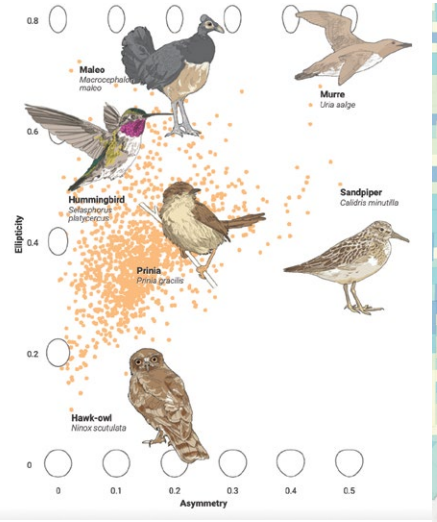
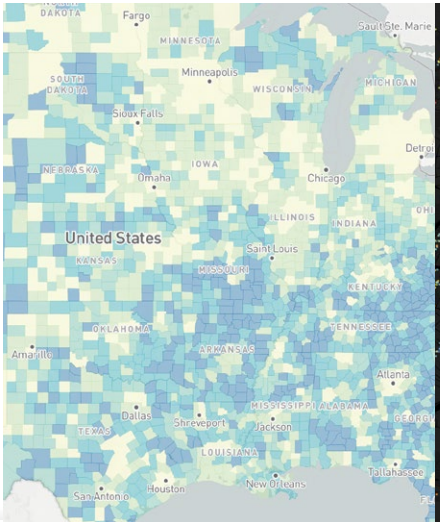
PLACES & SPACES
MAPPING SCIENCE

MACROSCOPES FOR A NEW PERSPECTIVE

ANNUAL REPORT 2022






The *Places & Spaces* exhibit is dedicated to bringing the best in science mapping and interactive visualizations to diverse audiences around the world.

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A Message from the Curators

Exhibit curators Katy Börner, Lisel Record, and Todd Theriault under *Amatria* in Indiana University's Luddy Hall, the institutional home of *Places & Spaces*.

It's hard to believe that *Places & Spaces: Mapping Science* is now 18 years old. If the exhibit resided in one of many countries in Europe, Africa, and South America, it would legally be able to raise a glass of champagne in celebration. But as the exhibit operates out of the United States, it will have to make do with a glass of water.

But we *will* raise a toast of some kind, simply because we have so very much to celebrate. First and foremost, our three-month residency at the University of Michigan saw the exhibit's first large-scale display since a worldwide pandemic rendered such events nearly extinct. We also organized Indiana University's first-ever Data Visualization Bazaar, an event that brought a lively collection of speakers, maps and macroscopes, robots, and do-it-yourself data viz activities to the Indiana University student community. Published at the end of 2021, Katy Börner's *Atlas of Forecasts* spent the beginning of 2022 collecting enthusiastic reviews and winning a prestigious Association of American Publishers PROSE Award. We even added an unlikely venue location when we brought *Places & Spaces* to the metaverse with our new virtual exhibit gallery.

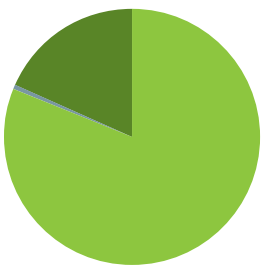
You will find more information on these and other accomplishments in the pages that follow. As always, we wish to thank all those who support us by offering their resources, expertise, and passion. To those who have been with the exhibit since the beginning, and to those who just discovered us in 2022, we invite you to celebrate with us as we look back on another full and fulfilling year of *Places & Spaces*.

Numbers and Impact

Finances

Exhibit finances are managed by the Cyberinfrastructure for Network Science Center at the Luddy School of Informatics, Computing, and Engineering at Indiana University. Shown below are exhibit expenditures for January 1–December 31, 2022.

2022 EXPENSES



Total: $15,706

Compensation	$12,740
Travel	$119
Supplies and Expenses	$2,847

2022 REVENUE

Total: $15,706

CNS Support	$15,706
Sales and Services	$0

100

MAPS
in large format, full color, and high resolution.

215

MAPMAKERS
from fields as disparate as art, urban planning, engineering, and the history of science.

86

MACROSCOPE MAKERS
including one whose job title is "Truth and Beauty Operator."

32

MACROSCOPES
for touching all kinds of data.

461

DISPLAY VENUES
from the Cannes Film Festival to the World Economic Forum.

229

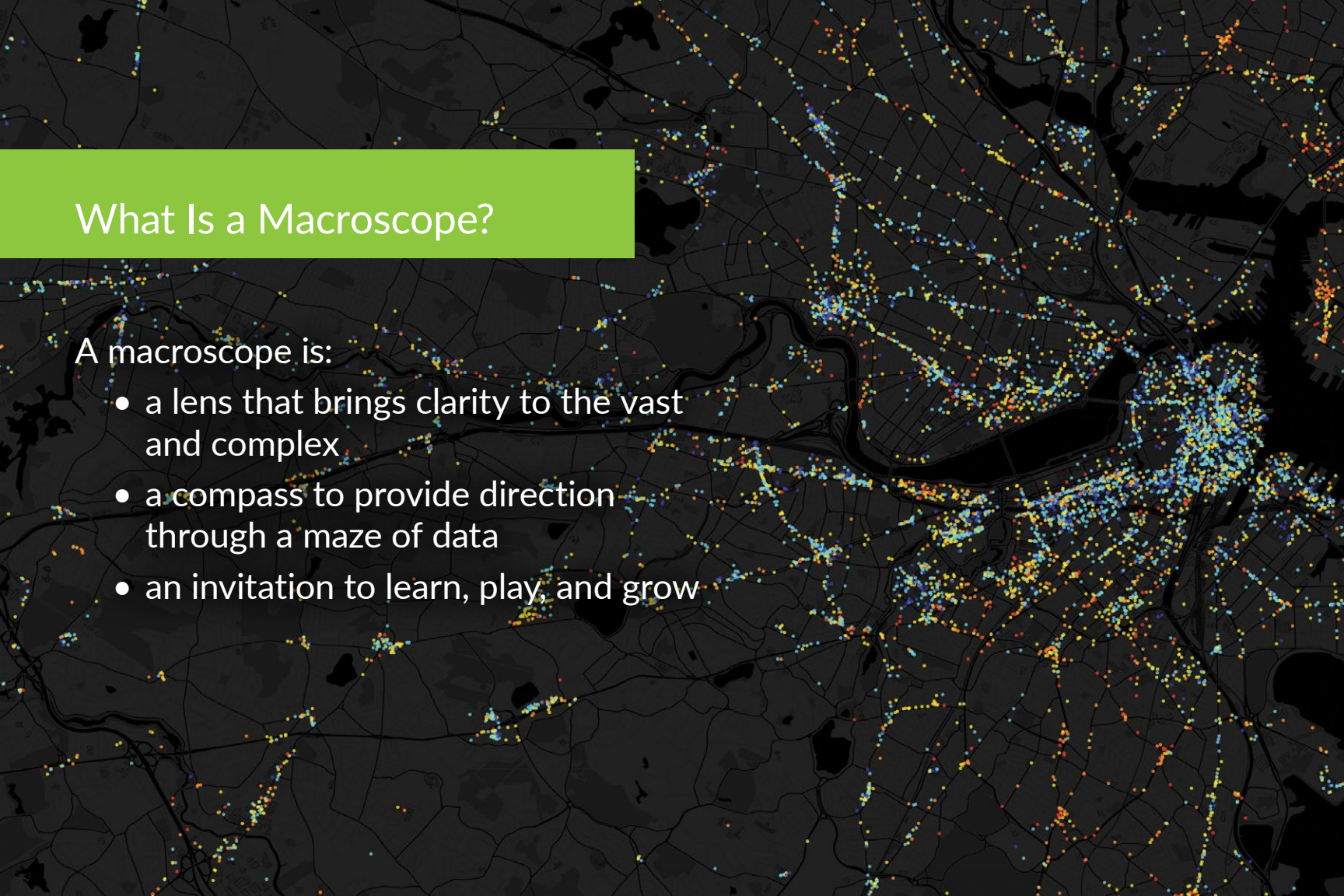
PRESS ITEMS
including articles in *Nature*, *Science*, *USA Today*, and *Wired*.

39

WORKSHOPS ORGANIZED

7,693,716

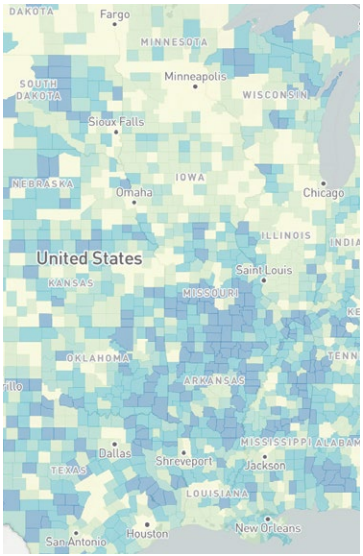
WEBSITE VISITS



What Is a Macroscope?

A macroscope is:

- a lens that brings clarity to the vast and complex
- a compass to provide direction through a maze of data
- an invitation to learn, play, and grow



XVIII. Macroscopes for a New Perspective

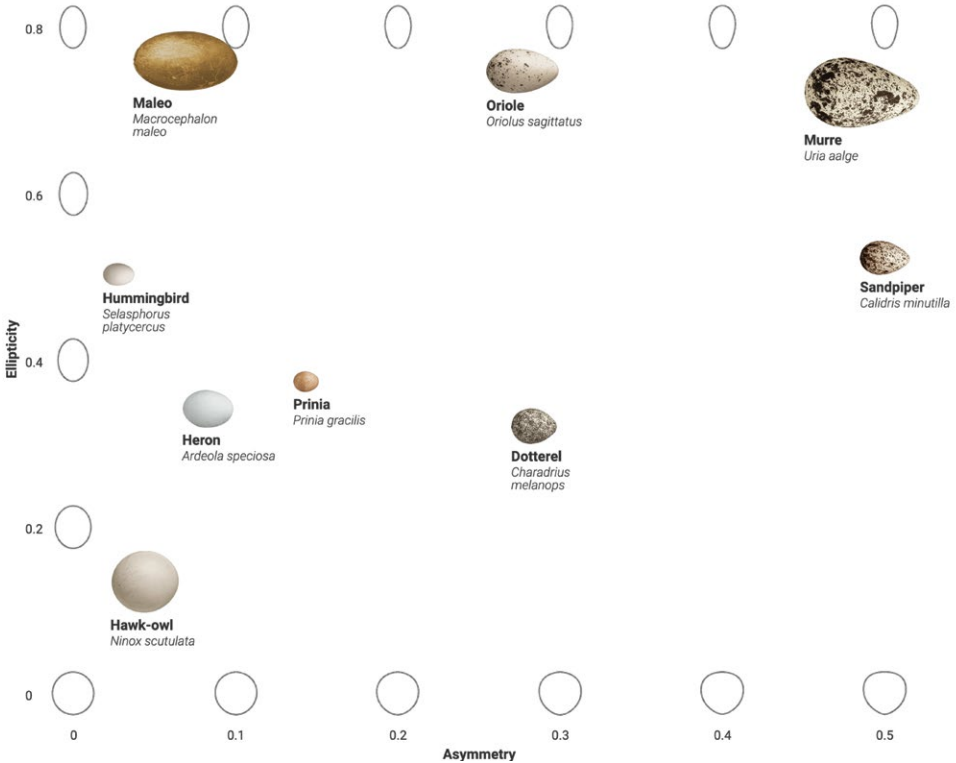
In the 18th iteration, you will find interactive visualizations that disrupt old habits of seeing, that challenge common patterns of perception so we might see things anew. Looking at wellness through the lens of social, economic, and infrastructure factors, for example, opens up ideas for how policy and research can improve health. Looking at income segregation at the level of the individual visitor within the landscape captures the dimension of movement. A shift in perspective can result in a richer and more multifaceted understanding of the subject at hand, whether that subject is egg shape or the motion of the stars.

Star Mapper

With this macroscope you can:

- take up stargazing in a whole new way
- track the movement of stars over the next million years
- zoom through space to visit your favorite constellation

Celestial objects have the distinction of being, at the same time, both mundane and mysterious. Although we see them on a regular basis, we realize that such sightings convey only a fraction of what there is to know about them. And that's what makes this macroscope from data experience designer Jan Willem Tulp such a valuable tool for star gazers of all stripes. Using a partial data set from the European Space Agency's Hipparcos mission, *Star Mapper* enables the interactive exploration of nearly 60,000 stars. Different filters allow different features of the stars to come to the forefront: you can toggle between apparent and absolute magnitude views, study how stars evolve with the Hertzsprung-Russell diagram, and track the movement of stars through space.

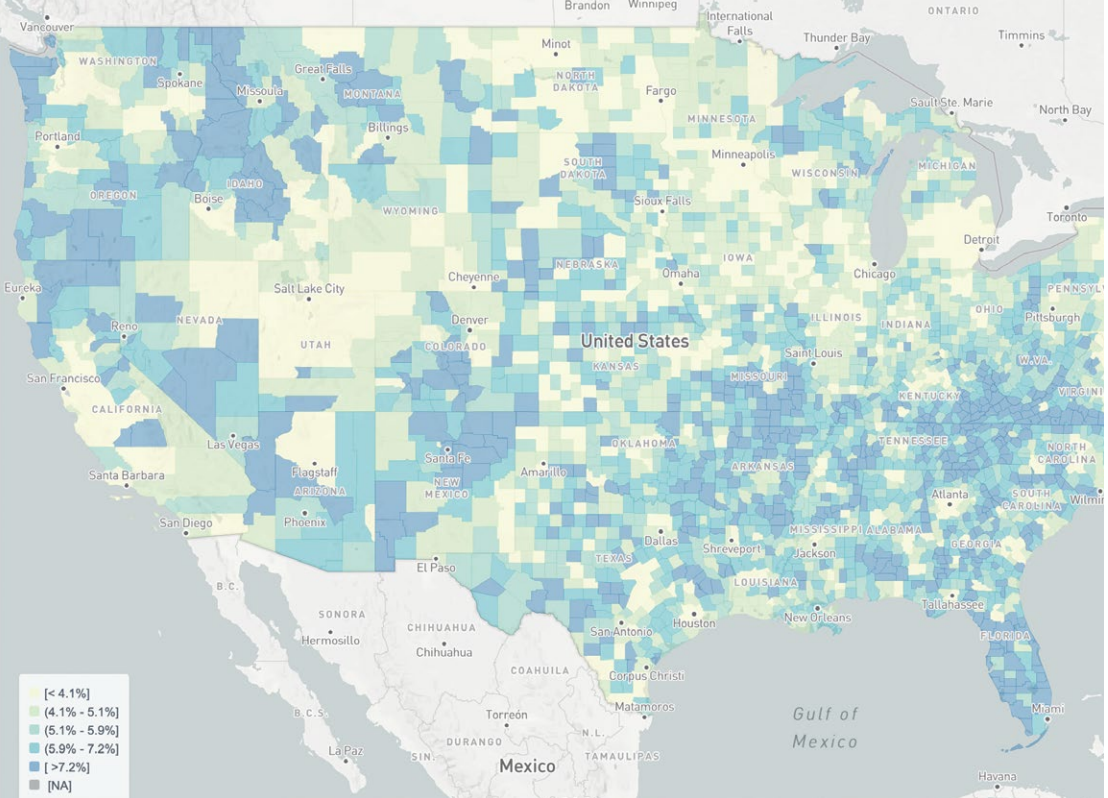


Cracking the Mystery of Egg Shape

With this macroscope you can:

- see how scientists solve nature's riddles
- scroll to follow how the eggs roll
- learn how all eggs are not the same—and why that's a good thing

Conceived and produced (or should we say "hatched"?) by *Science* senior podcast producer Sarah Crespi and UX designer Jia You, *Cracking the Mystery of Egg Shape* is a wonderful example of how "scrollytelling" can be used to convey scientific findings in an accurate and accessible way. Originally published in the journal *Science*, this work of data journalism follows researchers as they attempt to answer an age-old question: Why is there such variation in egg shape from bird to bird? Crespi and You take readers through the process of doing science: from asking questions to forming a hypothesis, from gathering data to conducting analysis and drawing conclusions. To do this research, the team analyzed photographs of 49,175 bird eggs collected over the last 100 years and held by the Museum of Vertebrate Zoology at Berkeley. They used a special computer program to estimate egg measurements from the photographs. Animations throughout the narrative provide a dynamic view of how various factors influence egg shape.



Social Determinants of Health

With this macroscope you can:

- find relations between health and literacy
- identify “food deserts” in communities near you
- acquire the facts needed to advocate for meaningful change

Social determinants of health (SDOH) are community conditions known to have a significant effect on people’s health and well-being. You might be surprised by the number of things that affect a person’s health. These could include everything from access to grocery stores with healthy foods to the availability of opportunities to acquire language and literacy skills. Use this macroscope to search for specific SDOH measures by individual county or Zip Code Tabulation Area (ZCTA) and track changes to those measures over time. Understanding spatial and temporal patterns of SDOH will help researchers and policymakers make informed decisions about public health research and practice. This visualization tool was created by research methodologists Chang Zhao and Peter Herman and data analyst Andrea Malpica. All are members of NORC at the University of Chicago, one of the largest independent social research groups in the U.S.

Atlas of Inequality

With this macroscope you can:

- identify places in your city where people of all income levels gather
- discover where places of vast wealth inequality exist side-by-side
- make informed, socially conscious decisions about the places you inhabit

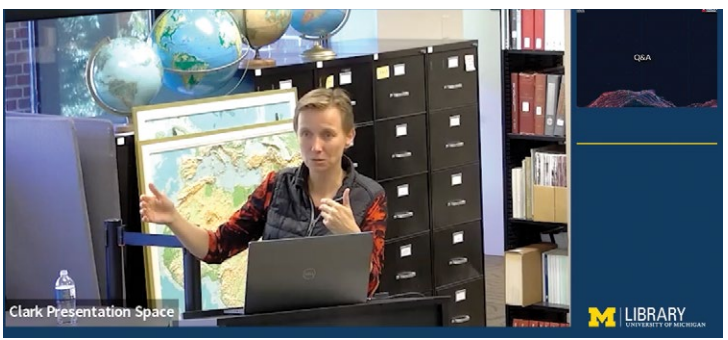
How much income segregation we experience is based on our daily movements, not just where are homes are. Increased interaction with people from other economic backgrounds helps social cohesion, so urban planners are interested in better ways to measure and understand this behavior. Created by Esteban Moro, Alex 'Sandy' Pentland, Xiaowen Dong, and Dan Calacci, all current or former members of the MIT Media Lab, the *Atlas of Inequality* attempts to make income segregation visible. It uses aggregated anonymous location data from digital devices to approximate where people spend their time, and it combines that with census tract data on incomes. This calculation is called the "place inequality metric," and it was developed to estimate how much diversity in income there is among visitors to particular city businesses or destinations.

Venues and Events

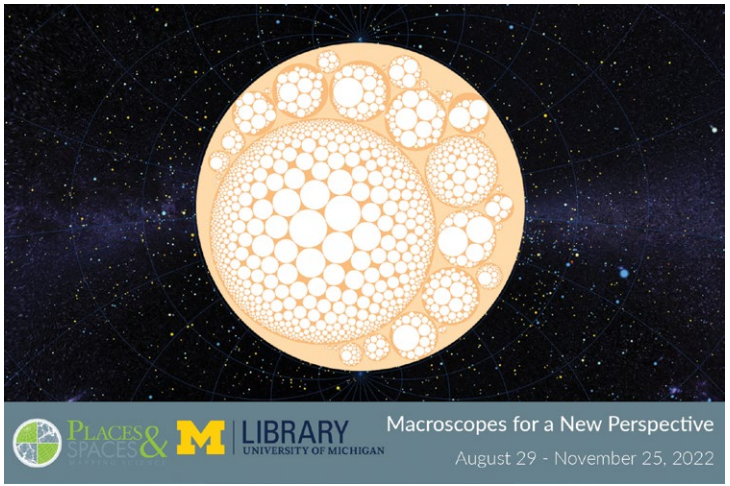
University of Michigan's Clark Library

August 29, 2022–January 25, 2023

In fall of 2022, *Places & Spaces* traveled to Ann Arbor, Michigan, for a five-month residency at the University of Michigan's Clark Library. The exhibit's current selection of macroscopes appeared alongside exhibit maps from the library's own archived collection. The four new macroscopes that comprise the 18th Iteration made their official debut in the library on September 30. Curator Katy Börner was on-site to deliver a commemorative talk entitled "Science Maps and Macroscopes," which was also broadcast online. The iteration's debut coincided with the September 2022 Colloquium of the Michigan Institute for Data Science (MIDAS), an event that shared space and inspiration with the *Mapping Science* exhibit.

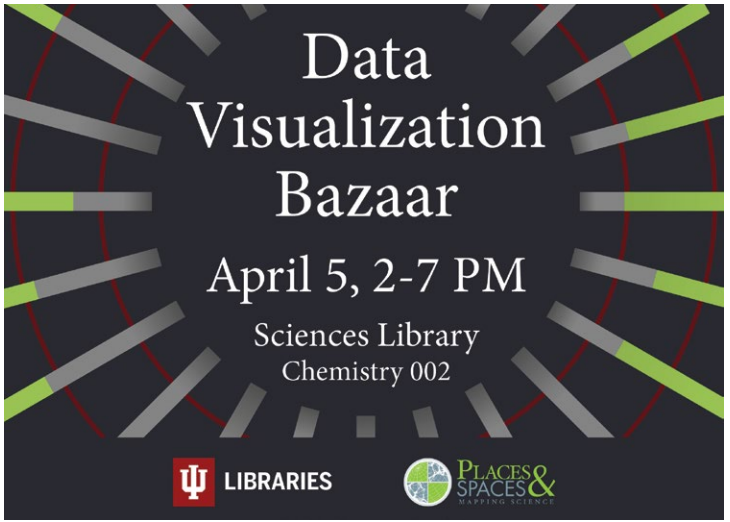


Katy Börner takes questions from the audience following her talk on "Science Maps and Macroscopes" during the 18th Iteration debut celebration.



Ella Edelstein and Tim Utter created "A Brief History of Infographics" display (below) to complement and provide additional context to the maps and macroscopes of *Places & Spaces*. Along with a general introduction, the display included a dozen significant works in the history of information graphics—from Florence Nightingale's *Diagram of the Causes of Mortality in the Army in the East* to *City and Rural Population* by W.E.B. Du Bois and *The United States of Attica, 1972* by Faith Ringgold.

Digital Engagement Librarian Leanne Nay and Exhibit Assistant Ezra Engels visualize data using everyday objects like yarn, hooks, and pegboard.



Data Visualization Bazaar

Traditionally, the word “bazaar” refers to the bustling open markets of North Africa and the Middle East where sellers try to capture the attention of patrons wandering through an array of small booths, stalls, and shops. For 2022’s Data Visualization Bazaar, we wanted to capture the feel of these open markets by providing visitors the opportunity to let their interests guide them through a gathering of hands-on demos, do-it-yourself projects, eye-catching displays, and lively (and, at times, raucous) presentations by talented data viz practitioners. The event was a joint partnership with Indiana University’s Wells Library, Makerspace, and Sciences Library, where several of the exhibit’s science maps have found a longterm home.

An audience listens to Filipi Nascimento Silva's intro to network visualizations.

Graduate student Zach Christian Kaufman presents examples of social robotics.

CNS research scientist Andreas Bueckle demos the latest in VR data viz.

Fashion design expert Bo Choi talks about AI-generated textile patterns.

Resource table full of key works on data viz.

Indiana University and Beyond

Each year, we make sure to schedule events designed to serve Indiana University and the broader Bloomington community. To make it easier to pack up macroscopes and take them to local events, this year we invested in a tabletop macroscope kiosk and a rolling case. Here's what we were up to in 2022.

Science Fest

October 22, 2022

Once again, we took part in IU's annual Science Fest, a fun-filled educational event for parents and kids of all ages. Exhibit Assistant Ezra Engels was on hand to demonstrate our macroscopes and help participants construct *Amarias*, the latest in our series of *Amatria*-related architecture.

First Thursdays Festival

April 7, 2022

The exhibit has been part of the First Thursdays tradition since the festival began. This year, Medina Sydykanova brought exhibit materials and *Amarias* to this popular showcase for new ideas in the arts and humanities.

Makevention

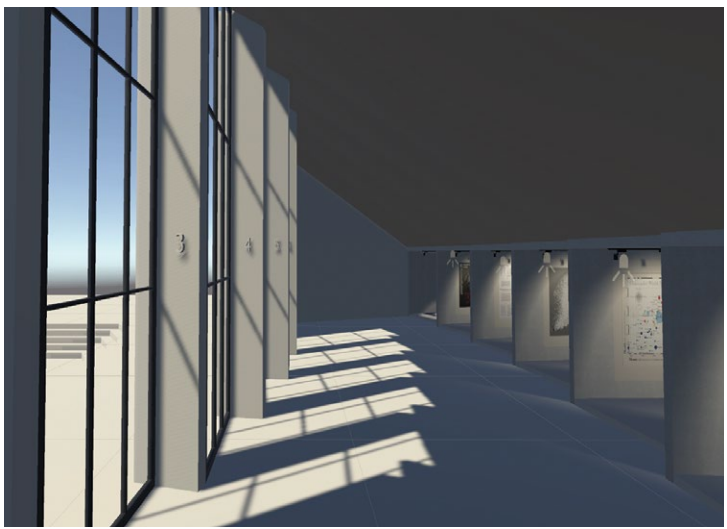
August 27, 2022

Science macroscopes joined up with virtual reality, robotics, 3D printing demos, and much more at Bloomington's annual Makevention. This was a great opportunity to meet with the city's community of talented makers and learn from each other.

Exhibit Assistant Ezra Engels all set up and waiting for the event to begin.

Into the Metaverse

In November, *Places & Spaces* offered its first exhibit tour in the metaverse. Our virtual exhibit gallery, created by CNS Research Assistant Naval Pandey, contained a selection of science maps that VR-headset-wearing visitors could wander through and browse at their leisure. Exhibit Curator Todd Theriault even showed up in avatar form to lead the tour group through the gallery. The gallery has since closed its doors, but we continue to explore alternative and expanded ways to share exhibit content on new platforms.



A view of the virtual exhibit gallery space.

The avatar of virtual exhibit gallery creator Naval Pandey.

Curator Todd Theriault's avatar saying something way more interesting about Knowledge Web than the "…" above his head would suggest.

The *Atlas of Forecasts*

The AAP PROSE Awards

In January, the final book in Katy Börner's *Atlas* trilogy, *Atlas of Forecasts: Modeling and Mapping Desirable Futures* received the Association of American Publishers PROSE Award for Excellence in Physical Sciences & Mathematics. In winning this award, the *Atlas of Forecasts* joins a group of past winners that includes David Reich's *Who We Are and How We Got Here* (Pantheon, 2018), Alan Turing: *His Work and Impact* (Elsevier, 2013) edited by S. Barry Cooper and Jan van Leeuwen, and the *Springer Handbook of Robotics* (2008) by Bruno Siciliano and Oussama Khatib. All in all, that's a pretty nice group to be a part of!

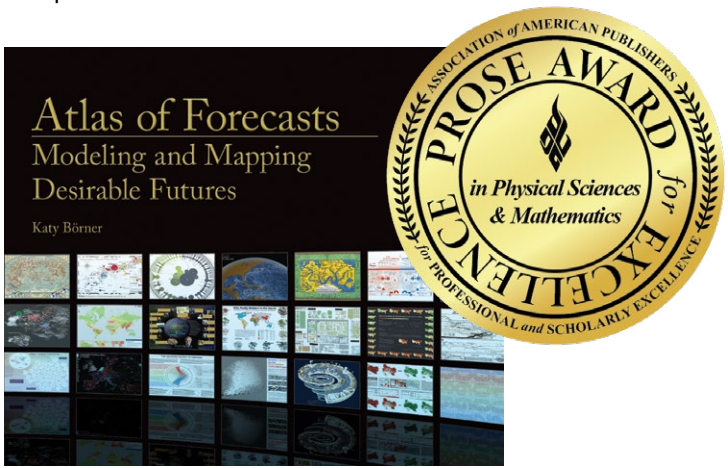


Exhibit Advisors

The Indiana University exhibit team benefits greatly from the expert input it receives from this international advisory board. Advisory board members review exhibition submissions and provide their expertise and guidance to the exhibit on many levels.

Gary Berg-Cross is a cognitive psychologist (PhD, SUNY–Stony Brook) who has taught at a number of institutions over his career (SUNY, Widener, University of Delaware, George Washington, George Mason University, and others). For eight years, he served as the Spatial Ontology Community of Practice (SOCoP) Executive Secretariat helping to run workshops and vocabulary development efforts to advance the field. Currently, Berg-Cross serves as a consulting knowledge engineer on earth science projects and is co-organizer of the annual Ontology Summit hosted at NSF and NIST. [Potomac, MD, USA]

Donna J. Cox is the first Michael Aiken Chair, director of the Advanced Visualization Laboratory (AVL) at the National Center for Supercomputing Applications, and director of the Illinois eDream Institute, all at the University of Illinois at Urbana-Champaign. She is a recognized pioneer in Renaissance Teams and supercomputer visualizations for public outreach, and in 2006 she was selected by the Chicago Museum of Science as one of 40 modern-day Leonardo da Vincis. [Urbana-Champaign, IL, USA]

Bonnie DeVarco writes and lectures on design science, virtual worlds, next-generation geographic information systems, information visualization, and the culture of cyberspace. Previously, DeVarco was a Distinguished Visiting Scholar with the Media X Research Network at Stanford University (2009-2012) and served as chief archivist for the Buckminster Fuller Archives. Currently, DeVarco is completing a book on Buckminster Fuller and is coauthor with Eileen Clegg of *Shape of Thought*, on the history and evolution of visual language. [Palo Alto, CA, USA]

Ingo Günther has tried to cross-infuse journalism and art even before he founded the first independent TV station in Eastern Europe (Leipzig's Channel X) in 1989. That same year he began the Worldprocessor project, which has resulted in well over 1,000 modified thematic globes that not only reside in museum collections but have also graced the covers and pages of political magazines (Foresight, Harper's). His works have appeared in museums all over the world, including the Nationalgalerie Berlin, the Guggenheim Museum, Kunsthalle Düsseldorf, Espacio Buenos Aires, Iwaki City Art Museum, Somerset House in London, Hood Museum at Dartmouth, and the MIT Museum. [Karlsruhe, Germany]

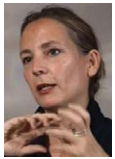
Francis Harvey is head of the Department of Cartography and Visual Communication at the Leibniz Institute for Regional Geography and professor of Visual Communication in Geography at the University of Leipzig, Germany. His research and teaching activities center around geographic information systems (GIS), particularly their technologies, applications, ethical dimensions, and societal implications. Harvey's *Primer of GIS: Fundamental Geographic and Cartographic Concepts* (Guilford, 2015) is now in its second edition. [Leipzig, Germany]

Peter A. Hook is an associate law librarian at the University of Notre Dame Law School. He received his doctorate from the Luddy School of Informatics, Computing, and Engineering at Indiana University where his primary research focus was information visualization, particularly the visualization of knowledge organization systems, concept mapping, and the spatial navigation of bibliographic data in which the underlying structural organization of the domain is conveyed to the user. [South Bend, IN, USA]

Lev Manovich is professor at the City University of New York (CUNY) Graduate Center and author of several books on digital culture, including *Software Takes Command* (Bloomsbury Academic, 2013). In 2007, Manovich founded the Software Studies Initiative in order to develop a new paradigm of Cultural Analytics through data analysis and interactive visualization of patterns and trends in media and visual cultures. [New York, NY, USA]

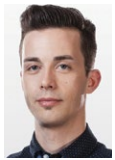
Elijah Meeks is the executive director of the Data Visualization Society and a data visualization engineer at Apple. His prior experience includes working in the digital humanities at Stanford and developing data visualization applications at Netflix. He is the author of D3.js in Action, the data visualization library Semiotic, and various essays on the subject of modern professional data visualization. His work includes the development of data visualization libraries, tools and exploratory applications. [Los Gatos, CA, USA]

André Skupin, professor of geography at San Diego State University, is interested in the application of geographic metaphors, cartographic principles, and computational methods to the visualization of non-geographic information. His research is interdisciplinary, aimed at increased cross-fertilization between geography, information science, and computer science. Recent work includes novel methods for visualizing human movement and demographic change as trajectories in n-dimensional attribute space. [San Diego, CA, USA]



Olga Subirós is an architect, exhibition designer, and founder of Olga Subirós Studios. Recently, she co-curated (with José Luis de Vicente) Big Bang Data, a major exhibition of data-driven artworks and objects that provide crucial insight into the world of big data. Since 2014, the exhibit has toured worldwide, appearing at the Centre de Cultura Contemporànea de Barcelona (CCCB), Fundación Telefónica in Madrid, Somerset House London, ArtScience Museum Singapore, Centro de Cultura Digital in Mexico, and the DOX Centre for Contemporary Art in Prague. [Barcelona, Spain]

Stephen Uzzo is vice president of science and technology for the New York Hall of Science where he works on exhibit and program development projects related to STEM learning, scientific visualization, sustainability, and network science. Uzzo also serves on the faculty of the New York Institute of Technology Graduate School of Education, where he teaches STEM teaching and learning. [Queens, NY, USA]



Benjamin Wiederkehr is founding partner and managing director of the Zürich-based design and data visualization studio, Interactive Things. He is also part of the Open Government Data task force in Switzerland and helps to facilitate open access to government data for everyone. On **Datavisualization.ch**, Wiederkehr provides insight into his research and working process and documents topical use cases in the field of data visualization. [Zürich, Switzerland]

Host the Exhibit

The *Places & Spaces* exhibit travels in a variety of formats to fit every space and budget. Visit **scimaps.org** to explore the many ways you can bring the exhibit to your space. In the meantime, see what others are saying about hosting the exhibit:

"The University of Michigan's Clark Library was very excited to host the newest iteration of the Places & Spaces *exhibit, "Macroscopes for a New Perspective." To complement the macroscopes, we displayed thirty-three of the* Places & Spaces *maps and created a small exhibit, "A Brief History of Infographics." We previously hosted the exhibit in 2011 and it was very popular so we knew that the macroscopes would be well received. We had hundreds of visitors, including several university and a few K-12 classes that came to view the exhibit, and in some cases included it in their coursework. It was especially rewarding to see parents come in with their children and spend long periods exploring topics in the Macroscopes."*

—**Tim Utter**, Manager of the Clark Library for Maps, Government Information and Data Services at the University of Michigan

"This exhibit reveals the power that a good visualization has to convey complex information. Visualizations tell the story of data in a way that isn't readily evident when you're only looking at raw numbers."

—**Kristi Holmes**, Director, Galter Health Sciences Library and Professor of Preventive Medicine (Health and Biomedical Informatics) and Medical Education at the Feinberg School of Medicine, Northwestern University.

"Hosting Places & Spaces: Mapping Science *was a wonderful opportunity for Duke. The diversity of maps meant that there was something for everyone. It was also incredibly meaningful to be able to get up close and see all of the magnificent detail of the complex visualizations. There was always something new to discover in the exhibit. It brought the campus community together around data visualization and enriched the environment in which we teach, research, work, and play."*

—**Angela Zoss**, Interim Head, Assessment and User Experience Strategy, Duke University

Ingo Günther's *WorldProcessor Globes*.

The high-definition touchscreen macroscope kiosk.

Resources

Books and Essays

Börner, Katy. 2010. *Atlas of Science: Visualizing What We Know.* Cambridge, MA: The MIT Press. (**mitpress.mit.edu/books/atlas-science**)

Börner, Katy. 2015. *Atlas of Knowledge: Anyone Can Map.* Cambridge, MA: The MIT Press. (**mitpress.mit.edu/books/atlas-knowledge**)

Börner, Katy. 2021. *Atlas of Forecasts: Modeling and Mapping Desirable Futures.* Cambridge, MA: The MIT Press. (**mitpress.mit.edu/books/atlas-forecasts**)

Börner, Katy. 2020. "Modeling and Envisioning Complex Systems." Winter issue on Complex Unifiable Systems, *The Bridge* 50 (4): 19-20.

Börner, Katy, Andreas, Bueckle, and Michael Ginda. 2019. "Data Visualization Literacy: Definitions, Conceptual Frameworks, Exercises, and Assessments." *PNAS* 116 (6): 1857-1864. doi: 10.1073/pnas.1807180116.

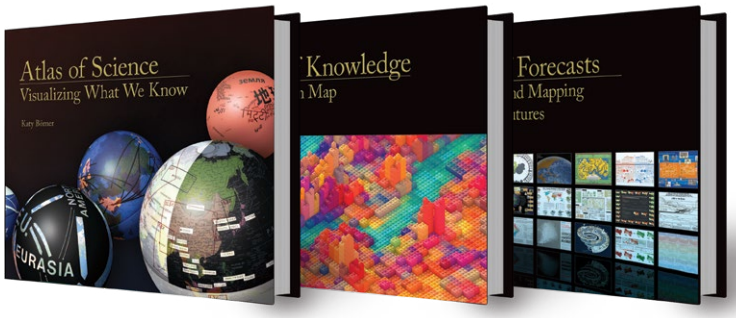
Börner, Katy, and David E. Polley. 2014. *Visual Insights: A Practical Guide to Making Sense of Data.* Cambridge, MA: The MIT Press.

Börner, Katy, and Adam Maltese, Russell Nelson Balliet, and Joe Heimlich. 2015. "Investigating Aspects of Data Visualization Literacy Using 20 Information Visualizations and 273 Science Museum Visitors." *Information Visualization* 15 (3): 198-213.

Boyack, Kevin W., and Katy Börner, eds. 2014. "Mapping Science." Special issue, *Bulletin of the Association for Information Science and Technology* 41 (2).

Scharnhorst, Andrea, Katy Börner, and Peter van den Besselaar, eds. 2012. *Models of Science Dynamics: Encounters Between Complexity Theory and Information Sciences.* Berlin: Springer-Verlag.

Shiffrin, Richard M., and Katy Börner, eds. 2004. "Mapping Knowledge Domains." Special issue, *PNAS* 101 (Suppl. 1).



Websites and Videos

Places & Spaces: Mapping Science. (**scimaps.org**)

YouTube. CNS Channel. (**www.youtube.com/user/CNSCenter**)

YouTube. HuBMAP Consortium Channel. (**tinyurl.com/y95t8ux9**)

Courses

The Visual Analytics Certificate (VAC) (**visanalytics.cns.iu.edu**) course provides an overview about the state of the art in information visualization. It teaches the process of producing effective visualizations that take the needs of users into account.

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Funding for *Places & Spaces* is provided by the National Science Foundation under grants IIS-0238261, CHE-0524661, IIS-0534909, IIS-0715303, DRL-1713567, DMS-1839167, DGE-1735095, OIA-1936656, and OIA-2033569; the James S. McDonnell Foundation; and Clarivate Analytics. Additional funding comes from the Cyberinfrastructure for Network Science Center, University Information Technology Services, and the Luddy School of Informatics, Computing, and Engineering—all three located at Indiana University. Some of the data used to generate science maps is from Clarivate Analytics and Elsevier. Any opinions, findings, and conclusions or recommendations expressed in this material are those of the author(s) and do not necessarily reflect the views of the National Science Foundation or other sponsors.