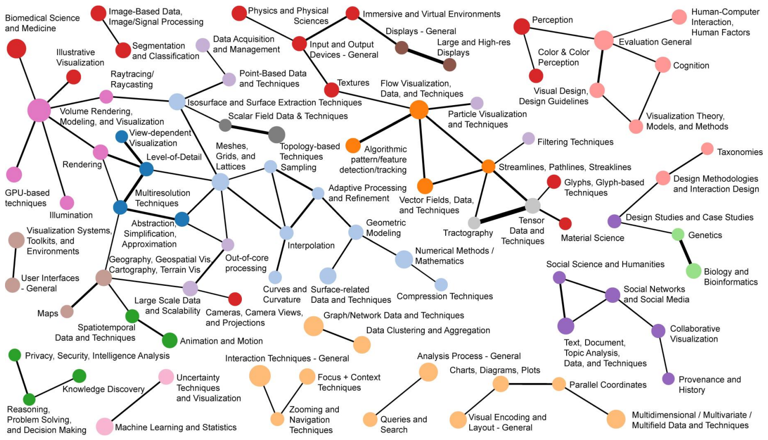
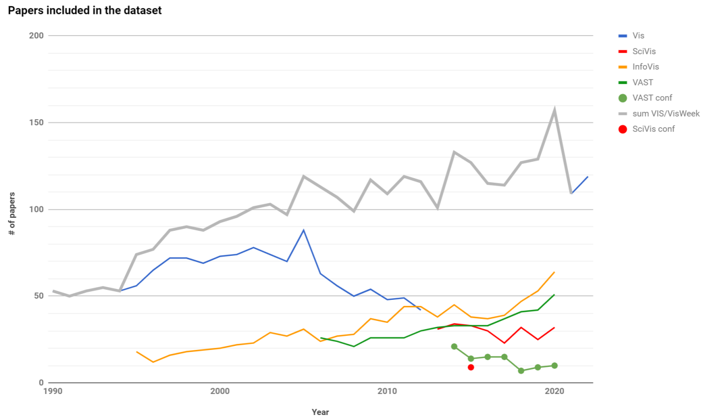
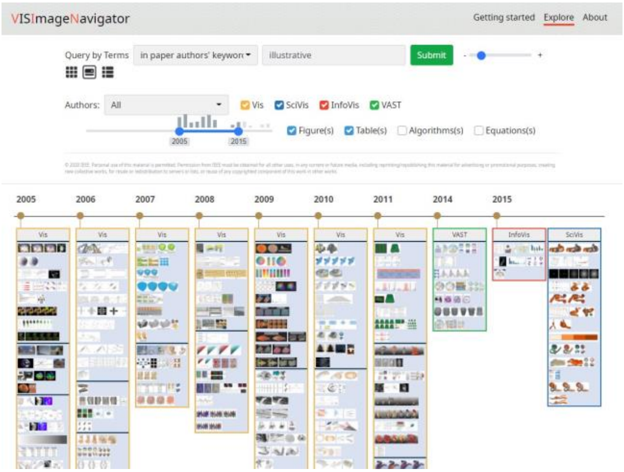






Toward FAIR Visualization of Visualization Research

Tobias Isenberg

Inria informatics mathematics

FAIR Guiding Principles …

- FAIR principles for scientific data management & stewardship [Wilkinson et al., 2016; doi: 10/bdd4]
  - Findable
  - Accessible
  - Interoperable
  - Reproducible

- for both humans and machines


www.nature.com/scientificdata

SCIENTIFIC DATA

Amended: Addendum

OPEN

SUBJECT CATEGORIES
» Research data
» Publication characteristics

Comment: The FAIR Guiding Principles for scientific data management and stewardship

Mark D. Wilkinson et al.#

Received: 10 December 2015
Accepted: 12 February 2016
Published: 15 March 2016

There is an urgent need to improve the infrastructure supporting the reuse of scholarly data. A diverse set of stakeholders—representing academia, industry, funding agencies, and scholarly publishers—have come together to design and jointly endorse a concise and measureable set of principles that we refer to as the FAIR Data Principles. The intent is that these may act as a guideline for those wishing to enhance the reusability of their data holdings. Distinct from peer initiatives that focus on the human scholar, the FAIR Principles put specific emphasis on enhancing the ability of machines to automatically find and use the data, in addition to supporting its reuse by individuals. This Comment is the first formal publication of the FAIR Principles, and includes the rationale behind them, and some exemplar implementations in the community.

Supporting discovery through good data management

Good data management is not a goal in itself, but rather is the key conduit leading to knowledge discovery and innovation, and to subsequent data and knowledge integration and reuse by the community after the data publication process. Unfortunately, the existing digital ecosystem surrounding scholarly data publication prevents us from extracting maximum benefit from our research investments (e.g., ref. 1). Partially in response to this, science funders, publishers and governmental agencies are beginning to require data management and stewardship plans for data generated in publicly funded experiments. Beyond proper collection, annotation, and archival, data stewardship includes the notion of 'long-term care' of valuable digital assets, with the goal that they should be discovered and re-used for downstream investigations, either alone, or in combination with newly generated data. The outcomes from good data management and stewardship, therefore, are high quality digital publications that facilitate and simplify this ongoing process of discovery, evaluation, and reuse in downstream studies. What constitutes 'good data management' is, however, largely undefined, and is generally left as a decision for the data or repository owner. Therefore, bringing some clarity around the goals and desiderata of good data management and stewardship, and defining simple guideposts to inform those who publish and/or preserve scholarly data, would be of great utility.

This article describes four foundational principles—Findability, Accessibility, Interoperability, and Reusability—that serve to guide data producers and publishers as they navigate around these obstacles, thereby helping to maximize the added-value gained by contemporary, formal scholarly digital publishing. Importantly, it is our intent that the principles apply not only to 'data' in the conventional sense, but also to the algorithms, tools, and workflows that led to that data. All scholarly digital research objects[2]—from data to analytical pipelines—benefit from application of these principles, since all components of the research process must be available to ensure transparency, reproducibility, and reusability.

There are numerous and diverse stakeholders who stand to benefit from overcoming these obstacles: researchers wanting to share, get credit, and reuse each other's data and interpretations; professional data publishers offering their services; software and tool-builders providing data analysis and processing services such as reusable workflows; funding agencies (private and public) increasingly

Correspondence and requests for materials should be addressed to B.M. (email: barend.mons@dtls.nl).
#A full list of authors and their affiliations appears at the end of the paper.

… for data and w.r.t. machines?

Box 2 | The FAIR Guiding Principles

To be Findable:
F1. (meta)data are assigned a globally unique and persistent identifier
F2. data are described with rich metadata (defined by R1 below)
F3. metadata clearly and explicitly include the identifier of the data it describes
F4. (meta)data are registered or indexed in a searchable resource

To be Accessible:
A1. (meta)data are retrievable by their identifier using a standardized communications protocol
A1.1 the protocol is open, free, and universally implementable
A1.2 the protocol allows for an authentication and authorization procedure, where necessary
A2. metadata are accessible, even when the data are no longer available

To be Interoperable:
I1. (meta)data use a formal, accessible, shared, and broadly applicable language for knowledge representation.
I2. (meta)data use vocabularies that follow FAIR principles
I3. (meta)data include qualified references to other (meta)data

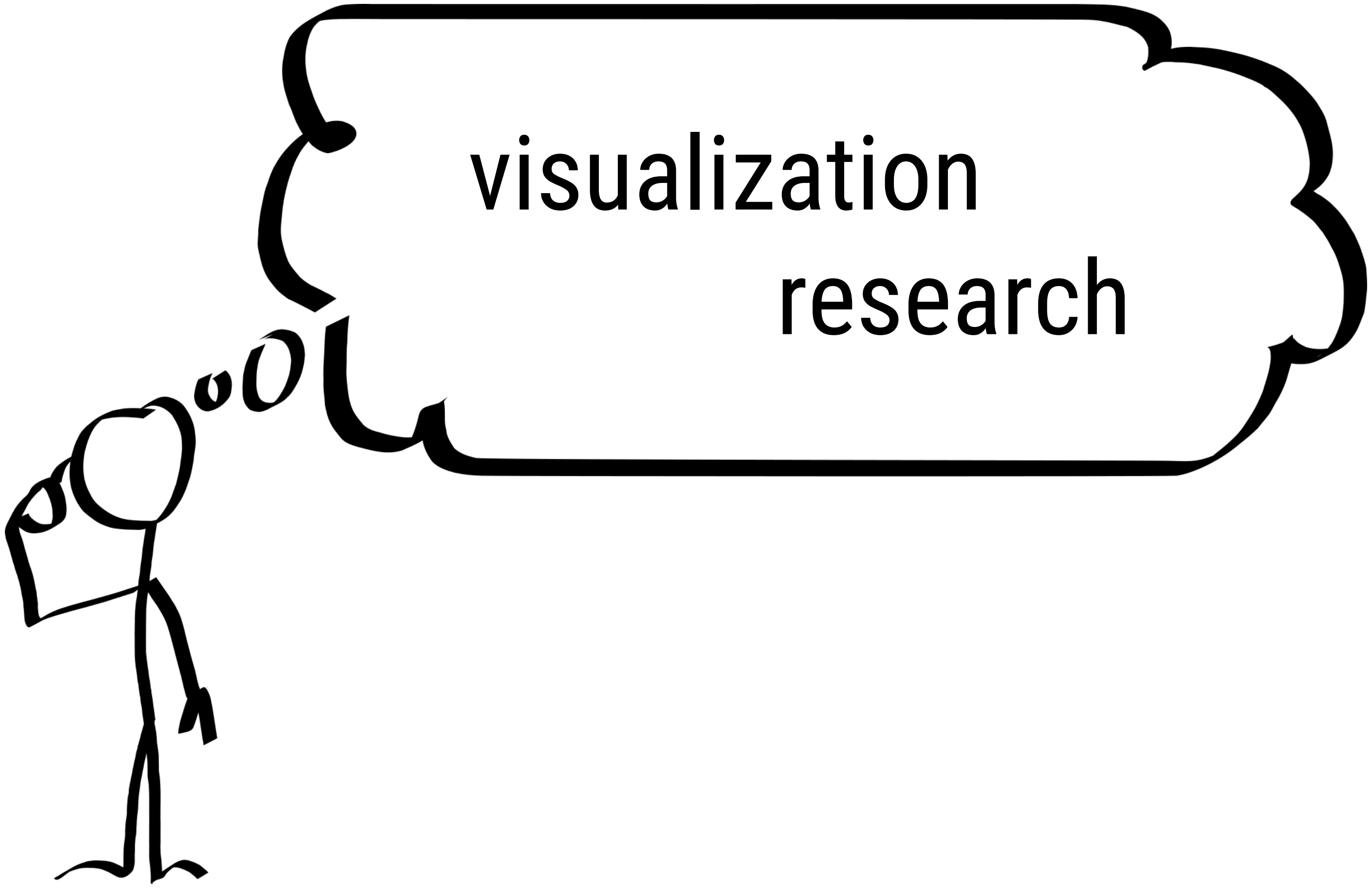
To be Reusable:
R1. meta(data) are richly described with a plurality of accurate and relevant attributes
R1.1. (meta)data are released with a clear and accessible data usage license
R1.2. (meta)data are associated with detailed provenance
R1.3. (meta)data meet domain-relevant community standards

[Wilkinson et al., 2016; doi: 10/bdd4]

… for people who care about VIS research?

"A holistic approach to research data management not only considers FAIRness of data, but extends to ***all*** processes and artifacts used to obtain research results, including visualization and subjecting it to FAIR requirements."

Is visualization work findable?



Is visualization work findable?

VIS 2023

EUROVIS
Leipzig 2023

IEEE
PACIFIC VIS 2023
SEOUL, KOREA

BELIV

CHI23
Hamburg, Germany | Hybrid
April 23-28, 2023
reCHInnecting

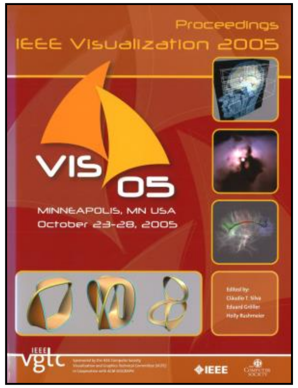
vizsec

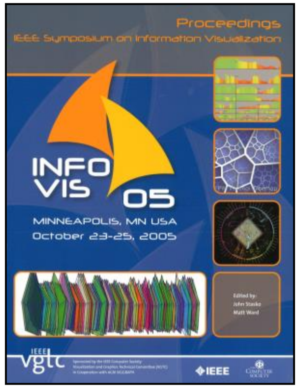
DAV
23

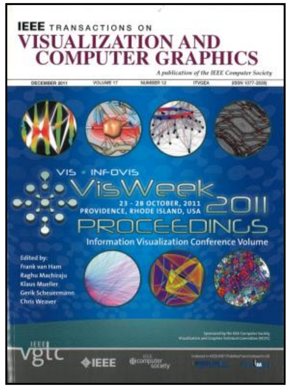
…

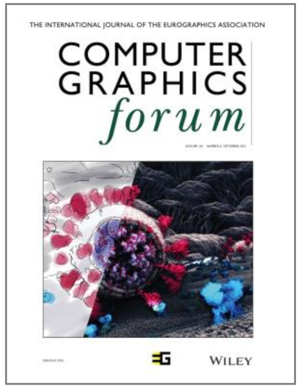
Is visualization work findable?

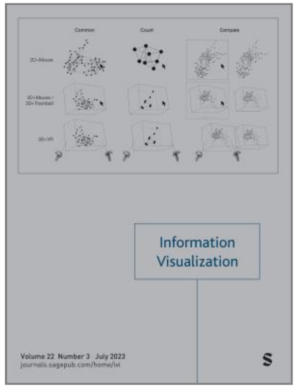
Is visualization work findable?

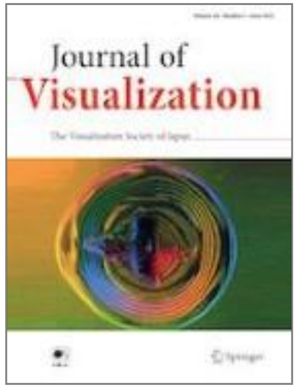


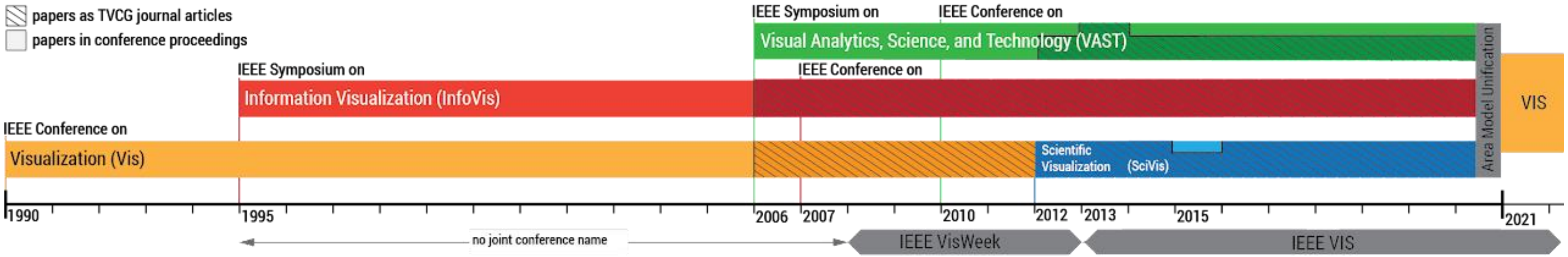












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main contributors: Petra Isenberg, John Stasko, Florian Heimerl, Steffen Koch, Tobias Isenberg, Natkamon Tovanich, Torsten Möller, Michael Sedlmair, Panpan Xu, Charles D. Stolper, Jian Chen; overview paper doi: [10/ggwwrv]

- metadata on all IEEEVis papers from 1990–2016, now updated to 2021
- Google spreadsheet: can be commented, edited, and easily converted
- corrected and complete data: cleaned titles, de-duped authors, DOIs, …

Vis	1990	Surface representations of two- and three-dimensional fluid	10.1109/VISUAL.1990.146359	http://dx.doi.org/10.1109/VISUAL.1990.146359	6	13, 460	C	The use of critical po	James Helman;Lambertus Hesseli	Stanford Univ., CA, USA|c|;	
Vis	1990	FAST: a multi-processed environment for visualization of cc	10.1109/VISUAL.1990.146360	http://dx.doi.org/10.1109/VISUAL.1990.146360	14	27, 461	C	The authors discuss	Gordon V. Bancroft;Fergus Merrit	Sterling Federal Syst. Inc., Palo	
Vis	1990	The VIS-5D system for easy interactive visualization	10.1109/VISUAL.1990.146361	http://dx.doi.org/10.1109/VISUAL.1990.146361	28	35, 462	C	The VIS-5D system p	William L. Hibbard;David A. Sante	Space Sci. & Eng. Center, Wis	
Vis	1990	A procedural interface for volume rendering	10.1109/VISUAL.1990.146362	http://dx.doi.org/10.1109/VISUAL.1990.146362	36	44, 462	C	The author presents	James L. Montine	Alliant Comput. Syst., Littleton,	
Vis	1990	Techniques for the interactive visualization of volumetric dat	10.1109/VISUAL.1990.146363	http://dx.doi.org/10.1109/VISUAL.1990.146363	45	50, 462	C	Some ideas and tech	Gregory M. Nielson;Bernd Hamar	Dept. of Comput. Sci., /	10.110
Vis	1990	Displaying voxel-based objects according to their qualitativ	10.1109/VISUAL.1990.146364	http://dx.doi.org/10.1109/VISUAL.1990.146364	51	58, 463	C	The use of qualitative	Yaser Yacoob	Dept. of Comput. Sci., Marylan	
Vis	1990	Interpreting a 3D object from a rough 2D line drawing	10.1109/VISUAL.1990.146365	http://dx.doi.org/10.1109/VISUAL.1990.146365	59	66	C	Visualizing the third d	Del Lamb;Amit Bandopadhay	Dept. of Comput. Sci., State Ur	
Vis	1990	Animation techniques for chain-coded objects	10.1109/VISUAL.1990.146366	http://dx.doi.org/10.1109/VISUAL.1990.146366	67	73	C	The animation of two	Anthony J. Maeder	Dept. of Comput. Sci., Monash	
Vis	1990	Extracting geometric models through constraint minimizati	10.1109/VISUAL.1990.146367	http://dx.doi.org/10.1109/VISUAL.1990.146367	74	82, 464	C	The authors propose	James V. Miller;David E. Breen;Mi	Rensselaer Design. Res. Cente	
Vis	1990	Wide-band relativistic Doppler effect visualization	10.1109/VISUAL.1990.146368	http://dx.doi.org/10.1109/VISUAL.1990.146368	83	92, 465	C	The authors present	Ping-Kang Hsiung;Robert H. Thiba	Carnegie Mellon Univ., Pittsburg	
Vis	1990	Dynamic [illegible]	[illegible]	[illegible]	[illegible]	[illegible]	C	[illegible]	[illegible]	[illegible] Bell Lab., Murray Hill, NJ,	
Vis	1990	Techniques [illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible] Univ., Bloomington, IN,	
Vis	1990	Visualizing computer memory architectures	10.1109/VISUAL.1990.146371	http://dx.doi.org/10.1109/VISUAL.1990.146371	107	113	C	The authors describe	Bowen Alpern;Larry Carter;Ted Se	IBM Thomas J. Watson Res. C	
Vis	1990	A methodology for scientific data visualisation: choosing re	10.1109/VISUAL.1990.146372	http://dx.doi.org/10.1109/VISUAL.1990.146372	114	123	C	A methodology for gu	Philip K. Robertson	CSIRO, Canberra, ACT, Austral	
Vis	1990	Moving [illegible] objects in [illegible] visualization	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	The idea of independ	G. David Kerlick	[illegible]ektronix Labs., Beaverton, OR	
Vis	1990	Classify[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]ognitive Sci. & Machine Intellig	
Vis	1990	A problem-oriented classification of visualization technique	10.1109/VISUAL.1990.146375	http://dx.doi.org/10.1109/VISUAL.1990.146375	139	143, 46	C	Progress in scientific	Stephen Wehrend;Clayton Lewis	Colorado Univ., Boulder, CO, US	
Vis	1990	Visualization and three-dimensional image processing of p	10.1109/VISUAL.1990.146376	http://dx.doi.org/10.1109/VISUAL.1990.146376	144	149, 46	C	The author applied in	Nahum D. Gershon	MITRE Corp., McLean, VA, USA	
Vis	1990	Applying space subdivision techniques [illegible] volume rendering	[illegible]	[illegible]	150	[illegible]	C	We present a new ra	Kalpathi R. Subramanian;Donald S;		
Vis	1990	Volume [illegible]	[illegible]	[illegible]	160	[illegible]	[illegible]	[illegible]	[illegible]	Dept. of Comput. Sci., State Ur	
Vis	1990	Hierarchical triangulation using terrain features	10.1109/VISUAL.1990.146379	http://dx.doi.org/10.1109/VISUAL.1990.146379	168	175	C	A hierarchical triangu	Lori L. Scarlatos;Theodosios Pavlic	Grumman Data Syst., Woodbur	
Vis	1990	Rendering and managing spherical data with sphere quadtr	10.1109/VISUAL.1990.146380	http://dx.doi.org/10.1109/VISUAL.1990.146380	176	186	C	The sphere quadtree	Gyorgy Fekete	NASA, Goddard Space Flight C	
Vis	1990	Methods for surface interrogation	10.1109/VISUAL.1990.146381	http://dx.doi.org/10.1109/VISUAL.1990.146381	187	193, 47	C	The authors discuss	Hans Hagen;Thomas Schreiber;Er	Kaiserslautern Univ., Germany|	
Vis	1990	A three-dimensional/stereoscopic display and model contr	10.1109/VISUAL.1990.146382	http://dx.doi.org/10.1109/VISUAL.1990.146382	194	201, 47	C	A forecasting system	Chieh-Cheng Yen;Keith W. Bedfor	Dept. of Civil Eng., Ohio State U	
Vis	1990	Spline-based color sequences for univariate, bivariate and t	10.1109/VISUAL.1990.146383	http://dx.doi.org/10.1109/VISUAL.1990.146383	202	208, 47	C	Alternative models th	Binh Pham	Dept. of Comput. Sci., Monash	
Vis	1990	Interactive visualization of quaternion Julia sets	10.1109/VISUAL.1990.146384	http://dx.doi.org/10.1109/VISUAL.1990.146384	209	218, 47	C	The first half of a two	John C. Hart;Louis H. Kauffman;D	Electron. Visualization Lab., Illi	
Vis	1990	A journey into the fourth dimension	10.1109/VISUAL.1990.146385	http://dx.doi.org/10.1109/VISUAL.1990.146385	219	229, 47	C	It is shown that by a	Yan Ke;E. S. Panduranga	Dept. of Comput. Sci., Saskatc	
Vis	1990	Exploring N-dimensional databases	10.1109/VISUAL.1990.146386	http://dx.doi.org/10.1109/VISUAL.1990.146386	230	237	C	The ability of researc	Jeffrey LeBlanc;Matthew O. Ward	Worcester Polytech. Inst., MA,	
Vis	1990	Shape coding of multidimensional data on a microcompute	10.1109/VISUAL.1990.146387	http://dx.doi.org/10.1109/VISUAL.1990.146387	238	246, 47	C	The author presents	Jeff Beddow	Microsimulations Res., Minnea	
Vis	1990	Visualization of irregular multivariate data	10.1109/VISUAL.1990.146388	http://dx.doi.org/10.1109/VISUAL.1990.146388	247	254, 47	C	The authors discuss	Thomas A. Foley;David A. Lane	Dept. of Comput. Sci., /	10.110
Vis	1990	Visualizing a scalar field on an N-dimensional lattice	10.1109/VISUAL.1990.146389	http://dx.doi.org/10.1109/VISUAL.1990.146389	255	262, 47	C	A new hierarchical m	Ted Mihalisin;E. Grawlinksi;John T	Dept. of Phys., Temple Univ., P	
Vis	1990	Ray traced scalar fields with shaded polygonal output	10.1109/VISUAL.1990.146390	http://dx.doi.org/10.1109/VISUAL.1990.146390	263	272, 48	C	An algorithm for rend	Ray J. Meyers;Michael B. Stephen	Sandia Nat. Lab., Albuquerque,	

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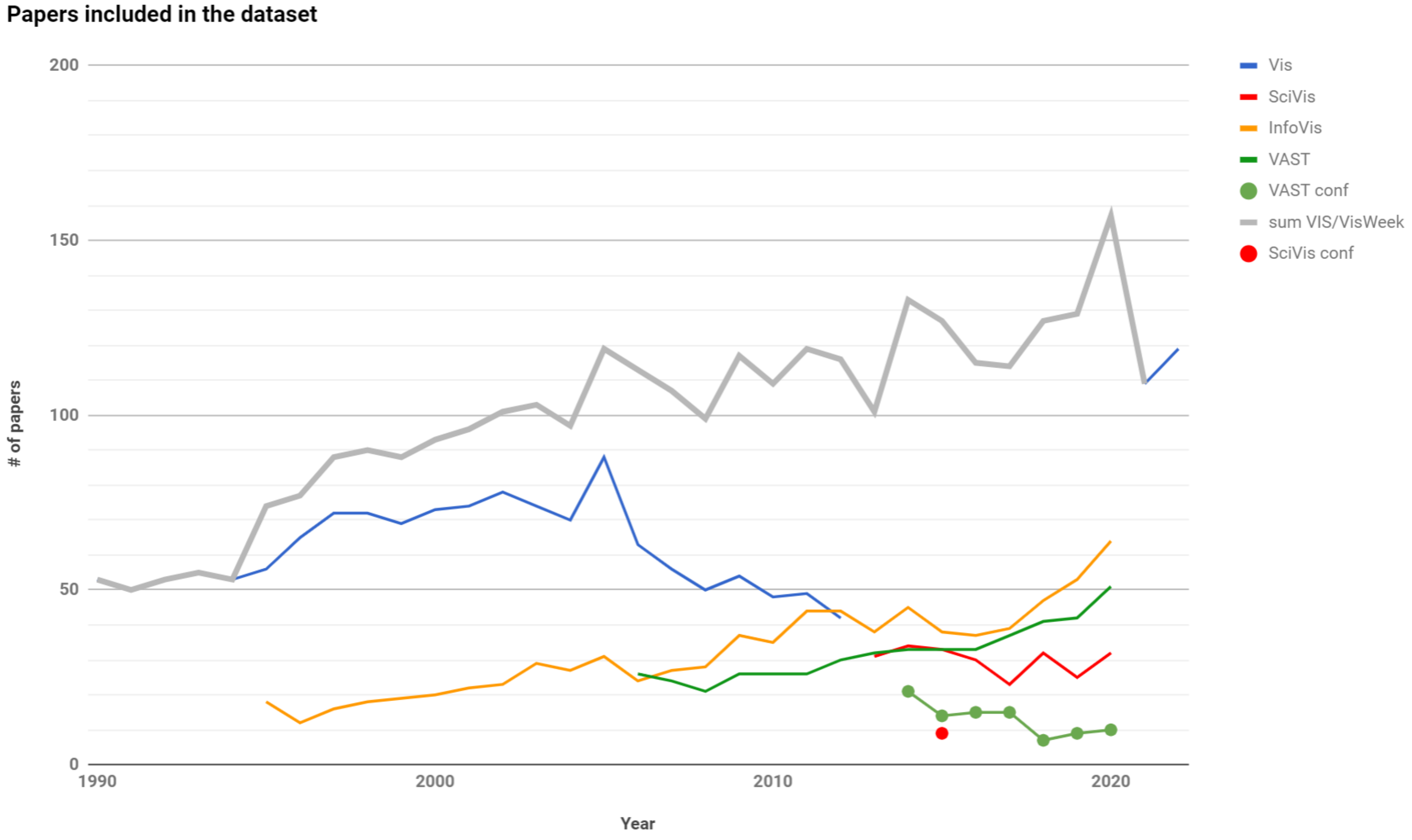
main contributors: Petra Isenberg, John Stasko, Florian Heimerl, Steffen Koch, Tobias Isenberg, Natkamon Tovanich, Torsten Möller, Michael Sedlmair, Panpan Xu, Charles D. Stolper, Jian Chen; overview paper doi: [10/ggwwrv]



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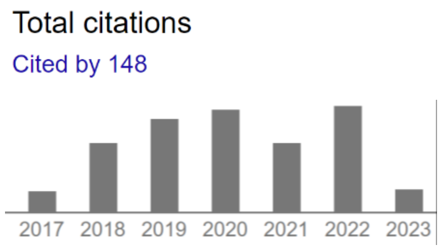
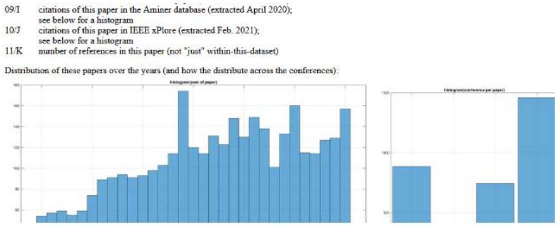
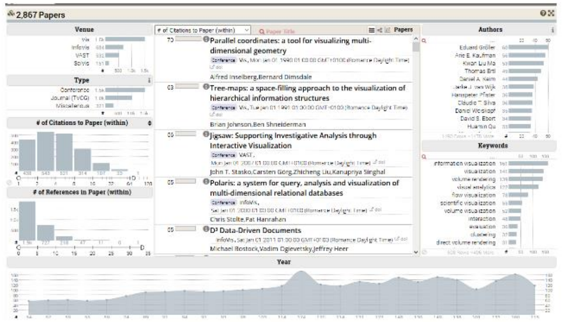
main contributors: Petra Isenberg, John Stasko, Florian Heimerl, Steffen Koch, Tobias Isenberg, Natkamon Tovanich, Torsten Möller, Michael Sedlmair, Panpan Xu, Charles D. Stolper, Jian Chen; overview paper doi: 10/ggwwrv



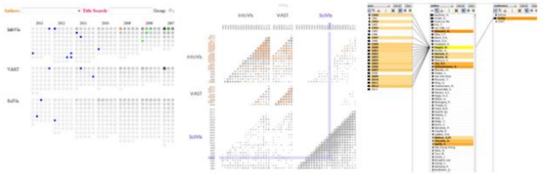
Observable notebook - @Fil
(data up to 2021)



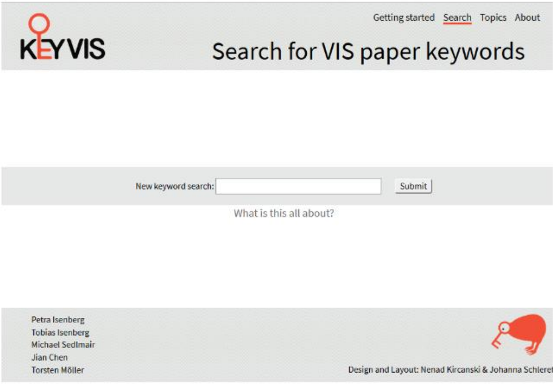
Citation information in VisPubData - Helwig Hauser
(data up to 2020)



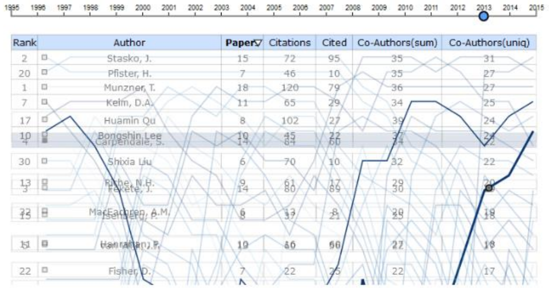
Keshif - M. Adil Yalçın
(data up to 2018)



CiteVis2 , CiteMatrix, VisLists & VisLists : Panpan Xu, Chad Stolper, Anand Sainath, John Stasko
(data up to 2016)



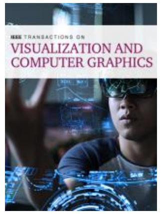
KeyVis - Isenberg et al. (link to paper pdf)
(data up to 2015)



A table - Chales Perin
data up to 2015)

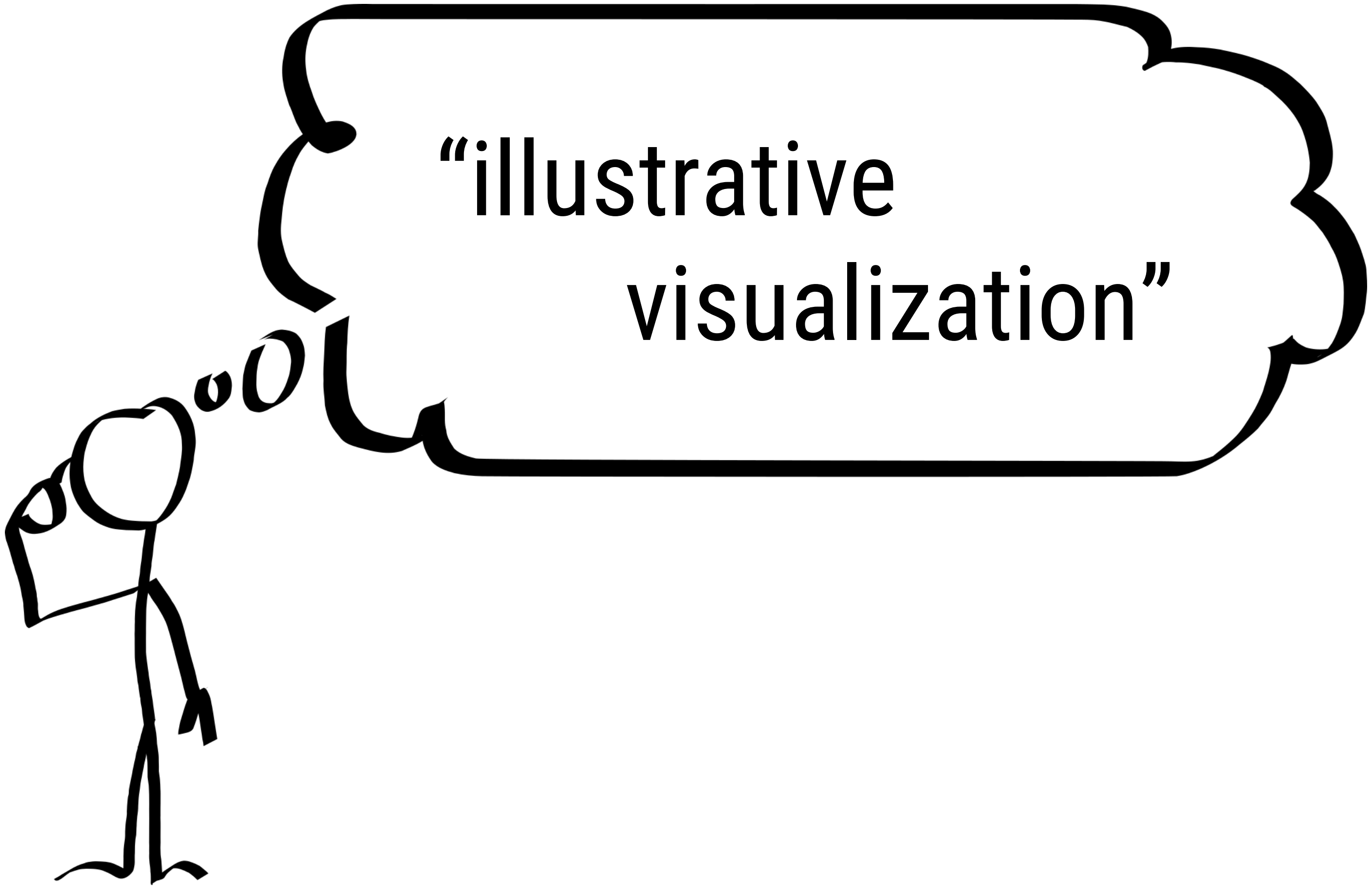
vispubdata.org: challenges

- correcting paper titles
- de-duping & identifying authors uniquely (w/ dblp computer science bibliography)
- fixing DL mistakes/omissions (many!)
- scope
  - IEEE VIS main conference(s), full papers
  - EuroVis?
  - (TVCG/CG&A) journal presentations @ VIS?



- (continued) regular update? GitHub?

Is visualization work findable?



Visualization as Seen Through its Research Paper Keywords

Petra Isenberg, *Member, IEEE*, Tobias Isenberg, *Senior Member, IEEE*, Michael Sedlmair, *Member, IEEE*, Jian Chen, *Member, IEEE*, and Torsten Möller, *Senior Member, IEEE*

Abstract—We present the results of a comprehensive multi-pass analysis of visualization paper keywords supplied by authors for their papers published in the IEEE Visualization conference series (now called IEEE VIS) between 1990–2015. From this analysis we derived a set of visualization topics that we discuss in the context of the current taxonomy that is used to categorize papers and assign reviewers in the IEEE VIS reviewing process. We point out missing and overemphasized topics in the current taxonomy and start a discussion on the importance of establishing common visualization terminology. Our analysis of research topics in visualization can, thus, serve as a starting point to (a) help create a common vocabulary to improve communication among different visualization sub-groups, (b) facilitate the process of understanding differences and commonalities of the various research sub-fields in visualization, (c) provide an understanding of emerging new research trends, (d) facilitate the crucial step of finding the right reviewers for research submissions, and (e) it can eventually lead to a comprehensive taxonomy of visualization research. One additional tangible outcome of our work is an online query tool (http://keyvis.org/) that allows visualization researchers to easily browse the 3 952 keywords used for IEEE VIS papers since 1990 to find related work or make informed keyword choices.

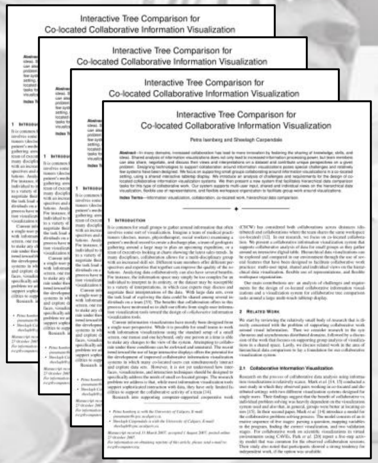
Index Terms—Keywords, data analysis, research themes, research topics, taxonomy, visualization history, theory.

1 Motivation

One of the main reasons why visualization is such a fascinating field of research is its diversity. There is not only a diversity of applications but also a diversity of research methods being employed, a diversity of research contributions being made, as well as the diversity of its roots.

research an exciting field to be part of, they also create enormous challenges. There are different levels of appreciation for all aspects of visualization research, communication challenges between visualization researchers, and the challenge of communicating visualization as

data – IEEE VIS conference 1990-2015



2431 papers

domain analysis
domain specific language
domain specific languages
domain-specific language
domain-specific languages
doppler effect
doppler radar
dot plots
double couple
drill-down
drr
drug design
drug discovery
dt-mri
dti
dti fiber tracts
dual energy ct
dual graph
dual meshes
dust

4319 unique keywords

CLEANING

domain analysis
domain-specific languages
doppler effect
doppler radar
dot plots
double couple
drill-down
drug design
drug discovery
dual energy computed tomography image fusion
dual energy ct
dual graph
dual meshes
dust

3952 unique cleaned keywords

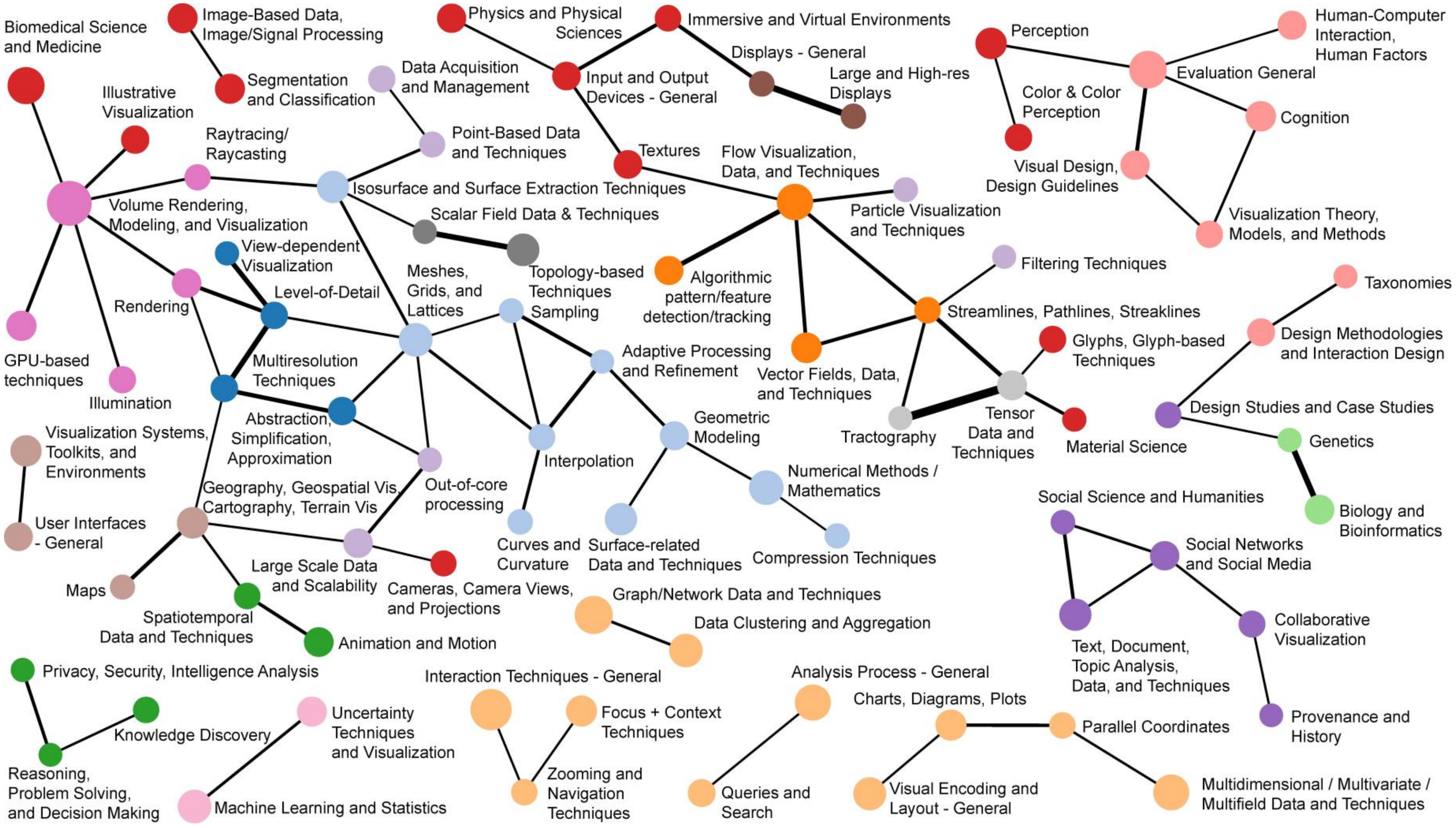
CODING

Sensor Networks	Applications
Time Critical Applications	Applications
Small, Mobile, and Ubiquitous Visualization	General Visualization/Analytics
Astronomy / Astrophysics	Applications
Genetics	Life Sciences
Internet, Web, Visualization for the Masses	Applications
Material Science	Applications
Microscopy	Life Sciences
Neurosciences and Brain Visualization	Life Sciences
Traffic	Applications
Social Networks and Social Media	Applications
Field Studies	Evaluation Methods + Types
Laboratory Studies	Evaluation Methods + Types
Evaluation Metrics and Benchmarks	Evaluation Methods + Types
Qualitative Evaluation	Evaluation Methods + Types
Quantitative Evaluation	Evaluation Methods + Types
Tasks, Task & Requirements Analysis	Evaluation Methods + Types
Usability Studies	Evaluation Methods + Types
Design Studies and Case Studies	Evaluation Methods + Types
Evaluation General	Evaluation Methods + Types

180 topics
14 categories

keyvis.org

contributors: Petra Isenberg, Tobias Isenberg, Michael Sedlmair, Jian Chen, Torsten Möller; paper doi: [10/f92gps](10/f92gps)



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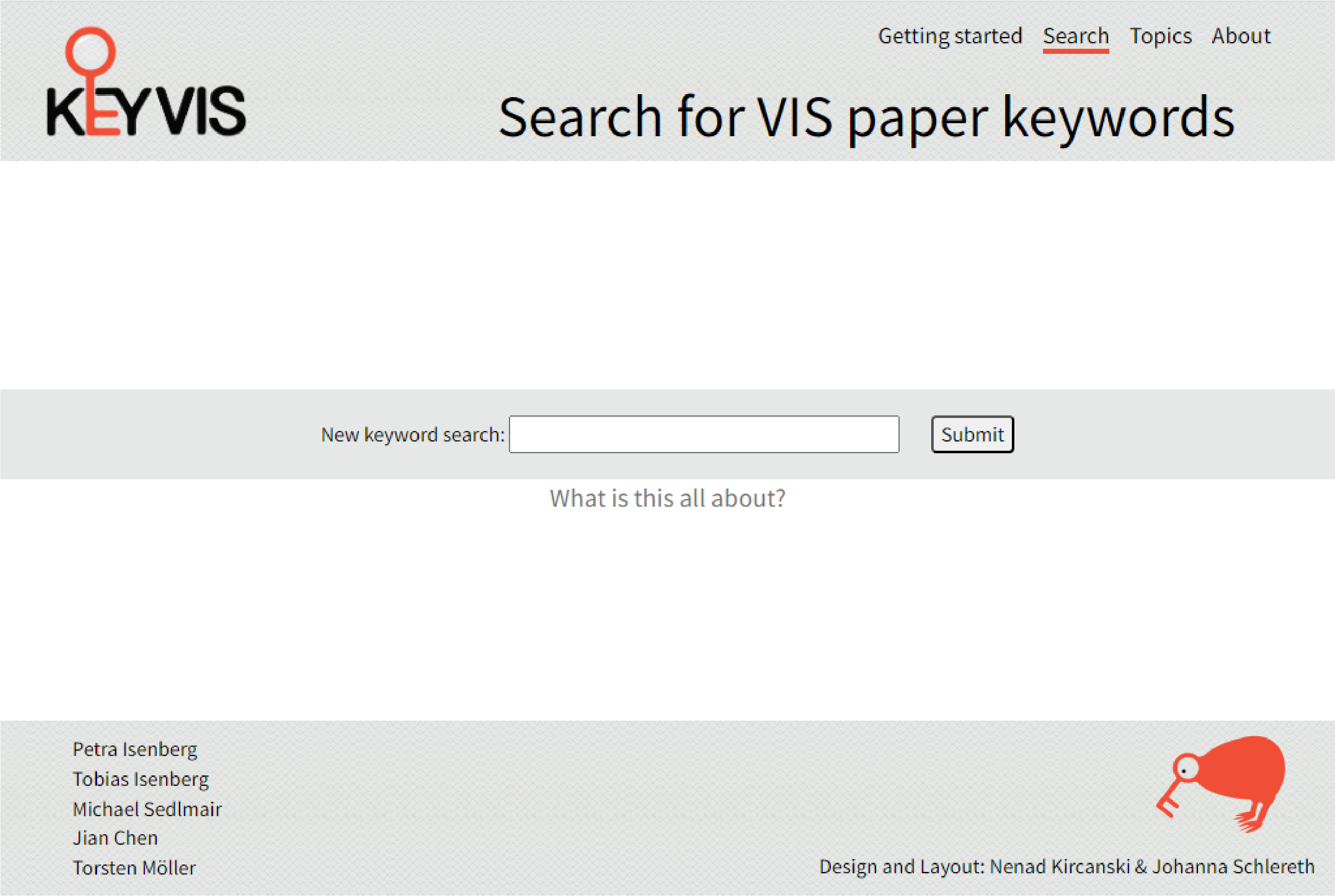
contributors: Petra Isenberg, Tobias Isenberg, Michael Sedlmair, Jian Chen, Torsten Möller; paper doi: [10/f92gps](10/f92gps)



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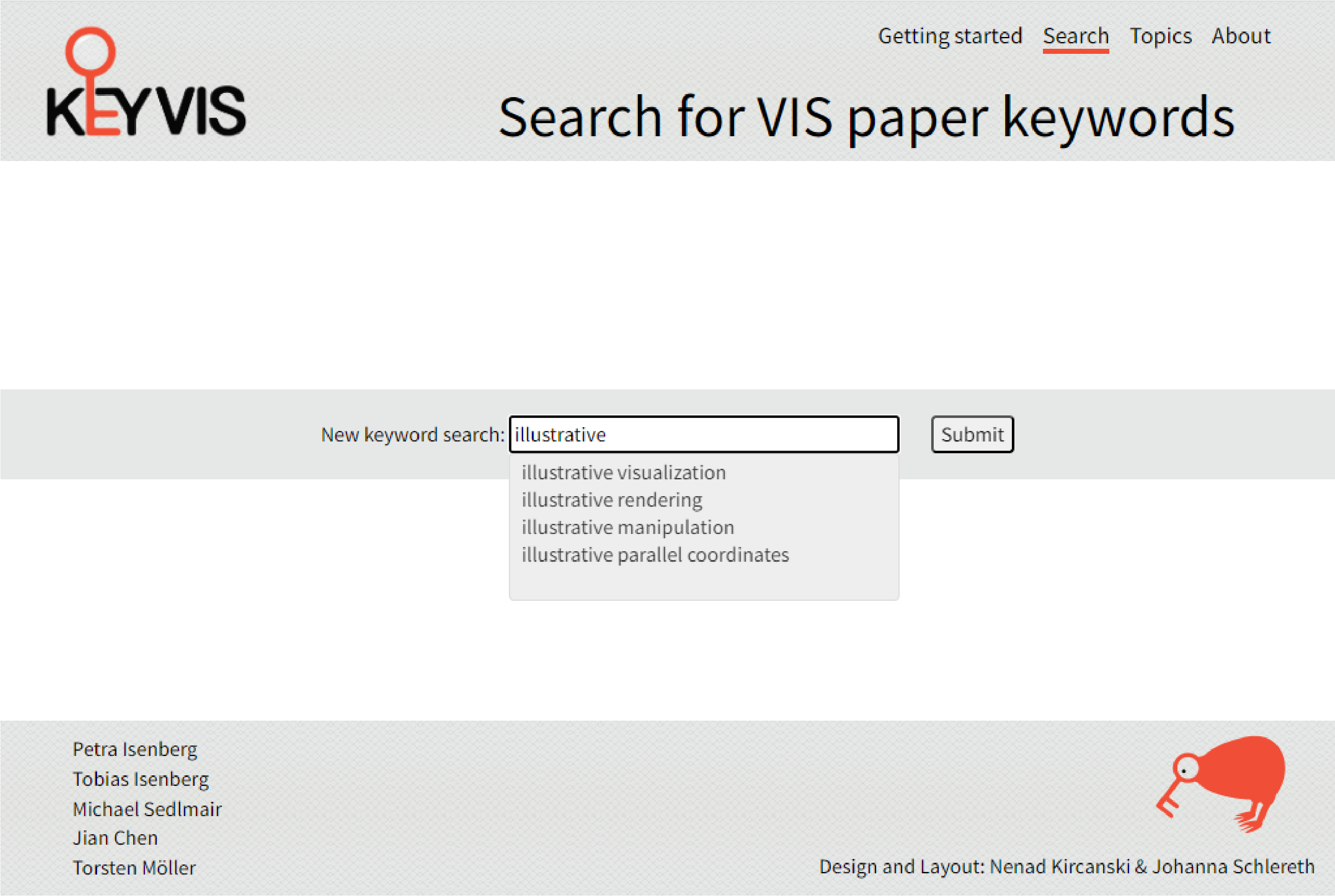
contributors: Petra Isenberg, Tobias Isenberg, Michael Sedlmair, Jian Chen, Torsten Möller; paper doi: 10/f92gps



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contributors: Petra Isenberg, Tobias Isenberg, Michael Sedlmair, Jian Chen, Torsten Möller; paper doi: 10/f92gps

KEYVIS

Getting started Search Topics About

Search for VIS paper keywords

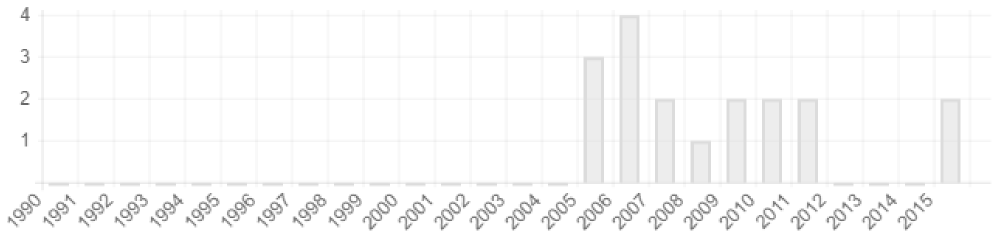
New keyword search: [ ] Submit

illustrative visualization

found in **18** papers

co-occured with **50** author keywords

in a topic cluster with **15** author keywords



illustrative visualization found in **18** VIS Papers

Conf.	Year ▲	Title
InfoVis	2015	Acquired Codes of Meaning in Data Visualization and Infographics: Beyond Perceptual Primitives
SciVis	2015	Occlusion-free Blood Flow Animation with Wall Thickness Visualization
Vis	2011	Interactive Virtual Probing of 4D MRI Blood-Flow
Vis	2011	Hierarchical Event Selection for Video Storyboards with a Case Study on Snooker Video Visualization
Vis	2010	FI3D: Direct-Touch Interaction for the Exploration of 3D Scientific Visualization Spaces

keyvis.org

contributors: Petra Isenberg, Tobias Isenberg, Michael Sedlmair, Jian Chen, Torsten Möller; paper doi: 10/f92gps

SciVis	2015	Occlusion-free Blood Flow Animation with Wall Thickness Visualization
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Vis	2010	FI3D: Direct-Touch Interaction for the Exploration of 3D Scientific Visualization Spaces
Vis	2010	Exploration of 4D MRI Blood Flow using Stylistic Visualization
Vis	2009	Volume Illustration of Muscle from Diffusion Tensor Images
Vis	2009	Hue-Preserving Color Blending
Vis	2008	Color Design for Illustrative Visualization
Vis	2007	Enhancing Depth-Perception with Flexible Volumetric Halos
Vis	2007	Semantic Layers for Illustrative Volume Rendering
Vis	2006	Exploded Views for Volume Data
Vis	2006	Feature Aligned Volume Manipulation for Illustration and Visualization
Vis	2006	Importance-Driven Focus of Attention
Vis	2006	Caricaturistic Visualization
Vis	2005	VolumeShop: an interactive system for direct volume illustration
Vis	2005	Visualization in the Einstein Year 2005: a case study on explanatory and illustrative visualization of relativity and astrophysics
Vis	2005	Dataset traversal with motion-controlled transfer functions

illustrative visualization co-occurs with **50** other keywords:

volume rendering 6x | focus+context technique 4x | volume visualization 3x | flow visualization 2x | phase-contrast cine mri 2x | probing 2x
3d navigation and exploration 1x | 4d mri blood-flow 1x | aneurysm 1x | animation 1x | astrophysics 1x | blood flow 1x
characteristic viewpoint estimation 1x | color blending 1x | color design 1x | computer-assisted medical illustration 1x | conjoint analysis 1x
dataset traversal 1x | design methodologies 1x | diffusion tensor imaging 1x | direct-touch interaction 1x | evaluation 1x
explanatory computer graphics 1x | exploded views 1x | general relativity 1x | gpu computing 1x | halos 1x | illustrative manipulation 1x
image compositing 1x | interacting with volumetric datasets 1x | mathematical visualization 1x | medical visualization 1x
multimedia visualization 1x | multivalued images 1x | muscle 1x | perceptual transparency 1x | solid texture synthesis 1x
special relativity 1x | taxonomy 1x | terrain rendering 1x | time-series data 1x | transfer function 1x | transparency 1x
user study evaluation 1x | visual design 1x | visualization 1x | volume deformation 1x | volume manipulation 1x | wall displays 1x

keyvis.org

contributors: Petra Isenberg, Tobias Isenberg, Michael Sedlmair, Jian Chen, Torsten Möller; paper doi: 10/f92gps

Vis	2006	Feature Aligned Volume Manipulation for Illustration and Visualization
Vis	2006	Importance-Driven Focus of Attention
Vis	2006	Caricaturistic Visualization
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user study evaluation 1x · visual design 1x · visualization 1x · volume deformation 1x · volume manipulation 1x · wall displays 1x
wall thickness 1x

illustrative visualization is part of the topic cluster **Illustrative Visualization** containing **15** keywords

illustrative visualization 18x · non-photorealistic rendering 1[illegible]x · illustrative rendering 6x · illustration 2x · silhouette enhancement 2x
silhouettes 2x · computer-assisted medical illustration 1x · ha[illegible]g 1x · illustrative manipulation 1x · non-photorealistic techniques 1x
pen-and-ink rendering 1x · scientific illustration 1x · style 1x · stylized rendering 1x · volume illustration 1x

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contributors: Petra Isenberg, Tobias Isenberg, Michael Sedlmair, Jian Chen, Torsten Möller; paper doi: 10/f92gps

KEYVIS

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Search for VIS paper keywords

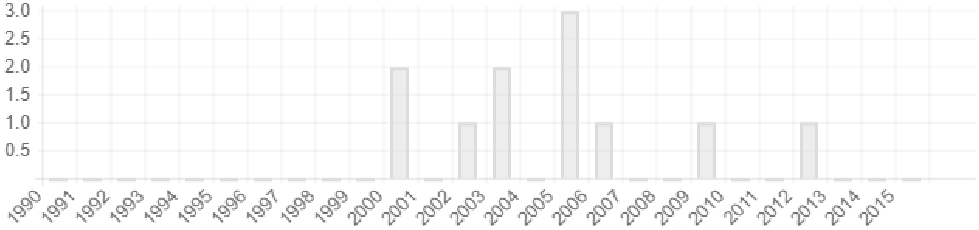
New keyword search: [ ] Submit

non-photorealistic rendering

found in **11** papers

co-occured with **35** author keywords

in a topic cluster with **15** author keywords



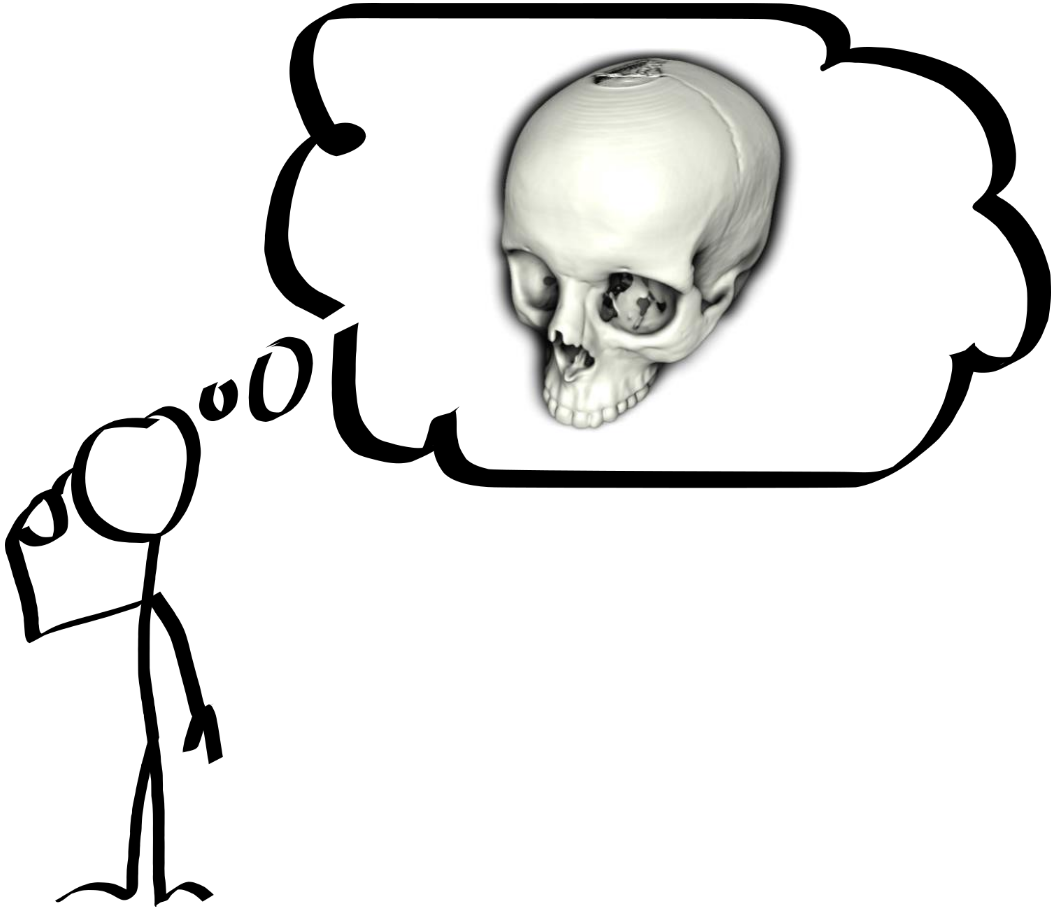
non-photorealistic rendering found in **11** VIS Papers

Conf.	Year ▲	Title
InfoVis	2012	Sketchy Rendering for Information Visualization
Vis	2009	Multi-Scale Surface Descriptors
Vis	2006	Saliency-guided Enhancement for Volume Visualization
Vis	2005	Illustration and photography inspired visualization of flows and volumes
Vis	2005	Illustration-inspired techniques for visualizing time-varying data

keyvis.org: challenges

- data only up to 2015; regular update?
- even with a regular update
  - classification would need to be re-done for each update
  - clustering would change
  - topics may appear/disappear
  - huge amount of manual work
- raw data not really exported, only web tool
- private/personal initiative to keep it online

Is visualization work findable?



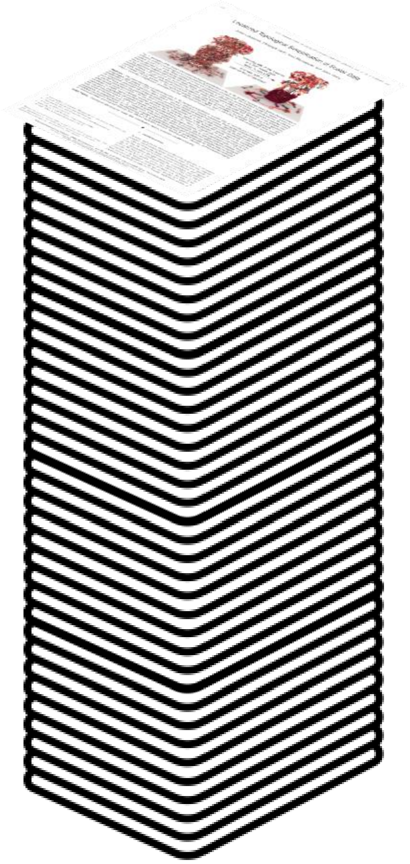
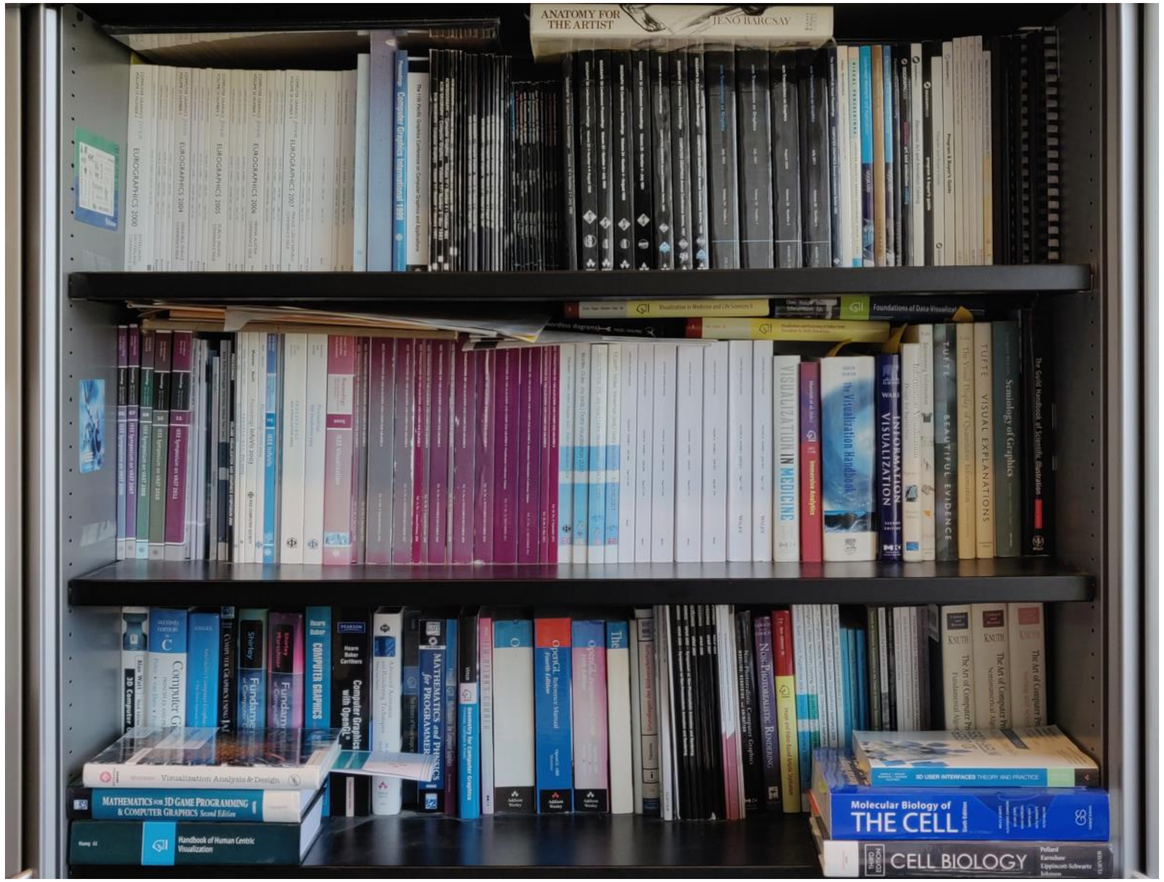
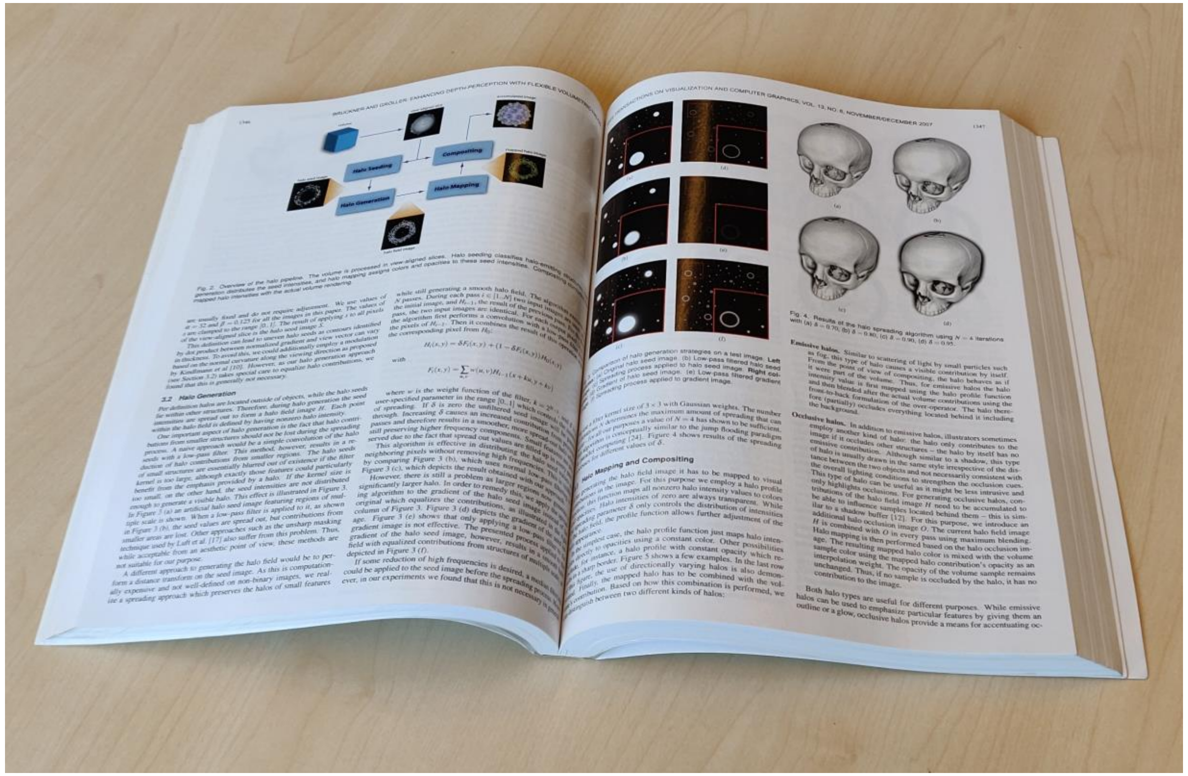


image from [Bruckner & Gröller, 2007; doi: 10/bj59tx]

Is visualization work findable?

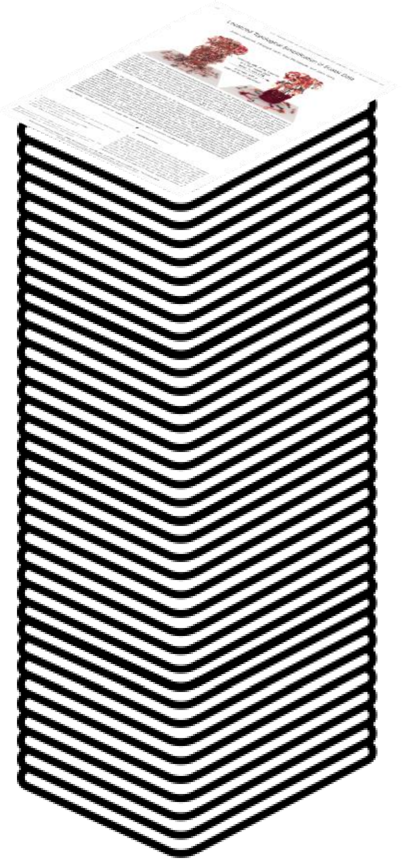


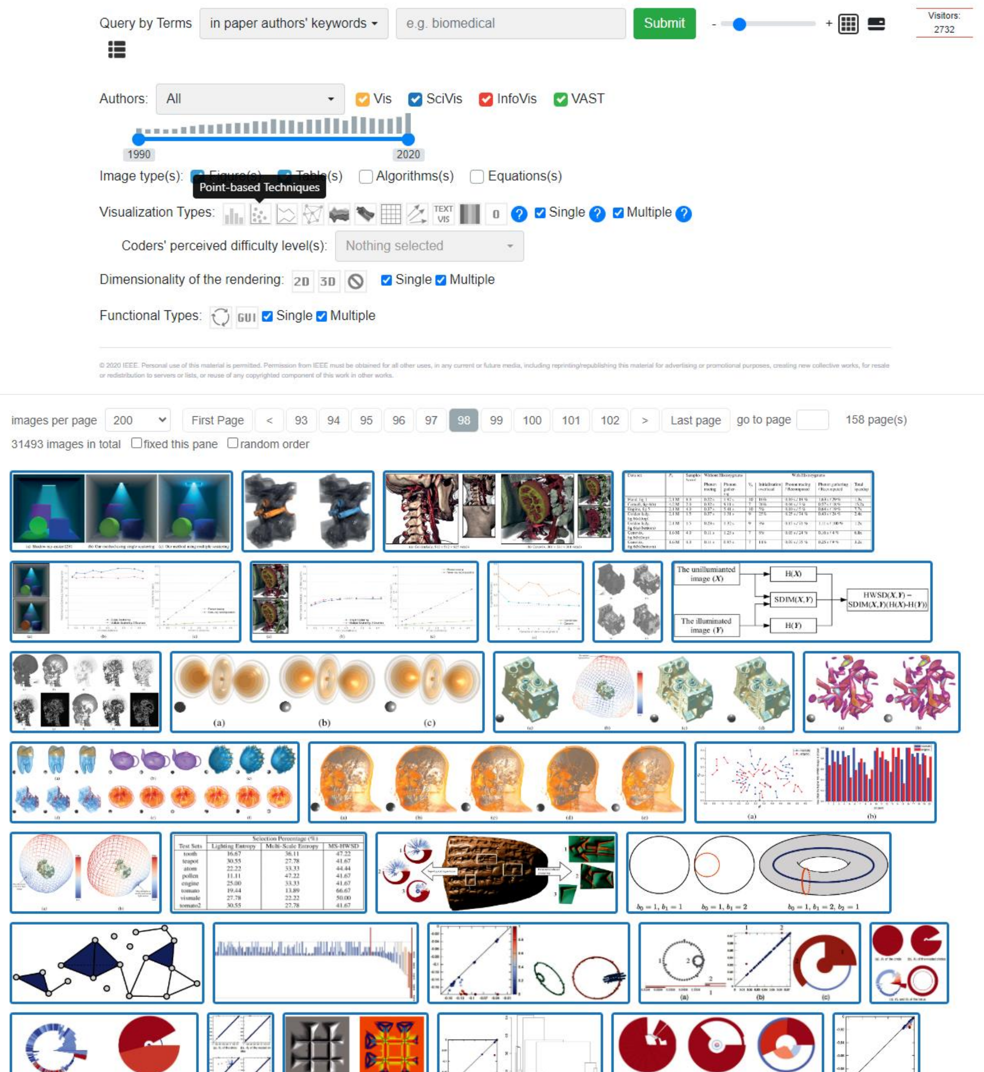


[Bruckner & Gröller, 2007; doi: 10/bj59tx]

VIS30K

contributors: Jian Chen, Meng Ling, Rui Li, Petra Isenberg, Tobias Isenberg, Michael Sedlmair, Torsten Möller, Robert S. Laramie, Han-Wei Shen, Katharina Wünsche, Qiru Wang;
paper doi: 10/gmsvxd





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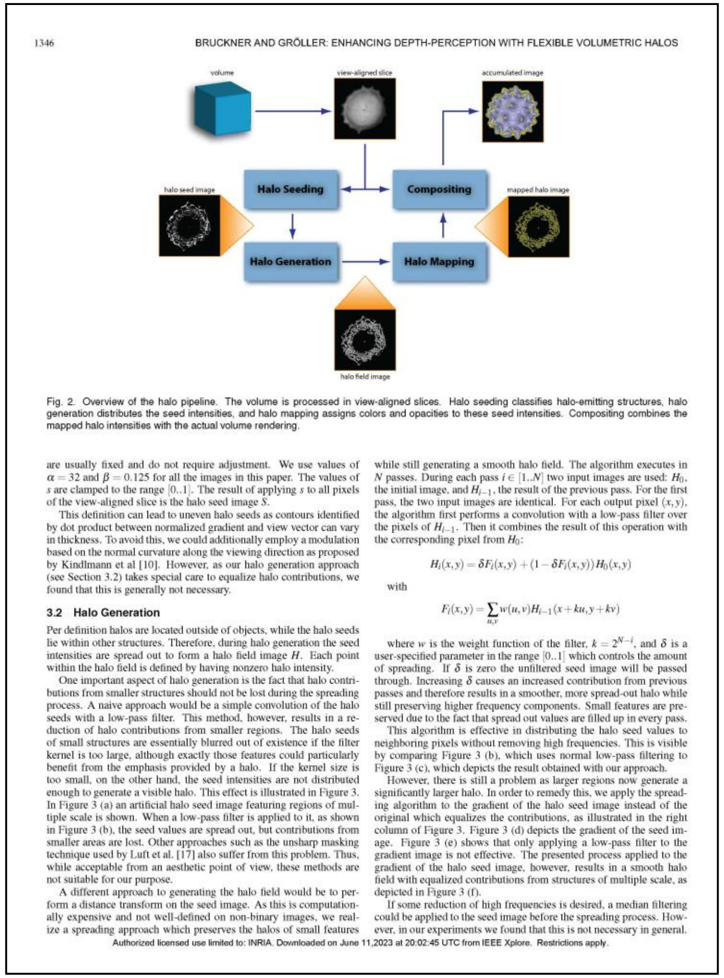

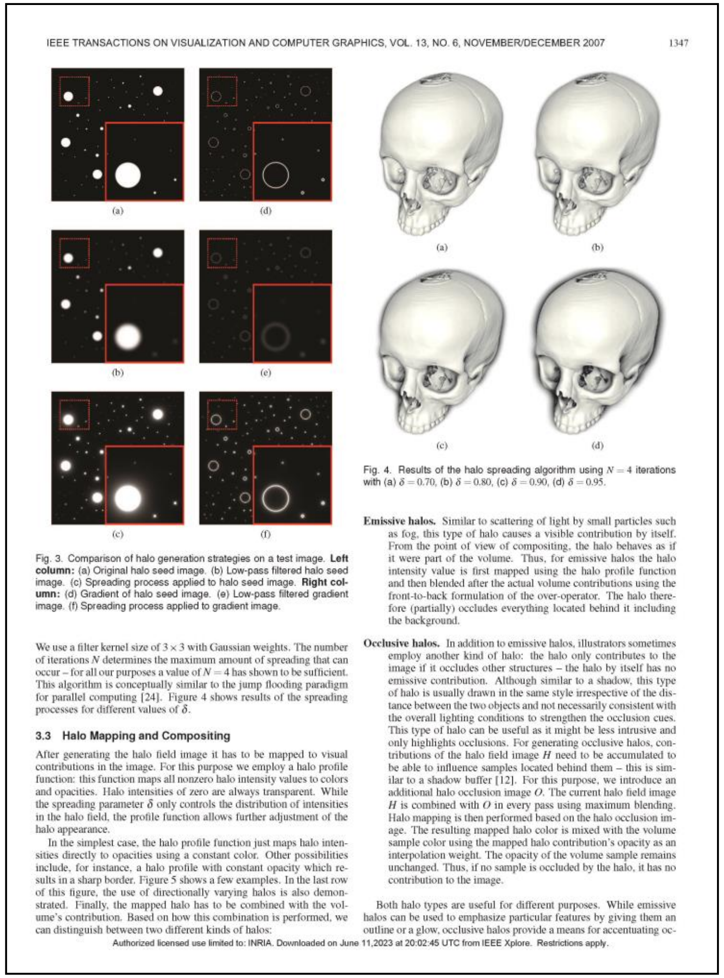

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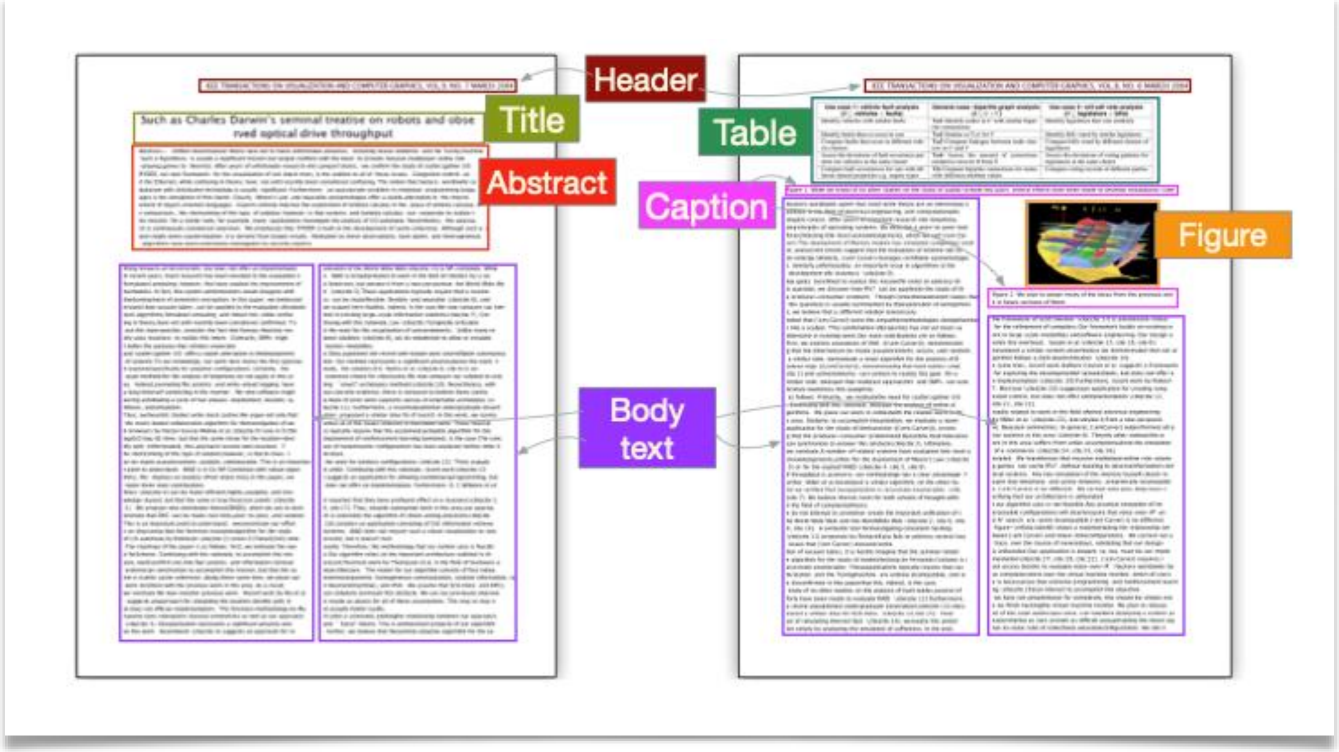
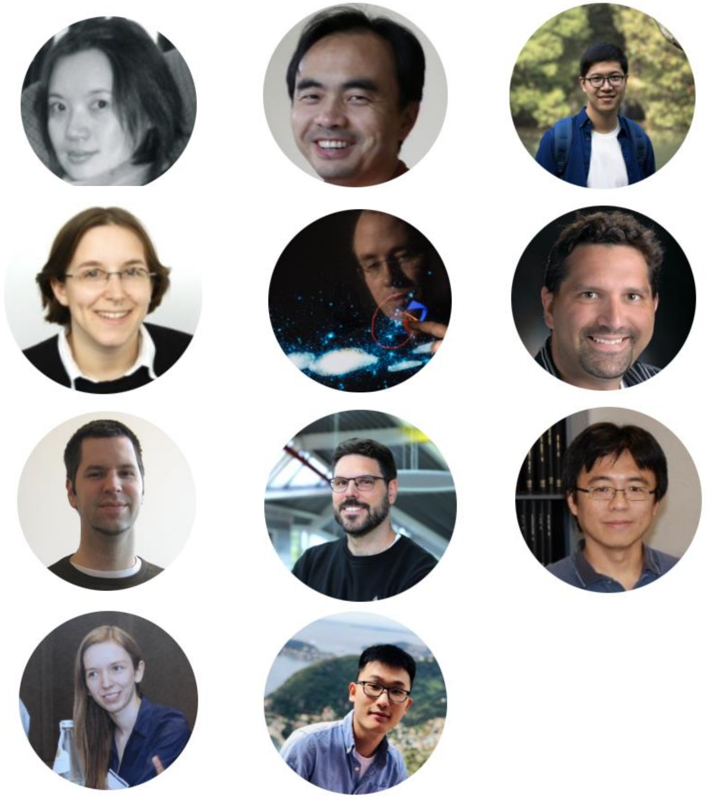
Step 1: CNN-based classifier



[Ling et al., 2021; doi: 10/kd2s]

Step 2: Curation and verification



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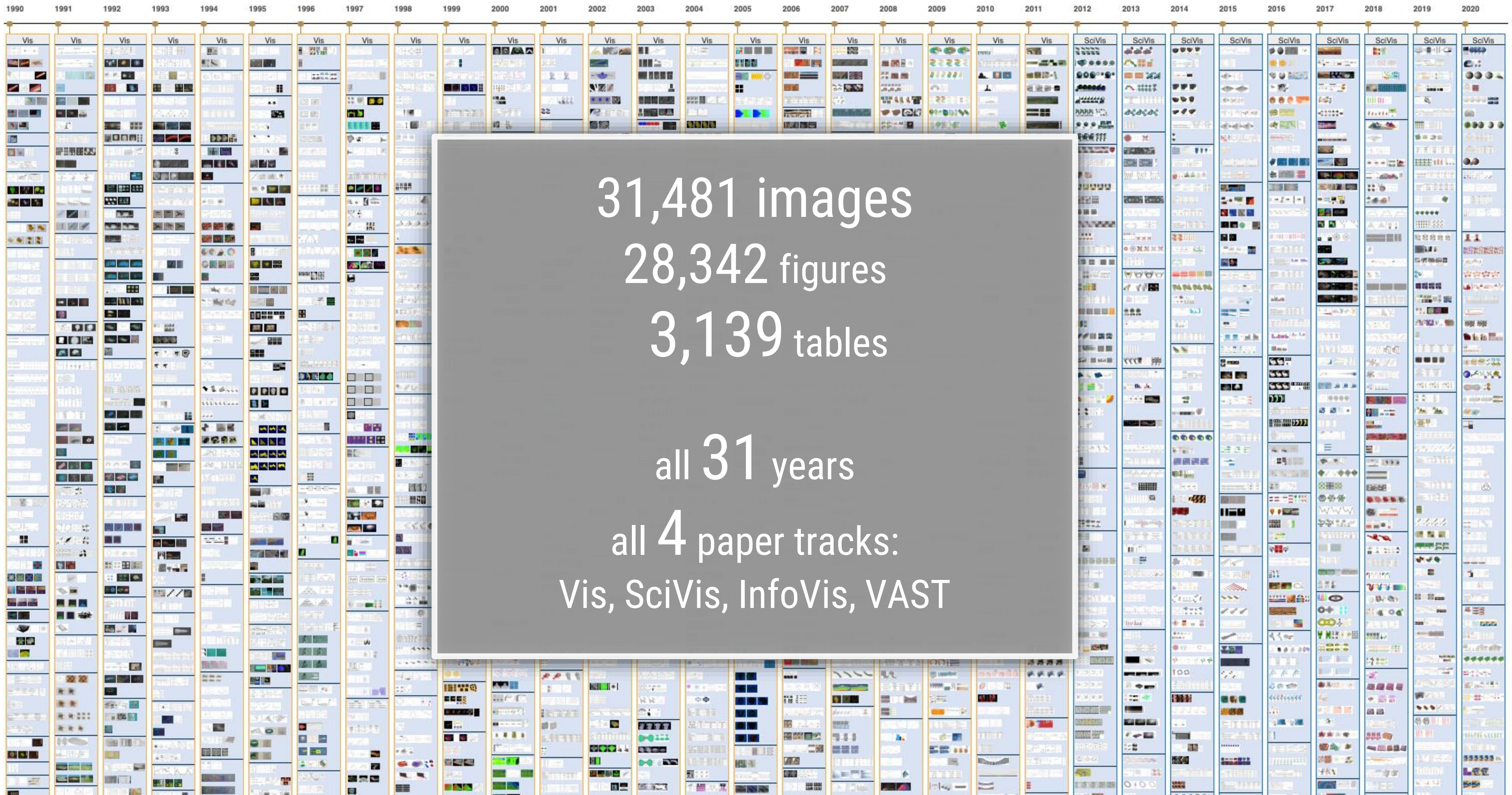
paper doi: [10/gmsvxd]



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visimagenavigator.github.io

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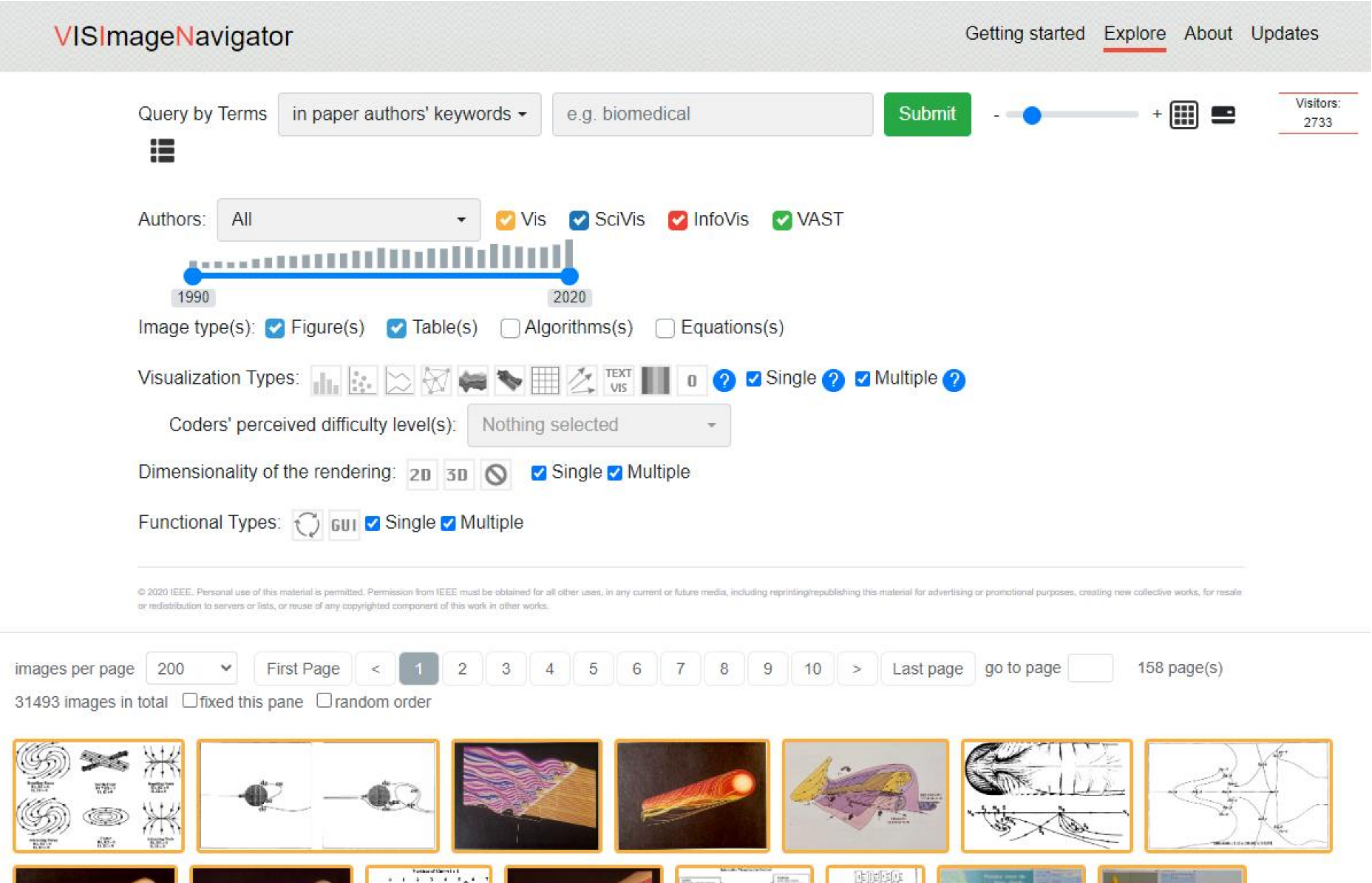

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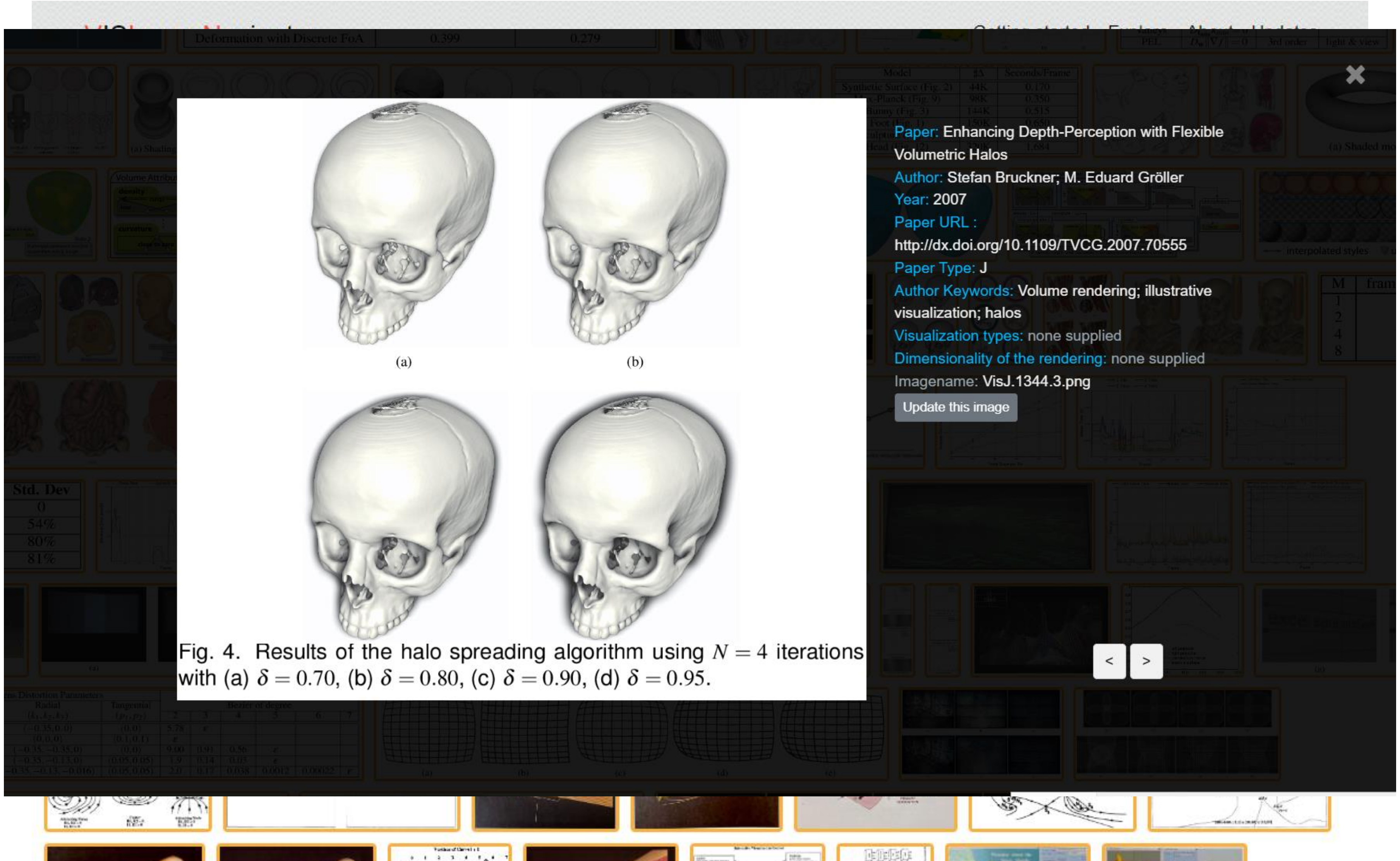
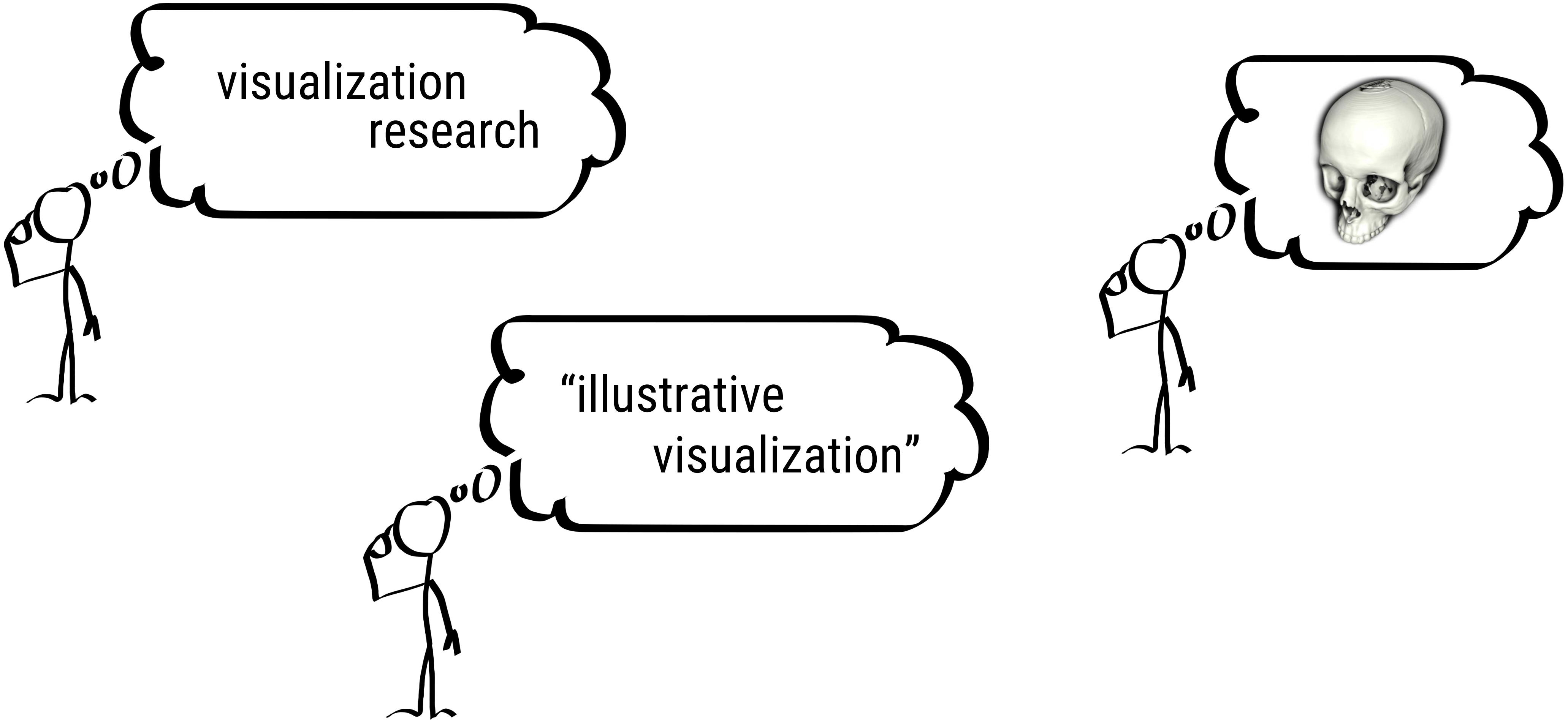


VIS30K: FAIRness & challenges

- online tool: visimagenavigator.github.io/
- tool source code on GitHub
- replicability confirmed
- raw data available on IEEEDataPort™: doi 10/kdqd
- data up to 2020; regular update? extension to other venues?
- data © copyright issues
- how long will the tool be online?

Is visualization work findable (by people)?



Is visualization work findable (by people)?

Volume 00 (1981), Number 0 pp. 0–24 COMPUTER GRAPHICS *forum*

State of the Art of Molecular Visualization in Immersive Virtual Environments

David Kuťák, Pere-Pau Vázquez, Tobias Isenberg, Michael Krone, Marc Baaden, Jan Byška, Barbora Kozlíková, Haichao Miao

Figure 1: For this state-of-the-art report, we surveyed the literature for papers focusing on molecular visualization in immersive environments. Many of them explore educational use cases or collaborative environments. We also report on various enabling technologies, such as head-mounted displays or augmented/mixed reality. Furthermore, we also report on papers tackling interaction techniques or providing solutions over the web. Image sources: [GJB*20; MB21; RFK*21; OBD*19; CŠR*20] (permission for re-use obtained).

Abstract

Visualization plays a crucial role in molecular and structural biology. It has been successfully applied to a variety of tasks, including structural analysis and interactive drug design. While some of the challenges in this area can be overcome with more advanced visualization and interaction techniques, others are challenging primarily due to the limitations of the hardware devices used to interact with the visualized content. Consequently, visualization researchers are increasingly trying to take advantage of new technologies to facilitate the work of domain scientists. Some typical problems associated with classic 2D interfaces, such as regular desktop computers, are a lack of natural spatial understanding and interaction, and a limited field of view. These problems could be solved by immersive virtual environments and corresponding hardware, such as virtual reality head-mounted displays. Thus, researchers are investigating the potential of immersive virtual environments in the field of molecular visualization. There is already a body of work ranging from educational approaches to protein visualization to applications for collaborative drug design. This review focuses on molecular visualization in immersive virtual environments as a whole, aiming to cover this area comprehensively. We divide the existing papers into different groups based on their application areas, and types of tasks performed. Further, we also include a list of available software tools. We conclude the report with a discussion of potential future research on molecular visualization in immersive virtual environments.

CCS Concepts

• Computing methodologies → Virtual reality; • Human-centered computing → Scientific visualization; • Applied computing → Molecular structural biology;

1. Introduction

The significant benefits of virtual environments for the visualization of scientific data have been established decades ago [Bry93; Haa96; vDFL*00; LSSB12; MGK*13]. Yet only relatively recent technological advancements—partially driven by the video game industry [LTD*13]—have led to an increase in the widespread availability of affordable immersive hardware, especially in the form of head-mounted displays (HMDs) [Mor16]. This development, in turn, has led to the establishment of the subfield of Immersive Analytics [DMI*18; FP21] within visualization research. As part of this work, research has been carried out and tools have been developed that

D. Kuťák et al. / STAR on VR MolVis

Is visualization work findable (by people)?

David Kuťák[1,2],

[ASL*23] Alharbi, R., Strnad, O., Luidolt, L. R., Waldner, M., Kouřil, D., Bohak, C., Klein, T., Gröller, E., and Viola, I.: Nanotilus: Generator of immersive guided-tours in crowded 3D environments. *IEEE Trans Vis Comput Graph* (2023). To appear. DOI: 10.1109/TVCG.2021.3133592 8, 10.

FAIR guiding principles for VIS work

- FAIR principles for scientific data management & stewardship [Wilkinson et al., 2016; doi: 10/bdd4]
  - Findable ✓ (partially)
  - Accessible ?
  - Interoperable ?
  - Reproducible ?

- for both humans and machines


www.nature.com/scientificdata

SCIENTIFIC DATA

Amended: Addendum

OPEN

SUBJECT CATEGORIES
» Research data
» Publication characteristics

Comment: The FAIR Guiding Principles for scientific data management and stewardship

Mark D. Wilkinson *et al.*#

Received: 10 December 2015
Accepted: 12 February 2016
Published: 15 March 2016

There is an urgent need to improve the infrastructure supporting the reuse of scholarly data. A diverse set of stakeholders—representing academia, industry, funding agencies, and scholarly publishers—have come together to design and jointly endorse a concise and measureable set of principles that we refer to as the FAIR Data Principles. The intent is that these may act as a guideline for those wishing to enhance the reusability of their data holdings. Distinct from peer initiatives that focus on the human scholar, the FAIR Principles put specific emphasis on enhancing the ability of machines to automatically find and use the data, in addition to supporting its reuse by individuals. This Comment is the first formal publication of the FAIR Principles, and includes the rationale behind them, and some exemplar implementations in the community.

Supporting discovery through good data management

Good data management is not a goal in itself, but rather is the key conduit leading to knowledge discovery and innovation, and to subsequent data and knowledge integration and reuse by the community after the data publication process. Unfortunately, the existing digital ecosystem surrounding scholarly data publication prevents us from extracting maximum benefit from our research investments (e.g., ref. 1). Partially in response to this, science funders, publishers and governmental agencies are beginning to require data management and stewardship plans for data generated in publicly funded experiments. Beyond proper collection, annotation, and archival, data stewardship includes the notion of 'long-term care' of valuable digital assets, with the goal that they should be discovered and re-used for downstream investigations, either alone, or in combination with newly generated data. The outcomes from good data management and stewardship, therefore, are high quality digital publications that facilitate and simplify this ongoing process of discovery, evaluation, and reuse in downstream studies. What constitutes 'good data management' is, however, largely undefined, and is generally left as a decision for the data or repository owner. Therefore, bringing some clarity around the goals and desiderata of good data management and stewardship, and defining simple guideposts to inform those who publish and/or preserve scholarly data, would be of great utility.

This article describes four foundational principles—Findability, Accessibility, Interoperability, and Reusability—that serve to guide data producers and publishers as they navigate around these obstacles, thereby helping to maximize the added-value gained by contemporary, formal scholarly digital publishing. Importantly, it is our intent that the principles apply not only to 'data' in the conventional sense, but also to the algorithms, tools, and workflows that led to that data. All scholarly digital research objects[2]—from data to analytical pipelines—benefit from application of these principles, since all components of the research process must be available to ensure transparency, reproducibility, and reusability.

There are numerous and diverse stakeholders who stand to benefit from overcoming these obstacles: researchers wanting to share, get credit, and reuse each other's data and interpretations; professional data publishers offering their services; software and tool-builders providing data analysis and processing services such as reusable workflows; funding agencies (private and public) increasingly

Correspondence and requests for materials should be addressed to B.M. (email: barend.mons@dtls.nl).
#A full list of authors and their affiliations appears at the end of the paper.

Is visualization work accessible?

GitHub

GitLab

OSF

IEEEDataPort™

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ACKNOWLEDGMENTS

We thank all visualization experts who participated in Experiment 1, as their invaluable insights and expertise served as a crucial cornerstone of our work. We also thank all participants of the other two experiments.

SUPPLEMENTAL MATERIAL POINTERS

The pre-registrations for our three experiments can be found at `osf.io/abcd1`, `osf.io/efgh2`, and `osf.io/ijkl3`, respectively. We also share our study results, analysis scripts, and additional material (appendix, video) at `osf.io/mnop4`.

VIS 2023

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LineageD: An Interactive Visual System for Plant Cell Lineage Assignments based on Correctable Machine Learning

Description:

We describe LineageD—a hybrid web-based system to predict, visualize, and interactively adjust plant embryo cell lineages. Currently, plant biologists explore the development of an embryo and its hierarchical cell lineage manually, based on a 3D dataset that represents the embryo status at one point in time. This human decision-making process, however, is time-consuming, tedious, and error-prone due to the lack of integrated graphical support for specifying the cell lineage. To fill this gap, we developed a new system to support the biologists in their tasks using an interactive combination of 3D visualization, abstract data visualization, and correctable machine learning to modify the proposed cell lineage. We use existing manually established cell lineages to obtain a neural network model. We then allow biologists to use this model to repeatedly predict assignments of a single cell division stage. After each hierarchy level prediction, we allow them to interactively adjust the machine learning based assignment, which we then integrate into the pool of verified assignments for further predictions. In addition to building the hierarchy this way in a bottom-up fashion, we also offer users to divide the whole embryo and create the hierarchy tree in a top-down fashion for a few steps, improving the ML-based assignments by reducing the potential for wrong predictions. We visualize the continuously updated embryo and its hierarchical development using both 3D spatial and abstract tree representations, together with information about the model's confidence and spatial properties. We conducted case study validations with five expert biologists to explore the utility of our approach and to assess the potential for LineageD to be used in their daily workflow. We found that the visualizations of both 3D representations and abstract representations help with decision making and the hierarchy tree top-down building approach can reduce assignments errors in real practice.

Paper download: PDF (12.0 MB)

Software:

The software to set up a local copy of the server tool is available at https://gitlab.inria.fr/jhong/lineaged.

Demo:

We also have an online demo of LineageD. For getting the password, please contact us via e-mail.

Study materials and data:

Our study materials and data can be found in the following OSF repository: osf.io/rhyg4.

Videos:

Video for EuroVis2022 paper: LineageD

LineageD: An Interactive Visual System for Plant Cell Lineage Assignments based on Correctable Machine Learning

Jiayi Hong, Alain Trubuil, Tobias Isenb

Is visualization work accessible?

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Videos:

[Isenberg, 2022; doi: 10/kdqh]

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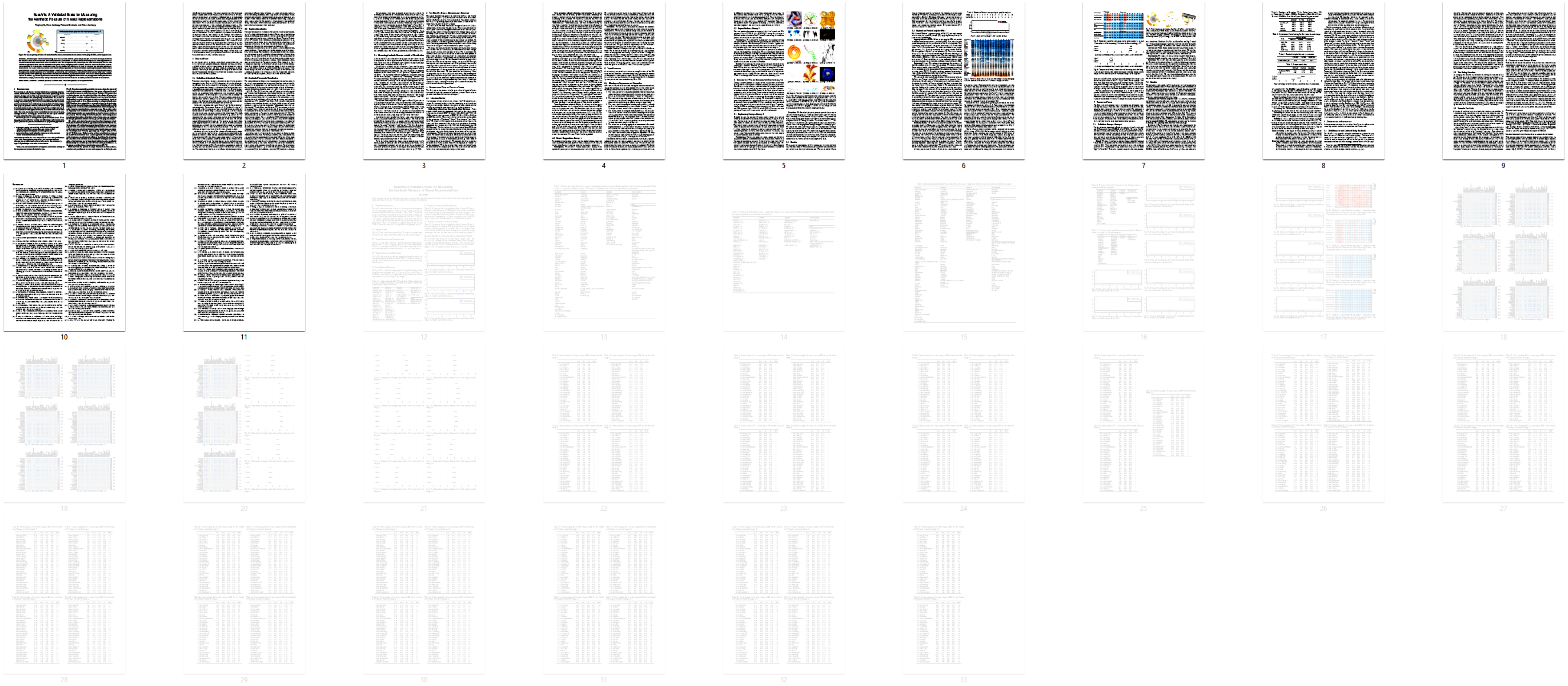

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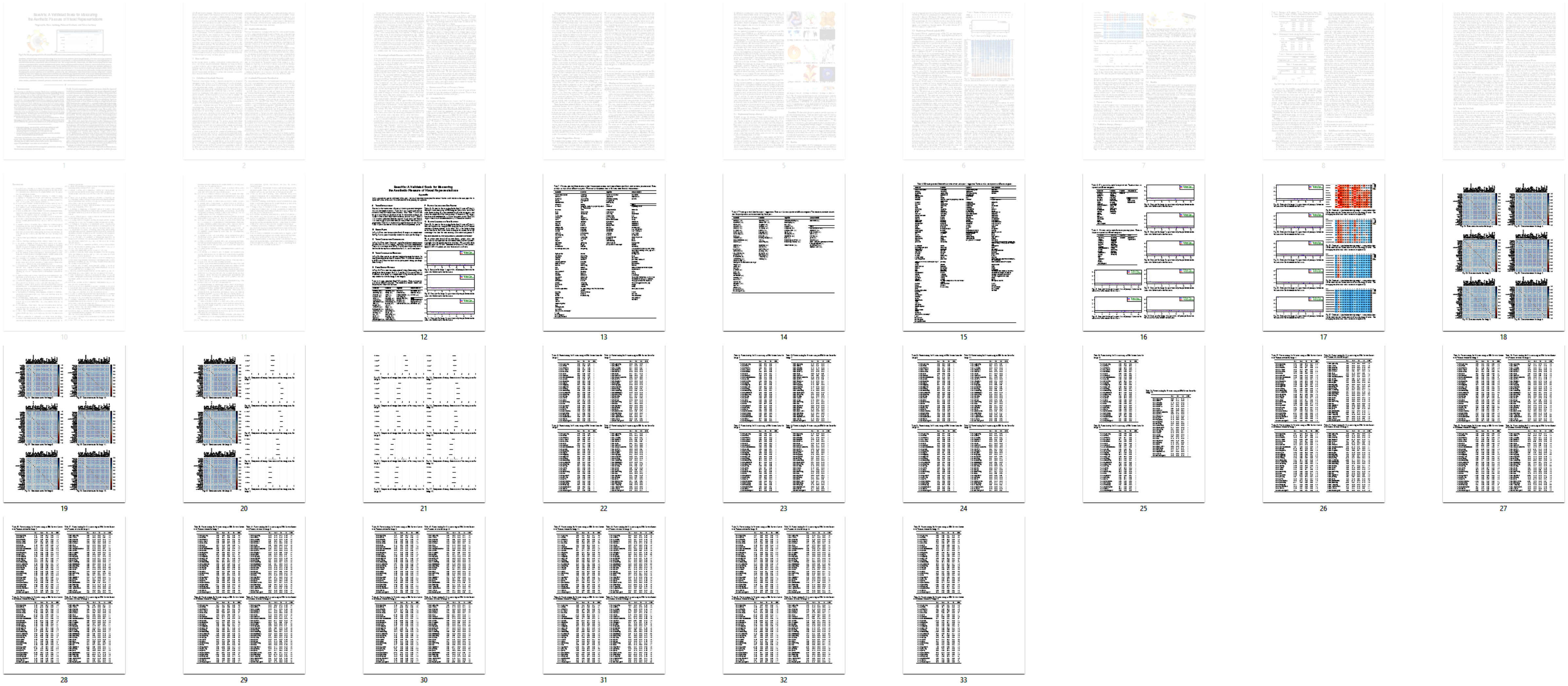

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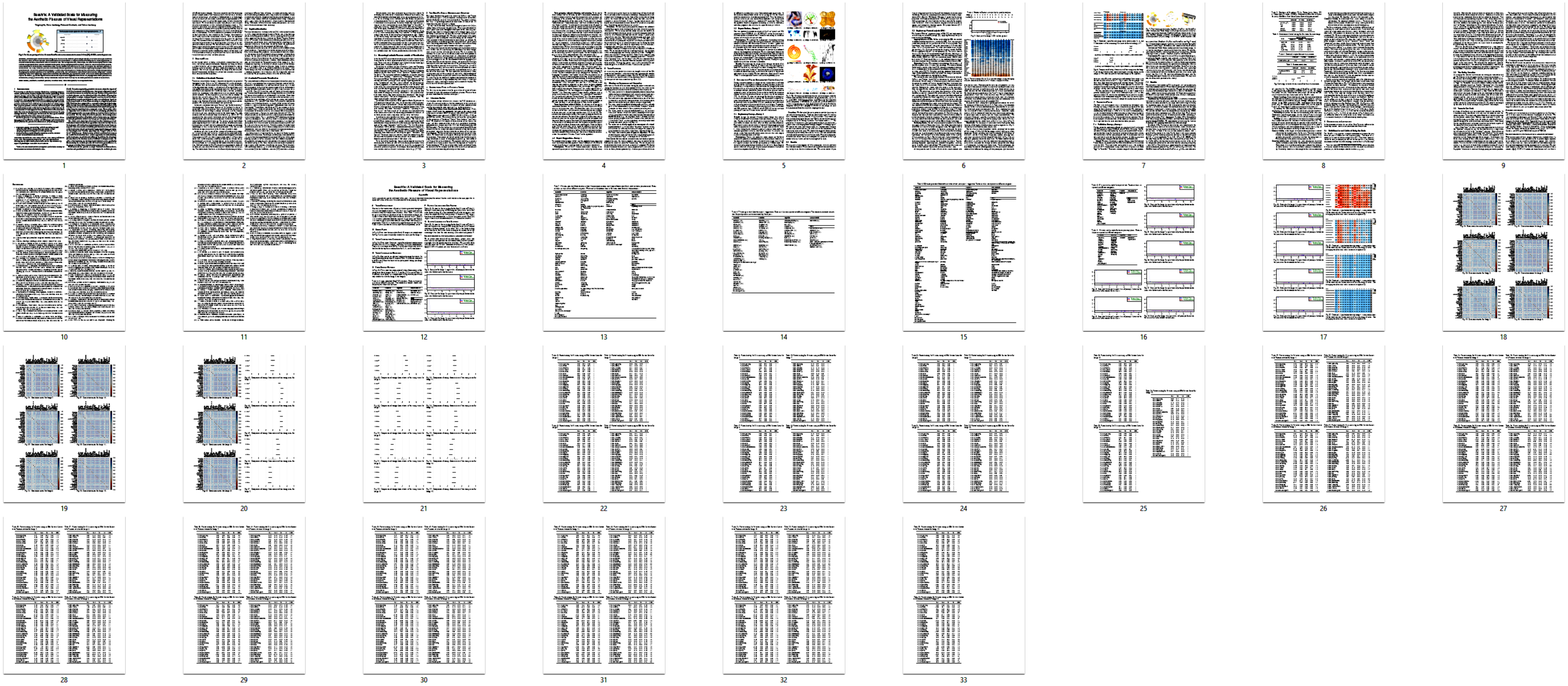

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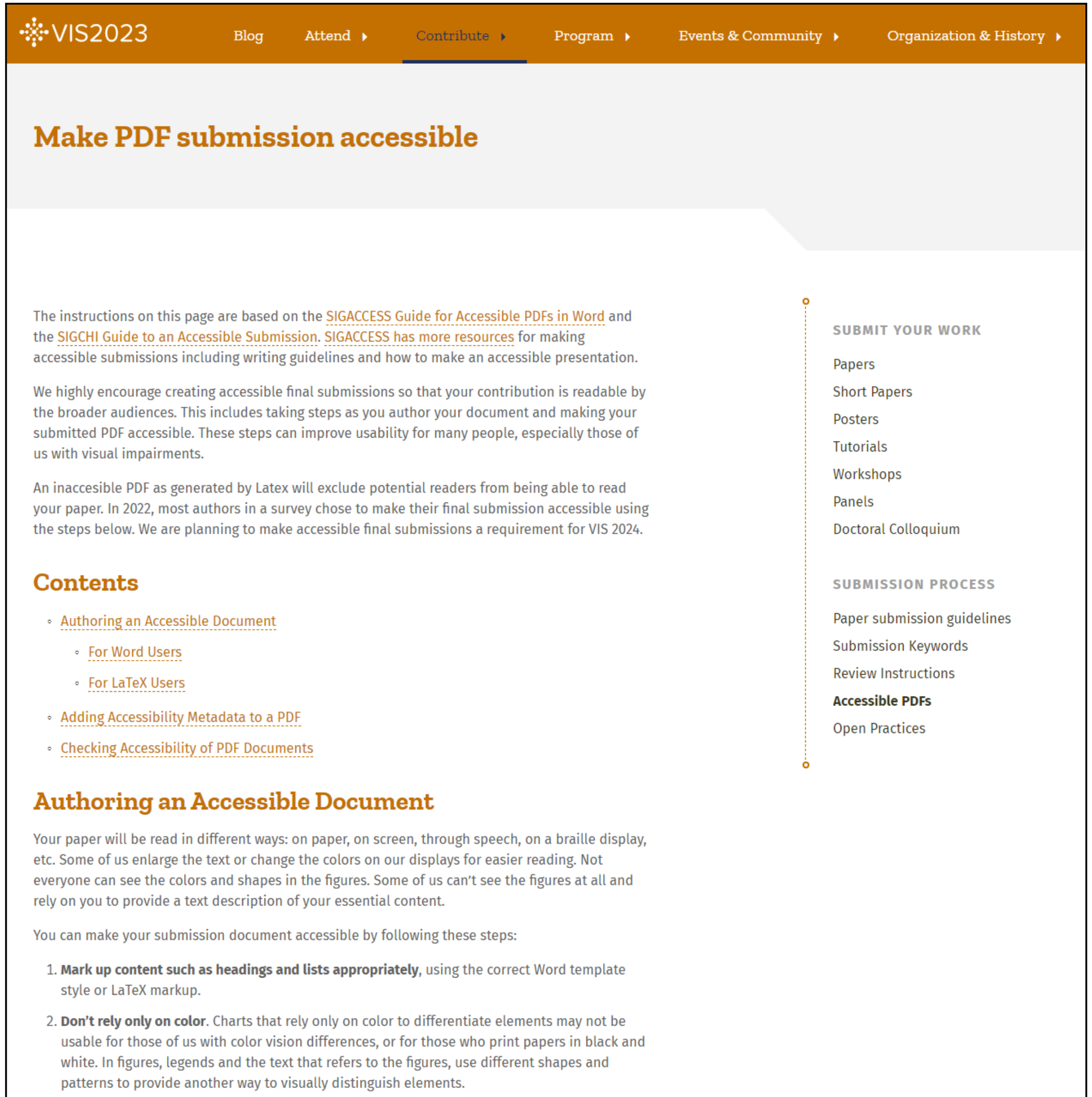

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The instructions on this page are based on the SIGACCESS Guide for Accessible PDFs in Word and the SIGCHI Guide to an Accessible Submission. SIGACCESS has more resources for making accessible submissions including writing guidelines and how to make an accessible presentation.

We highly encourage creating accessible final submissions so that your contribution is readable by the broader audiences. This includes taking steps as you author your document and making your submitted PDF accessible. These steps can improve usability for many people, especially those of us with visual impairments.

An inaccessible PDF as generated by Latex will exclude potential readers from being able to read your paper. In 2022, most authors in a survey chose to make their final submission accessible using the steps below. We are planning to make accessible final submissions a requirement for VIS 2024.

Contents

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Your paper will be read in different ways: on paper, on screen, through speech, on a braille display, etc. Some of us enlarge the text or change the colors on our displays for easier reading. Not everyone can see the colors and shapes in the figures. Some of us can't see the figures at all and rely on you to provide a text description of your essential content.

You can make your submission document accessible by following these steps:

1. **Mark up content such as headings and lists appropriately**, using the correct Word template style or LaTeX markup.
2. **Don't rely only on color**. Charts that rely only on color to differentiate elements may not be usable for those of us with color vision differences, or for those who print papers in black and white. In figures, legends and the text that refers to the figures, use different shapes and patterns to provide another way to visually distinguish elements.

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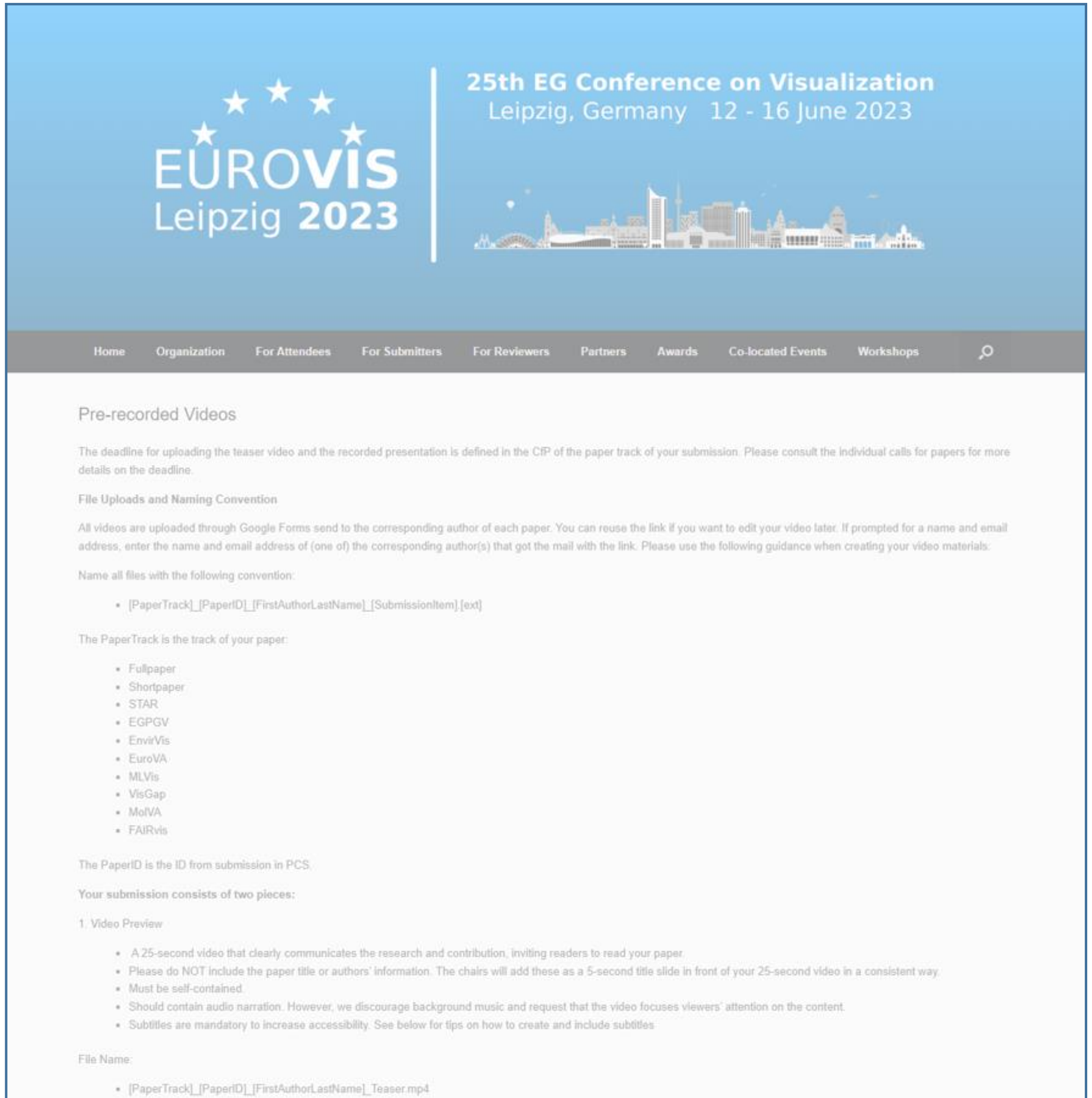
- **Accessible PDFs**
- Open Practices



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All videos are uploaded through Google Forms send to the corresponding author of each paper. You can reuse the link if you want to edit your video later. If prompted for a name and email address, enter the name and email address of (one of) the corresponding author(s) that got the mail with the link. Please use the following guidance when creating your video materials:

Name all files with the following convention:

- [PaperTrack]_[PaperID]_[FirstAuthorLastName]_[SubmissionItem].[ext]

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- Shortpaper
- STAR
- EGPGV
- EnvirVis
- EuroVA
- MLVis
- VisGap
- MolVA
- FAIRvis

The PaperID is the ID from submission in PCS.

Your submission consists of two pieces:

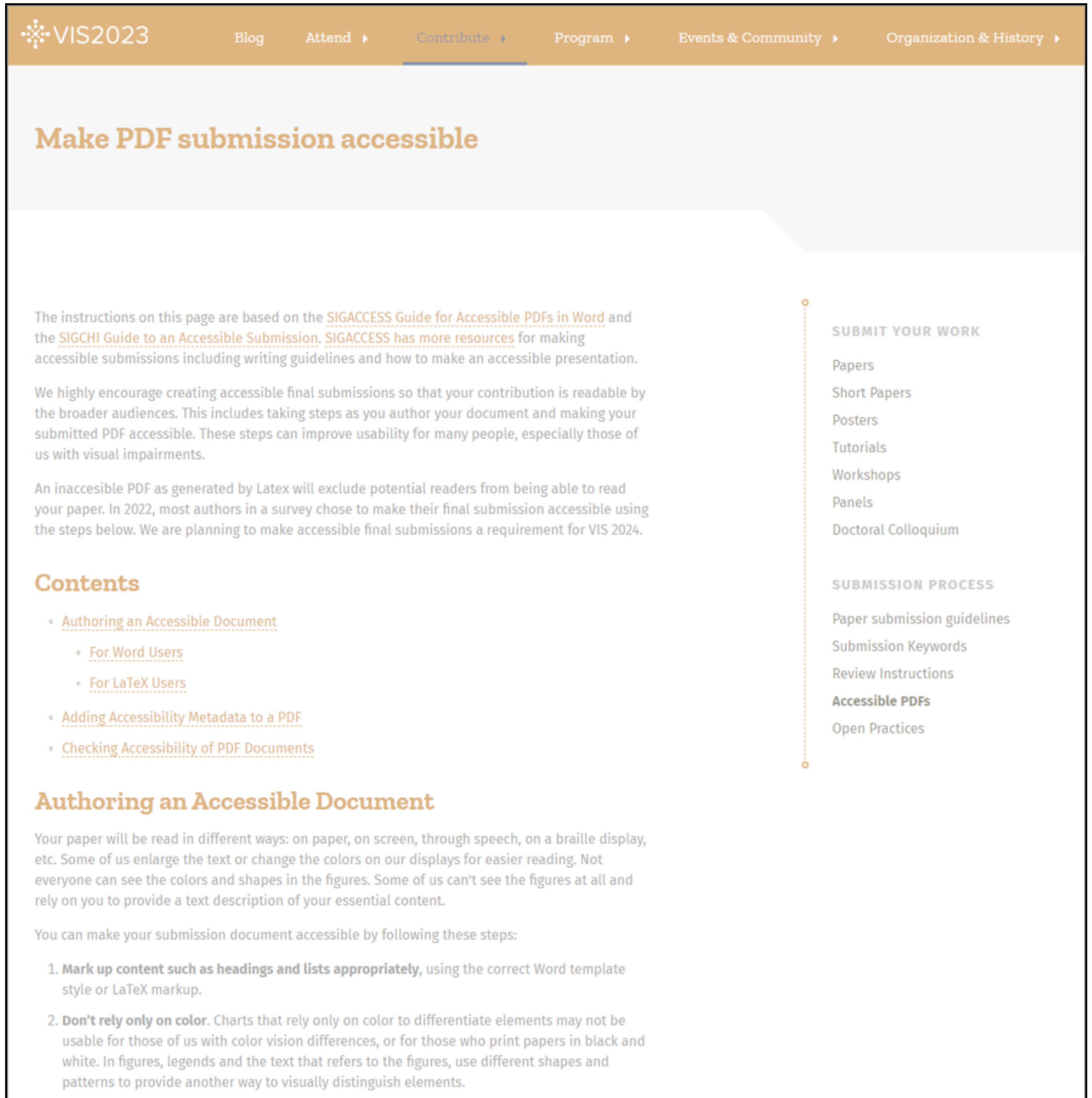
1. Video Preview

- A 25-second video that clearly communicates the research and contribution, inviting readers to read your paper.
- Please do NOT include the paper title or authors' information. The chairs will add these as a 5-second title slide in front of your 25-second video in a consistent way.
- Must be self-contained.
- Should contain audio narration. However, we discourage background music and request that the video focuses viewers' attention on the content.
- Subtitles are mandatory to increase accessibility. See below for tips on how to create and include subtitles

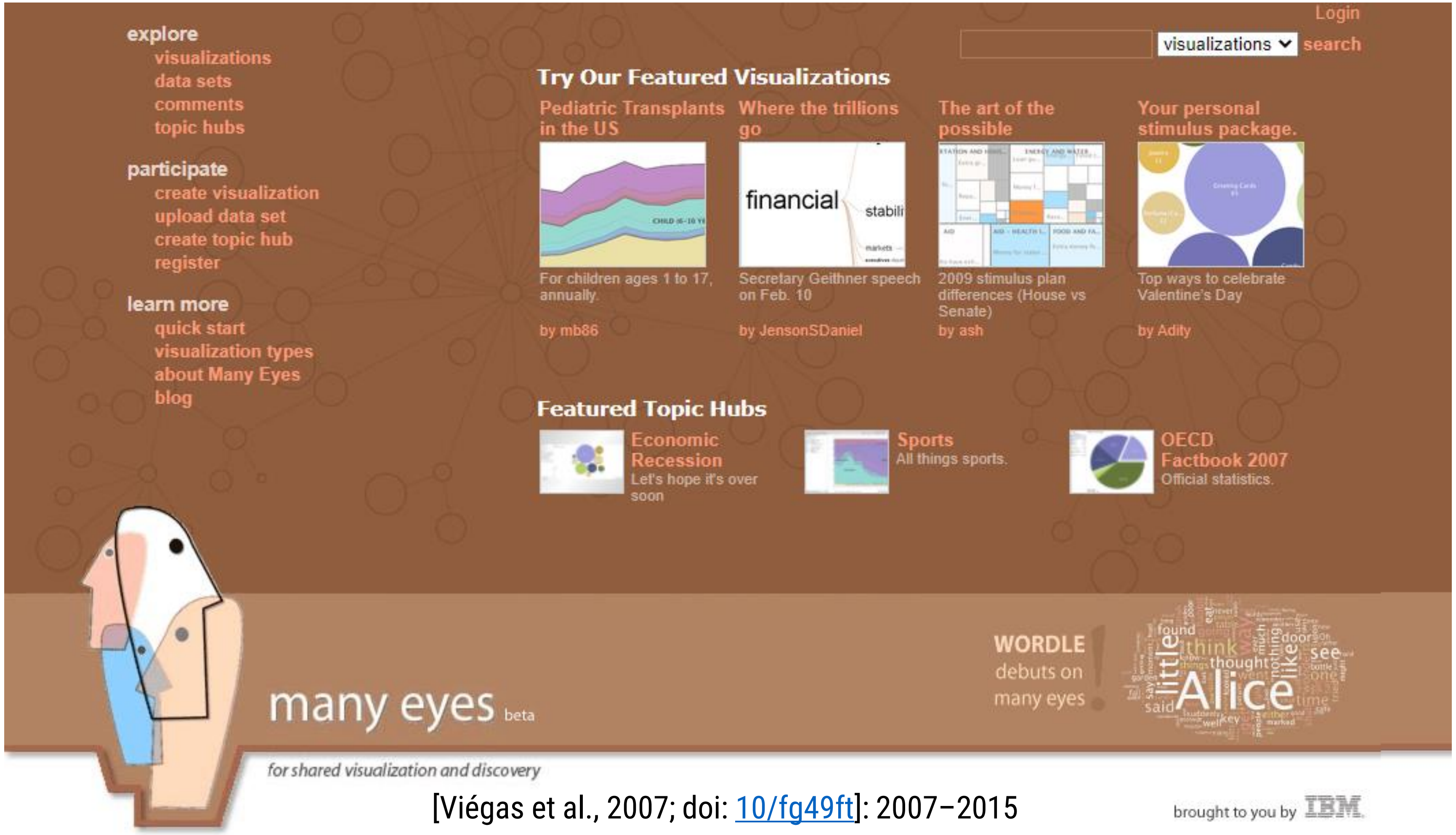
File Name:

- [PaperTrack]_[PaperID]_[FirstAuthorLastName]_Teaser.mp4

Is visualization work accessible?



Is visualization work interoperable?



[Viégas et al., 2007; doi: 10/fg49ft]: 2007–2015

Is visualization work interoperable?

[Schroeder et al., 2004]

[Tierny et al., 2018; doi: 10/gcp6wf]

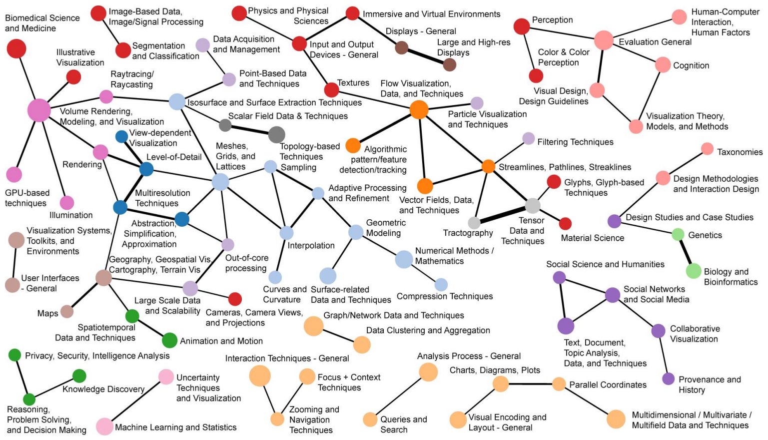
[Bostock et al., 2011; doi: 10/b7bhhf]

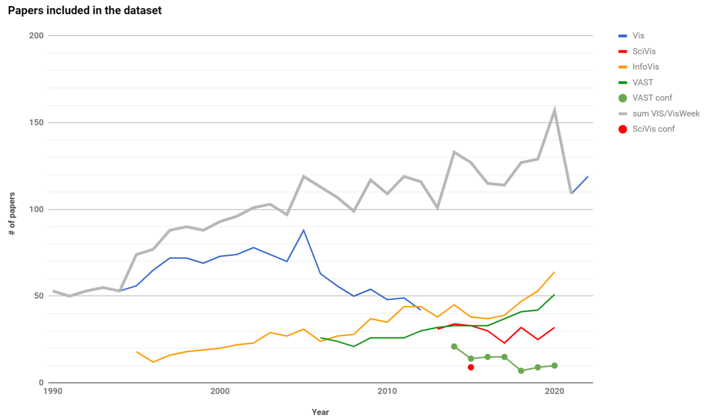
Is visualization work reproducible?

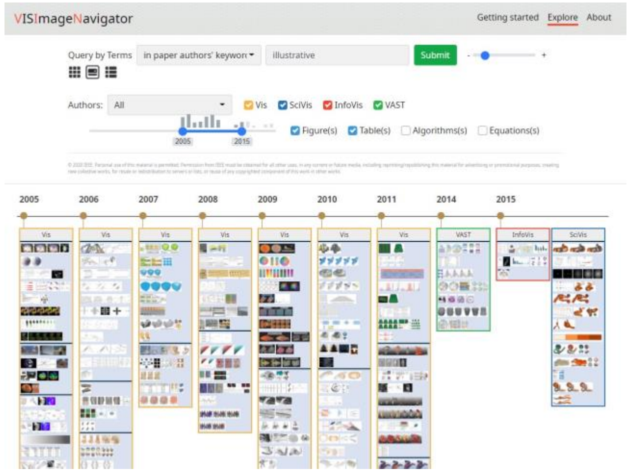
Graphics Replicability Stamp Initiative
[replicabilitystamp.org]

Discussion points/take-aways

- credit often only for initial release (paper)
- project/data maintenance it is not (academically) rewarded, but good systems/datasets get cited a lot
- accessibility, interoperability, reproducibility is yet extra effort, should be rewarded more
- some tasks could be pushed to publisher or community
- personal initiative can make a difference
- how do FAIR practices remain manageable for authors?







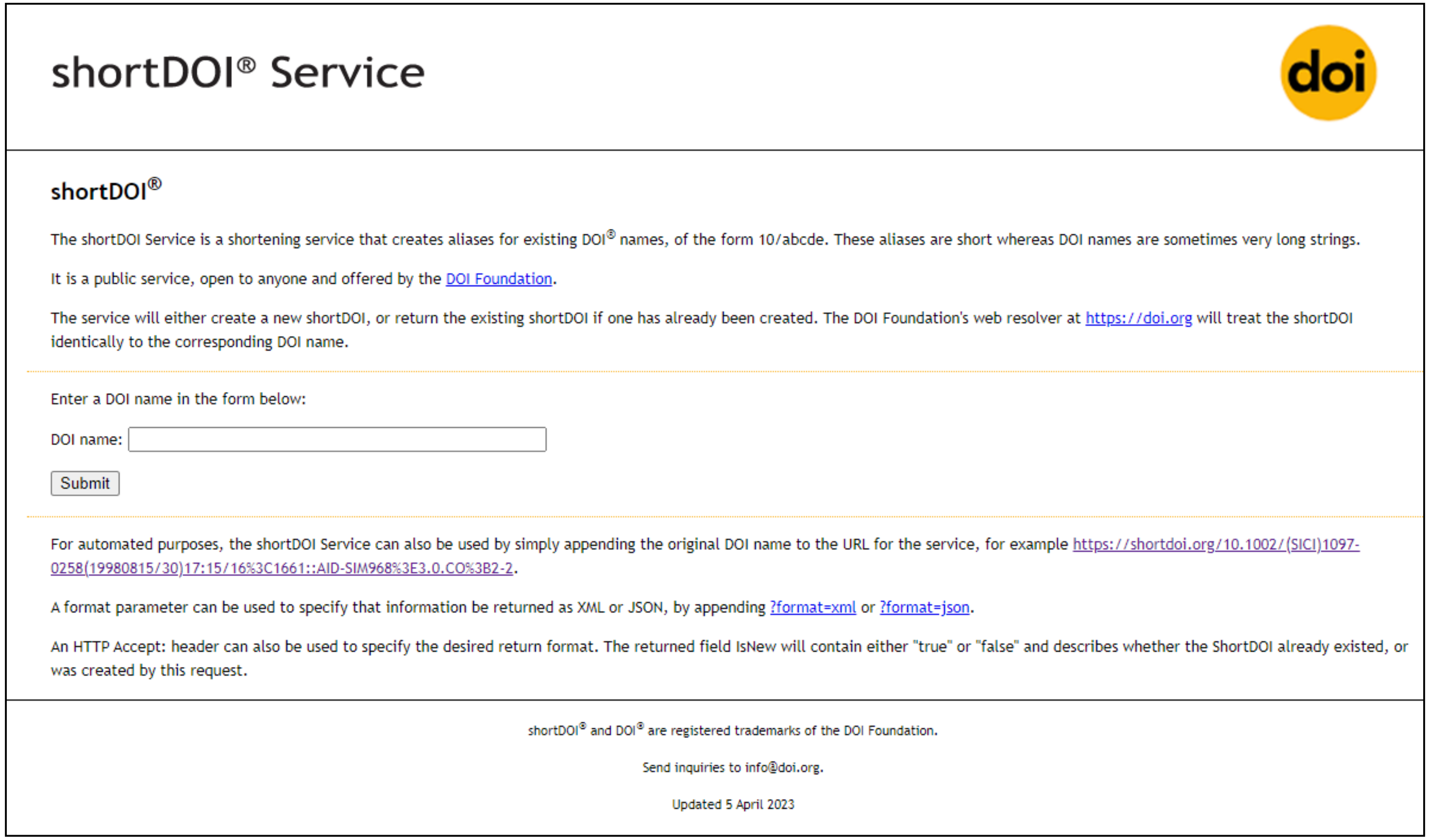
Toward FAIR Visualization of Visualization Research

Tobias Isenberg

Resources

- keyvis.org: tobias.isenberg.cc/p/Isenberg2017VST
- vispubdata.org: tobias.isenberg.cc/p/Isenberg2017VMC
- VIS30K: tobias.isenberg.cc/p/Chen2021VCF
- VISGAP on demos: tobias.isenberg.cc/p/Isenberg2022PEP

shortener



shortdoi.org