BioVis 2019

PHYSICAL, CONTEXTUAL, AND FULL OF VALUE?

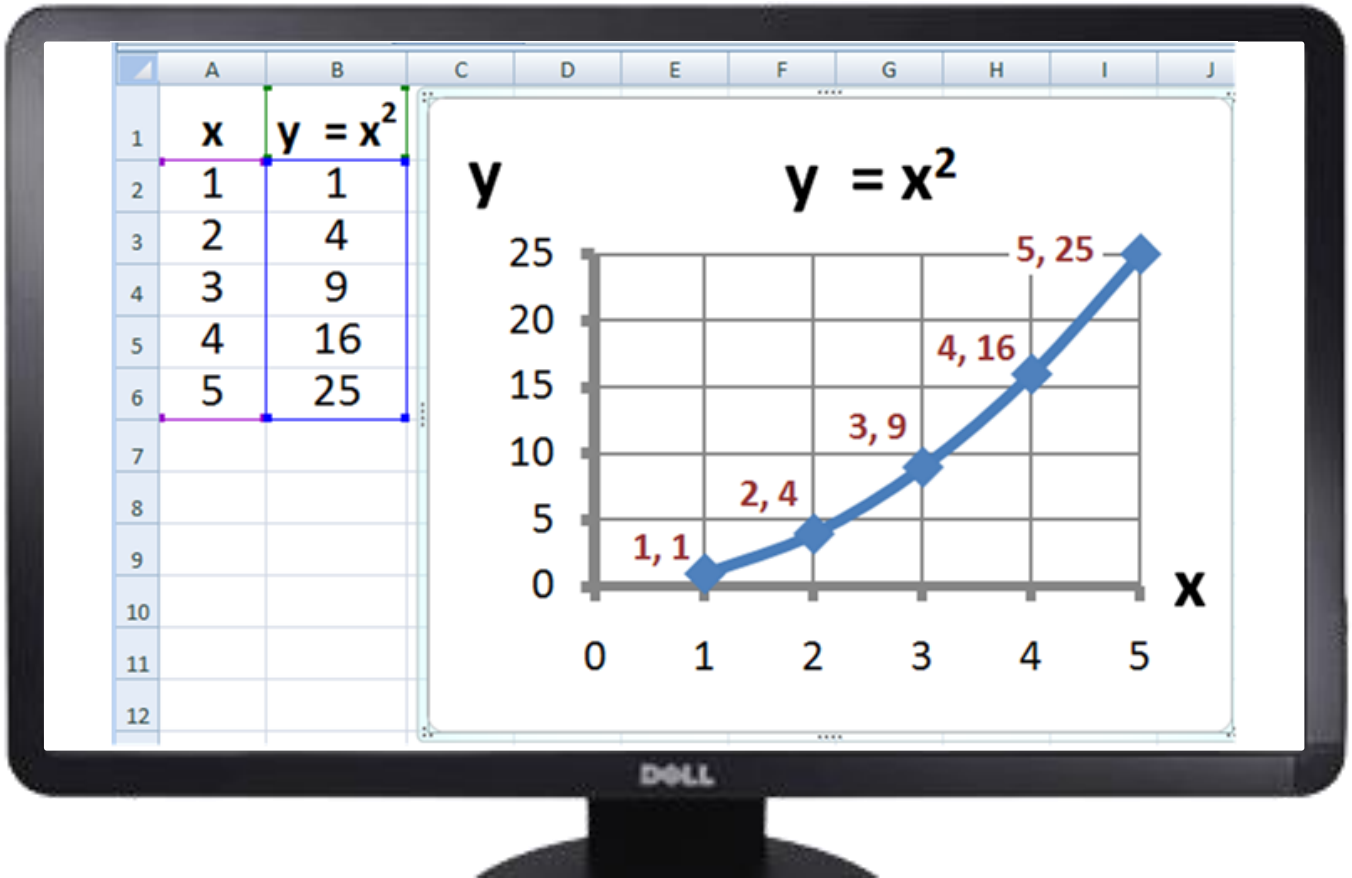
What do novel directions in Visualization teach us about judging the value of Visualization?

Inria informatics mathematics
Aviz Visual Analytics Project

Petra Isenberg @dr_pi
http://petra.isenberg.cc/

by Chris on Flickr

Data analysis software, simple statistics, …



Tools for experts…

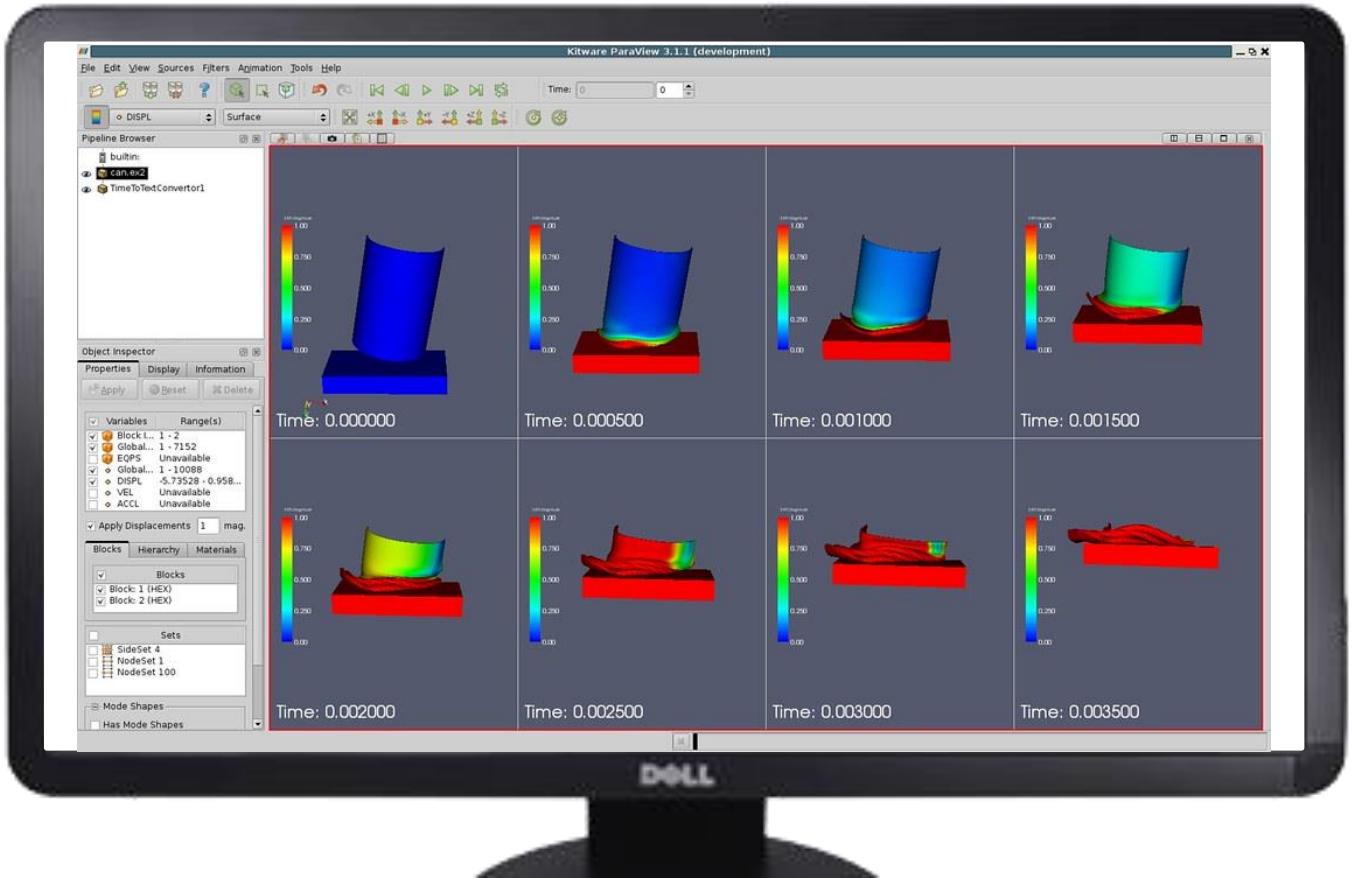
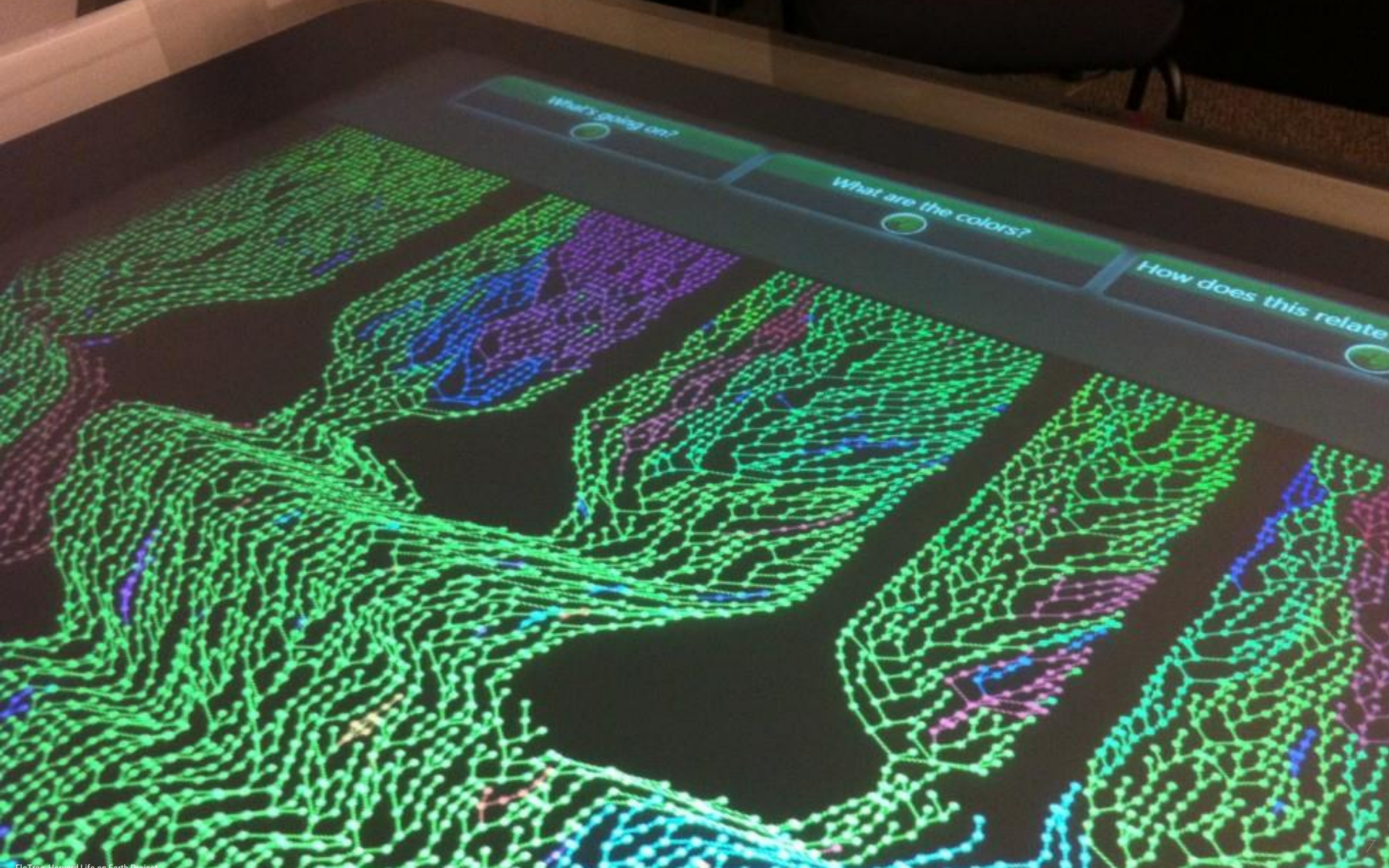


Photo by rawpixel.com from Pexels


Coffee
5:43
$$$$ 1.4 km
Café
Différance
8.9 Café
$$$$ 1.4 km
DAVIDsTEA
8.1 Tea Room
$$$$ 1.2 km

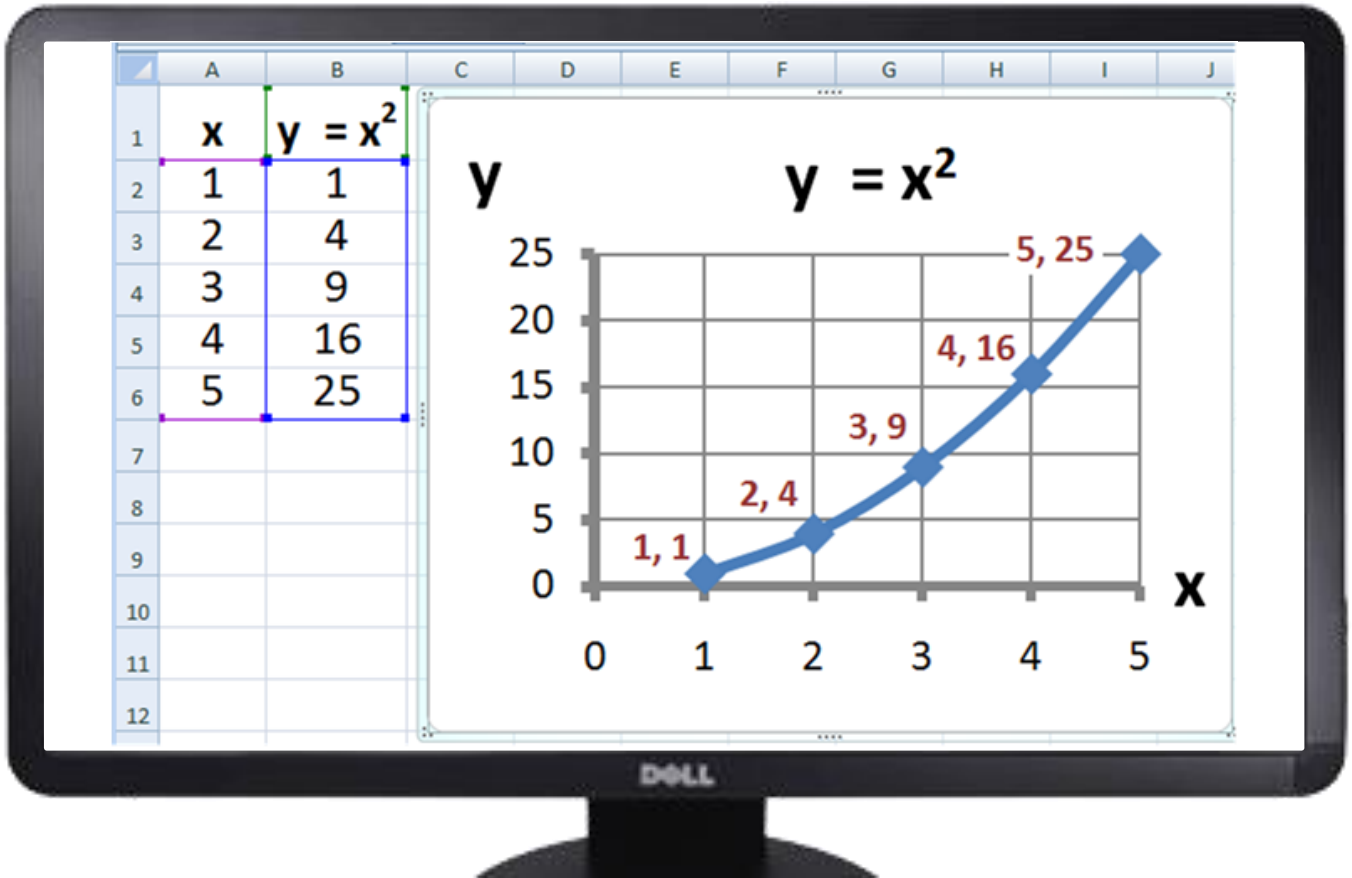

What's going on?
What are the colors?
How does this relate

Vanhawks Valour

LETS GET BACK TO OUR ROOTS FIRST

by Chris on Flickr

Data analysis software, simple statistics, …



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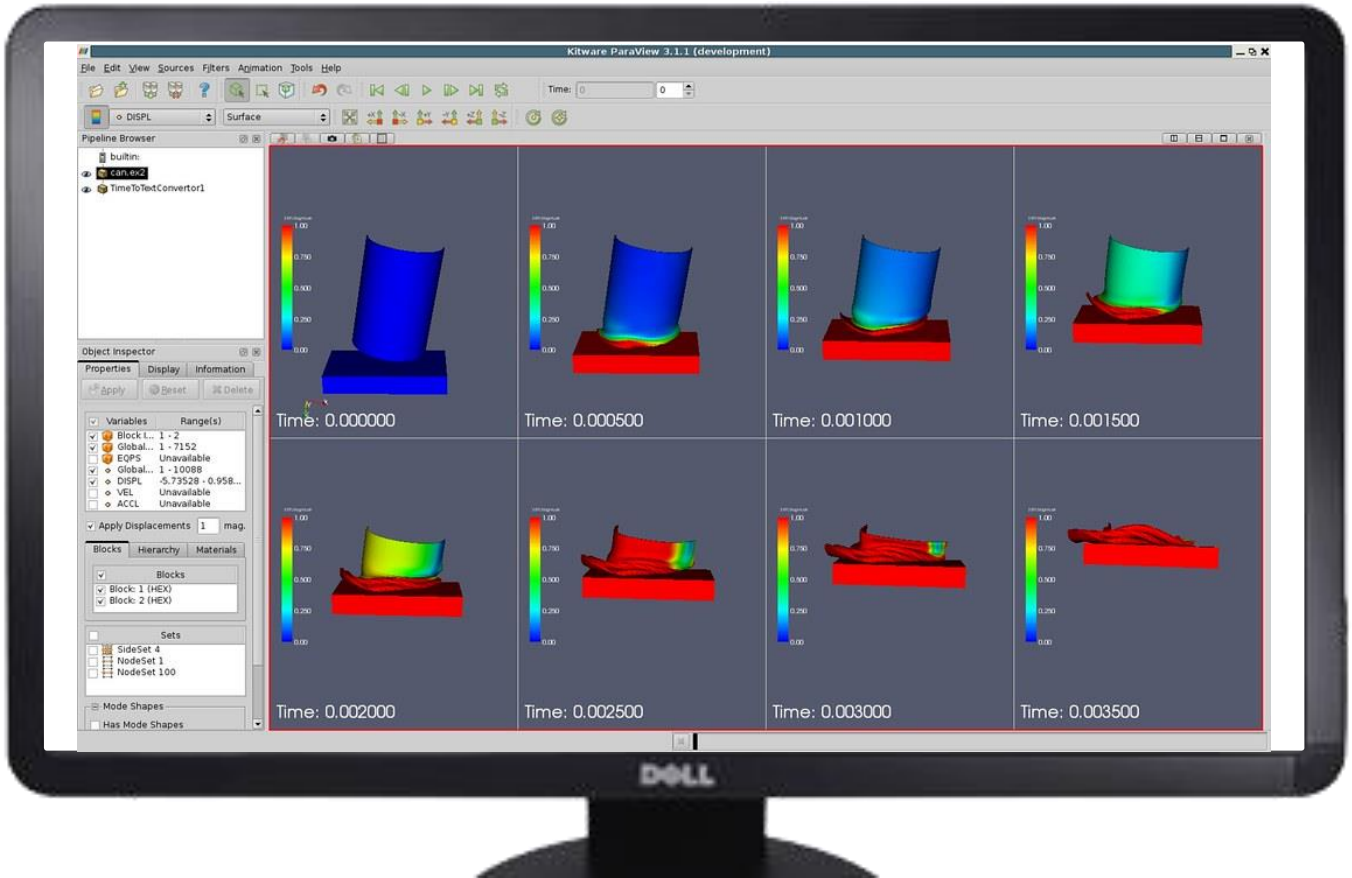


DO THESE VISUALIZATIONS HAVE VALUE?

…but first….

WHY DO WE ASK THIS QUESTION?

When do we judge the value of visualizations?

- Reviewer
  - Is this worth publishing?
- Funding agency
  - Is this worth investing in?
- Advisor to students or companies
  - Is this worth developing further?
- Designer
  - Is this an idea worth pursuing?
- Customer
  - Is this worth buying
- Viewer
  - Should I keep looking at this?
- …

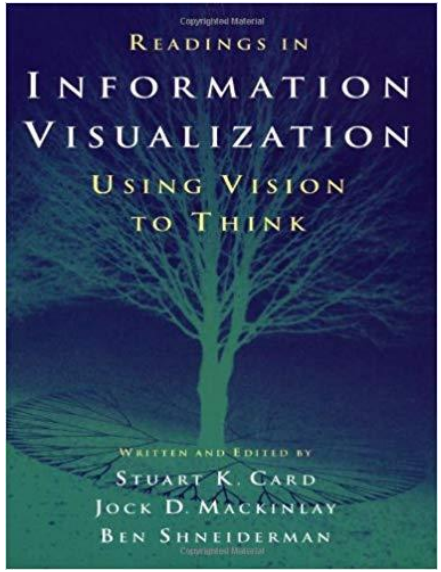
HOW HAS THIS QUESTION BEEN ANSWERED?

Benefits of visualization

AMPLIFICATION OF COGNITION

1999

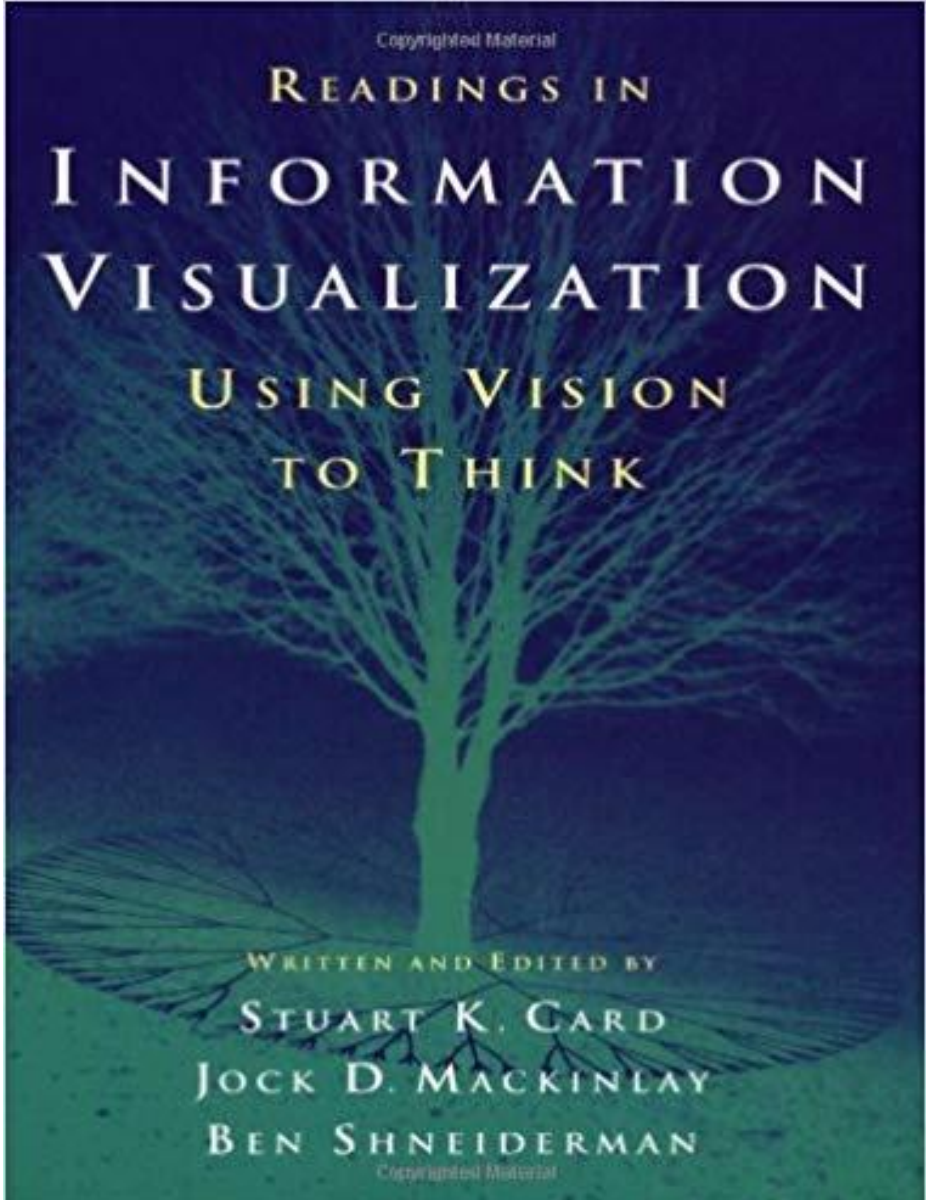
- expand human working memory
  - offload cognitive resources to the visual system,
- reduce search
  - by representing a large amount of data in a small space,
- enhance the recognition of patterns
  - by making them visually explicit
- aid monitoring of a large number of potential events
- provides a manipulable medium & allows exploration of a space of parameter values.



TRUST

- Theoretical benefits exist
- To what extent can we trust that they apply?

→ See also: An Empire Built On Sand:
Reexamining What We Think We Know About Visualization
Robert Kosara, Beliv 2016



2005

The Value of Visualization

Jarke J. van Wijk*
Dept. Mathematics and Computer Science
Technische Universiteit Eindhoven

Abstract

The field of Visualization is getting mature. Many problems have been solved, and new directions are sought for. In order to make good choices, an understanding of the purpose and meaning of visualization is needed. Especially, it would be nice if we could assess what a good visualization is. In this paper an attempt is made to determine the value of visualization. A technological viewpoint is adopted, where the value of visualization is measured based on effectiveness and efficiency. An economic model of visualization is presented, and benefits and costs are established. Next, consequences for and limitations of visualization are discussed (including the use of alternative methods, high initial costs, subjectiveness, and the role of interaction), as well as examples of the use of the model for the judgement of existing classes of methods and understanding why they are or are not used in practice. Furthermore, two alternative views on visualization are presented and discussed: viewing visualization as an art or as a scientific discipline. Implications and future directions are identified.

CR Categories: H.5.2 [Information Interfaces and Presentation]: User Interfaces; I.3.6 [Computer Graphics]: Methodology and Techniques I.3.8 [Computer Graphics]: Applications

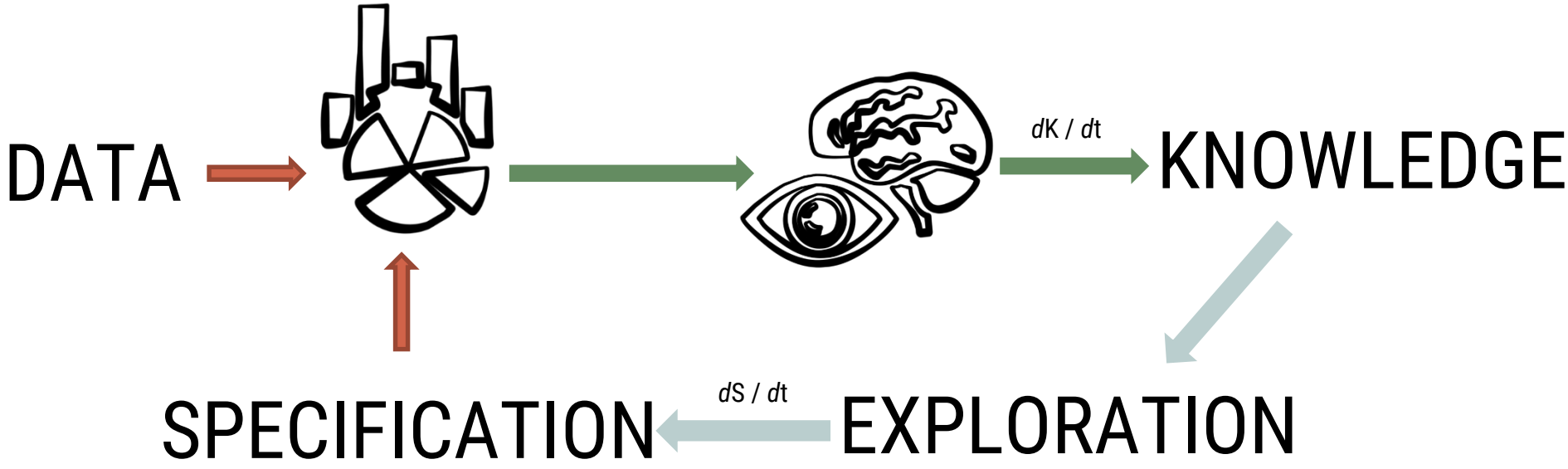
Keywords: Visualization, evaluation

In this paper I want to give a contribution to the discussion on the status and possible directions of our field. Rather than to pinpoint specific topics and activities, my aim is to detect overall patterns, and to find a way to understand and qualify visualization in general. This is an ambitious and vague plan, although the basic ground for this is highly practical.

I have to make decisions on visualization in many roles. As a researcher, decisions have to be made ranging from which area to spend time on to which particular solution to implement; as a supervisor, guidance to students must be provided; as a reviewer, new results and proposals for new research must be judged, and opinions are expected if they are worth publishing or funding; as advisor in a start-up company, novel and profitable directions must be spotted. All these cases imply judgement of the value of visualization in varying senses.

How to assess the value of visualization? Visualization itself is an ambiguous term. It can refer to the research discipline, to a technology, to a specific technique, or to the visual result. If visualization is considered as a technology, i.e., as a collection of methods, techniques, and tools developed and applied to satisfy a need, then standard measures apply: Visualization has to be *effective* and *efficient*. In other words, visualization should do what it is supposed to do, and has to do this using a minimal amount of resources. One immediate and obvious implication is that we cannot judge visualization on its own, but have to take into account the context in which it is used .

VISUALIZATIONS ARE NOT GOOD BY DEFINITION



Icons: Mysitemyway

Factors influencing

VALUE

- knowledge gain
- # users
- # usage sessions

- costs
  - intial development costs
  - initial costs per user (e.g. learning its use)
  - initial costs per session (e.g. setup)
  - perception & exploration costs

…the exact formula: $F = nm (W (dK) - Cs - kCe) - Ci - nCu$

Technological perspective on Visualization

Vis = a collection of methods, techniques, and tools developed and applied to satisfy a need

→ Visualization has to be **EFFECTIVE** and **EFFICIENT**

2008

The Value of Information Visualization

Jean-Daniel Fekete[1], Jarke J. van Wijk[2], John T. Stasko[3], and Chris North[4]

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Abstract. Researchers and users of Information Visualization are convinced that it has value. This value can easily be communicated to others in a face-to-face setting, such that this value is experienced in practice. To convince broader audiences, and also, to understand the intrinsic qualities of visualization is more difficult, however. In this paper we con-

A great visualization method is used by many people, who use it routinely to obtain highly valuable knowledge, while having to spend little time and money on hardware, software, and effort.

And also, no alternatives that are more cost-effective should be available.

2014

Value-Driven Evaluation of Visualizations

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ABSTRACT

Existing evaluations of data visualizations often employ a series of low-level, detailed questions to be answered or benchmark tasks to be performed. While that methodology can be helpful to determine a visualization's usability, such evaluations overlook the key benefits that visualization uniquely provides over other data analysis methods. I propose a *value-driven evaluation* of visualizations in which a person illustrates a system's value through four important capabilities: minimizing the time to answer diverse questions, spurring the generation of insights and insightful questions, conveying the essence of the data, and generating confidence and knowledge about the data's domain and context. Additionally, I explain how interaction is instrumental in creating much of the value that can be found in visualizations.

Categories and Subject Descriptors

H.5.2 **[Information Interfaces and Presentation, (e.g., HCI)]**: User interfaces – *Evaluation/Methodology*.

General Terms

Measurement, Design, Human Factors, Theory.

One potential angle of evaluation is to improve the techniques and systems one builds. That is, a developer of a new system should evaluate it and find the embedded problems and faults in order to help improve the system and make it better. This activity can be iterated repeatedly and is a fundamental component of formative evaluation that one encounters in the area of human-computer interaction.

A second style of evaluation is to compare two specific approaches to each other. Is technique A or technique B a better approach for a given problem? The specificity of this type of evaluation is appealing in many ways, but it is frequently quite difficult to conduct such an evaluation in the field of data visualization because very few techniques or systems are built for the exact same purpose, domain, and the same type of data. Examples of this type of evaluation do exist [14,29] but it is typically very difficult to "compare apples to apples."

Another angle of evaluation is more general than these first two. When a person develops a new visualization technique or system, there is a fundamental desire to determine whether it is any *good*. Simply put, is the technique useful and beneficial? Researchers want to show the value and utility of their new ideas, and they seek methods to answer those questions.

VISUALIZATION VALUE =

A holistic ability to convey a true understanding of the data

VALUE =

TIME + INSIGHT + ESSENCE + CONFIDENCE

In the mean time: the rise of

EVALUATION IN VISUALIZATION

In the following I will use the term…

EVALUATION AS A WAY TO SHOW VALUE

FOR NOW: EVALUATION IN VIS

an assessment of a visualization or its context of use, including:

- a multitude of methods / methodologies
- at any point in the development cycle

→ not just with participants

Empirical Studies in Information Visualization: Seven Scenarios

Heidi Lam Enrico Bertini Petra Isenberg Catherine Plaisant Sheelagh Carpendale

Abstract—We take a new, scenario based look at evaluation in information visualization. Our seven scenarios, evaluating visual data analysis and reasoning, evaluating user performance, evaluating user experience, evaluating environments and work practices, evaluating communication through visualization, evaluating visualization algorithms, and evaluating collaborative data analysis were derived through an extensive literature review of over 800 visualization publications. These scenarios distinguish different study goals and types of research questions and are illustrated through example studies. Through this broad survey and the distillation of these scenarios we make two contributions. One, we encapsulate the current practices in the information visualization research community and, two, we provide a different approach to reaching decisions about what might be the most effective evaluation of a given information visualization. Scenarios can be used to choose appropriate research questions and goals and the provided examples can be consulted for guidance on how to design one's own study.

Index Terms—Information visualization, evaluation

1 Introduction

Evaluation in information visualization is complex since, for a thorough understanding of a tool, it not only involves assessing the visualizations themselves, but also the complex processes that a tool is meant to support. Examples of such processes are exploratory data analysis and reasoning, communication through visualization, or collaborative data analysis. Researchers and practitioners in the field have long identified many of the challenges faced when planning, conducting, and executing an evaluation of a visualization tool or system [10, 41, 54, 63]. It can be daunting for evaluators to identify the right evaluation questions to ask,

- Understanding Environments and Work Practices (UWP)
- Evaluating Visual Data Analysis and Reasoning (VDAR)
- Evaluating Communication Through Visualization (CTV)
- Evaluating Collaborative Data Analysis (CDA)

The scenarios for understanding visualizations are:

- Evaluating User Performance (UP)
- Evaluating User Experience (UE)
- Evaluating Visualization Algorithms (VA)

Our goal is to provide an overview of different types of

A Systematic Review on the Practice of Evaluating Visualization

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

Abstract—We present an assessment of the state and historic development of evaluation practices as reported in papers published at the IEEE Visualization conference. Our goal is to reflect on a meta-level about evaluation in our community through a systematic understanding of the characteristics and goals of presented evaluations. For this purpose we conducted a systematic review of ten years of evaluations in the published papers using and extending a coding scheme previously established by Lam et al. [2012]. The results of our review include an overview of the most common evaluation goals in the community, how they evolved over time, and how they contrast or align to those of the IEEE Information Visualization conference. In particular, we found that evaluations specific to assessing resulting images and algorithm performance are the most prevalent (with consistently 80–90% of all papers since 1997). However, especially over the last six years there is a steady increase in evaluation methods that include participants, either by evaluating their performances and subjective feedback or by evaluating their work practices and their improved analysis and reasoning capabilities using visual tools. Up to 2010, this trend in the IEEE Visualization conference was much more pronounced than in the IEEE Information Visualization conference which only showed an increasing percentage of evaluation through user performance and experience testing. Since 2011, however, also papers in IEEE Information Visualization show such an increase of evaluations of work practices and analysis as well as reasoning using visual tools. Further, we found that generally the studies reporting requirements analyses and domain-specific work practices are too informally reported which hinders cross-comparison and lowers external validity.

Index Terms—Evaluation, validation, systematic review, visualization, scientific visualization, information visualization

1 Motivation

In this paper, we report a systematic review of 581 papers from ten years of IEEE Visualization conference publications with respect to their use of evaluation. We provide a quantitative and objective report of the types of evaluations encountered in the literature. At the same time, we also qualitatively assess our observations from coding these 581 papers. Specifically, we put evaluation practices into historic perspective and assess and compare them in context to those of the larger visualization community. Our goal in pursuing this work is to get an understanding of the practices of evaluation in visualization research as a whole.

The importance of evaluation to the field of visualization has become well recognized—demonstrated by the growing body of work on how to conduct visualization evaluation and by the growing amount of research papers that incorporate some form of formal or informal evaluation. In this article we contribute to the body of work by providing a systematic assessment and understanding of the evaluation practices reflected by published peer-reviewed visualization papers that have not been subject to such a systematic assessment in the past.

Our work is based on Lam et al.'s [38] recent literature analysis, in which they identified seven evaluation scenarios in visualization research articles. Their paper is an important contribution but does not reflect on the entire visualization community. It focuses on what is known as the 'information visualization' sub-community and excludes all other visualization flavors. While Lam et al. primarily focused on identifying evaluation scenarios, our goal with this paper is different. We aim to complete the assessment for the larger visualization community by answering the question: What are evaluation practices in the 'scientific visualization' part of our community? What are similarities and differences between these sub-communities? To do so, we use and extend Lam et al.'s scenarios to systematically analyze the literature that appeared at the IEEE Visualization conference. We believe that our extended work is fundamental to understanding all subcultures in visualization and to properly sample all aspects of visualization work, not only those labeled as 'information visualization.'

By looking at the historic record, we were hoping to uncover some trends by examining how the field of visualization has been changing over the last 15 years. We were wondering whether some of the self-reflection by some of the field's leaders in the early 2000's has left its mark on our community and whether it led to more rigor in our evaluations. Likewise, our work is an opportunity to compare the IEEE Information Visualization and IEEE Visualization conferences to better understand their differences and commonalities. Our analysis of evaluation methods in visualization exposed a number of both weaknesses and strengths from which we, as a community, can learn for future work. Hence, we not only describe the current evaluation practices but also show what evaluation types are possible and how to improve their reporting in visualization papers. We thus expose exemplary papers and discuss a number of pitfalls that should be avoided.

In summary, the contributions of our paper are threefold. First, we objectively report the current evaluation practices in the visualization community. This is a quantitative report, focusing on the works in the IEEE Visualization conference, complementing the work done by Lam et al. [38]. Second, we give a historical overview of the use of evaluation in the visualization community as reported in the IEEE Information Visualization and IEEE Visualization conferences and put evaluation practices into perspective. This is a qualitative assessment and provides a historical perspective by comparing current and past evaluation practices. And, third, we provide information for researchers conducting evaluation by assisting them to identify, justify, and refine evaluation approaches as well as helping them to recognize and avoid pitfalls that can be learned from previous research.

2 Fundamentals and Related Work

There are two traditions of evaluation that the visualization community draws from—evaluation in the sciences (both social and natural) and evaluation in design. On the one hand, scientists try to understand the world and seek a representative model, often a mathematical model (e. g., Newton's law or Fitts' law), while designers and engineers introduce a tool and henceforth seek to alter the world in which they live and

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Manuscript received 31 March 2013; accepted 1 August 2013; posted online 13 October 2013; mailed on 4 October 2013.
For information on obtaining reprints of this article, please send e-mail to: tvcg@computer.org.

2013

LOOKED AT ~ 581 SciVis PAPERS
& 8 evaluation scenarios

ONLY 12 PAPERS WITHOUT EVAL

http://goo.gl/CGswy

~98%

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.

Diversity of roots: The term ***visualization*** can be understood very broadly, expressing a long history of its use in common language. Therefore, it is not surprising that concepts of visual thinking have penetrated many areas of science, engineering, and philosophy. The field of modern (computer-based) visualization has been greatly influenced by research methods from the fields of numerics and computer graphics, which have given it its birth in 1990. The impact of human-computer interaction affected the birth of the InfoVis community in 1995 and the influence of applied statistics (such as data mining) and cognition has led to the establishment of VAST in 2006.

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 an independent field of research to the outside. These issues lead, in particular, to the frequently asked question "what is visualization?"—among funding agencies or even between colleagues. Given our field's broad nature, we need to ask how we can comprehensively describe and summarize all on-going visualization research. These are not just theoretical and philosophical questions, but the answer to these questions has many real-world (e. g., career-deciding) impacts—from finding the right reviewers during peer-review to administrative strategic decisions on conference and journal structures and foci.

So while "what is visualization?" is a fundamental question, it has

SIGNIFICANT TEMPORAL TRENDS

interaction techniques—general

evalua

machi

timese

multid

analys

graph

visual

data c

visuali

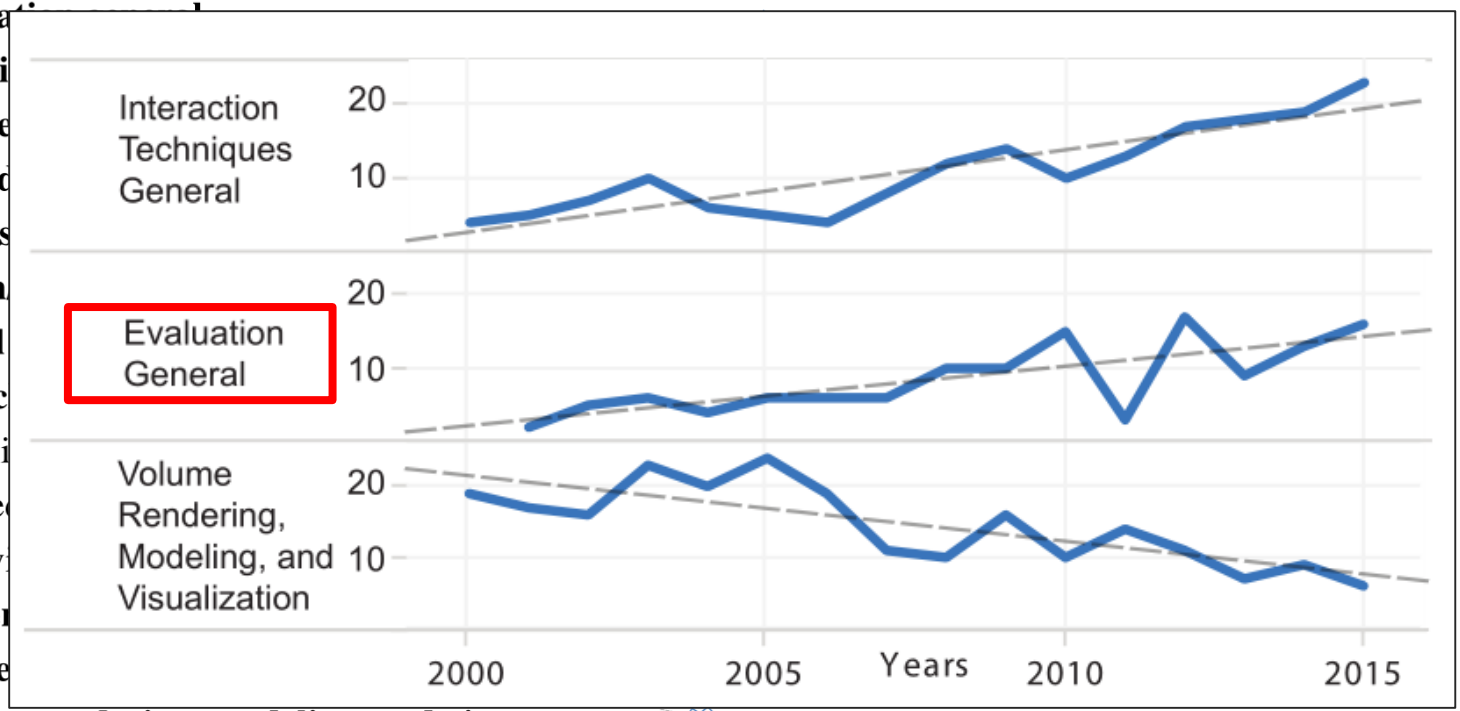
biome

flow v

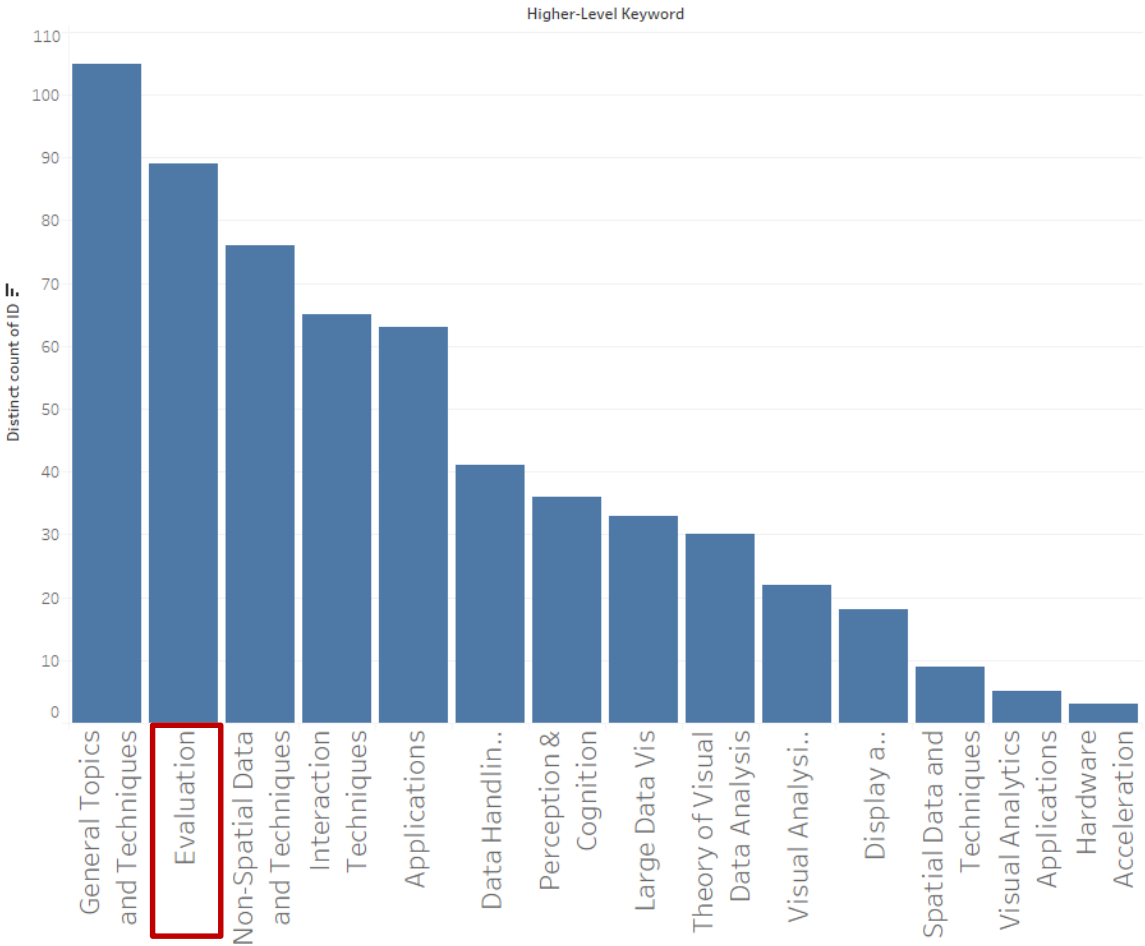
numer

meshe

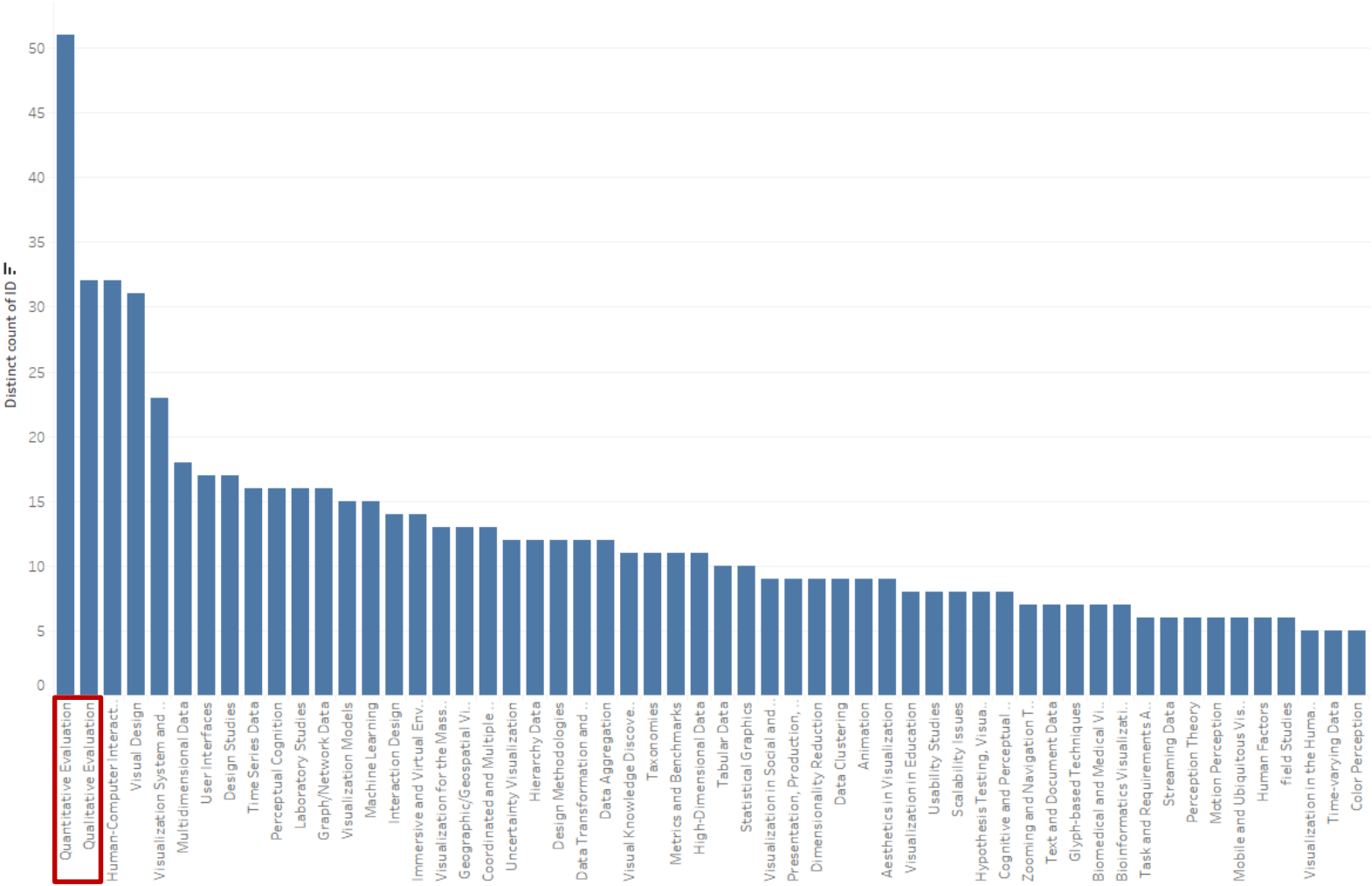
volume rendering, modeling, and vis.



PCS submission keyword categories for InfoVis 2019



PCS individual submission keywords, InfoVis 2019



Current discussions…

SHOULD EVERY PAPER INCLUDE EVALUATION?

TYRANNY

Tips for being a Good Visualization Paper Reviewer

John Stasko

December 23, 2016

3 Comments

This past year I was papers co-chair for the IEEE VAST (Visual Analytics) Conference, and it gave me the opportunity to read lots of paper reviews again. I had been papers co-chair for VAST once before, in 2009, and twice for the IEEE InfoVis Conference shortly before that. Additionally, I've been a (simple) reviewer for hundreds of papers since starting as a professor in 1989, and my students, colleagues, and I have written many papers that have received their own sets of reviews. Add it all up, and I've likely read over a thousand reviews in my career.

So what makes a good review, especially for visualization and HCI-related research papers? Reading so many VAST reviews this spring got me thinking about that topic, and I started jotting down some ideas about particular issues I observed. Eventually, I had a couple pages of notes that have served as the

Search …

ABOUT

"As I See It" is a collection of thoughts and writings by John Stasko, a Professor in the School of Interactive Computing at Georgia Tech. Some topics you'll find discussed here include information visualization, visual analytics, and computer science.

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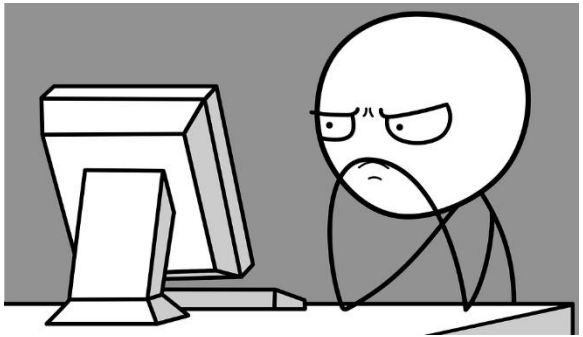
• **Don't require a user study** – OK, here's one that's going to ruffle a few feathers. There is virtually nothing that I dislike more in a review than reading, "The paper has no user study, thus I'm not able to evaluate its quality/utility." Simply put, that's hogwash. You have been asked to be a reviewer for this prestigious conference or journal, so presumably that means you have good knowledge about this research area. You've read about the project in the paper, so judge its quality and utility. Would a user study, which is often small, over-simplified, and assessing relatively unimportant aspects of a system really convince you of its quality? If so, then I think you need higher standards. Now, a paper should convince the reader that its work is an innovative contribution and/or does provide utility. But there are many ways to do that, and I feel others are often better than (simple) user studies. My 2014 BELIV Workshop article argues that visualization papers can do a better job explaining utility and value to readers through mechanisms such as example scenarios of use and case studies. Unfortunately, user studies on visualization systems often require participants to perform simple tasks that don't adequately show a system's value and that easily could be performed without visualization. Of course, there are certain types of papers that absolutely do require user studies. For example, if authors introduce a new visualization technique for a particular type of data and they claim that this technique is better than an existing one, then this claim absolutely should be tested. Relatively few papers of that style are submitted, however.

"would a user study, which is often small, over-simplified, and assessing relatively unimportant aspects of a system really convince you of its quality?"



MY POINT OF VIEW

we need to focus on establishing the **value** of our work

instead of dismissing user studies:

take a wider view on evaluation
embrace a larger set of validation methods
work on new and improved methods
consider a broad range of value metrics

COMMON VALUE METRICS

- Efficiency
  - Time to x…
  - Memorability
- Effectiveness
  - Correctness of answers / decisions
  - Knowledge / insights gained
- Subjective metrics
  - Usefulness
  - Usability
  - Satisfaction
  - Preference
  - Confidence in answers / decisions

WHICH VALUE METRICS WE ARE MISSING?

Acknowledgments

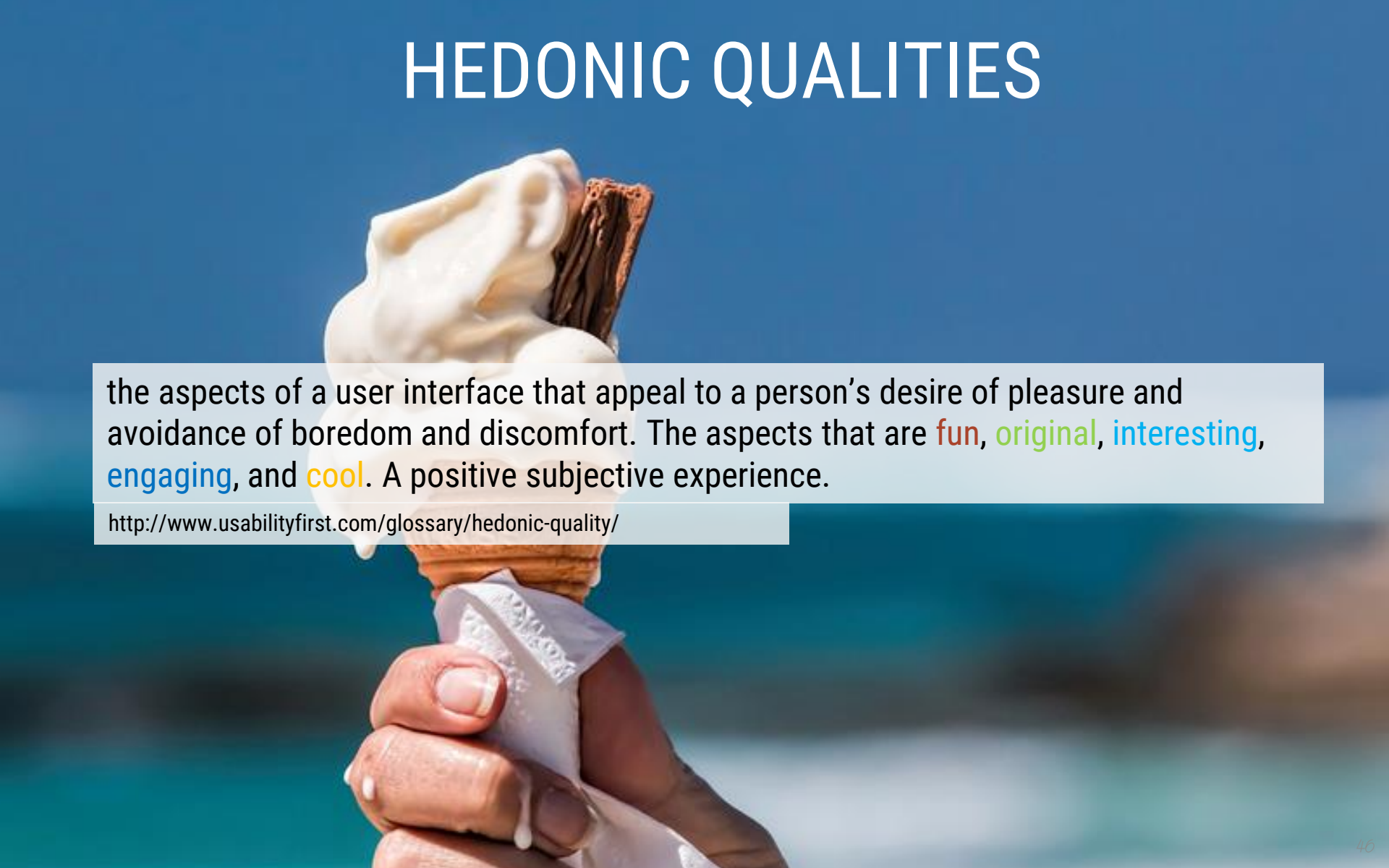
SCHLOSS DAGSTUHL
Leibniz-Zentrum für Informatik

DATA PHYSICALIZATIONS

“A data physicalisation (or simply physicalization) is a physical artifact whose geometry or material properties encode data”

Yvonne Jansen, Pierre Dragicevic, Petra Isenberg, Jason Alexander, Abhijit Karnik, Johan Kildal, Sriram Subramanian, Kasper Hornbæk. **Opportunities and Challenges for Data Physicalization**. CHI 2015 - Proceedings of the SIGCHI Conference on Human Factors in Computing Systems. ACM, 2015.

HEDONIC QUALITIES



the aspects of a user interface that appeal to a person's desire of pleasure and avoidance of boredom and discomfort. The aspects that are fun, original, interesting, engaging, and cool. A positive subjective experience.

http://www.usabilityfirst.com/glossary/hedonic-quality/

Department: Visualization Viewpoints
Editor: Theresa-Marie Rhyne, theresamarierhyne@gmail.com

An Emotional Response to the Value of Visualization

Yun Wang
Microsoft Research

Adrien Segal
Adriensegal.com

Roberta Klatzky
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Petra Isenberg
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Eva Hornecker
Bauhaus-Universität Weimar

Tim Dwyer
Monash University

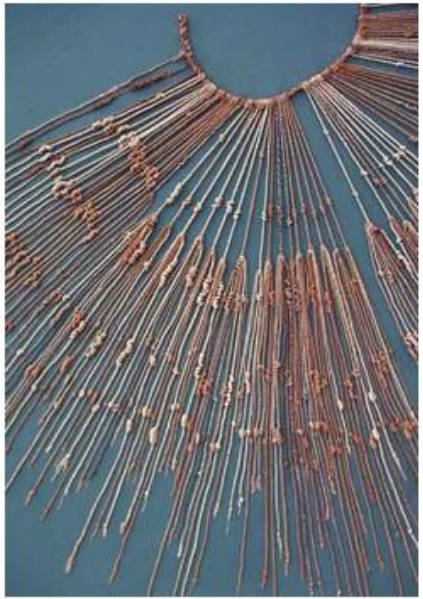
Stephen Barrass
SONIFICATION.COM

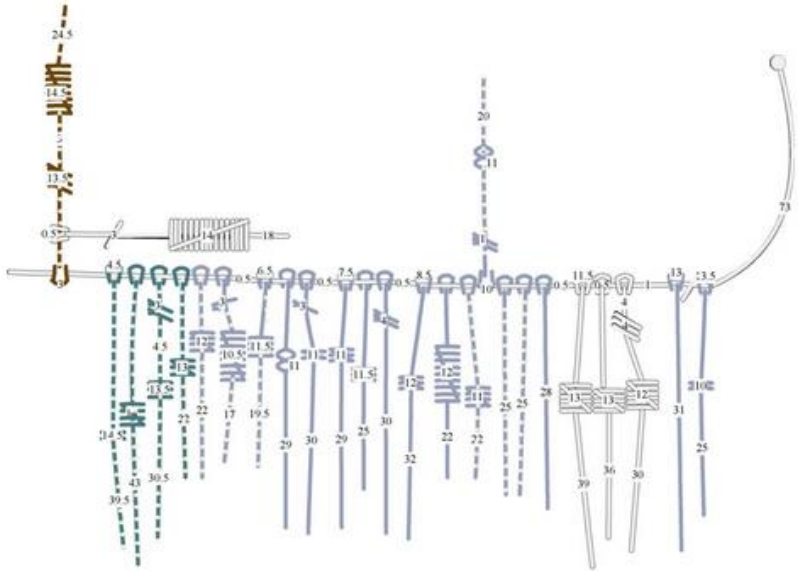
***Abstract*—When assessing the value of visualizations, researchers traditionally focus on efficiency, comprehension, or insight. However, analyzing successful data physicalizations leads to a deep appreciation for hedonic qualities. Informed by the role of emotion in psychology, art, design, marketing, and HCI, we argue for an expanded definition of *value*, applicable to all forms of data visualization.**

Data physicalization—the process of creat-

practiced by diverse communities of scholars.

2600 BC – Inca Quipus





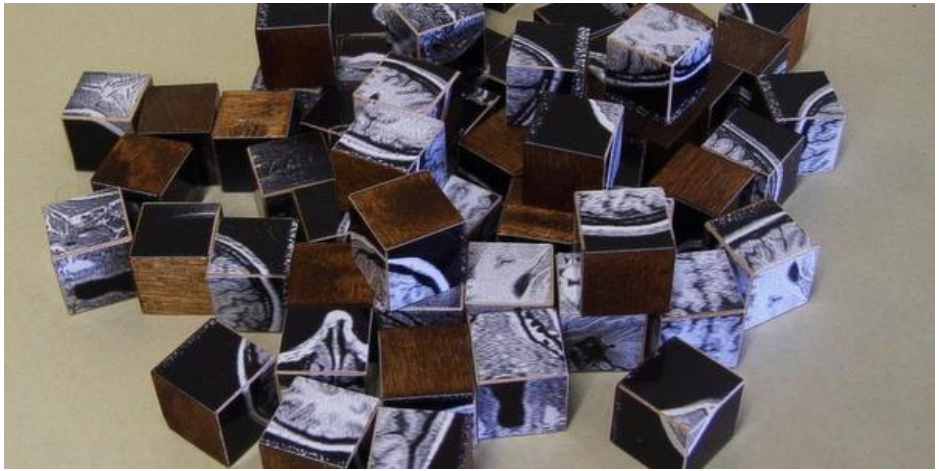
Quipus were complex assemblies of knotted ropes that were used in South America as a data storage device and played an important role in the Inca administration. Only a handful of specialists could use and decipher them. Their meaning mostly remains a mystery but it seems that color, relative position of knots, knot types and rope length were used to encode categorical and quantitative variables.

The oldest known Quipu is 4600 years old. In the late 16th century quipus were still being used by Peruvians until the Roman Catholic church decreed they were "the devil's work" and had most of them destroyed.

Sources:

- Paul Beynon-Davies (2009) Significant Threads.
- Dead Media Archive Peruvian Quipu.
- K. Kris Hirst. South America's Oldest Writing System.
- Left image from https://courses.cit.cornell.edu/quipu/, right image from Beynon-Davies (2009).

Max Perutz ~1968:
Constructing the hemoglobin molecule
via: tinyurl.com/physvis



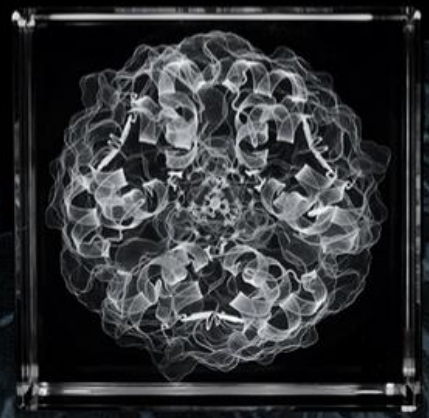
by Neil Fraser '08 via: tinyurl.com/physvis & infosthetics.com

2014 – Silver Ring Shaped by DNA Profile

https://www.crystalproteins.com

CrystalProteins

Home | Quote | Gallery | About | Billing



We'll make your data **beautiful**.

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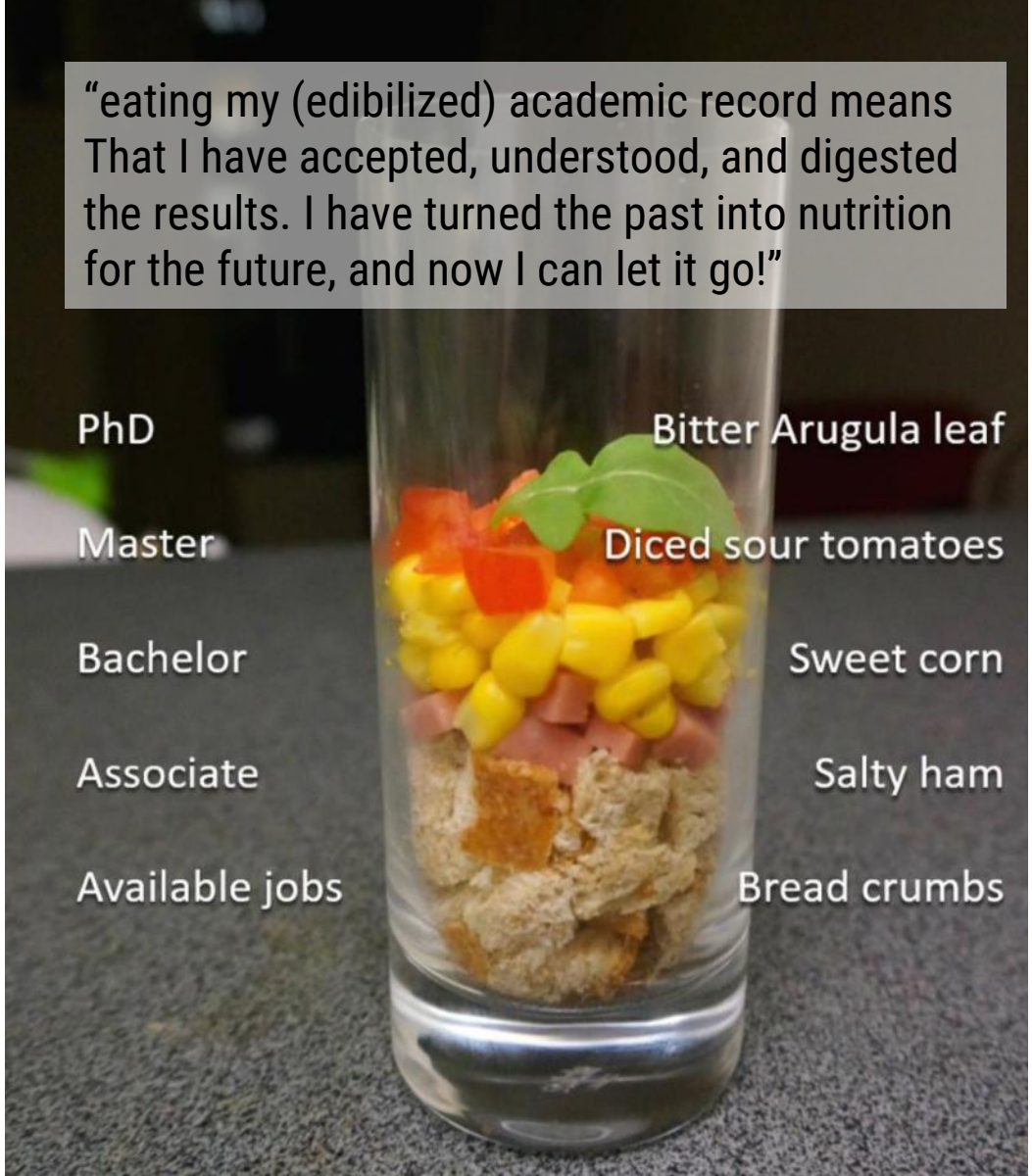
CrystalProteins creates accurate 3D etchings inside blocks of glass, giving real-world insight into complex structures. We work with proteins, small molecules, image stacks, and all kinds of 3D data, direct from your files. Sizes are paperweights to large awards, with optional light bases. If you'd like an inscription or logo, we can add it right in the glass.

They're useful as visualization tools for research, thoughtful gifts for a colleague, student or advisor, elegant mementos of a discovery or deal. Sculptor Bathsheba Grossman and laser etchers Precision Crystal have worked together for over a decade, making thousands of crystals in many scientific subjects. Our specialized software and high-resolution lasers give clean, fine-grained images, plus we bring an artist's vision to every project.


“eating my (edibilized) academic record means That I have accepted, understood, and digested the results. I have turned the past into nutrition for the future, and now I can let it go!”
PhD
Master
Bachelor
Associate
Available jobs
Bitter Arugula leaf
Diced sour tomatoes
Sweet corn
Salty ham
Bread crumbs

DATA SCULPTURES

“data-driven artifacts [...] built by artists and designers who seek to elicit emotions and convey meaning beyond mere data.”

Yvonne Jansen, Pierre Dragicevic, Petra Isenberg, Jason Alexander, Abhijit Karnik, Johan Kildal, Sriram Subramanian, Kasper Hornbæk. **Opportunities and Challenges for Data Physicalization**. CHI 2015 - Proceedings of the SIGCHI Conference on Human Factors in Computing Systems. ACM, 2015.

Grewingk Glacier

https://www.adriensegal.com/grewingk-glacier

ADRIEN SEGAL

PROJECTS STATEMENT EXHIBITIONS PRESS ABOUT

Grewingk Glacier

DATA SOURCE:
Kachemak Bay Research Reserve / Alaska Department of Fish and Game
Glacier Maps provided by Steve Baird, Research Analyst, GIS

GREWINGK GLACIER is an ephemeral data sculpture whose form is derived from maps of the terminus of Grewingk Glacier as it has receded over 150 years time. Located in Kachemak Bay on the Kenai Peninsula in Alaska, Grewingk is part of the larger Harding Icefield , an expansive area that spawns 40 glaciers over 300 square miles. Aerial maps from photographic and satellite imagery show the perimeter of the glacier in 1952, 1985, 1996. 2003, and 2008.Grewingk glacier has been receding an average of 92 feet per year.

What is the value of an accurate melting representation of a glacier?

Do people understand the data more quickly?

Does it allow for correct reading of data?

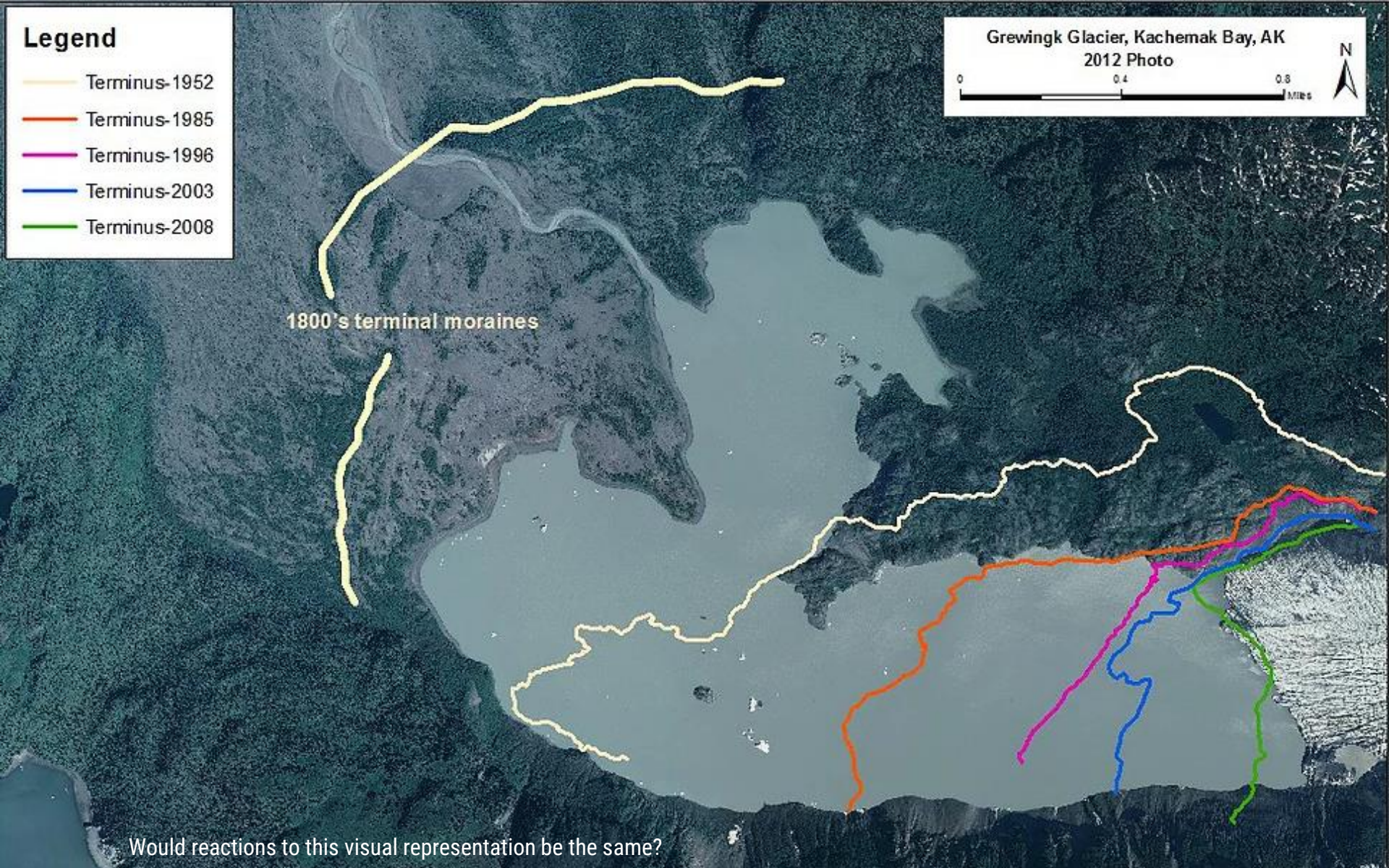
What is the knowledge gain?

Responses

“Audiences often gasp when the ice collapses and begins to disappear”

“Viewers often express a desire to touch it to feel the cold”

Feeling of personal connection to changes that occur in the natural landscape

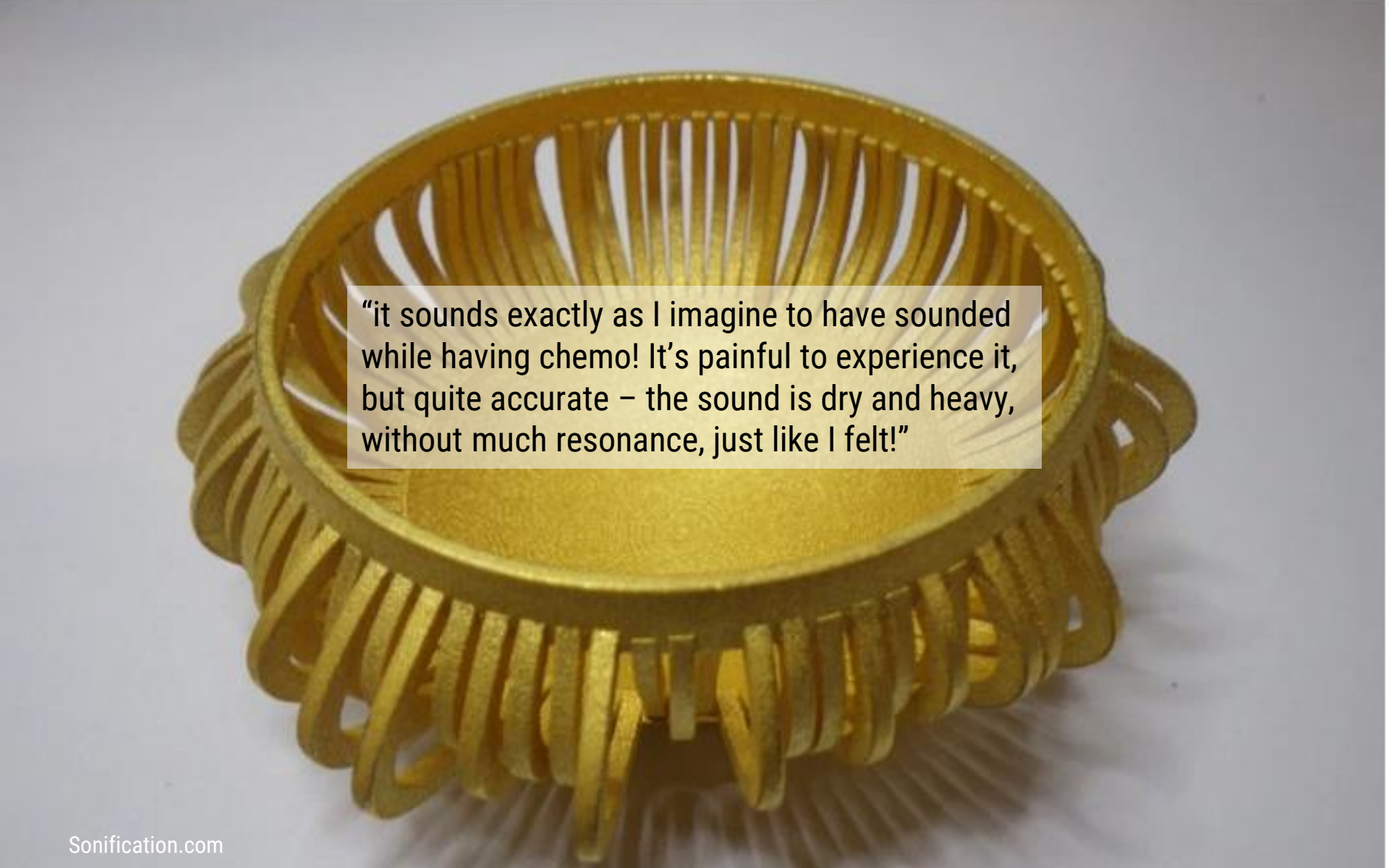


Would reactions to this visual representation be the same?

CHEMO SINGING BOWL

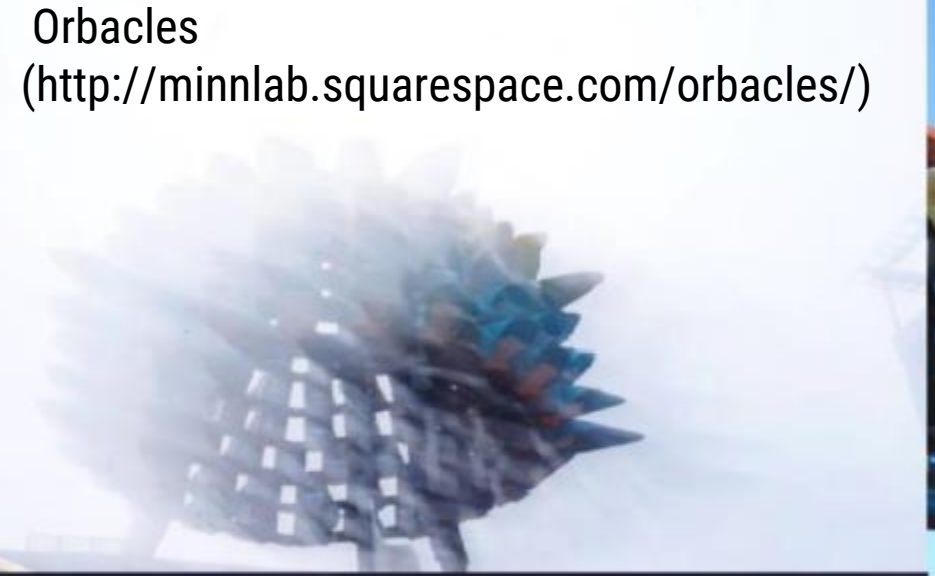
Sonification.com

https://www.youtube.com/watch?v=oob8zENYt0g

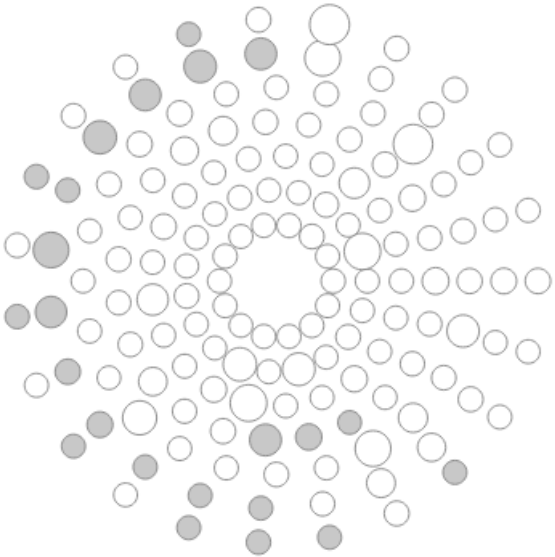


“it sounds exactly as I imagine to have sounded while having chemo! It’s painful to experience it, but quite accurate – the sound is dry and heavy, without much resonance, just like I felt!”

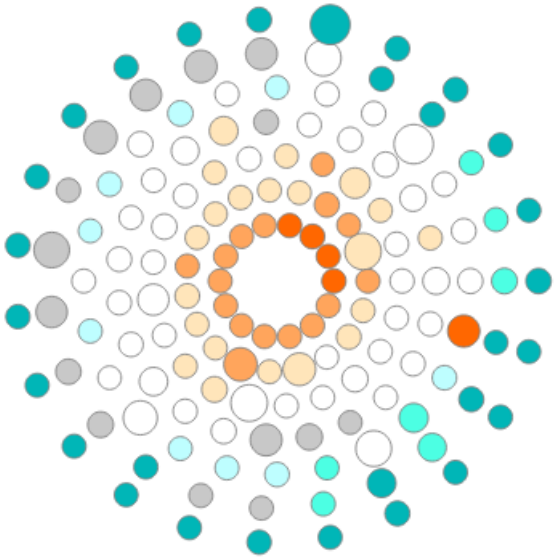
Orbacles
(http://minnlab.squarespace.com/orbacles/)



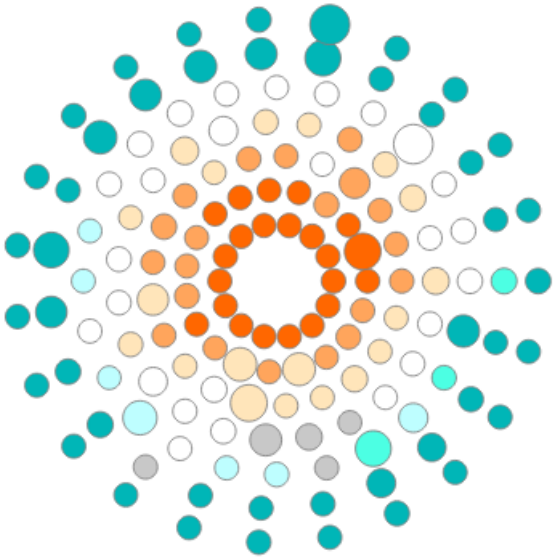
CURRENTLY



FUTURE (LOW EMISSIONS SCENARIO)



FUTURE (HIGH EMISSIONS SCENARIO)



Color indicates change in prevalence of each species in MN.

- White is a baseline, the current prevalence for each species.
- Gray means the species is not generally present in MN.

Radius is proportional to the typical size of the birds.

- The smallest birds (Ruby-throated Hummingbird, length = 3 in.)
- The largest birds (Turkey Vulture, wingspan = 72 in.)

Some will increase in prevalence, some will be new to MN.

- > 15% increase in prevalence
- > 45% increase in prevalence
- > 75% increase in prevalence

Many will decrease in prevalance, or leave MN entirely.

- > 15% decrease in prevalence
- > 45% decrease in prevalence
- > 75% decrease in prevalence

HOW DO WE PLACE VALUE ON DATA REPRESENTATIONS THAT ENGAGE PEOPLE ON A PHYSICAL AND EMOTIONAL LEVEL?

MEANWHILE IN HCI…

Focused

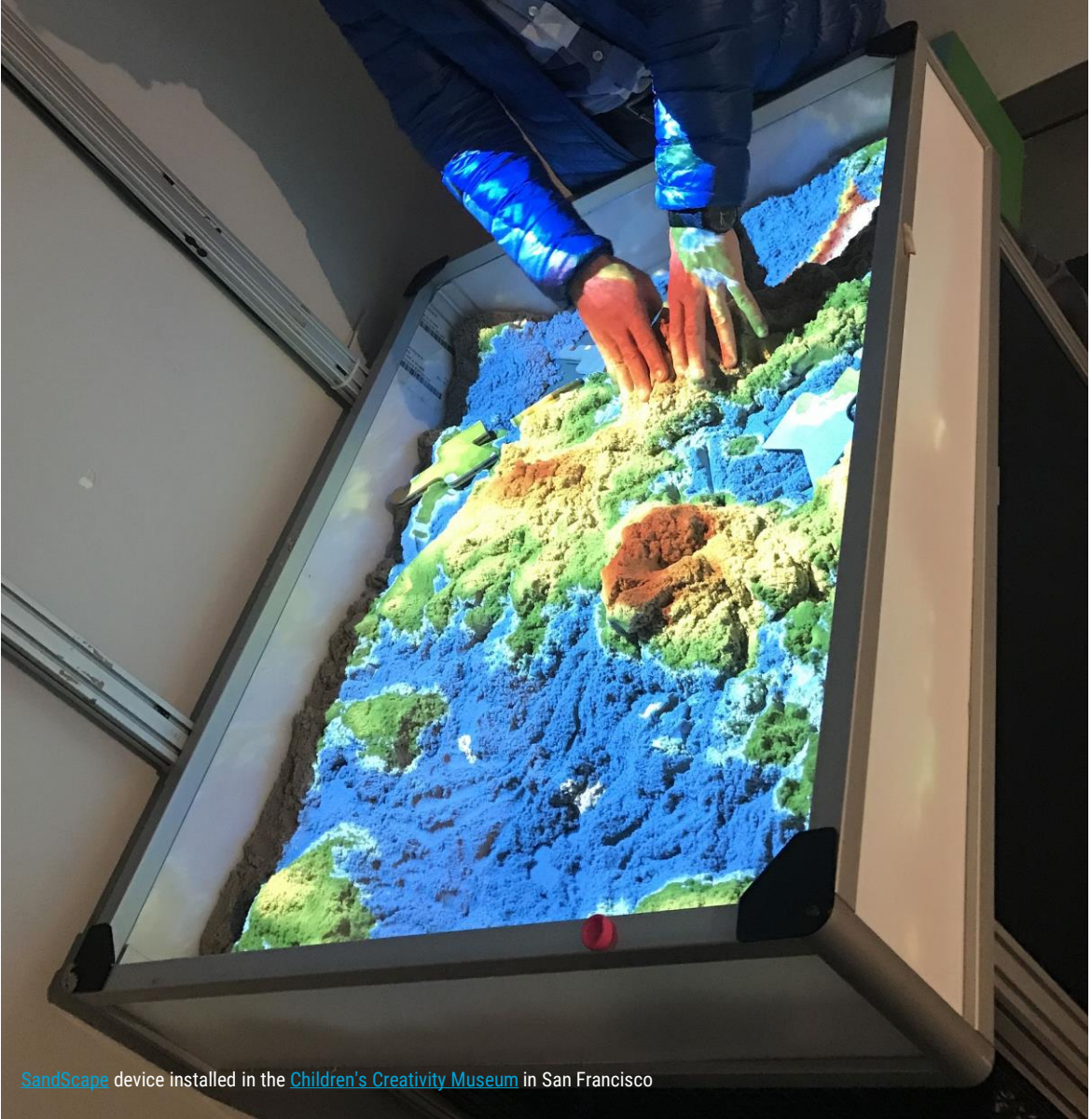
Holistic

USABILITY → USER EXPERIENCE

Effectiveness
Efficiency
Learnability
Error prevention
Memorability

Satisfaction
Enjoyment
Pleasure
Fun
Value

. . . user experience goals differ from the more **objective** usability goals in that they are concerned with how users **experience** an interactive product from their perspective rather than assessing how useful or productive a system is from its own perspective. (Preece et al. 2002, p. 19)

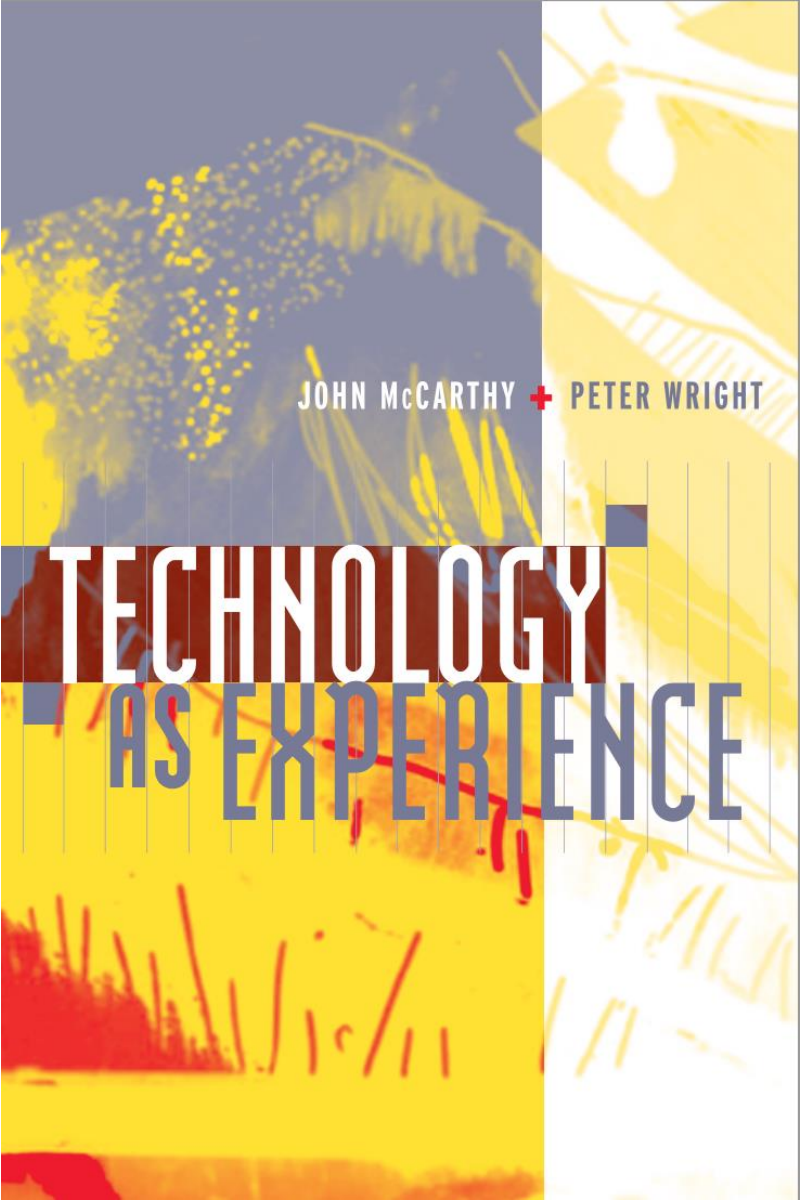


SandScape device installed in the Children's Creativity Museum in San Francisco

Tangible Uis

Mixed evidence on user performance and learning

High on user experience



Emotional qualities of experience are part of sensemaking and integral to our process of understanding

MEANWHILE IN PSYCHOLOGY…

Emotion and Decision Making Explained

https://books.google.fr/books?isbn=0199659893 - Diese Seite übersetzen

Edmund T. Rolls - 2013 - Vorschau - Mehr Ausgaben

What is the relation between emotion, and reward value, and subjective feelings of pleasure? These are just some of the question considered in this book, written by a leading neuroscientist in this field.

Emotions, Ethics and Decision-Making

https://books.google.fr/books?isbn=1846639409 - Diese Seite übersetzen

Wilfred J. Zerbe, Charmine E. J. Härtel, Neal M. Ashkanasy - 2008 - Vorschau - Mehr Ausgaben

This volume includes articles, which represent a selection of the papers presented at the sixth International Conference on Emotions and Organizational Life.

Twenty Years After the Iowa Gambling Task: Rationality, Emotion, and ...

https://books.google.fr/books?isbn=2889455289 - Diese Seite übersetzen

Jong-Tsun Huang, Yao-Chu Chiu, Ching-Hung Lin - 2018 - Vorschau

Chronic pain patients are impaired on an **emotional decisionmaking** task. Pain 108, 129–136. doi:10.1016/j.pain.2003.12.015 Assadi, S. M., Yücel, M., and Pantelis, C. (2009). Dopamine modulates neural networks involved in effort-based ...

Emotional vs. logical/rational decision making - A research project ...

https://books.google.fr/books?isbn=3640170474 - Diese Seite übersetzen

Christian Mogler - 2008 - Vorschau

Research Paper (postgraduate) from the year 2006 in the subject Psychology - Personality Psychology, grade: A, Prairie Bible College (Prairie Bible College), 5 entries in the bibliography, language: English, abstract: Project Abstract: The ...

JOURNAL OF CONSUMER PSYCHOLOGY, *11*(2), 75–85

An Influence of Positive Affect on Decision Making in Complex Situations: Theoretical Issues With Practical Implications

Alice M. Isen

Johnson Graduate School of Management and Department of Psychology
Cornell University

In most circumstances, positive affect enhances problem solving and decision making, leading to cognitive processing that is not only flexible, innovative, and creative, but also thorough and efficient.

This artic nces
problem s ible,
innovativ ard-
ing consu ons,
and servi

These in-
teraction der-
standing. and
particularly for a role for employee positive affect, or employee satisfaction, in generating customer satisfaction.

Moreover, studies specifically in the domain of medical decision making and problem solving indicate that these implications would apply to the specific areas of doctor–patient interaction, medical decision making, and medical consumer satisfaction. Finally, it is suggested that

As one of the artists at Dagstuhl put it…

IN ART…

Representing information in the realm of the physical increases accessibility of the embedded information to the user and enhances the ability to have an engaging experience by enhancing perceptual, affective, and cognitive responses.

Emotional Data Visualization: Periscopic's "U.S. Gun Deaths" and the Challenge of Uncertainty

By Alberto Cairo
Apr 3, 2013

it would be appropriate to just enjoy the creativity and beauty of projects like this, to quietly mourn the people behind the data, and to think about what the future of gun legislation should be

MEANWHILE IN VISUALIZATION…

2007

Artistic Data Visualization:
Beyond Visual Analytics

Neutral analysis is not the only important task in life. […] there are often valid reasons to want to change the way people think and it may be that much of the value of visualization comes from its ability to change attitudes.

121 Homes for Sale, LA/Orange County | *114 Homes for Sale, Dallas/Ft. Worth Metroplex* | *112 Homes for Sale, Miami-Dade County*

Fig. 1 *Homes for Sale, Digital C-prints by Jason Salavon.*

Values of Visualizations in the Digital Humanities

In Defense of Sandcastles
Research Thinking through Visualization in Digital Humanities

Uta Hinrichs (University of St Andrews; uh3@st-andrews.ac.uk)

Stefania Forlini (University of Calgary; sforlini@ucalgary.ca)

Bridget Moynihan (University of Edinburgh; bridgetc.moynihan@gmail.com)

ABSTRACT

Although recent research acknowledges the potential of visualization methods in digital humanities (DH), the predominant terminology used to describe visualizations (prototypes, tools) focuses on their use as a means to an end and, more importantly, as an instrument in the service of humanities research. We introduce the sandcastle as a metaphorical lens and provocative term to highlight visualization as a research process in its own right. We argue that building *visualization sandcastles* provides a holistic approach to cross-disciplinary knowledge generation that embraces visualization as (1) an aesthetic provocation to elicit critical insights, interpretation, speculation, and discussions within and beyond scholarly audiences, (2) a dynamic process wherein speculation and re-interpretation advance knowledge within all disciplines involved, and (3) a mediator of ideas and theories within and across disciplines. Our argument is grounded in critical theory, DH, design, human computer interaction (HCI), and visualization, and based on our own

Values of Visualization in Digital Humanities

- An aesthetic provocation to promote critical interpretation
- A speculative process that advances all disciplines involved
- A mediator that fuels an open-ended participatory discourse between disciplines.

Data is Personal: Attitudes and Perceptions of Data Visualization in Rural Pennsylvania

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ABSTRACT

Many of the guidelines that inform how designers create data visualizations originate in studies that unintentionally exclude populations that are most likely to be among the "data poor". In this paper, we explore which factors may drive attention and trust in rural populations with diverse economic and educational backgrounds - a segment that is largely underrepresented in the data visualization literature. In 42 semi-structured interviews in rural Pennsylvania (USA), we find that a complex set of factors intermix to inform attitudes and perceptions about data visualization - including educational background, political affiliation, and personal experience. The data and materials for this research can be found at https://osf.io/uxwts/

CCS CONCEPTS

• **Human-centered computing** → *Visualization theory, concepts and paradigms*;

KEYWORDS

information visualization, data, information literacy, rural

Figure 1: We interviewed 42 community members in rural PA about their perceptions of data visualization. Above: Lewisburg Farmers market - one of our interview sites

1 INTRODUCTION

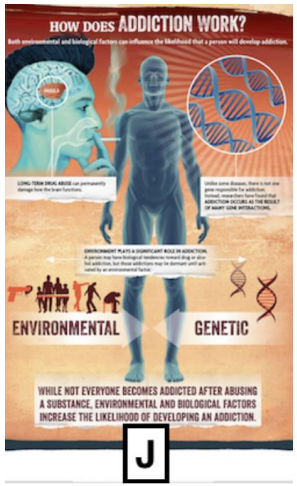
Access to data can provide insight into our political, social, and physical environment. Following the development of web-based creation tools [7, 50, 51, 59], the recent prevalence of data visualization on the web has ushered in new-found hope for broadly accessible, engaging visualizations that can

availability, and internet access [25, 45, 46]. For example, Burrell remarks that digital inequality in rural regions is fundamentally a matter of exclusion [10].

Initiatives to broaden the accessibility of visualization are hardly novel. However, while traditional efforts to improve

Expressions of value in survey of urban population

- Straight forward visual encodings (ability to quickly extract gist)
- **Relatability**
  Well [GraphJ] obviously gets me because I drink and smoke."
  P30, 25-34 year old, some high school but no diploma
- Social Framing: Will this help other people?
  "I ranked them based on the fact that I am a [school] principal and [which graphs] I would be wanting to show to my kids and parents; It was based on the information that's provided, and then also the appeal; the visual aspect of it and what is going to engage them" – P31, 35-44 year old, postgraduate degree
- Trust in data / sources



Values of Constructing Visualizations

http://constructive.gforge.inria.fr

Self-Reflection and Personal Physicalization Construction

Alice Thudt[1] **Uta Hinrichs**[2] **Samuel Huron**[3] **Sheelagh Carpendale**[1]
[1]InnoVis Group [2]SACHI Group [3]Télécom ParisTech
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ABSTRACT
Self-reflection is a central goal of personal informatics systems, and constructing visualizations from physical tokens has been found to help people reflect on data. However, so far, constructive physicalization has only been studied in lab environments with provided datasets. Our qualitative study investigates the construction of personal physicalizations in people's domestic environments over 2–4 weeks. It contributes an understanding of (1) the process of creating personal physicalizations, (2) the types of personal insights facilitated, (3) the integration of self-reflection in the physicalization process, and (4) its benefits and challenges for self-reflection. We found that in constructive personal physicalization, data collection, construction and self-reflections are deeply intertwined. This extends previous models of visualization creation and data-driven self-reflection. We outline how benefits such as reflection through manual construction, personalization, and presence in everyday life can be transferred to a wider set of digital and physical systems.

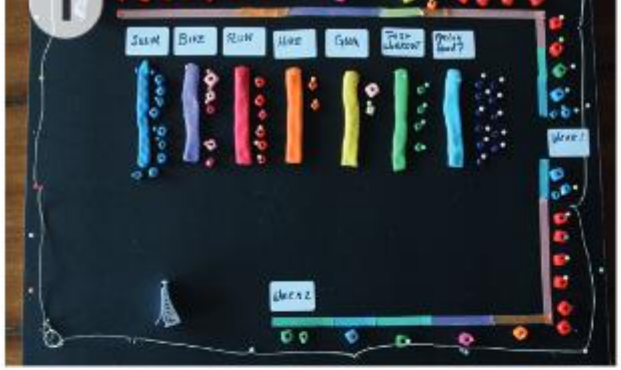
ACM Classification Keywords
H.5.m. Information Interfaces and Presentation (e.g. HCI): Miscellaneous

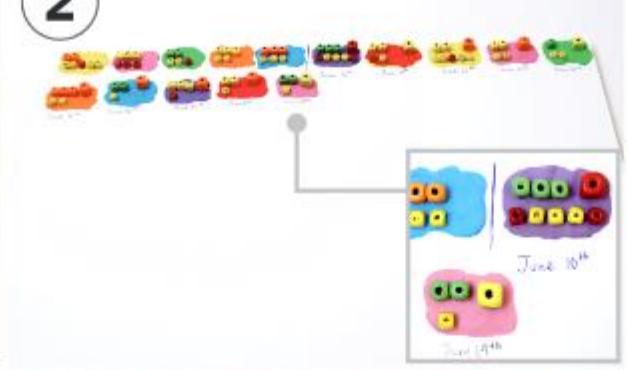
Author Keywords
Self-Reflection; Constructive Visualization; Personal Data

INTRODUCTION
"Active, persistent, and careful consideration of any be-

foster reflection. But even millennia before these research fields existed, people have created and reflected on physical representations of data (i.e., *physicalizations* [28]; see [15]), to track, for example, menstrual cycles [52], or personal accomplishments [20]. The manual construction of personal visualizations using simple physical building blocks persists until today (e.g., Hunger's Lego time tracking physicalization [23]). The constructive visualization paradigm [25] is promising for supporting self-reflection as it fosters active engagement with the data and draws on simple and familiar actions and materials [25], rather than requiring learning and navigating interface components [51]. However, so far, the manual construction of visualizations has not been studied in a personal context. Previous empirical studies were conducted in lab environments with test datasets.

To address this gap, we have investigated how people manually construct physicalizations of their own data and within their personal environment over a 2–4 week period. Our main goal is to gain an in-depth understanding of how constructive physicalization approaches are applied in personal contexts. Our analysis reveals details about how people approached the creation of their physicalizations and suggests that this process allows for personal reflections that are deeply intertwined with the manual construction. From this first exploration of physicalization construction in a personal context, we contribute (1)


1
SWIM
BIKE
RUN
HIKE
GYM
WEEKS


2
June 10th


3
Ten Little Fingers and Ten Little Toes
Three Bears in a Boat


4


5


6

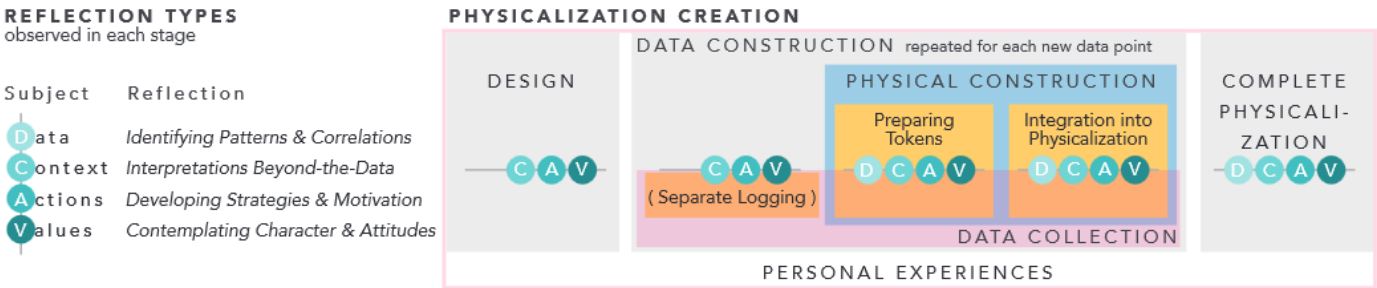

7


8


9

Values for the Participants

- Insights
- (Re-)interpretation of the data in personal context
- Trigger for reminiscing about represented events
- Motivation and development of actionable strategies
- Contemplation of one's character, values, and attitudes



Questions that follow from expanded values…

If affect, experiences, and emotion are an important part of decision making & understanding – can we influence them?

If yes, how can we study the effects of encodings that are meant to elicit certain reactions?

Affective Color in Visualization

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Maureen Stone
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ABSTRACT
Communicating the right affect, a feeling, experience or emotion, is critical in creating engaging visual communication. We carried out three studies examining how different color properties (lightness, chroma and hue) and different palette properties (combinations and distribution of colors) contribute to different affective interpretations in information visualization where the numbers of colors is typically smaller than the rich palettes used in design. Our results show how color and palette properties can be manipulated to achieve affective expressiveness even in the small sets of colors used for data encoding in information visualization.

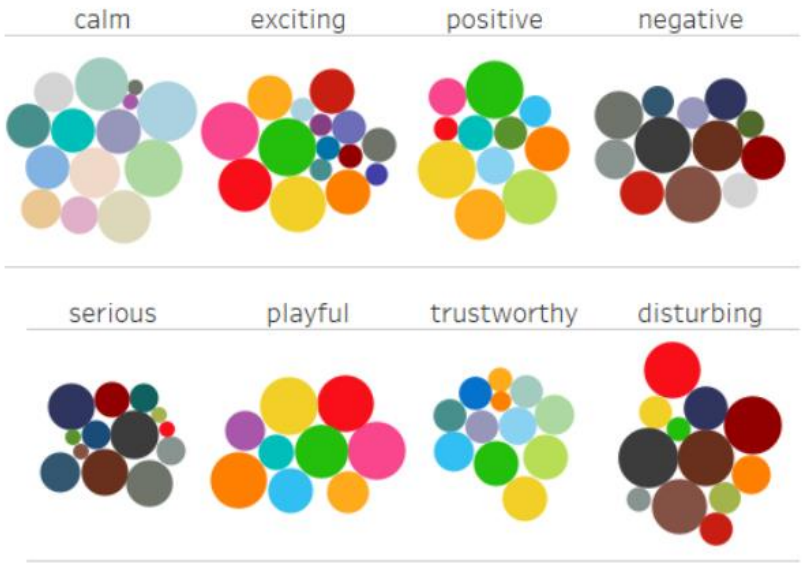
ACM Classification Keywords
H.5.m. Information Interfaces and Presentation: Misc-Colors

Author Keywords
Affective Visualization; Color Perception; Design

INTRODUCTION
in professional craft and is qualitatively rather than empirically validated. Color psychology has proven the connection between individual colors and affect, but to date there are no studies in how combinations of colors (palettes) may convey different affect in the limited scope used in categorical information visualization.

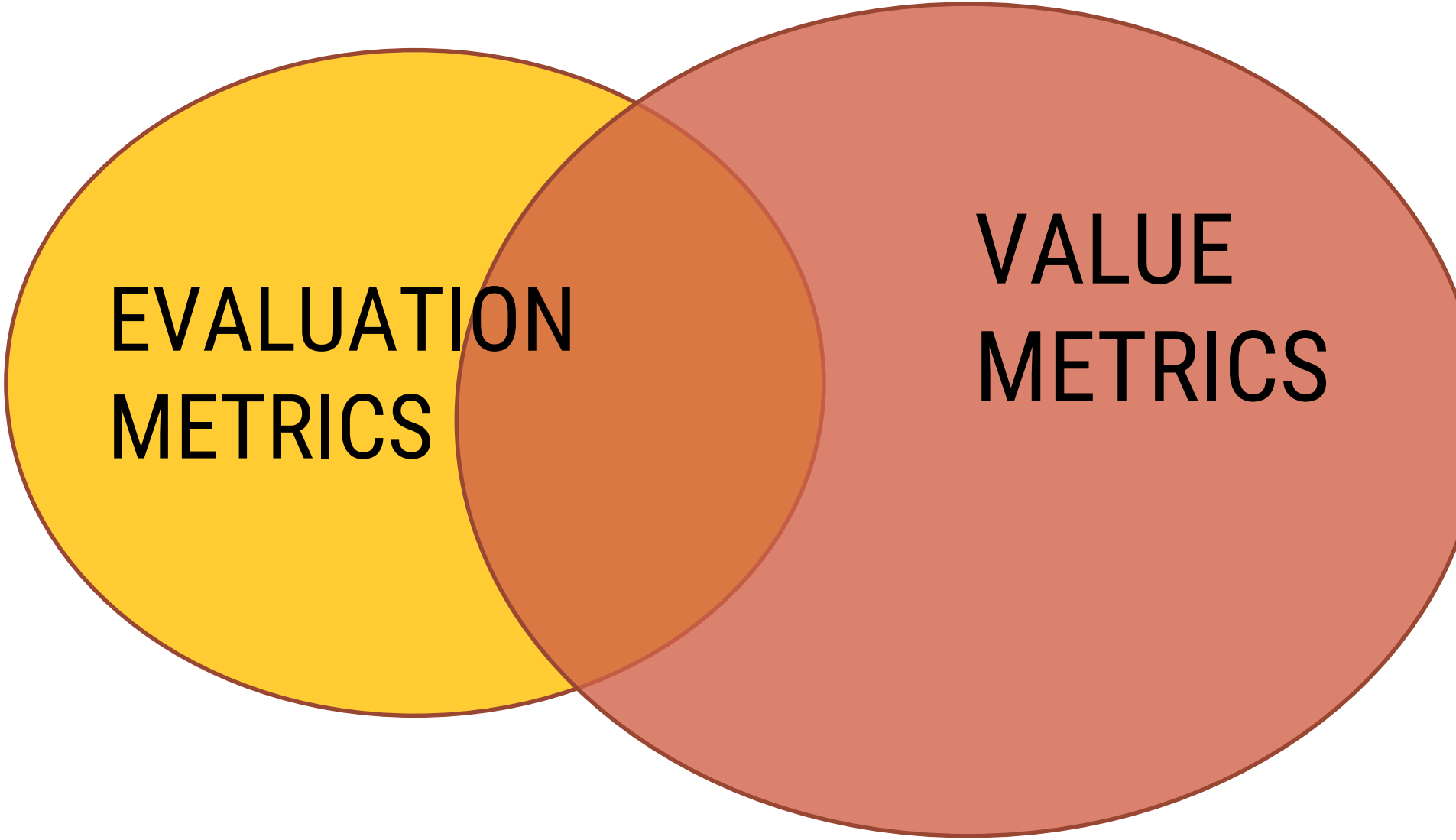
Unlike the rich palettes available to design applications, mapping colors to categorical data (the most common use of color in visualization) introduces two important constraints. First, the usable scale of the palette is small: typically, 5-10 colors [42]. Second, the colors need to be strongly perceptually distinct [39]. We are interested in validated computational models of how color relates to desired affect in these constrained palettes.

We had two basic research questions. First, can we relate certain affective impressions to properties of a color palette in abstract images such as simple visualizations? And second, what might this mean operationally for the design of affective color palettes that are useful in information visualization?



Our results show a validated relationship between affect, perceptual color properties (hue, chroma and lightness), and palette composition for the eight categories we measured.

WHAT REMAINS TO BE DONE?


EVALUATION METRICS
VALUE METRICS

Department: Visualization Viewpoints
Editor: Theresa-Marie Rhyne, theresamarierhyne@gmail.com

An Emotional Response to the Value of Visualization

Yun Wang
Microsoft Research

Adrien Segal
Adriensegal.com

Roberta Klatzky
Carnegie Mellon University

Daniel F. Keefe
University of Minnesota

Petra Isenberg
Inria

Jörn Hurtienne
Julius-Maximilians-Universität Würzburg

Eva Hornecker
Bauhaus-Universität Weimar

Tim Dwyer
Monash University

Stephen Barrass
SONIFICATION.COM

***Abstract*—When assessing the value of visualizations, researchers traditionally focus on efficiency, comprehension, or insight. However, analyzing successful data physicalizations leads to a deep appreciation for hedonic qualities. Informed by the role of emotion in psychology, art, design, marketing, and HCI, we argue for an expanded definition of *value*, applicable to all forms of data visualization.**

Data physicalization—the process of creating data representations that can be touched, heard, tasted, and/or seen and that encode data through geometric or material properties—can be traced back to 5500 BC and has been practiced by diverse communities of scholars, artists, learners, and others. Our group of coauthors, representing computer science, cognitive science, psychology, art, and design, gathered at a recent Dagstuhl workshop to learn more about this history and to synthesize ideas from the many disciplines that will shape the future of data physicalization.

Digital Object Identifier 10.1109/MCG.2019.2923483

V = C + E (A, P, I , S)

C: Creativity = introduction of new ideas

E: Engagement = ability to engage through

A: affective engagement
P: physical engagement
I: intellectual engagement
S: social engagement

$F = nm (W (dK) - Cs - kCe) - Ci - nCu$

$V = I + C + E + T$

$V = C + E (A, P, I, S)$

WE NEED BROADER VALUE MODELS

USABILITY STUDY

USER STUDY

CONTROLLED EXPERIMENT

ETHNOGRAPHIC OBSERVATION

...

WE NEED TO (STILL) WORK ON METHODS TO ASSESS BROADER VALUE

WE NEED TO GO BEYOND EFFECTIVENESS & EFFICIENCY & KNOWLEDGE GAIN

Implications for BioVis?

- Are you interested in correct analysis tools?
  - →effectiveness & efficiency is an important value for you
  - → knowledge / insight gain also

- Do you want to communicate your results?
  - → do you need to convince, engage, reach broad audiences?
  - → here other values come into play

- Do you want to achieve follow-up action, personal reflection, discussion, …
  - → Consider eliciting engagements beyond quick & efficient interactions

Limitations & Future Work

- I left out a lot of literature
  - In psychology
  - In HCI (e.g. all of Ubicomp)
  - In Visualization (much ongoing work in studying engagement)
  - Vis-in-the-wild (e.g. the racing bar charts phenomenon, Hans Rosling, …)
  - … (probably a lot more, tell me!)

- BUT I am happy to
  - continue discussions
  - see more concrete and crazier formulas ☺
  - see more papers on value metrics at Beliv 2020

BioVis 2019

PHYSICAL, CONTEXTUAL, AND FULL OF VALUE?

What do novel directions in Visualization teach us about judging the value of Visualization?

Inria informatics mathematics
Aviz Visual Analytics Project

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