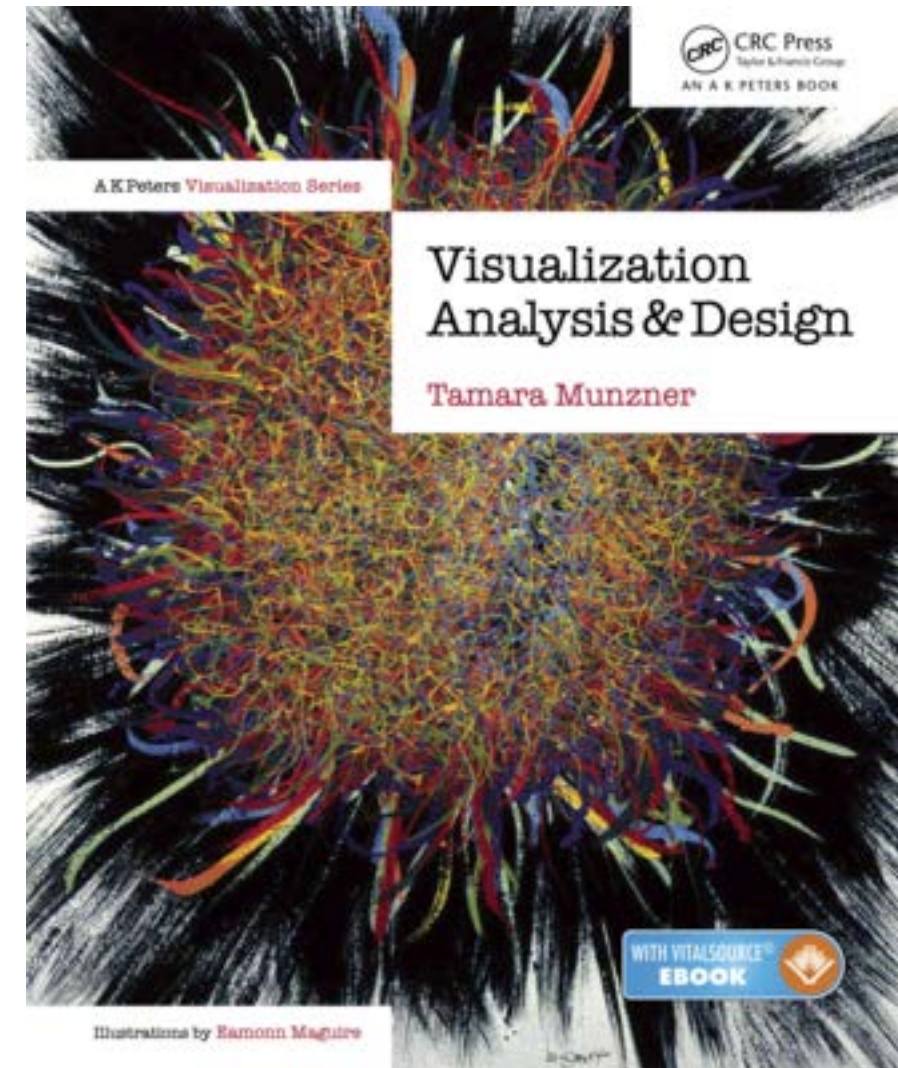


Visualization Analysis & Design

Full-Day Tutorial

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<http://www.cs.ubc.ca/~tmm/talks.html#vad16act>

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Defining visualization (vis)

Computer-based visualization systems provide visual representations of datasets designed to help people carry out tasks more effectively.

Why?...

Why have a human in the loop?

Computer-based visualization systems provide visual representations of datasets designed to help people carry out tasks more effectively.

Visualization is suitable when there is a need to augment human capabilities rather than replace people with computational decision-making methods.

- don't need vis when fully automatic solution exists and is trusted
- many analysis problems ill-specified
 - don't know exactly what questions to ask in advance
- possibilities
 - long-term use for end users (e.g. exploratory analysis of scientific data)
 - presentation of known results
 - stepping stone to better understanding of requirements before developing models
 - help developers of automatic solution refine/debug, determine parameters
 - help end users of automatic solutions verify, build trust

Why use an external representation?

Computer-based visualization systems provide **visual representations** of datasets designed to help people carry out tasks more effectively.

- external representation: replace cognition with perception



[Cerebral: Visualizing Multiple Experimental Conditions on a Graph with Biological Context. Barsky, Munzner, Gardy, and Kincaid. IEEE TVCG (Proc. InfoVis) 14(6):1253-1260, 2008.]

Why depend on vision?

Computer-based visualization systems provide visual representations of datasets designed to help people carry out tasks more effectively.

- human visual system is high-bandwidth channel to brain
 - overview possible due to background processing
 - subjective experience of seeing everything simultaneously
 - significant processing occurs in parallel and pre-attentively
- sound: lower bandwidth and different semantics
 - overview not supported
 - subjective experience of sequential stream
- touch/haptics: impoverished record/replay capacity
 - only very low-bandwidth communication thus far
- taste, smell: no viable record/replay devices

Why represent all the data?

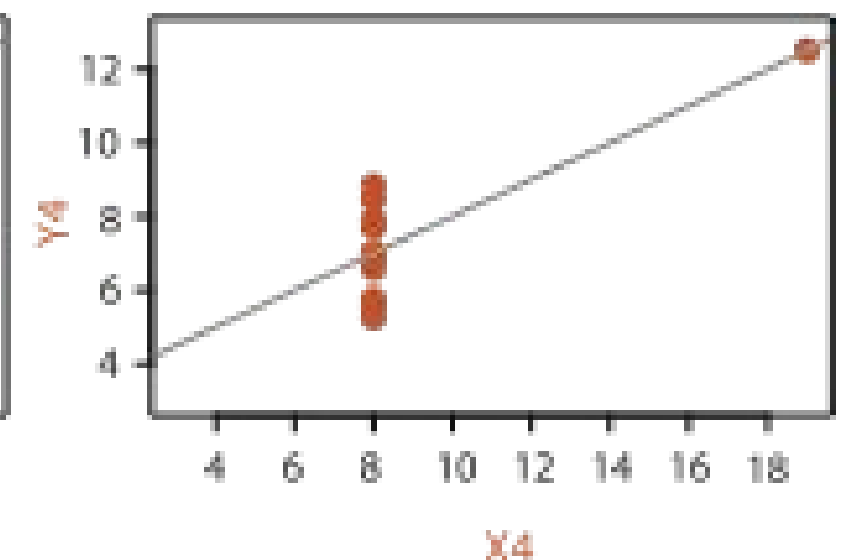
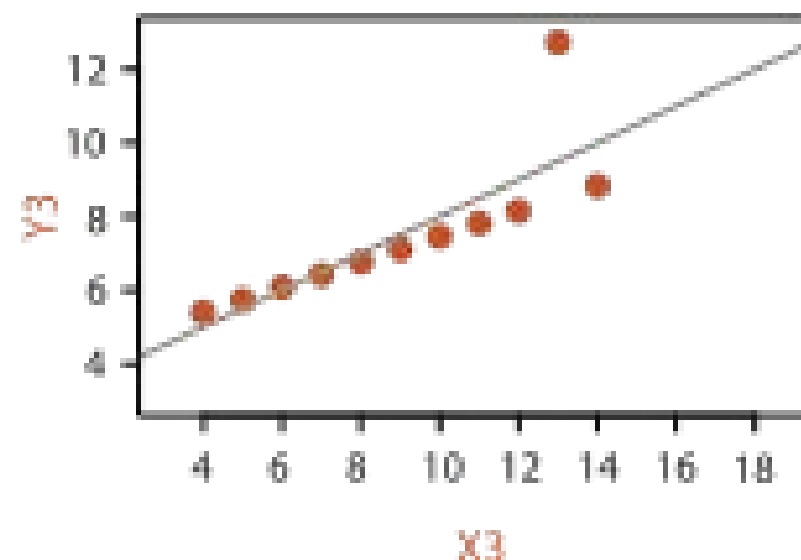
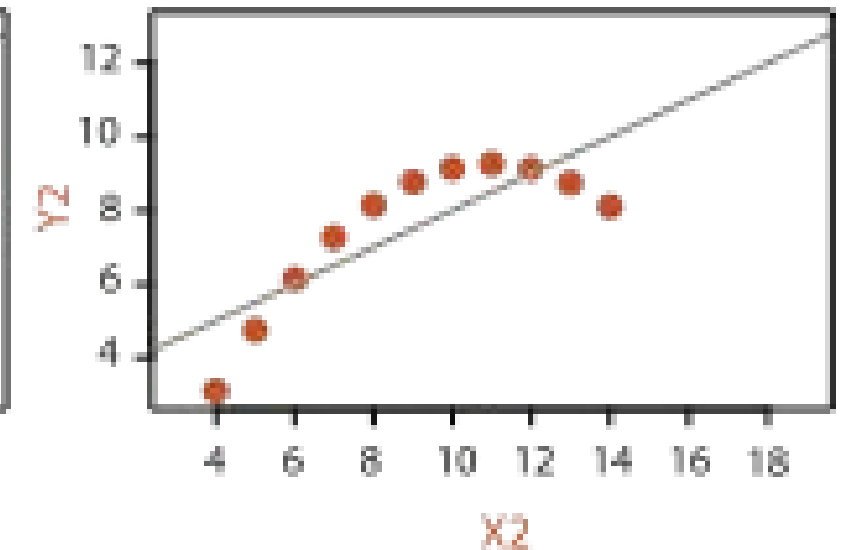
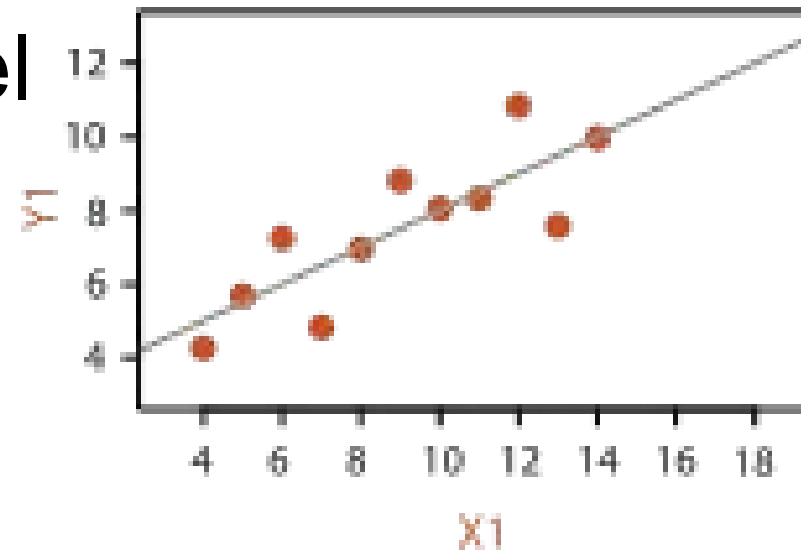
Computer-based visualization systems provide visual representations of datasets designed to help people carry out tasks more effectively.

- summaries lose information, details matter
 - confirm expected and find unexpected patterns
 - assess validity of statistical model

Anscombe's Quartet

Identical statistics

x mean	9
x variance	10
y mean	7.5
y variance	3.75
x/y correlation	0.816



Why focus on tasks and effectiveness?

Computer-based visualization systems provide visual representations of datasets designed to help people carry out tasks more effectively.

- tasks serve as constraint on design (as does data)
 - idioms do not serve all tasks equally!
 - challenge: recast tasks from domain-specific vocabulary to abstract forms
- most possibilities ineffective
 - validation is necessary, but tricky
 - increases chance of finding good solutions if you understand full space of possibilities
- what counts as effective?
 - novel: enable entirely new kinds of analysis
 - faster: speed up existing workflows

What resource limitations are we faced with?

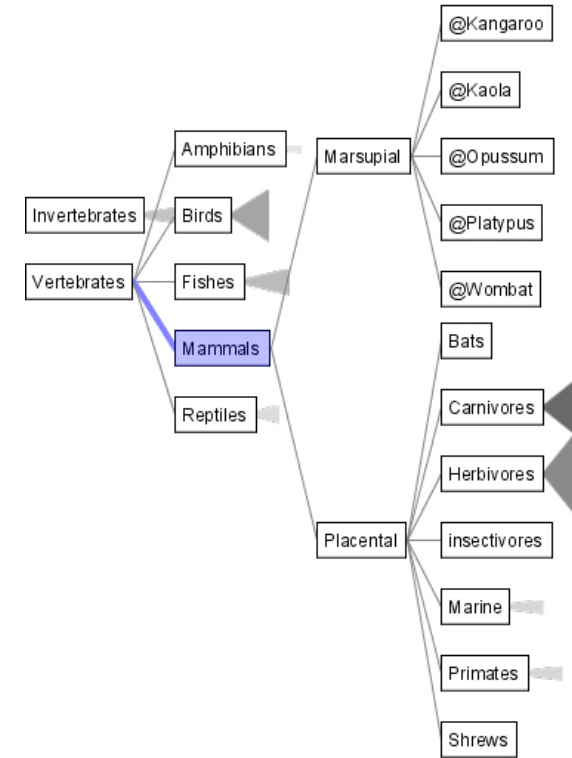
Vis designers must take into account three very different kinds of resource limitations: those of computers, of humans, and of displays.

- computational limits
 - processing time
 - system memory
- human limits
 - human attention and memory
- display limits
 - pixels are precious resource, the most constrained resource
 - information density: ratio of space used to encode info vs unused whitespace
 - tradeoff between clutter and wasting space, find sweet spot between dense and sparse

Why analyze?

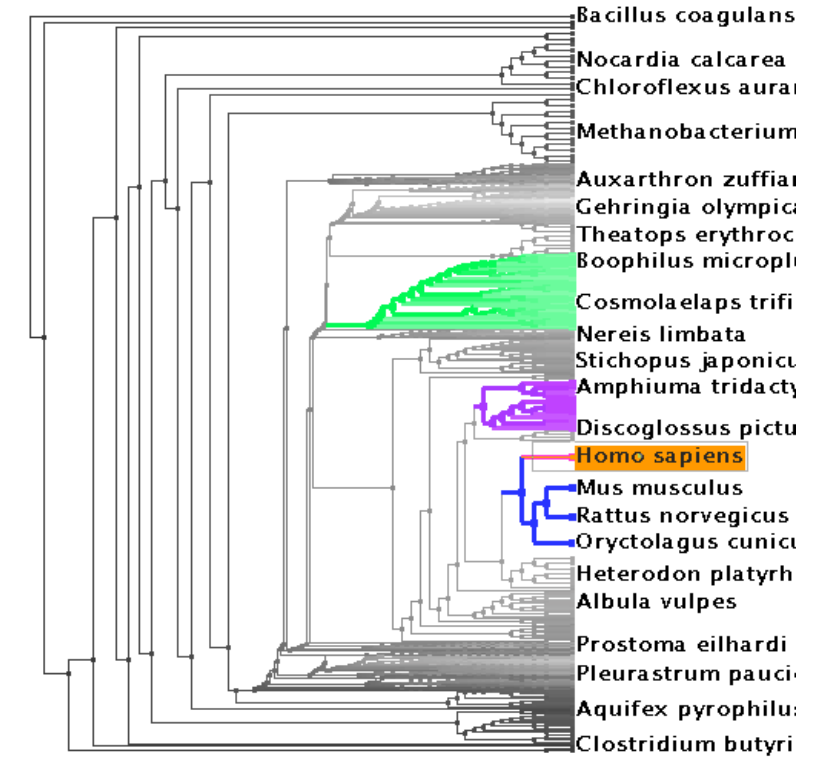
- imposes structure on huge design space
 - scaffold to help you think systematically about choices
 - analyzing existing as stepping stone to designing new
 - most possibilities ineffective for particular task/data combination

SpaceTree



[SpaceTree: Supporting Exploration in Large Node Link Tree, Design Evolution and Empirical Evaluation. Grosjean, Plaisant, and Bederson. Proc. InfoVis 2002, p. 57-64.]

TreeJuxtaposer



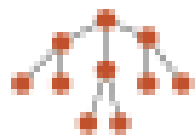
[TreeJuxtaposer: Scalable Tree Comparison Using Focus+Context With Guaranteed Visibility. ACM Trans. on Graphics (Proc. SIGGRAPH) 22:453-462, 2003.]

What?

Why?

How?

Tree

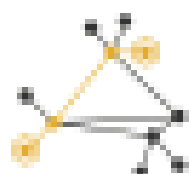


Actions



Targets

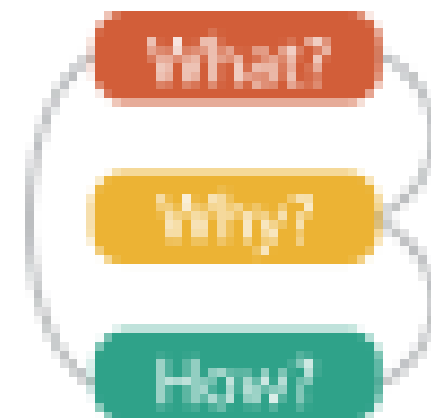
→ Path between two nodes



SpaceTree



TreeJuxtaposer



Further reading

- Visualization Analysis and Design. Munzner. AK Peters Visualization Series, CRC Press, 2014.
 - *Chap 1: What's Vis, and Why Do It?*

Analysis framework: Four levels, three questions

- *domain* situation
 - who are the target users?

- *abstraction*

- translate from specifics of domain to vocabulary of vis

- **what** is shown? data abstraction

- often don't just draw what you're given: transform to new form

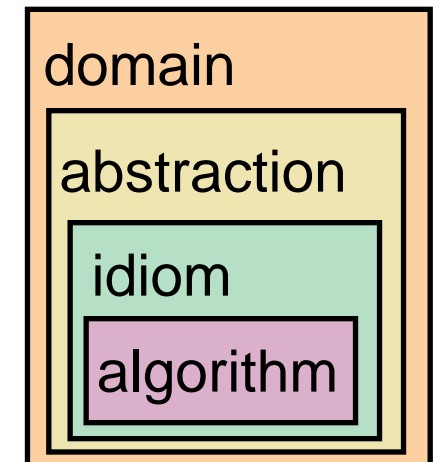
- **why** is the user looking at it? task abstraction

- *idiom*

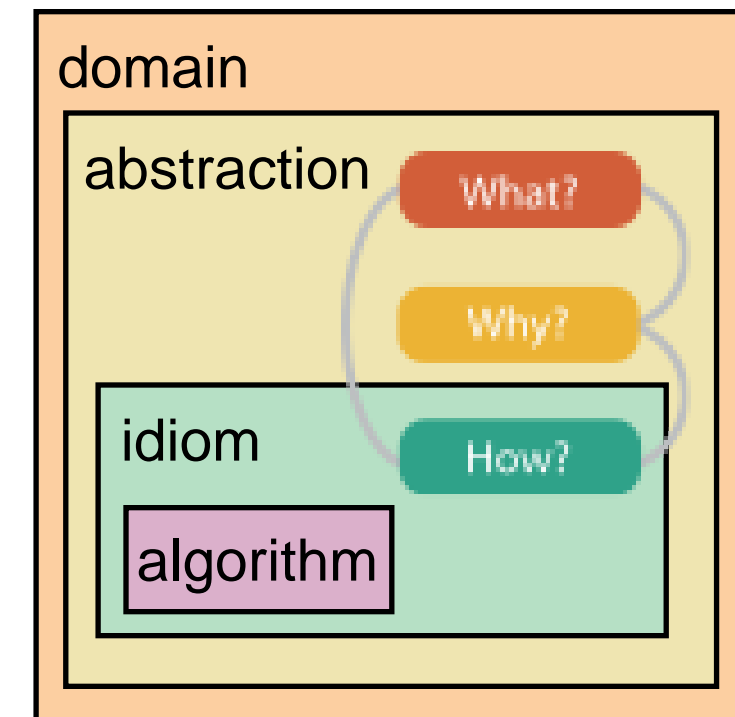
- **how** is it shown?

- visual encoding idiom: how to draw
- interaction idiom: how to manipulate

- *algorithm*



[A Nested Model of Visualization Design and Validation. Munzner. IEEE TVCG 15(6):921-928, 2009 (Proc. InfoVis 2009).]

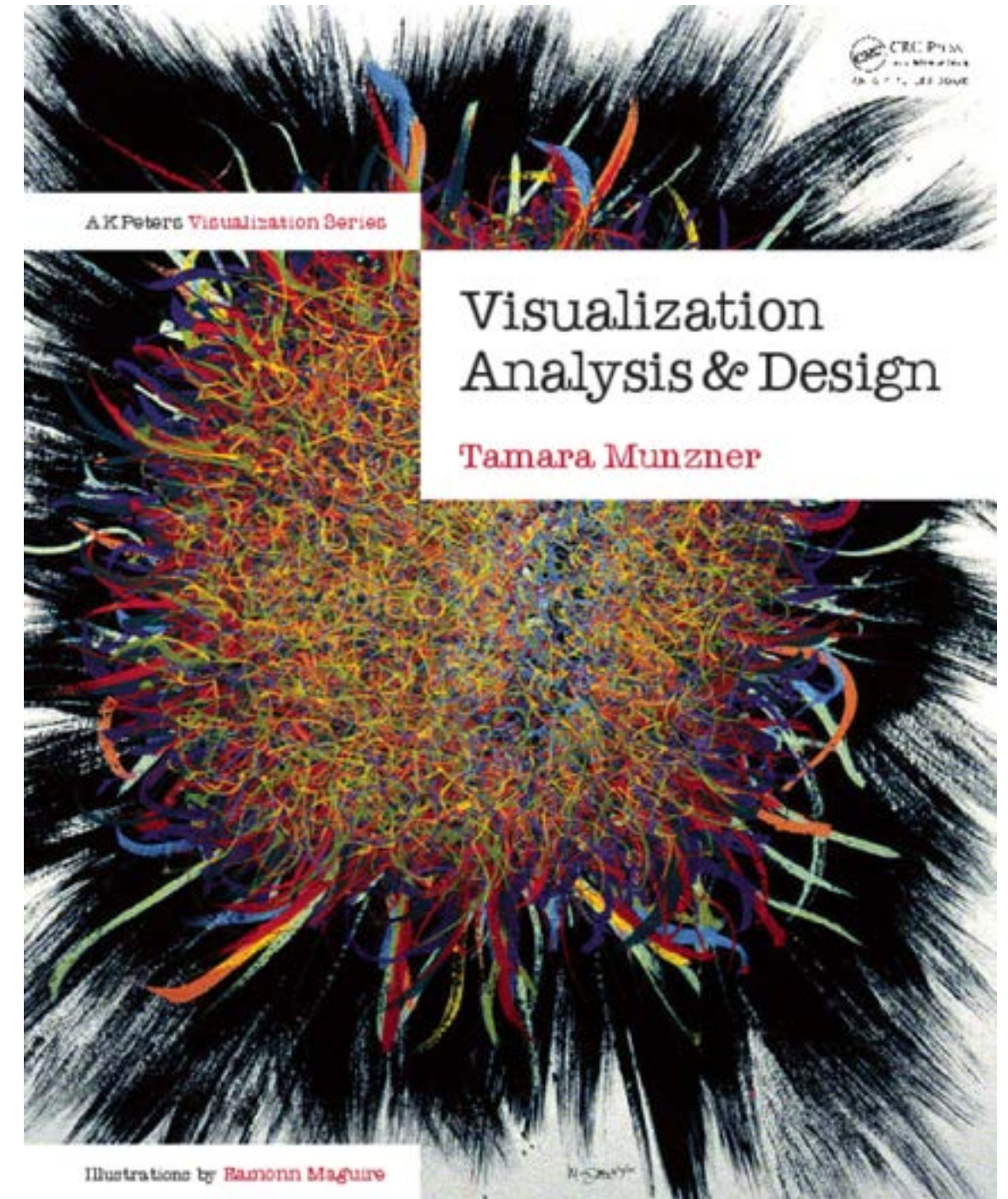


[A Multi-Level Typology of Abstract Visualization Tasks Brehmer and Munzner. IEEE TVCG 19(12):2376-2385, 2013 (Proc. InfoVis 2013).]

More Information

[@tamaramunzner](https://twitter.com/tamaramunzner)

- this talk
<http://www.cs.ubc.ca/~tmm/talks.html#vad16act>
- book page (including tutorial lecture slides)
<http://www.cs.ubc.ca/~tmm/vadbook>
 - 20% promo code for book+ebook combo:
HVN17
 - <http://www.crcpress.com/product/isbn/9781466508910>
 - illustrations: Eamonn Maguire
- papers, videos, software, talks, courses
<http://www.cs.ubc.ca/group/infovis>
<http://www.cs.ubc.ca/~tmm>



Visualization Analysis and Design.
Munzner. A K Peters Visualization Series, CRC Press, Visualization Series, 2014.