Please note our measures concerning Coronavirus / Covid 19

SCHLOSS DAGSTUHL
Leibniz-Zentrum für Informatik

https://www.dagstuhl.de/21152

April 11 – 16 , 2021, Dagstuhl Seminar 21152

Multi-Level Graph Representation for Big Data Arising in Science Mapping

Organizers

Katy Börner (Indiana University – Bloomington, US)
Stephen G. Kobourov (University of Arizona – Tucson, US)

For support, please contact

Susanne Bach-Bernhard for administrative matters

Shida Kunz for scientific matters

Documents

List of Participants
Shared Documents
Dagstuhl Seminar Wiki
Dagstuhl Seminar Schedule (Upload here)
(Use personal credentials as created in DOOR to log in)

Documentation

In the series Dagstuhl Reports each Dagstuhl Seminar and Dagstuhl Perspectives Workshop is documented. The seminar organizers, in cooperation with the collector, prepare a report that includes contributions from the participants' talks together with a summary of the seminar.

Download overview leaflet (PDF).

Publications

Furthermore, a comprehensive peer-reviewed collection of research papers can be published in the series Dagstuhl Follow-Ups.

Dagstuhl's Impact

Please inform us when a publication was published as a result from your seminar. These publications are listed in the category Dagstuhl's Impact and are presented on a

https://www.dagstuhl.de/en/program/calendar/semhp/?semnr=21152

On-site participants

- Katy Börner (Indiana University – Bloomington, US) [dblp]
- Ingo Günther (Worldprocessor Studio – New York, US)
- Francis Harvey (Leibniz Institut für Länderkunde – Leipzig, DE) [dblp]
- Michael Kaufmann (Universität Tübingen, DE) [dblp]
- Alexander Wolff (Universität Würzburg, DE) [dblp]

Remote participants

- Patrizio Angelini (John Cabot University – Rome, IT) [dblp]
- Michael A. Bekos (Universität Tübingen, DE) [dblp]
- Kevin Boyack (SciTech Strategies Inc. – Albuquerque, US)
- David Chavalarias (CNRS – Paris, FR)
- Giuseppe Di Battista (University of Rome III, IT) [dblp]
- Sara Irina Fabrikant (Universität Zürich, CH) [dblp]
- Jean-Daniel Fekete (INRIA Saclay – Orsay, FR) [dblp]
- Lynda Hardman (CWI – Amsterdam, NL) [dblp]
- Ben Jacobsen (University of Arizona – Tucson, US)
- Philipp Kindermann (Universität Trier, DE) [dblp]
- Karsten Klein (Universität Konstanz, DE) [dblp]
- Stephen G. Kobourov (University of Arizona – Tucson, US) [dblp]
- Thomas Köhler (TU Dresden, DE)
- Vincent Larivière (University of Montreal, CA)
- Tamara Mchedlidze (Utrecht University, NL) [dblp]
- Guy Melançon (University of Bordeaux, FR) [dblp]
- Staša Milojevic (Indiana University – Bloomington, US)
- Filipi Nascimento Silva (Indiana University – Bloomington, US)
- Martin Nöllenburg (TU Wien, AT) [dblp]
- Adam Ploszaj (University of Warsaw, PL)
- Sergey Pupyrev (Facebook – Menlo Park, US) [dblp]
- Chrysanthi Raftopoulou (National Technical University of Athens, GR) [dblp]
- Andrea Scharnhorst (Royal Netherlands Academy of Arts and Sciences, NL) [dblp]
- André Skupin (San Diego State University, US) [dblp]
- Cassidy Rose Sugimoto (Indiana University – Bloomington, US)
- Antonios Symvonis (National TU – Athens, GR) [dblp]
- Markus Wallinger (TU Wien, AT)
- Angela Zoss (Duke University – Durham, US)

Motivation

For centuries, cartographic maps have guided human exploration. While being rather imperfect initially, they helped explorers find promised lands and return home safely. Recent advances in data, algorithms, and computing infrastructures make it possible to map humankind's collective scholarly knowledge and technology expertise by using topic maps on which “continents” represent major areas of science (e.g., mathematics, physics, or medicine) and zooming reveals successively more detailed subareas. Basemaps of science and technology are generated by analyzing citations links between millions of publications and/or patents. “Data overlays” (e.g., showing all publications by one scholar, institution, or country or the career trajectory of a scholar as a pathway) are generated by science-locating relevant publication records based on topical similarity. Despite the demonstrated utility of such maps, current approaches do not scale to the hundreds of millions of data records now available. The main challenge is designing efficient and effective methods to visualize and interact with more than 100 million scholarly publications at multiple levels of resolution.

This Dagstuhl Seminar will bring together researchers in cartography, information visualization, science of science, and graph drawing to discuss novel graph mining and layout algorithms and their application to the development of science mapping standards and services. We will also organize an exhibition of art contributed by scientists and science maps contributed by artists, and use this to stimulate discussion.

This Dagstuhl Seminar will bring together researchers in cartography, information visualization, science of science, and graph drawing to discuss novel graph mining and layout algorithms and their application to the development of science mapping standards and services. We will also organize an exhibition of art contributed by scientists and science maps contributed by artists, and use this to stimulate discussion.

One of our main goals is to create a special journal issue on the topics related to the development of the next generation science map, SciMap2020. Among others, we will aim to answer:

1. What data is most robust to design SciMap2020?
2. What information should the nodes and link encode in SciMap2020?
3. What user experience metaphors, functionality, and interactive user interfaces are best?
4. What user studies should be run to compare options and study knowledge gains?

On the algorithmic front, specific research problems include:

1. Construct a hierarchy of graphs, so that each represents the underlying large graph well
2. Study the complexity of underlying problem: computing multi-level graph sketches
3. Design efficient algorithms for computing multi-level graph sketches and clustering
4. Design graph layout algorithms, driven by multi-level sketches and clustering

We look forward to a stimulating week that brings together world-leading experts to tackle these research challenges.

Monday

07:30-08:45 Breakfast

09:00-09:15 Welcome by Katy Börner

09:15-10:00 Brief Introductions / Research Overviews

- Francis Harvey, University of Leipzig
- David Chavalarias, ISC-PIF
- Mohammad Khaledur Rahman, IU, "BatchLayout: A batch-parallel force-directed graph layout algorithm in shared memory"

10-10:30 Overview Talk

- Katy Börner, IU: "Big Data Arising in Science Mapping" (30mins)

10:30-11:00 Coffee Break

11:00-12:00 Brief Introductions / Research Overviews

- Thomas Koehler, TU Dresden
- Kilian Buehling, TU Dresden
- Andrea Scharnhorst, DANS, NL; https://pure.knaw.nl/portal/en/persons/andrea-scharnhorst
- Ingo Günther, https://ingogunther.com/worldprocessor

12:15-13:00 Lunch

Brief Introductions / Research Overviews

- Title slide with name, affiliation(s), picture
- Main research areas
- **Research relevant for this Dagstuhl seminar**
- Why did you decide to attend this seminar?
- What paper might you contribute to the July/Aug 2022 special issue in *IEEE Computer Graphics and Applications* on "Multi-Level Graph Representations for Big Data in Science"?

12:15-13:00 Lunch

14:00 Introduction of Medina who will serve as the VCA Monday-Thursday 14:00-20:00.

14:10-15:00 Overview Talks (30mins each)

- Stephen Kobourov, UA: Welcome by Stephen & Multi-Level Graph Representations
- Sara Fabrikant, Department of Geography, University of Zürich: Cognitive research on landmarks, color, uncertainty & The Future of Geographic Information Displays
  Maybe better for this late in the evening: Susceptibility of domain experts to color manipulation indicate a need for design principles in data visualization

15:00-15:30 Coffee Break / Katy welcomes all to Amatria's Virtual Birthday Party

15:30-16:30 Brief Introductions / Research Overviews (10mins each)

- Andreas Bueckle, IU: Science Map Metaphors: A Comparison of Network Versus Hexmap-Based Visualizations
- Angela Zoss, Duke U: XXX
- Pino di Battista: Schematic Representation of Large Biconnected Graphs
- Alexander Wolff, U Würzburg: Using the Metro Map Metaphor for Drawing Hypergraphs
- Guy Melançon, Vice President of Digital Transformation, Université de Bordeaux*
- Adam Ploszaj, University of Warsaw

16:30-18:00 Challenges & Opportunities and Discussion of Topics for Special Issue in IEEE Computer Graphics and Applications (Katy and Stephen)

18:00-19:00 Dinner

19:00-20:00 **WEBINAR** Special Event: Dagstuhl Exhibit Debut with Francis Harvey & Katy Börner

The July/Aug 2022 special issue in *IEEE Computer Graphics and Applications* on "Multi-Level Graph Representations for Big Data in Science"

Articles due for review: December 29, 2021

Guest editors:

- Katy Börner, Indiana University, Bloomington, US
- Stephen G. Kobourov, University of Arizona, Tucson, US

https://www.computer.org/digital-library/magazines/cg/call-for-papers-special-issue-on-multi-level-graph-representations-for-big-data-in-science

Call for Papers: Special Issue on Multi-level Graph Representations for Big Data in Science

CG&A seeks submissions for this upcoming special issue.

For centuries, cartographic maps have guided human exploration. While being rather imperfect initially, they helped explorers find promised lands and return home safely. Recent advances in data, algorithms, and computing infrastructures make it possible to map humankind's collective scholarly knowledge and technology expertise by using topic maps on which "continents" represent major areas of science (e.g., mathematics, physics, or medicine) and zooming reveals successively more detailed subareas. Basemaps of science and technology are generated by analyzing citations links between millions of publications and/or patents. "Data overlays" (e.g., showing all publications by one scholar, institution, or country or the career trajectory of a scholar as a pathway) are generated by science-locating relevant publication records based on topical similarity. Despite the demonstrated utility of such maps, current approaches do not scale to the hundreds of millions of data records now available. The main challenge is designing efficient and effective methods to visualize and interact with more than 100 million scholarly publications at multiple levels of resolution.

This special issue invites researchers in cartography, data visualization, science of science, graph drawing, and other domains to submit novel and promising new research on graph mining and layout algorithms and their application to the development of science mapping standards and services. Topics of interest include:

- Science of science user needs and applications
- Efficient multi-level graph algorithms
- Network visualizations
- Effective user interfaces to large-scale data visualizations

Deadlines

Submissions due: 29 December 2021
Preliminary notification: 2 March 2022
Revisions due: 6 April 2022
Final notification: 11 May 2022
Final version due: 25 May 2022
Publication: July/August 2022

15:00-15:30 Coffee Break / Katy welcomes all to Amatria's Virtual Birthday Party

CNS Cyberinfrastructure for Network Science Center

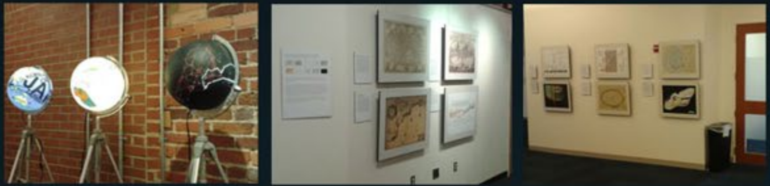
INDIANA UNIVERSITY SCHOOL OF INFORMATICS, COMPUTING, AND ENGINEERING

Mapping Science Exhibit

http://scimaps.org

101st Annual Meeting of the Association of American Geographers, Denver, CO.
April 5th - 9th, 2005 (First showing of Places & Spaces)

University of Miami, Miami, FL.
September 4 - December 11, 2014.



Duke University, Durham, NC.
January 12 - April 10, 2015

http://scimaps.org

The David J. Sencer CDC Museum, Atlanta, GA.
January 25 - June 17, 2016.

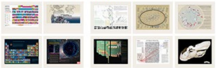
Places & Spaces: Mapping Science Exhibit

1st Decade (2005-2014)

Maps

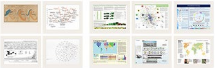
Iteration I (2005)
The Power of Maps

Iteration II (2006)
The Power of Reference Systems



Iteration III (2007)
The Power of Forecasts

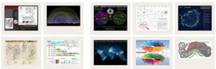
Iteration IV (2008)
Science Maps for Economic Decision Makers



Iteration V (2009)
Science Maps for Science Policy Makers

Iteration VI (2010)
Science Maps for Scholars

Iteration VII (2011)
Science Maps as Visual Interfaces to Digital Libraries



Iteration VIII (2012)
Science Maps for Kids

Iteration IX (2013)
Science Maps Showing Trends and Dynamics

Iteration X (2014)
The Future of Science Mapping

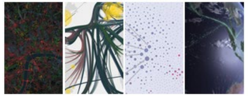
2nd Decade (2015-2024)

Macroscopes

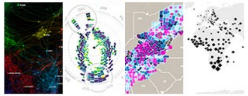
Iteration XI (2015)
Macroscopes for Interacting with Science

Iteration XIII (2017)
Macroscopes for Playing with Scale

Iteration XII (2016)
Macroscopes for Making Sense of Science



Iteration XIV (2018)
Macroscopes for Ensuring our Well-being



100
MAPS
in large format, full color, and high resolution.

248
MAPMAKERS
from fields as disparate as art, urban planning, engineering, and the history of science.

43
MACROSCOPE MAKERS
including one whose job title is "Truth and Beauty Operator."

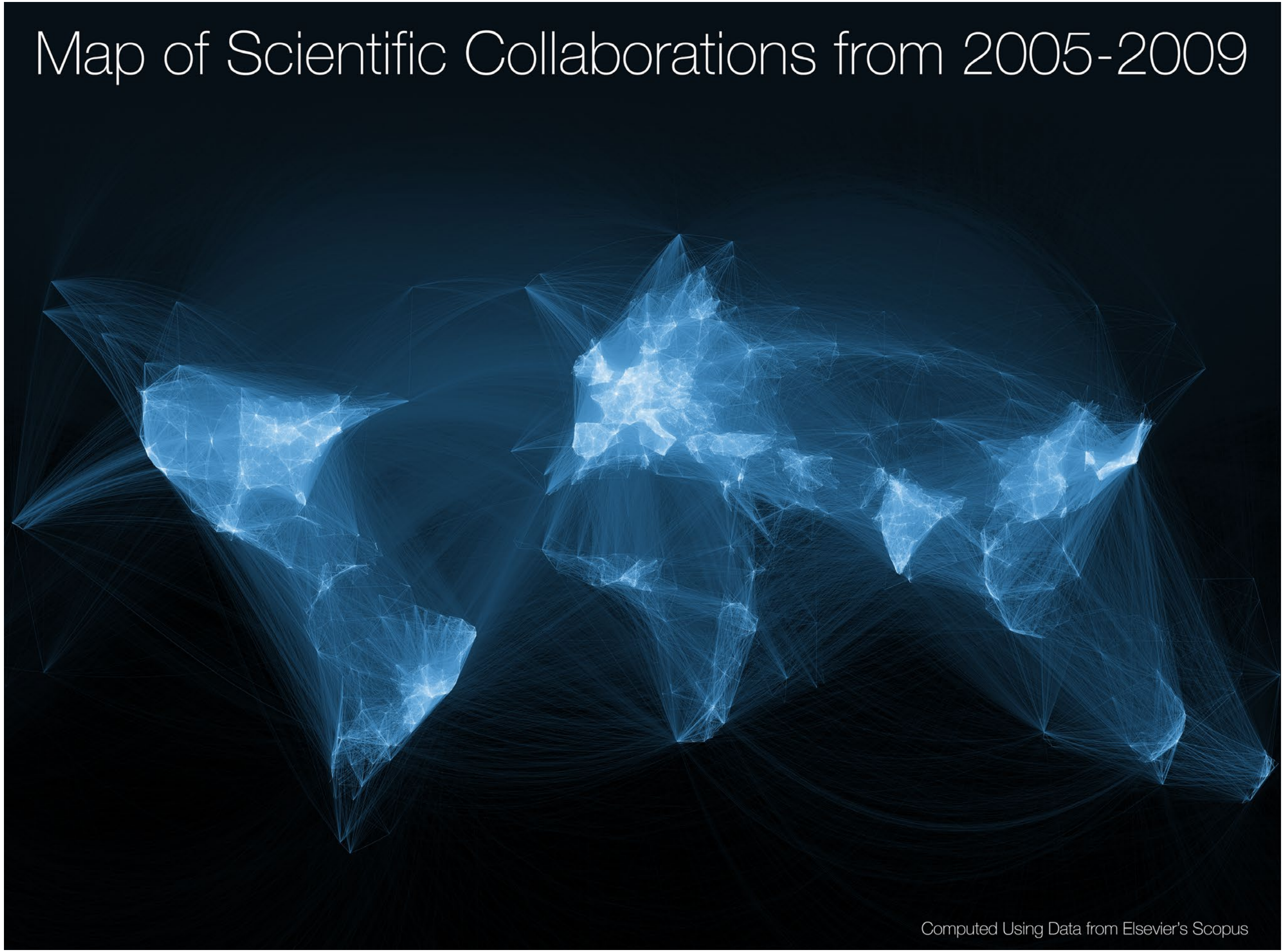
20
MACROSCOPES
for touching all kinds of data.

382
DISPLAY VENUES
from the Cannes Film Festival to the World Economic Forum.

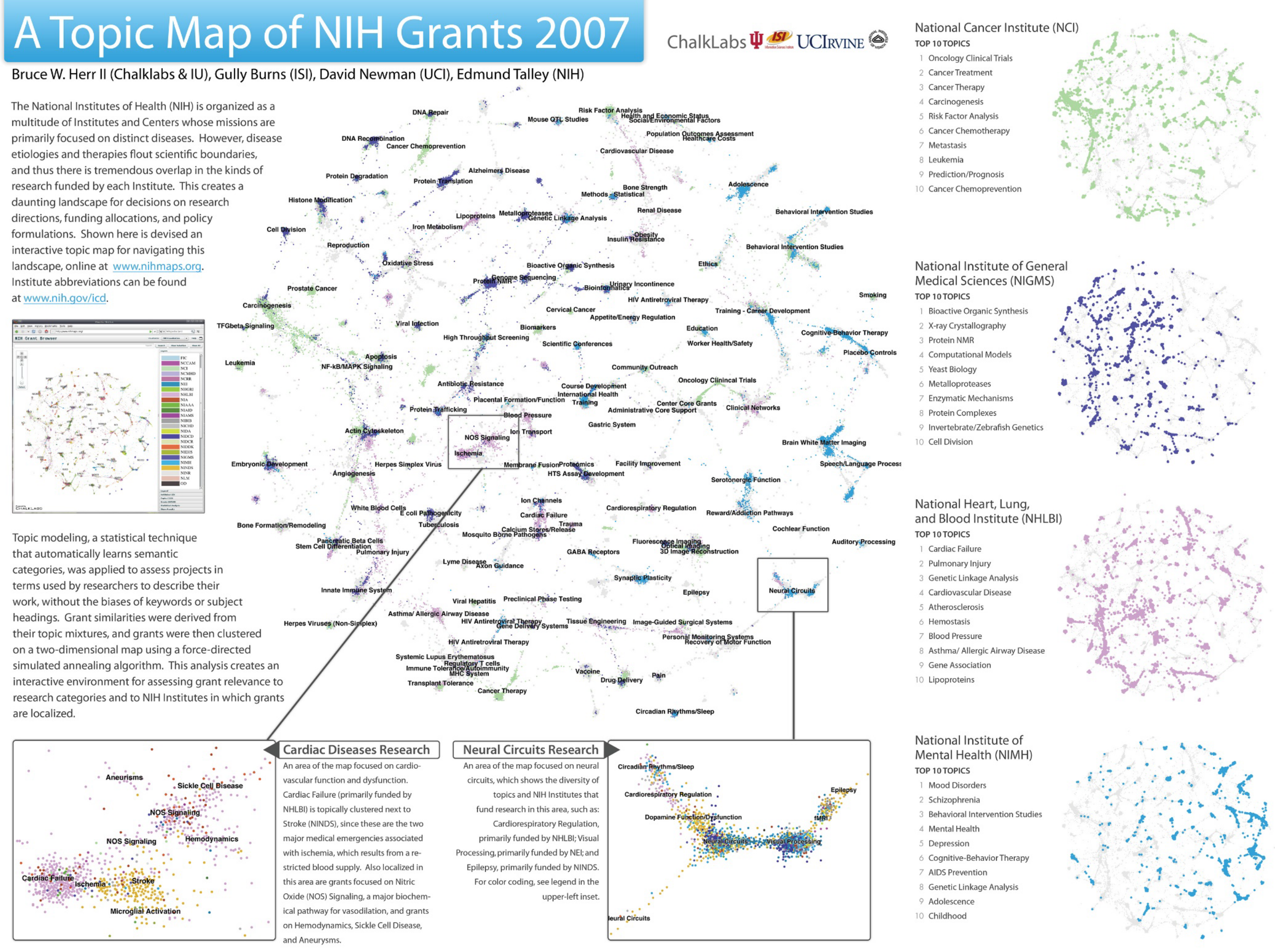
354
PRESS ITEMS
including articles in *Nature*, *Science*, *USA Today*, and *Wired*.

http://scimaps.org

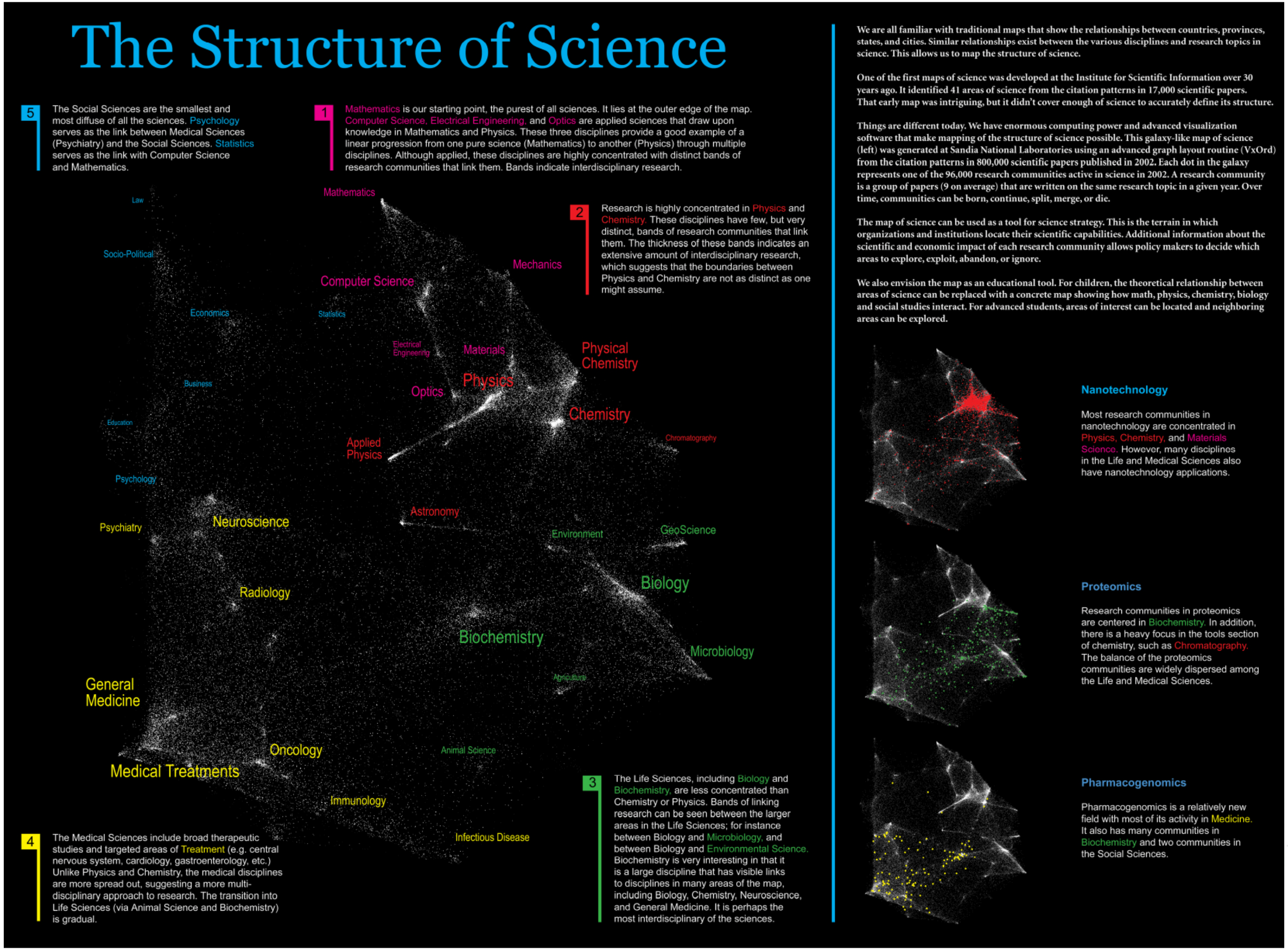
CNS Cyberinfrastructure for Network Science Center



VII.6 Stream of Scientific Collaborations Between World Cities - Olivier H. Beauchesne - 2012



V.7 *A Topic Map of NIH Grants 2007* - Bruce W. Herr II, Gully A.P.C. Burns, David Newman, and Edmund Talley - 2009



I.10 *The Structure of Science* - Kevin W. Boyack and Richard Klavans - 2005

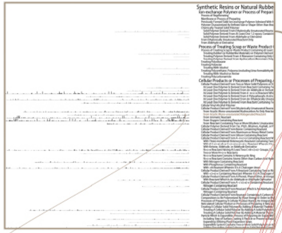
The US Patent Hierarchy

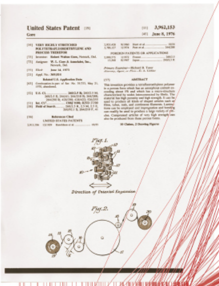
Impact

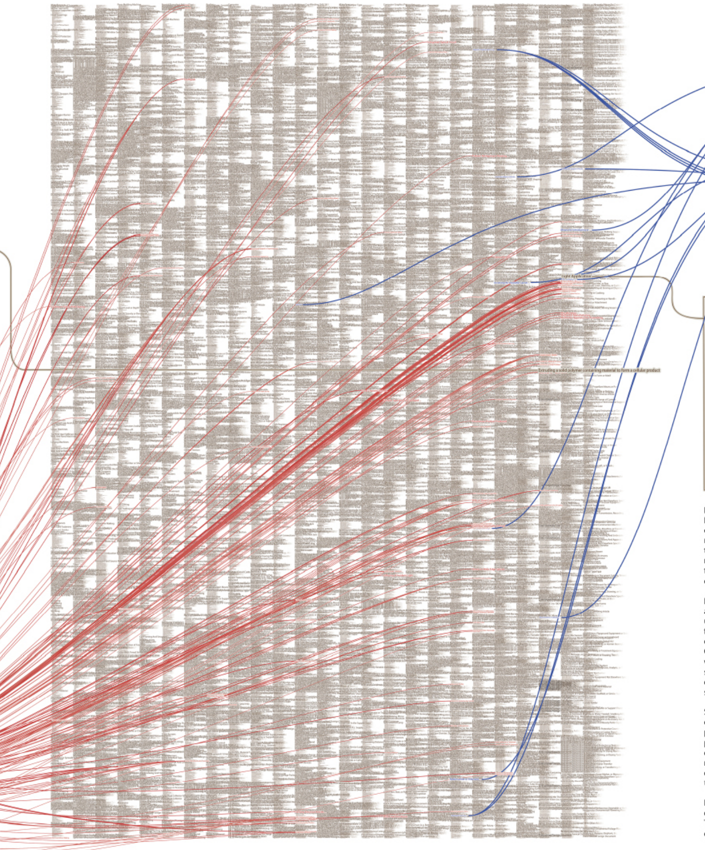
The United States Patent and Trademark Office does scientists and industry a great service by granting patents to protect inventions. Inventions are categorized in a taxonomy that groups patents by industry or use, proximate function, effect or product, and structure. At the time of this writing there are 160,523 categories in a hierarchy that goes 15 levels deep. We display the first three levels (13,529 categories) at right in what might be considered a textual map of inventions.

Patent applications are required to be unique and non-obvious, partially by revealing any previous patents that might be similar in nature or provide a foundation for the current invention. In this way we can trace the impact of a single patent, seeing how many patents and categories it affects.

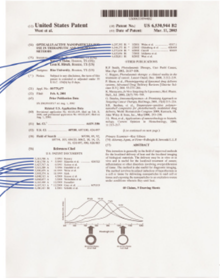
The patent on Goretex—a lightweight, durable synthetic fiber—is an example of one that has had significant impact. The box below enlarges the section of the hierarchy where it is filed, and the red lines (arranged to start along a time line from 1981 to 2006) point to the 130 categories that contain 182 patents, from waterproof clothing to surgical cosmetic implants, that mention Goretex as "prior art."

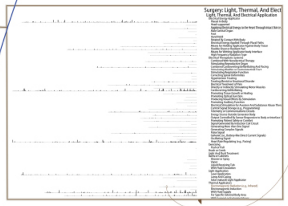






Prior Art





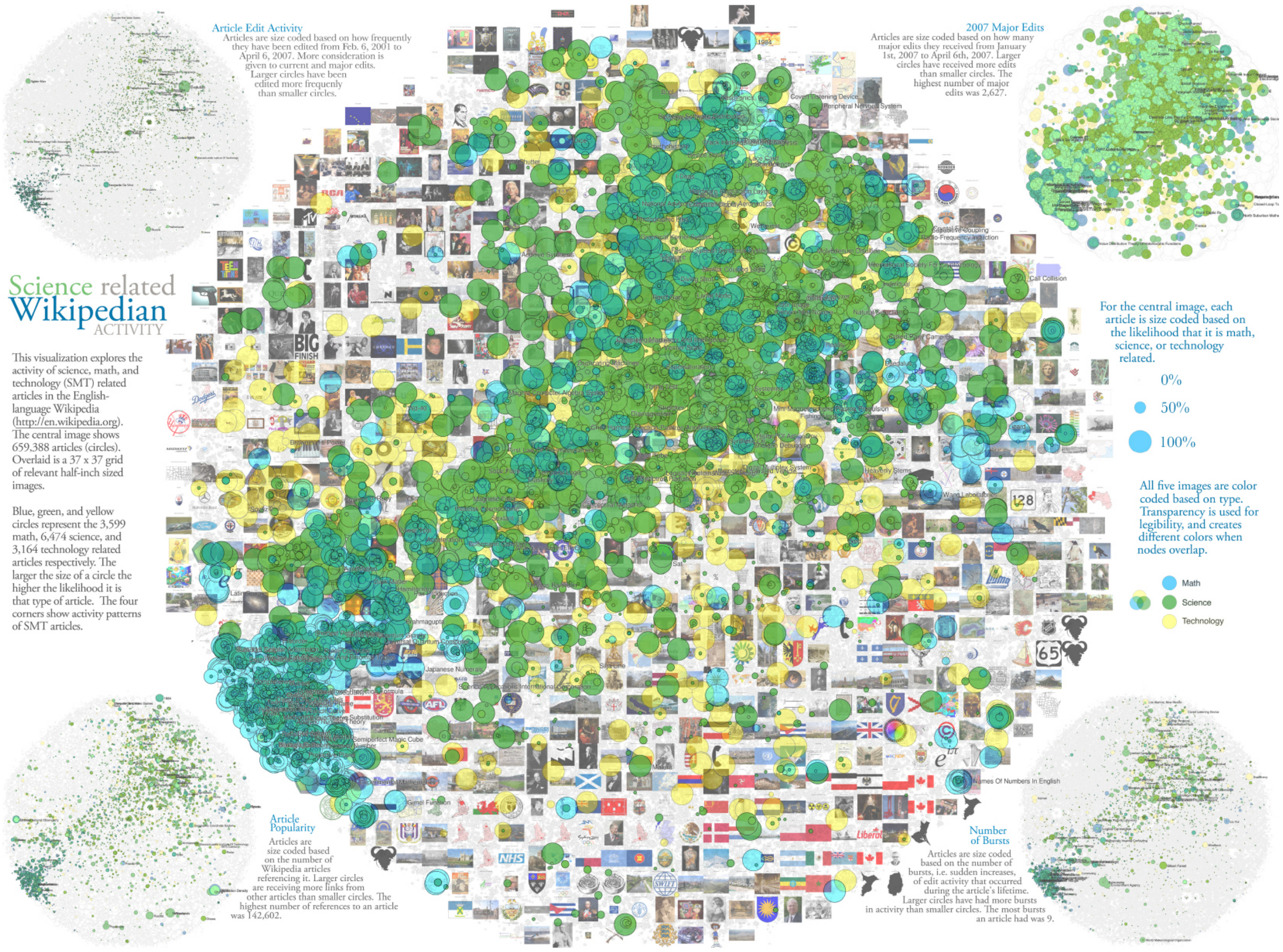
New patents often build on older ideas from many different categories. Here, blue lines originate in the sixteen categories that contain patents cited as prior art for a patent on "gold nanoshells." Gold nanoshells are a new invention: tiny gold spheres (with a diameter ten million times smaller than a human hair) that can be used to make tumors more visible in infra-red scans; they have even helped cause complete remission of tumors in tests with laboratory mice. The blue lines show that widely separated categories provided background for this invention.

Keeping categories understandable is an important part of maintaining any taxonomy, including the patent hierarchy. Categories are easier to understand, search, and maintain if they contain elements that comfortably fit the definition of the category. The box above shows tiny bar charts, part of a *Taxonomy Validator* that reveals whether elements fit their categories. Categories may need to be redefined, and sometimes need to be split when they get too vague or large; a problem shared by many classification systems in this information-rich century. But how can we tell which ones to eliminate, add or revise—or how to revise them—in the complex, abstract sociolinguistic spaces we partition into ontologies?

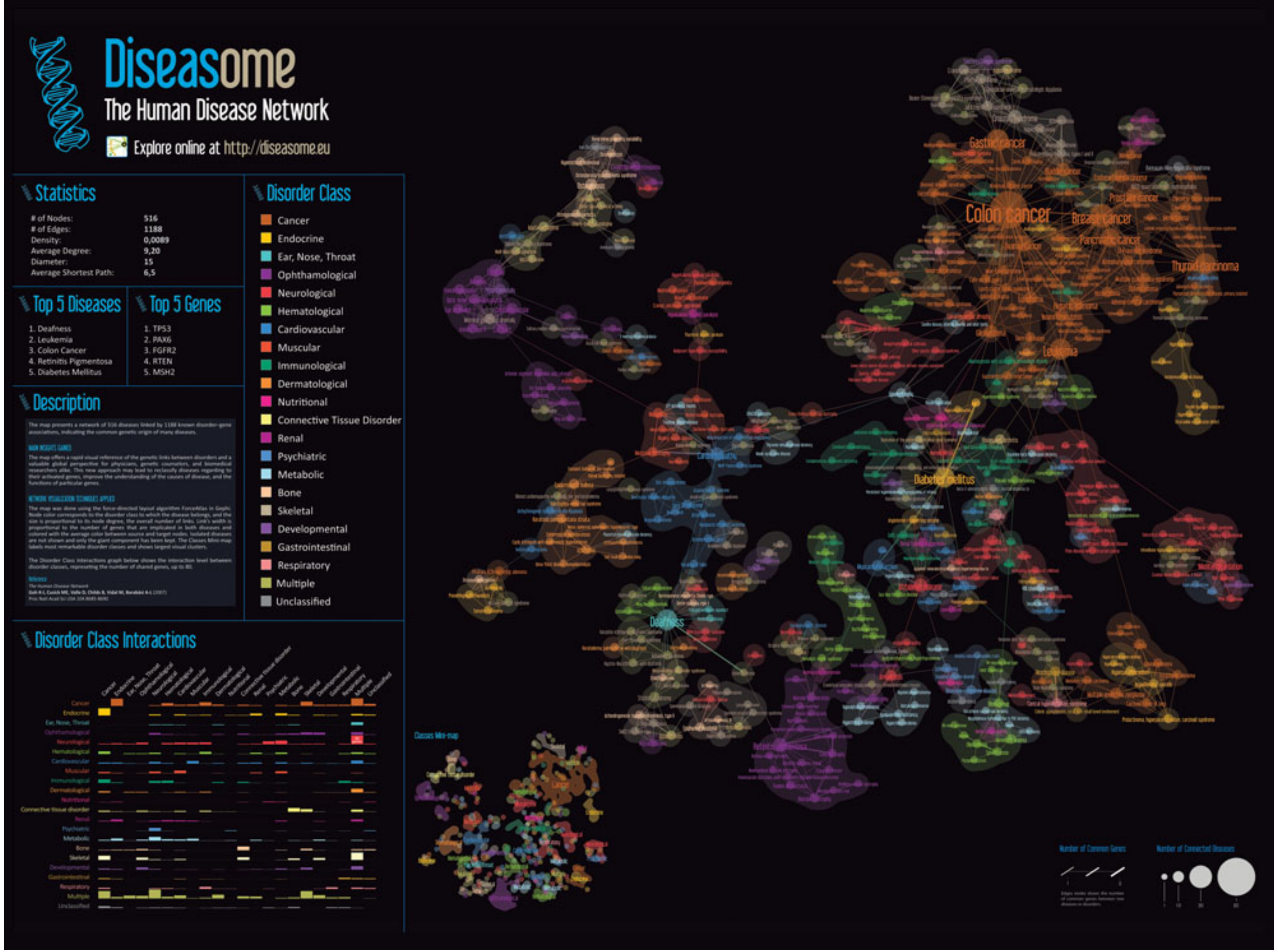
Something as simple as a bar chart helps people see how entities in a category relate to that category. Here, each bar encodes a "distance to prototype": how much each patent differs from an idealized "prototype patent" for that category. A measure like this can be based on statistics, computational linguistics, or even human insight. Thus a category with mostly small bars is a good one, and a generally ragged one needs scrutiny or reorganization; but one that has only two or three tall bars may mean that only those few elements don't belong.

Even simple visuals can make thinking easier by providing better distilled data to the eye: vastly more data than working memory can hold as words. They focus people on exactly the right issues, and support them with the comprehensive overviews they need to make more informed judgements.

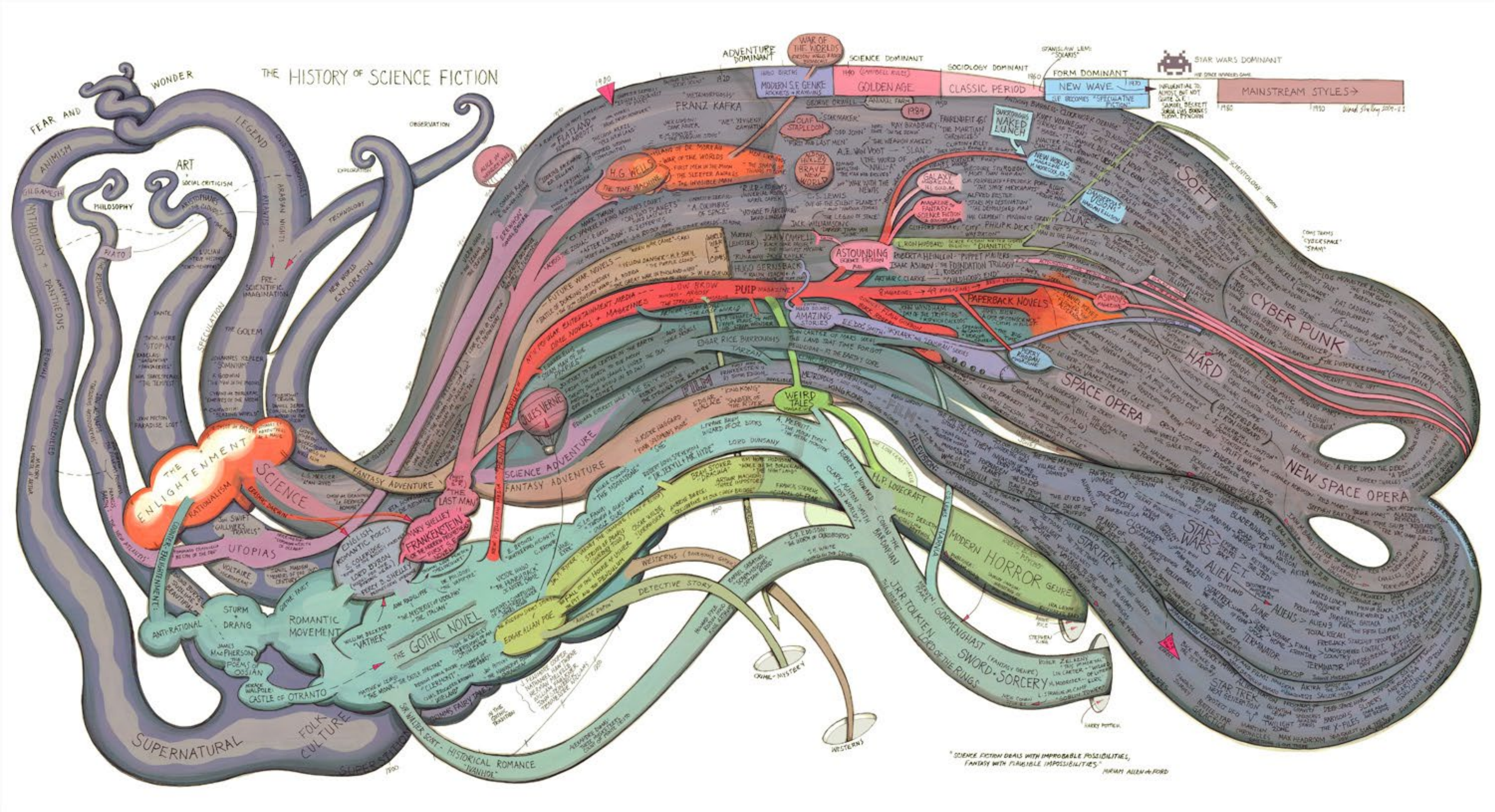
II.8 *Taxonomy Visualization of Patent Data* - Katy Börner, Elisha F. Hardy, Bruce W. Herr II, Todd Holloway, and W. Bradford Paley - 2006



III.8 *Science-Related Wikipedian Activity* - Bruce W. Herr II, Todd M. Holloway, Elisha F. Hardy, Katy Börner, and Kevin Boyack - 2007



VI.3 *Diseasome: The Human Disease Network* - Mathieu Bastian and Sébastien Heymann - 2009



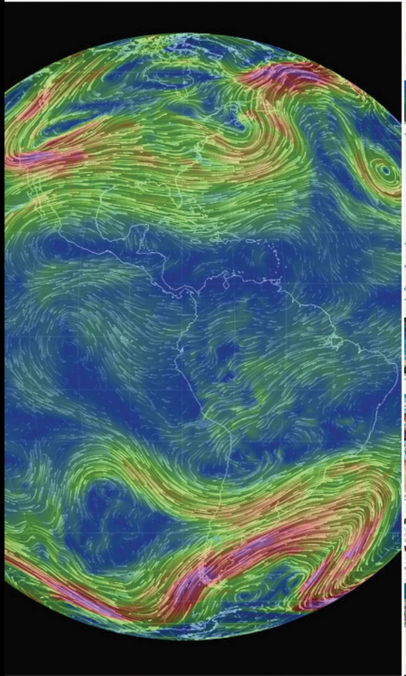
VII.10 *History of Science Fiction* - Ward Shelley - 2011

Check out our Zoom Maps online!

Visit scimaps.org and check out all our maps in stunning detail!

MACROSCOPES FOR INTERACTING WITH SCIENCE

PLACES & SPACES
MAPPING SCIENCE
scimaps.org

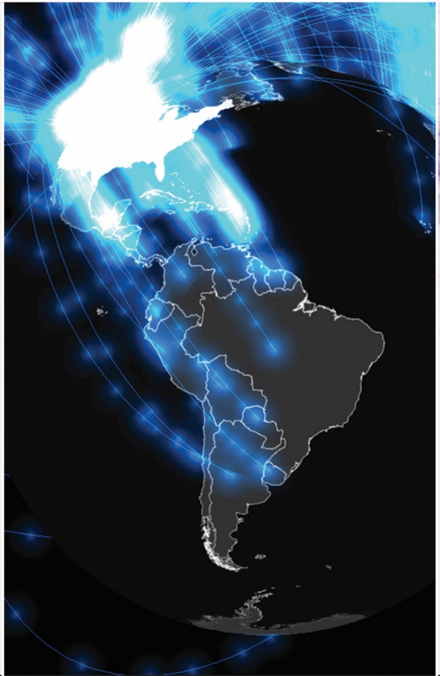


Earth

Weather on a worldwide scale

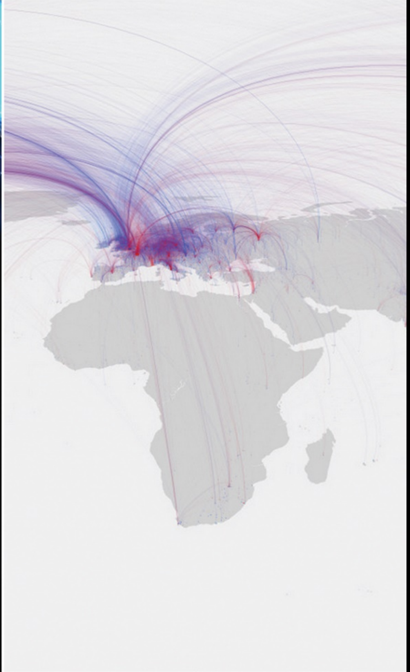
AcademyScope

Exploring the scientific landscape



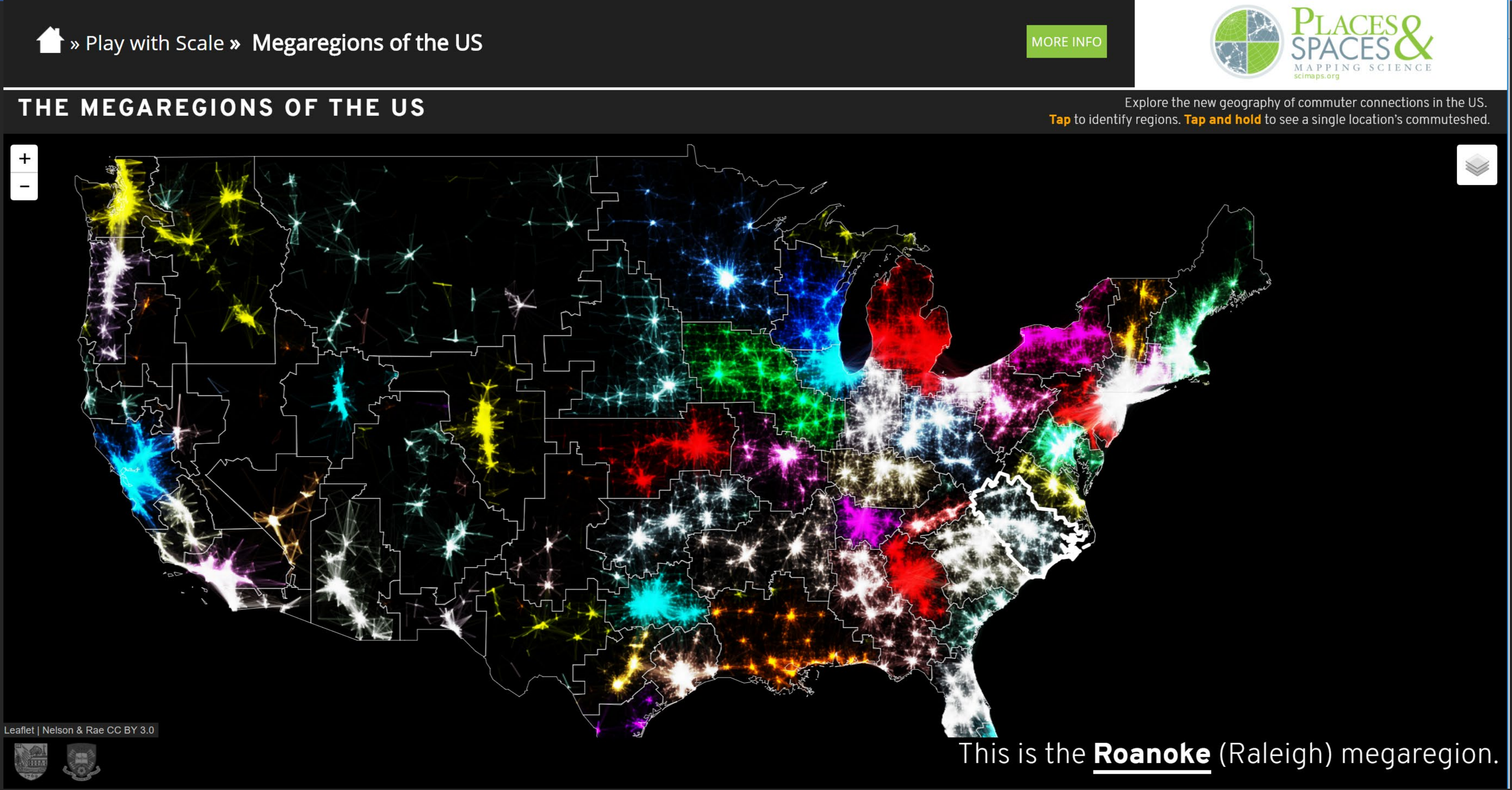
Mapping Global Society

Local news from a global perspective



Charting Culture

2,600 years of human history in 5 minutes

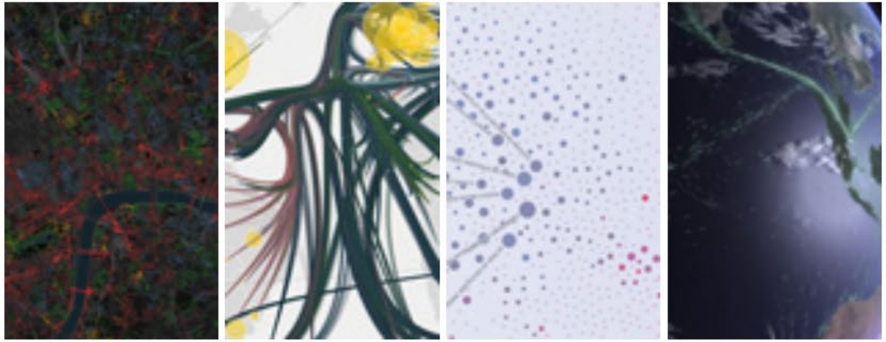


Megaregions of the US –Garrett Dash Nelson and Alasdair Rae – 2016

Smelly Maps – Daniele Quercia, Rossano Schifanella, and Luca Maria Aiello – 2015

Iteration XII (2016)

Macroscopes for Making Sense of Science

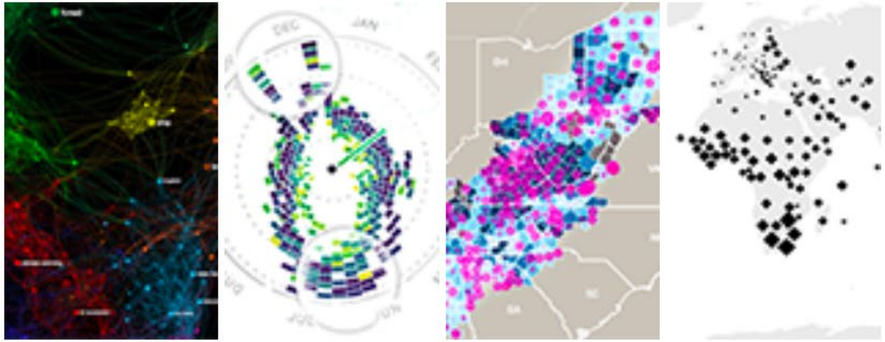


Iteration XIII (2017)

Macroscopes for Playing with Scale

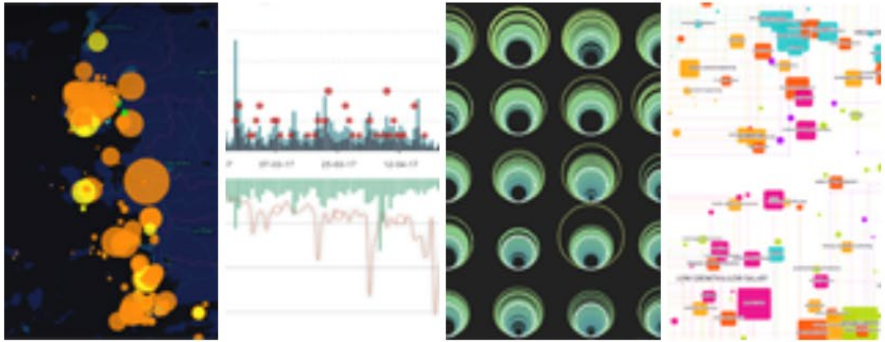
Iteration XIV (2018)

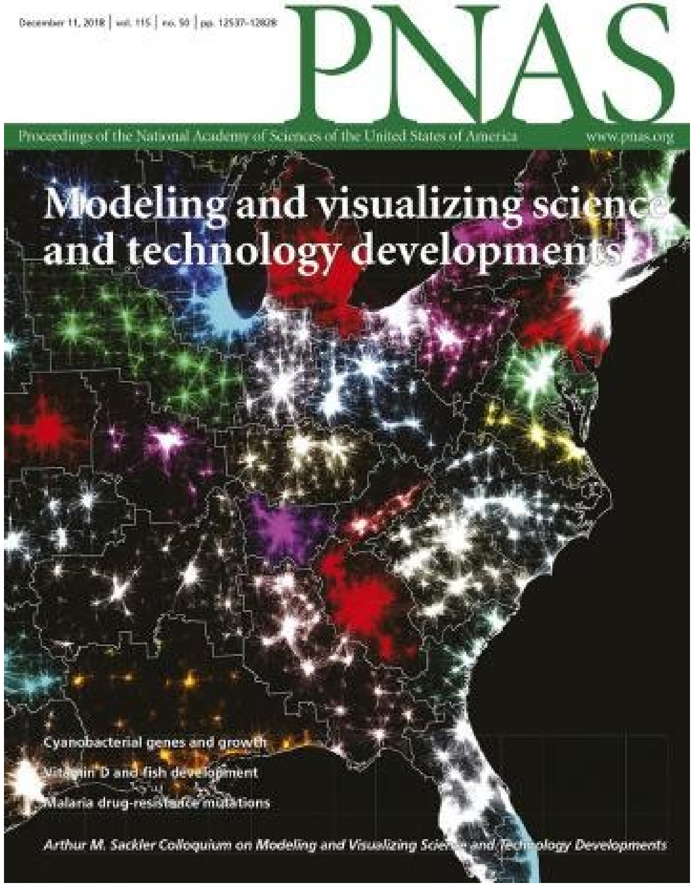
Macroscopes for Ensuring our Well-being

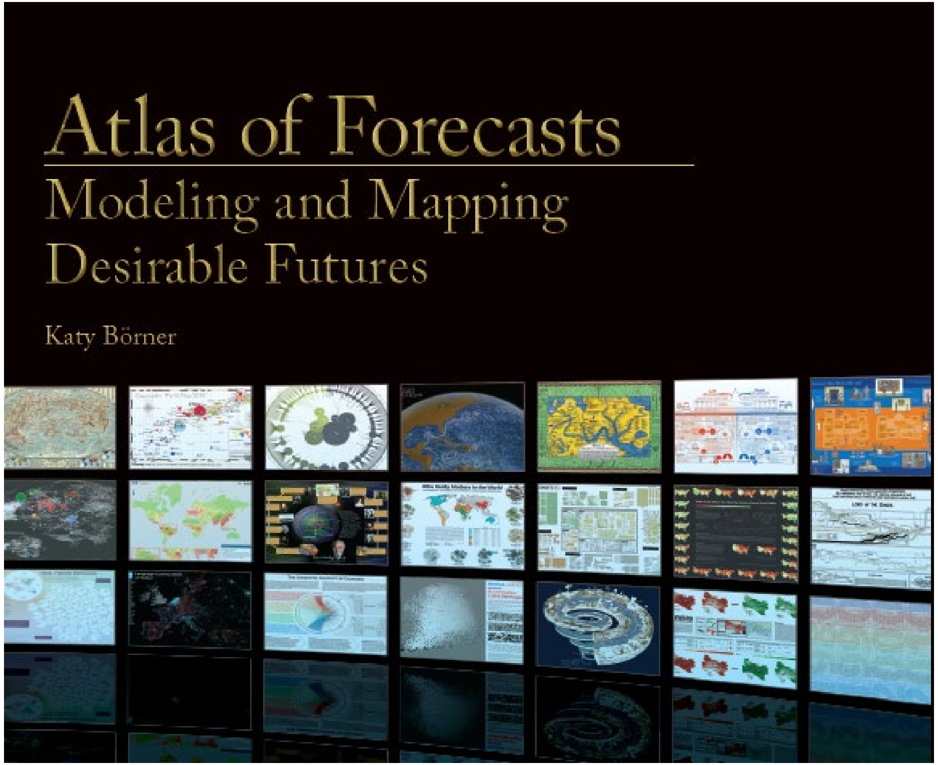


Iteration XV (2019)

Macroscopes for Tracking the Flow of Resources







https://www.pnas.org/modeling

https://mitpress.mit.edu/books/atlas-forecasts

Acknowledgments

Exhibit Curators

The exhibit team: Lisel Record, Katy Börner, and Todd Theriault.

http://scimaps.org

Plus, we thank the more than 250 authors of the 100 maps and 16 interactive macroscopes.

Exhibit Advisory Board

Gary Berg-Cross
Cognitive psychologist (PhD, SUNY-Stony Brook). Potomac, MD, USA

Donna J. Cox, MFA, Ph.D.
Director of the Advanced Visualization Laboratory at the National Center for Supercomputing Applications, University of Illinois at Urbana-Champaign, IL, USA

Bonnie DeVarco
Media X Distinguished Visiting Scholar at Stanford University, Palo Alto, CA, USA

Peter A. Hook
Head of Digital and Scholarly Services and LawArXiv Administrator, Cornell Law Library. Ithaca, NY, USA

Francis Harvey
Professor of Visual Communication in Geography at the Liebnitz Institute for Regional Geography, Leipzig University, Germany

Lev Manovich
Professor, The Graduate Center, City University of New York; Director, Software Studies Initiative (big data, digital humanities, visualization)

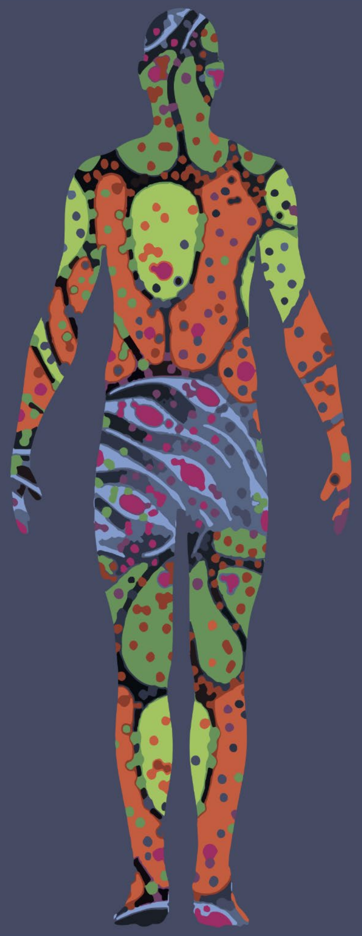
André Skupin
Associate Professor of Geography at San Diego State University, California

Moritz Stefaner
Freelance designer on the crossroads of data visualization, information aesthetics, and user interface design in Germany

Olga Subirós
Curator of Big Bang Data and Founder of Olga Subirós Studio in Barcelona, Spain

Stephen Uzzo
Vice President of Science and Technology for the New York Hall of Science

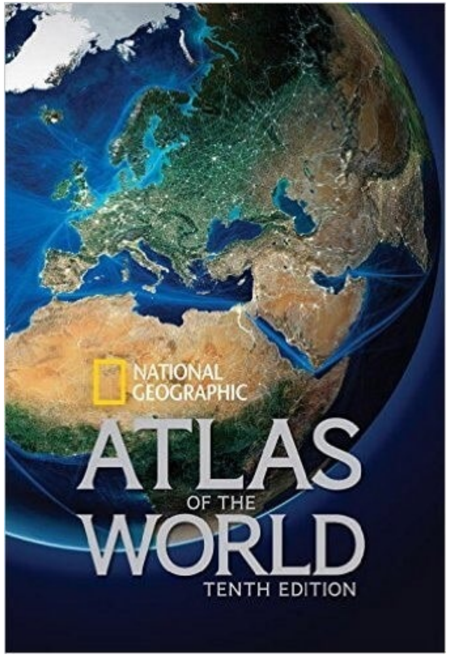
Benjamin Wiederkehr
Founding Partner and Managing Director of Interactive Things in Zürich, Switzerland

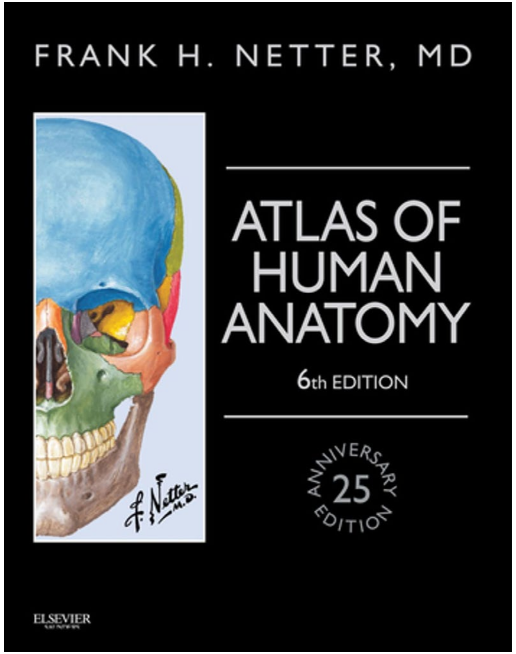


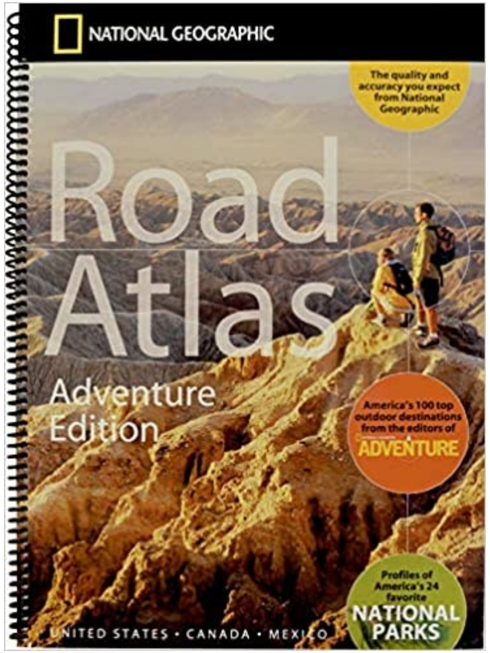
HuBMAP Reference Atlas:
Toward a human [reference] map

An **atlas** is an oversized, bound book of maps.

It has descriptive text, an index, possibly other data visualizations.







An human cell **atlas** might show a landscape of all cells, or

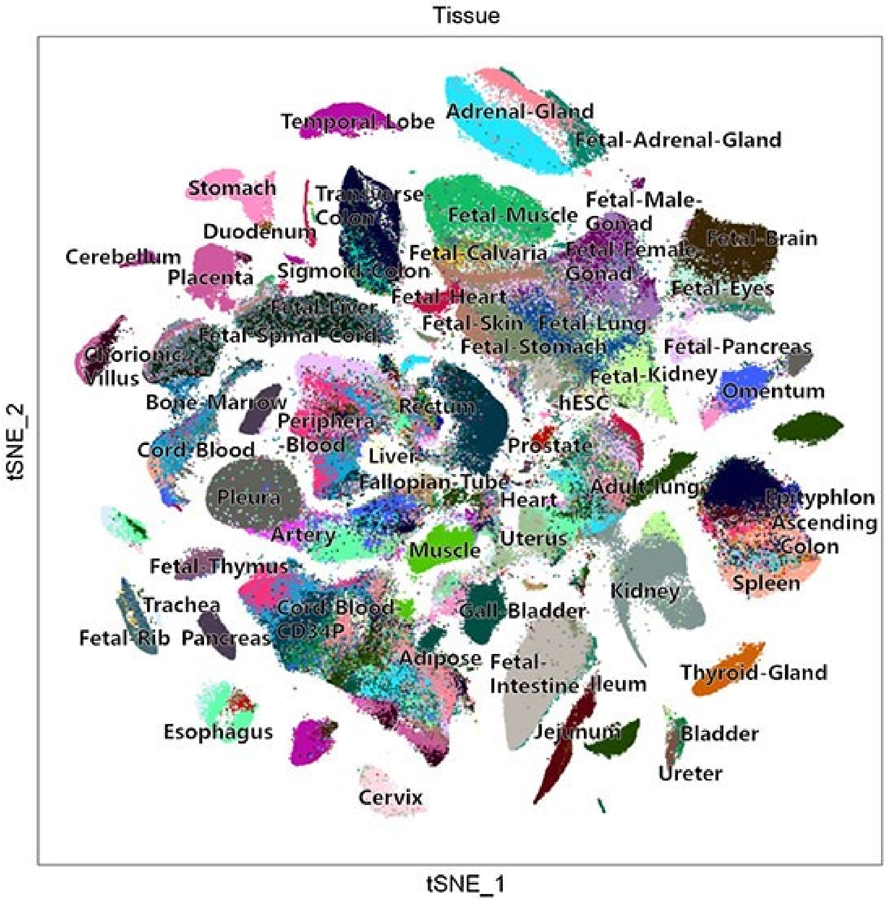
Maps of cells per tissue type/anatomical structure.

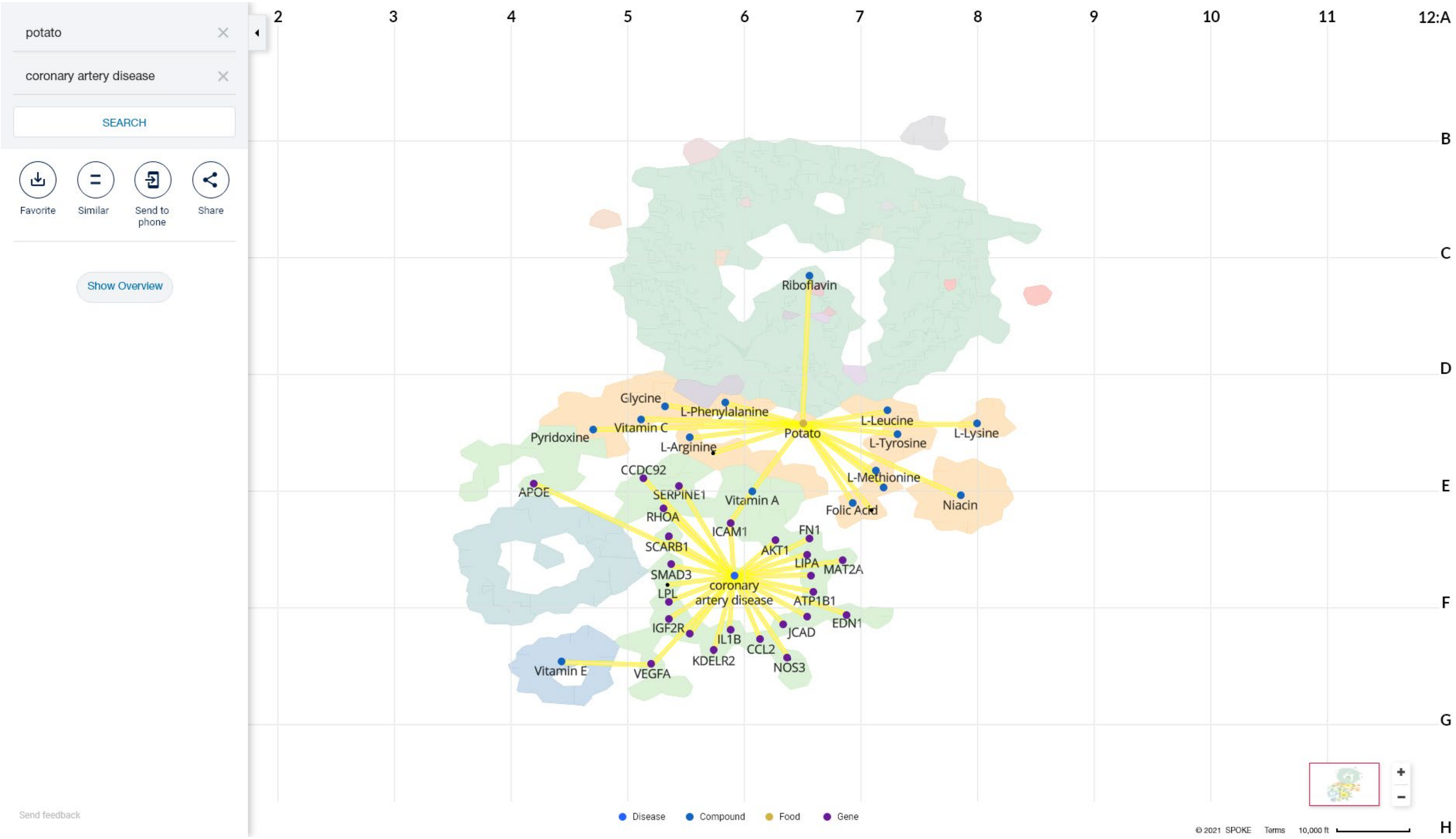
Article | Published: 25 March 2020

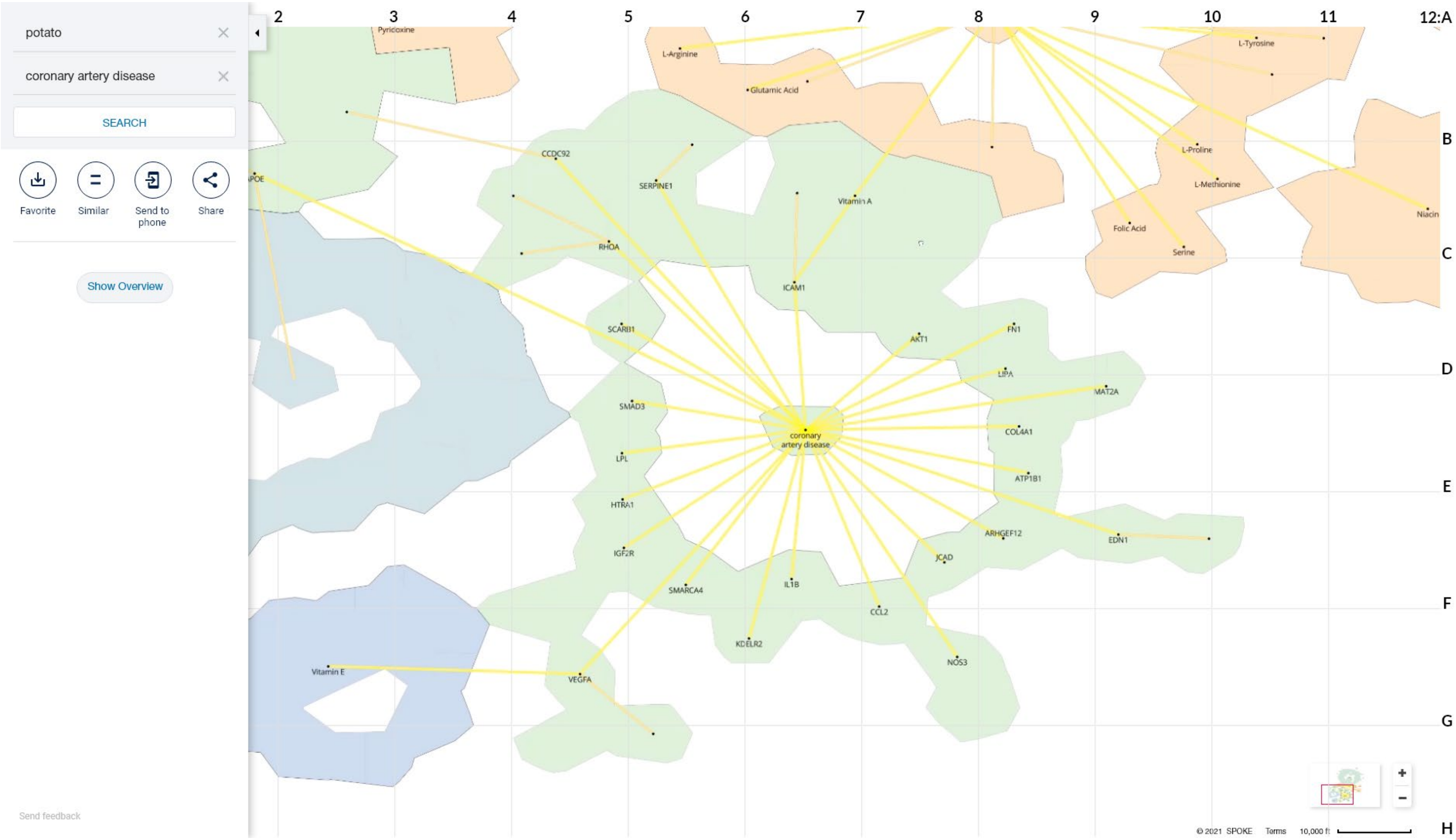
Construction of a human cell landscape at single-cell level

Xiaoping Han, Ziming Zhou, [...] Guoji Guo

Nature **581**, 303–309(2020) | Cite this article

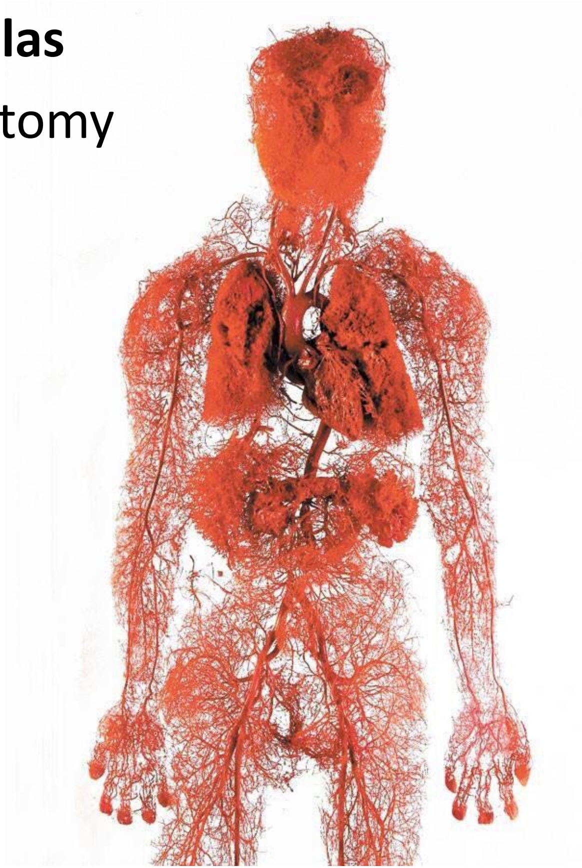



potato
coronary artery disease
SEARCH
Favorite
Similar
Send to phone
Share
Show Overview
Send feedback
2
3
4
5
6
7
8
9
10
11
12:A
B
C
D
E
F
G
H
Riboflavin
Glycine
L-Phenylalanine
Vitamin C
Pyridoxine
L-Arginine
Potato
L-Leucine
L-Lysine
L-Tyrosine
L-Methionine
Niacin
Folic Acid
Vitamin A
CCDC92
APOE
SERPINE1
RHOA
ICAM1
FN1
AKT1
SCARB1
LIPA
MAT2A
SMAD3
coronary artery disease
LPL
ATP1B1
EDN1
IGF2R
JCAD
IL1B
CCL2
KDELR2
NOS3
Vitamin E
VEGFA
Disease
Compound
Food
Gene
© 2021 SPOKE
Terms
10,000 ft

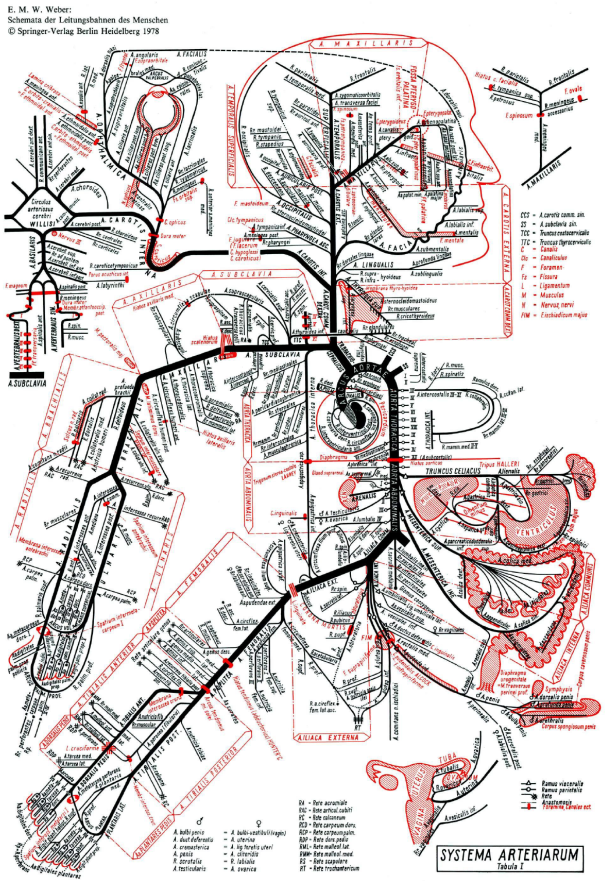

potato
coronary artery disease
SEARCH
Favorite
Similar
Send to phone
Share
Show Overview
Send feedback
2
3
4
5
6
7
8
9
10
11
12:A
B
C
D
E
F
G
H
Pyridoxine
L-Arginine
Glutamic Acid
L-Tyrosine
L-Proline
L-Methionine
Niacin
Folic Acid
Serine
CCDC92
SERPINE1
Vitamin A
APOE
RHOA
ICAM1
SCARB1
AKT1
FN1
LIPA
MAT2A
SMAD3
coronary artery disease
COL4A1
LPL
ATP1B1
HTRA1
ARHGEF12
EDN1
IGF2R
JCAD
SMARCA4
IL1B
CCL2
KDELR2
NOS3
Vitamin E
VEGFA
© 2021 SPOKE
Terms
10,000 ft

A human reference **atlas** might use human anatomy as a ‘basemap,’ or

an abstract space.



https://bodyworlds.com



Weber, 1978

The Human Body at Cellular Resolution: The NIH Human Biomolecular Atlas Program. Snyder et al. *Nature*. 574, p. 187-192.

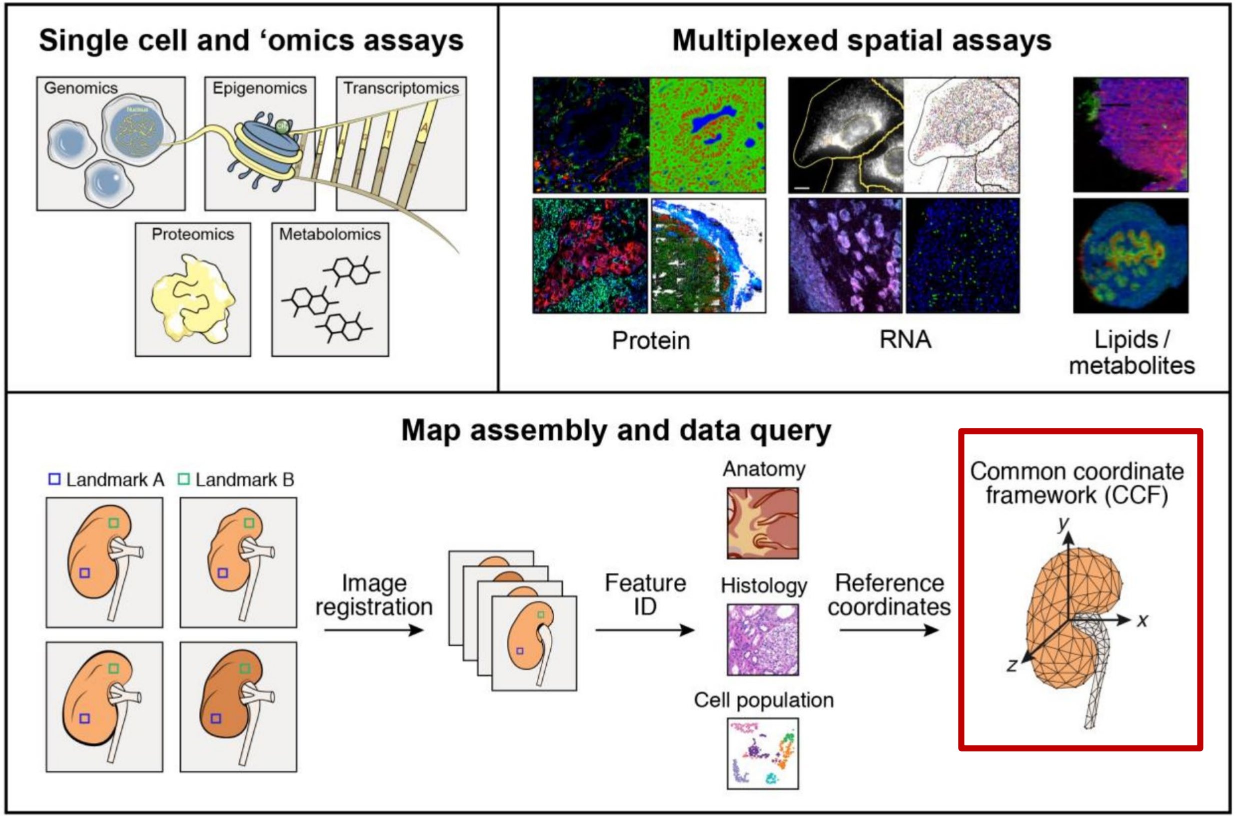
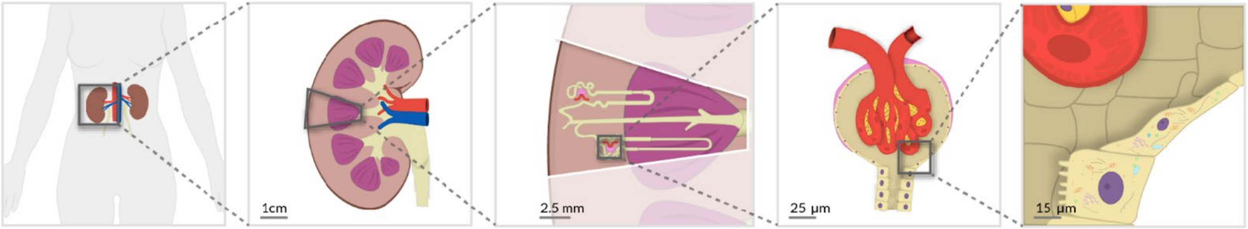


Fig. 3 | Map generation and assembly across cellular and spatial scales. HuBMAP aims to produce an atlas in which users can refer to a histological slide from a specific part of an organ and, in any given cell, understand its contents on multiple 'omic levels—genomic, epigenomic, transcriptomic, proteomic, and/or metabolomic. To achieve these ends, centres will apply a combination of imaging, 'omics and mass spectrometry techniques to specimens collected in a reproducible manner from specific sites in the body. These data will be then be integrated to arrive at a high-resolution, high-content three-dimensional map for any given tissue. To ensure inter-individual differences will not be confounded with collection heterogeneity, a robust CCF will be developed.

CCF Requirements

The CCF must capture major **anatomical structures, cell types, and biomarkers** and their interrelations across **multiple levels of resolution**.

It should be **semantically explicit** (using existing ontologies, e.g., Uberon, CL) and **spatially explicit** (e.g., using 3D reference organs for registration and exploration).



Body
- Body
- Kidney (Left, Right)
- Aorta
- Renal artery
- Renal vein
- Ureter

Organ
- Renal capsule
- Renal pyramid
- Renal cortex
- Renal medulla
- Renal calyx
- Renal pelvis

Functional Tissue Unit
- Nephron
- Renal corpuscle
- Proximal convoluted tubule
- Loop of Henle
- Distal convoluted tubule
- Connecting tubule
- Collecting duct

FTU Sub-structure(s)
- Bowman's capsule
- Glomerulus
- Efferent arteriole
- Afferent arteriole

Cellular
- Parietal epithelial cell
- Capillary endothelial cell
- Mesangial cell
- Podocyte

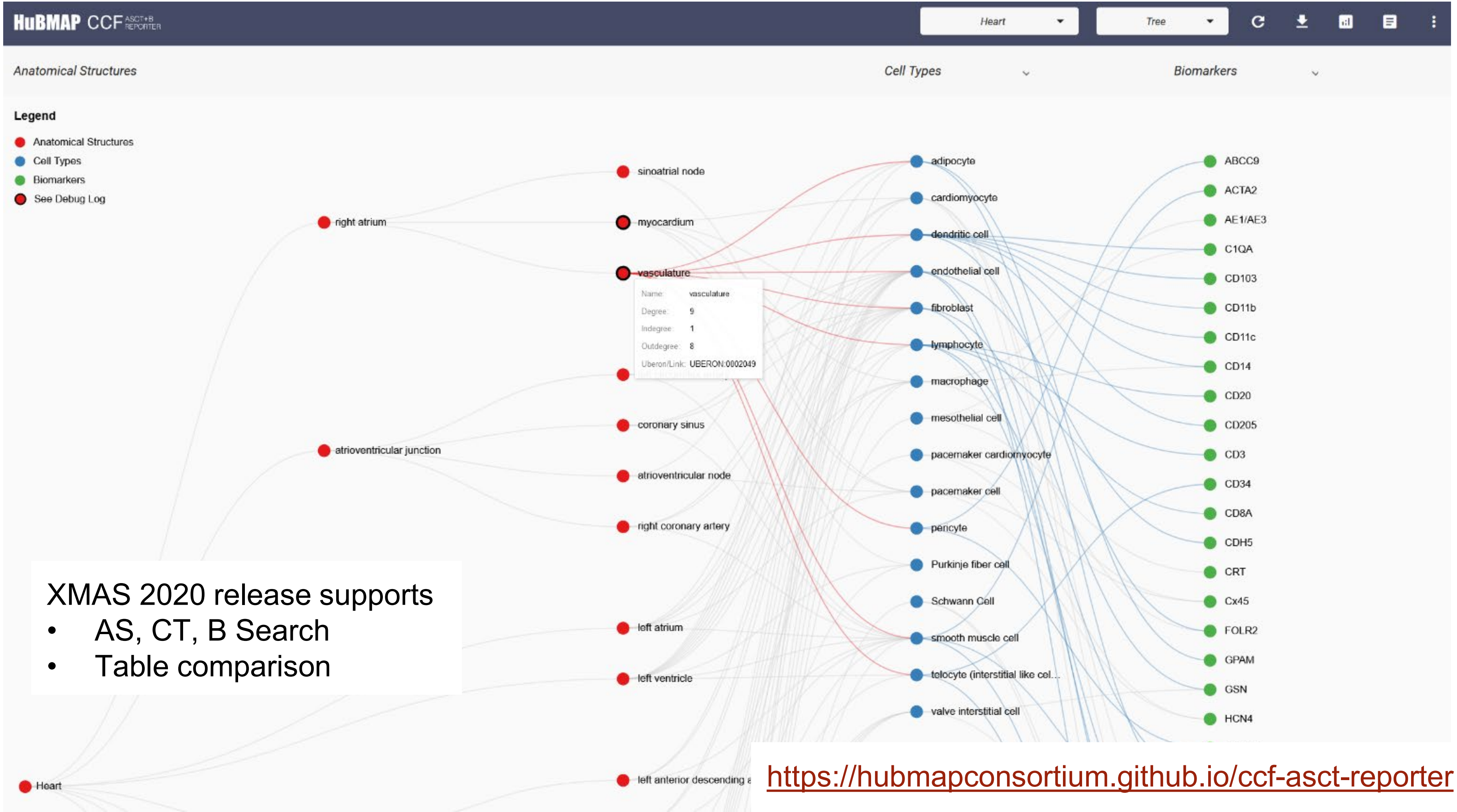
ASCT+B Tables

Anatomical Structures, Cell Types, and Biomarkers (ASCT+B) tables aim to capture the partonomy of anatomical structures, cell types, and major biomarkers (e.g., gene, protein, lipid or metabolic markers).

Structure/Region	**Substructure/Subregion**	**Cell Type**	**Subset of Marker Genes**
Renal Corpuscle	Bowman's Capsule	Parietal epithelial cell	*CRB2*, CLDN1**
	Glomerulus	Podocyte	*NPHS2*, PODXL*, NPHS1**
		Capillary Endothelial Cell	*EHD3*, EMCN*, HECW2*, FLT1*, AQP1**
		Mesangial Cell	*POSTN*, PIEZO2*, ROBO1*, ITGA8**

Partial ASCT+B Table from

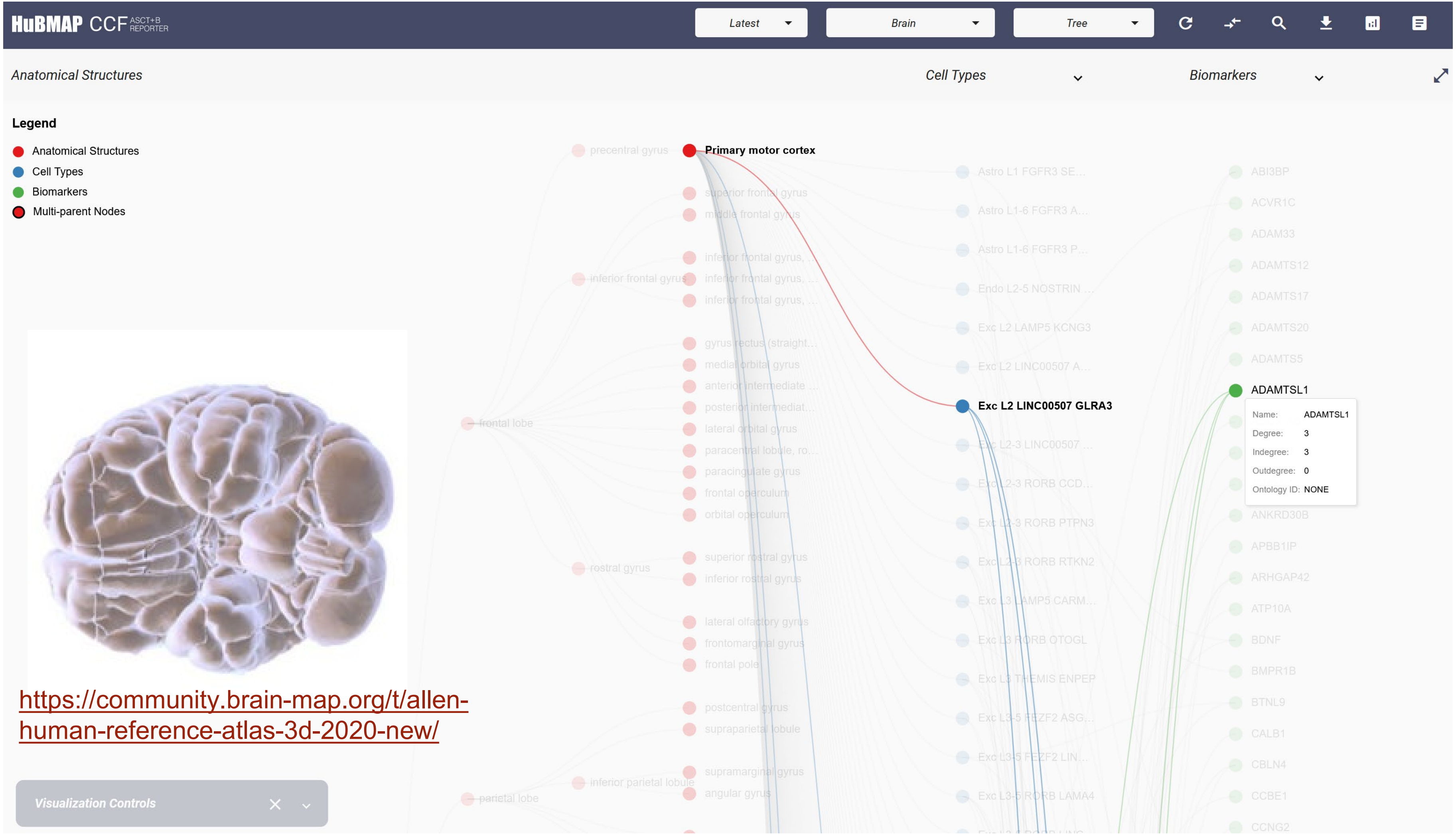
- El-Achkar et al. A Multimodal and Integrated Approach to Interrogate Human Kidney Biopsies with Rigor and Reproducibility: The Kidney Precision Medicine Project. bioRxiv. 2019, Updated Aug 2020. doi:10.1101/828665



XMAS 2020 release supports

- AS, CT, B Search
- Table comparison

https://hubmapconsortium.github.io/ccf-asct-reporter



https://community.brain-map.org/t/allen-human-reference-atlas-3d-2020-new/

ASCT+B Tables vs. 3D Reference Organs

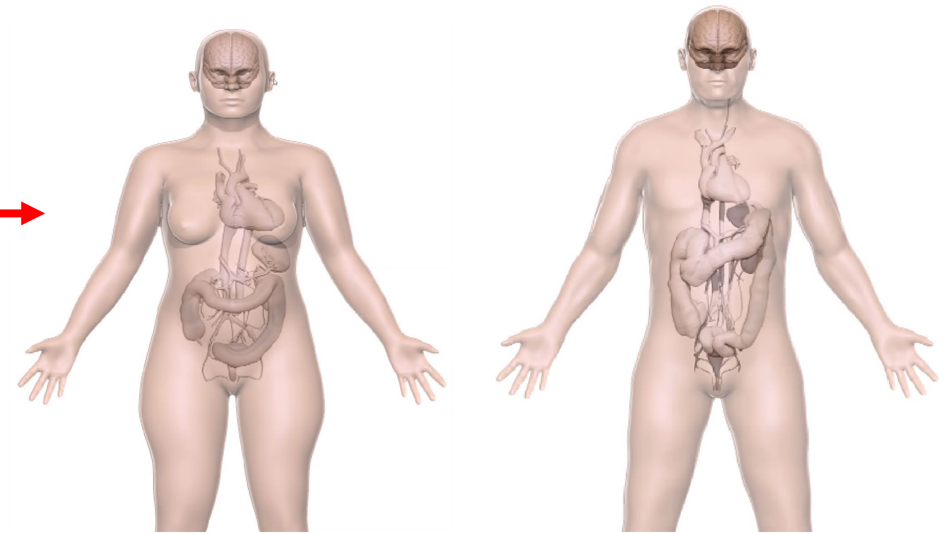
ASCT+B for 10 organs on 11/30/2020, 5:37pm ET:

Organ	#AS	#CT	#B	#AS-CT	#CT-B
Brain	184	127	254	127	346
Heart	23	16	35	73	42
Kidney	39	53	83	63	131
Large Intestine	22	33	45	306	72
Liver	16	27	34	29	35
Lung	18	62	103	110	128
Lymph nodes	34	30	50	63	110
Skin	14	32	57	37	99
Small Intestine	20	32	48	195	55
Spleen	33	26	46	48	72

Vasculature 751

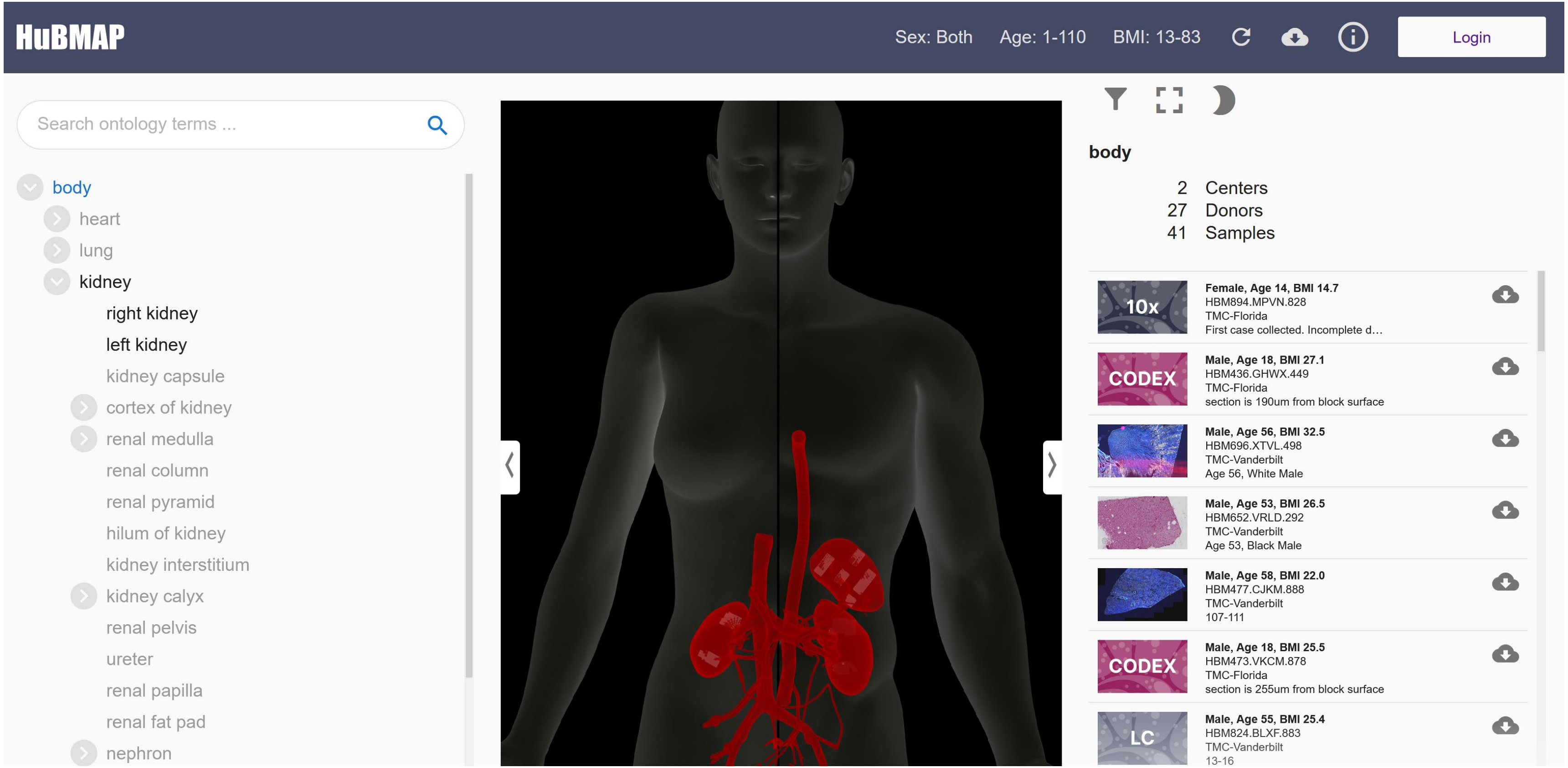
https://hubmapconsortium.github.io/ccf/pages/ccf-anatomical-structures.html

Female *Male*



https://hubmapconsortium.github.io/ccf/pages/ccf-3d-reference-library.html (NLM VH organs)
https://community.brain-map.org/t/allen-human-reference-atlas-3d-2020-new/ (brain)
https://www3.cs.stonybrook.edu/~ari/ (male colon)

CCF Exploration User Interface (EUI)



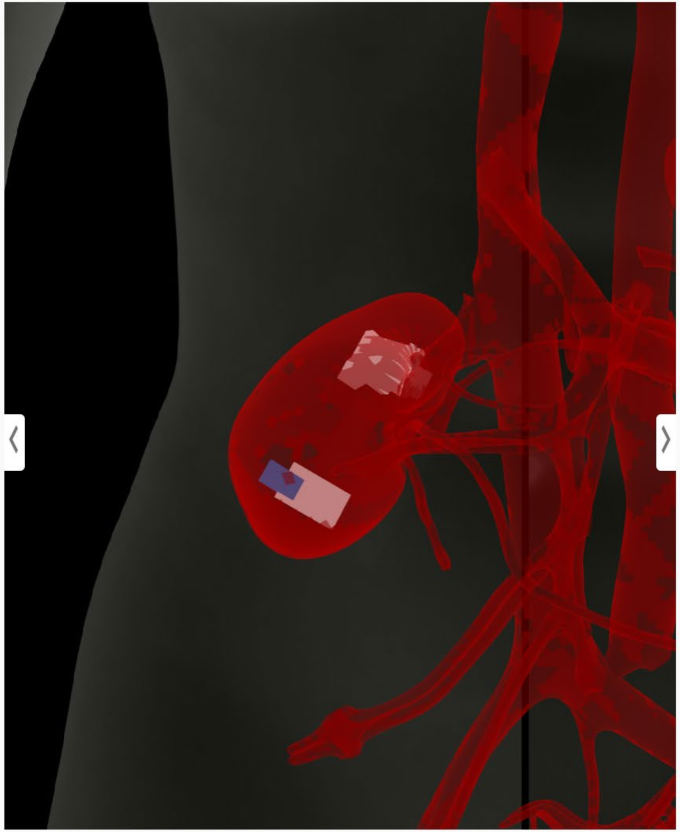
https://portal.hubmapconsortium.org/ccf-eui

HuBMAP

Sex: Both | Age: 1-110 | BMI: 13-83 | Logout

Search ontology terms ...

- body
  - heart
  - lung
  - kidney
    - right kidney
    - left kidney
    - kidney capsule
    - cortex of kidney
    - renal medulla
    - renal column
    - renal pyramid
    - hilum of kidney
    - kidney interstitium
    - kidney calyx
      - major calyx
      - minor calyx
    - renal pelvis
    - ureter
    - renal papilla
    - renal fat pad
    - nephron
  - spleen
  - colon



body

1 Centers
9 Donors
40 Samples

Male, Age 55, BMI 25.4
HBM695.RTLJ.484
TMC-Vanderbilt
13-16

Male, Age 21, BMI 21.8
HBM634.MMGK.572
TMC-Vanderbilt
Age 21 , White Male, Trauma Patient

Female, Age 44, BMI 28.0
HBM457.NNQN.252
TMC-Vanderbilt
Age 44, white female.

Female, Age 44, BMI 28.0
HBM465.VKHL.532
TMC-Vanderbilt
Age 44, white female.

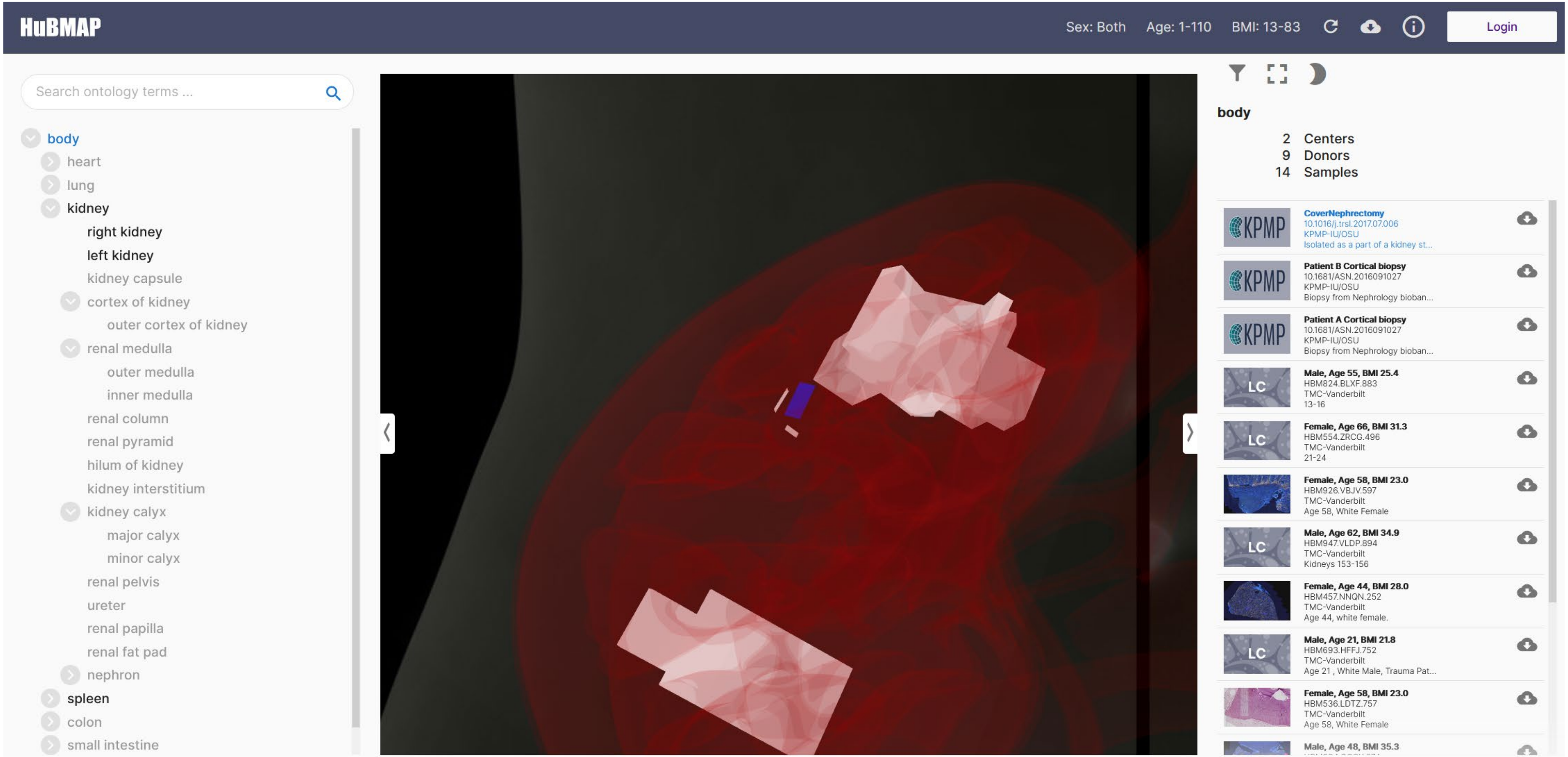
LC
Male, Age 21, BMI 21.8
HBM693.HFFJ.752
TMC-Vanderbilt
Age 21 , White Male, Trauma Patient

Female, Age 58, BMI 23.0
HBM536.LDTZ.757
TMC-Vanderbilt
Age 58, White Female

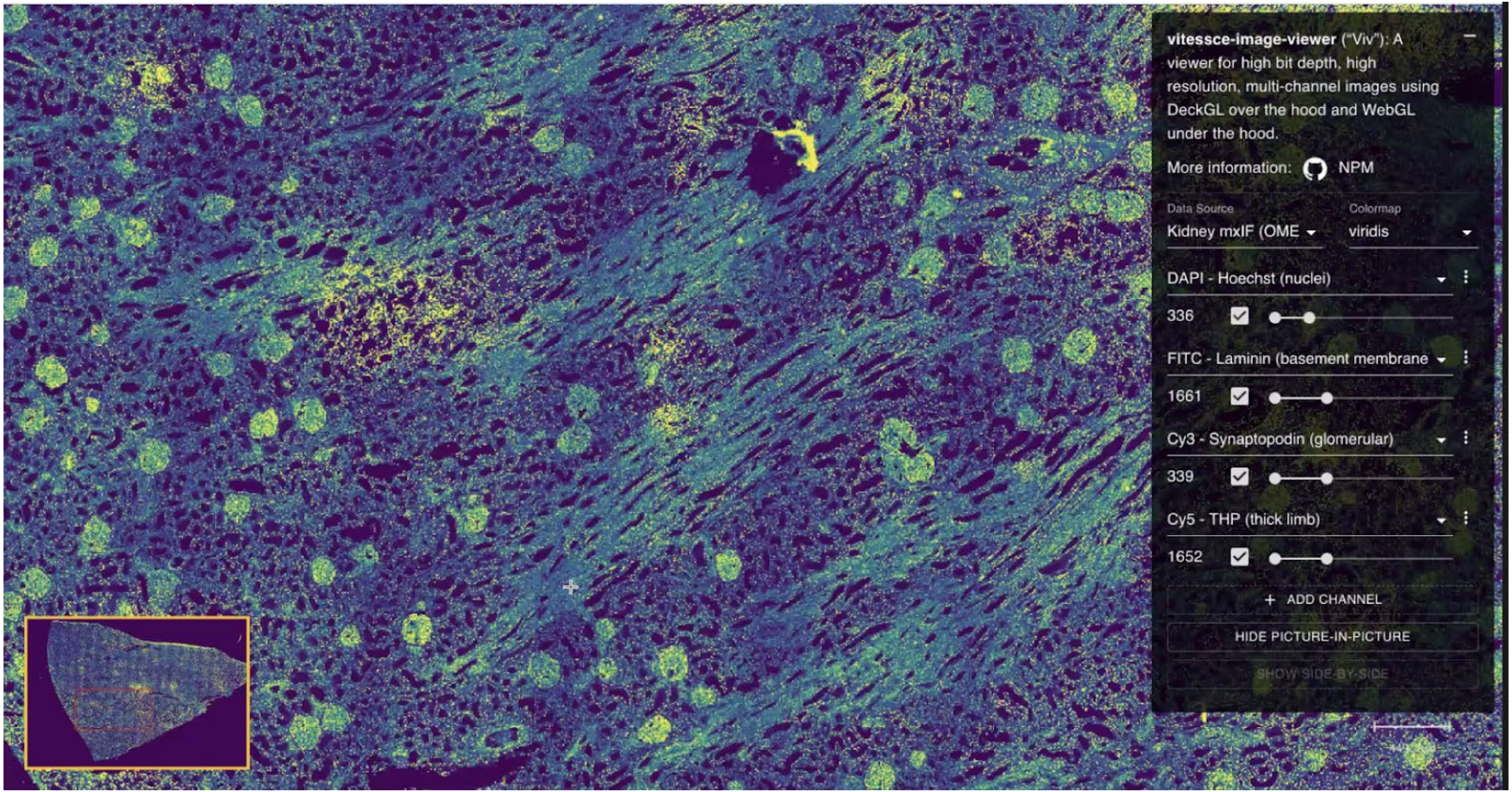
Male, Age 48, BMI 35.3
HBM334.GCCX.874
TMC-Vanderbilt
Age 48, White Male

Male, Age 31, BMI 32.6
HBM776.PKJF.786
TMC-Vanderbilt
Age 21, White Male

Female, Age 66, BMI 31.3
HBM284.TRCV.726



Register your data via https://hubmap-ccf-ui.netlify.app/rui/ so it can be spatially/semantically explored in EUI.



http://gehlenborglab.org/research/projects/vitessce/

Acknowledgements

HuBMAP Consortium (https://hubmapconsortium.org)

Thanks go to all the **patients** that agreed to volunteer healthy tissue and open use of their data.

NIH National Institutes of Health

Opportunity Pool Awardee
KIDNEY PRECISION MEDICINE PROJECT
kpmp.org

NSF

TMCs

Jeffrey Spraggins
TMC-Vanderbilt
Vanderbilt University

Sanjay Jain
TMC-UCSD
Washington University, St. Louis

Clive Wasserfall
TMC-UFL
University of Florida

Marda Jorgensen
TMC-UFL
University of Florida

3D Models

Kristen Browne
Medical Imaging and 3D Modeling Specialist
NIAID

MC-IU HIVE Team

Katy Börner
MC-IU PI
CNS Director

Griffin Weber
Assoc. Professor of Medicine
Harvard Medical School

Lisel Record
MC-IU PM
CNS Associate Director

Bruce Herr II
Sr. Systems Architect/PM

Ellen Quardokus
Sr. Research Analyst

Yingnan Ju
PhD Candidate

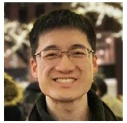
Andreas Bueckle
PhD Candidate

Leonard Cross
Sr. UX/UI Designer

Matthew Martindale
Center Assistant

Daniel Bolin
Software Developer

Adam Phillips
Software Developer



Edward Lu
Software Developer

Paul Hrishikesh
Research Assistant

Leah Scherschel
Research Assistant

Avinash Boppana
Research Consultant

Yashvardhan Jain
Research Assistant

Kasturi Nikharge
Software Developer

References

Börner, Katy, Chen, Chaomei, and Boyack, Kevin. (2003). **Visualizing Knowledge Domains.** In Blaise Cronin (Ed.), *ARIST*, Medford, NJ: Information Today, Volume 37, Chapter 5, pp. 179-255. http://ivl.slis.indiana.edu/km/pub/2003-borner-arist.pdf

Shiffrin, Richard M. and Börner, Katy (Eds.) (2004). **Mapping Knowledge Domains**. *Proceedings of the National Academy of Sciences of the United States of America*, 101(Suppl_1). http://www.pnas.org/content/vol101/suppl_1

Börner, Katy (2010) **Atlas of Science: Visualizing What We Know**. The MIT Press. http://scimaps.org/atlas

Scharnhorst, Andrea, Börner, Katy, van den Besselaar, Peter (2012) **Models of Science Dynamics**. Springer Verlag.

Katy Börner, Michael Conlon, Jon Corson-Rikert, Cornell, Ying Ding (2012) **VIVO: A Semantic Approach to Scholarly Networking and Discovery**. Morgan & Claypool.

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

Börner, Katy (2015) **Atlas of Knowledge: Anyone Can Map**. The MIT Press. http://scimaps.org/atlas2

Börner, Katy (2021) **Atlas of Forecasts: Modeling and Mapping Desirable Futures**. The MIT Press.

Q&A