PLACES & SPACES

MAPPING SCIENCE

MACROSCOPES AS DIGITAL ATLASES

ANNUAL REPORT 2023

A Message from the Curators

Exhibit co-curators Todd Theriault, Katy Börner, and Lisel Record stand with exhibit assistant Ezra Engels in front of *Spain Lives in Flats*, a macroscope from the exhibit's 19th iteration: "Macroscopes as Digital Atlases."

Here at the *Places & Spaces: Mapping Science* exhibit, it's no secret that we love a good atlas. After all, exhibit founder Katy Börner's trilogy of books covering the past, present, and future of science mapping all feature the word "Atlas" in their title. And this trend will continue in our forthcoming *Atlas of Epic Data Adventures: Interactive Macroscopes* (The MIT Press, 2025). What's more, we all spend much of our non-exhibit time helping build the Human Reference Atlas (HRA)—a comprehensive, high-resolution, three-dimensional atlas of all the cells in the healthy human body.* So it's safe to say we've definitely had atlases on the brain lately.

No doubt this influenced our choice of theme for the 19th iteration. "Macroscopes as Digital Atlases" is an idea we've kicked around for a while but only decided to make explicit this year. Like a good atlas, a macroscope creates its own annotated world. It identifies and outlines an explorable sphere of interest, lays out paths of entry, and provides multiple guideposts for those already inside.

That's what makes these digital atlases both great introductions for beginners and useful references for experts. And like with the best atlases, you might find yourself immersed in the worlds these macroscopes create. But not to worry: you may lose track of time, but you won't lose your way!

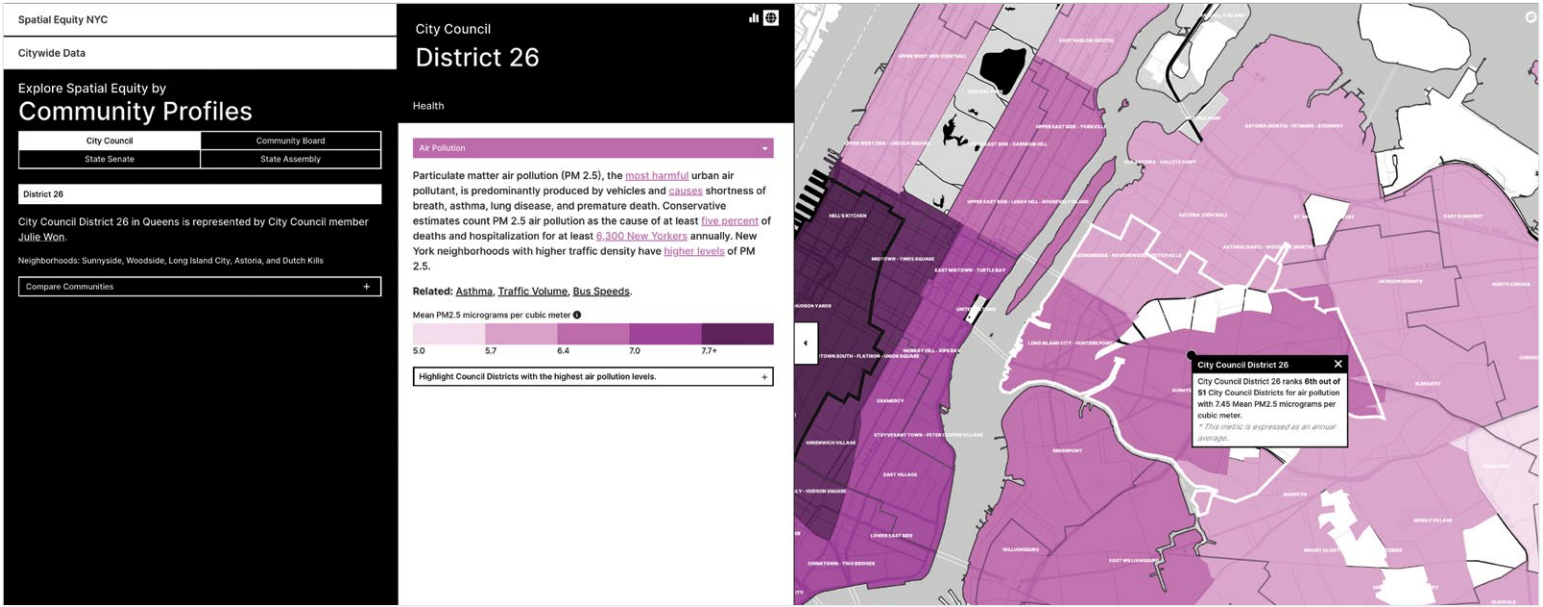
For now, though, we hope you'll immerse yourself in the pages that follow. There you'll find all the highlights, important events, new (and old) faces, and amazing new macroscopes that made 2023 such a great year for the *Places & Spaces* exhibit.

*See **humanatlas.io** for more information on this exciting project!

The exhibit team seen here enjoying André Skupin's *Coronavirus SoS*, another outstanding "digital atlas" from the 19th iteration.

XIX. Macroscopes as Digital Atlases

Digital atlases are collections of maps and charts that focus on a single theme. The power of a digital atlas is that it makes comparison within a collection easier. By linking related visualizations and datasets, patterns and relationships emerge. This iteration includes digital atlases that address spatial equity, housing, coronavirus research, and machine learning techniques. Like the best cartographic and anatomical atlases, they are engaging, insightful, and easy to use.

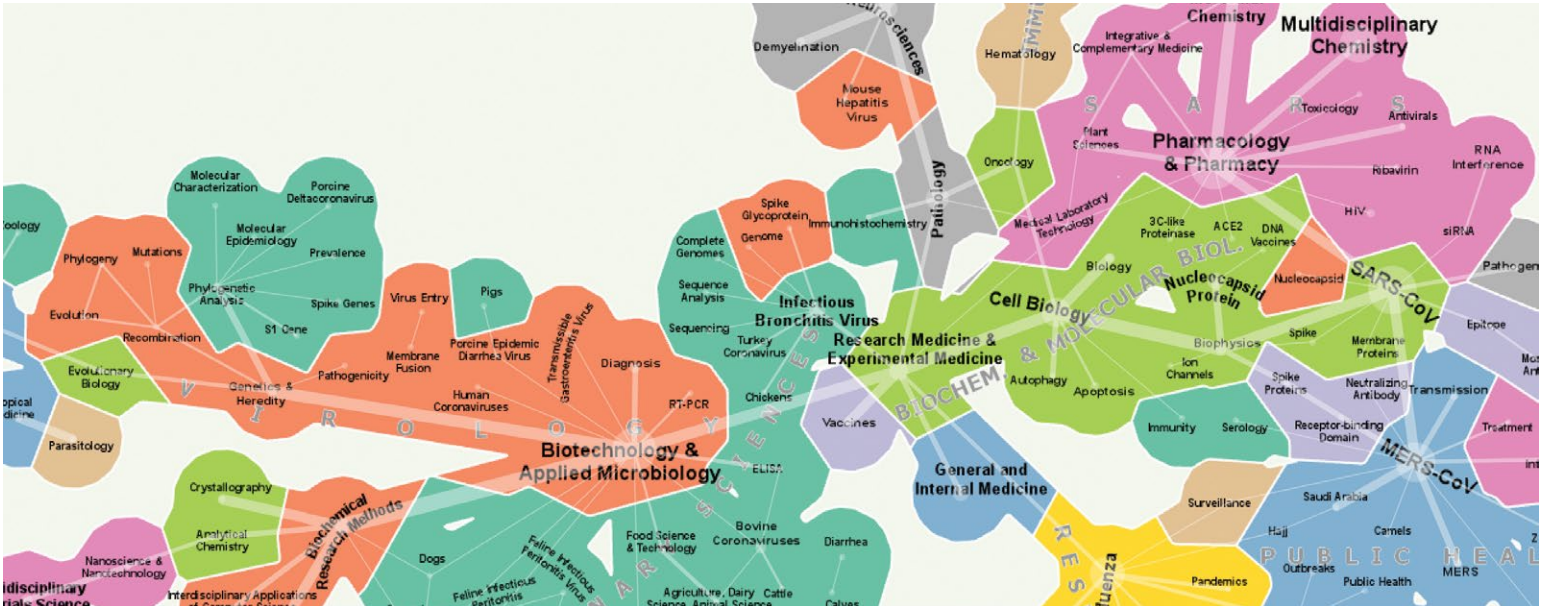


Spatial Equity NYC

When you live in the city, the design of public space can impact your quality of life. The presence of bike lanes, tree canopies, benches, narrow roads, and public green spaces can all add to residents' health and happiness. However, as this macroscope demonstrates, these amenities are more common in whiter, wealthier communities—and it is this spatial inequity that contributes to racial and economic disparities across the city as a whole. *Spatial Equity NYC*, a collaboration between MIT's Norman B. Leventhal Center for Advanced Urbanism and Transportation Alternatives, fosters data transparency by collecting and making usable a wealth of open city data. Users can search New York City neighborhoods to find correlations between planning decisions and negative health outcomes. *Spatial Equity NYC* encourages activism by equipping users with data-driven solutions and connecting them with opportunities for direct social action. Even if you don't call NYC your home, this macroscope can serve as an inspiration and a model for data-based engagement with the urban space in which you live or work.

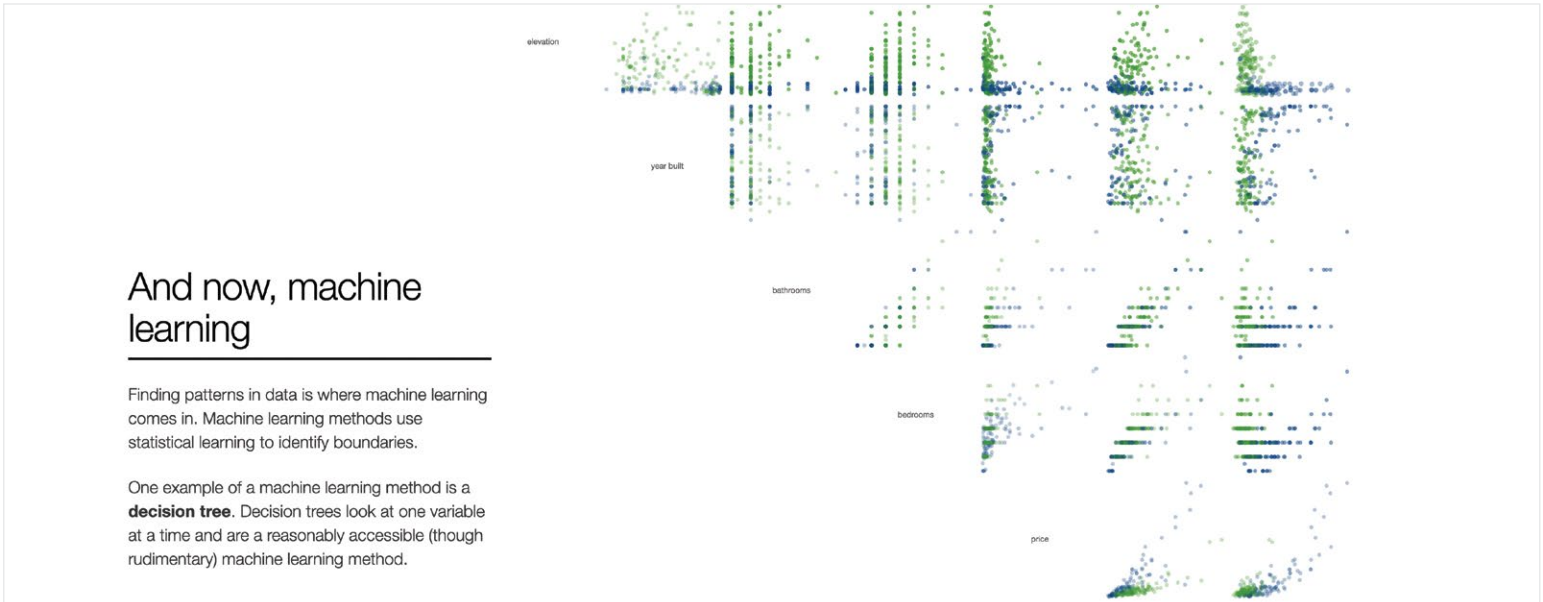
Spain Lives in Flats

This macroscope by Raúl Sánchez and Analía Plaza begins with a relatively straightforward question: Why does Spain have the highest percentage of apartment dwellers in the European Union? As this work of scrollytelling journalism demonstrates, answering that question must take into account everything from 19th-century attitudes toward cholera and mid-20th-century periods of urban migration to Francoist-era city engineering, late-century housing bubbles, and a 21st-century pandemic. It also requires a staggering amount of data—in this case, cartographic data on more than 12 million buildings—to tell the story of Spain's vertical urbanism. This wealth of data allows the analysis to move nimbly across scales, a movement that is reinforced by a visual narrative that hops from city to city, zooming in and out of urban areas to show how localized stories help explain larger national narratives. Towards the end, *Spain Lives in Flats* highlights models proposed by urban planning experts for building more sustainable futures.



Coronavirus SoS

Given the overwhelming amount of research devoted to the coronavirus over the years, the need is great for a tool that organizes and makes sense of all that science. Fortunately, cartographer and information visualization expert André Skupin, whose *In Terms of Geography* was included in the very first iteration of *Places & Spaces*, has returned to the exhibit with *Coronavirus SoS*. When Covid-19 first captured the attention of the scientific community, research into the virus did not have to begin from scratch. As Skupin's work demonstrates, early Covid-19 researchers could build off of a solid foundation of coronavirus studies going back over fifty years. Since then, of course, work on the virus has exploded, crossing the boundaries of many research fields in the process. *Coronavirus SoS* represents those knowledge domains as areas on a map, indicating topical overlap through relations of proximity and distance. What emerges is a valuable guide for coordinating the educational opportunities and multidisciplinary research teams needed to effectively confront both the current crisis and future pandemics.



A Visual Introduction to Machine Learning

Perhaps this describes your situation: You know that the term “machine learning” has been around since the 1950s, but now everyone’s talking about it and you’re embarrassed to admit you have no idea what it means. Fear not—Stephanie Yee and Tony Chu have created an accessible introduction to machine learning that is so fun to use that you’ll be excited to learn more about what it can do. The scrollytelling-style presentation begins by proposing a problem: how would a machine know whether a building is in San Francisco or New York based on criteria that have nothing to do with its location on a map? Taking us through the process, Yee and Chu cleverly visualize how machines are trained to use “if-then” statements to clearly distinguish one object’s data points from another. The goal, of course, is not only to have the machine identify with the highest accuracy a building’s location but also to use that model to make predictions in other situations and with other data. This generalizable predictive power is what makes machine learning so powerful, and *A Visual Introduction to Machine Learning* is a great first step in understanding how to put that power to use.

24-Hour Macroscope Event

On December 9–10, 2023, we held our third annual 24-hour, around-the-world event. While previous years focused on science mapping and the Human Reference Atlas, 2023 was the year that macroscopes took center stage. Exhibit curators Katy Börner, Lisel Record, and Todd Theriault kicked things off at noon on Saturday with a welcome, an explanation of the "macroscope" concept, and an introduction to these powerful interactive tools.

There were lively panel discussions on macroscopes in public places, the history and future of macroscopes, data storytelling, and visions for the AI future. CNS research lead Andreas Bueckle and his team were on hand to demo their amazing virtual reality work. Jazz artist Monika Herzig joined us for a fireside chat on improvisation, creativity, and innovation.

Over the course of the event, we attempted to feature something from every iteration of the exhibit's macroscope era—whether that be a live interview, hands-on demo, or a feature from our video collection.

For more information and to watch videos from the event, visit **tinyurl.com/24h-Macroscopes**.

An absolute highlight of the 24 hours was the 19th Iteration debut event. (Clockwise from top) Raúl Sánchez González and Analía Plaza presented their work *Spain Lives in Flats*; Hannah Shumway discussed *Spatial Equity NYC*; and André Skupin demonstrated the *Coronavirus SoS* dashboard. *A Visual Introduction to Machine Learning* makers Stephanie Yee and Tony Chu were unable to attend, but their macroscope still received its turn in the spotlight. The event was moderated by Katy, Lisel, and Todd.

ISSI 2023 at Indiana University

Poster session and reception held in Indiana Memorial Union's Tudor Room.

Exhibit maps in a summertime residency in Maxwell Hall attracted visitors from the ISSI Conference and other events at IU.

CNS Research Lead and IU Faculty Member Andreas Bueckle snaps a selfie with conference attendees in front of Luddy Hall's *Amatria* sculpture.

In previous years, the annual International Society for Scientometrics and Informetrics Conference, the premiere event for scholars in those fields, has been held in cities like Bangalore, Jerusalem, Istanbul, Beijing, Rome, Sydney, and Vienna. This year, due to the support of Scientific Committee Chair Katy Börner, the Cyberinfrastructure for Network Science, and the Indiana University Network Science Institute, the ISSI Conference came to Bloomington, Indiana, July 2–5, 2023, for four days of talks, panel discussions, workshops, tutorials, and even a little dancing. All papers from the conference are freely available at **zenodo.org/communities/issi-2023**.

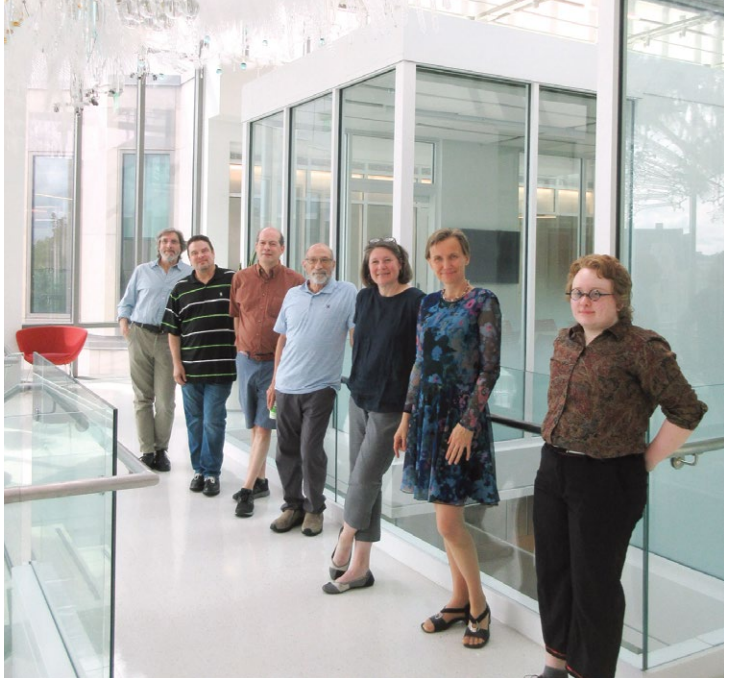
Many conference-goers made their way to Maxwell Hall to view a collection of some of our favorite maps from the *Places & Spaces* exhibit. The maps were part of an installation co-sponsored by the Bloomington Arts & Humanities Council that ran from June 8 to August 4, 2023, in the building's Grand Hall. This proved to be a wonderful way of showcasing the exhibit to scholars from 30 different countries who came to Bloomington for the ISSI conference.

Advisory Board Retreat

Given the international nature of our Exhibit Advisory Board, most of our meetings take place, by necessity, in virtual space. Once in a while, though, it's nice to get together in person for a day of catching up, round-table conversations, and good old-fashioned brainstorming. So on July 6, 2023, that's what we did.

On the agenda were a number of items, not the least of which was a discussion of possible directions for the exhibit's third decade. Nearing the end of the exhibit's "macroscope decade," we find ourselves at a decisive juncture. Such moments are when a diverse, international, multi-disciplinary advisory board can really shine by bringing in a wide array of ideas, technical know-how, expertise networks, and life experience.

The conversation was robust and wide-ranging, covering such topics as using visualization tools and techniques to explain AI, engaging all five human senses as pathways to understanding, working with teachers to develop a curriculum around the exhibit, and much more. We also discussed how science mapping, data visualization, and what constitutes an "exhibit experience" have changed since the exhibit began in 2005—and what all those things might look like in the future.



Top: In-person retreat attendees from left to right: Stephen Uzzo, Todd Theriault, Tim Utter, Gary Berg-Cross, Lisel Record, Katy Börner, and Ezra Engels. Below: Board members Ingo Günther, André Skupin, and Bonnie DeVarco join the discussion via Zoom.

Exhibit Advisory Board Member Spotlight: Tim Utter

Can you tell us a bit about the work you do at the Clark Library?

As director of the Social Sciences and Clark Library, I manage a team of seventeen librarians and a dozen students. I enjoy interacting with and learning from them and try to give back by sharing my knowledge and enthusiasm for our amazing collections. Part of my duties include curating our map collection of around 425,000 items. I especially like being able to share items from the collection through K-12 and university class visits, tours, and open houses. I'm also responsible for creating and bringing in exhibits.

Please tell us about your history with *Places & Spaces*?

I first became aware of *Places & Spaces* in 2012 when I worked with them to host their exhibit here at the University of Michigan. This was my first deep encounter with visualizations and we hosted Dr. Börner for a lecture. The exhibit and accompanying events were very well attended, so I was especially excited to host another exhibit and lecture in 2022. The macroscope kiosk was incredibly popular with visitors of all ages, and it was a great way to engage and excite patrons who were returning to the library after the pandemic.

What excites you about the exhibit currently, and what would you like to see it do in the future?

I still get excited about the original 10 iterations of visualizations, but even more so about the macroscopes. Their interactive nature and ability to address critical scientific and social issues is especially important. I would like to see the macroscopes get more classroom use and be integrated into course curricula. They are obviously a great tool for understanding complex questions and hopefully are inspiring future data scientists as well.

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 (Ph.D., 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]

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]

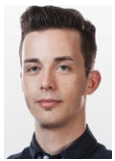
Elijah Meeks is the executive director of the Data Visualization Society and a data visualization engineer at Apple. His prior experience includes working in the digital humanities at Stanford and developing data visualization applications at Netflix. He is the author of D3.js in Action, the data visualization 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, curator, exhibition designer, and founder of Olga Subirós Studio. She is currently curating Matter Matters exhibition at the DHub-Design Museum of Barcelona that will open in December 2024. Subirós curated the project AIR at the Architecture Venice Biennale 2021. 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. From 2014–2018, the exhibit 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. Subirós is a guest lecturer for the Master's in Data Design program at the ELISAVA Barcelona School of Design and Engineering. [Barcelona, Spain]

Tim Utter is the director of the Social Sciences and Clark Library at the University of Michigan where he manages a team of seventeen librarians and a dozen students. His duties include curating a map collection of around 425,000 items, and he enjoys sharing items from the collection through K-12 and university class visits, tours, and open houses. He is also responsible for creating and bringing in exhibits. [Ann Arbor, MI, USA]

Stephen Uzzo is currently chief technology officer for the National Museum of Mathematics and former chief scientist for the New York Hall of Science. He works in museum planning and design and research initiatives to study and integrate data-driven and complexity science into teaching and learning. Dr. Uzzo is concerned with providing opportunities for underserved learners to navigate a future in which AI and big data predominate and the risks of misuse of personal data expand. [New York, NY, USA]



Benjamin Wiederkehr is funding partner and managing director of Interactive Things, a design and development studio for human data interaction. He is part of the Open Government Data task force in Switzerland and helps to facilitate open access to government data for everyone. Wiederkehr organizes the Data Visualization Zürich lecture series and writes, speaks, and teaches about the intersection of data, design, and people. [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." 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**, Director, Social Sciences and Clark Library, 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."

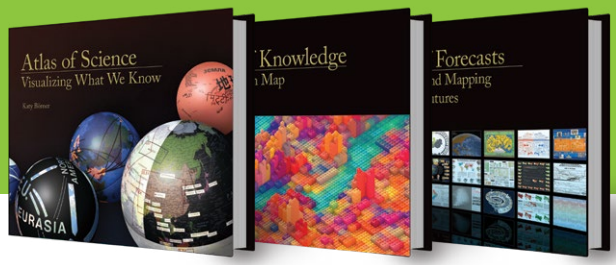
—**Kristi Holmes**, Director, Galter Health Sciences Library and Professor of Preventive Medicine (Health and Biomedical Informatics) and Medical Education at the Feinberg School of Medicine, Northwestern University.

"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

Views of Ingo Günther's WorldProcessor Globes, exhibit maps and macroscopes, and 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**)

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.

Exhibit by the Numbers

As of December 31, 2023: *Places & Spaces* was first shown at the Annual Meeting of the Association of American Geographers in April 2005. Since then, the exhibition has traveled to 167 cities in 30 countries on 6 continents. It showcases the work of 215 mapmakers and 100 macroscope makers that hail from around the globe.

Venues: The exhibit has appeared in various formats at 466 venues since its inception in 2005.

Exhibit in Numbers (since 2005)

Exhibit Maps: **100**
Exhibit Macroscopes: **36**
Mapmakers: **215**
Macroscope Makers: **100**
Display Venues and Events: **466**
Press Items: **215**
Workshops Organized: **40**
Website Visits: **7,789,299**

2023 Expenses

Compensation: $6,203.36
Board Retreat: $1,797.39
Supplies & Expenses: $5,378.41
Total: $13,379.16

2023 Revenue

CNS Support: $4,790.33
Sales & Services: $8,588.83
Total: $13,379.16

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Places & Spaces: Mapping Science
Cyberinfrastructure for Network Science Center (CNS)
Luddy School of Informatics, Computing, and Engineering
Indiana University
Luddy Hall, 700 N. Woodlawn Avenue
Bloomington, IN 47408, USA

PHONE 812-855-4831
EMAIL cnscntr@iu.edu
WEB scimaps.org

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