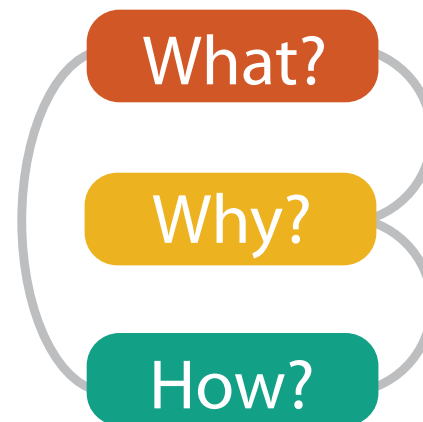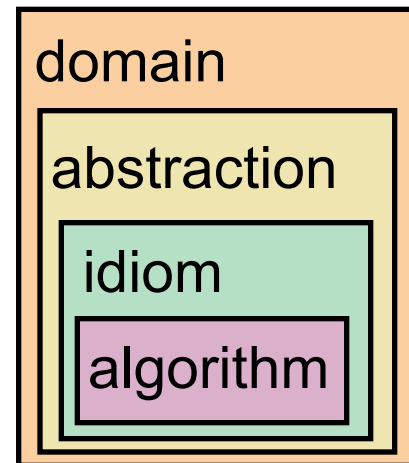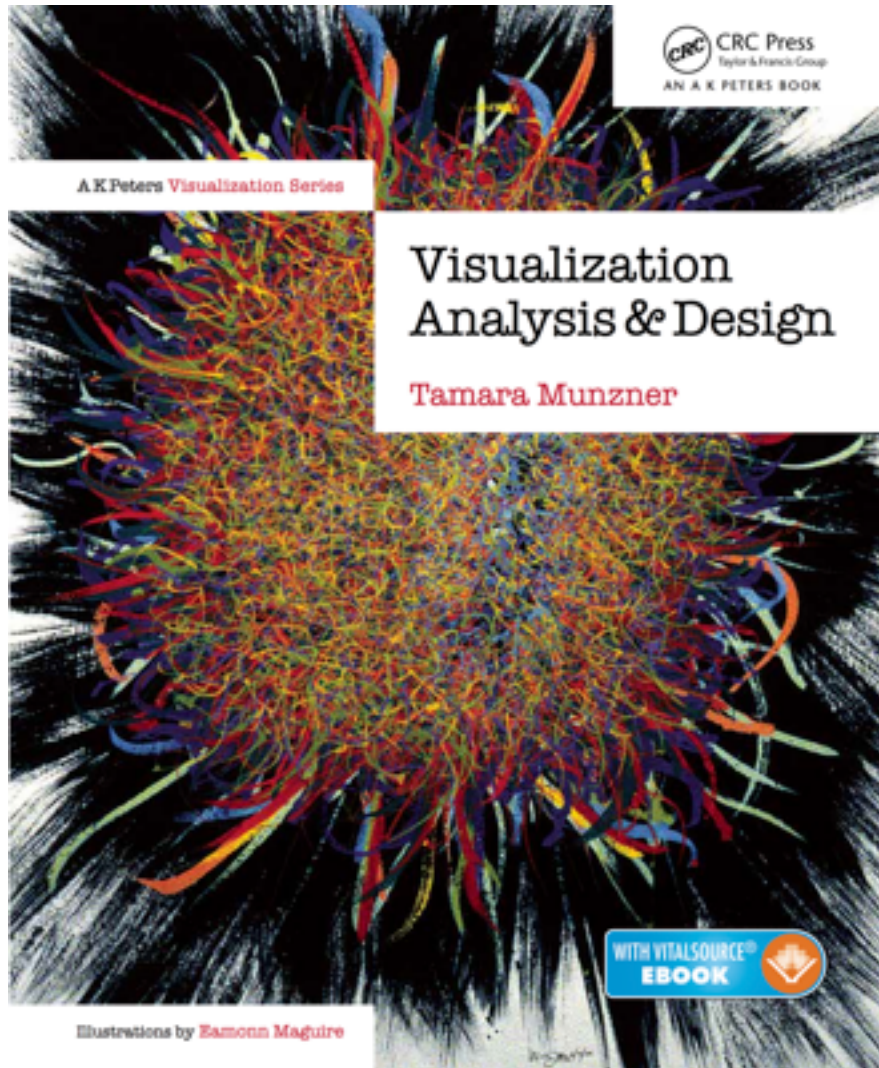# Principles and design choices
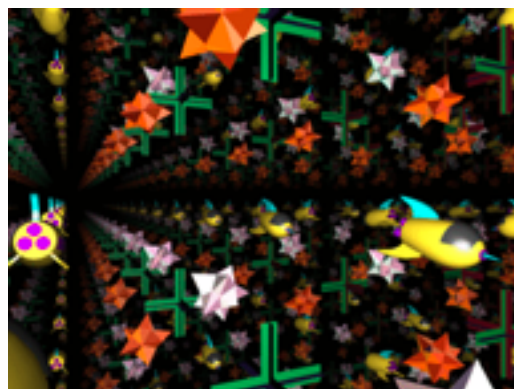

Visualization Analysis & Design

Wow, thanks! I'm so very deeply honored by this award. My thinking on a comprehensive framework of principles and design choices for vis hit a milestone last year when I finished the book Visualization Analysis and Design. I certainly thank all of the students in my research group for bearing with me during the six years it took to write the book, and also everybody who used drafts as a teacher or student and gave me useful feedback. I also want thank the people I've had the privilege of working with over the past 25 years – they've all influenced my thinking about vis! I'll briefly tell a bit of that story.
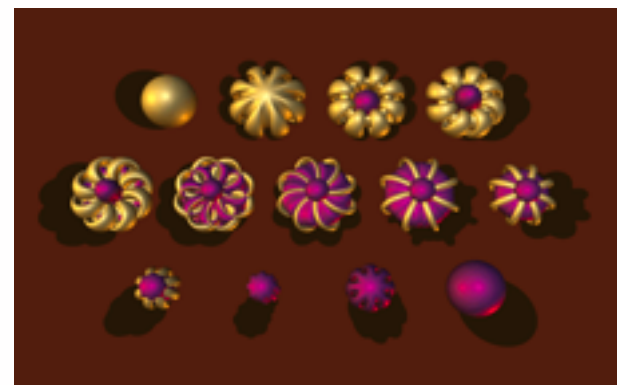
Geometry Center 1990-1995

Geomview

The Shape of Space

Outside In

Charlie Gunn

Stuart Levy

Mark Phillips

Delle Maxwell

It all started at The Geometry Center, with Charlie Gunn as my mentor when I was a summer undergrad intern. I returned after graduating as technical staff, and worked on an interactive 3D, 4D, and non-Euclidean geometry viewer with Stuart Levy and Mark Phillips. Delle Maxwell was my co-director for two videos that brought ideas about topology to a wide audience.
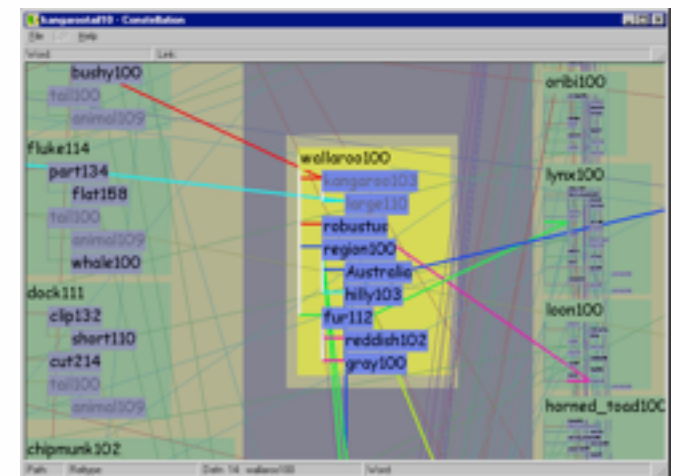
Stanford 1995-2000

Pat Hanrahan

Diane Tang Chris Stolte Robert Bosch
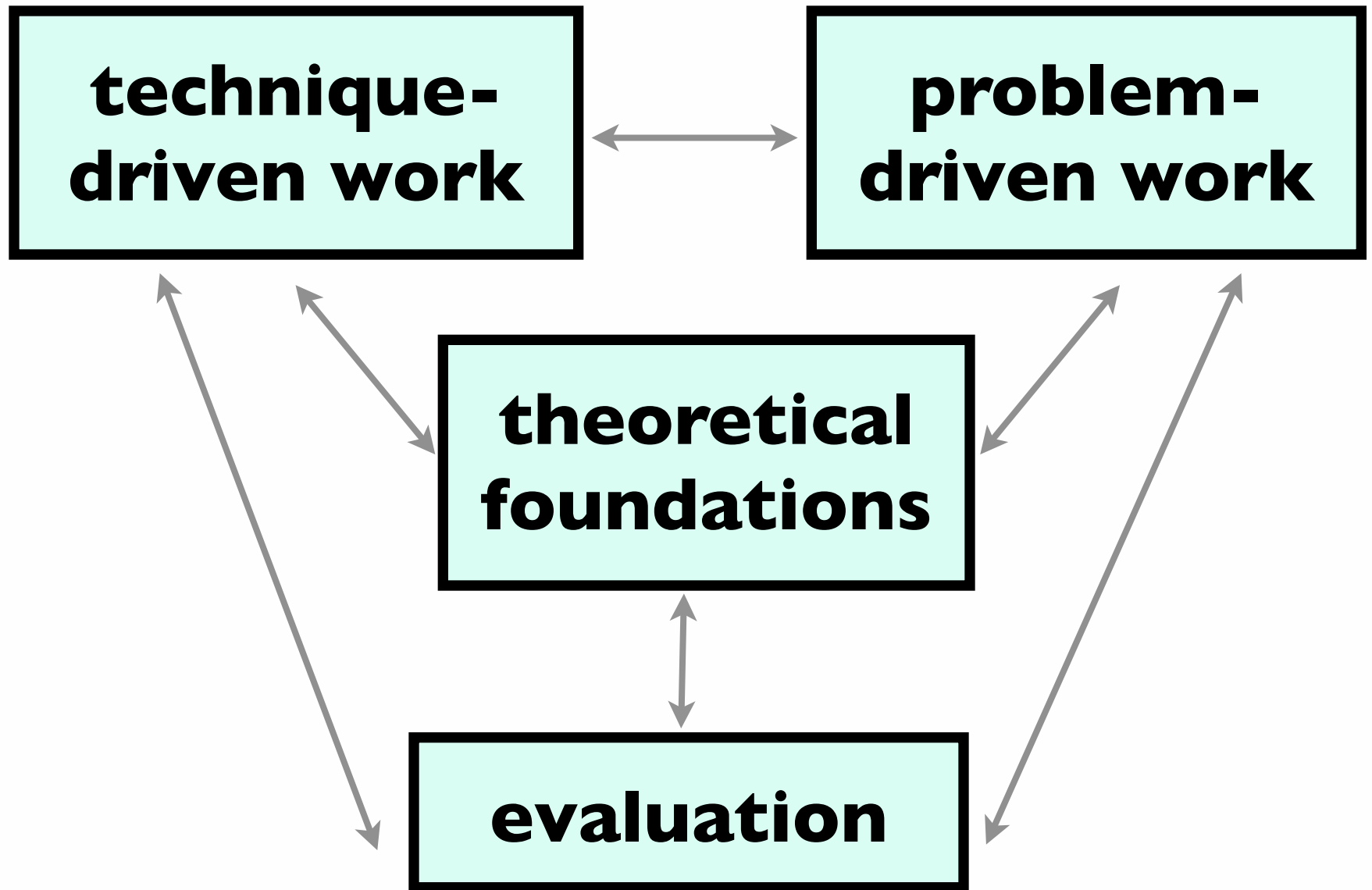

H3

Maneesh Agrawala   **Francois Guimbretiere**

Constellation

I decided I needed a PhD and went to Stanford to work with the amazing Pat Hanrahan, who was, is, and always will remain an inspiration to me. I ended up doing more with hyperbolic geometry to show network structure. I also learned a lot from debates with fellow grad students Diane Tang, Chris Stolte, and Robert Bosch, whose work on Rivet led to Tableau, Maneesh Agrawala, and particularly Francois Guimbretiere, who worked with me on vis for computational linguistics algorithm developers.

```
technique-          <-->          problem-
driven work                     driven work
        \          theoretical          /
         \         foundations         /
          \             |             /
           \        evaluation       /
```

Over the 13 years that I've been at UBC, I've become convinced that the interplay between different angles of attack is extremely valuable. I like to do a mix of technique and algorithm development, problem–driven work like design studies, and evaluation – and then try to synthesize what we've learned into new guidelines and theoretical foundations.
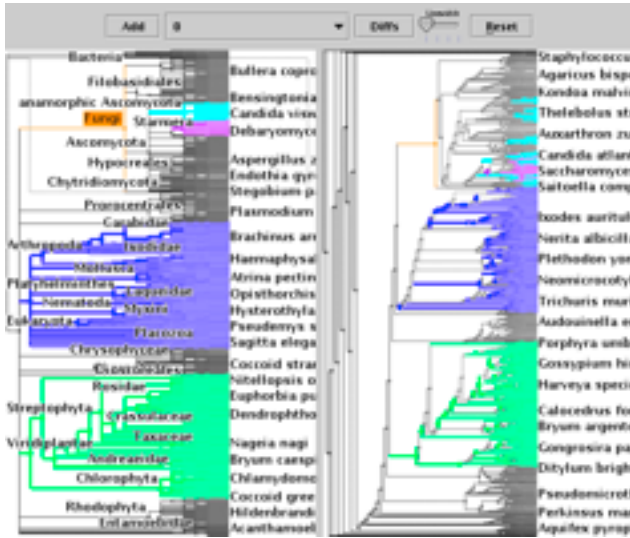
Technique-driven: Graph drawing

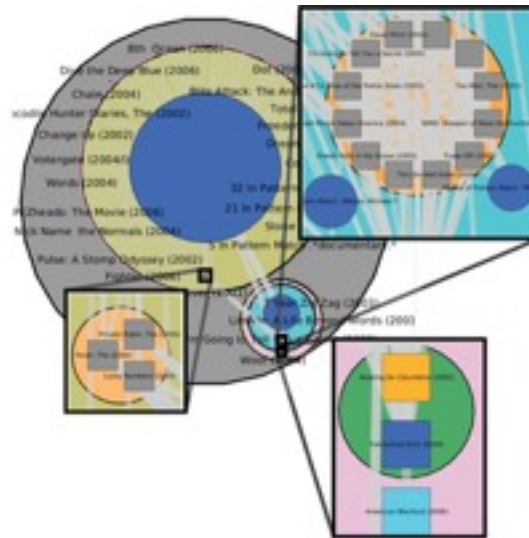**TreeJuxtaposer**

James Slack

Kristian Hildebrand

Daniel Archambault

David Auber (Bordeaux)

TopoLayout
SPF
Grouse
GrouseFlocks
TugGraph

Some of my technique–driven work has focused on graph drawing at scale. I worked on tree comparison with many folks including students James Slack and Kristian Hildebrand. Scalable layout and interaction for large multi–level networks was the focus of Daniel Archambault's entire PhD, co-supervised by David Auber of Bordeaux.

Evaluation: Graph drawing

Dmitry Nekrasovski Adam Bodnar

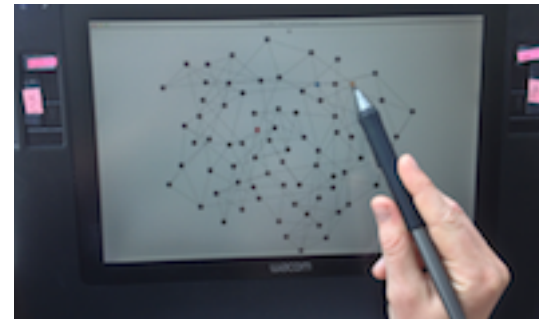Joanna McGrenere
(UBC)

Stretch and squish navigation

Jessica Dawson

Joanna McGrenere
(UBC)

Search set model of path tracing

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We've also done a lot of graph drawing evaluation, including comparing techniques for navigating them with Dmitry Nekrasovski and Adam Bodnar, co-supervised by Joanna McGrenere. She and Jessica Dawson and I recently developed a behavioral model of how people trace paths through graphs.

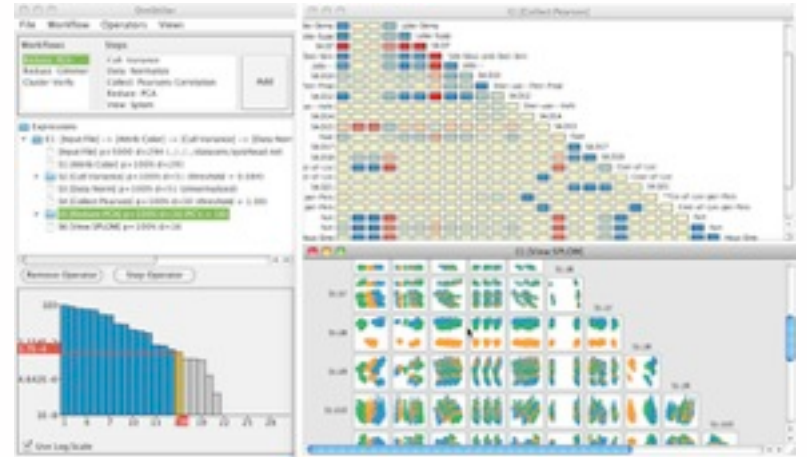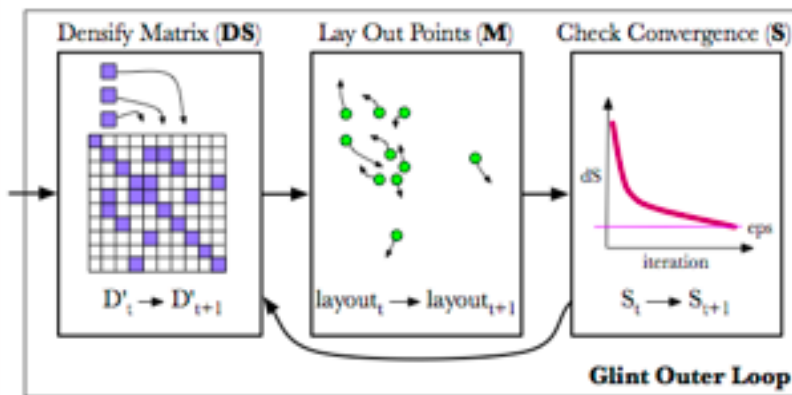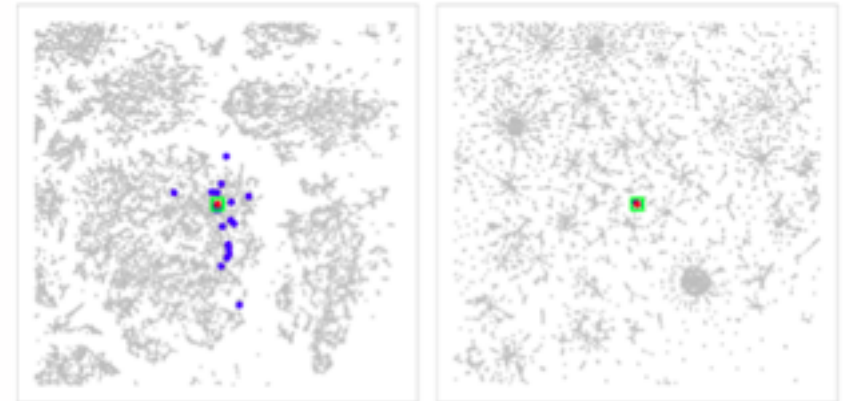# Technique-driven: Dimensionality reduction

Stephen Ingram

Glimmer

DimStiller

Glint

QSNE

I've also done a lot of work on dimensionality reduction, much of it with PhD student Stephen Ingram. We've developed several new algorithms and a system that provides guidance on which algorithms to use.
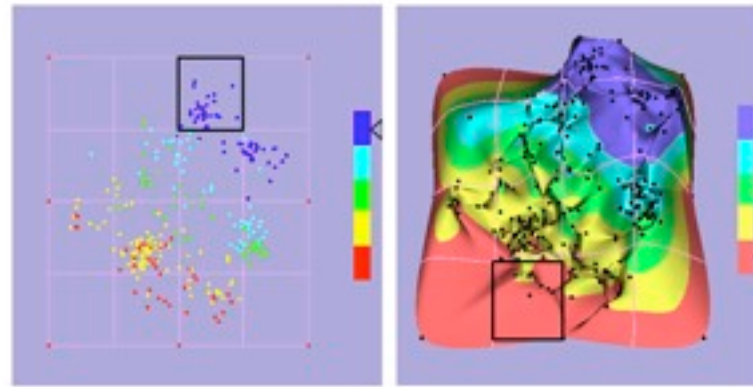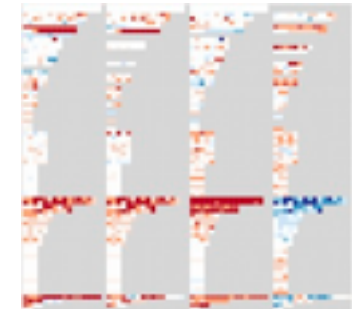
Evaluation: Dimensionality reduction

Melanie Tory

**Points vs landscapes for
dimensionally reduced data**

**Guidance on DR &
scatterplot choices**

Michael Sedlmair

Melanie Tory
(UVic)

Within-Class Factors · Variance · Between-Class Factors

Taxonomy of cluster separation factors

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We've also evaluated how to handle dimensionally reduced data, including an empirical study showing that points beat landscapes, done with Melanie Tory when she was a postdoc with me. And then later with postdoc Michael Sedlmair we characterized the drawbacks of 3D scatterplots and the perceptual response people have to clusters.
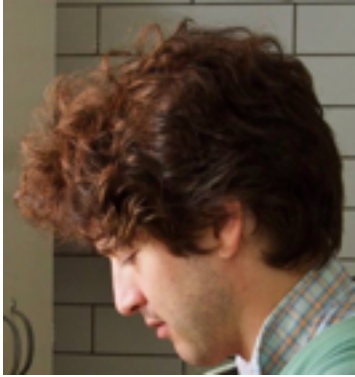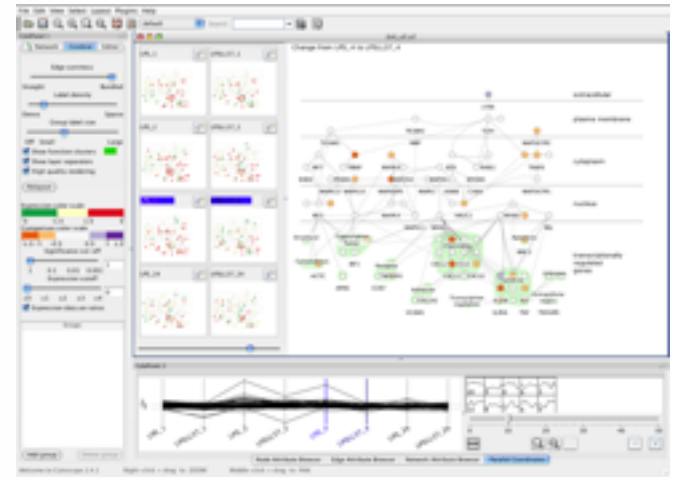
Problem-driven: Genomics

Aaron Barsky

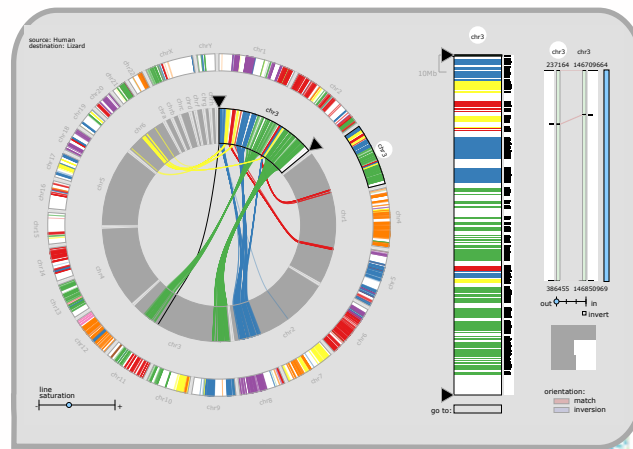**Jenn Gardy (Microbio)**

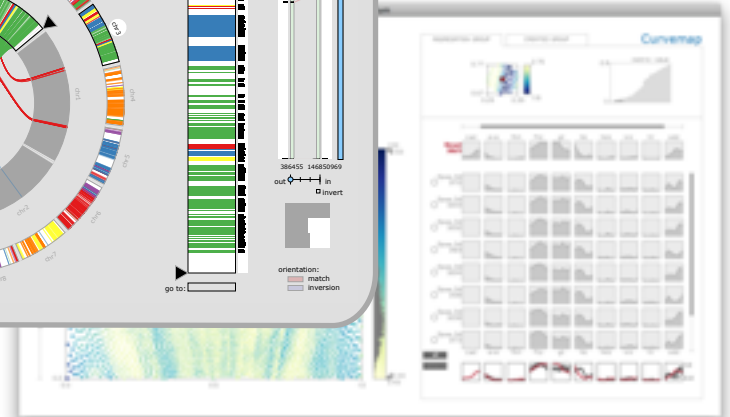**Robert Kincaid (Agilent)**

Cerebral

Miriah Meyer

Hanspeter Pfister (Harvard)

MizBee

MulteeSum, Pathline

I've gotten particularly excited about genomics because it's got such rich and complex datasets. Aaron Barsky and I did a design study in collaboration with Jenn Gardy at UBC Microbiology and Robert Kincaid of Agilent. Hanspeter Pfister and I co–supervised Miriah Meyer as a postdoc on three design studies with biologists at the Broad and Harvard.
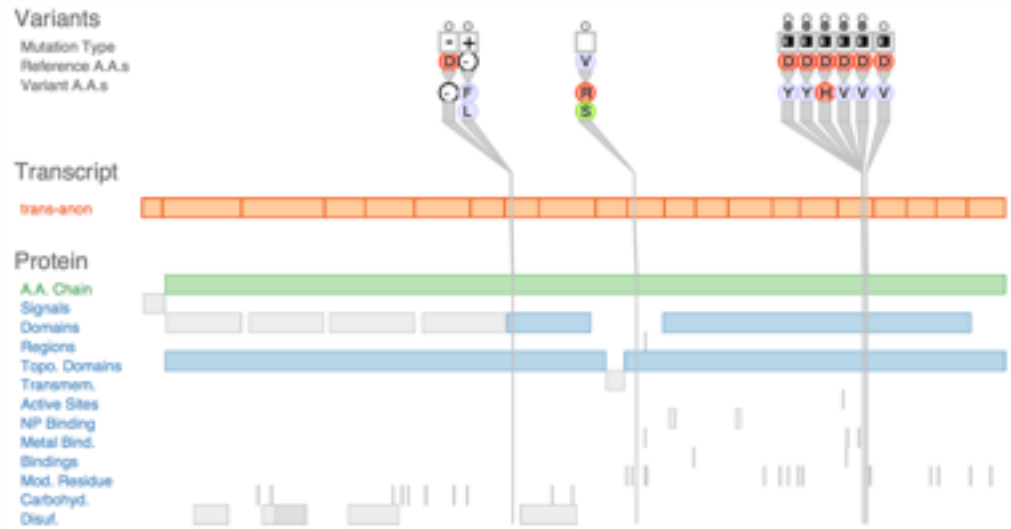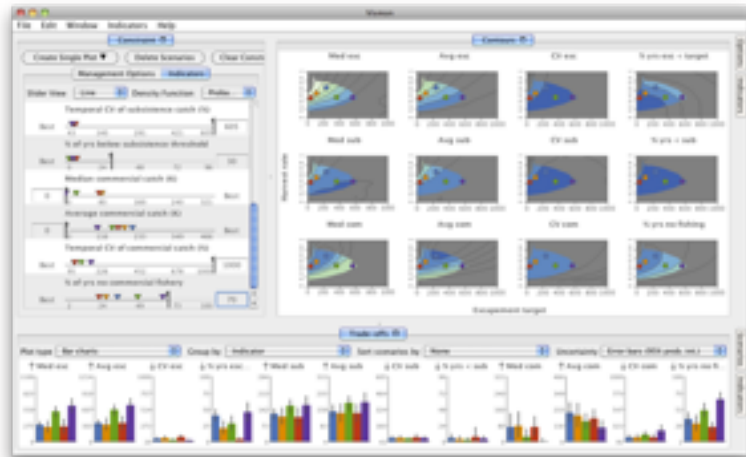
Problem-driven: Genomics, fisheries

Joel Ferstay

Cydney Nielsen (BC Cancer)

Variant View

Vismon

Maryam Booshehrian

Torsten Moeller (SFU)

Variant View was another genomics project, with Master's student Joel Ferstay and Cydney Nielsen at BC Cancer Agency. A fisheries simulation design study for guiding policy decisions was with Maryam Booshehrian and Torsten Moeller.

Problem-driven: Many domains

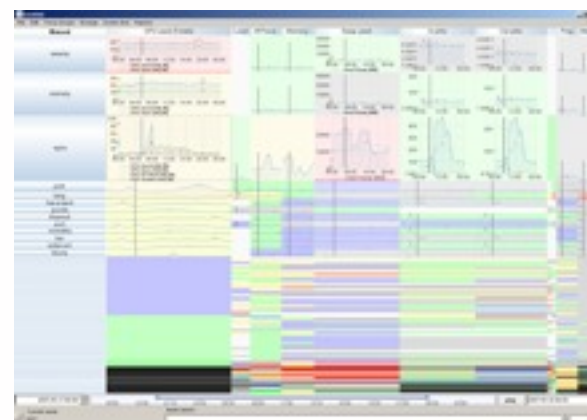**SessionViewer: web log analysis**

Heidi Lam

Diane Tang
(Google)

Peter McLachlan

Stephen North
(AT&T Research)

LiveRAC: systems time-series

We've done design studies in a lot of other domains too, including web log analysis with Heidi Lam and Diane Tang from Google, and system management time–series data with Peter McLachlan and Stephen North from AT&T.
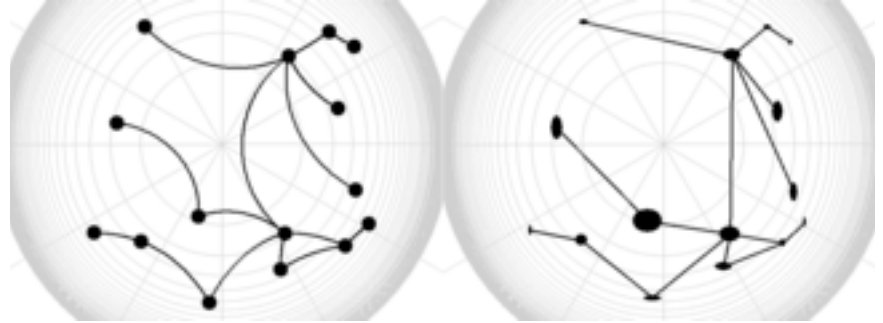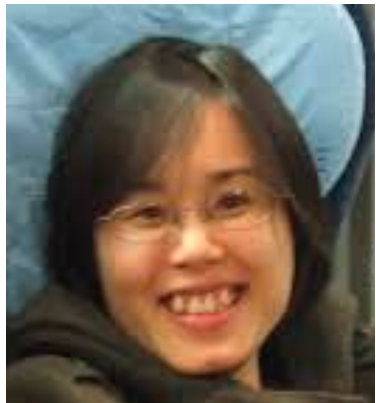
Evaluation: Focus+Context
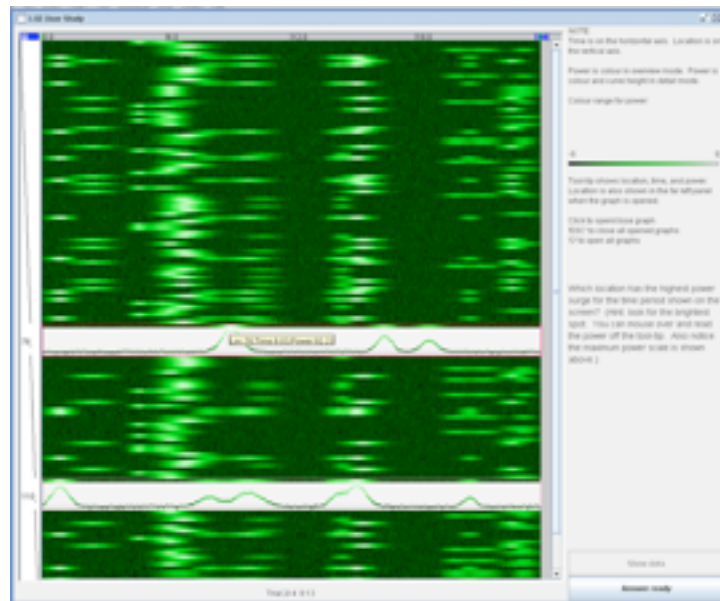
Heidi Lam

Ron Rensink
(UBC)

Distortion impact on search/memory

Heidi Lam

Robert Kincaid
(Agilent)

Separate vs integrated views

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Heidi and I also ran empirical studies to characterize focus+context techniques and their tradeoffs versus multiple linked views, with both Ron Rensink at UBC and Robert.

Journalism

Matt Brehmer

Stephen Ingram

Jonathan Stray
(Assoc Press)

Overview

Johanna Fulda
(Sud. Zeitung)

Matt Brehmer

TimeLineCurator

With PhD students Matt Brehmer and Stephen I've worked with journalists Jonathan Stray of the Associated Press and Johanna Fulda.
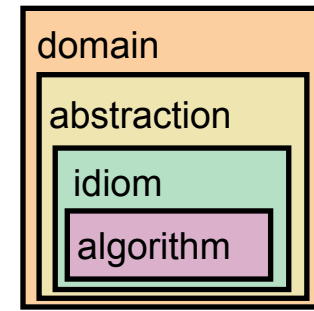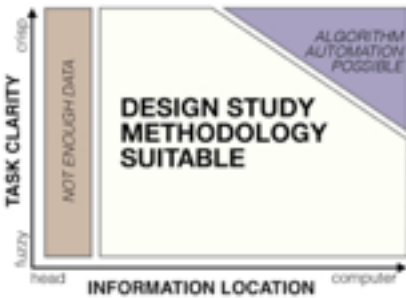
Theoretical foundations

- Visual Encoding Pitfalls
  - Unjustified Visual Encoding
  - Hammer In Search Of Nail
  - 2D Good, 3D Better
  - Color Cacophony
  - Rainbows Just Like In The Sky
- Strategy Pitfalls
  - What I Did Over My Summer
  - Least Publishable Unit
  - Dense As Plutonium
  - Bad Slice and Dice

Papers Process & Pitfalls

domain
abstraction
idiom
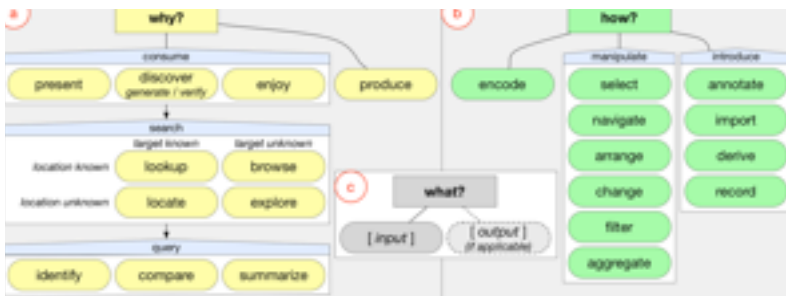algorithm

Nested Model

Design Study Methodology

Michael Sedlmair

Miriah Meyer

Abstract Tasks

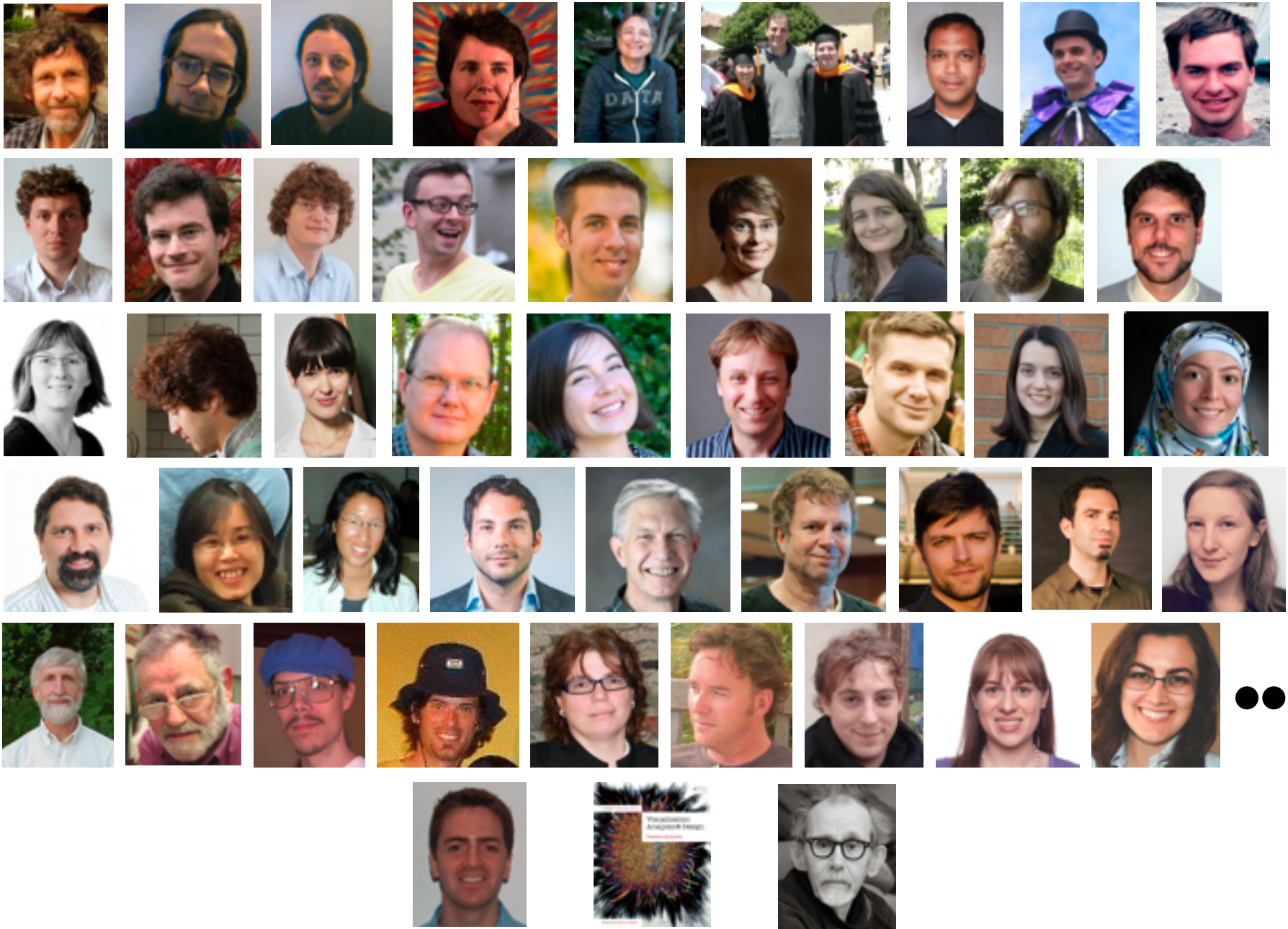**Matt Brehmer**

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Some of my theoretical foundations work I think of as "meta–papers" on how to create papers. The Process and Pitfalls paper is now linked to in the calls for papers for 4 of the 5 major vis conferences. The Nested Model unified previously disparate research threads on building and evaluating, and I needed to write it to start the book. Postdocs Michael and Miriah and I distilled the lessons learned from 21 design studies into concrete methodological advice. The typology of abstract tasks paper with Matt was the missing link I needed to finish the book. I first tried to write that paper back in '99 with Francois Guimbretiere, and after a few months decided I didn't know enough yet and figured I should come back to it in a decade or so – and that's just what happened!

Thanks to many!

Besides those I've mentioned by name, there's a longer story than I have time to tell now, including other people I've written papers with and worked with. I'm also grateful to Eamonn Maguire for the illustrations within the book and my father Ari Munzner for the painting on its cover. Thanks to all of you!