INTRODUCTION
P5 & DATA ANALYSIS CHALLENGE

PETRA ISENBERG

INFOVIS

DATA ANALYSIS

Challenge

BIBLIOMETRICS

Study of measuring and analysing science, technology and innovation

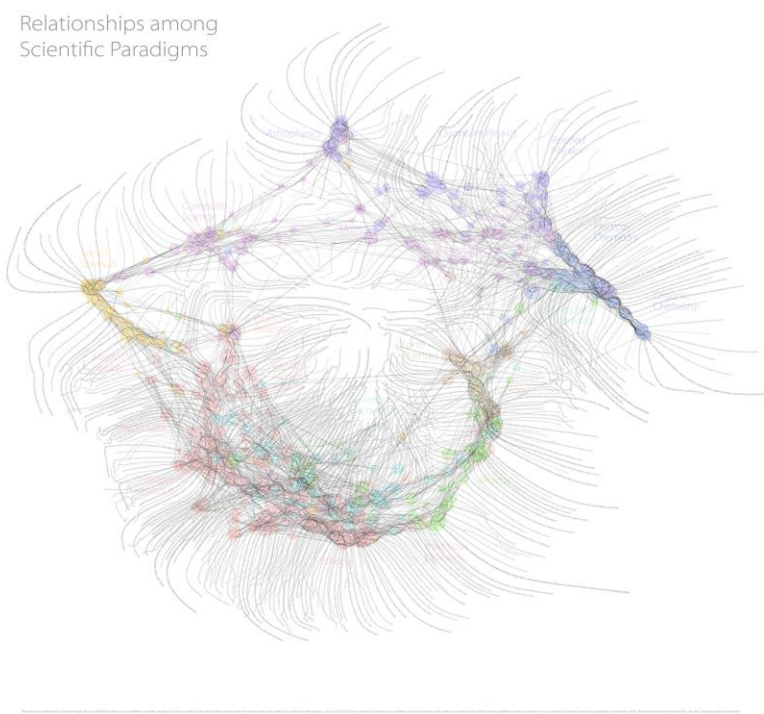
BIBLIOMETRICS

the application of mathematical and statistical methods to books and other media of communication (Pritchard, 1969)

Scientometrics: the science of measuring and analyzing science

WHY?

to understand science



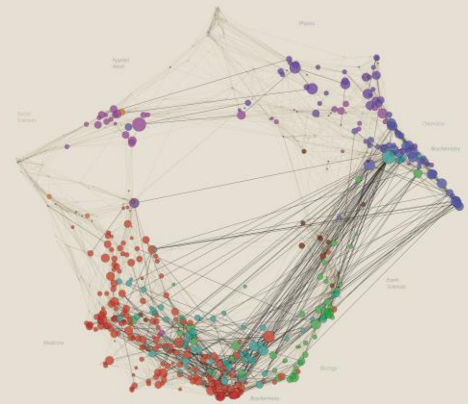
http://wbpaley.com/brad/mapOfScience/

The Scientific Paradigms that Support Patent Generation

This network diagram directs attention to the areas of science that support patents. Each circular node represents scientific publications on a topic (more accurately called a paradigm). There are 776 nodes in all, distributed in a ring-like structure; the larger colored ones are the ones that represent scientific paradigms that generate many patents. General groupings of paradigms include those that concern physics (at approximately 1:00), Chemistry (2:00), nodes that form the jutting peninsula of Organic Chemistry (at 3:00), clusters of nodes dealing with Earth Sciences and Biology (4:00), an interesting span of real Biochemistry from 4:00 to 6:00, linking Chemistry to Medicine (from 6:00 to 8:00), the Social Sciences (9:00) and Applied Math (including Computer Science, at 10:00).

The size of each colored node represents the number of patents that build from that area of science. Patents emerge from three general areas of science. There is a concentration of network of research in the computer science (around 10:00), a larger band of science in physics in chemistry (between 12:30 and 3:00), and a very large band of science in the medical sciences that yield patents. There are relatively fewer patents emerging from the social sciences (9:00), astrophysics (12:00) and the earth sciences (3:30).

The edges (lines between nodes) represent papers that explore multiple scientific paradigms; the black edges are the ones where patents are created. Chemistry and medicine seem to have many edges between them. This represents the large number of pharmaceutical patents that must do interdisciplinary work to bridge these disparate scientific paradigms. There are a particularly large number of links between areas of chemistry dealing with analytical methods (at 2:30) and the treatment of infectious diseases (5:00). There are also many patents that build from disparate paradigms within medicine (between 6:00 and 8:00).



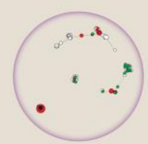
Drilling Down for Additional Insights

Paradigm 365

A paradigm in computer science has been pulled out of the diagram. Additional edges, showing relationships between this paradigm and other areas of science, illustrate that this paradigm links to the social sciences, chemistry, biology and medical science.

Research Communities within Paradigm 365

There are 85 unique research communities within this paradigm that are further grouped into four research areas. The size of each circle represents the amount of research in the area. The color represents performance: white for average, red for high-vitality science, green for patent-producing communities, black for communities that both get patents and practice high-vitality science.



Author Communities within Paradigm 365

The size of each circle represents the amount of research from each the 132 author clusters in this paradigm. The color represents performance, as mentioned at left. Author communities are much more dispersed (only 39% of the authors could be clustered). Authors that are members of clusters are much more likely to be associated with high performing science.

Themes within Paradigm 365

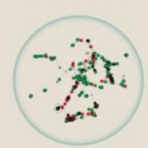
Another way to gain insights into this paradigm is to cluster the keywords in the 2160 scientific publications. The 127 keyword clusters shown below are more interconnected than the other two diagrams. The largest and most interconnected theme (the large black circle near the middle) deals with the use of network diagrams to understand the development of the World Wide Web.

Paradigm 735

One of the largest and most important paradigms in Chemistry has been pulled out of the diagram in order to show its impact in medicine.. There are 8982 publications in this paradigm. The strongest edges connecting it and other paradigms are shown to illustrate the wide variety of scientific disciplines with which it shares publications.

Research Communities within Paradigm 735

There are 455 unique research communities within paradigm 735. The relationships between these clusters suggest a relatively complex but highly structured set of research topics. The dispersion of patent-supporting science (green and black) suggest areas to focus on and areas where the science is not as likely to generate patents.



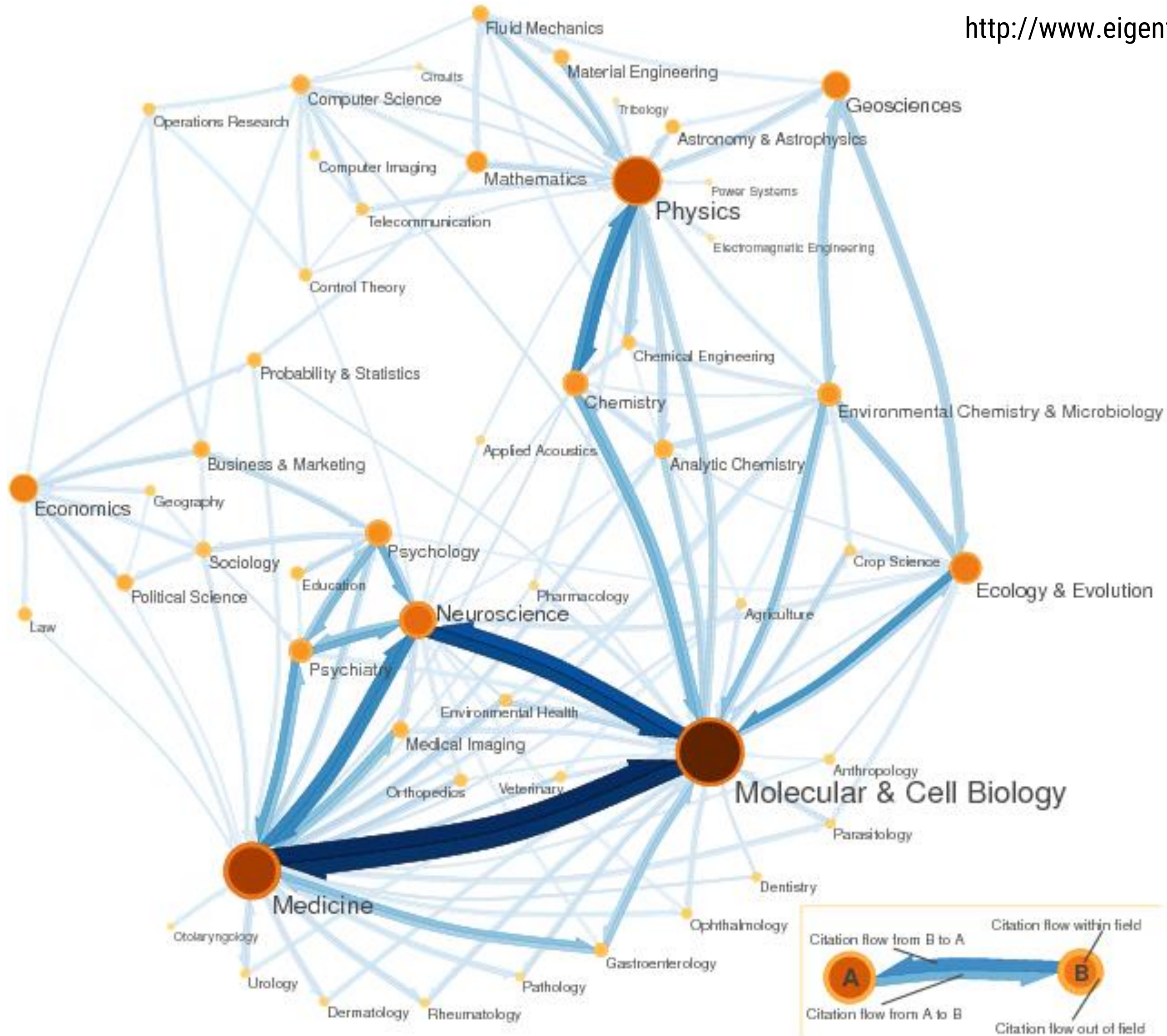
Author Communities within Paradigm 735

The size of each circle represents the amount of research from the 902 author clusters in this paradigm. Author communities are more dispersed that the paradigm shown above (only 28% of the authors are members of an author community). However, authors that are members of these clusters are much more likely to be associated with high performing science.

Themes within Paradigm 735

The 892 clusters of keywords shown below form a very tight star pattern. This suggests a central theme to the research area. The largest and most interconnected theme in the paradigm deals with proteomics. Overall, the paradigm deals with many of the new work in chemistry that is being applied to drug development.

http://www.eigenfactor.org/map/maps.php



WHY?

- to understand science
- to manage science / research
  - ranking of scholarly output of researchers / institutions
  - identifying the centers of excellence

WHY IMPORTANT?

- Globalization of research
- Availability of large databases
- Increased research output → need for awareness
- Quickly evolving research fields

HOW WILL WE ANALYZE SCIENCE?

- through the study of scientific publications
- in the domains of Visual Analytics and Visualization
- by building our own tools

SCIENTIFIC PUBLICATIONS

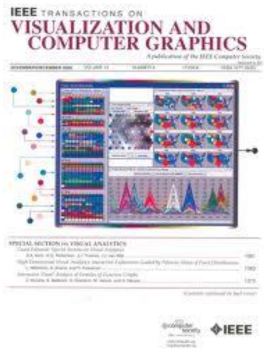
Why are they there?

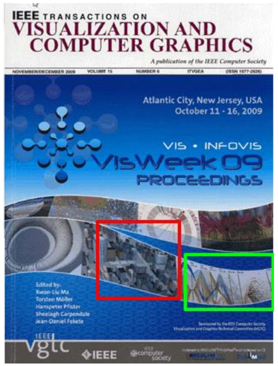
1. Sharing scientific results/methods/processes
2. To show research performance
3. To allow validation of findings
4. To gain prestige and recognition

PUBLICATION VENUES

Conferences vs. Journals

- journals typical publication venues in most sciences
- in computer science (some) conference publications are highly regarded (with acceptance rates <25%)





RESEARCH QUESTIONS

- Simple & boring
  - Numbers of papers at IEEE VIS 2015
- Boring
  - Numbers of papers by P. Isenberg in 2015
- Interesting (unfortunately not simple)
  - In the domain of visual analytics growing or shrinking?
  - Are visual analytics and visualization the same community?
  - Are research interests of specific researchers changing?
  - What are new research trends in visual analytics?
  - To which university should I go to do a PhD in visual analytics?
  - Who are good reviewers for a certain topic?
  - Who should be in the program committee of VAST / VIS 2017?
  - How does a change in affiliation impact a researcher’s interests?
  - I there a relation between affiliation and citations?

Exploring the Placement and Design of Word-Scale Visualizations

Pascal Goffin, Wesley Willett, Jean-Daniel Fekete *Senior Member, IEEE* and Petra Isenberg

Abstract—We present an exploration and a design space that characterize the usage and placement of word-scale visualizations within text documents. Word-scale visualizations are a more general version of sparklines—small, word-sized data graphics that allow meta-information to be visually presented in-line with document text. In accordance with Edward Tufte's definition, sparklines are traditionally placed directly before or after words in the text. We describe alternative placements that permit a wider range of word-scale graphics and more flexible integration with text layouts. These alternative placements include positioning visualizations between lines, within additional vertical and horizontal space in the document, and as interactive overlays on top of the text. Each strategy changes the dimensions of the space available to display the visualizations, as well as the degree to which the text must be adjusted or reflowed to accommodate them. We provide an illustrated design space of placement options for word-scale visualizations and identify six important variables that control the placement of the graphics and the level of disruption of the source text. We also contribute a quantitative analysis that highlights the effect of different placements on readability and text disruption. Finally, we use this analysis to propose guidelines to support the design and placement of word-scale visualizations.

Index Terms—Information visualization, text visualization, sparklines, glyphs, design space, word-scale visualizations

1 Introduction

Small high-resolution data graphics, included alongside words or word sequences in text documents, can often communicate information that could not be succinctly conveyed by the text itself. Examples include small stock charts embedded next to the name of a company, game statistics next to the name of a soccer team, or weather trends next to the name of a city. Traditionally, most of these "*word-scale visualizations*" have consisted of small line charts and bar charts and been placed in-line with text. Edward Tufte terms these word-scale visualizations "sparklines" [30], and provides some guidelines for their visual design. However, Tufte provides little guidance for *placing* word-scale visualizations with respect to text, suggesting only that they be placed in a "relevant context"—usually just after the word that they complement. However, the space of design and placement options for word-scale visualizations is actually quite large, and the consequences of placement decisions, in particular, are not well-understood.

In this paper, we provide design considerations for placing word-scale visualizations associated with words or word sequences (what we refer to as "entities") in a document. Our work is motivated by a close collaboration on digital note-taking with historians in the digital humanities. When visiting an archive, the historians we work with regularly take detailed notes on their findings. In these notes, they specifically tag entities such as the people, locations, or dates that occur in their document sources. The goal of tagging these entities is to help historians build an understanding of how entities relate to one another, where else the same entities appear in their notes, and what kinds of metadata are associated with them. Embedding this information using word-scale visualizations is a promising approach, because these small visualizations can add additional information in-context without distracting attention from the primary reading task.

In prior work, sparklines have typically been placed before or after the word they are related to. However, this is often not possible for the kinds of notes taken by our historians—e. g. when adding information to scanned documents and other immutable texts. Placing word-scale visualizations in-line with text may also be undesirable in other situations, as it requires reflowing the text and restricts the visualization's maximum height to that of the font—making visualizations hard to read when small font sizes were chosen. In-line visualizations can also disrupt sentences, making the text more difficult to read.

To better understand the options available for integrating word-scale visualizations in text documents, we outline a design space of possible placements relative to the text. In doing so, we relax some aspects of Tufte's original sparkline definition, imposing less restrictive size requirements and allowing the small visualizations to extend beyond strictly "word sized." Also, while Tufte did not restrict sparklines to specific visual encodings, the term "sparkline" does inherently suggest a "line-based" data encoding such as a line chart. In contrast, we specifically allow a variety of encodings, including geographical maps, heat maps, pie charts, and more complex visualizations and, thus, chose the term *word-scale visualizations*. We also formalize the notion of an *entity*—a concrete piece of text with associated metadata that can be encoded in a word-scale visualization. This explicit connection between an entity and a word-scale visualization directly affects the options for placing the visualization, and allows us to formally characterize the spatial relationship between text and graphic.

We begin our discussion by reviewing related work on small-scale and text visualizations. Then, in Section 3 we introduce the design space, its focus, and dimensions. Section 4 details several placement options and discusses trade-offs between word-scale visualization placement options. In Section 5 we discuss three examples that demonstrate the importance of the association between word-scale visualization and entity for the purpose of layout and interaction. Finally, in Section 6 we provide an in-depth analysis that examines how various placement options affect word-scale visualization placement in real documents. Based on this analysis, we provide recommendations that can help designers choose the right word-scale visualization given their own constraints.

2 Related Work

Our work relates closely to four research areas: (a) the use of sparklines and the design of word-scale visualizations (b) the integration of meta-data within text documents, (c) research on labeling in visualization, and (d) the readability of texts and visualizations.

2.1 Sparklines and Small-Scale Visualizations

According to Tufte [30] sparklines are "small, intense, simple, word-sized graphics with typographic resolution" that can be included anywhere a word or number can be—e. g. in a sentence, table, headline, map, spreadsheet or graphic. Tufte presents several examples of these embeddings. One example shows sparklines embedded in-line with text in order to provide metadata for a single word, for example glucose measurements next to the word glucose. In another, sparklines

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References

[1] A. Abdul-Rahman, J. Lein, K. Coles, E. Maguire, M. Meyer, M. Wynne, C. R. Johnson, A. Trefethen, and M. Chen. Rule-based visual mappings–with a case study on poetry visualization. *Computer Graphics Forum*, 32(3):381–390, 2013.

[2] E. Bertini, M. Rigamonti, and D. Lalanne. Extended excentric labeling. *Computer Graphics Forum*, 28(3):927–934, 2009.

[3] S. Bird, E. Klein, and E. Loper. *Natural Language Processing with Python*. O'Reilly Media Inc., 2009.

[4] R. Borgo, J. Kehrer, D. H. Chung, E. Maguire, R. S. Laramee, H. Hauser, M. Ward, and M. Chen. Glyph-based visualization: Foundations, design guidelines, techniques and applications. In *Eurographics 2013–State of the Art Reports*, pages 39–63. The Eurographics Association, 2012.

[5] M. Bostock, V. Ogievetsky, and J. Heer. D^3 data-driven documents. *IEEE Transactions on Visualization and Computer Graphics*, 17(12):2301–2309, 2011.

[6] U. Brandes, B. Nick, B. Rockstroh, and A. Steffen. Gestaltlines. *Computer Graphics Forum*, 32(3):171–180, 2013.

[7] B.-W. Chang, J. D. Mackinlay, P. T. Zellweger, and T. Igarashi. A negotiation architecture for fluid documents. In *Proceedings of the Conference on User Interface Software and Technology (UIST)*, pages 123–132. ACM, 1998.

[8] W. S. Cleveland, M. E. McGill, and R. McGill. The shape parameter of a two-variable graph. *Journal of the American Statistical Association*, 83(402):289–300, 1988.

[9] M. C. Dyson. How physical text layout affects reading from screen. *Behaviour & Information Technology*, 23(6):377–393, 2004.

[10] J.-D. Fekete and C. Plaisant. Excentric labeling: Dynamic neighborhood labeling for data visualization. In *Proceedings of the Conference on Human Factors in Computing Systems (CHI)*, pages 512–519. ACM, 1999.

[11] S. Few. Time on the horizon, Last read: March 2014. `http://www.perceptualedge.com/articles/visual_business_intelligence/time_on_the_horizon.pdf`.

[12] J. Fuchs, F. Fischer, F. Mansmann, E. Bertini, and P. Isenberg. Evaluation of alternative glyph designs for time series data in a small multiple setting. In *Proceedings of the Conference on Human Factors in Computing Systems (CHI)*, pages 3237–3246. ACM, 2013.

[13] P. Goffin, W. Willett, J.-D. Fekete, and P. Isenberg. Sparklificator, Last read: June 2014. `http://inria.github.io/sparklificator/`.

[14] B. Greenhill, M. Ward, and A. Sacks. The separation plot: A new visual method for evaluating the fit of binary models. *American Journal of Political Science*, 55(4):991–1002, 2011.

[15] J. Heer and M. Agrawala. Multi-scale banking to 45 degrees. *IEEE Transactions on Visualization and Computer Graphics*, 12(5):701–708, 2006.

[16] J. Heer, N. Kong, and M. Agrawala. Sizing the horizon: The effects of chart size and layering on the graphical perception of time series visualizations. In *Proceedings of the Conference on Human Factors in Computing Systems (CHI)*, pages 1303–1312. ACM, 2009.

[17] M. R. Jakobsen and K. Hornbæk. Transient visualizations. In *Proceedings of the Conference on Computer-Human Interaction (OzCHI)*, pages 69–76. ACM, 2007.

[18] B. Lee, N. H. Riche, A. K. Karlson, and S. Carpendale. SparkClouds: Visualizing trends in tag clouds. *IEEE Transactions on Visualization and Computer Graphics*, 16(6):1182–1189, 2010.

[19] J. Pearson, G. Buchanan, and H. Thimbleby. Improving annotations in digital documents. In *Research and Advanced Technology for Digital Libraries*, pages 429–432. Springer, 2009.

[20] C. Perin, R. Vuillemot, and J.-D. Fekete. SoccerStories: A kick-off for visual soccer analysis. *IEEE Transactions on Visualization and Computer Graphics*, 19(12):2506–2515, 2013.

[21] P. Pirolli and S. Card. Information foraging. *Psychological Review*, 106(4):643–675, 1999.

[22] H. Reijner. The development of the horizon graph. In *Proceeding of Workshop From Theory to Practice: Design, Vision and Visualization Extended Abstracts of IEEE VisWeek*. Citeseer, 2008.

[23] T. Ropinski, S. Oeltze, and B. Preim. Survey of glyph-based visualization techniques for spatial multivariate medical data. *Computers & Graphics*, 35(2):392–401, 2011.

[24] T. Saito, H. N. Miyamura, M. Yamamoto, H. Saito, Y. Hoshiya, and T. Kaseda. Two-tone pseudo coloring: Compact visualization for one-dimensional data. In *Proceedings of the Conference on Information Visualization (InfoVis)*, pages 173–180. IEEE, 2005.

[25] H.-J. Schulz, T. Nocke, M. Heitzler, and H. Schumann. A design space of visualization tasks. *IEEE Transactions on Visualization and Computer Graphics*, 19(12):2366–2375, 2013.

[26] M. Steinberger, M. Waldner, M. Streit, A. Lex, and D. Schmalstieg. Context-preserving visual links. *IEEE Transactions on Visualization and Computer Graphics*, 17(12):2249–2258, 2011.

[27] M. Stone. In color perception, size matters. *IEEE Computer Graphics and Applications*, 32(2):8–13, 2012.

[28] J. Talbot, J. Gerth, and P. Hanrahan. An empirical model of slope ratio comparisons. *IEEE Transactions on Visualization and Computer Graphics*, 18(12):2613–2620, 2012.

[29] E. R. Tufte. *Envisioning Information*. Graphics Press, Cheshire, CT, 1990.

[30] E. R. Tufte. *Beautiful Evidence*. Graphics Press, Cheshire, CT, 2006.

[31] M. O. Ward. A taxonomy of glyph placement strategies for multidimensional data visualization. *Information Visualization*, 1(3-4):194–210, 2002.

[32] W. Willett, J. Heer, and M. Agrawala. Scented widgets: Improving navigation cues with embedded visualizations. *IEEE Transactions on Visualization and Computer Graphics*, 13(6):1129–1136, 2007.

[33] D. Yoon, N. Chen, and F. Guimbretière. TextTearing: Opening white space for digital ink annotation. In *Proceedings of the Conference on User Interface Software and Technology (UIST)*, pages 107–112. ACM, 2013.

[34] P. T. Zellweger, S. H. Regli, J. D. Mackinlay, and B.-W. Chang. The impact of fluid documents on reading and browsing: An observational study. In *Proceedings of the Conference on Human Factors in Computing Systems (CHI)*, pages 249–256. ACM, 2000.

DATA SET

16 columns, 2753 rows

	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P
1	Conference	Year	Paper.Title	Paper.DOI	Link	First.page	Last.page	Paper.typ	Abstract	Author.Na	First.Auth	Deduped.	Reference	Author.Ke	OCR.Title	OCR.Authors
2	InfoVis	2015	A comparative stud	10.1109/TVCG.201	http://dx.	619	628	J	RadViz an	Rubio-San	;;;	Rubio-San	10.1109/V	RadViz, St	A compara	Rubio-S Â´ Anchez,Manuel;Raya,Laura;DÃ-az,Francisco;Sanchez,Alberto
3	InfoVis	2015	A Linguistic Approa	10.1109/TVCG.201	http://dx.	698	707	J	When dat	Setlur, V.;	;	Setlur, V.;Stone, M.(		linguistics	A Linguist	Setlur,Vidya;Stone,Maureen
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5	InfoVis	2015	A Simple Approach	10.1109/TVCG.201	http://dx.	678	687	J	General m	Simonetto	;;	Simonetto	10.1109/T	Euler diag	A Simple A	Simonetto,Paolo;Archambault,Daniel;Scheidegger,Carlos
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7	InfoVis	2015	AggreSet: Rich and	10.1109/TVCG.201	http://dx.	688	697	J	Datasets c	Yalcin, M.A	Univ. of M	Yalcin, M.A	10.1109/T	Multi-valu	AggreSet:	Adil YalÃ§Ä±n,M;Bederson,Benjamin
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11	InfoVis	2015	Beyond Weber's La	10.1109/TVCG.201	http://dx.	469	478	J	Models of	Kay, M.;He	;	Kay, M.;He	10.1109/T	Weber's la	Beyond W	Kay,Matthew;Heer,Jeffrey
12	InfoVis	2015	Evaluation of Paral	10.1109/TVCG.201	http://dx.	579	588	J	The parall	Johansson	Norrkopin	Johansson	10.1109/T	Survey, ev	Evaluation	Johansson,Jimmy;Forsell,Camilla
13	InfoVis	2015	Guidelines for Effe	10.1109/TVCG.201	http://dx.	489	498	J	Semi-auto	Strobelt, H	;;;;	Strobelt, H	10.1109/T	Text highl	Guideline	Strobelt,Hendrik;Oelke,Daniela;Kwon,Chul;Schreck,Tobias;Pfister,Hanspeter
14	InfoVis	2015	High-Quality Ultra-	10.1109/TVCG.201	http://dx.	339	348	J	Prior rese	Yoghourdj	;;;;;	Yoghourdj	10.1109/T	Network v	High-Qual	Yoghourdjian,Vahan;Dwyer,Tim;Gange,Graeme;Kieffer,Steve;Klein,Karsten;M
15	InfoVis	2015	HOLA: Human-like	10.1109/TVCG.201	http://dx.	349	358	J	Over the l	Kieffer, S.	;;;	Kieffer, S.	10.1109/T	Graph layo	HOLA: Hu	Kieffer,Steve;Dwyer,Tim;Marriott,Kim;Wybrow,Michael
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17	InfoVis	2015	Improving Bayesian	10.1109/TVCG.201	http://dx.	529	538	J	Decades c	Ottley, A.;	;;;;;;;	Ottley, A.;	10.1109/T	Bayesian F	Improving	Ottley,Alvitta;Peck,Evan;Harrison,Lane;Afergan,Daniel;Ziemkiewicz,Caroline
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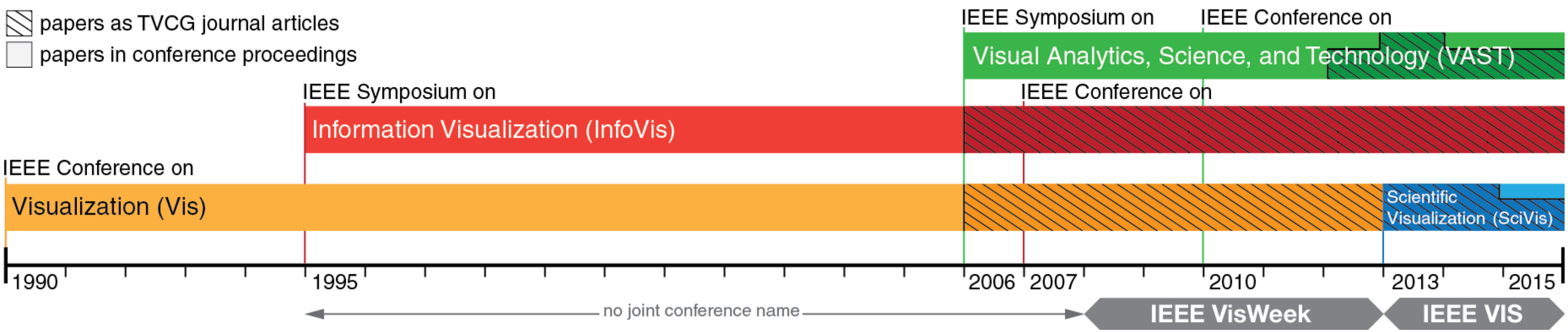
20	InfoVis	2015	Optimal Sets of Pro	10.1109/TVCG.201	http://dx.	609	618	J	Finding go	Lehmann,	Univ. of M	Lehmann,	10.1109/V	Multivaria	Optimal S	Lehmann,Dirk;Theisel,Holger

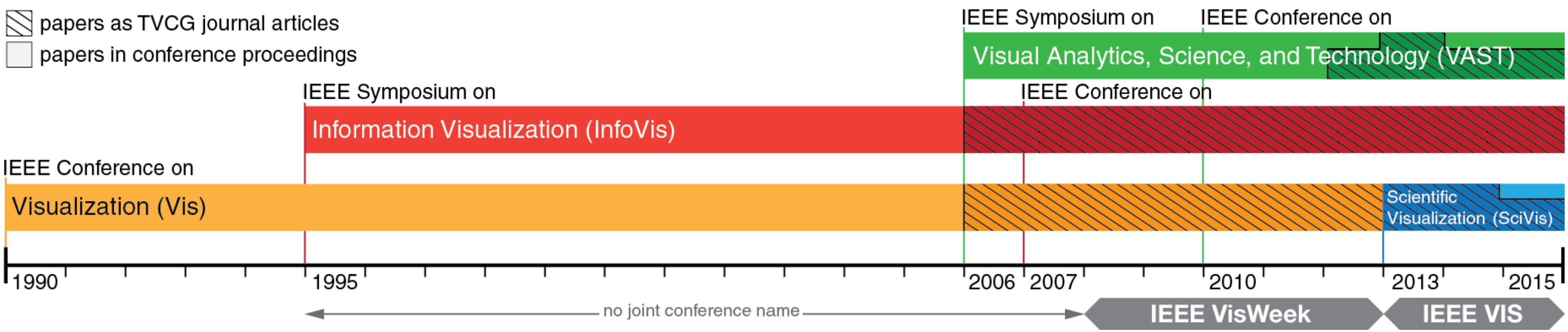
a version of: http://www.vispubdata.org/site/vispubdata/

CONFERENCE



{InfoVis, Vis, SciVis, VAST}

YEAR



{1990 - 2015}

TITLE

Exploring the Placement and Design of Word-Scale Visualizations

Pascal Goffin, Wesley Willett, Jean-Daniel Fekete *Senior Member, IEEE* and Petra Isenberg

Abstract—We present an exploration and a design space that characterize the usage and placement of word-scale visualizations within text documents. Word-scale visualizations are a more general version of sparklines—small, word-sized data graphics that allow meta-information to be visually presented in-line with document text. In accordance with Edward Tufte's definition, sparklines are traditionally placed directly before or after words in the text. We describe alternative placements that permit a wider range of word-scale graphics and more flexible integration with text layouts. These alternative placements include positioning visualizations between lines, within additional vertical and horizontal space in the document, and as interactive overlays on top of the text. Each strategy changes the dimensions of the space available to display the visualizations, as well as the degree to which the text must be adjusted or reflowed to accommodate them. We provide an illustrated design space of placement options for word-scale visualizations and identify six important variables that control the placement of the graphics and the level of disruption of the source text. We also contribute a quantitative analysis that highlights the effect of different placements on readability and text disruption. Finally, we use this analysis to propose guidelines to support the design and placement of word-scale visualizations.

Index Terms—Information visualization, text visualization, sparklines, glyphs, design space, word-scale visualizations

1 Introduction

Small high-resolution data graphics, included alongside words or word sequences in text documents, can often communicate information that could not be succinctly conveyed by the text itself. Examples include small stock charts embedded next to the name of a company, game statistics next to the name of a soccer team, or weather trends next to

alization's maximum height to that of the font—making visualizations hard to read when small font sizes were chosen. In-line visualizations can also disrupt sentences, making the text more difficult to read.

To better understand the options available for integrating word-scale visualizations in text documents, we outline a design space of possible placements relative to the text. In doing so, we relax some aspects of Tufte's original sparkline definition, imposing less restrictive size

PAPER DOI

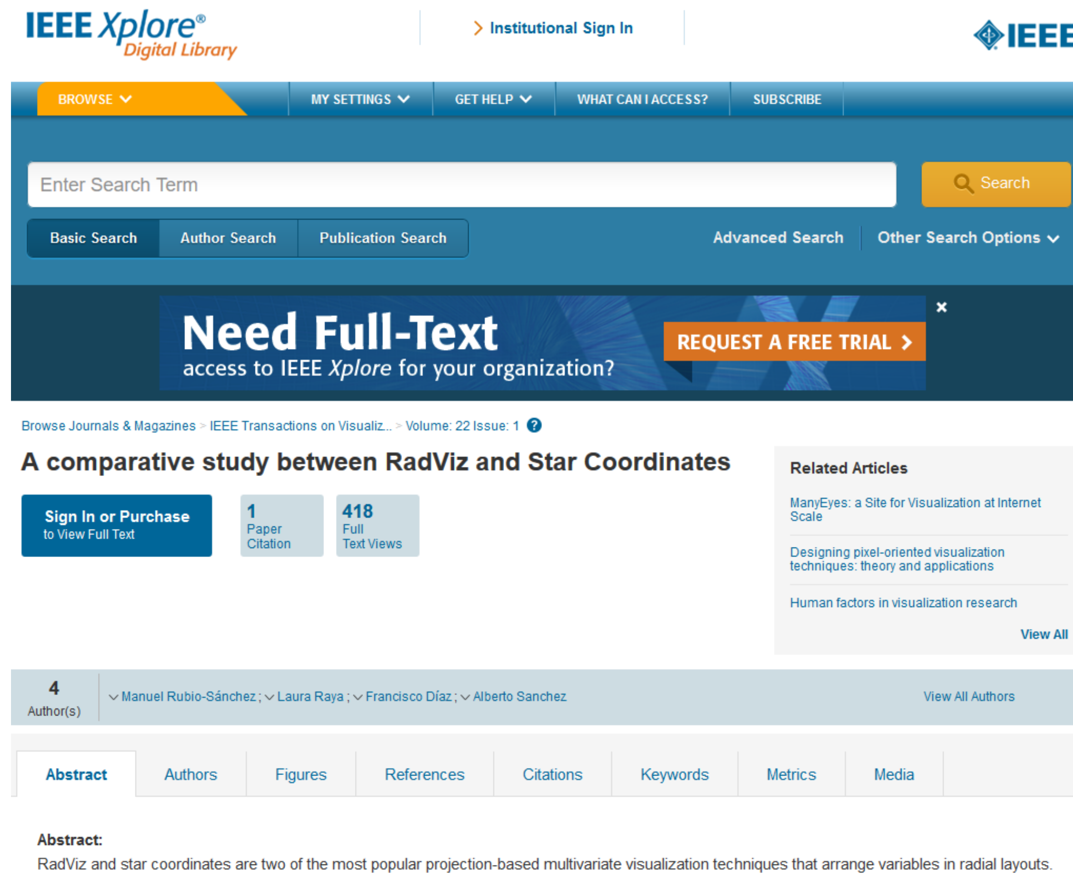
- A persistent identifier used to uniquely identify objects.
- Particularly used for electronic documents such as journal articles.

10.1109/TVCG.2015.2467471

= your unique key to each paper in the database

LINK

- A link to the digital library of the publisher of the paper
- The paper can be read/bought here



FIRST PAGE – LAST PAGE

- can be used to deduce page count
- likely not clean data

PAPER TYPE

- J = Journal
  - the most prestigious type
  - a full scientific paper (8-10 pages usually)
- C = Conference
  - a full scientific paper (8-10 pages usually)
- M = Miscellaneous
  - a poster (2 pages)
  - a talk abstract (1-2 pages)
  - NOT a full paper

ABSTRACT

a short summary of the paper content

Exploring the Placement and Design of Word-Scale Visualizations

Pascal Goffin, Wesley Willett, Jean-Daniel Fekete *Senior Member, IEEE* and Petra Isenberg

Abstract—We present an exploration and a design space that characterize the usage and placement of word-scale visualizations within text documents. Word-scale visualizations are a more general version of sparklines—small, word-sized data graphics that allow meta-information to be visually presented in-line with document text. In accordance with Edward Tufte's definition, sparklines are traditionally placed directly before or after words in the text. We describe alternative placements that permit a wider range of word-scale graphics and more flexible integration with text layouts. These alternative placements include positioning visualizations between lines, within additional vertical and horizontal space in the document, and as interactive overlays on top of the text. Each strategy changes the dimensions of the space available to display the visualizations, as well as the degree to which the text must be adjusted or reflowed to accommodate them. We provide an illustrated design space of placement options for word-scale visualizations and identify six important variables that control the placement of the graphics and the level of disruption of the source text. We also contribute a quantitative analysis that highlights the effect of different placements on readability and text disruption. Finally, we use this analysis to propose guidelines to support the design and placement of word-scale visualizations.

Index Terms—Information visualization, text visualization, sparklines, glyphs, design space, word-scale visualizations

1 INTRODUCTION

AUTHORS

- Lastname, F. – for Asian names often Firstname Lastname
- Separated by ;
- First author often the project lead
- Last author often the advisor

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DEDUPED AUTHORS

- Often authors appear with several spellings: Gröller, Groeller, Groller, M.E. Gröller, M. Gröller, E. Gröller
- This column has been cleaned up
- If you want to visualize author info, use this column

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OCR AUTHORS

- the papers have been run through an OCR algorithm
- it extracted full author names (full first name)
- it may not be clean

AUTHOR KEYWORDS

- added by the authors to a paper
- think of as tags describing the content

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REFERENCE

- which other VIS paper is cited from this particular paper
- based on DOI and separated by ;

10.1109/VAST.2010.5652433;10.1109/INFVIS.1998.729559;10.1109/VISUAL.1997.663916;10.1109/TVCG.2013.182;10.1109/TVCG.2014.2346258;10.1109/TVCG.2008.173

REFERENCES

[1] A. Abdul-Rahman, J. Lein, K. Coles, E. Maguire, M. Meyer, M. Wynne, C. R. Johnson, A. Trefethen, and M. Chen. Rule-based visual mappings–with a case study on poetry visualization. *Computer Graphics Forum*, 32(3):381–390, 2013.

[2] E. Bertini, M. Rigamonti, and D. Lalanne. Extended excentric labeling. *Computer Graphics Forum*, 28(3):927–934, 2009.

[3] S. Bird, E. Klein, and E. Loper. *Natural Language Processing with Python*. O'Reilly Media Inc., 2009.

[4] R. Borgo, J. Kehrer, D. H. Chung, E. Maguire, R. S. Laramee, H. Hauser, M. Ward, and M. Chen. Glyph-based visualization: Foundations, design guidelines, techniques and applications. In *Eurographics 2013–State of the Art Reports*, pages 39–63. The Eurographics Association, 2012.

[5] M. Bostock, V. Ogievetsky, and J. Heer. D^3 data-driven documents. *IEEE Transactions on Visualization and Computer Graphics*, 17(12):2301–2309, 2011.

[6] U. Brandes, B. Nick, B. Rockstroh, and A. Steffen. Gestaltlines. *Computer Graphics Forum*, 32(3):171–180, 2013.

[7] B.-W. Chang, J. D. Mackinlay, P. T. Zellweger, and T. Igarashi. A negotiation architecture for fluid documents. In *Proceedings of the Conference on User Interface Software and Technology (UIST)*, pages 123–132. ACM, 1998.

[8] W. S. Cleveland, M. E. McGill, and R. McGill. The shape parameter of a two-variable graph. *Journal of the American Statistical Association*, 83(402):289–300, 1988.

[9] M. C. Dyson. How physical text layout affects reading from screen. *Behaviour & Information Technology*, 23(6):377–393, 2004.

[10] J.-D. Fekete and C. Plaisant. Excentric labeling: Dynamic neighborhood labeling for data visualization. In *Proceedings of the Conference on Human Factors in Computing Systems (CHI)*, pages 512–519. ACM, 1999.

[11] S. Few. Time on the horizon, Last read: March 2014. http://www.perceptualedge.com/articles/visual_business_intelligence/time_on_the_horizon.pdf.

[12] J. Fuchs, F. Fischer, F. Mansmann, E. Bertini, and P. Isenberg. Evaluation of alternative glyph designs for time series data in a small multiple setting. In *Proceedings of the Conference on Human Factors in Computing Systems (CHI)*, pages 3237–3246. ACM, 2013.

[13] P. Goffin, W. Willett, J.-D. Fekete, and P. Isenberg. Sparklificator, Last read: June 2014. http://inria.github.io/sparklificator/.

[14] B. Greenhill, M. Ward, and A. Sacks. The separation plot: A new visual method for evaluating the fit of binary models. *American Journal of Political Science*, 55(4):991–1002, 2011.

[15] J. Heer and M. Agrawala. Multi-scale banking to 45 degrees. *IEEE Transactions on Visualization and Computer Graphics*, 12(5):701–708, 2006.

[16] J. Heer, N. Kong, and M. Agrawala. Sizing the horizon: The effects of chart size and layering on the graphical perception of time series visualizations. In *Proceedings of the Conference on Human Factors in Computing Systems (CHI)*, pages 1303–1312. ACM, 2009.

[17] M. R. Jakobsen and K. Hornbæk. Transient visualizations. In *Proceedings of the Conference on Computer-Human Interaction (OzCHI)*, pages 69–76. ACM, 2007.

[18] B. Lee, N. H. Riche, A. K. Karlson, and S. Carpendale. SparkClouds: Visualizing trends in tag clouds. *IEEE Transactions on Visualization and Computer Graphics*, 16(6):1182–1189, 2010.

[19] J. Pearson, G. Buchanan, and H. Thimbleby. Improving annotations in digital documents. In *Research and Advanced Technology for Digital Libraries*, pages 429–432. Springer, 2009.

[20] C. Perin, R. Vuillemot, and J.-D. Fekete. SoccerStories: A kick-off for visual soccer analysis. *IEEE Transactions on Visualization and Computer Graphics*, 19(12):2506–2515, 2013.

[21] P. Pirolli and S. Card. Information foraging. *Psychological Review*, 106(4):643–675, 1999.

[22] H. Reijner. The development of the horizon graph. In *Proceeding of Workshop From Theory to Practice: Design, Vision and Visualization Extended Abstracts of IEEE VisWeek*. Citeseer, 2008.

[23] T. Ropinski, S. Oeltze, and B. Preim. Survey of glyph-based visualization techniques for spatial multivariate medical data. *Computers & Graphics*, 35(2):392–401, 2011.

[24] T. Saito, H. N. Miyamura, M. Yamamoto, H. Saito, Y. Hoshiya, and T. Kaseda. Two-tone pseudo coloring: Compact visualization for one-dimensional data. In *Proceedings of the Conference on Information Visualization (InfoVis)*, pages 173–180. IEEE, 2005.

[25] H.-J. Schulz, T. Nocke, M. Heitzler, and H. Schumann. A design space of visualization tasks. *IEEE Transactions on Visualization and Computer Graphics*, 19(12):2366–2375, 2013.

[26] M. Steinberger, M. Waldner, M. Streit, A. Lex, and D. Schmalstieg. Context-preserving visual links. *IEEE Transactions on Visualization and Computer Graphics*, 17(12):2249–2258, 2011.

[27] M. Stone. In color perception, size matters. *IEEE Computer Graphics and Applications*, 32(2):8–13, 2012.

[28] J. Talbot, J. Gerth, and P. Hanrahan. An empirical model of slope ratio comparisons. *IEEE Transactions on Visualization and Computer Graphics*, 18(12):2613–2620, 2012.

[29] E. R. Tufte. *Envisioning Information*. Graphics Press, Cheshire, CT, 1990.

[30] E. R. Tufte. *Beautiful Evidence*. Graphics Press, Cheshire, CT, 2006.

[31] M. O. Ward. A taxonomy of glyph placement strategies for multidimensional data visualization. *Information Visualization*, 1(3-4):194–210, 2002.

[32] W. Willett, J. Heer, and M. Agrawala. Scented widgets: Improving navigation cues with embedded visualizations. *IEEE Transactions on Visualization and Computer Graphics*, 13(6):1129–1136, 2007.

[33] D. Yoon, N. Chen, and F. Guimbretière. TextTearing: Opening white space for digital ink annotation. In *Proceedings of the Conference on User Interface Software and Technology (UIST)*, pages 107–112. ACM, 2013.

[34] P. T. Zellweger, S. H. Regli, J. D. Mackinlay, and B.-W. Chang. The impact of fluid documents on reading and browsing: An observational study. In *Proceedings of the Conference on Human Factors in Computing Systems (CHI)*, pages 249–256. ACM, 2000.

RESEARCH QUESTIONS

What can we do with this data?

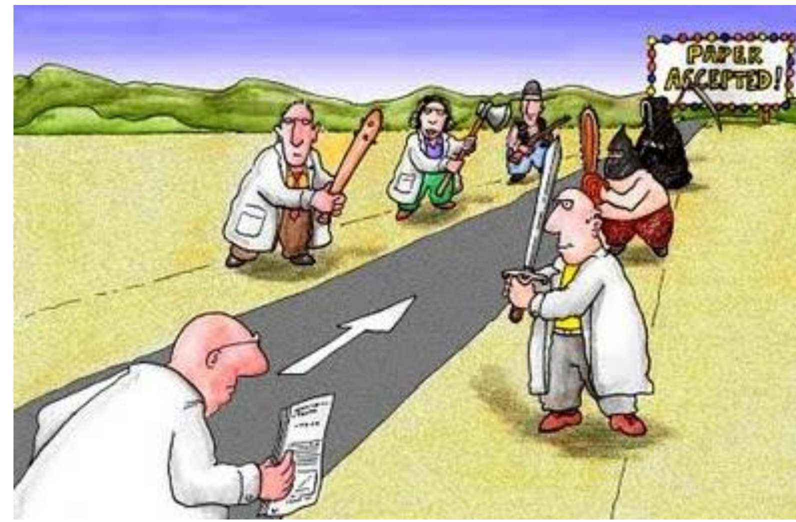
SUPPORT PEER-REVIEW

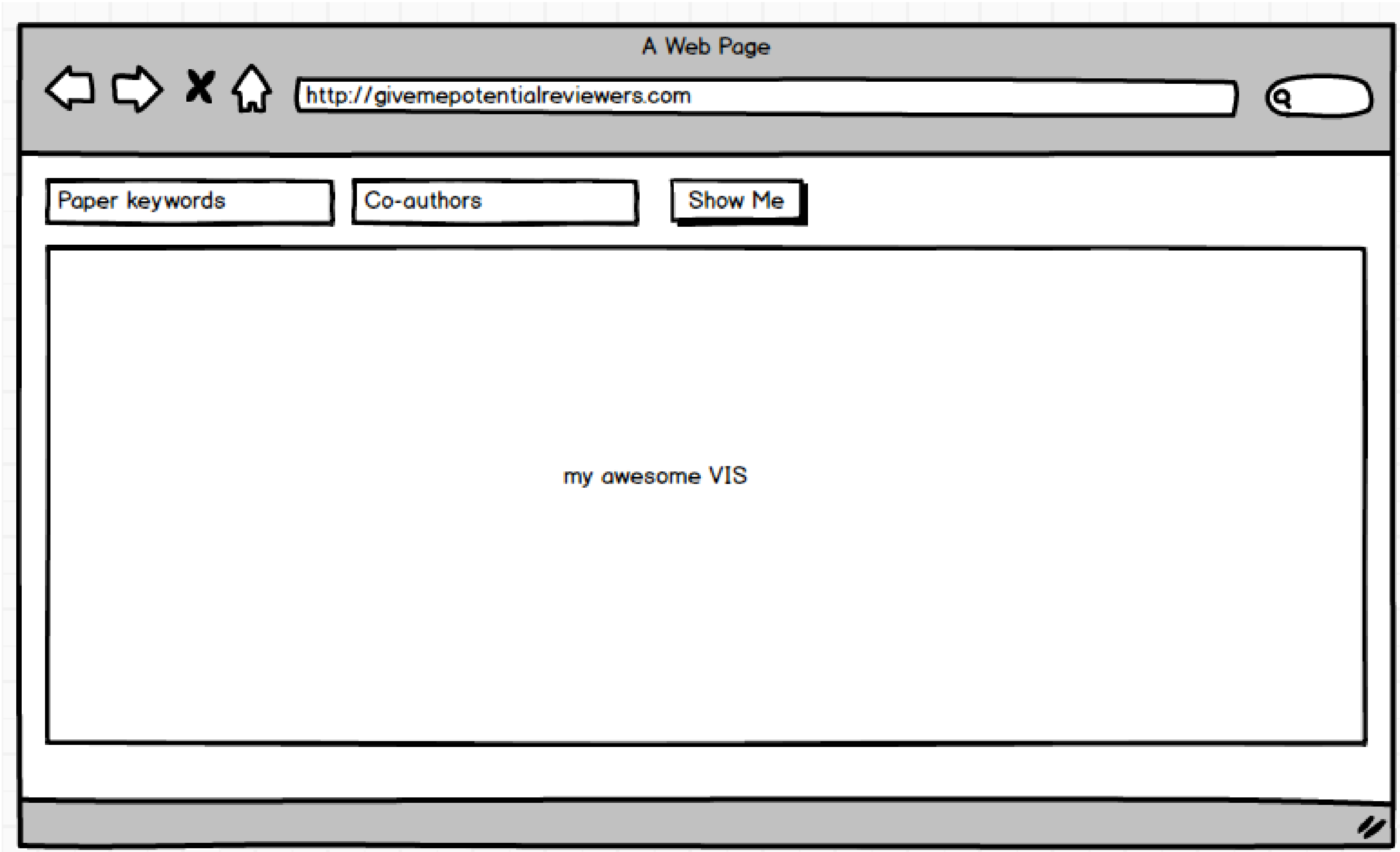
every paper submitted to a conference needs 3-4 reviewers

they should be

- experts on the topic
- have diverse expertise
- not be in conflict
- experienced

Can you help suggest good reviewers for a paper?

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Paper keywords
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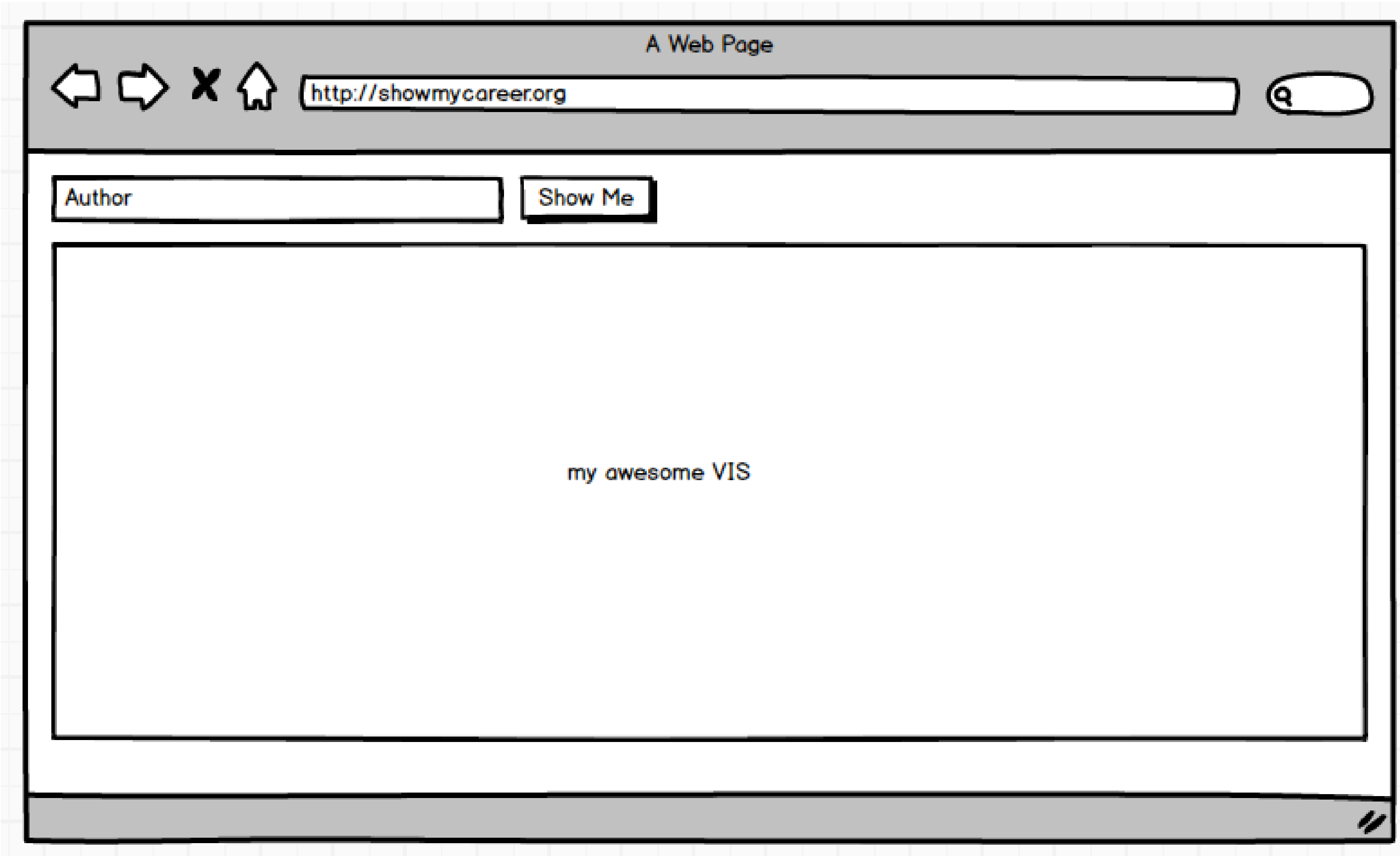
X’S RESEARCH CAREER

- researchers typically work on a variety of topics throughout their careers
- they also change institutions
- they are more or less active in specific years
- they may work with the same or different people

Can you visualize a researcher’s career?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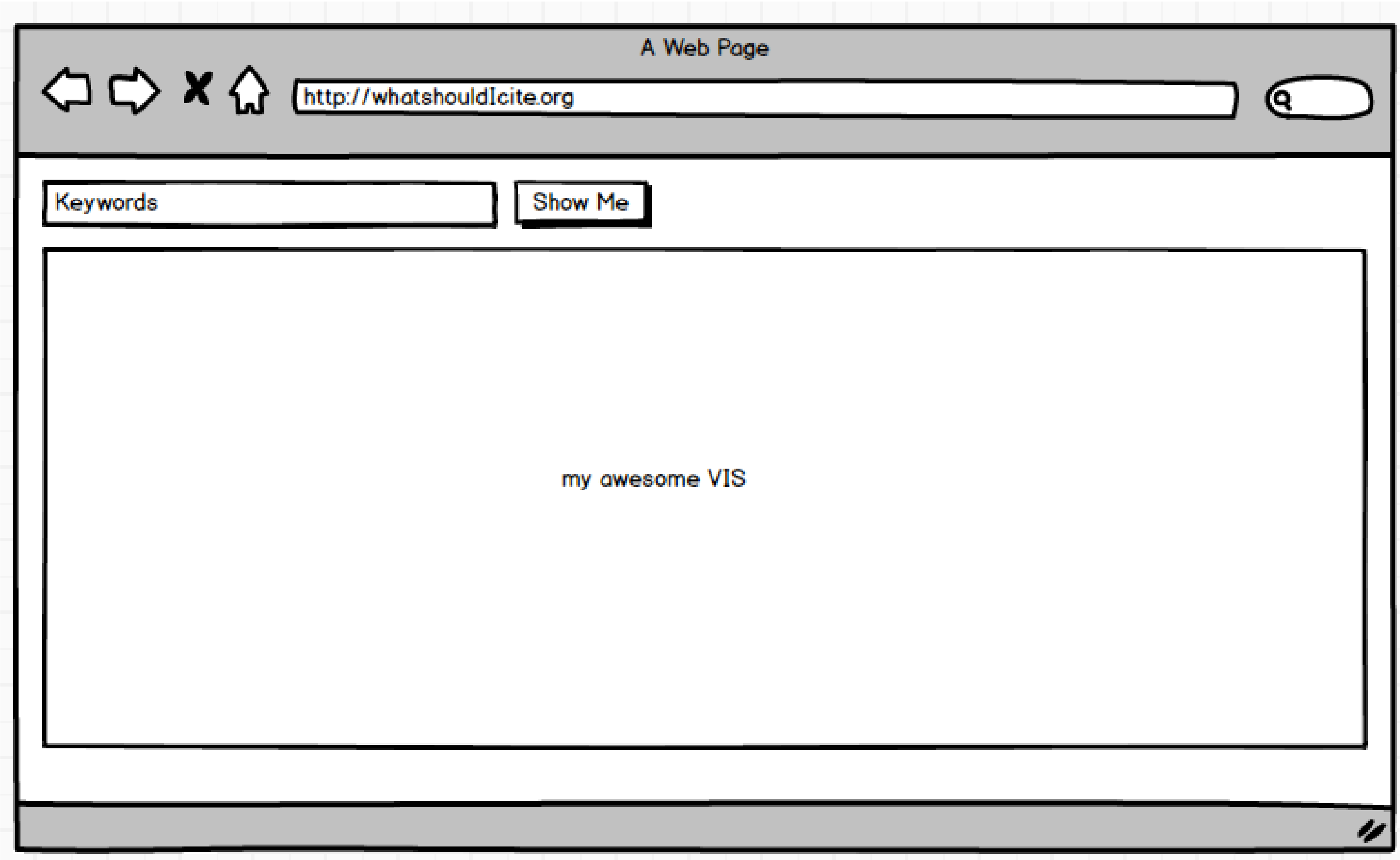
FINDING RELATED WORK

- when you write a paper you need to include a related work section
- covering the most important related work is difficult
- can you build a system that shows the most important relevant literature for a topic (a keyword, or a set of keywords)?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http://whatshouldIcite.org
Keywords
Show Me
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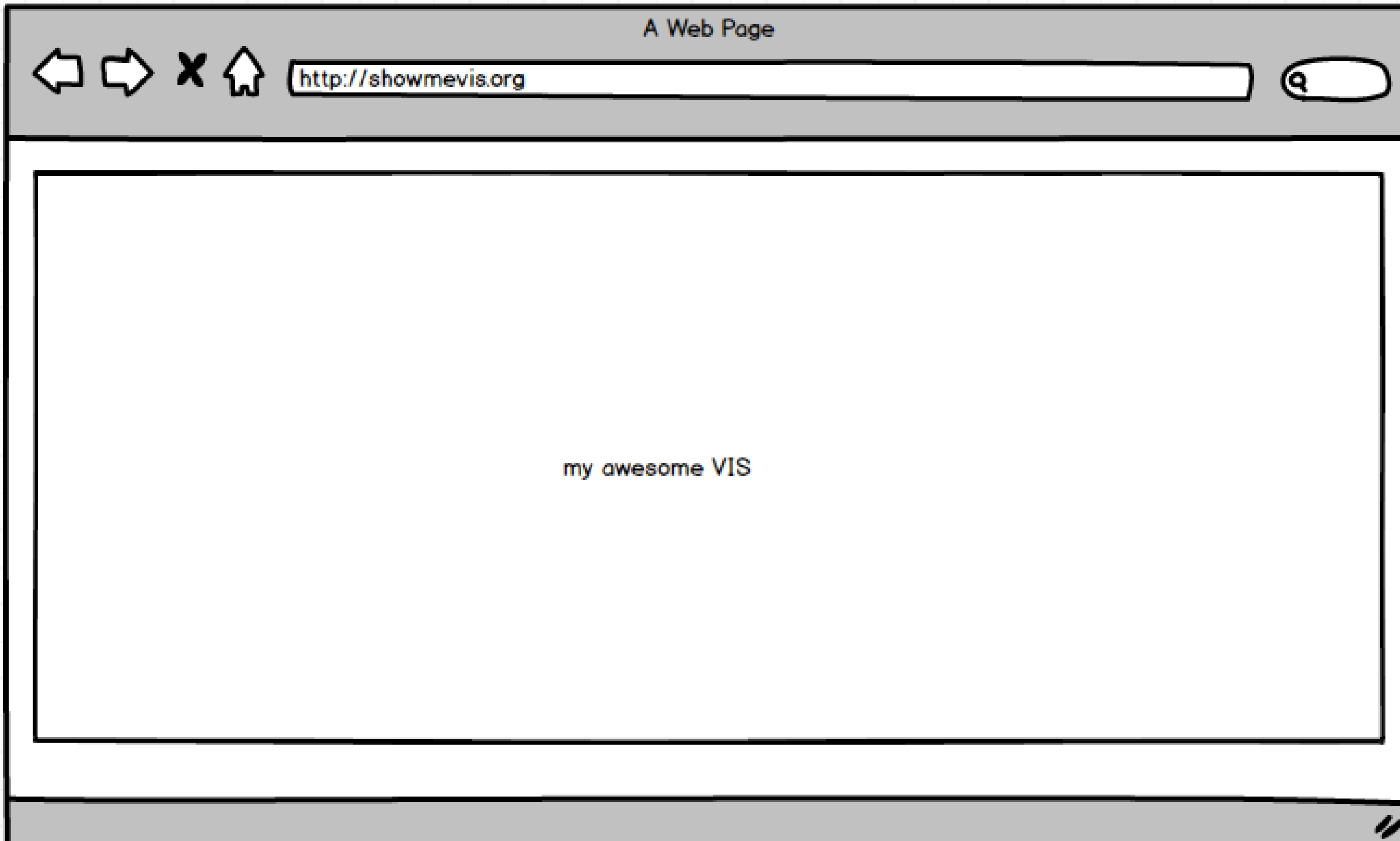
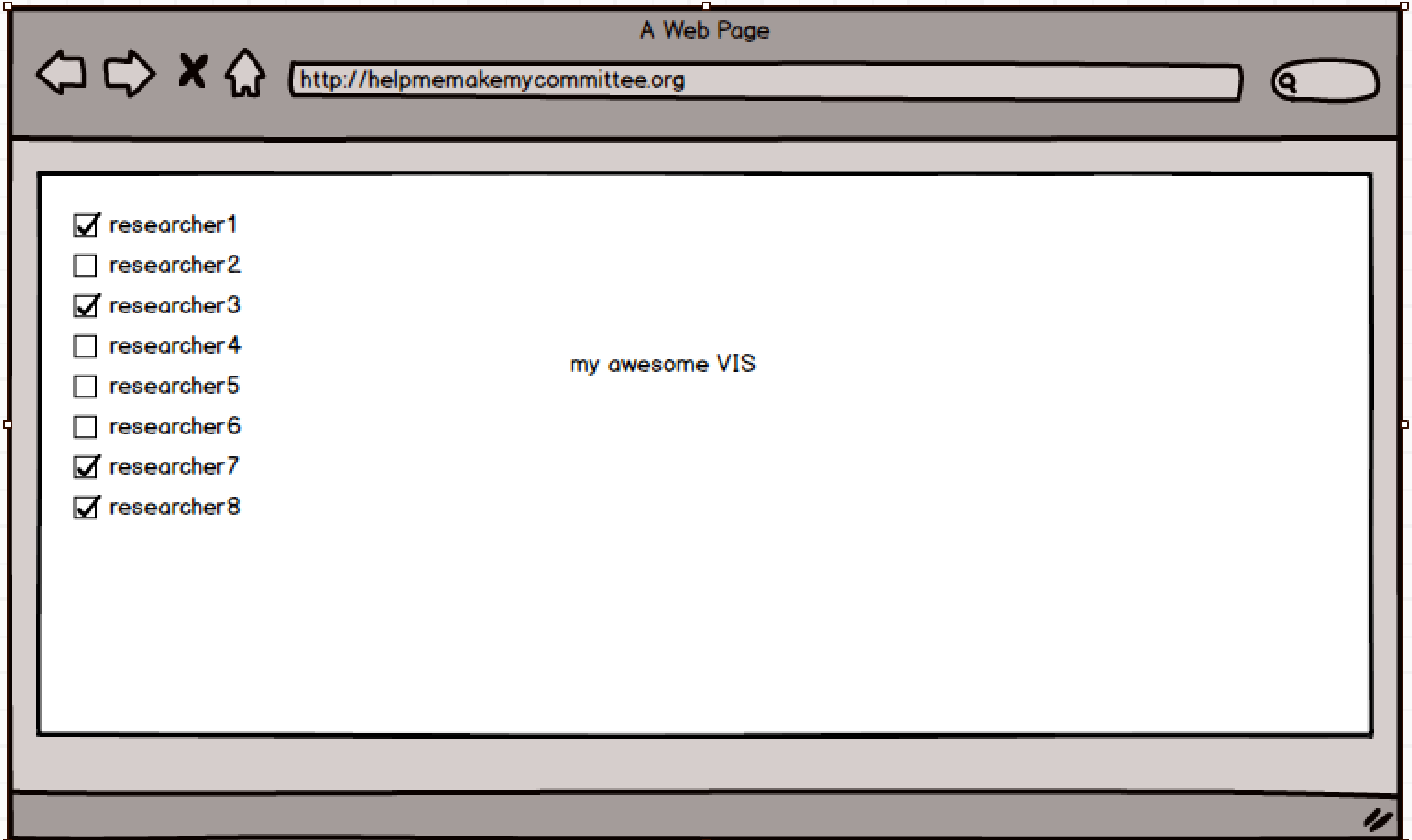
UNDERSTANDING IEEE VIS

- the IEEE VIS conference is very diverse in terms of topics, people, etc.
- can you build a visualization that describes what the community looks like?
  - what is the difference between InfoVis, SciVis, VAST?
  - are there people coming in and leaving regularly?
  - what are historic trends in the community?


A Web Page
http://showmevis.org
my awesome VIS

FINDING A PROGRAM COMMITTEE

- conference reviewing is led by a program committee. The members have to
  - have at least three years of expertise in the field
  - are from various affiliations
  - a mix of male and female
  - represent a variety of research topics
- can you help build a visualization tool to help choose a program committee?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my awesome VIS

CODING ENVIRONMENT

p5.js

Hello! p5.js is a JavaScript library that starts with the original goal of Processing, to make coding accessible for artists, designers, educators, and beginners, and reinterprets this for today's web.

Using the original metaphor of a software sketchbook, p5.js has a full set of drawing functionality. However, you're not limited to your drawing canvas, you can think of your whole browser page as your sketch! For this, p5.js has addon libraries that make it easy to interact with other HTML5 objects, including text, input, video, webcam, and sound.

p5.js is a new interpretation, not an emulation or port, and it is in active development. An official editing environment is coming soon, as well as many more features!

p5.js was created by Lauren McCarthy and is developed by a community of collaborators, with support from the Processing Foundation and NYU ITP. © Info.

Processing

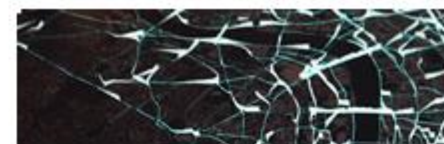
Welcome to Processing 3! Dan explains the new features and changes; the links Dan mentions are on the Vimeo page.

» Download Processing
» Browse Tutorials
» Visit the Reference

Processing is a flexible software sketchbook and a language for learning how to code within the context of the visual arts. Since 2001, Processing has promoted software literacy within the visual arts and

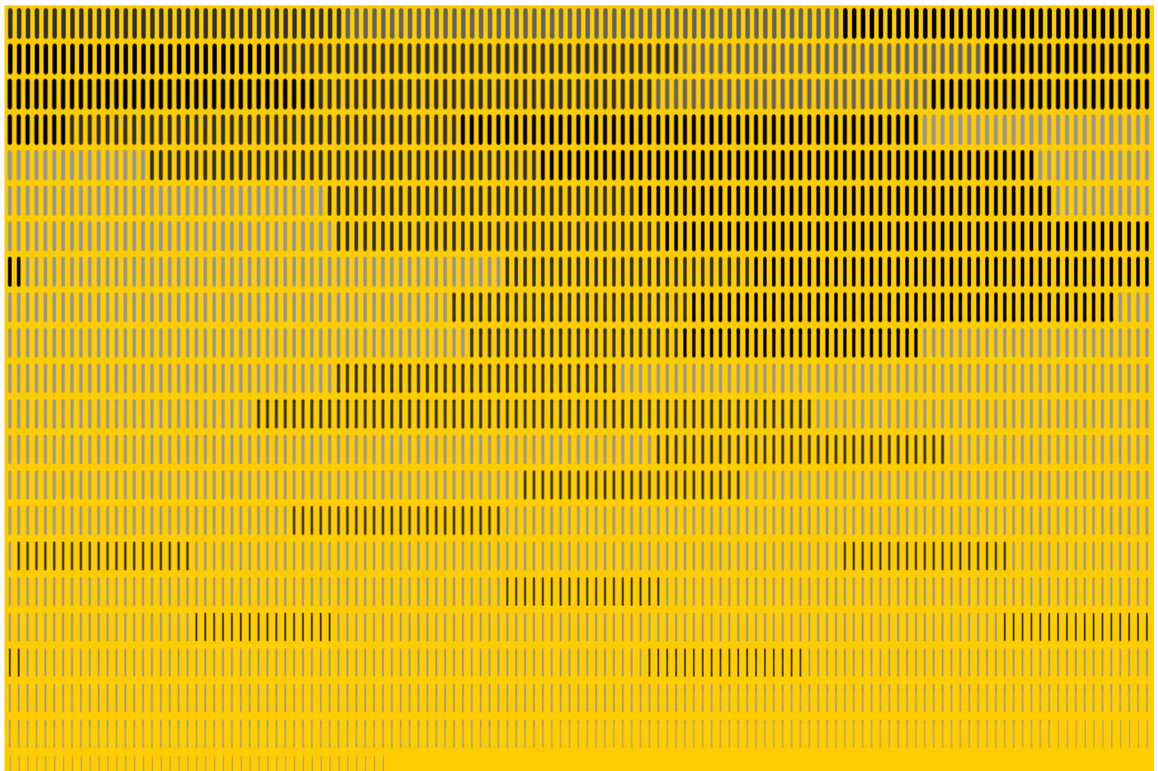
» Exhibition

Fluid Leaves
by Reinoud van Laar



cf.city flows
by Till Nagel and Christopher Pietsch

WHAT WE WILL BE BUILDING TODAY



DOWNLOAD

https://p5js.org/download/#editor

Start

Reference

Libraries

Tutorials

Examples

Books

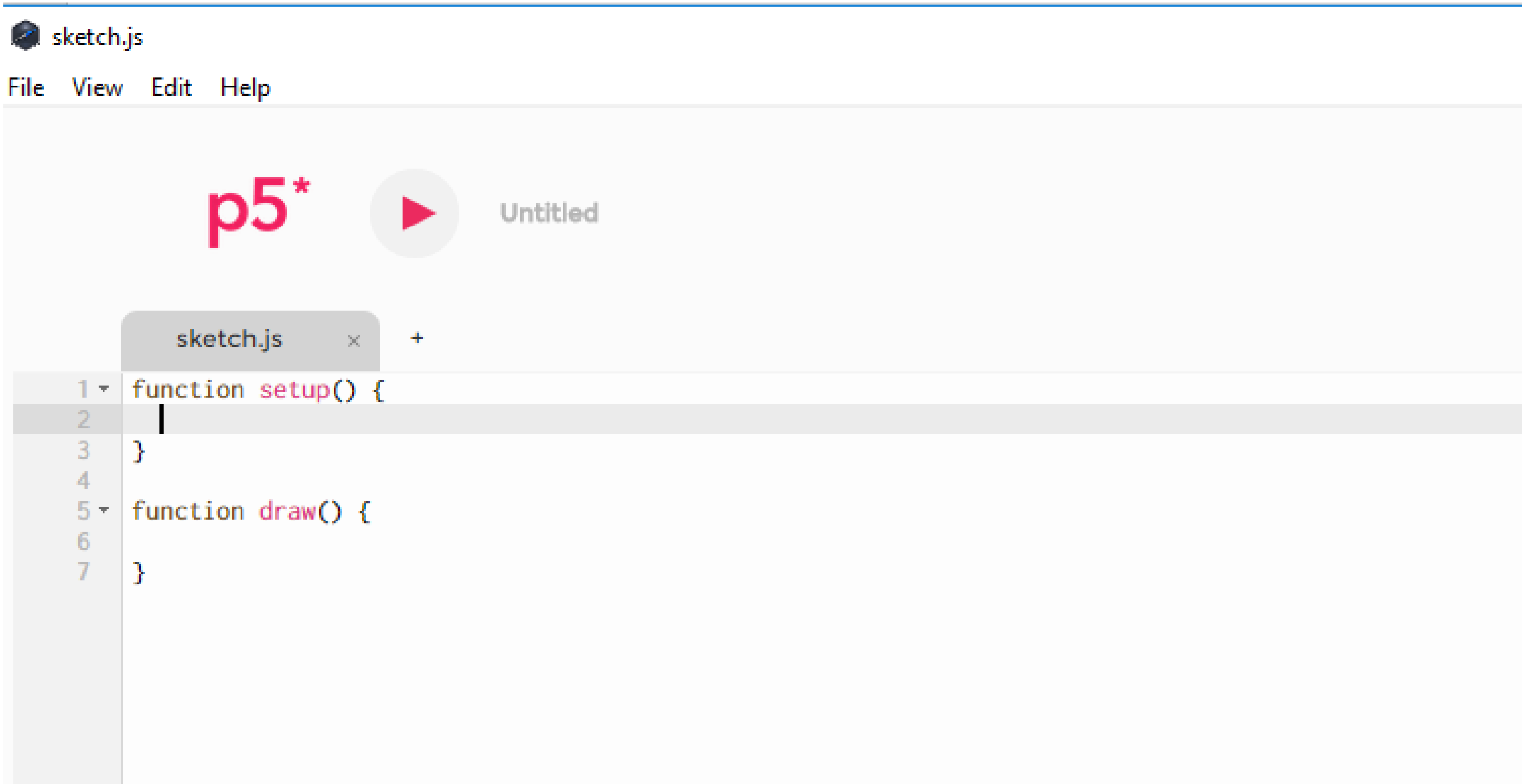
Community

Editor

The p5.js editor is currently in development, try out a beta version of it now. Help out by posting feedback and bugs.

Mac OS X	Windows	Linux
p5 editor version 0.6.1	p5 editor version 0.6.1	p5 editor version 0.6.1

START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Untitled
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function setup() {
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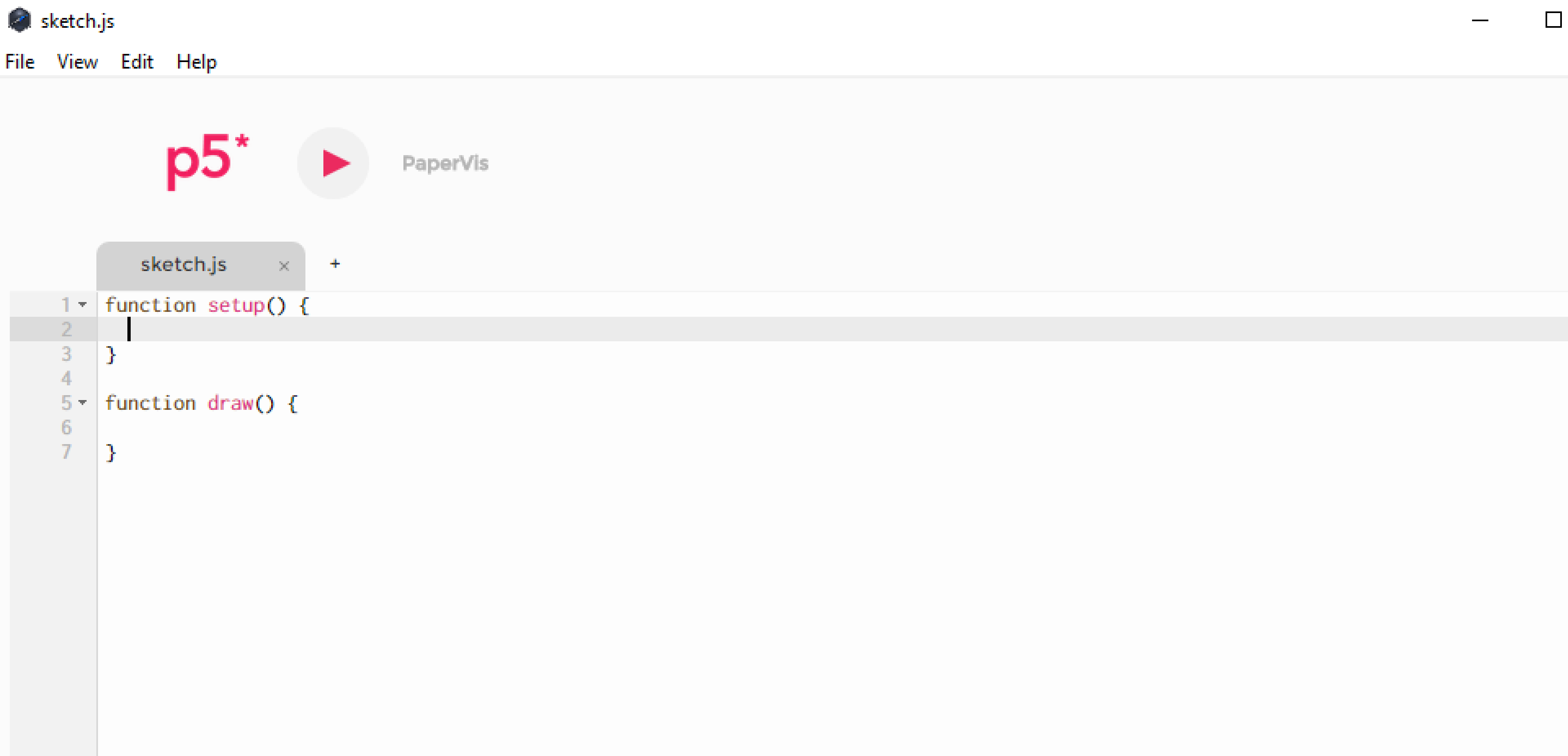
SAVE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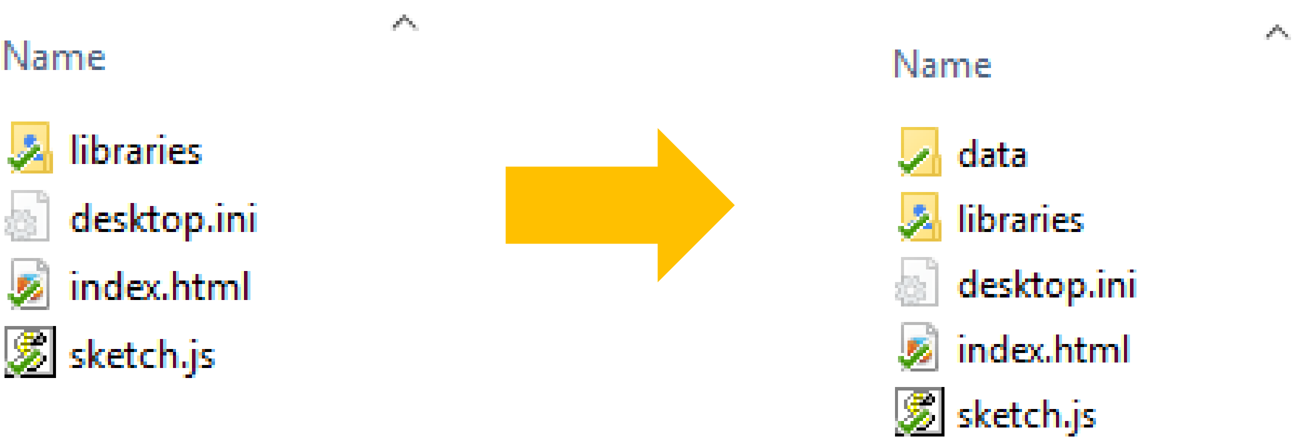
GO TO SKETCH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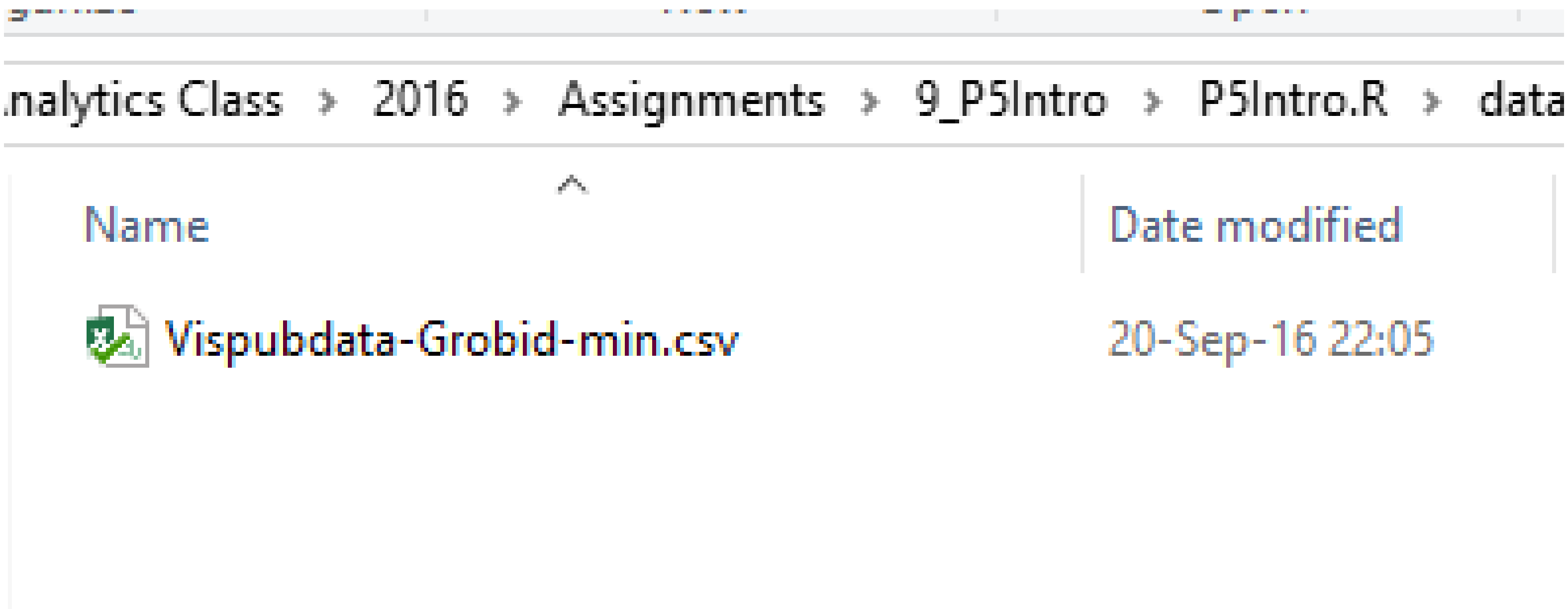
COPY DATA FILE



```
var w = 1300;
var h = 900;

function setup() {

  createCanvas(w, h);
  noLoop();
  background(255, 204, 0);
}

function draw() {

}

```

```
var w = 1300;
var h = 900;

function preload(){
  table = loadTable("data/Vispubdata-Grobid-min.csv","csv","header");
}

function setup() {

  createCanvas(w, h);
  noLoop();
  background(255, 204, 0);

  console.log(table.getRowCount() + " total rows in table");
  console.log(table.getColumnCount() + " total columns in table");
}

function draw() {


}
```

```
function draw() {

  var spacing = 10;
  var x = 0;
  var y = 5;
  var length = 10;
  var lineheight = 30;

  for (var i = 0; i < table.getRowCount(); i++)
   {

     x = x + spacing;

     if (x > w - spacing) {
        x = x % w + spacing;
        y = y + lineheight + 10;
     }

     line(x , y, x, y + lineheight)
   }

}
```

```
var table;

var yearCol;
var conferenceCol;
var minYear;
var maxYear;

var minWidth = 1;
var maxWidth = 5;

var fills = [0,50,100,150,200];
var conferences = ["VAST","InfoVis","SciVis","Vis"];
```

```
function setup() {

  createCanvas(w, h);
  noLoop();
  background(255, 204, 0);

  console.log(table.getRowCount() + " total rows in table");
  console.log(table.getColumnCount() + " total columns in table");

  yearCol = table.getColumn("Year");
  minYear = min(yearCol);
  maxYear = max(yearCol);

}
```

```
  for (var i = 0; i < table.getRowCount(); i++)
   {

    x = x + spacing;

    if (x > w - spacing) {
      x = x % w + spacing;
      y = y + lineheight + 10;
    }

    currentYear = yearCol[i]
    currentWidth = (currentYear - minYear) / (maxYear - minYear) * (maxWidth - minWidth) + minWidth;

    strokeWeight(currentWidth);

    line(x , y, x, y + lineheight)
   }
```

```
function setup() {

  createCanvas(w, h);
  noLoop();
  background(255, 204, 0);

  console.log(table.getRowCount() + " total rows in table");
  console.log(table.getColumnCount() + " total columns in table");

  yearCol = table.getColumn("Year");
  minYear = min(yearCol);
  maxYear = max(yearCol);

  conferenceCol = table.getColumn("Conference");

}
```

```
        var conf = conferenceCol[i];
        var index = conferences.indexOf(conf);
        var fillColor = fills[index];

        stroke(fillColor);

        line(x , y, x, y + lineheight)
    }
```