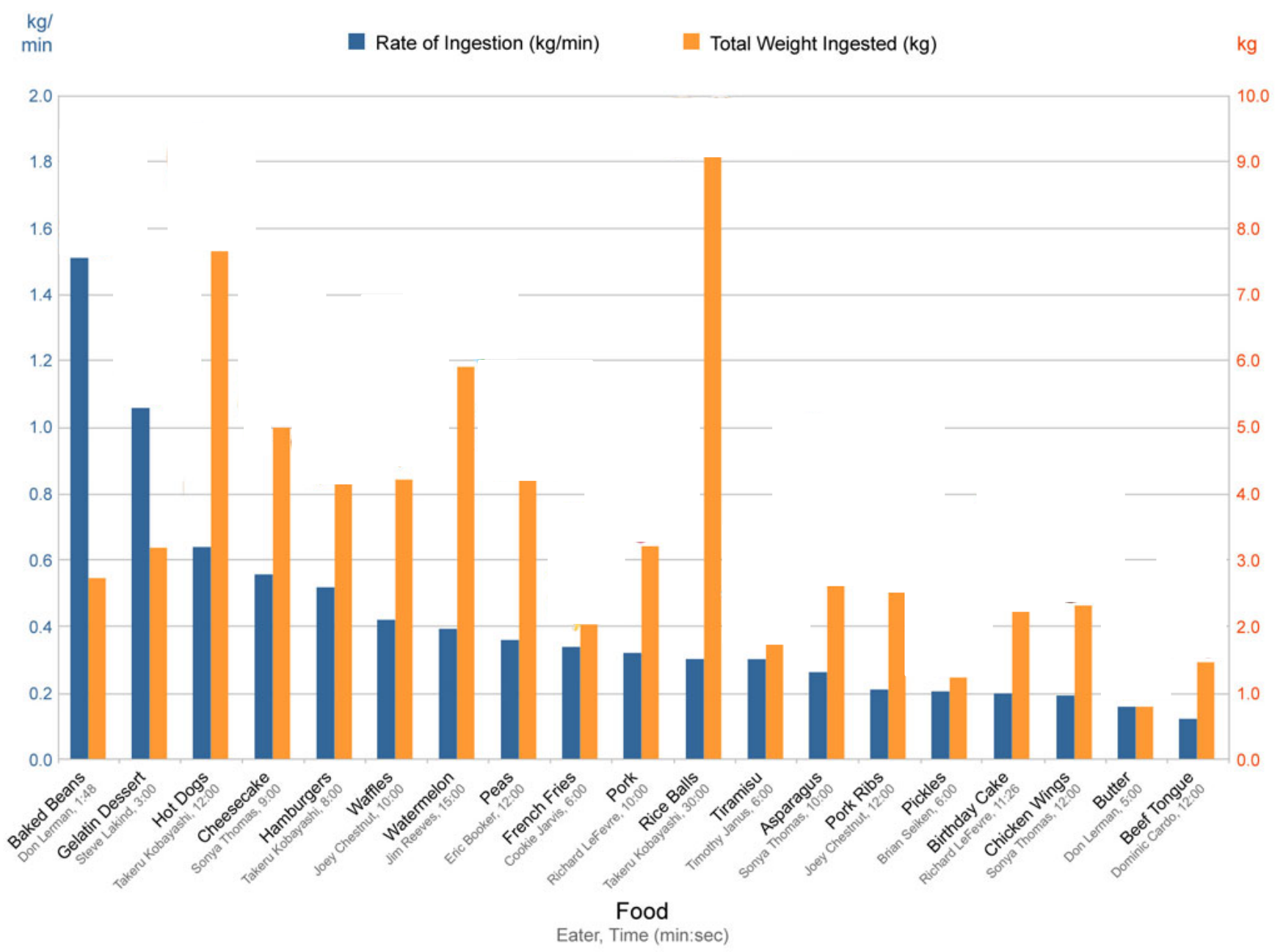
## Familiar graphic

- common reference system
- Simple graphics
- Labels

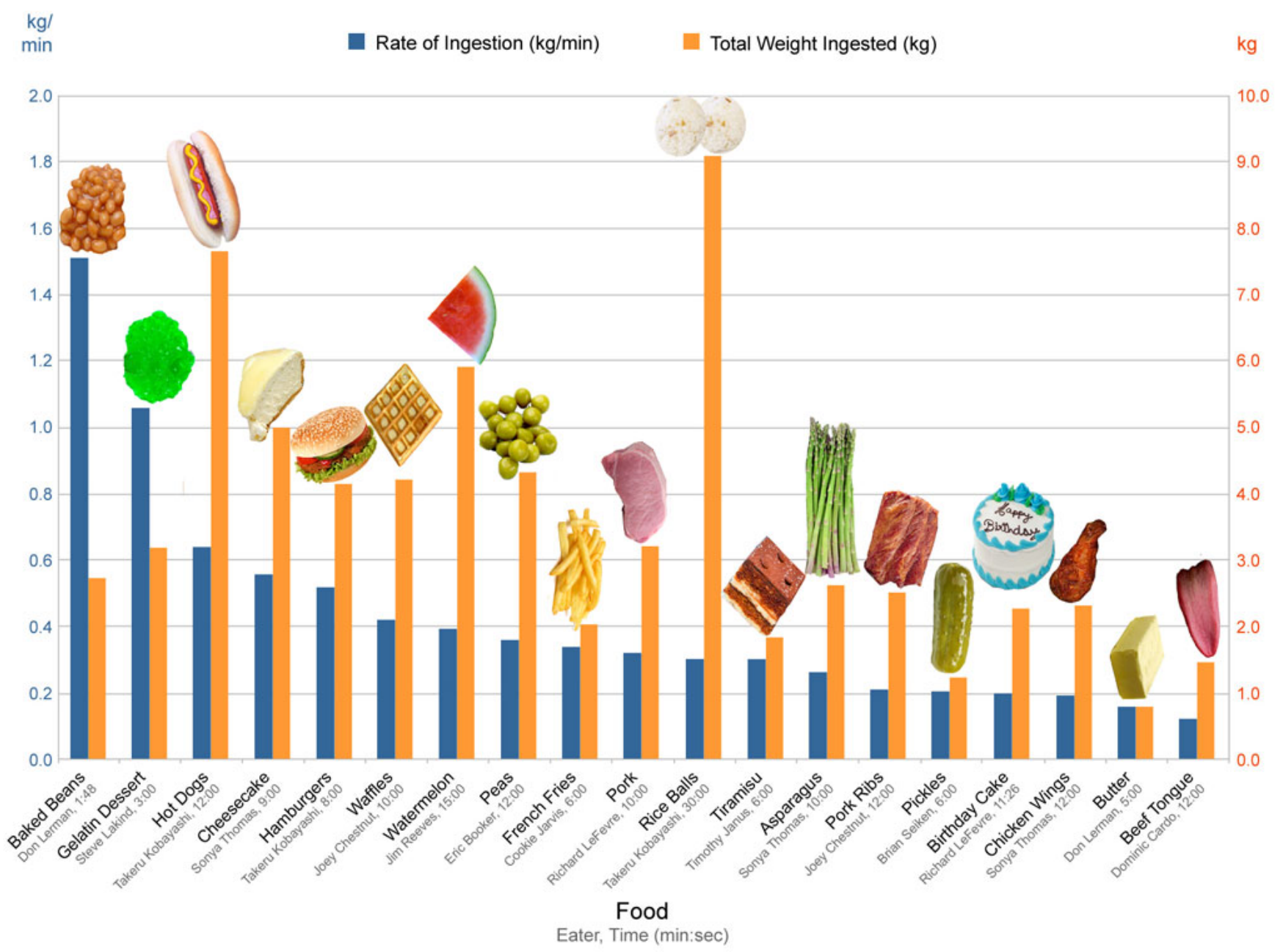




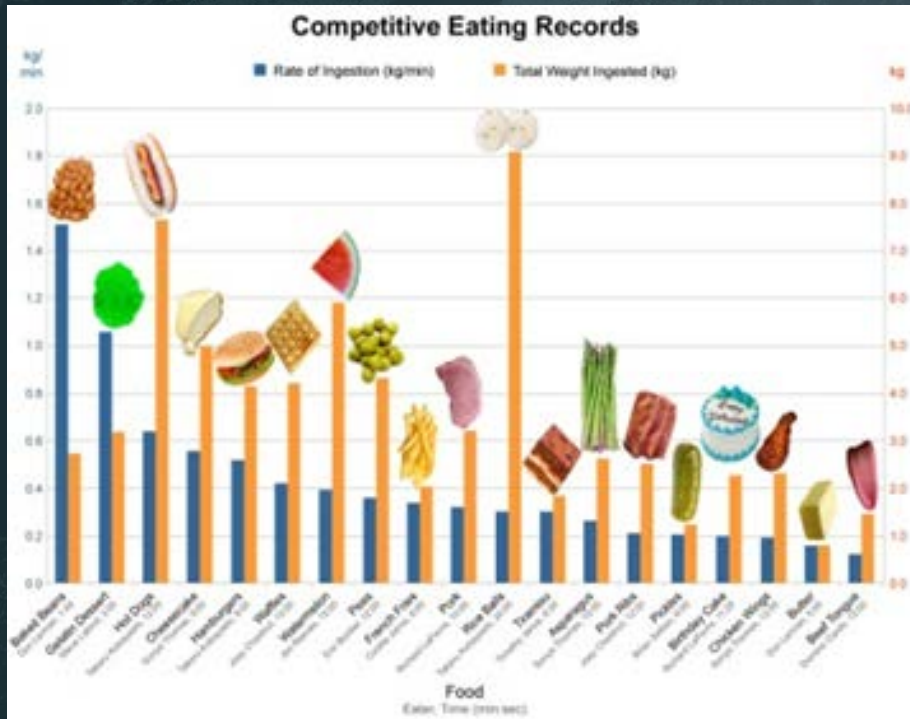






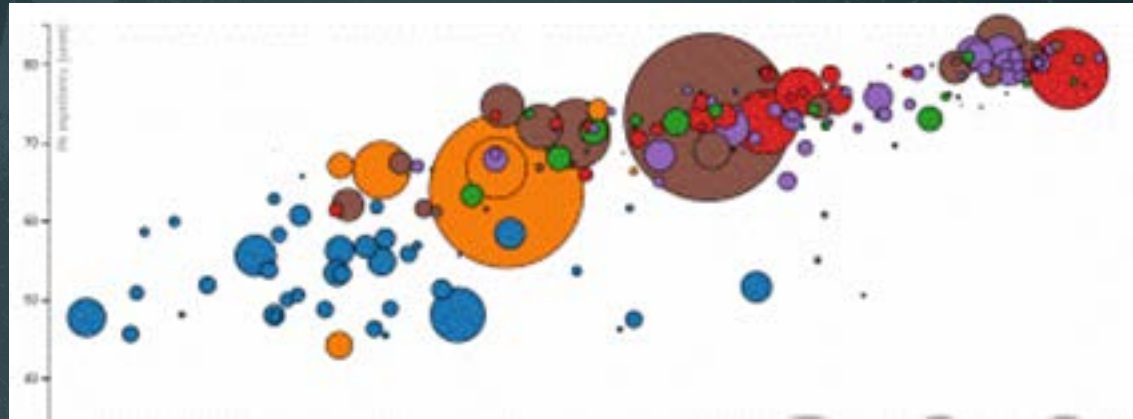


# Competitive Eating Records

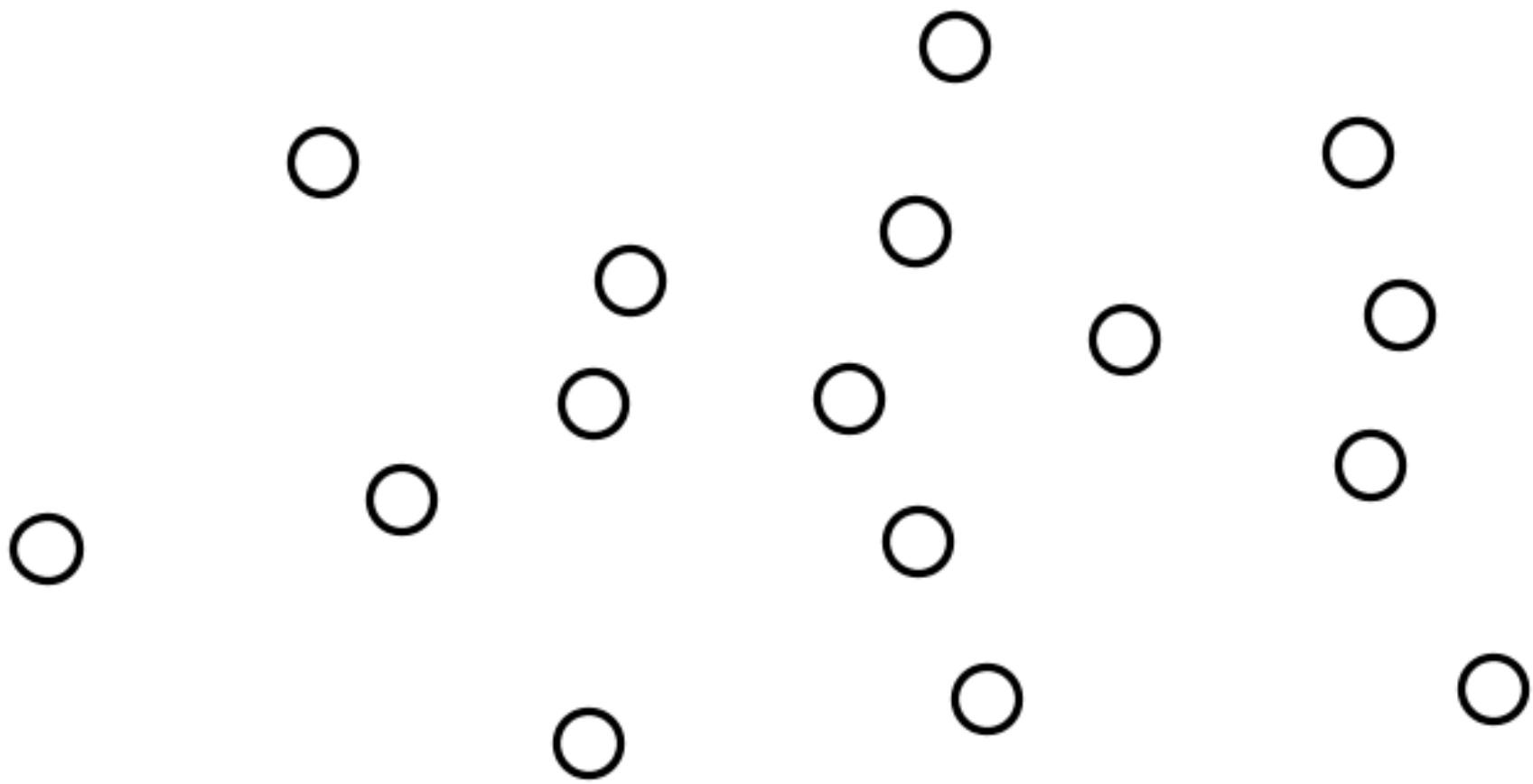


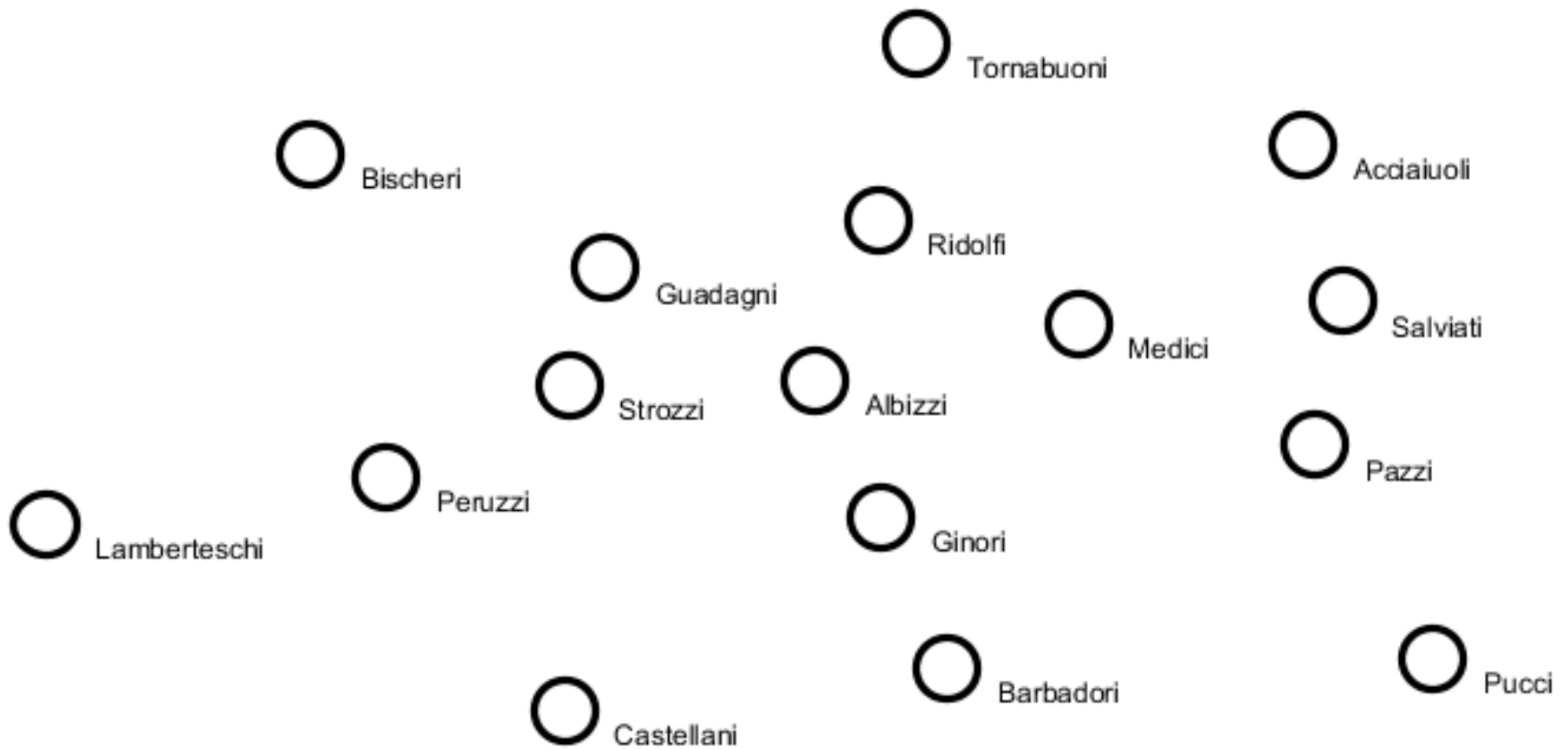
- Associated with food
- Incomplete understanding unless they were aware of competitive eating
- X Y graph and bar graph were familiar

# Gapminder World 2012

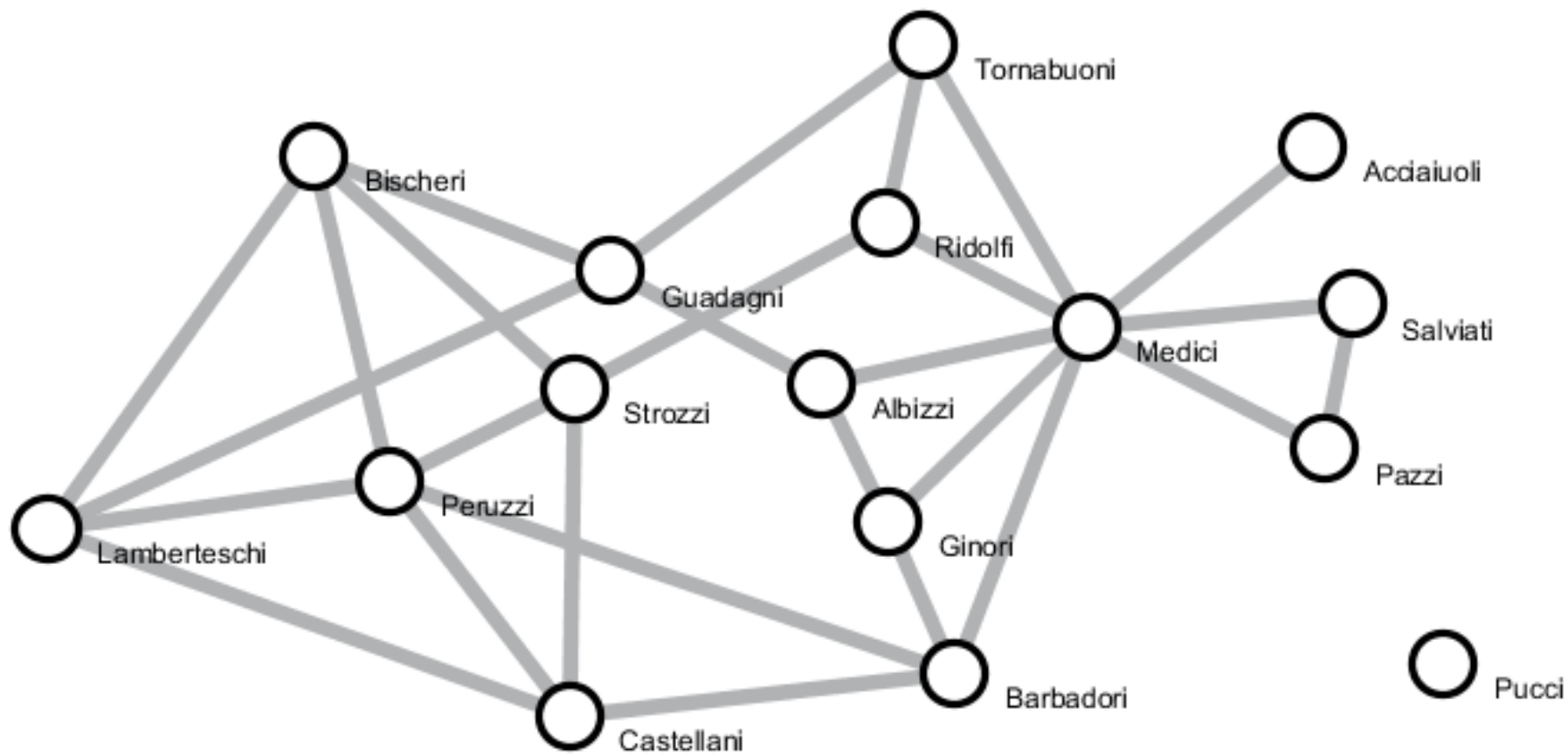


- X Y axis was familiar
- Majority understood, although it may have taken some time

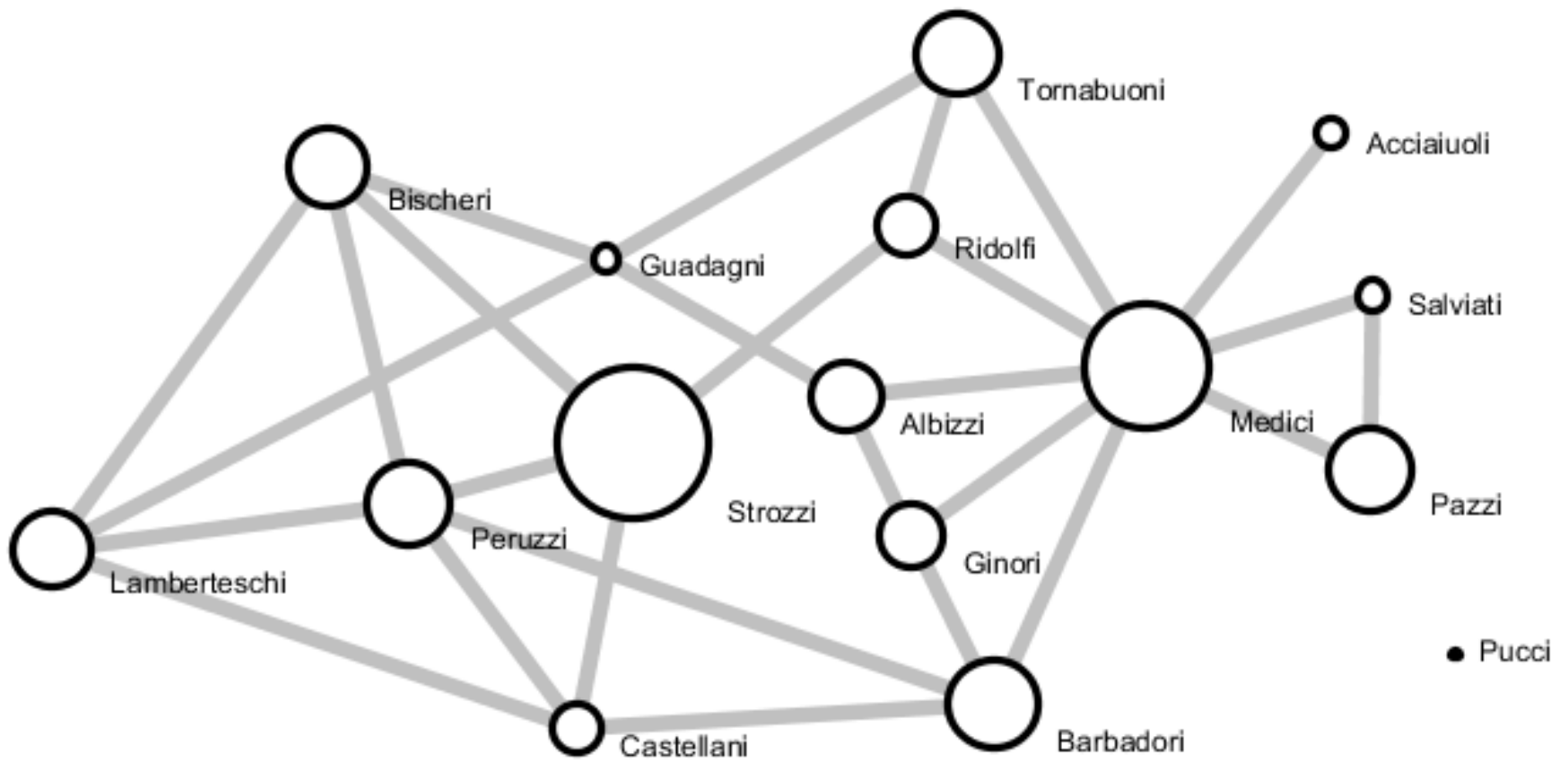




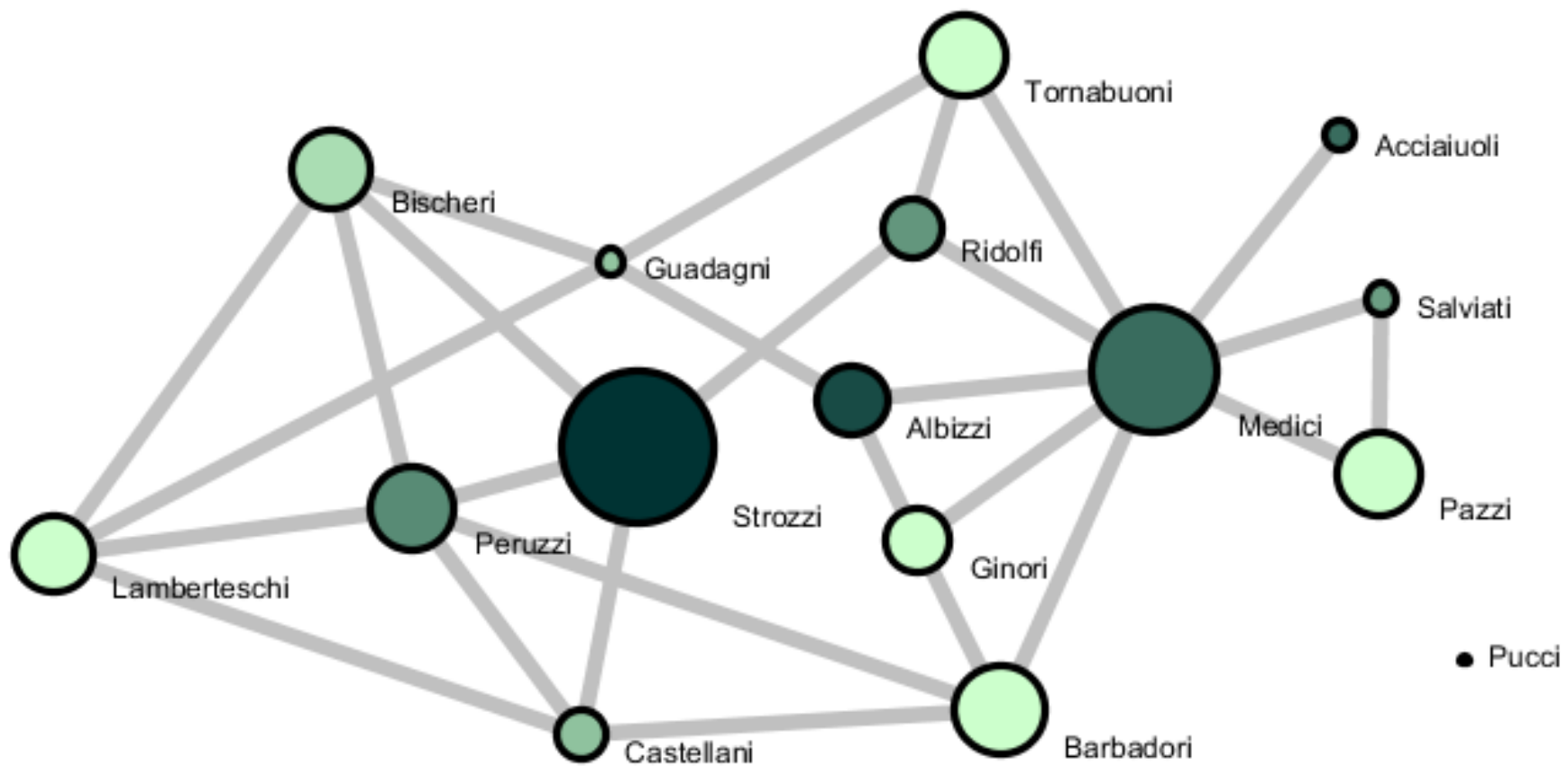
Label: Family Name



Label: Family Name

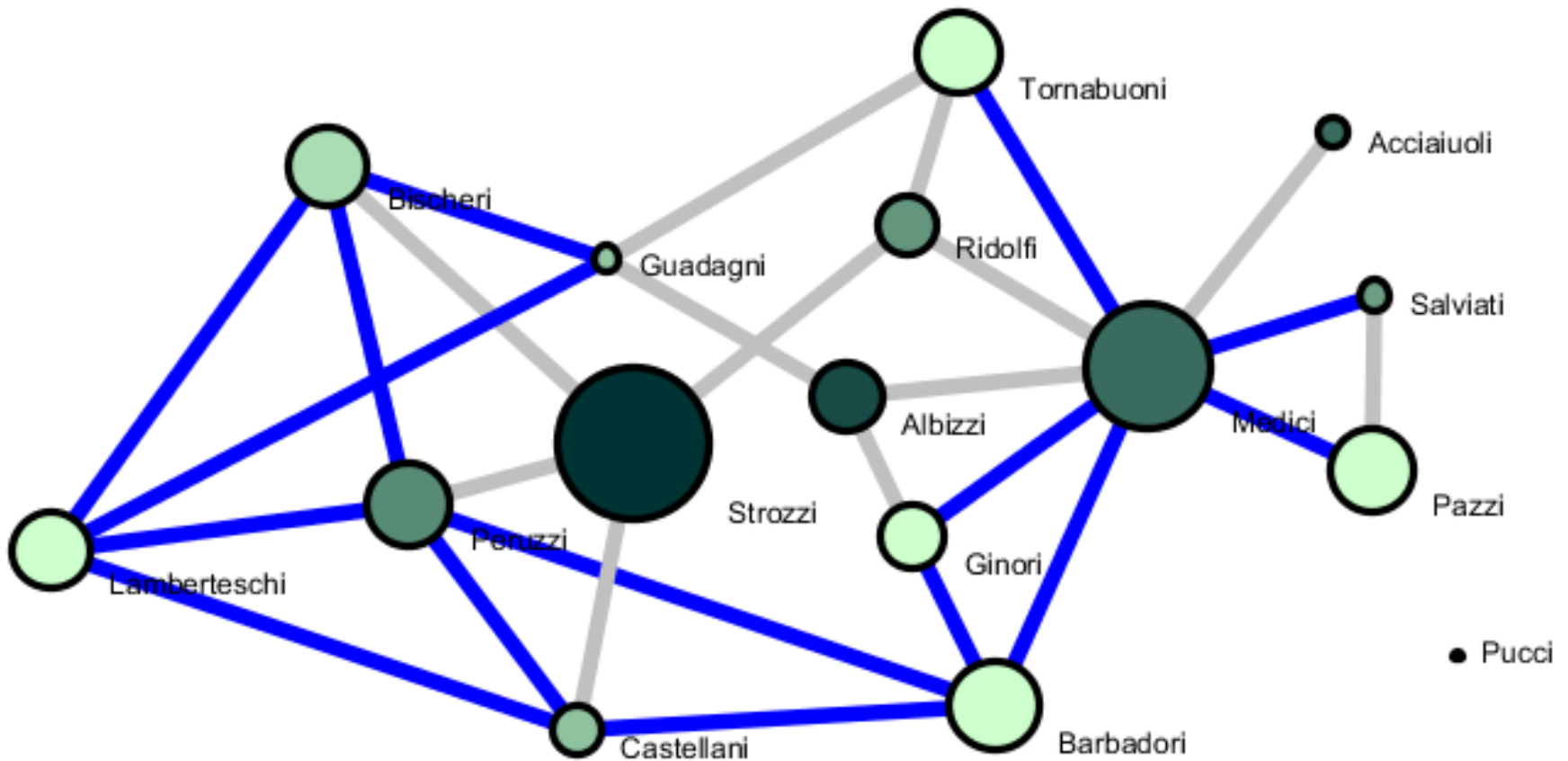


Circle size: Family's net wealth (in thousands of lira) in year 1427.

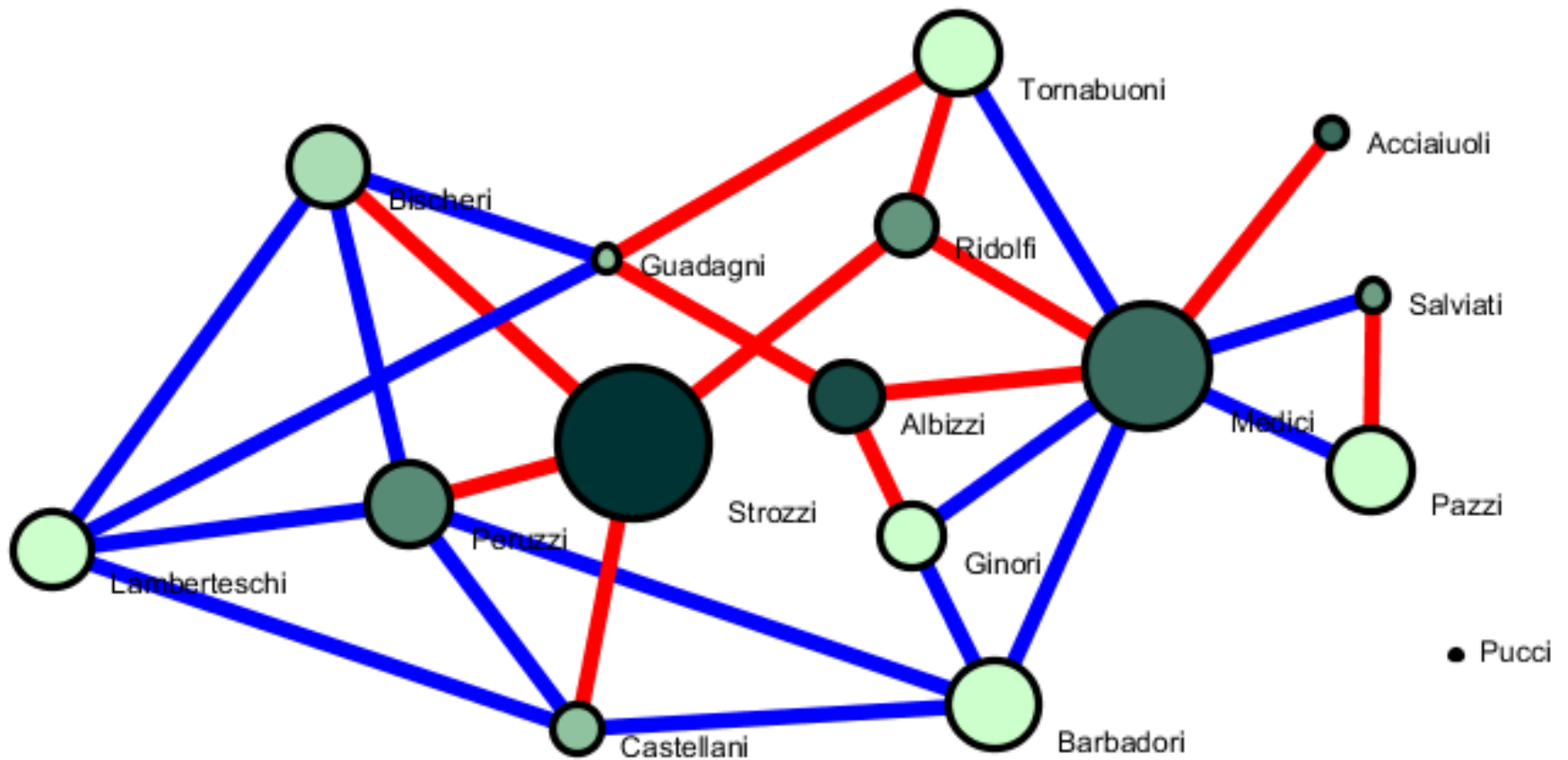


Circle color: Number of seats on the civic council held 1282-1344.



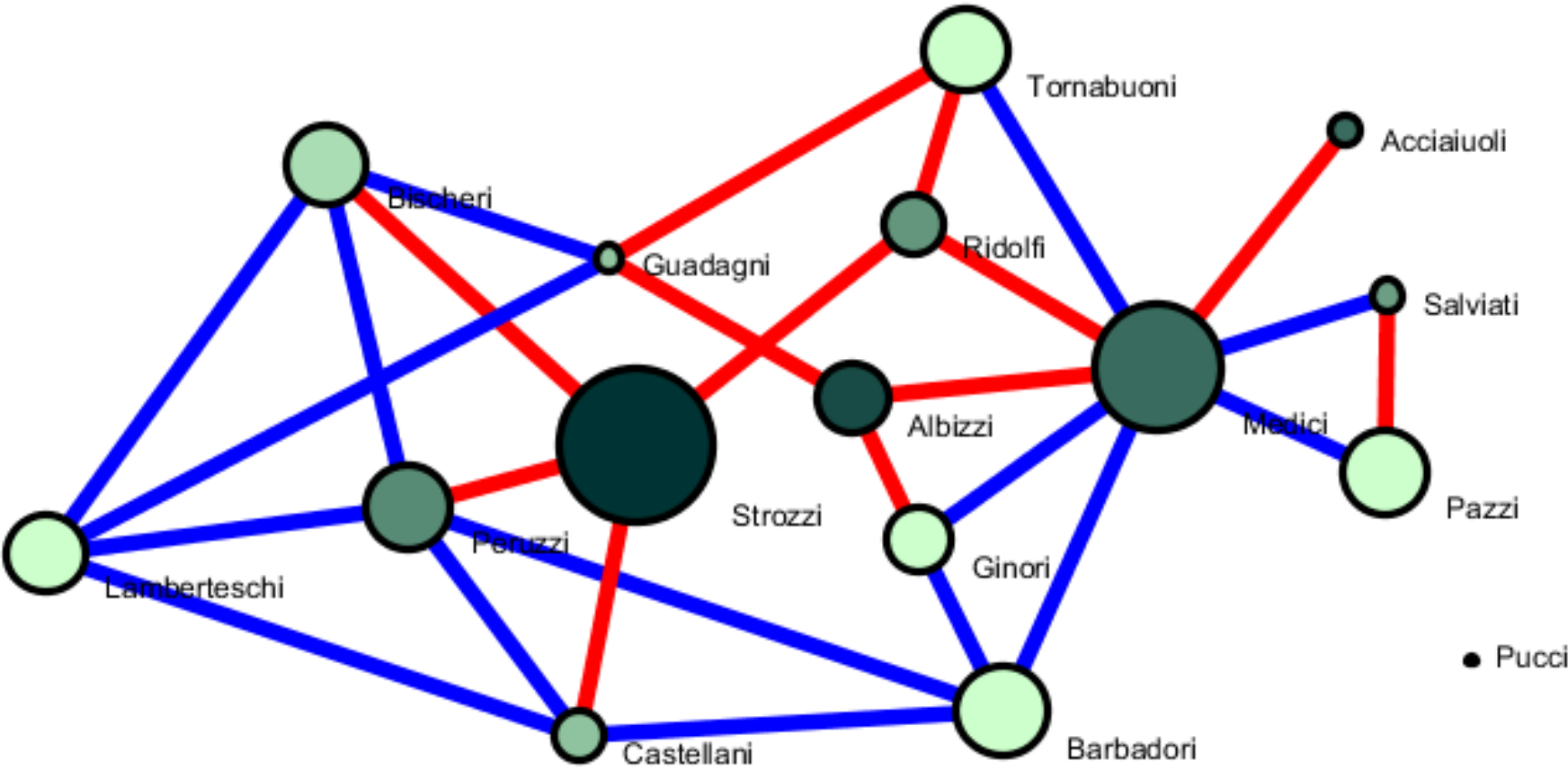


Link color: Business ties, e.g., loans, credits, and joint partnerships.



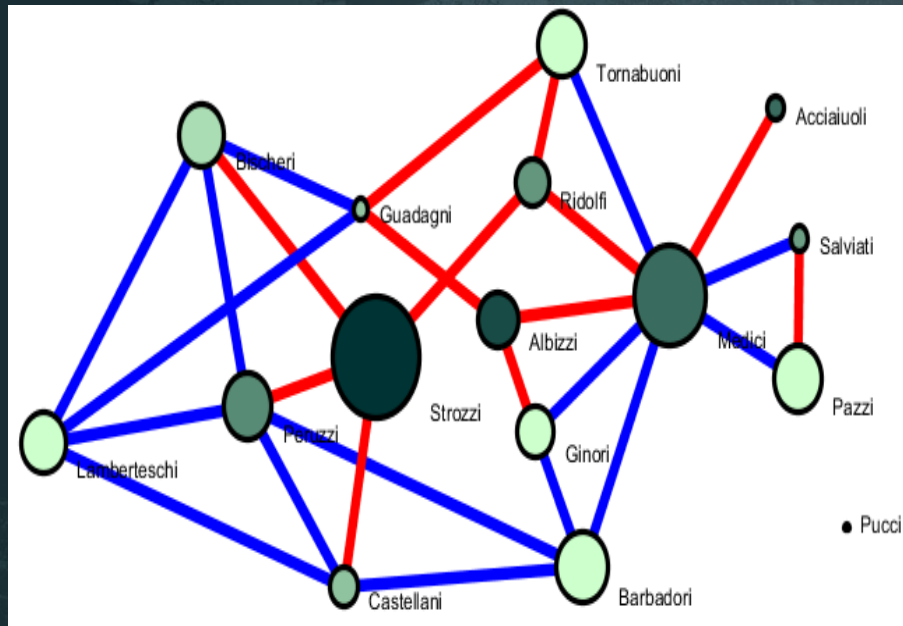
Link color: Marriage alliances.

# Padgett's Florentine Families



Link color: Marriage alliances.

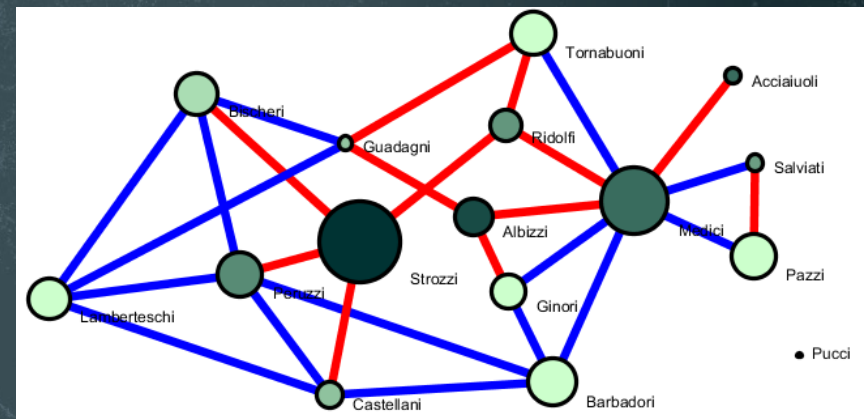
# Padgett's Florentine Families



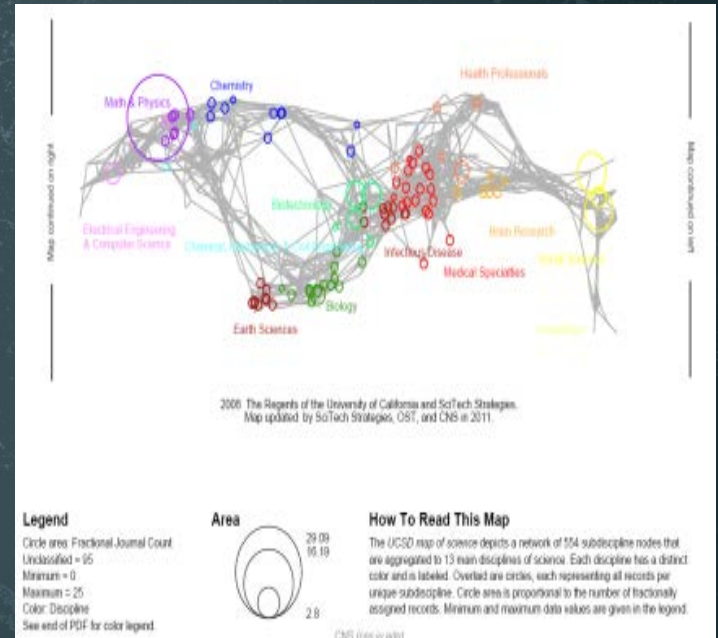
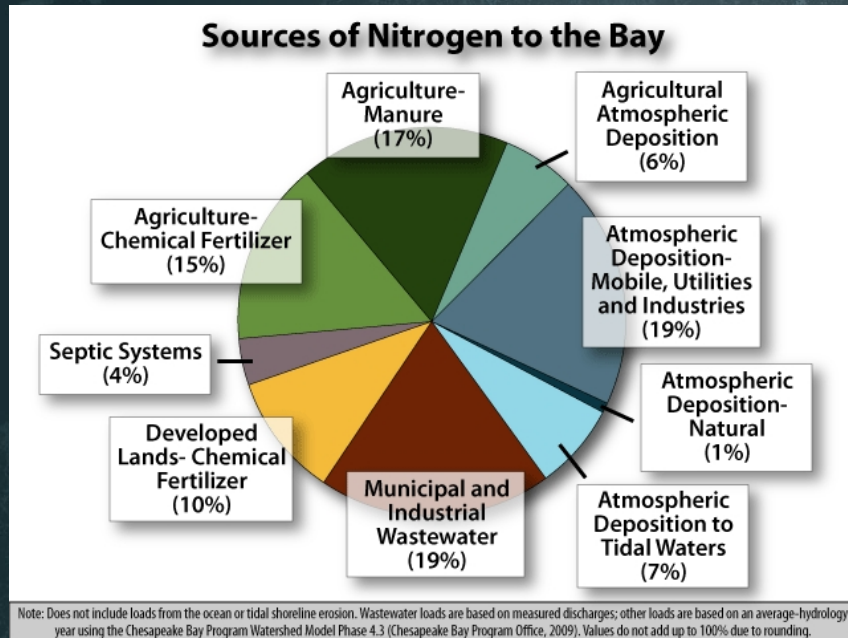
- Most challenging graphic to understand
- Unfamiliar format
- Unfamiliar content.
- Children were likely to make pictures from the dots and lines.

Visitors engaged in constructing the graphics were more likely to use cumulative reasoning; making deeper meaning as they viewed the graphic one layer at a time.

# Data visualizations exist on a continuum from simple to complex.



# Guests' knowledge of and familiarity with data visualizations exist on a continuum from unfamiliar to familiar.



# Implications for the Field



What do visitors  
think when they  
hear the words  
Big Data

# Implications for the Field

# Big Data Insight Needs Sort

Pasta  
sauce

Tofu

Peaches

Vienna Sausage

Lasagna

Carrots

Ham sandwich

# Two Main Sorting Methods

Method 1. (Most Popular)

Sort cards into emergent categories

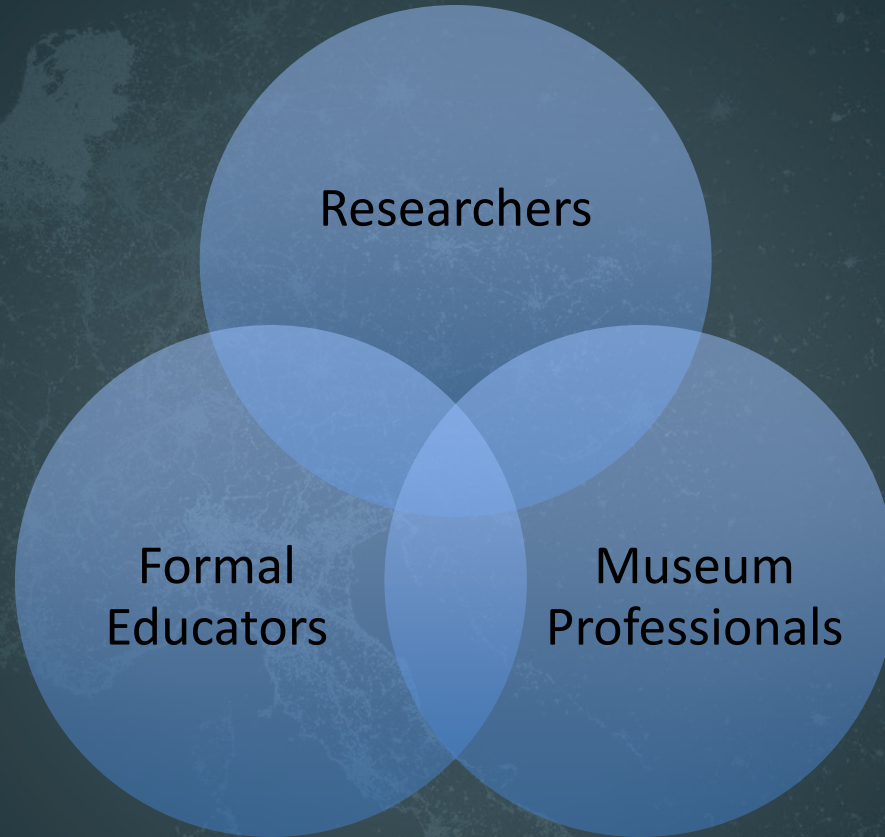
Method 2.

Examine all cards, decide on categories, and sort cards

# Dissonance in the data

# Recoding and Outliers

# Implications for Project Stakeholders





Researchers



- Emergent study design taught us what we needed to know
- Pulling back to what people actually know vs. assumptions of what they “should” know
- Insight into thinking of content experts led us to ask better questions

# Museum Staff

- Different audiences at different sites provided greater understanding of typical visitor responses to this topic
- Exhibit designers used knowledge gained through literature reviews and evaluation in thinking about a macroscope and proposal that grew out of it
- Program developers used data to create a theater program

# Formal Education

- One of (if not THE) most common responses was that participants interface with these visualizations as part of their formal education
- Both parents and youth had challenges, so can't count on support at home to "get it right" when interpreting visualization as part of homework or studying

# Questions

# Contact Information

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