Human-centered Network Visualization

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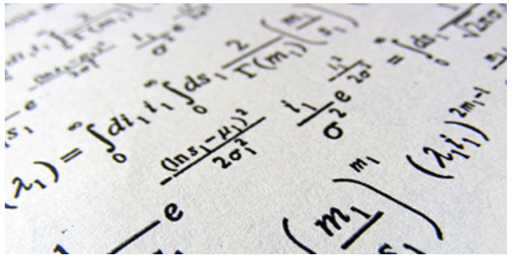
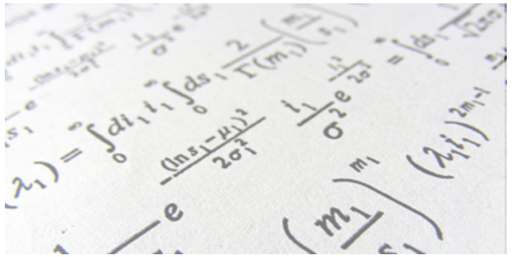
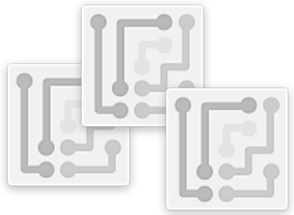
Data



https://www.strath.ac.uk/media/1newwebsite/imagesbysize/600x300/Applied_analysis_600x300.jpg

Visualization





Look at / Interact

Definition: Visualization (Vis)

"Computer-based visualization systems provide visual representations of datasets intended to help people carry out some task more effectively."

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

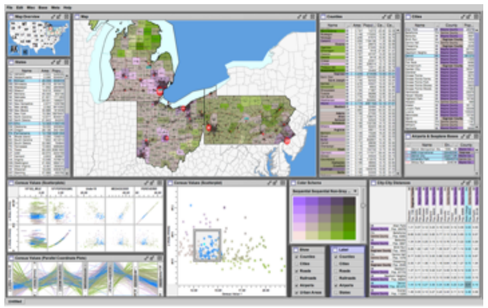
Interactive visual analysis

"Computer-based visualization systems provide visual representations of datasets intended to help people carry out some task more effectively."

Tableau

SAS

IBM Watson Analytics



Improvise

not pretty pictures

Why a human in the loop?

"Computer-based visualization systems provide visual representations of datasets intended to help people carry out some task more effectively."

not needed if fully automatic solution exists (and is trusted)

Ill-defined / ill-structured problems:

- no single optimal solution
- no clear objective measures

Herbert A. Simon.
The structure of ill-structured problems.
Artificial Intelligence, 4, 181-204. 1973.

Examples:

- exploratory analysis of scientific problems
- (collaborative) decision-making problems
- model building & validation

Effective support of ill-defined tasks!

"Computer-based visualization systems provide visual representations of datasets intended to help people carry out some task more effectively."

Metrics of success:

- Novel — entirely new insights
- Faster — speed up common workflows

Why visual representations?

"Computer-based visualization systems provide visual representations of datasets intended to help people carry out some task more effectively."

start

https://media.holidaycheck.com/data/urlaubsbilder/images/146/1166832900.jpg

end

http://www.schoenbrunn.at/en/services/media-center/photo-gallery/great-parterre.html

U1

- Leopoldau
- Großfeldsiedlung
- Aderklaaer Straße
- Rennbahnweg
- Kagraner Platz
- Kagran
- Alte Donau
- Kaisermühlen - VIC
- Donauinsel
- Vorgartenstraße
- Praterstern
- Nestroyplatz
- Schwedenplatz
- Stephansplatz
- Karlsplatz
- Taubstummengasse
- Südtiroler Platz
- Keplerplatz
- Reumannplatz

U2

- Seestadt
- Aspern
- Hausfeldstraße
- (An den alten Schanzen)
- Aspernstraße
- Donauspital
- Hardeggasse
- Stadlau
- Donaustadtbrücke
- Donaumarina
- Stadion
- Krieau
- Messe Prater
- Praterstern
- Taborstraße
- Schottenring
- Schottentor
- Rathaus
- Volkstheater
- Museumsquartier
- Karlsplatz

start →

U3

- Ottakring
- Kendlerstraße
- Hütteldorfer Straße
- Johnstraße
- Schweglerstraße
- Westbahnhof
- Zieglergasse
- Neubaugasse
- Volkstheater
- Herrengasse
- Stephansplatz
- Stubentor
- Landstraße
- Rochusgasse
- Kardinal-Nagl-Platz
- Schlachthausgasse
- Erdberg
- Gasometer
- Zippererstraße
- Enkplatz
- Simmering

→ end

U4

- Heiligenstadt
- Spittelau
- Friedensbrücke
- Roßauer Lände
- Schottenring
- Schwedenplatz
- Landstraße
- Stadtpark
- Karlsplatz
- Kettenbrückengasse
- Pilgramgasse
- Margaretengürtel
- Längenfeldgasse
- Meidling Hauptstraße
- Schönbrunn
- Hietzing
- Braunschweiggasse
- Unter St Veit
- Ober St Veit
- Hütteldorf

U6

- Floridsdorf
- Neue Donau
- Handelskai
- Dresdner Straße
- Jägerstraße
- Spittelau
- Nußdorfer Straße
- Währinger Straße
- Michelbeuern - AKH
- Alser Straße
- Josefstädter Straße
- Thaliastraße
- Burggasse
- Westbahnhof
- Gumpendorfer Straße
- Längenfeldgasse
- Niederhofstraße
- Philadelphiabrücke
- Tscherttegasse
- Am Schöpfwerk
- Alterlaa
- Erlaaer Straße
- Perfektastraße
- Siebenhirten

Why visual representations?

"Computer-based visualization systems provide visual representations of datasets intended to help people carry out some task more effectively."

U1
U2
U3
U4
U6

Perception beats Cognition!

Visualization research

technique-driven

problem-driven

New algorithms

New visualization techniques

Understand users & tasks

Design studies

Visualization research

technique-driven

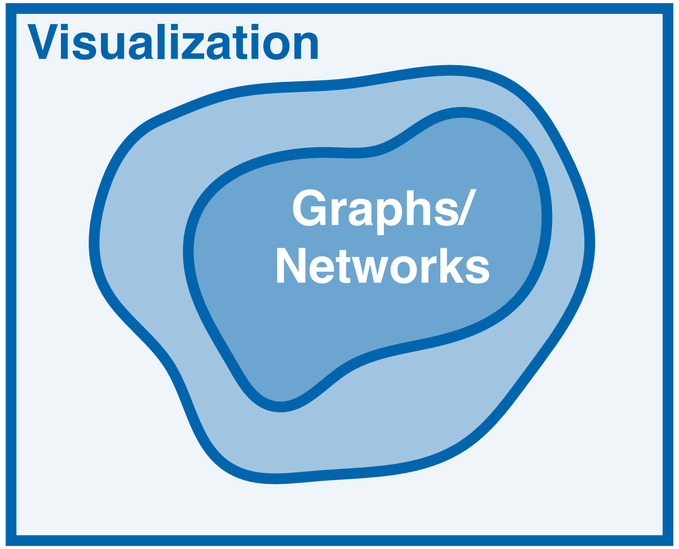
My research focus

problem-driven

Graph Drawing

Network Visualization

Today's goal:
Graph/network visualization and around



1. Technique-driven research
   - Trends in graph drawing
   - Trends in visualization — Related to graph drawing
2. Problem-driven research
   - Design Study Example — RelEx: Visualization of overlay networks
   - Design Study Methodology — Why care?

Outline

1. Technique-driven research
   - Trends in graph drawing
   - Trends in visualization — Related to graph drawing
2. Problem-driven research
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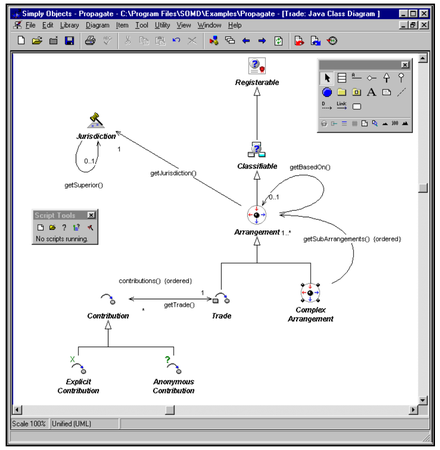
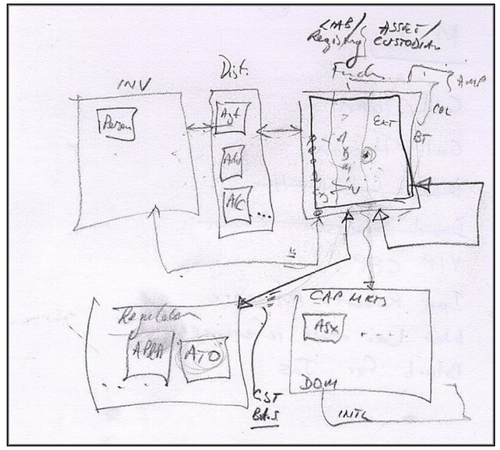
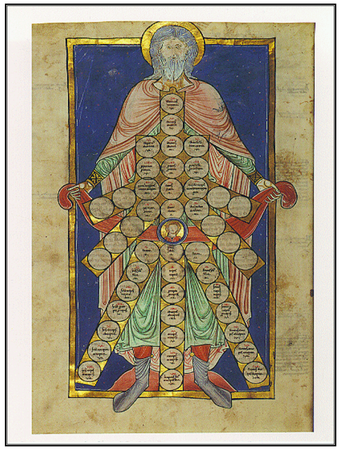
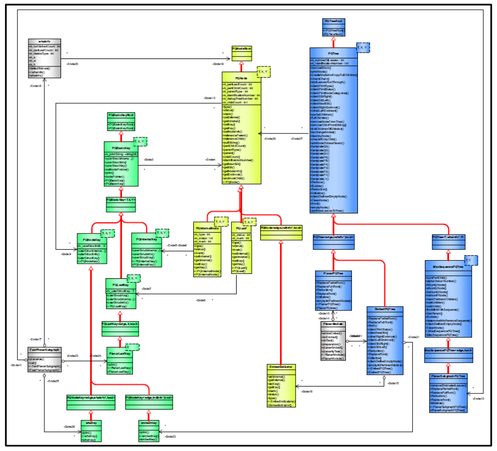
   - Design Study Methodology
3. Summary

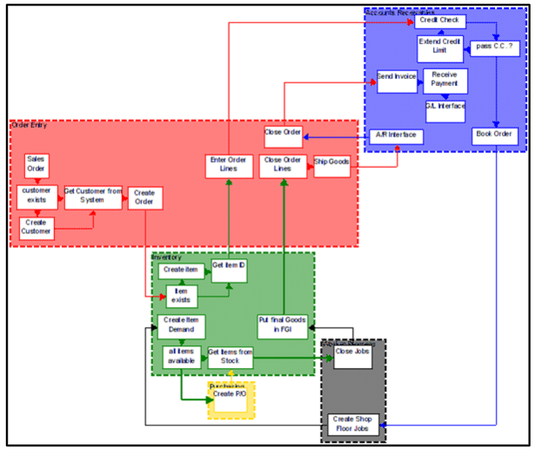
Networks & Graphs

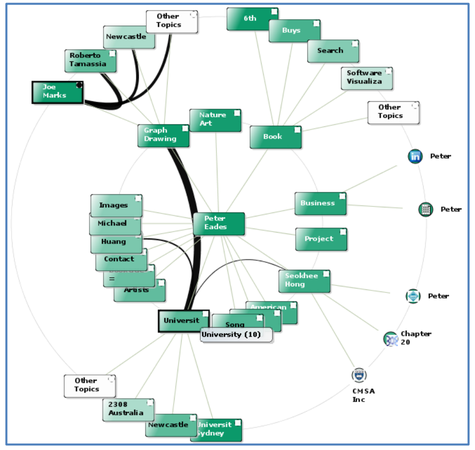












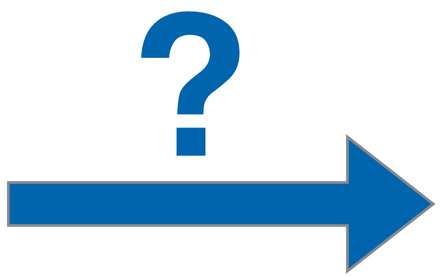
etc.

Graph Drawing

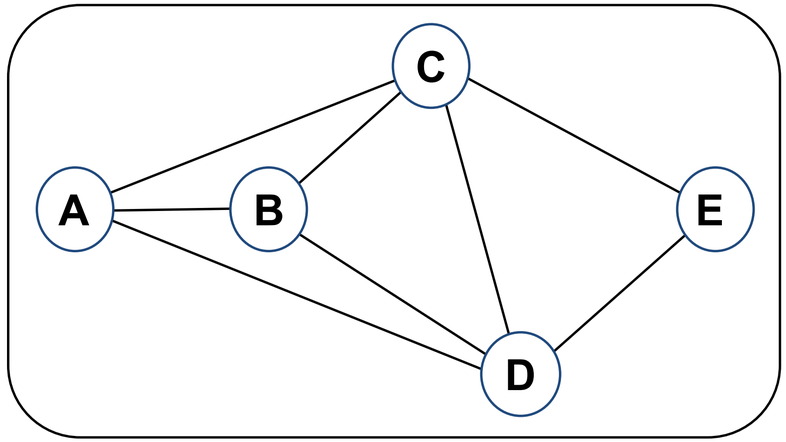
- The classical graph drawing problem is to develop **algorithms to draw graphs nicely.**

graph

A - B, C, D
B - A, C, D
C - A, B, D, E
D - A, B, D, E
E - C, D



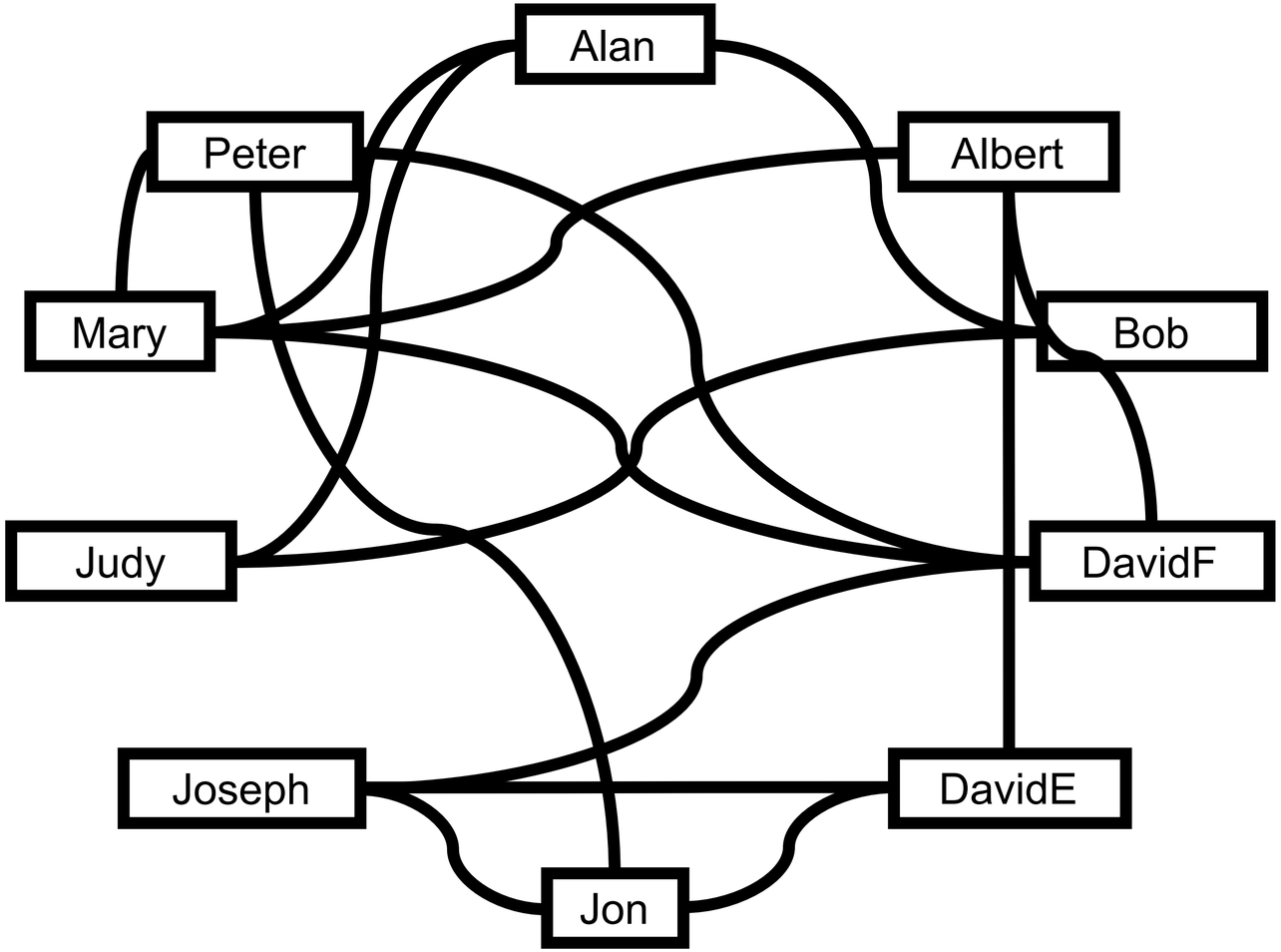
nice graph drawing



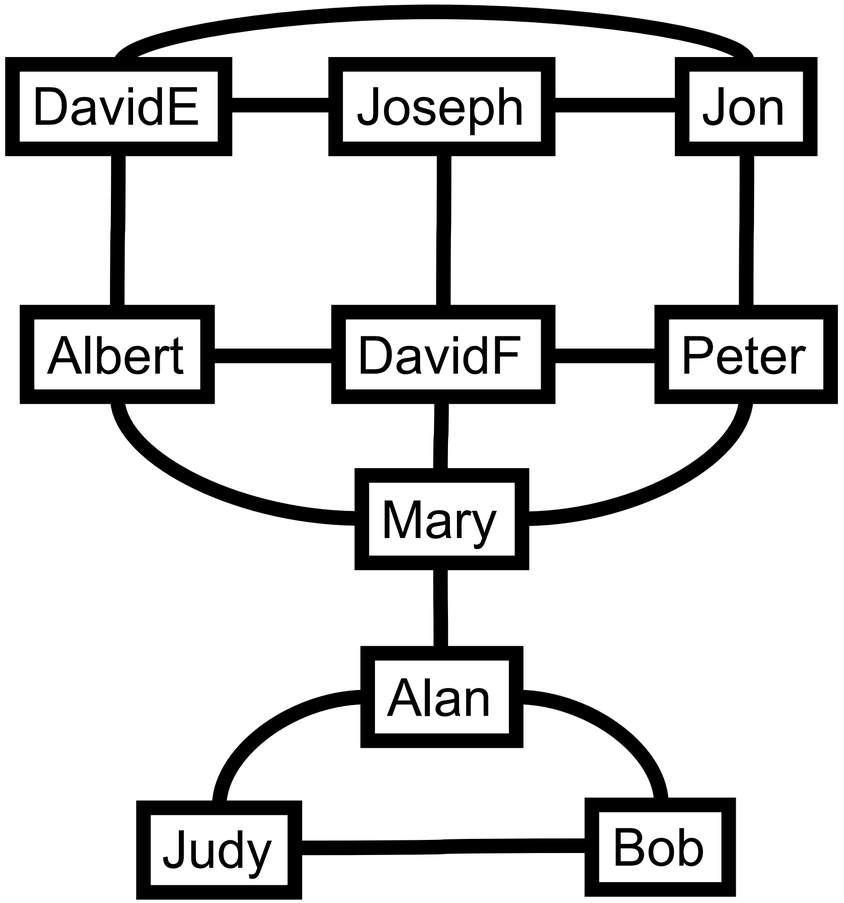
Example

X	***Adjacent to X***
Mary	Peter, Albert, DavidF, Peter
Judy	Bob, Alan
Peter	Mary, DavidF, Jon
DavidF	Albert, Joseph, Peter, Mary
Jon	Peter, Joseph, DavidE
DavidE	Jon, Joseph, Albert
Joseph	DavidE, Jon, DavidF
Bob	Judy, Alan
Alan	Bob, Mary, Judy
Albert	DavidF, Mary, DavidE

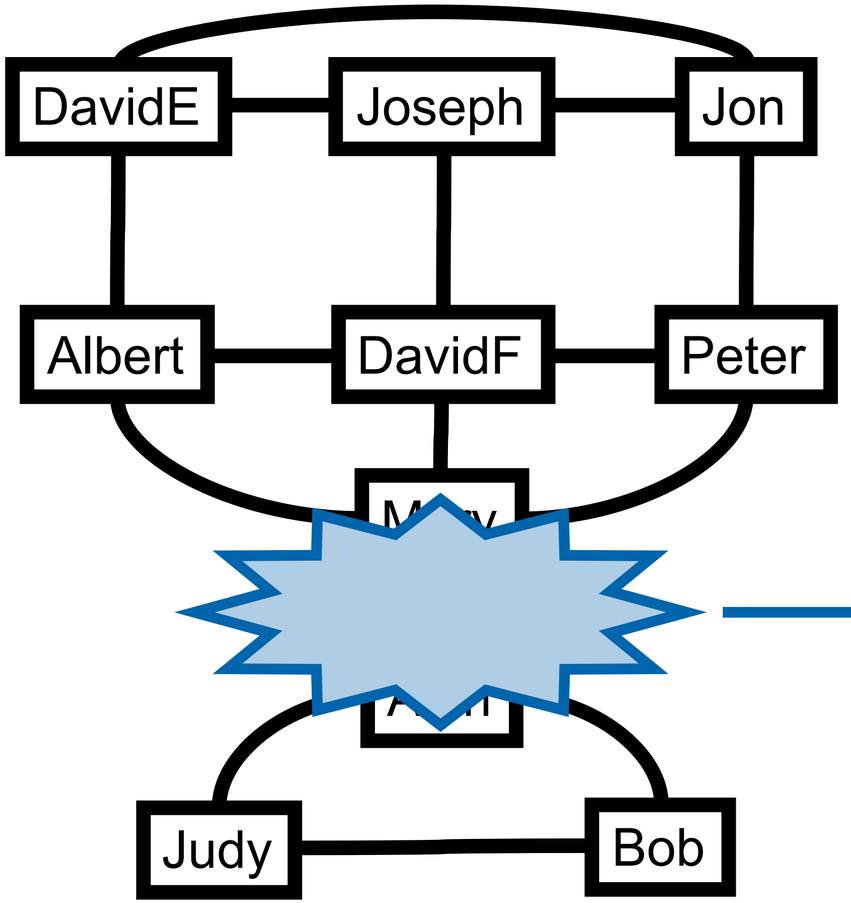
Example



Example



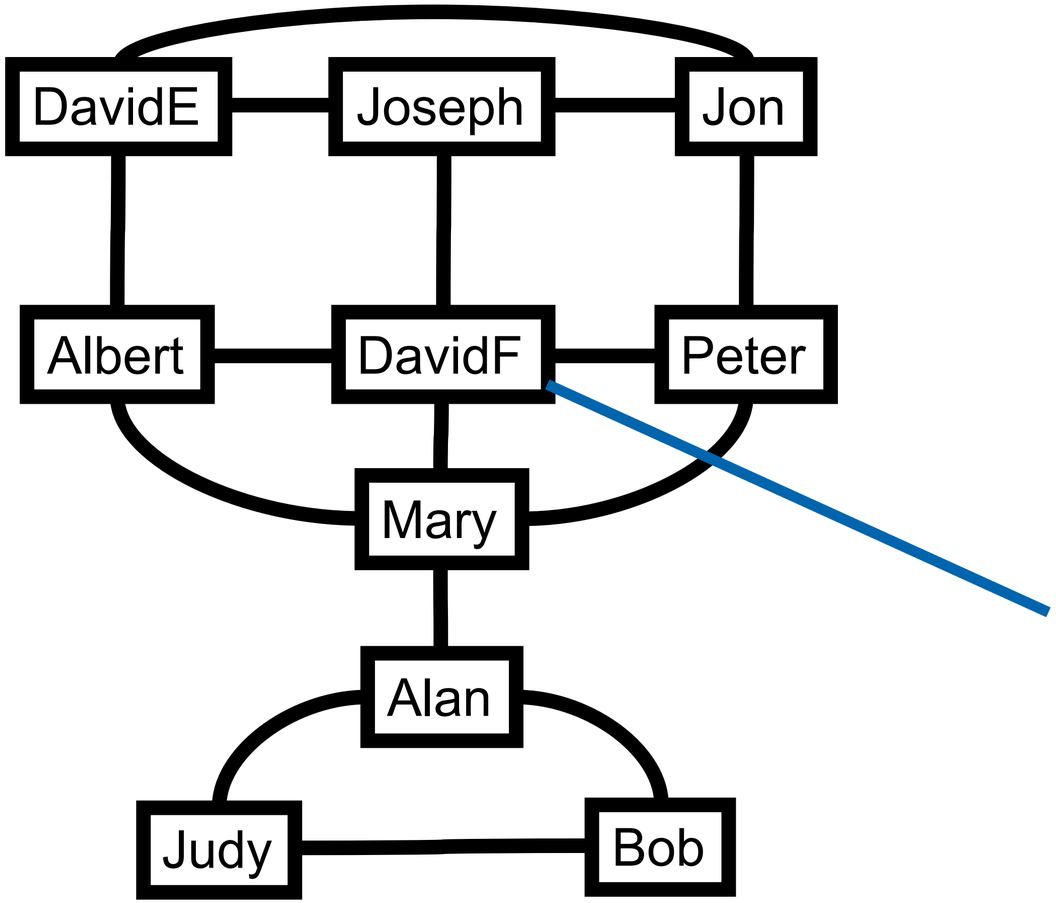
Example



Terrorist network

Eliminate

Example

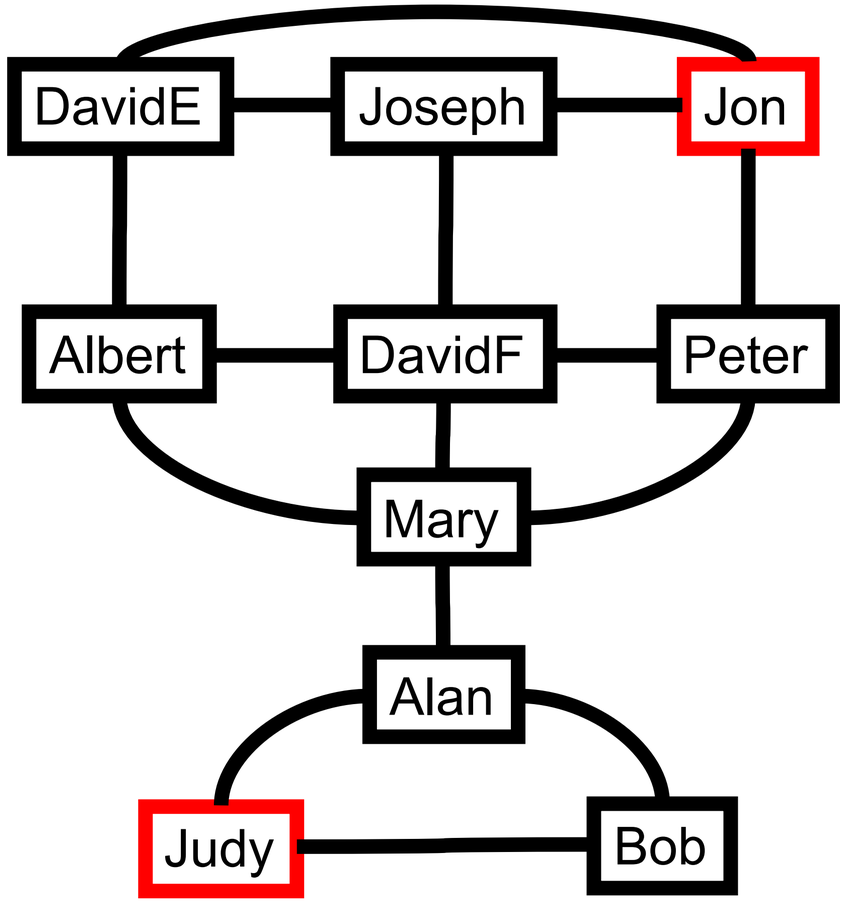


Mobile phone network:

* **nodes: people**
* **edges: phone calls**

Good deal $$$$

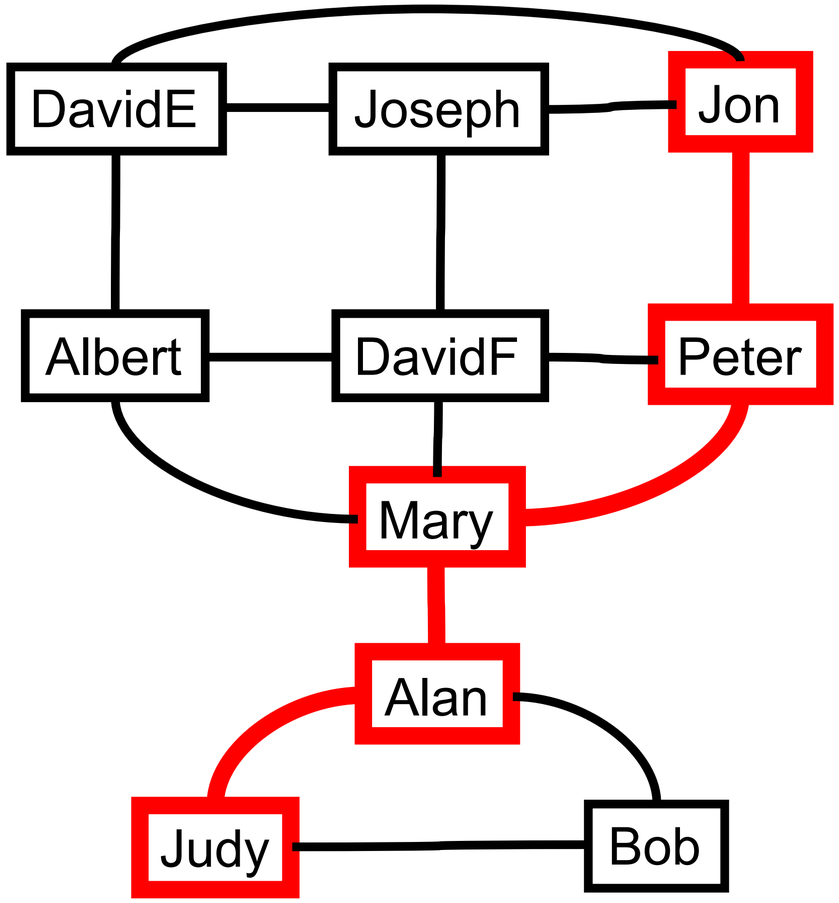
Example



Transport network:

* **nodes: places**
* **edges: train lines**

Example

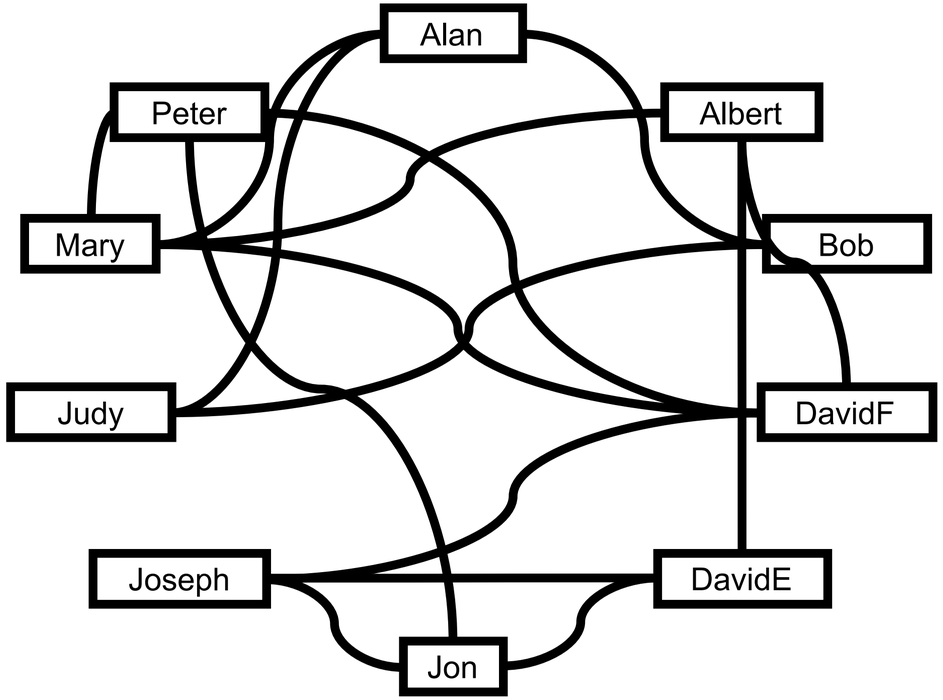


Transport network:

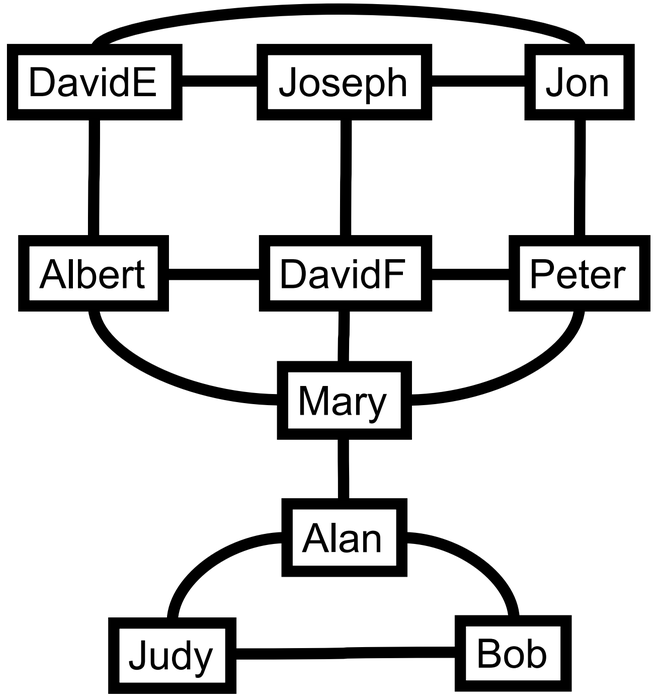
* **nodes: places**
* **edges: train lines**

Shortest path?

What algorithm give good drawings of graphs?

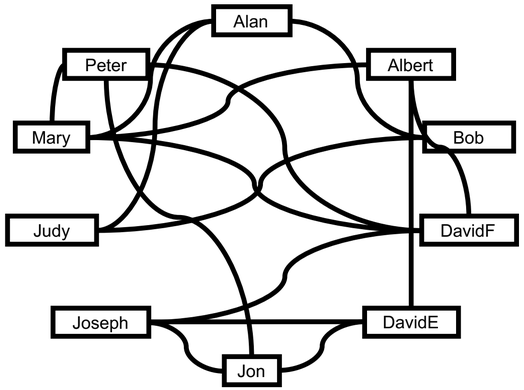


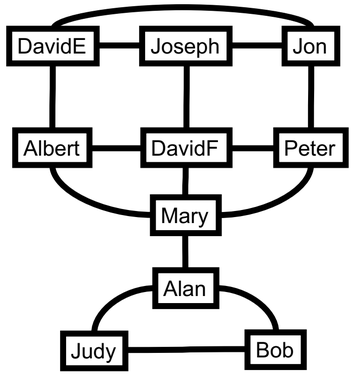
Bad



Good

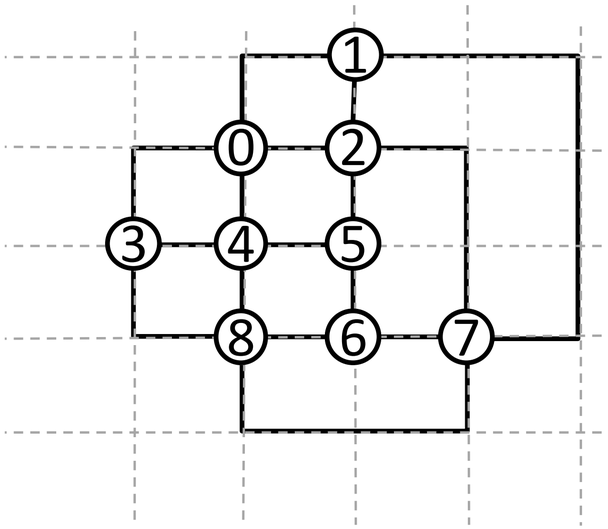
Quality measures for networks



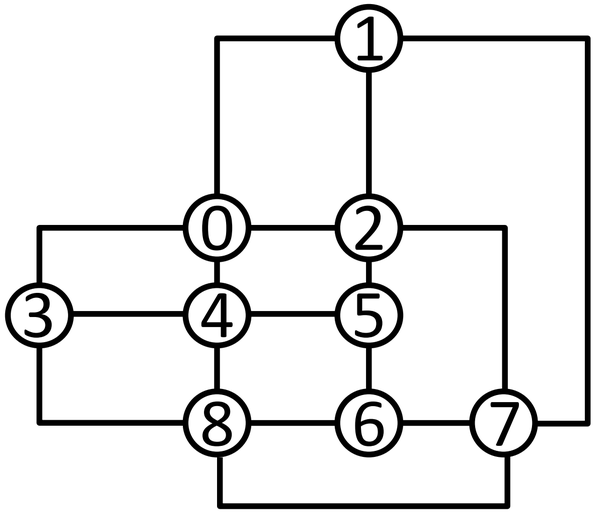


- Classical quality measures
  - minimize edge crossings
  - minimize bends
  - …
- Human subject experiments found crossings & bends to be most important *wrt* readability
  - Purchase et al.,1997
  - Ware et al 2002
  - Huang et al 2004

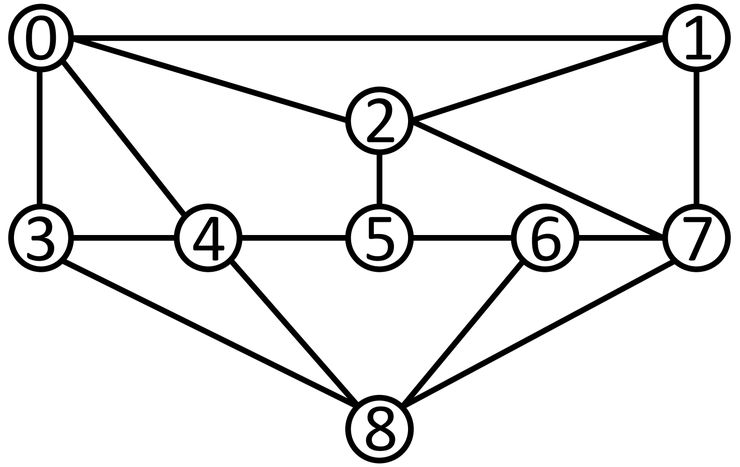
Different kinds of layouts



grid-based



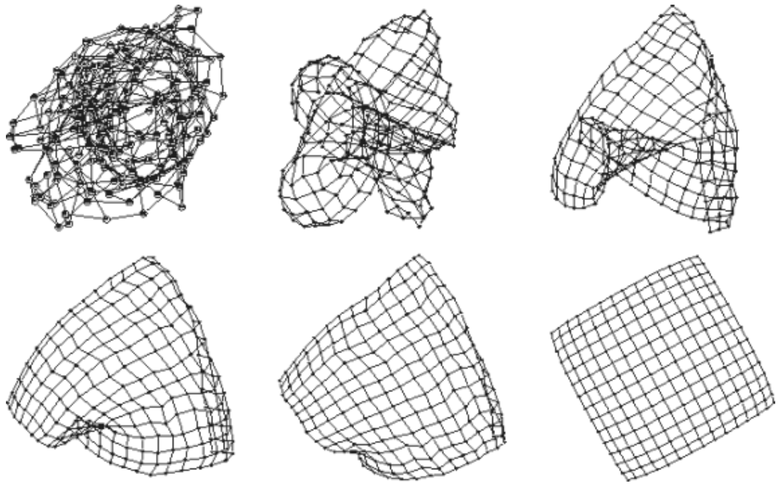
orthogonal



straight-line

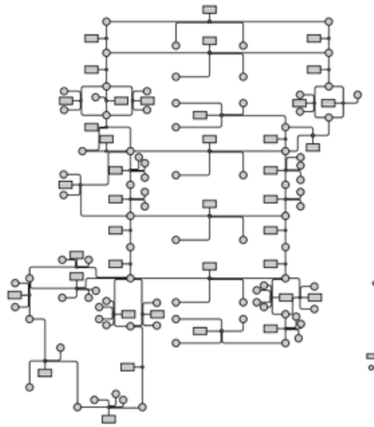
Force-directed layouts

https://bl.ocks.org/mbostock/4062045

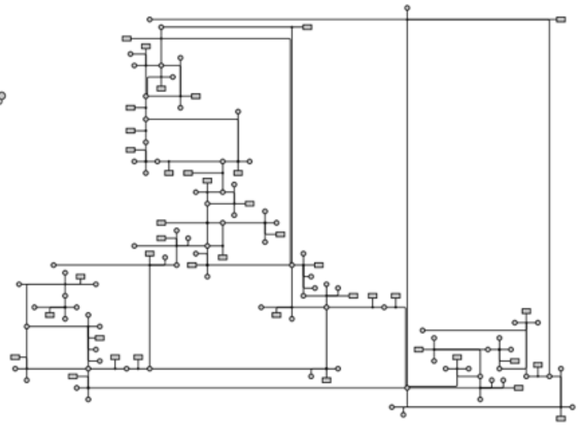


© Sander

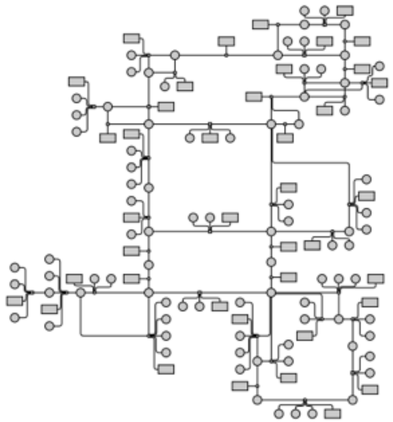
Human-centered layout



Human



algo-yFiles



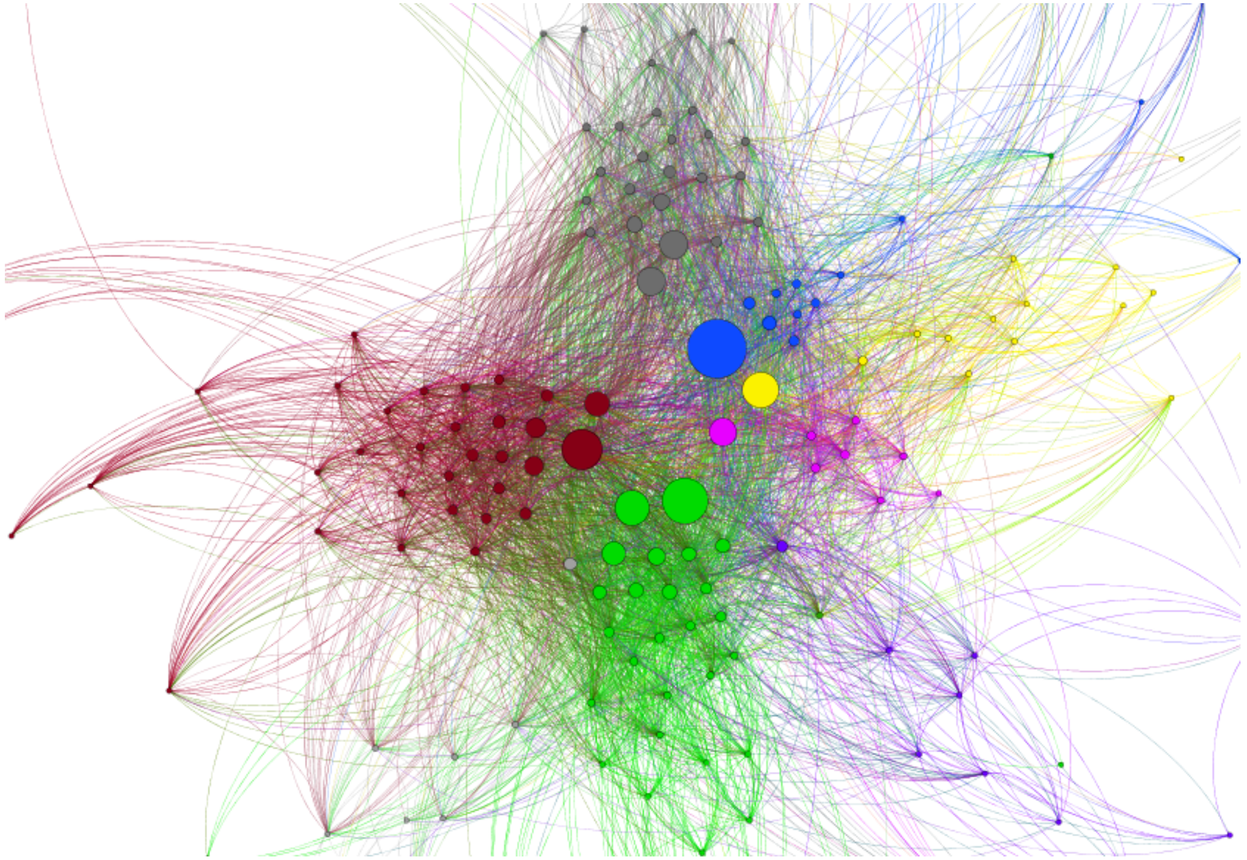
algo-HALO (new)

1. User study
2. Develop algorithm
3. Evaluate algo-created layouts against human-created layouts

Kiefer et al. (InfoVis 2015).
HOLA: Human-like Orthogonal Network Layout

Scalability — Too many nodes and/or edges

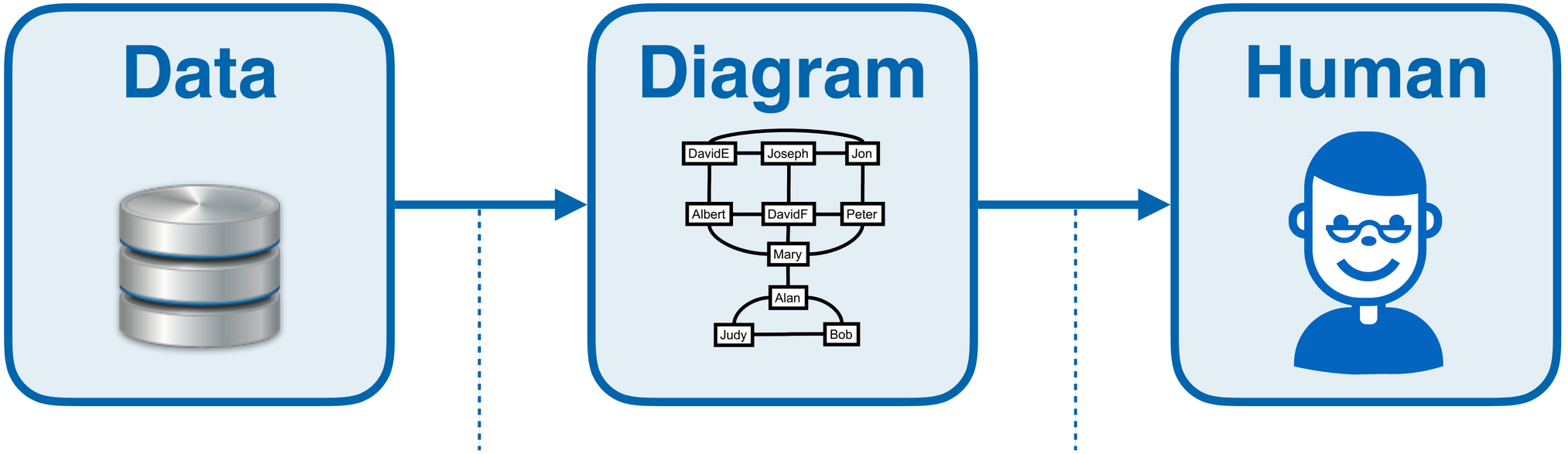
Showing all the data?



https://twitter.com/axelmaireder/media

Hairball

Measures: Faithfulness VS. Readability



Faithfulness measures how well the diagram represents the data.

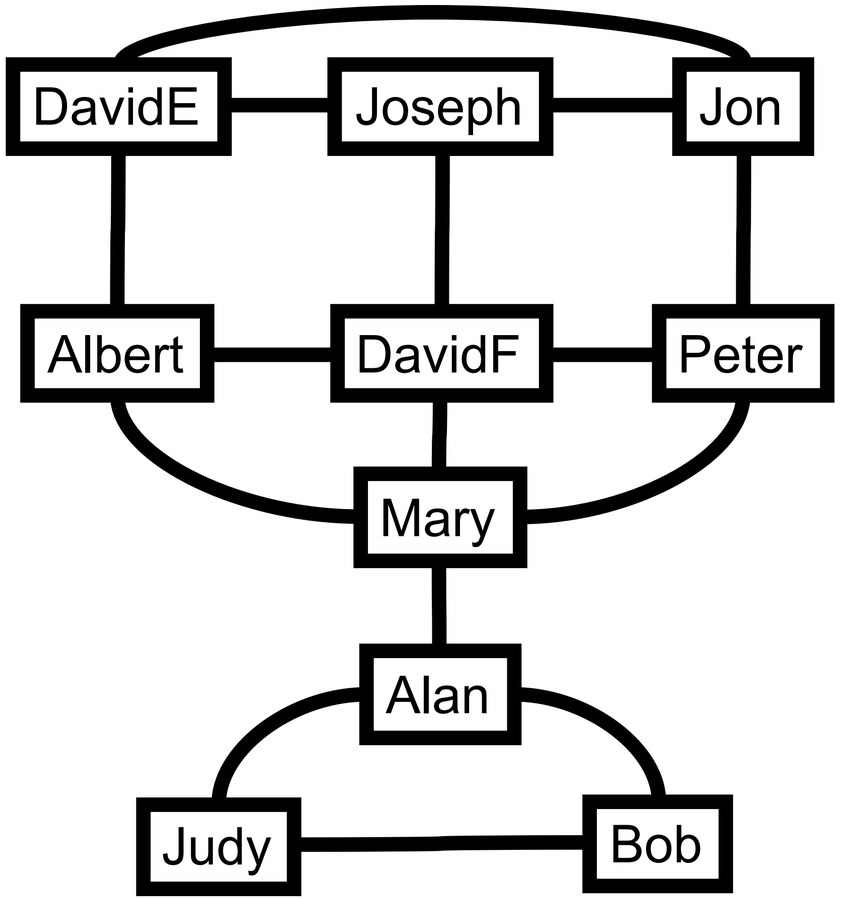
(a mathematical concept)

Readability measures how well the human understands the diagram.

(a psychological concept)

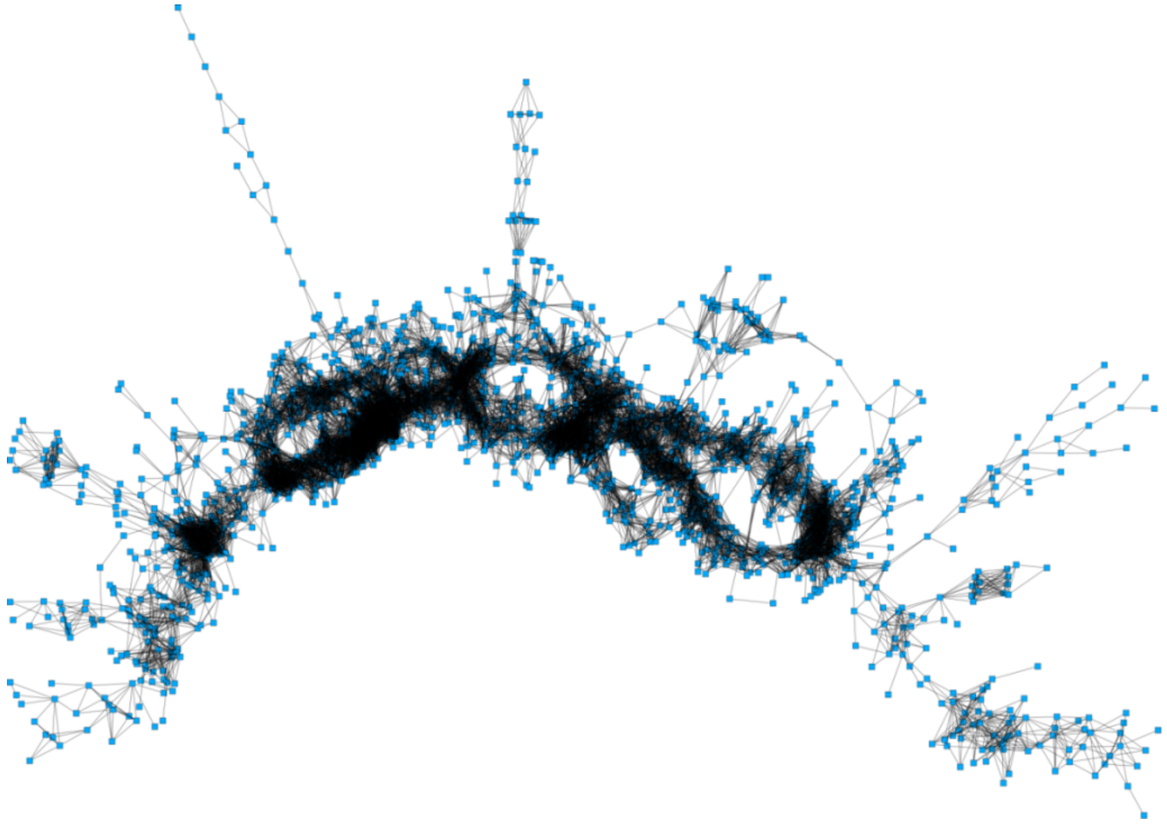
Quan Nguyen et al. (PacificVis 2013). On the faithfulness of graph visualizations

In small graphs: faithfulness usually given



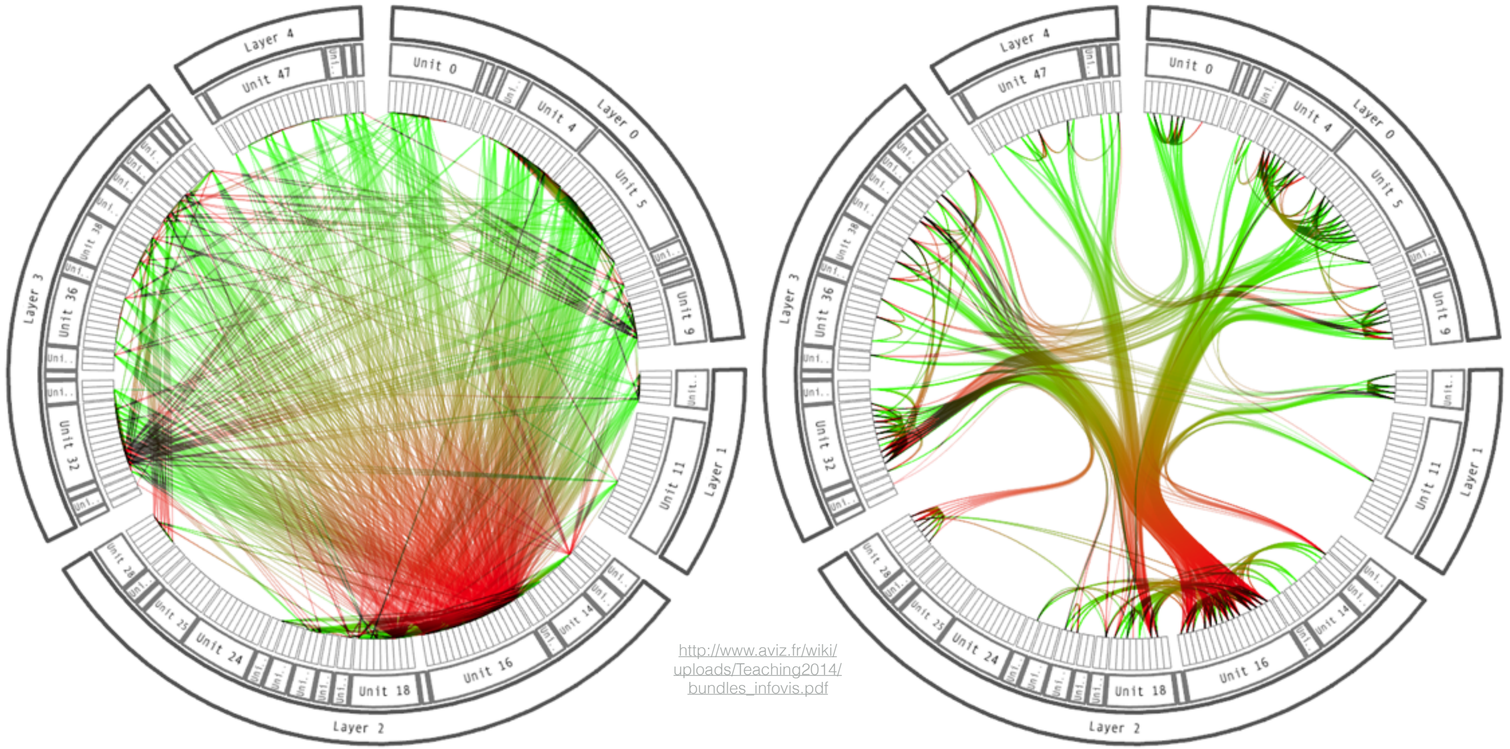
—> optimize readability

In large graphs: faithfulness usually not given



—> tradeoff between faithfulness & readability

Edge bundling

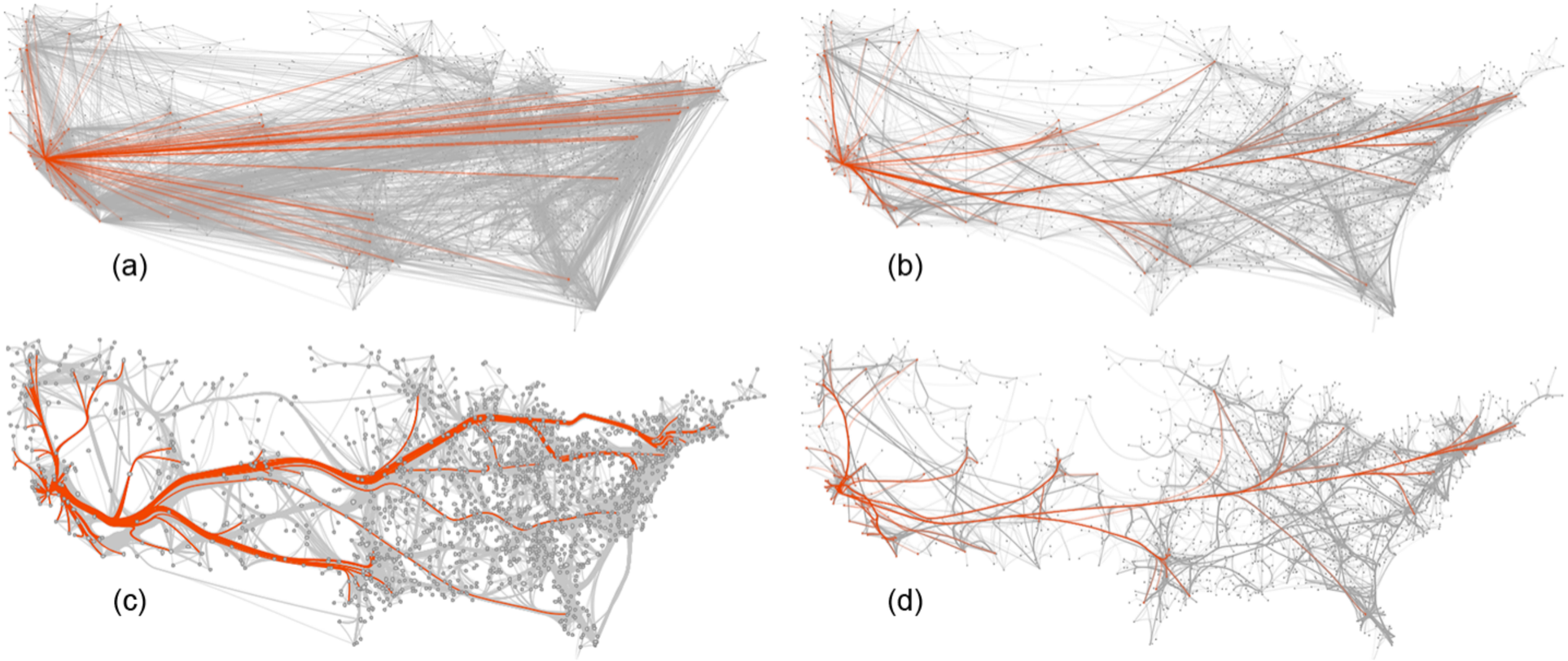


http://www.aviz.fr/wiki/uploads/Teaching2014/bundles_infovis.pdf

Sacrifice faithfulness, gain readability

Holten (InfoVis 2006).
Hierarchical Edge Bundles:
Visualization of Adjacency Relations in Hierarchical Data

Edge bundling

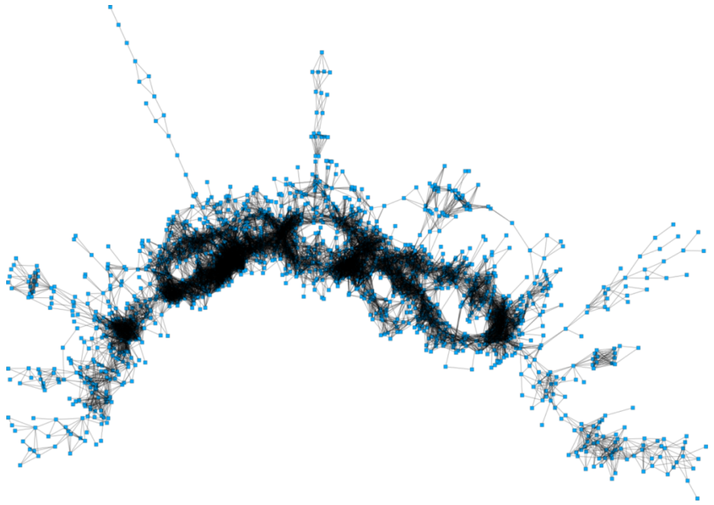


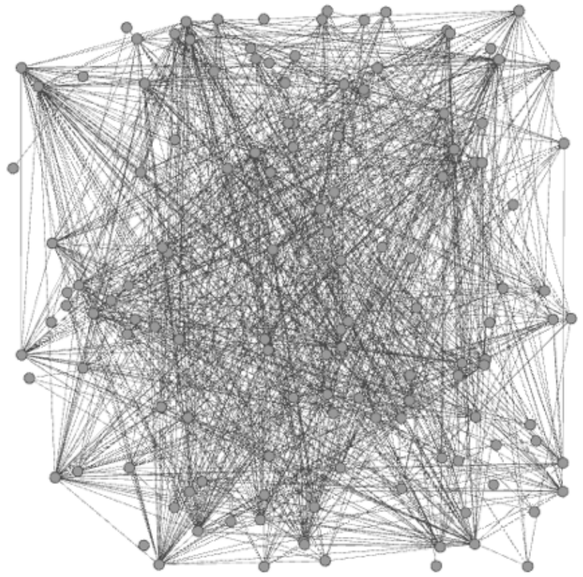
US migration graph

Holten & van Wijk (EuroVis 2009). Force-Directed Edge Bundling for Graph Visualization.

What about edge crossing?

- Some quality measures that work well for small graphs (such as edge crossing) seem to loose their importance the larger a graph gets

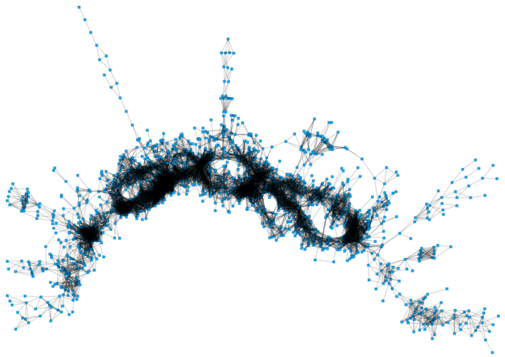




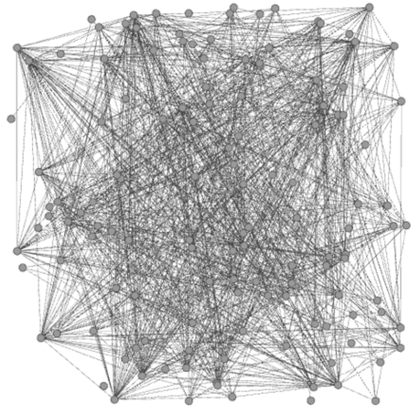
http://eppsnet.com/images/facebook-hairball.png

How many edge crossing do you see?

Instead: “Show me the structure”



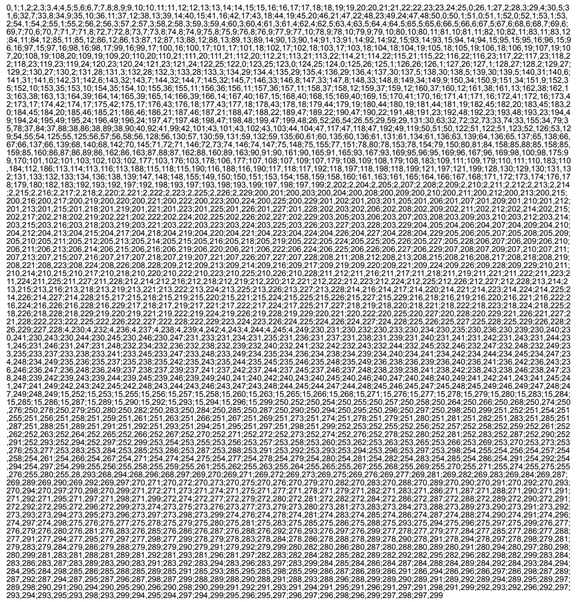
A



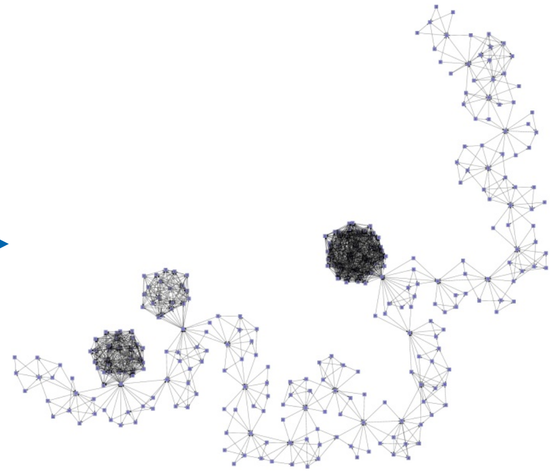
B

“Diagram A is better than diagram B because diagram A shows the structure of the graph, and diagram B does not show the structure.”

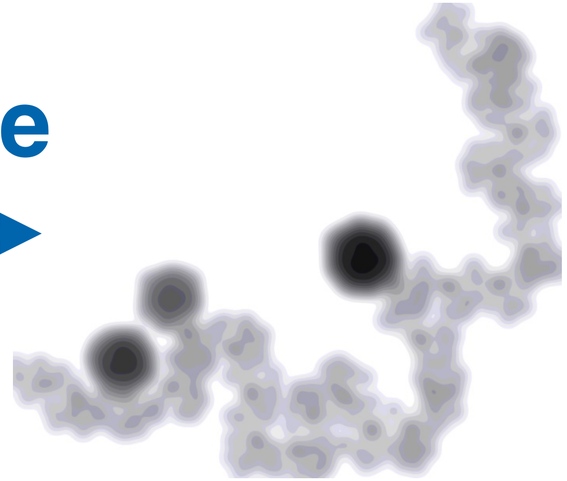
Shape



draw



shape



For a good quality drawing: the shape of the drawing should be faithful to the input graph.

Peter Eades et al. (Graph Drawing 2015). Shape-Based Quality Metrics for Large Graph Visualization.

Outline

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   - Trends in graph drawing
   - Trends in visualization — Related to graph drawing
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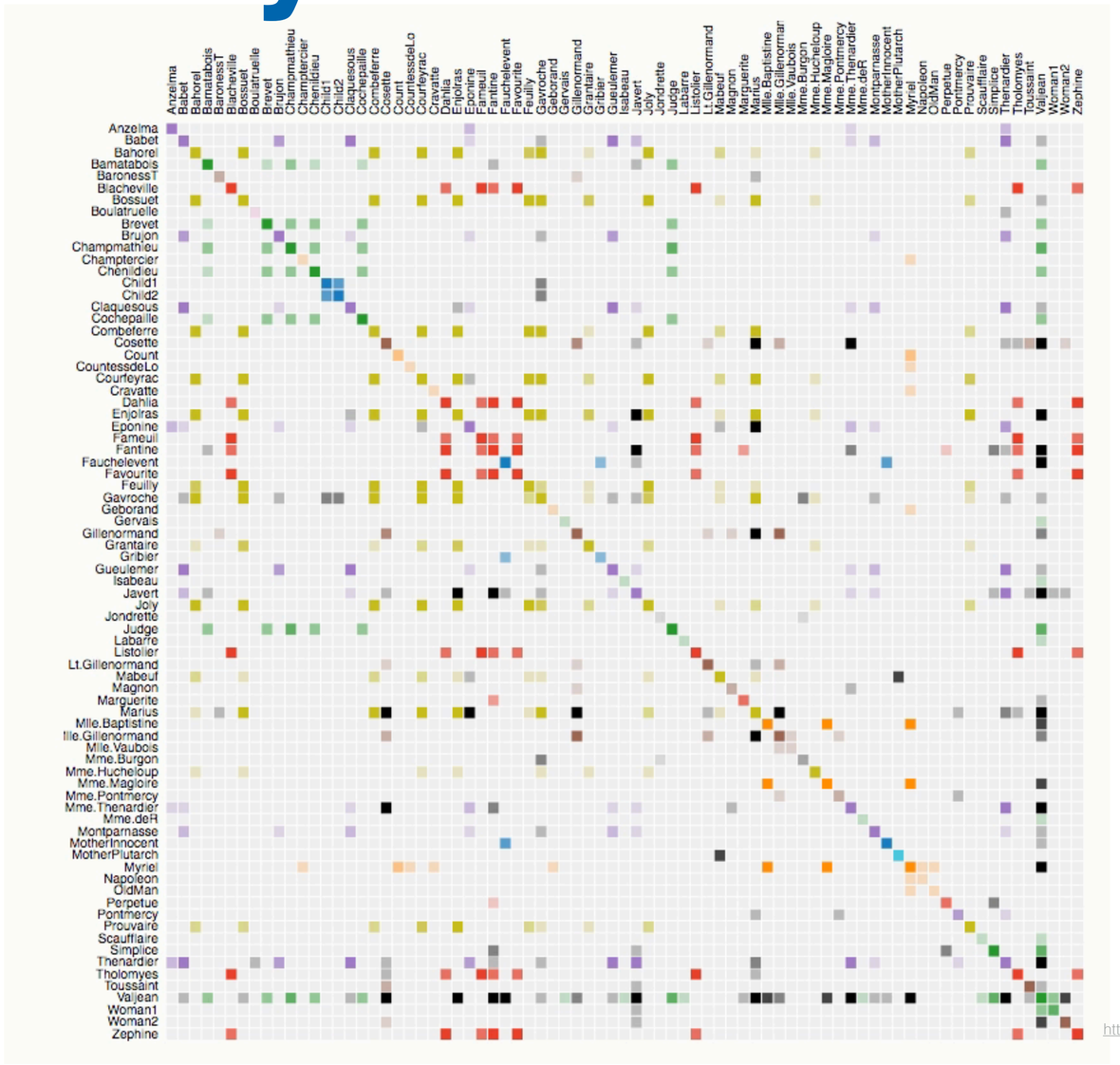
Alternative representations

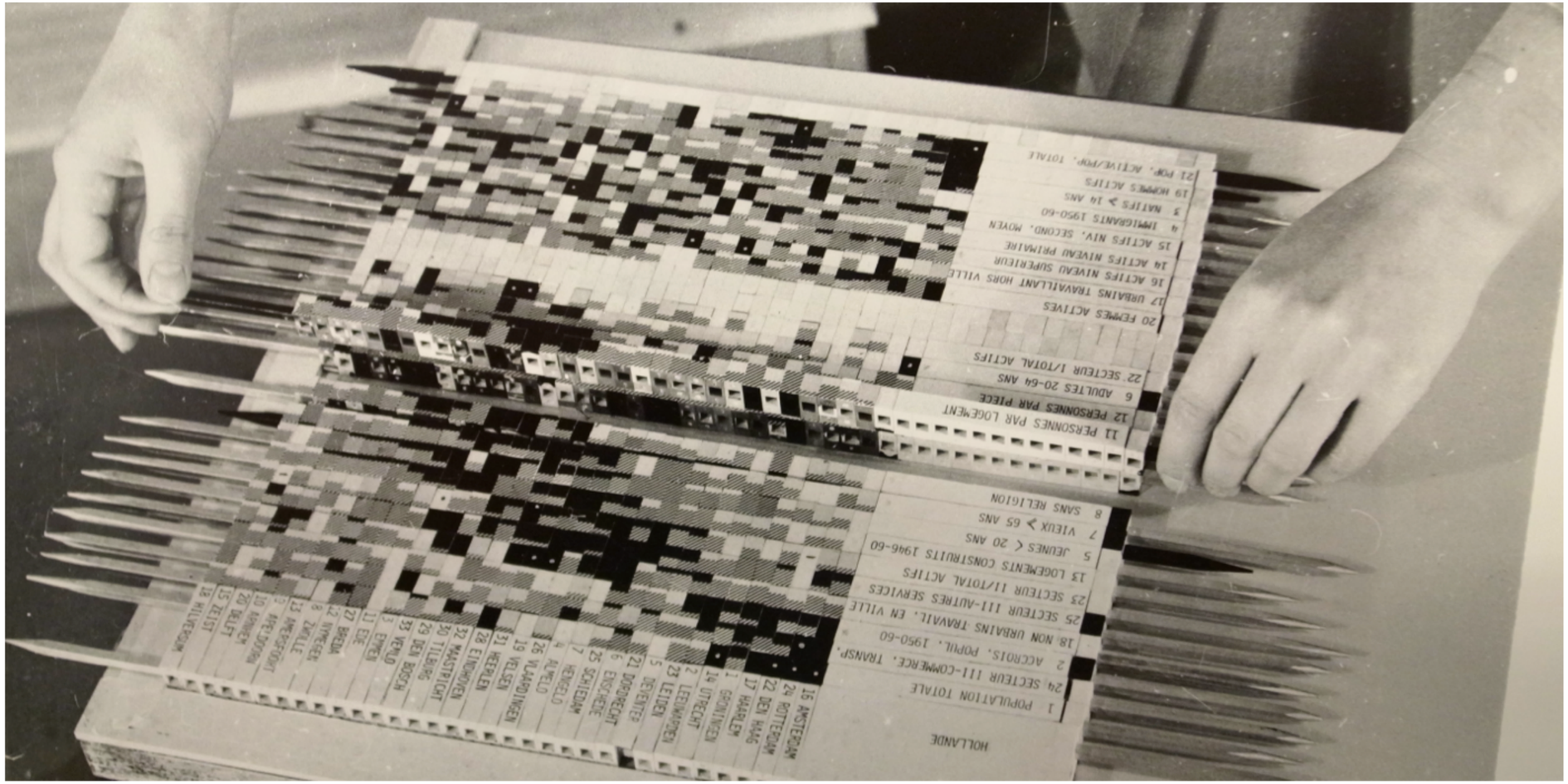
Adjacency Matrix



https://bost.ocks.org/mike/miserables/

Michael Behrisch, et al. (EuroVis STARs 2016). Matrix Reordering Methods for Table and Network Visualization.

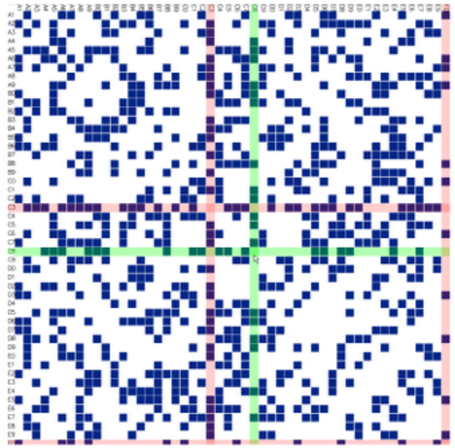
Adjacency Matrix (physical)

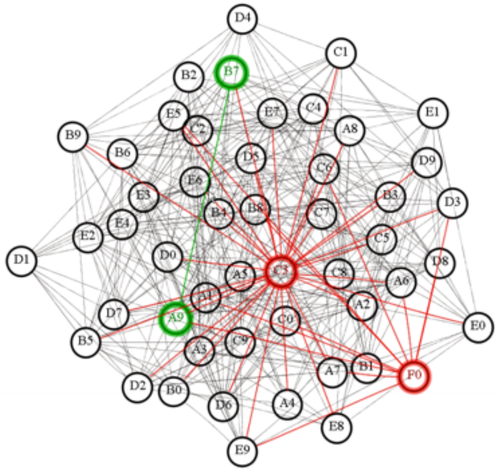


Jacques Bertin, 1968

http://www.aviz.fr/wiki/uploads/Bertifier/bertifier-authorversion.pdf

Matrix or Node-link?



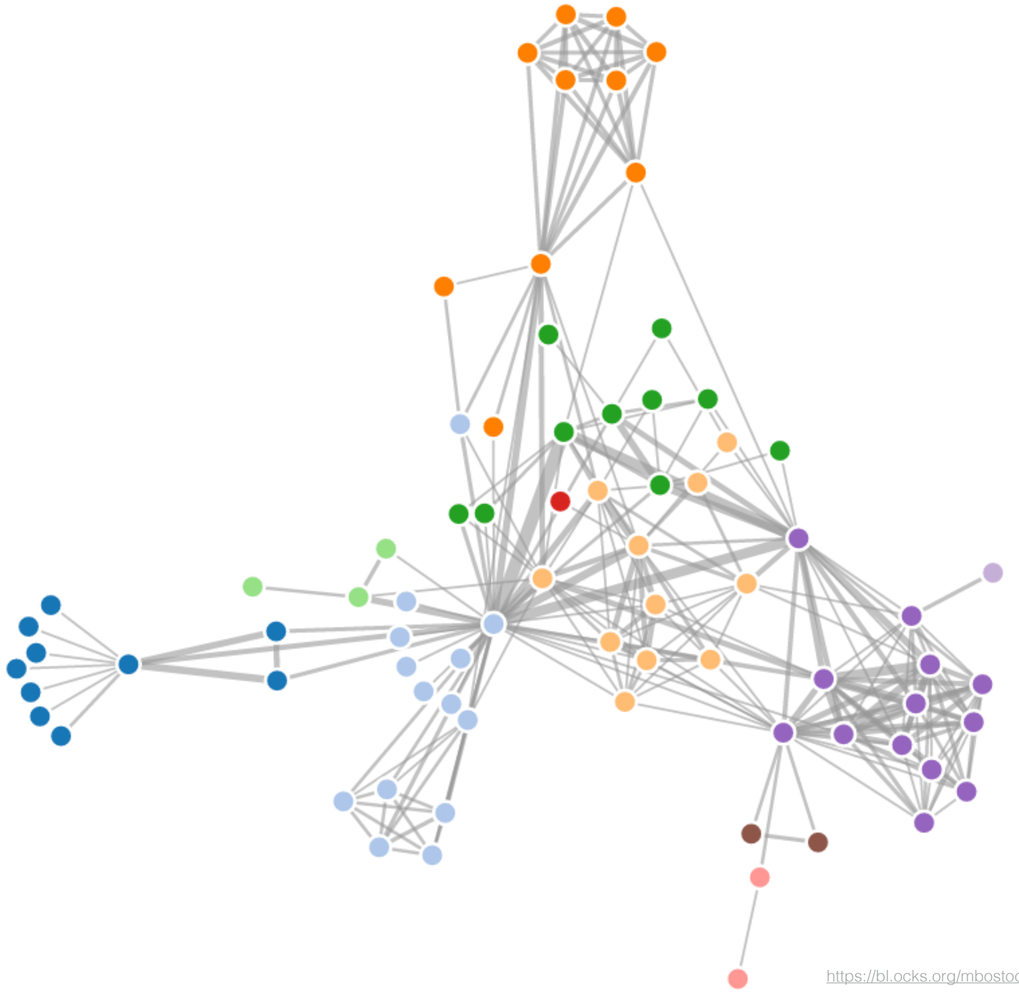


- Study
  - 36 users
  - 9 networks
  - 7 tasks —> measure time & errors
- Results
  - **Node-link** only for:
    - small graphs (~20 nodes)
    - path finding tasks
  - Else **Matrix**
- Limitations

Ghoniem et al. (InfoVis 2004).
A Comparison of the Readability of Graphs Using Node-Link and Matrix-Based Representations.

Additional encodings

Color and width

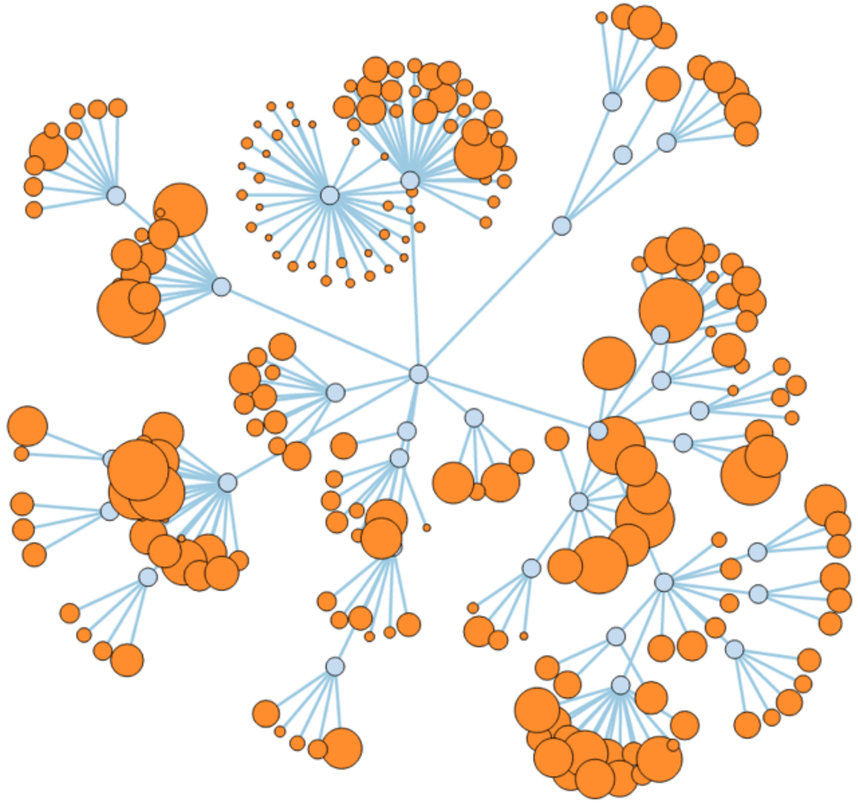


https://bl.ocks.org/mbostock/4062045

Additional encodings

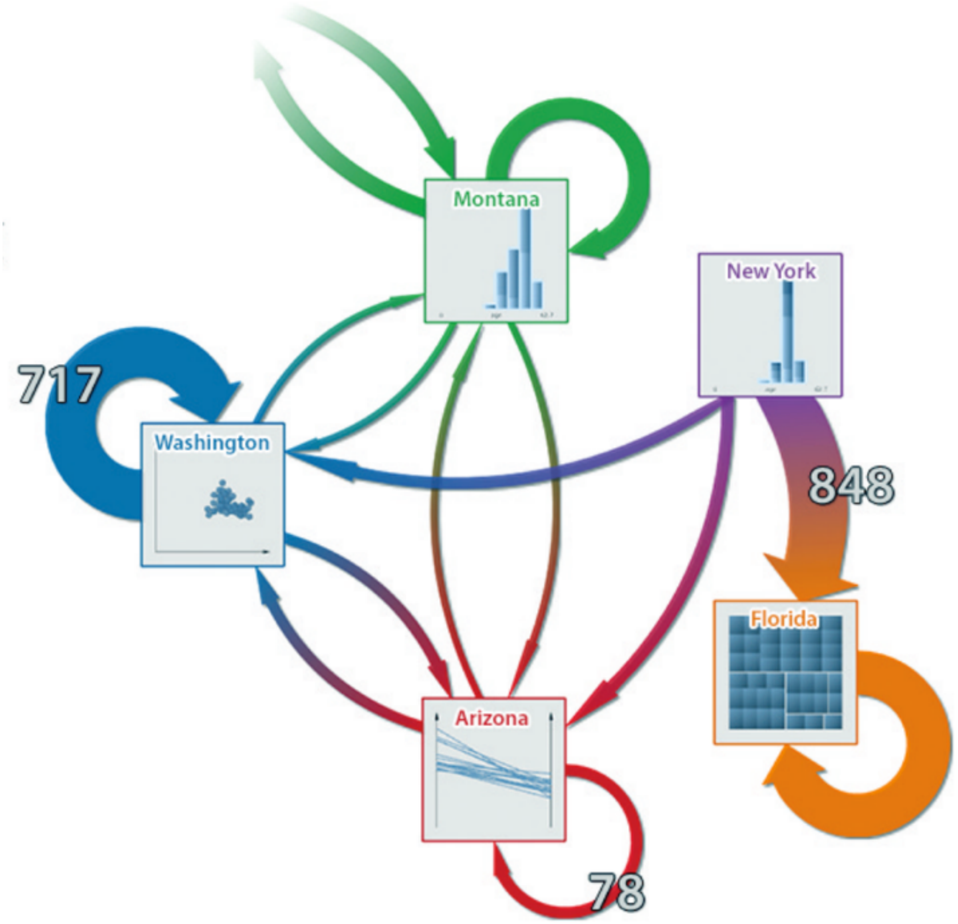
- Nodes, e.g. through color
- Edges, e.g. stroke-width

Size



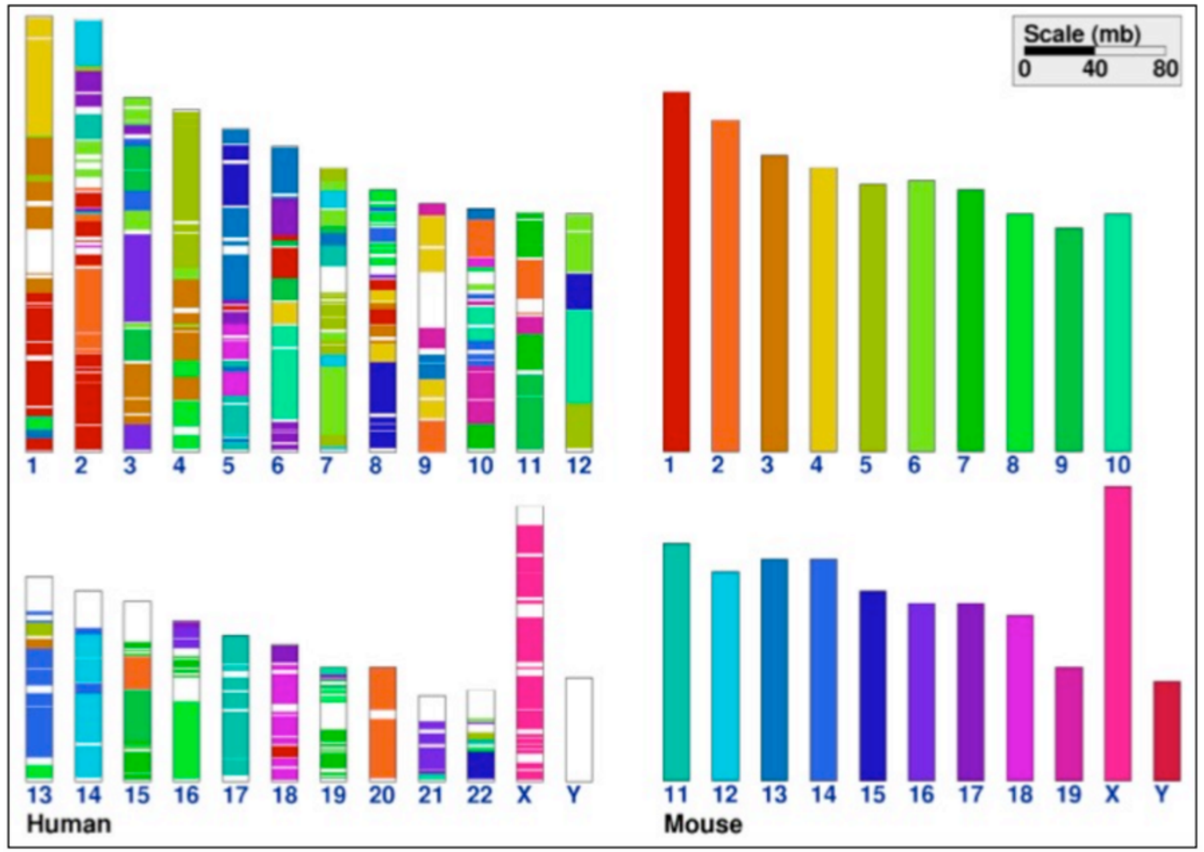
http://mbostock.github.io/d3/talk/20111116/force-collapsible.html

More complex data



Stef van den Elzen and Jarke J. van Wijk (InfoVis 2014)
Multivariate Network Exploration and Presentation:
From Detail to Overview via Selections and Aggregations

Visual Encoding: Color?

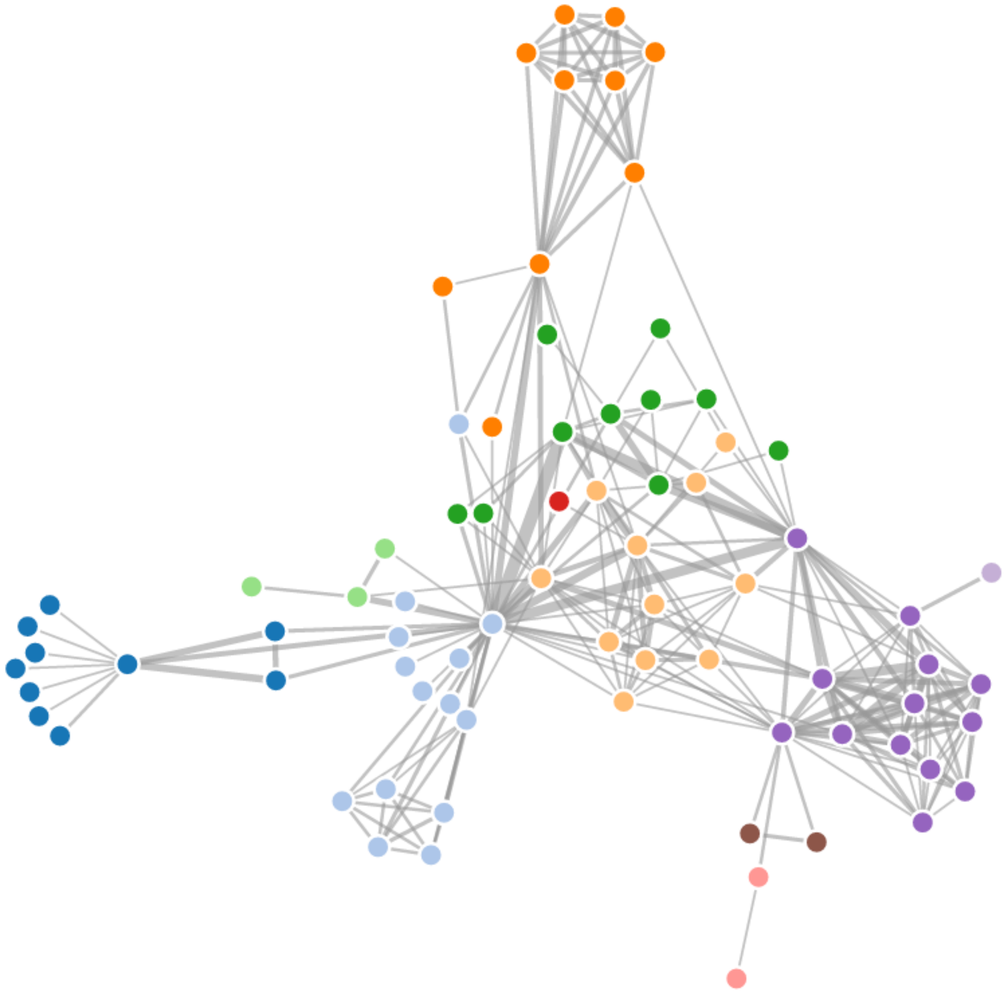


—> Achim!

noncontiguous small regions of color: only 6-12 bins

Sinha and Meller. Cinteny: flexible analysis and visualization of synteny and genome rearrangements in multiple organisms. Bioinformatics 2007.

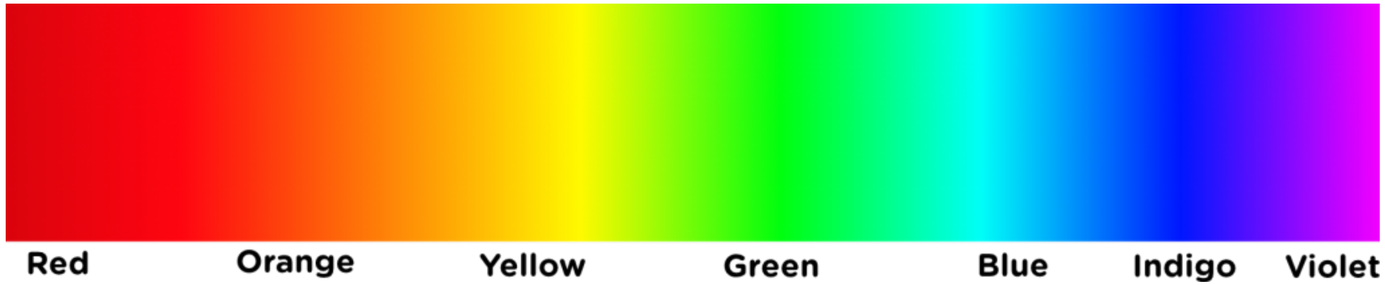
Visual Encoding: Color?



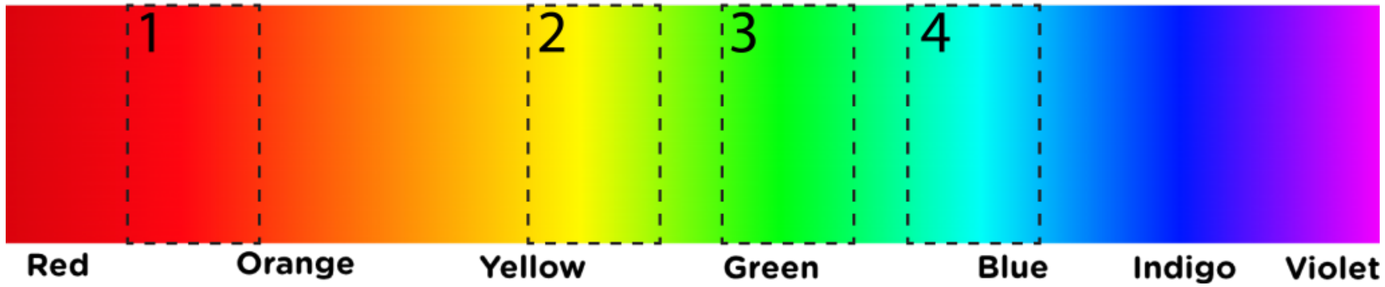
—> Achim!

noncontiguous small regions of color: only 6-12 bins

Rainbow color maps?



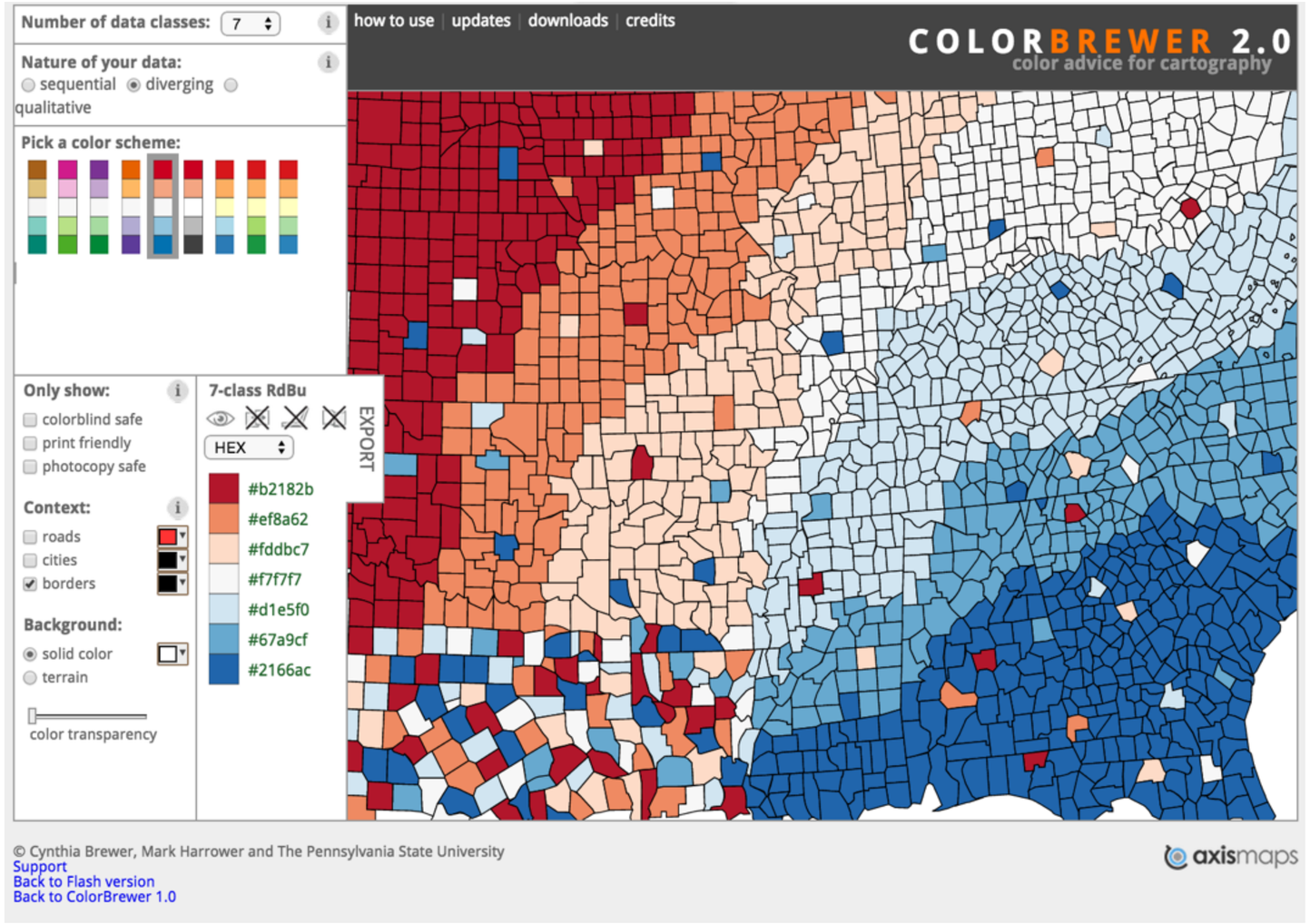
https://courses.washington.edu/engageuw/why-you-should-dump-the-rainbow/



—> Achim!

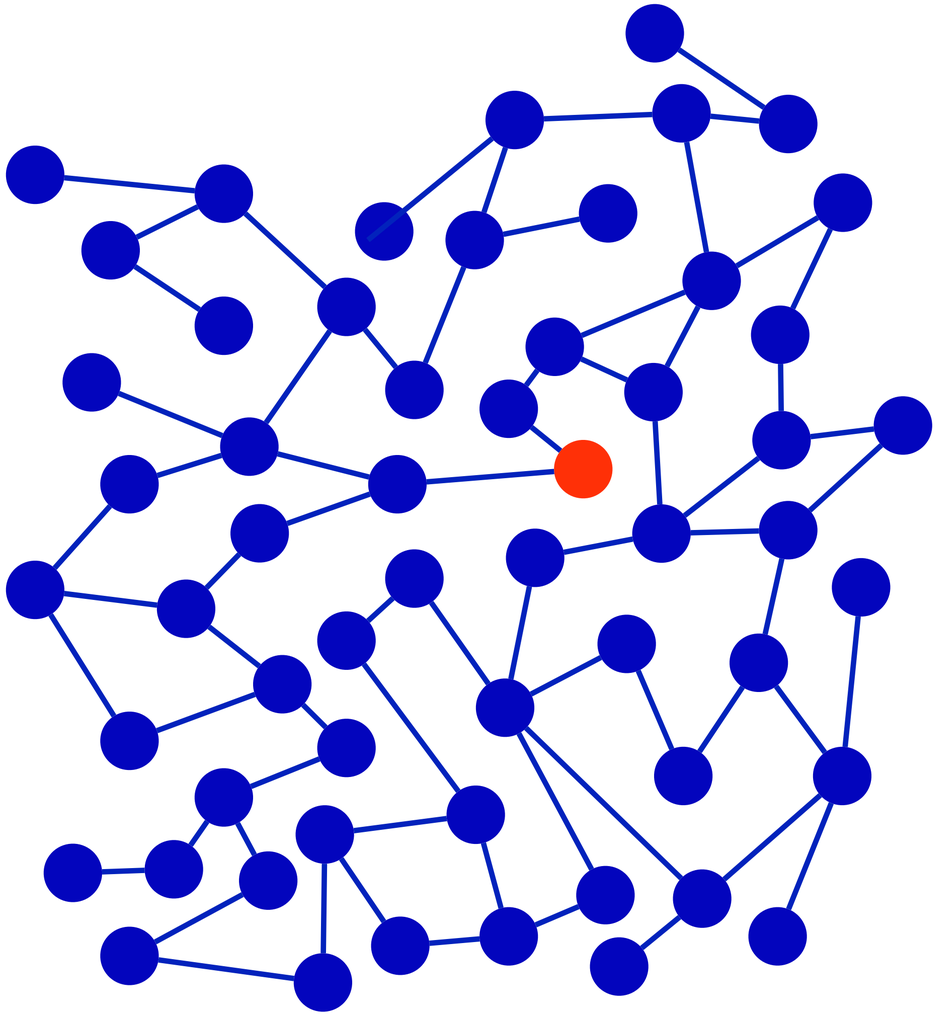
Maureen Stone

Solutions, e.g. ColorBrewer

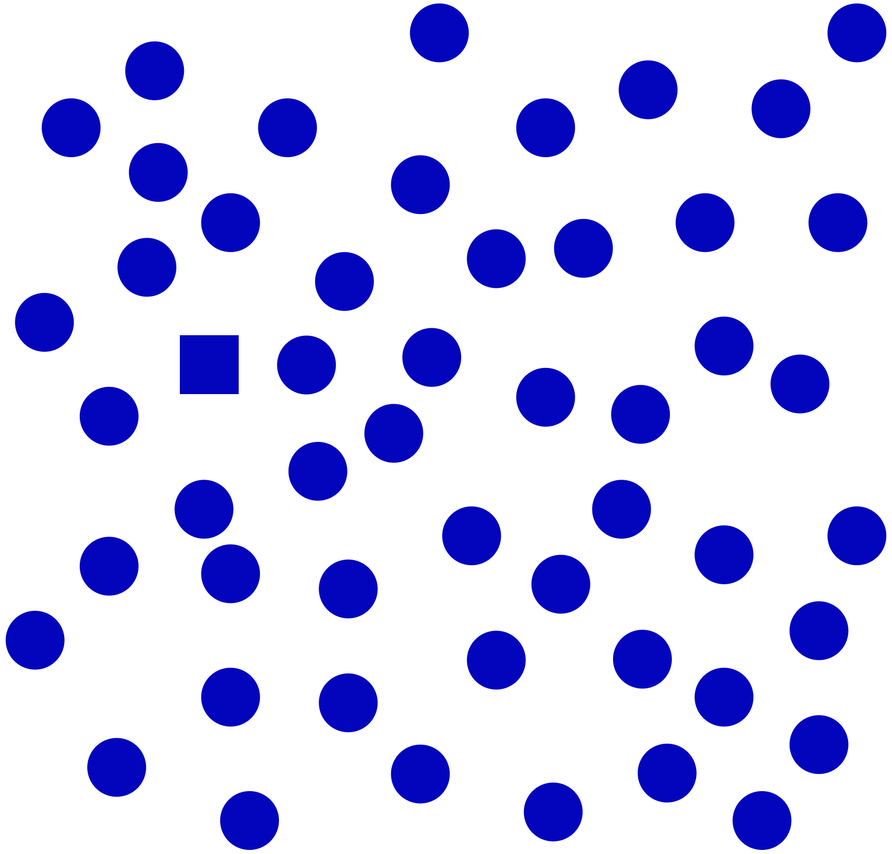


http://colorbrewer2.org/#type=sequential&scheme=BuGn&n=3

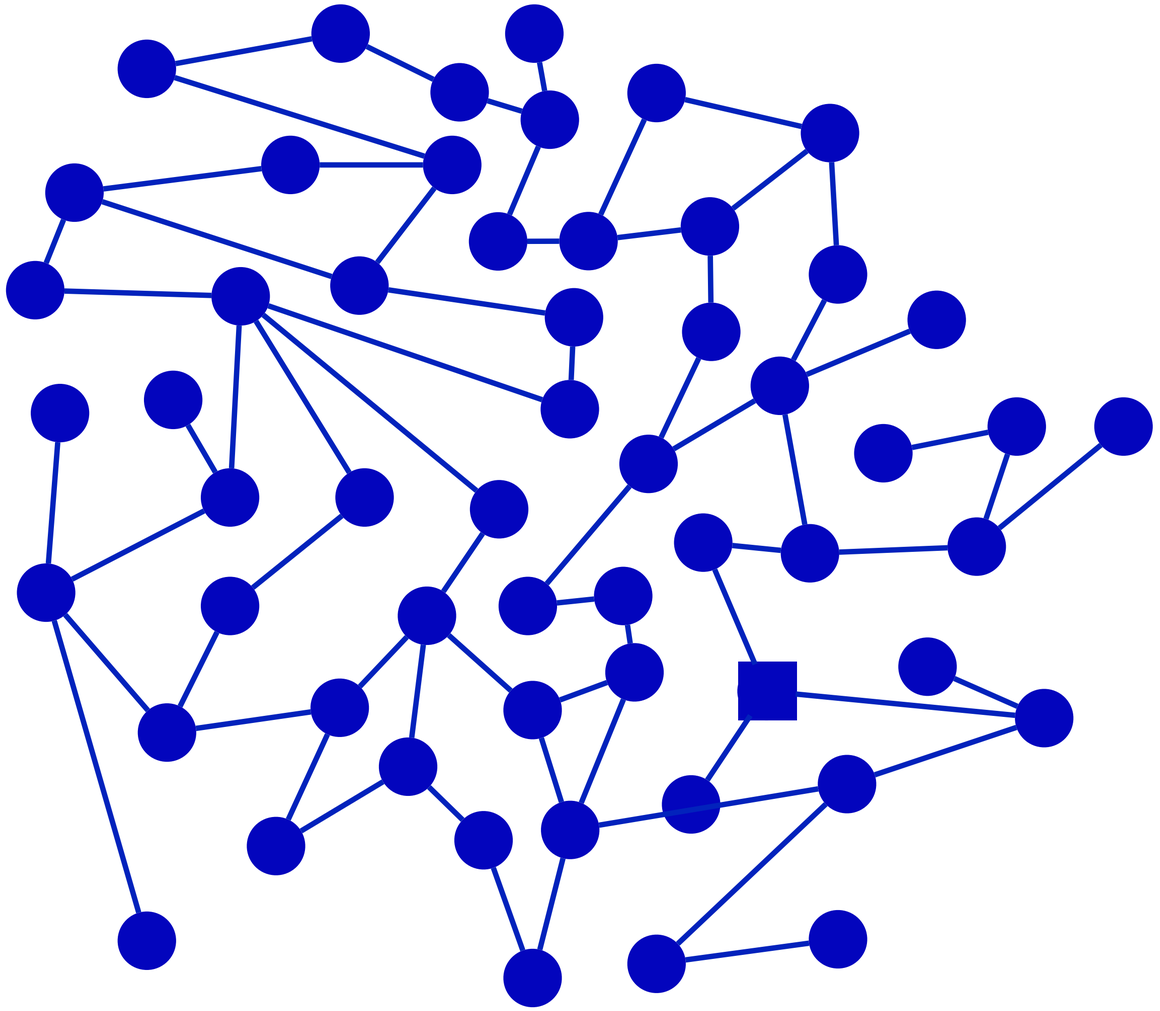
Popout



Popout

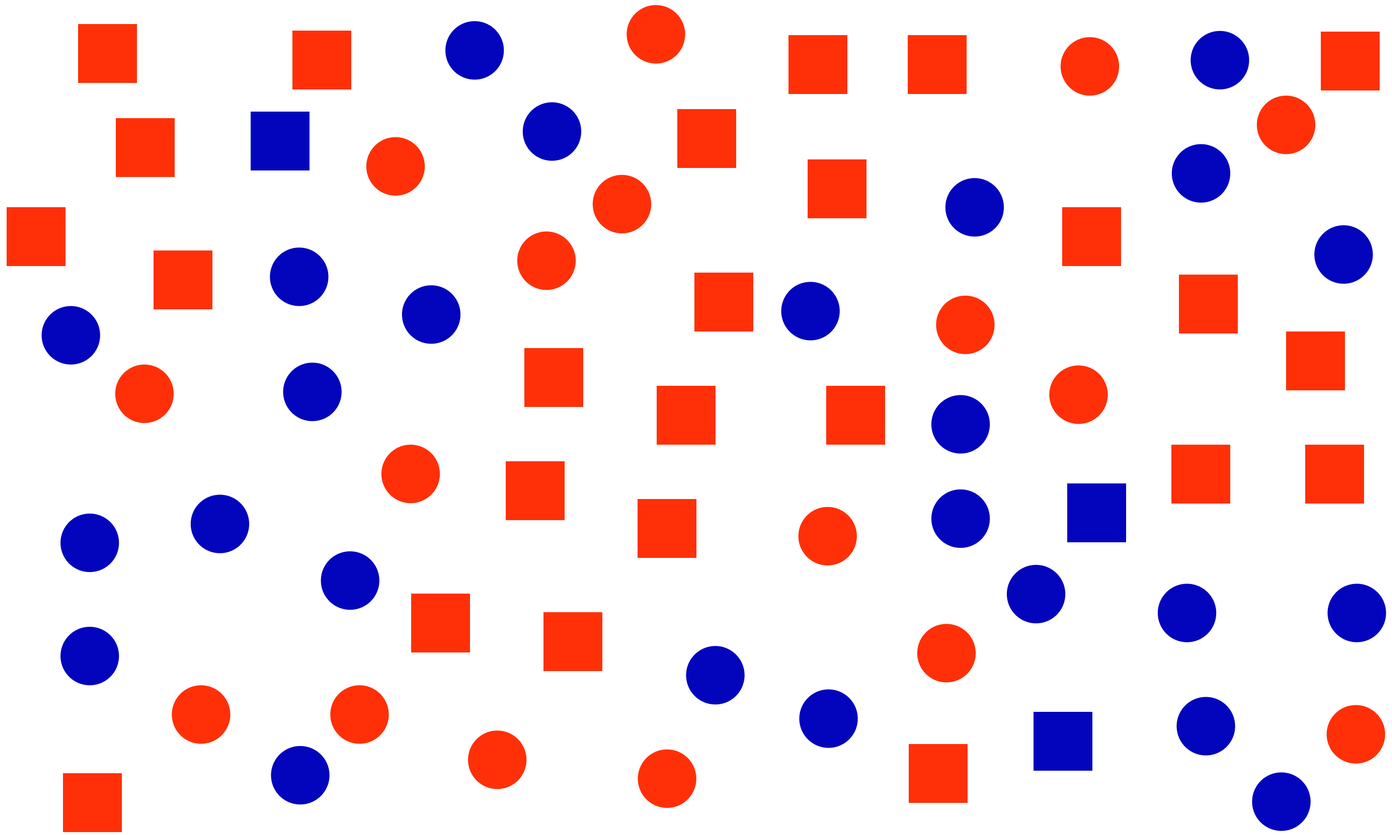


Popout



Popout: combining channels?

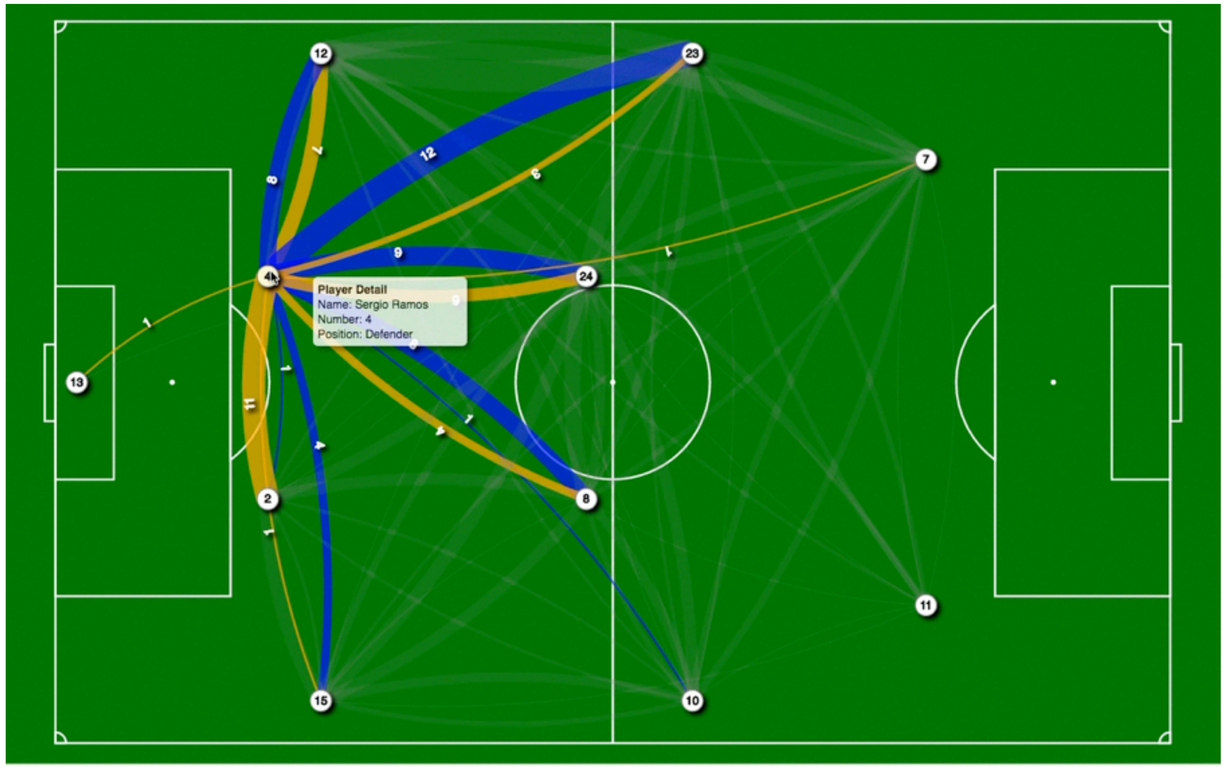
How many blue rectangles?



Interaction

(as a way of dealing with scalability)

Interactive highlighting

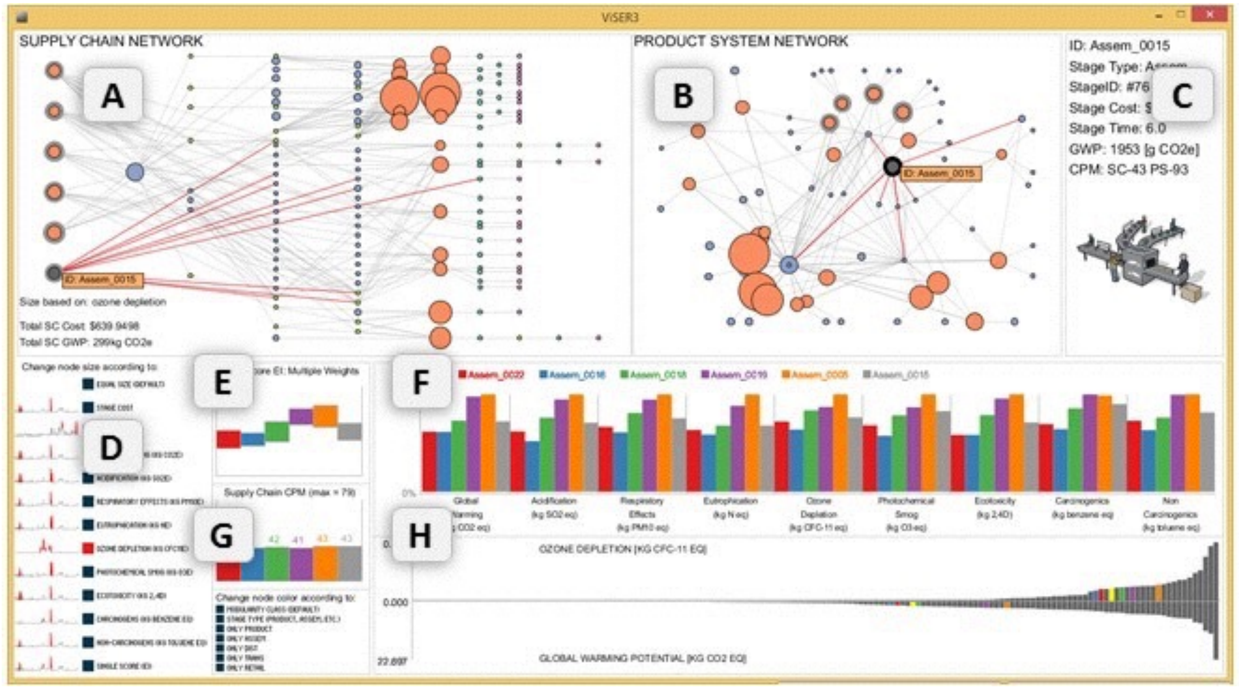


http://bl.ocks.org/fhernand/9a9f93f2a6b0e83a9294

Inherent design tradeoff:

- Amount of data shown
- Time (Interaction/Animation)

Multiple Views + Linking and brushing

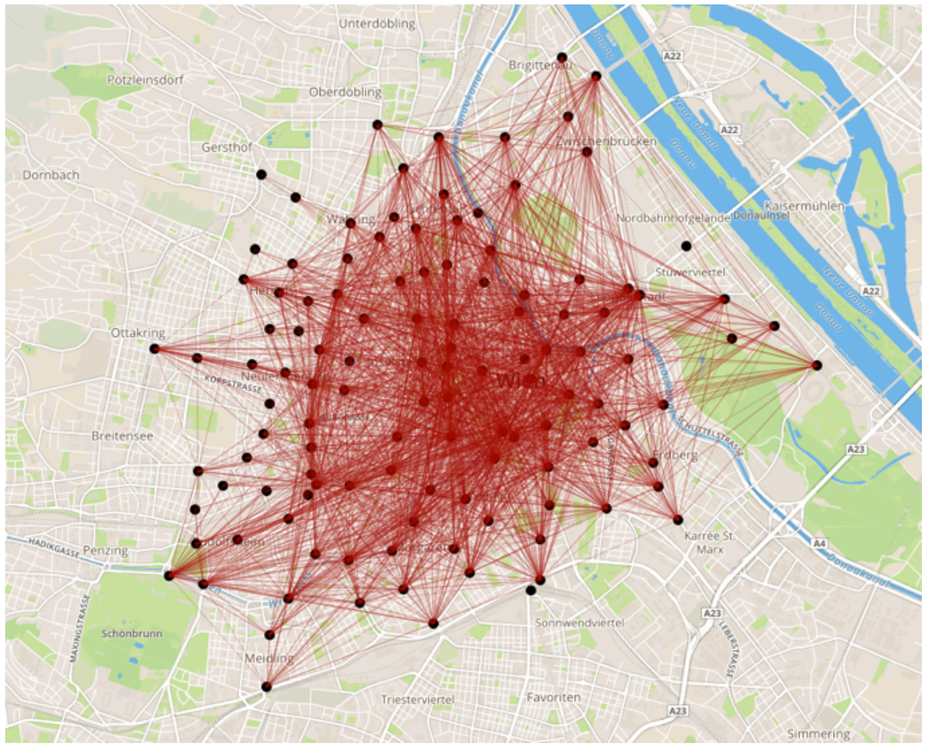


William Z. Bernstein, et al.
Mutually coordinated visualization of product and supply chain metadata for sustainable design.
Journal of Mechanical Design. 2015 Dec 1;137(12):121101.

Multiple Views + Linking and brushing

http://medientransparenz.validproject.at/

Demo: Bike Sharing Atlas



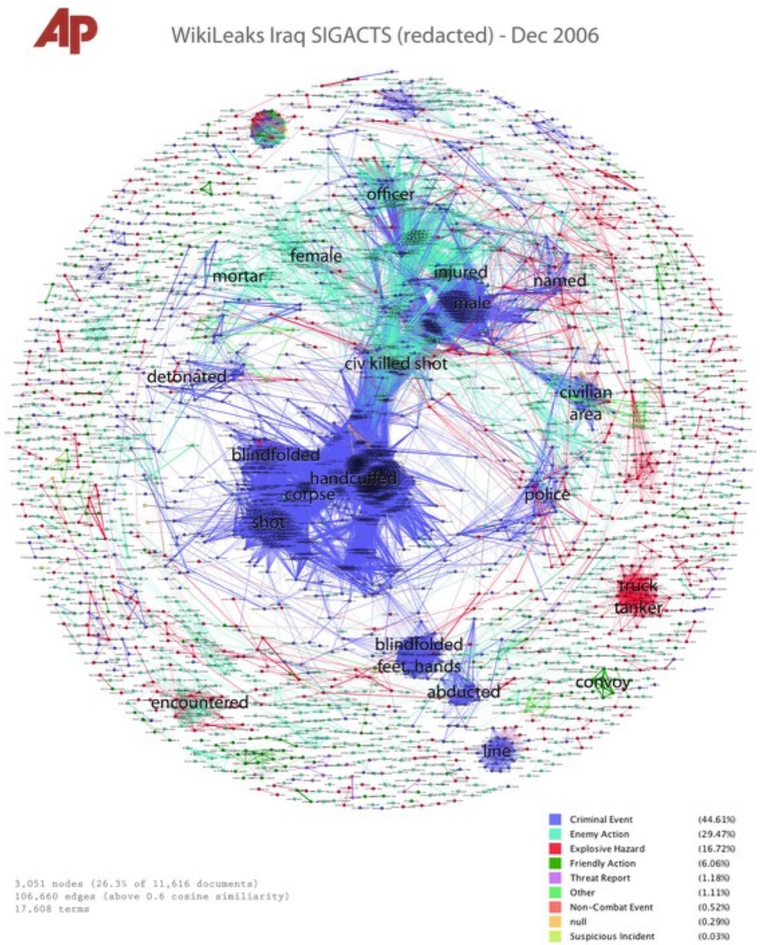
http://oppermann.at/citybike/routes.php

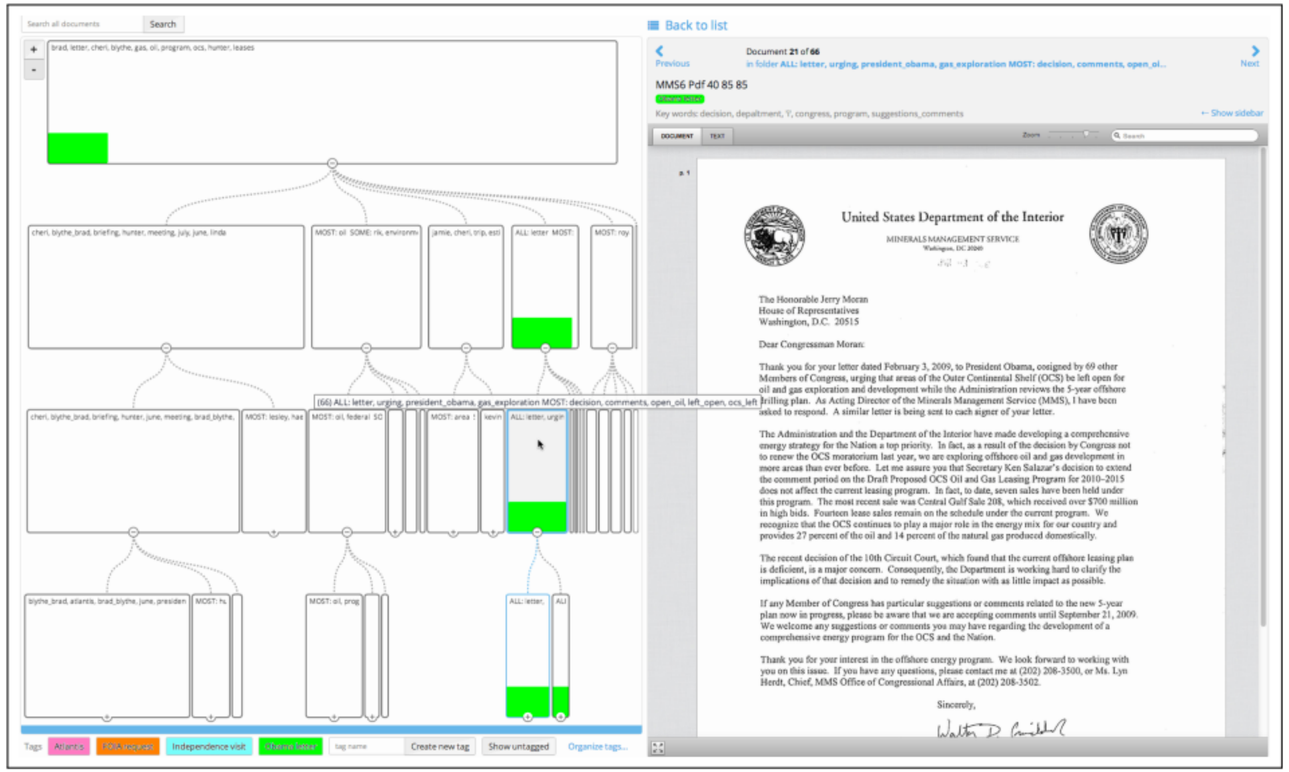
- Goal
  - visualize open data of 380 bike sharing networks
- Nodes: Stations
  - current status (full/empty)
  - filling levels record over 10 month (each 15 minutes)
  - …
- Edges: trips
  - (only for very few networks really available)

Demo

Michael Oppermann, Torsten Möller, Michael Sedlmair.
A Global Perspective on Bike-Sharing Networks and Urban Commuting Patterns.
In submission for ACM Conf. on Human Factors in Computing Systems (CHI), 2017.

Role of network vis in network problems?





Outline

1. Technique-driven research
   - Trends in graph drawing
   - Trends in visualization — Related to graph drawing
2. Problem-driven research
   - Design Study Example — RelEx
   - Design Study Methodology
3. Summary

The ominous “user”

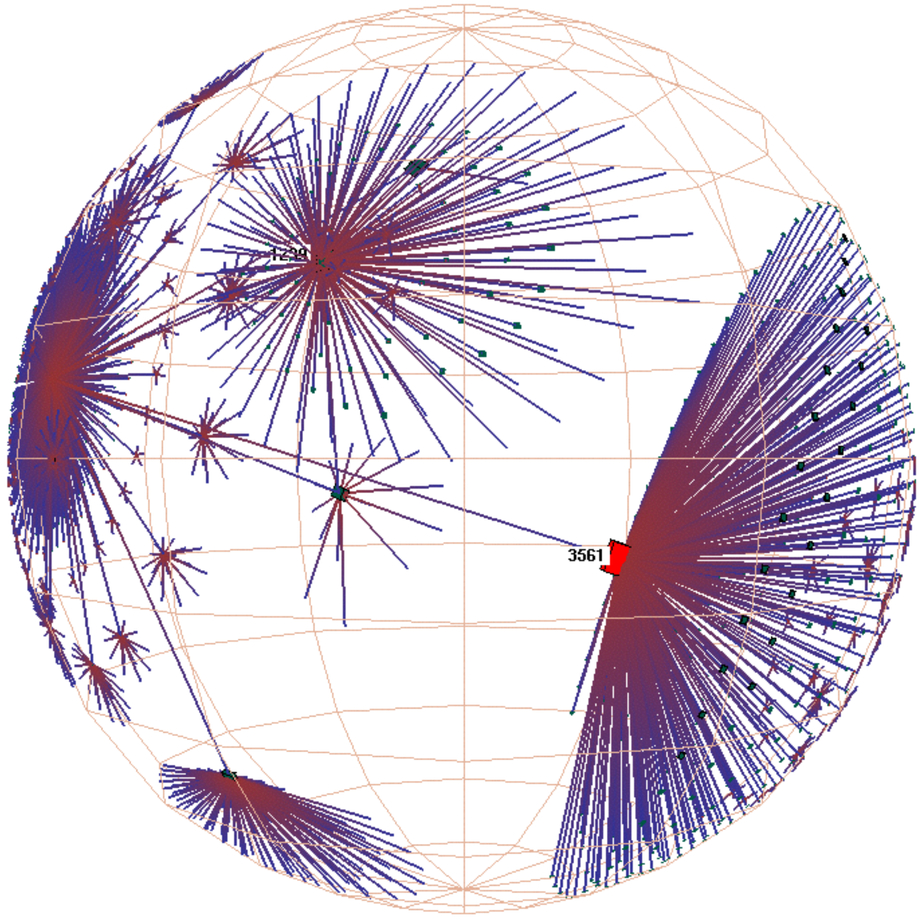
- Classical HCI pitfall: **The Elastic User**

http://flylib.com/books/en/2.151.1.84/1/

- Are our techniques really helping users?
- What exactly are their tasks, problems, and challenges?
- How to effectively combine existing and new techniques to help solving these problems?

http://businessmajors.about.com/od/jobprofiles/p/ProFinAnalysts.htm

Visualizing the internet?



https://graphics.stanford.edu/papers/h3cga/html/

http://www.huffingtonpost.com/dr-travis-bradberry/8-small-things-people-use_b_10169120.html

Tamara Munzner (IEEE CG&A 1998)
Exploring Large Graphs in 3D Hyperbolic Space

goal: help **people** with their
ill-defined (network) problems

How to involve humans into our design and research processes?

Design Studies

"A design study is a project in which visualization researchers analyze a specific

real-world problem *faced by domain experts,*

design *a visualization system that supports solving this problem,*

validate *the design, and*

reflect *about lessons learned in order to refine visualization design guidelines."*

Michael Sedlmair, Miriah Meyer, Tamara Munzner.
Design Study Methodology: Reflections from the Trenches and the Stacks .
IEEE TVCG (Proc. InfoVis), 2012.

Outline

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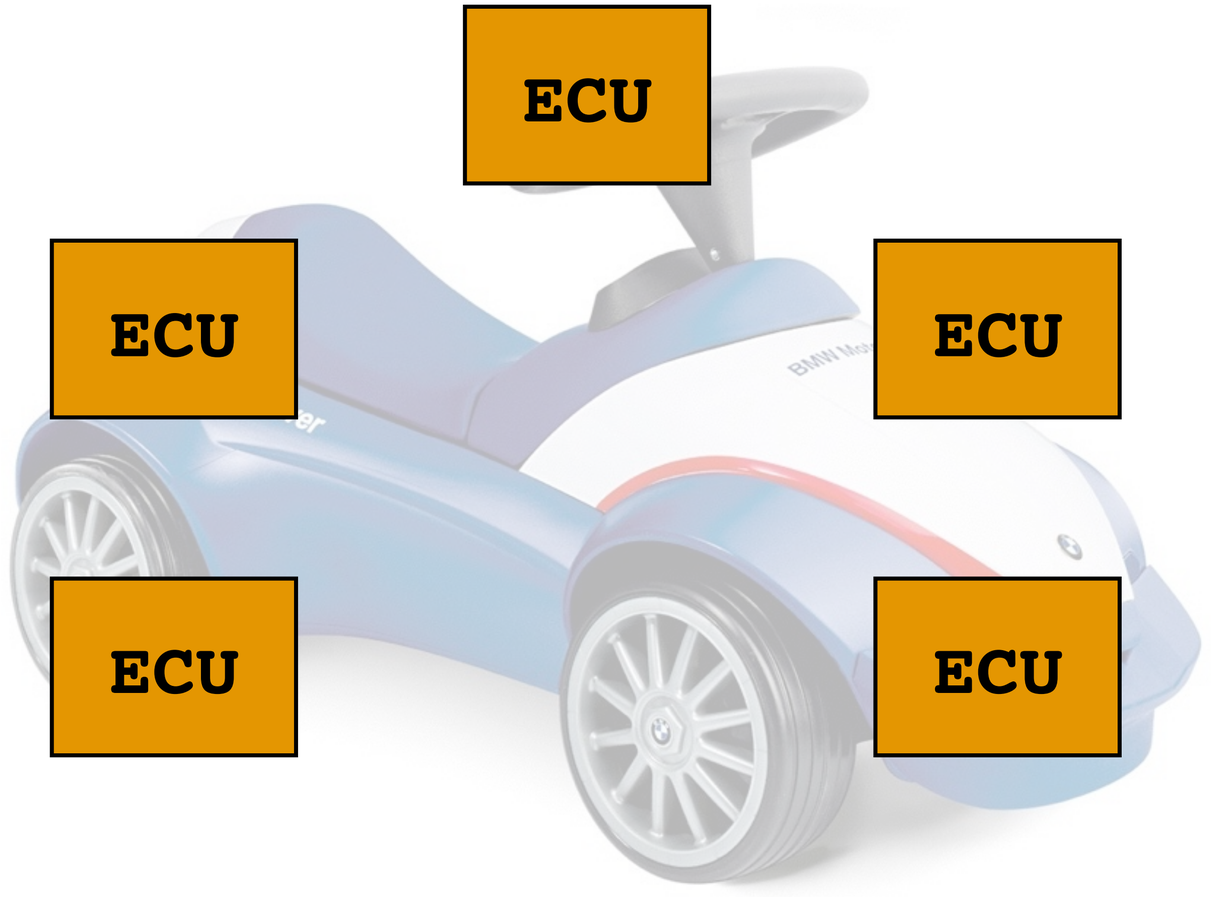
Michael Sedlmair, Annika Frank, Tamara Munzner, Andreas Butz.
RelEx: Visualization for Actively Changing Overlay Network Specifications.
IEEE TVCG (Proc. InfoVis), 2012.

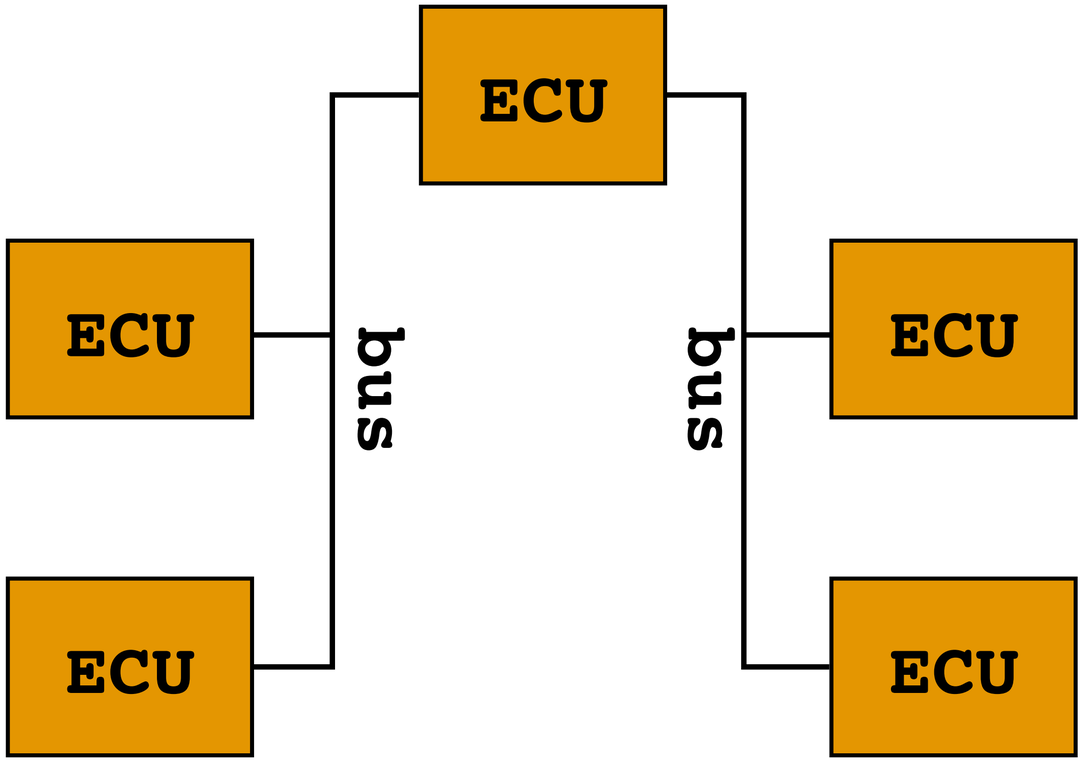
Domain: In-car Electronics

Physical network (Hardware)



~100 ECU (nodes)

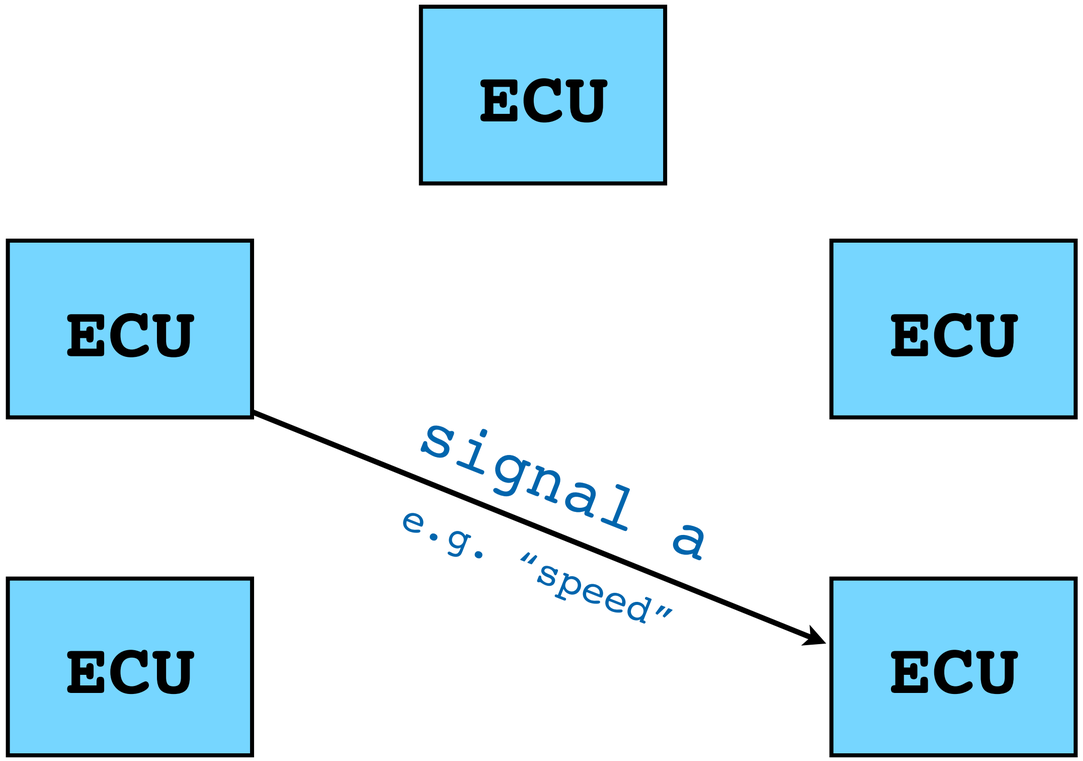
Physical network (Hardware)



~100 ECU (nodes)

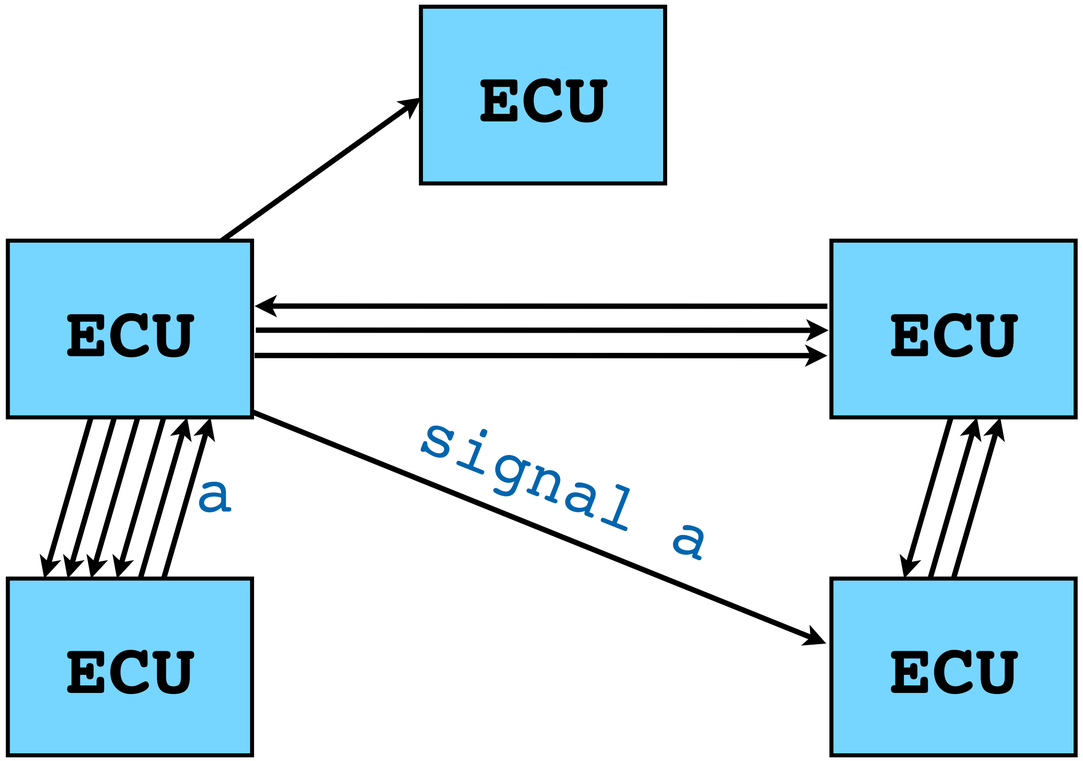
10-15 Bus systems (edges)

Logical Network (Software)



~100 ECU (nodes)

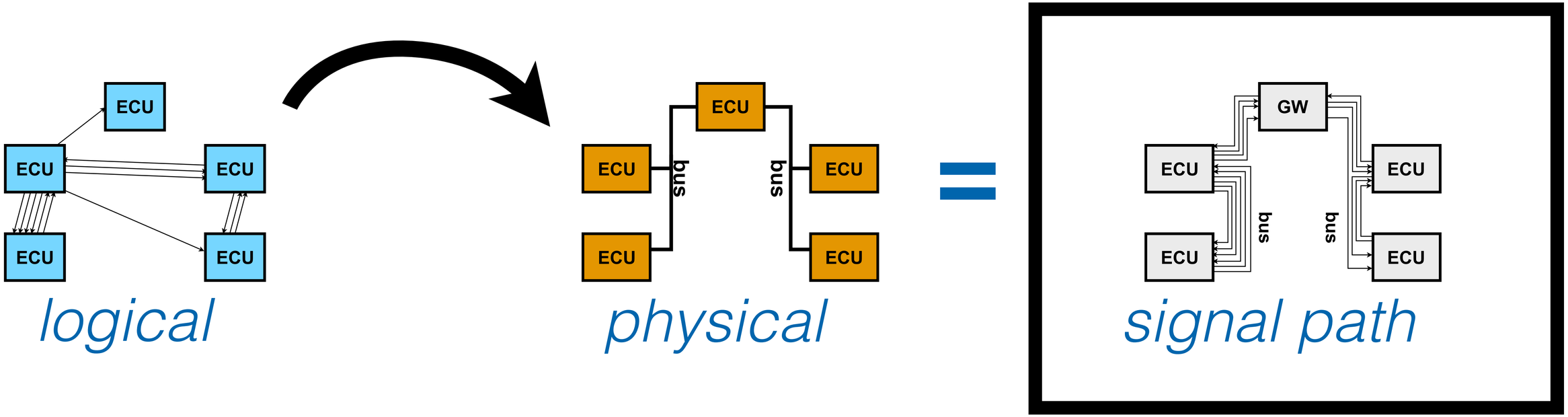
Logical Network (Software)



~100 ECU (nodes)

~10k signals (edges)

Tasks: Mapping

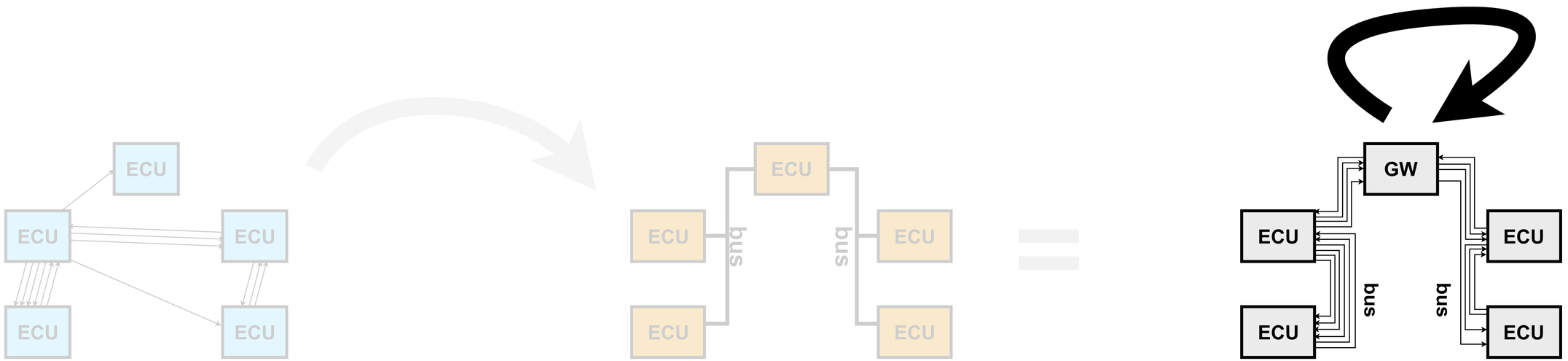


RelEx: Problem characterization

Problem characterization & abstraction
(3 month)

- Understanding
  - Talking/Observing
  - Focus groups
  - Analyzing previous tools
  - Reading
- Abstracting & requirements

Tasks: Multi-objective optimization

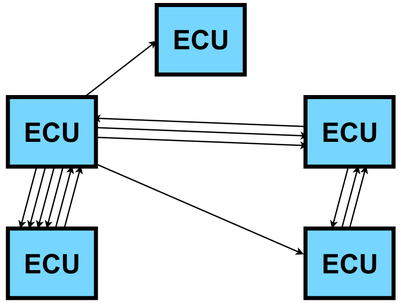


Ill-defined constraints

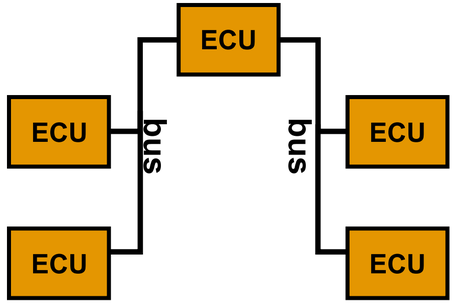
bandwidth ... delay/real time ...
path length ... load balance ...
reliability ... money ...

-- engineer, BMW --

Tasks: External Change Requests

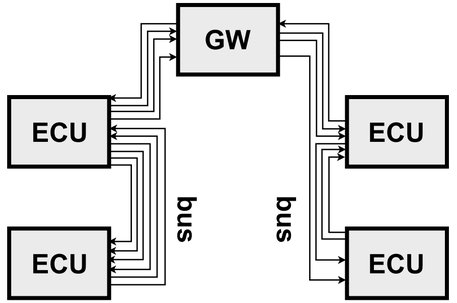


logical

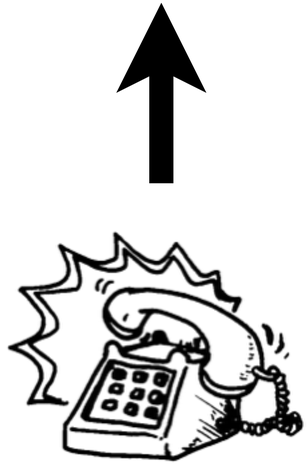


physical

=



signal path

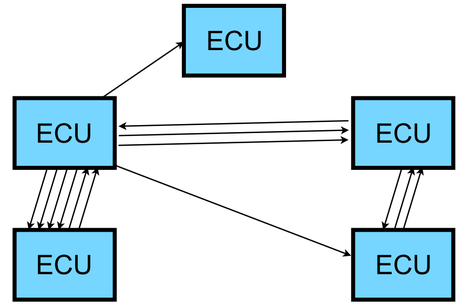


Change

(trivial requests might lead to complex changes)

Low Level Tasks

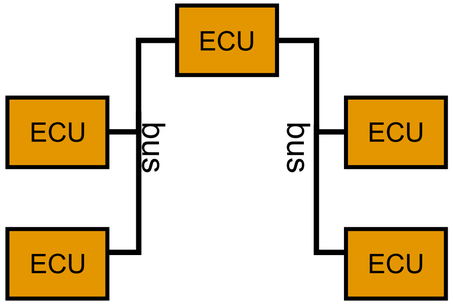
Queries about relations

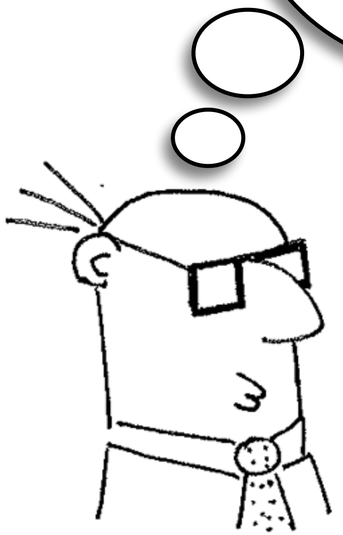


Which ECU is communicating with which ECU?

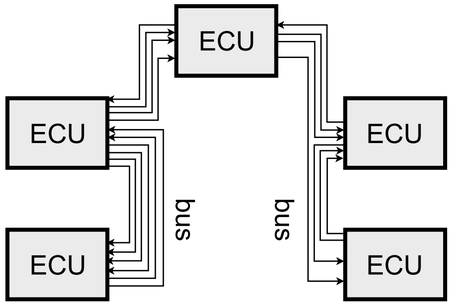
Which signals do they exchange?

What is the path the signals take? ...



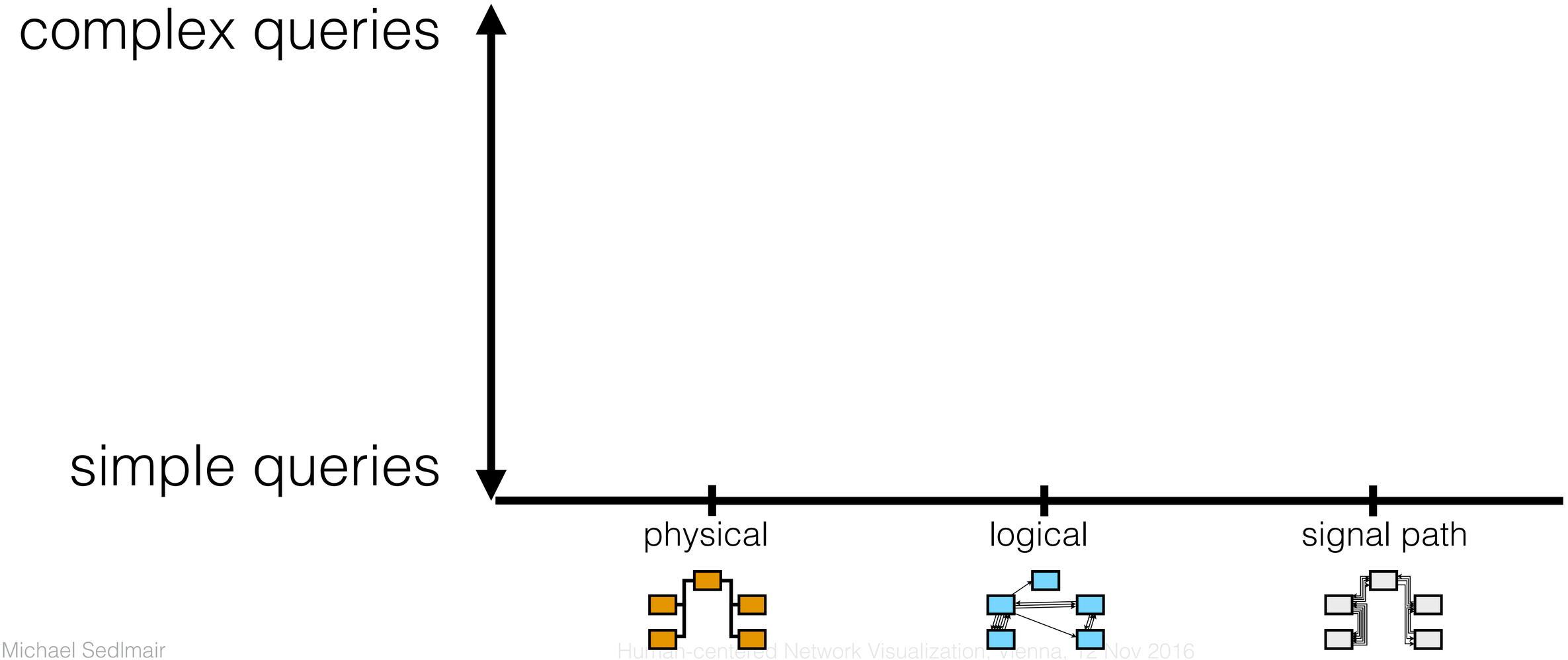


-- engineer, BMW --



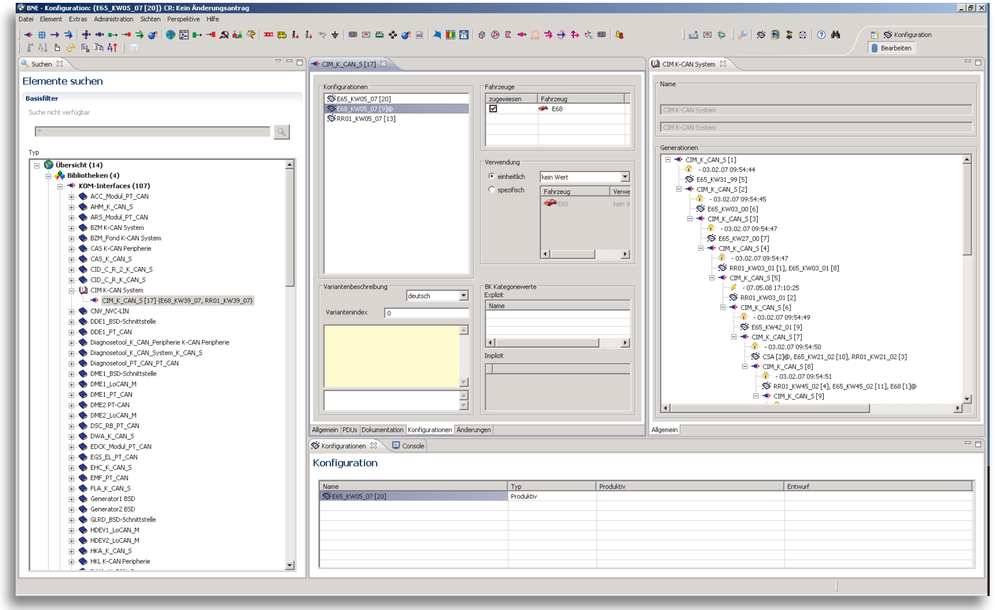
Low Level Tasks

Query complexity



Low Level Tasks

Query complexity



simple queries

2-way relations

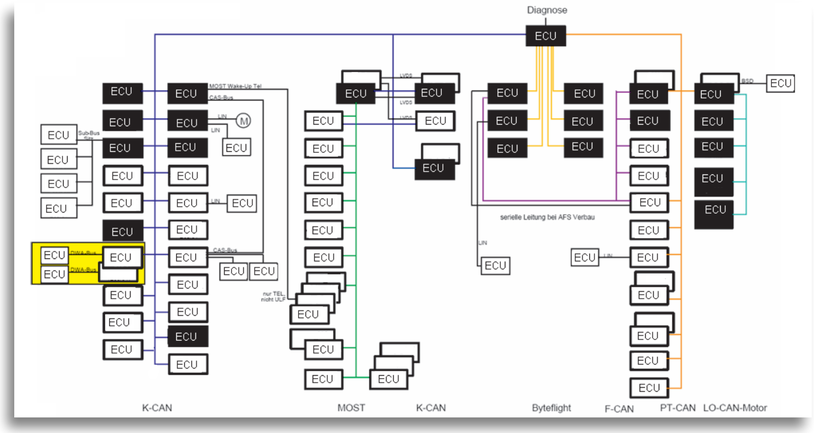
physical

logical

signal path

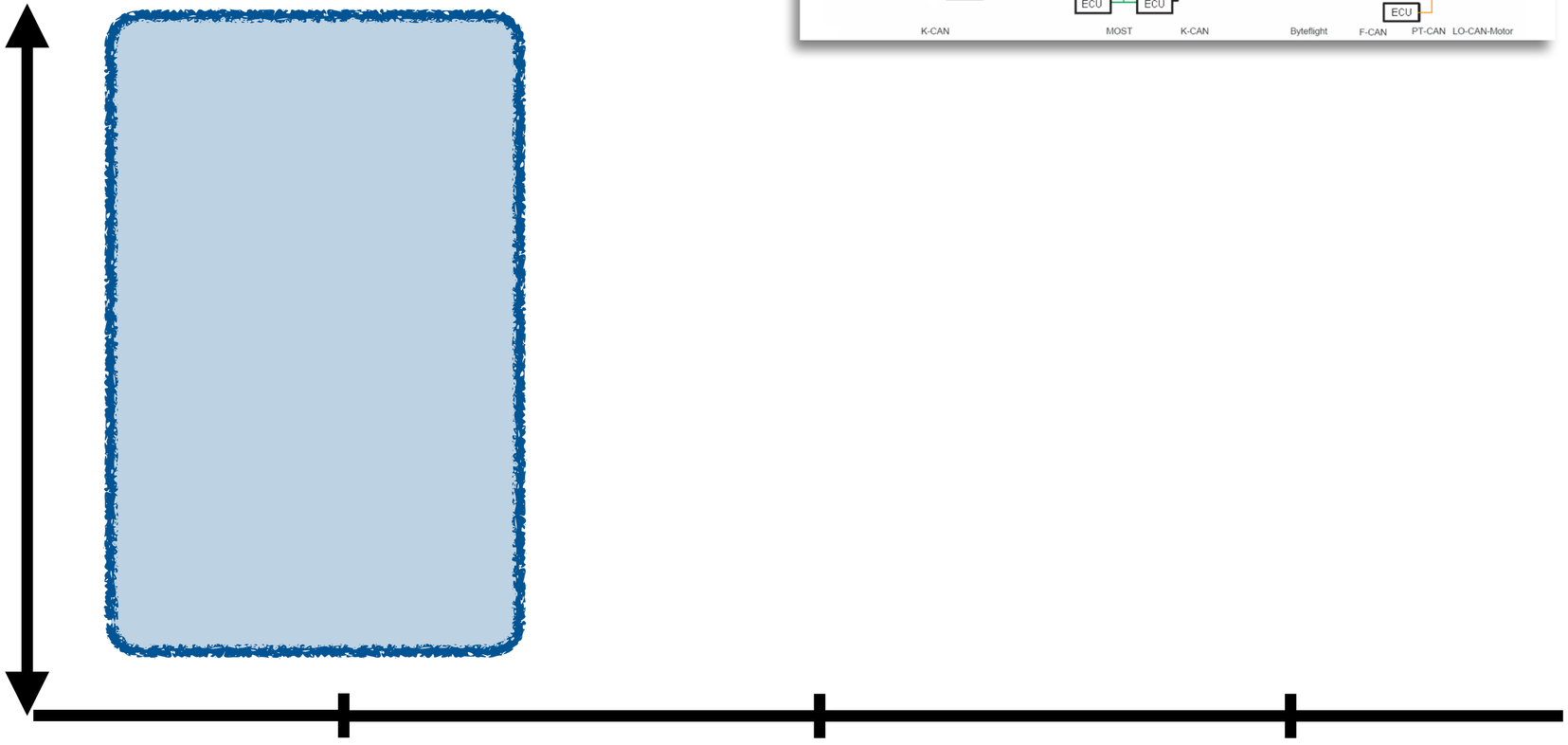
Low Level Tasks

Query complexity



complex queries

Overview

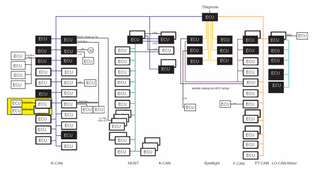


Low Level Tasks

Query complexity

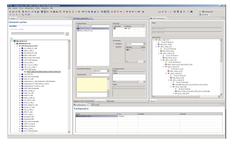
complex queries

simple queries



Unsupported need: **Logical Overview**

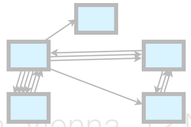
Unsupported need: **All path of a Signal**

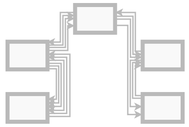


physical

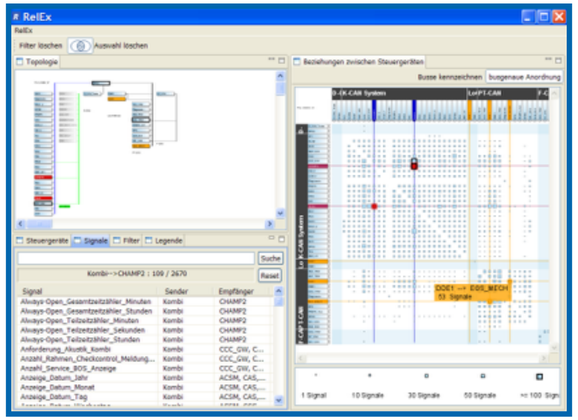
logical

signal path

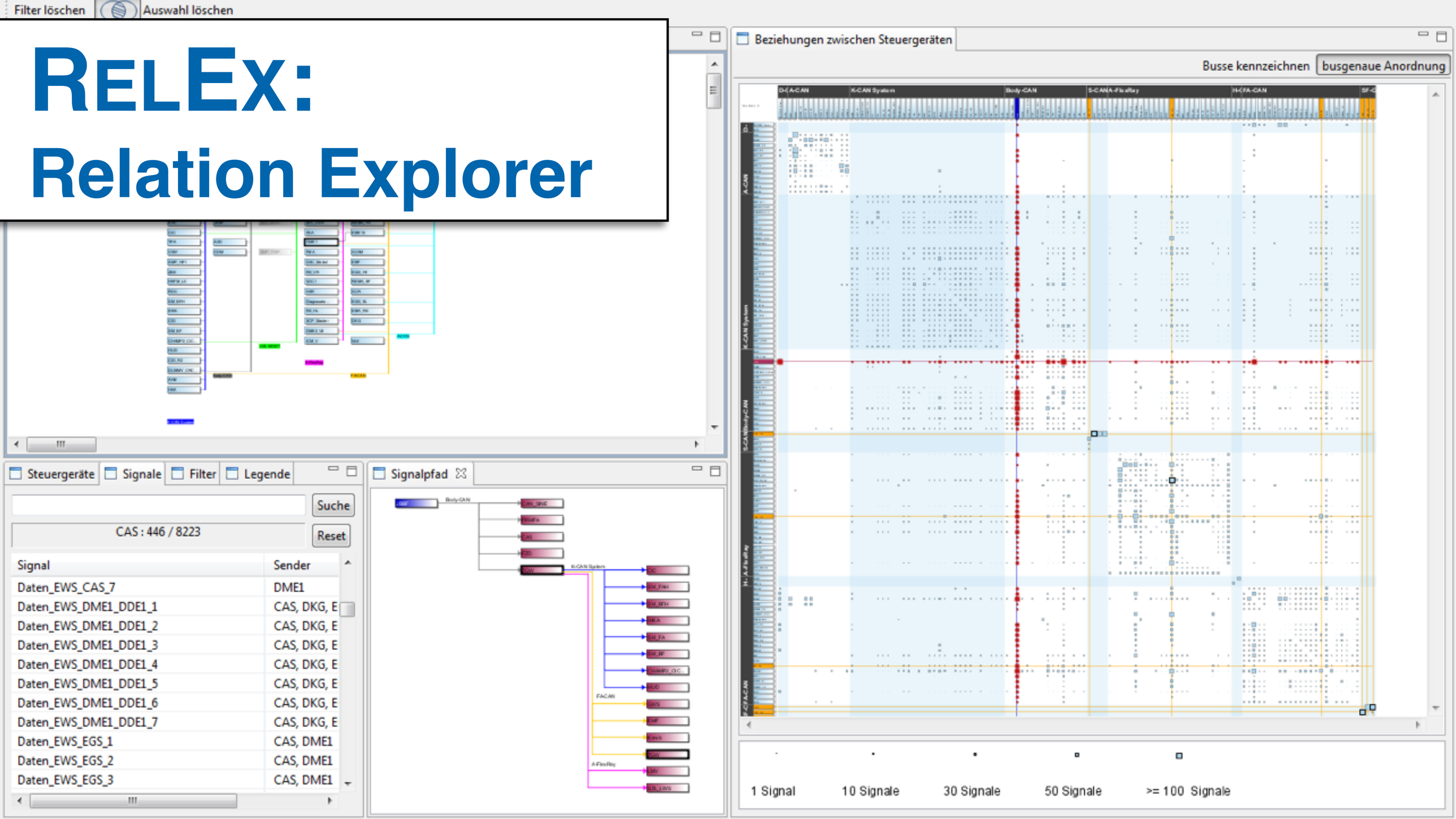




RelEx: Design

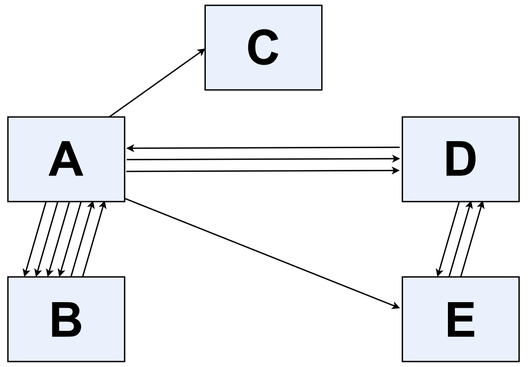


RELEX:
Relation Explorer



RELEX: Logical Overview

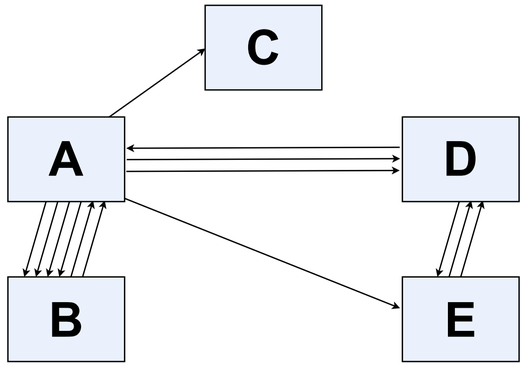
LOGICAL NETWORK



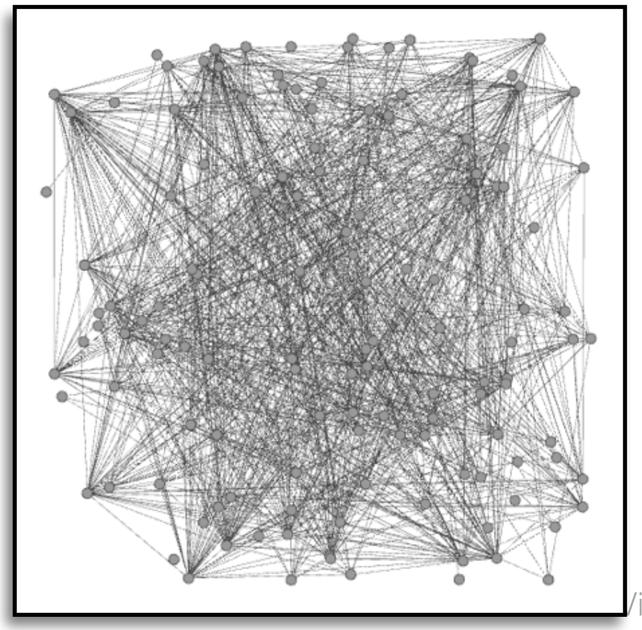
- multigraph
- 100 nodes/10k edges

RELEX: Logical Overview

LOGICAL NETWORK



- multigraph
- 100 nodes/10k edges

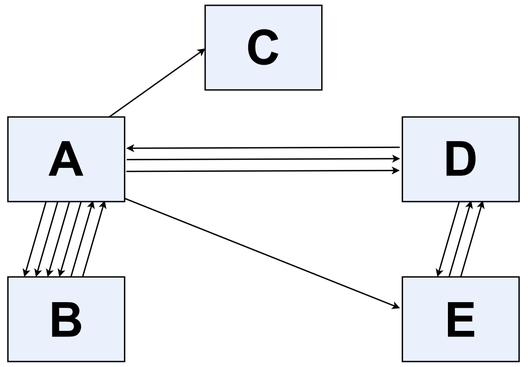


???

RELEX: Logical Overview

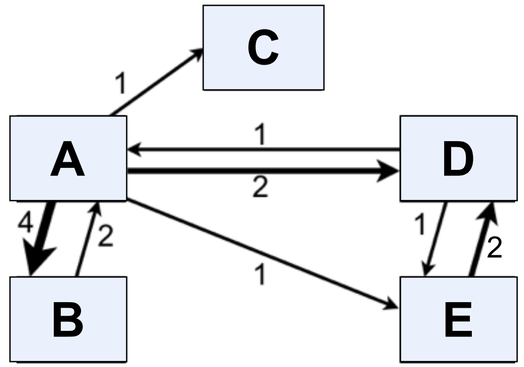
Guideline [Ghoniem 2004]
Matrix for dense graphs

LOGICAL NETWORK



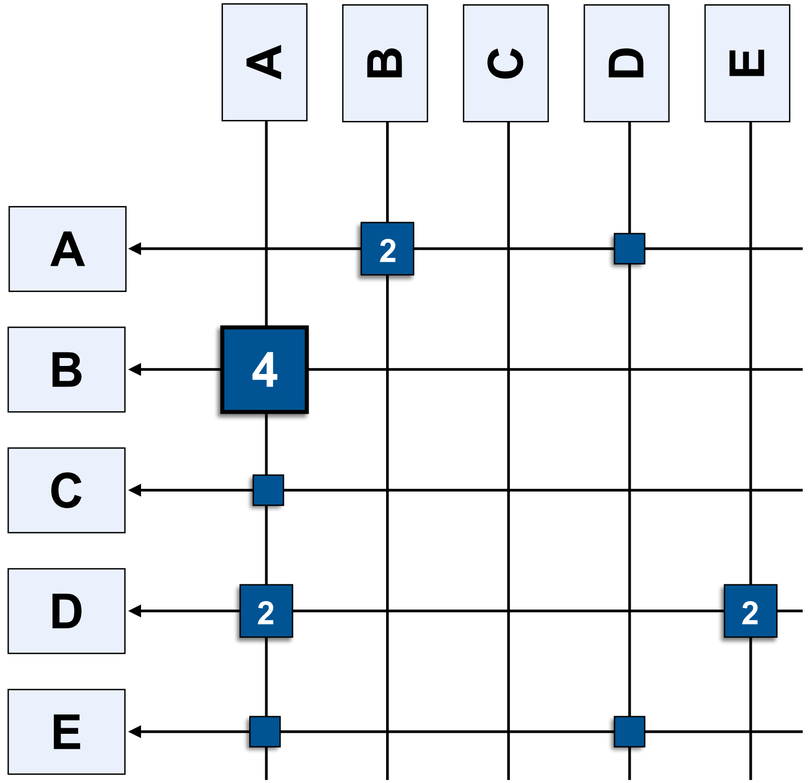
- multigraph
- 100 nodes /10k edges

SIGNAL COUNT NETWORK

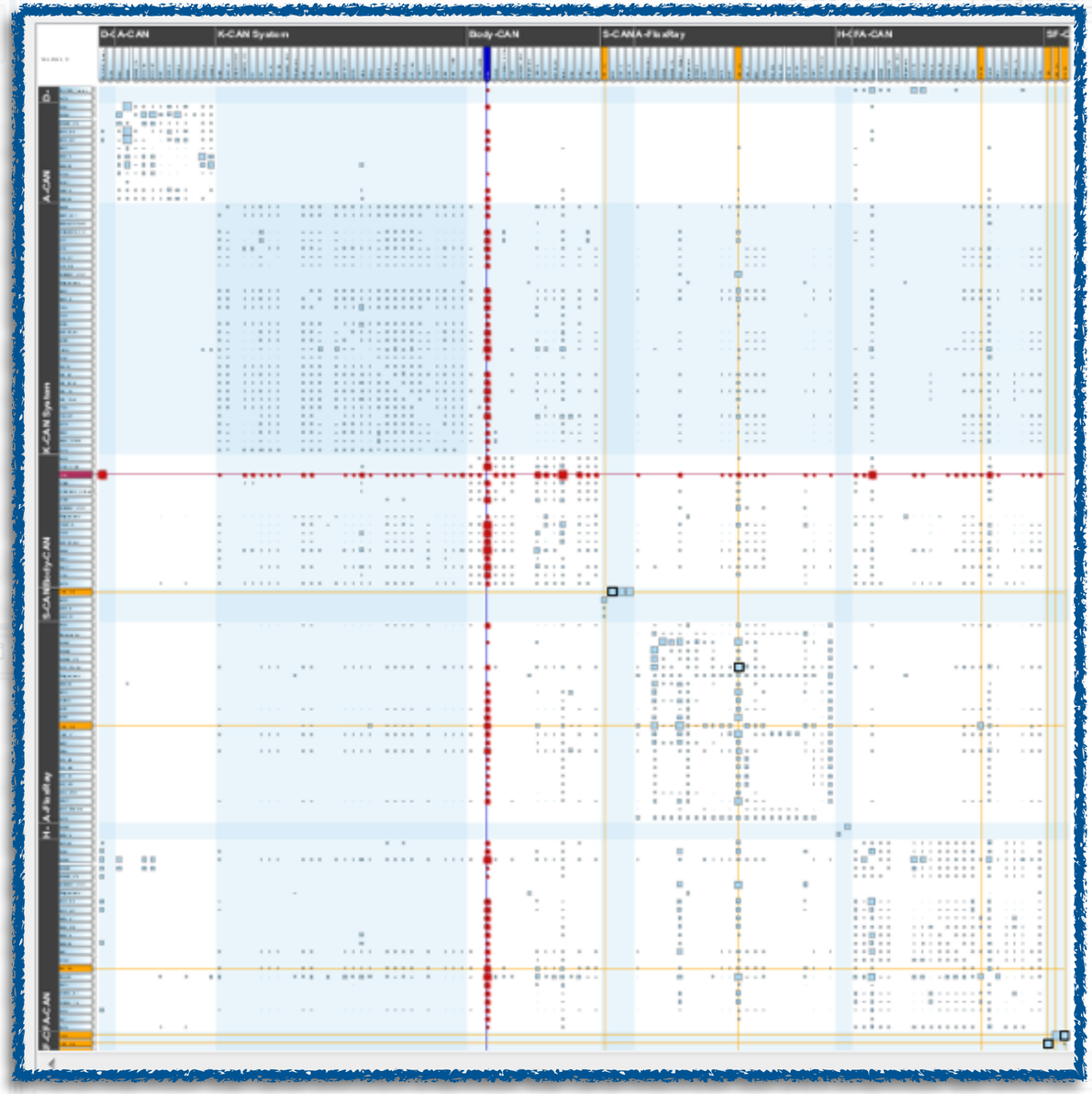


- directed graph
- 1k weighted edges

VISUAL ENCODING: SIZE-CODED MATRIX

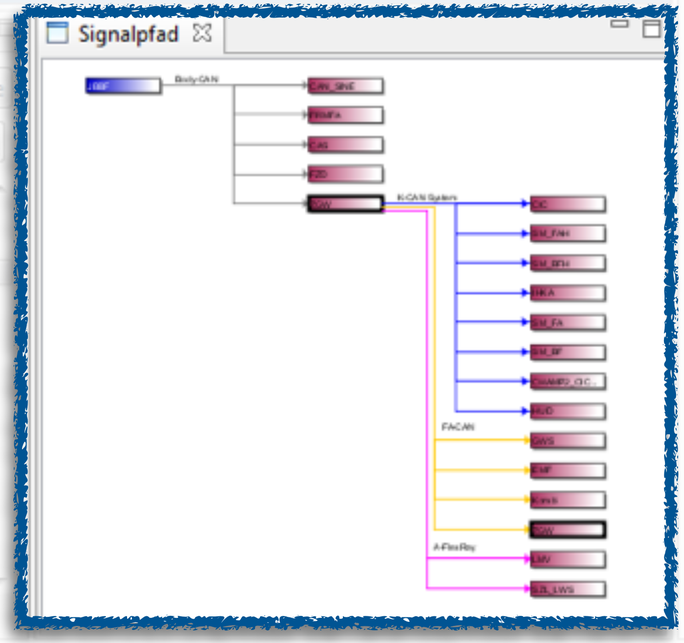


RELEX:
Logical Overview

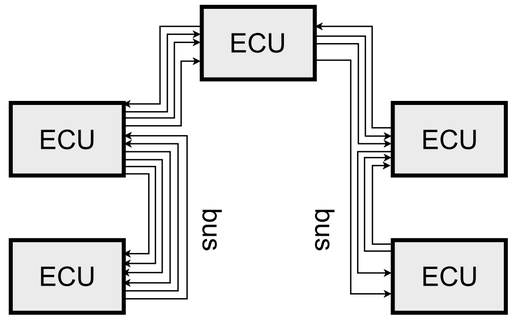


RELEX:
All Paths of a Signal

Guideline [Ghoniem 2004]
Node-link for path following tasks

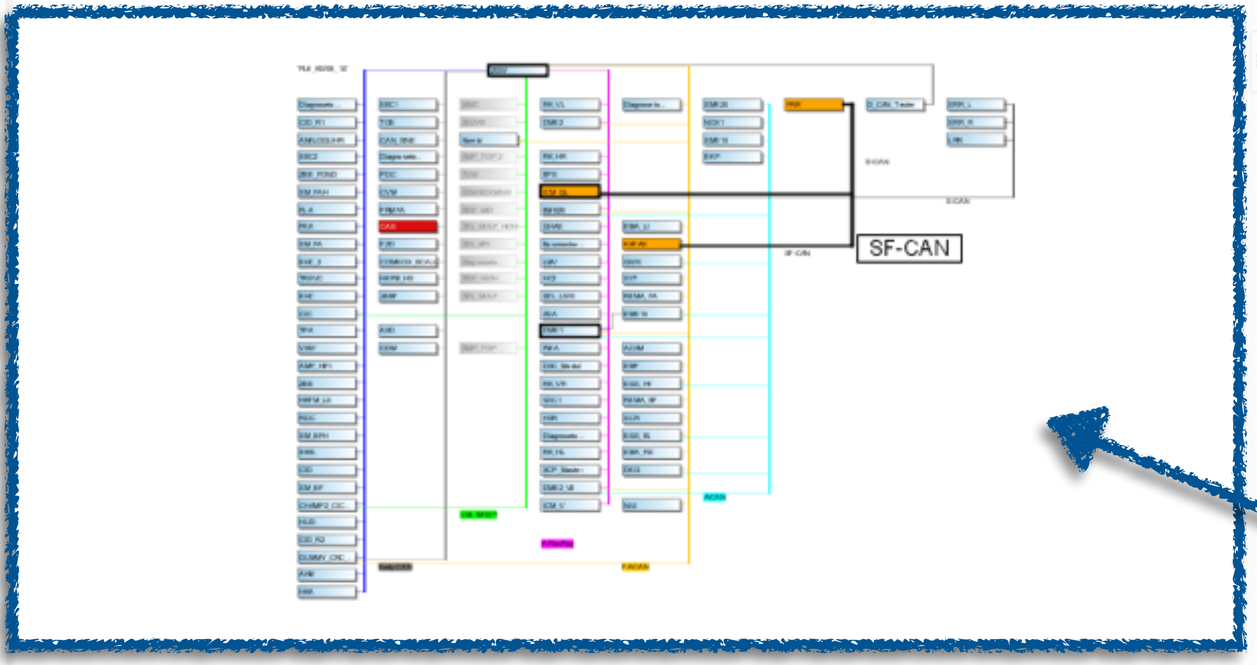


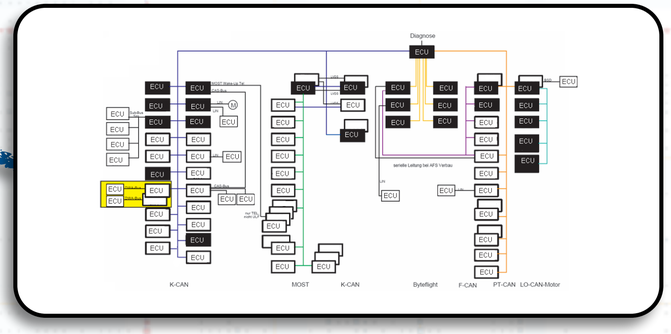
SIGNAL PATH NETWORK

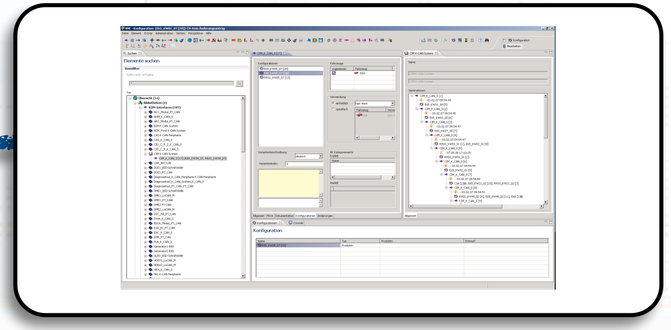


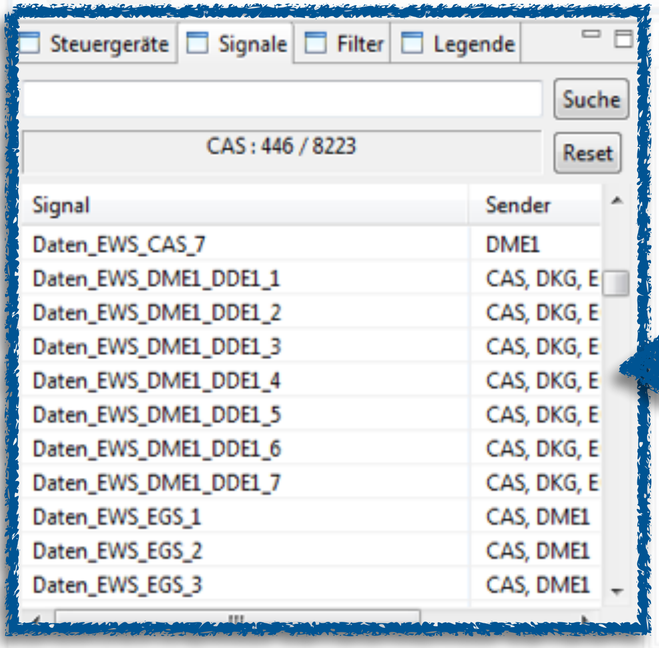
filtered by signal

More Stuff:
Support of Current Practices







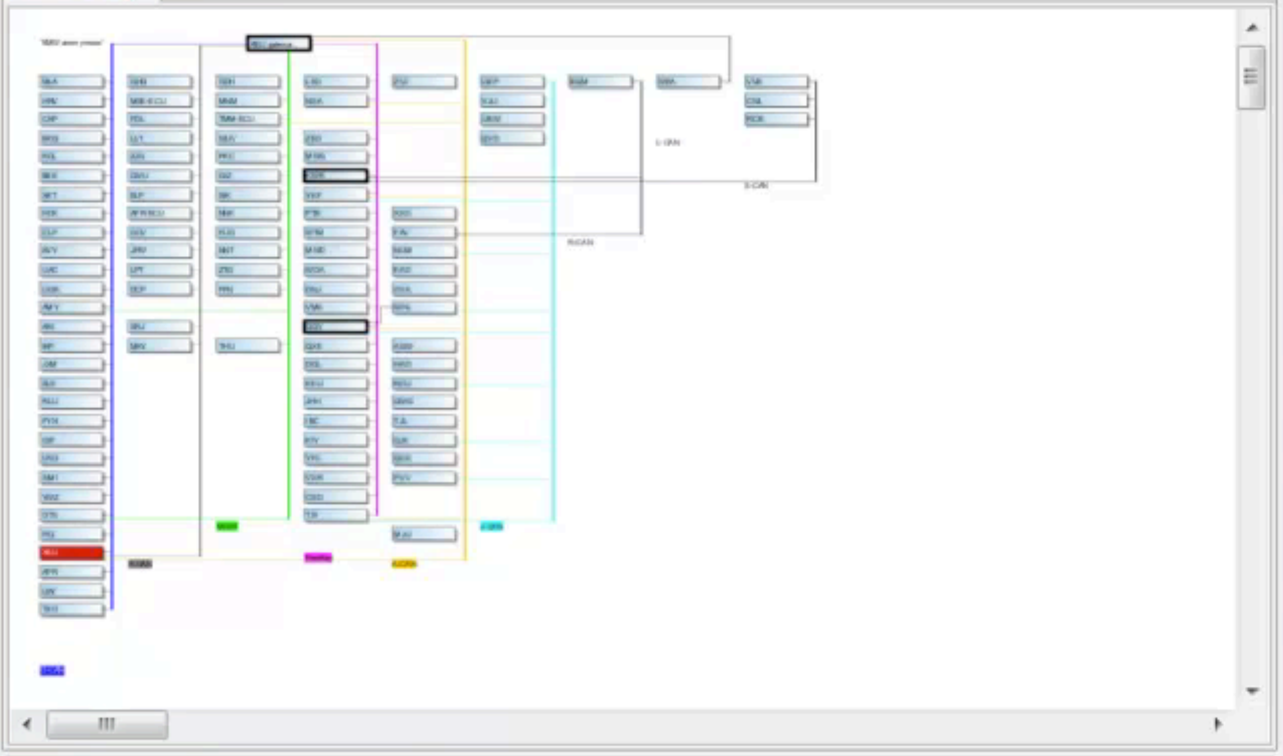


RelEx

RelEx

Filter löschen | Auswahl löschen

Topologie



Steuergeräte | Signale | Filter | Legende

Suche

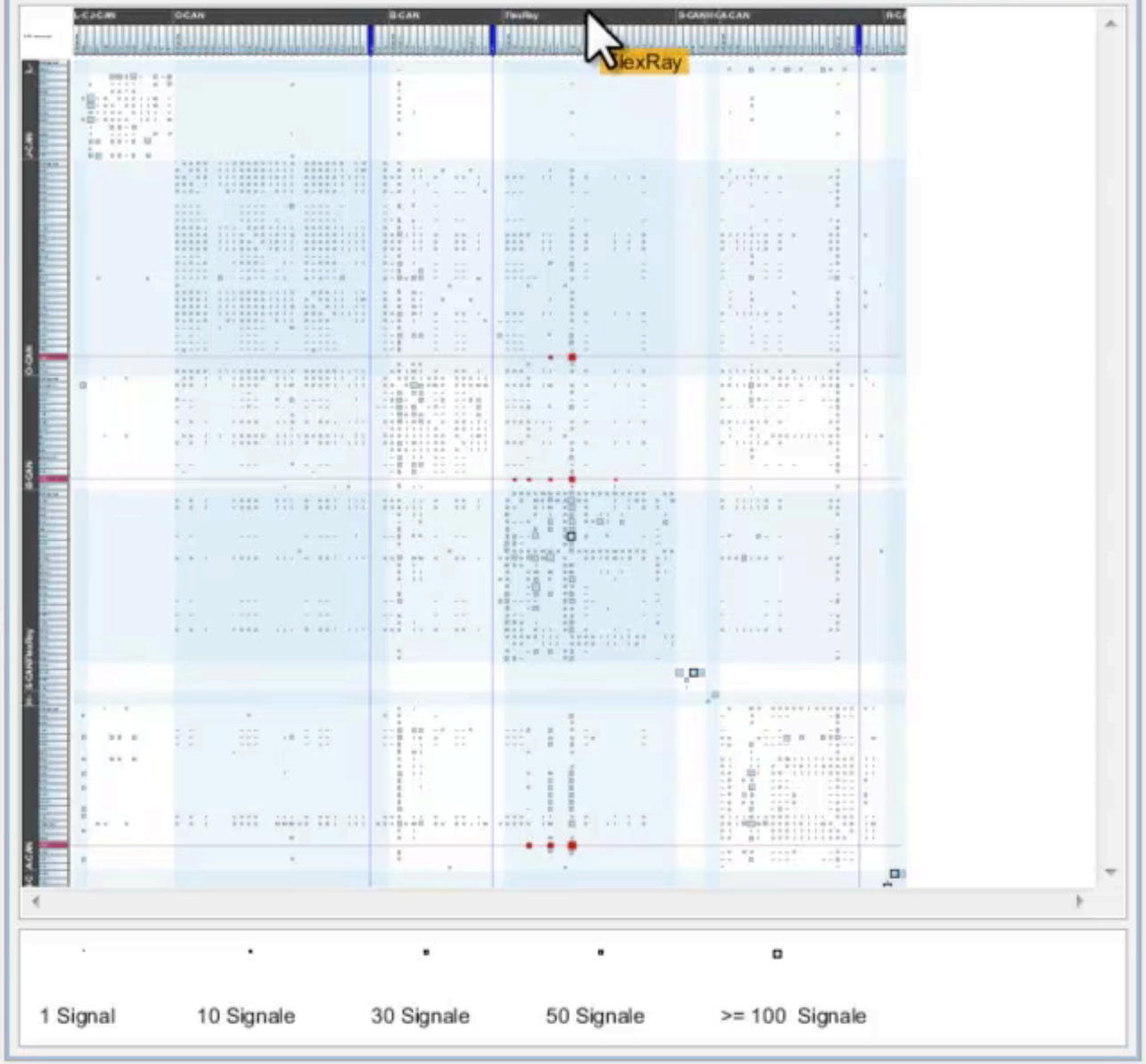
XBU : 158 / 8222

Reset

Signal	Sender	Empfänger
ABHN-Signal	KWR	TMM-ECU, XBU
AONQ-Signal	DNJ	KWR, XBU
APWC-Signal	KWR	XBU
ARNL-Signal	KWR	AGW, CSD, ELP, MSE-ECU, MWD,...
AWKZ-Signal	DNJ	ELP, FAV, KWR, MWQ, PVV, QXE, ...
AXYQ-Signal	KWR	BQM, CSD, IBC, JHH, MSE-ECU, X...

Beziehungen zwischen Steuergeräten

Busse kennzeichnen | busgenaue Anordnung



RelEx: Evaluation

Evaluation

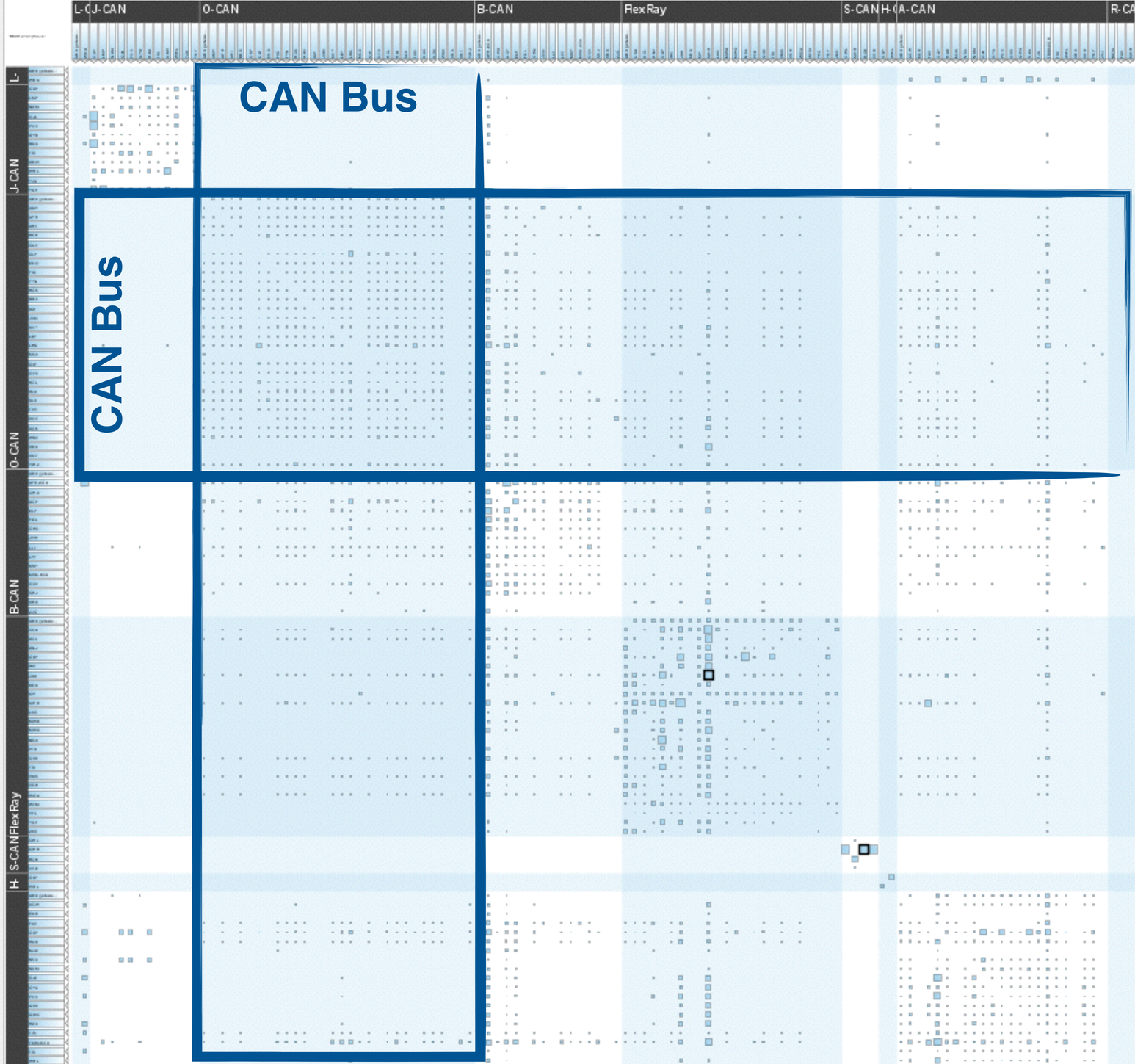
——————— *during design (formative)* ———————

- iterative paper prototyping
- agile design: 6 deployed releases
  - 3 lead users (domain experts)
- usability studies with
  - 4 users: domain experts & HCI students

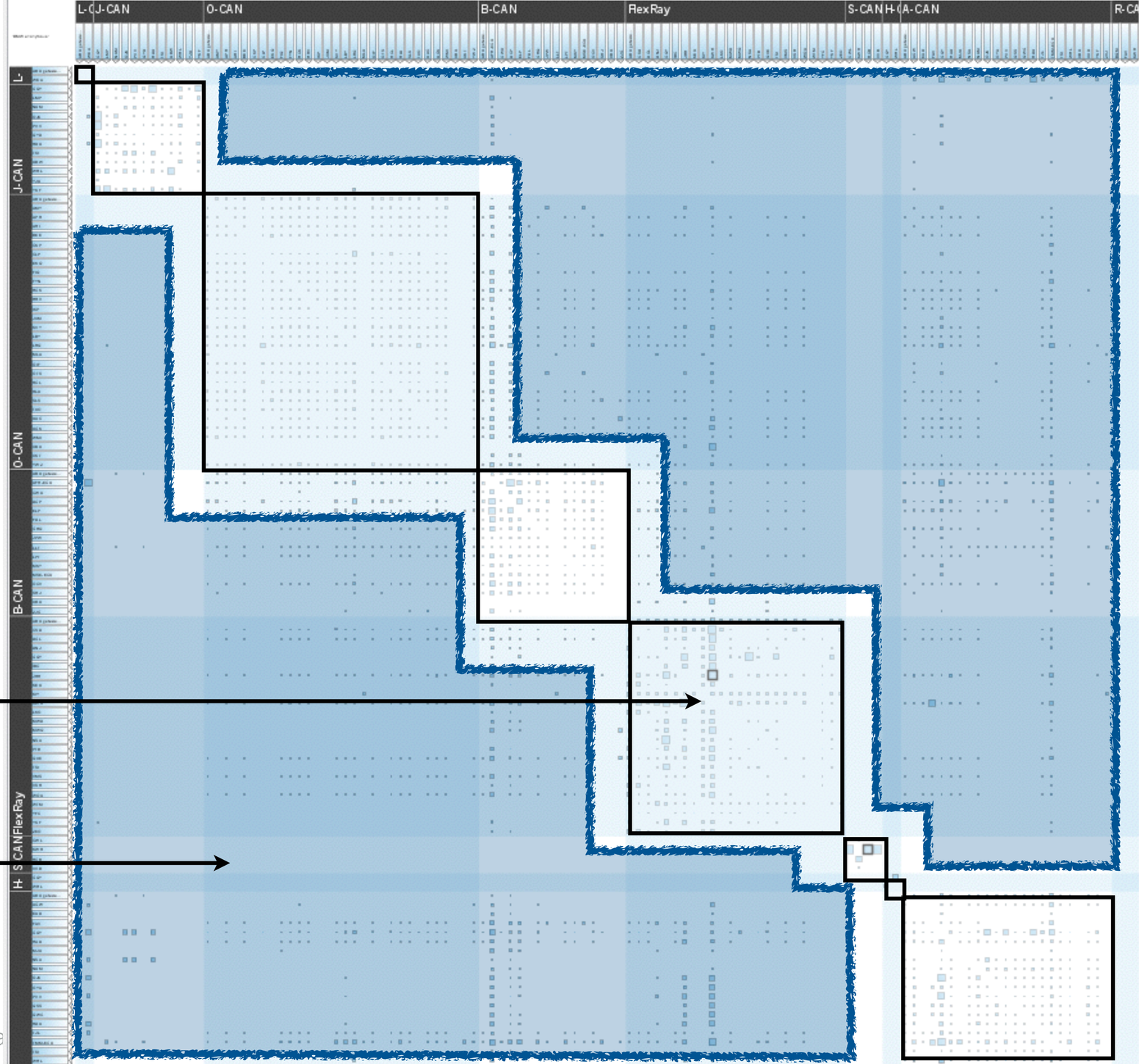
——————— *after design (summative)* ———————

- field study with final release
  - 7 engineers / 5 weeks
- think aloud study
  - 10 engineers / 1h sessions
- 3-month post study - adoption?

Novel insights: Bus communication patterns



Novel insights: Bus communication patterns

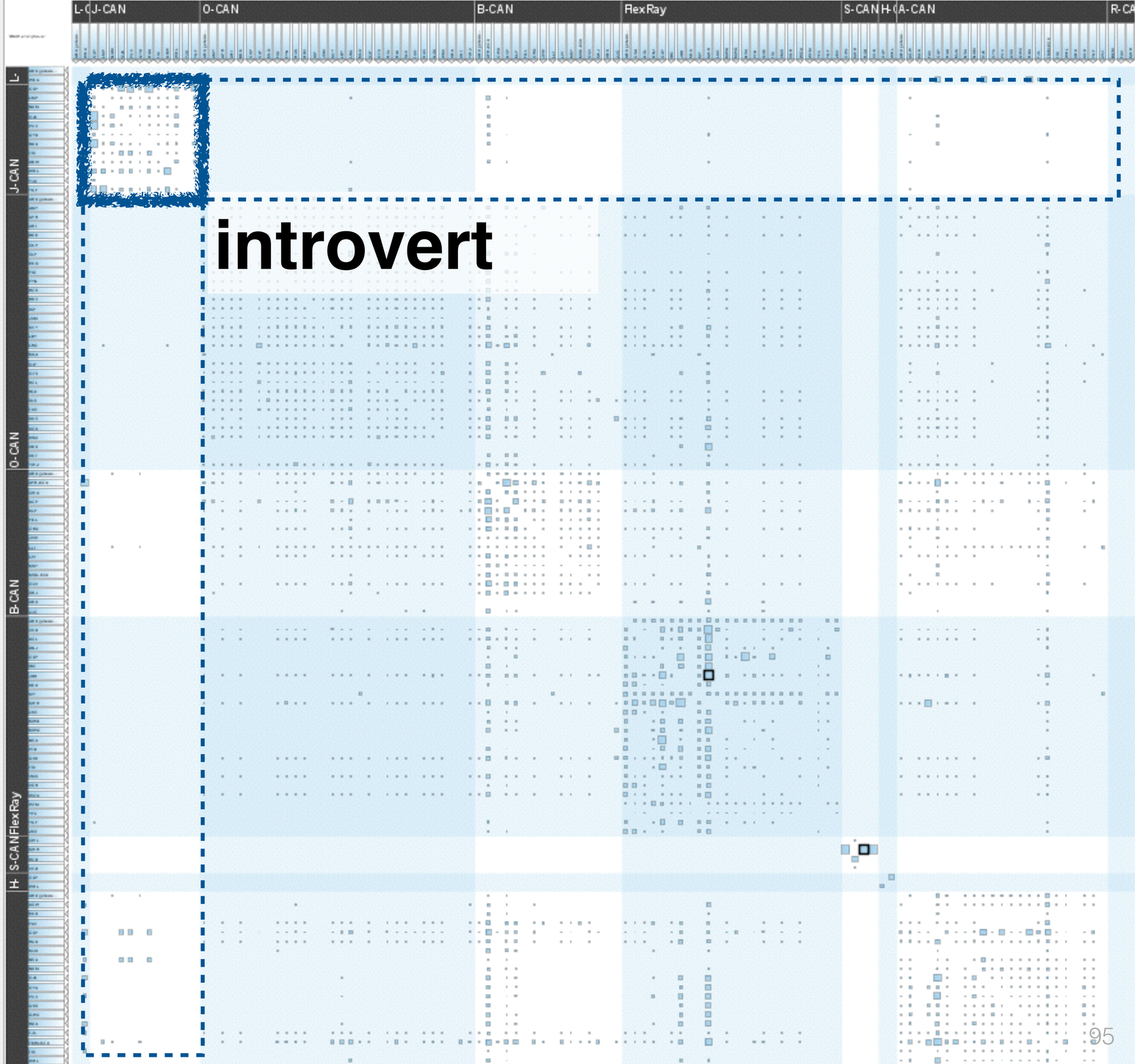


Within-bus

Between-bus

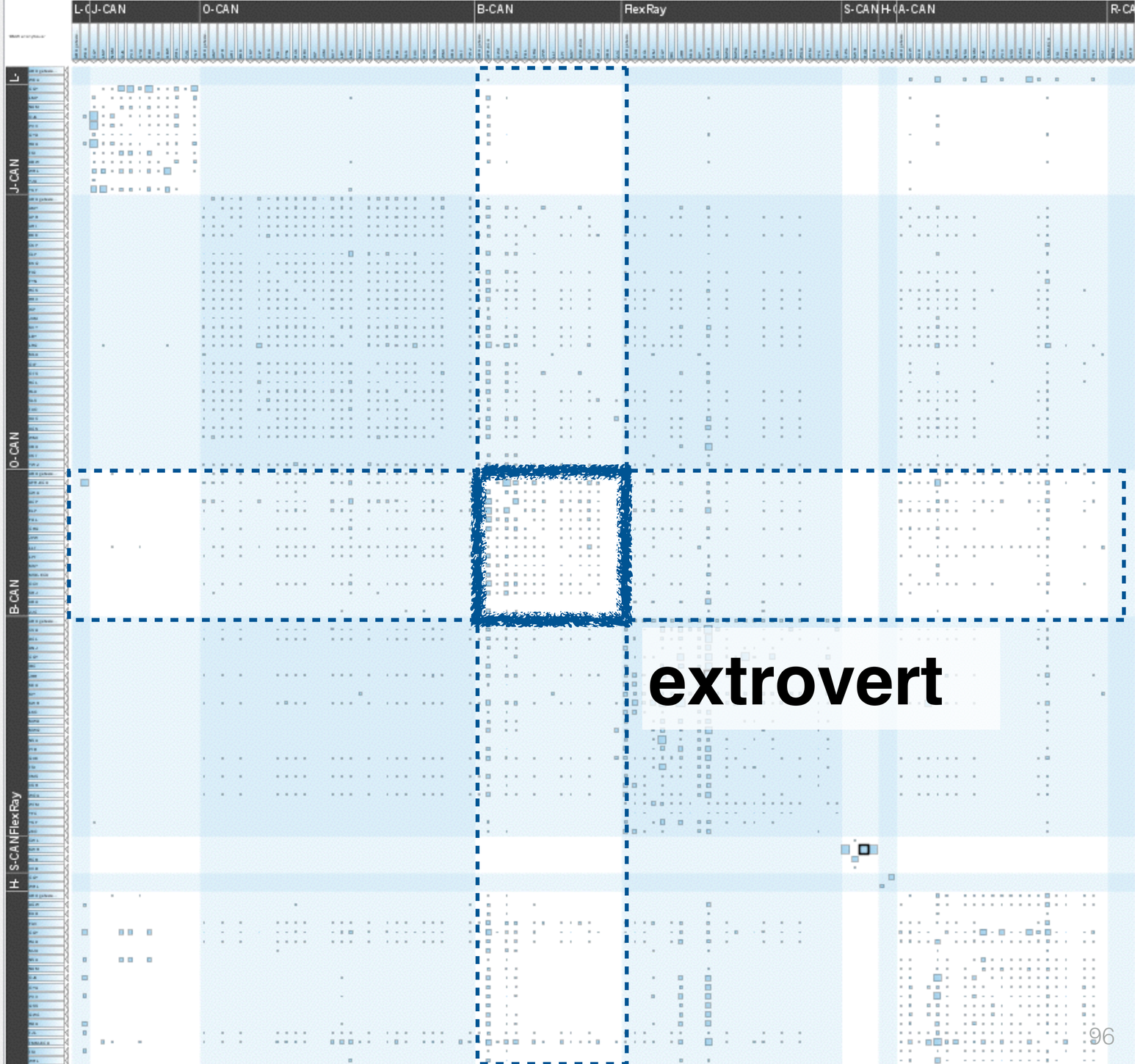
Novel insights: Bus communication patterns

introvert
vs.
extrovert



Novel insights: Bus communication patterns

introvert
vs.
extrovert



Speedup

“RelEx gives me a more compact, way faster access to the information I need”

BMW engineer
(translated from German).

Adoption

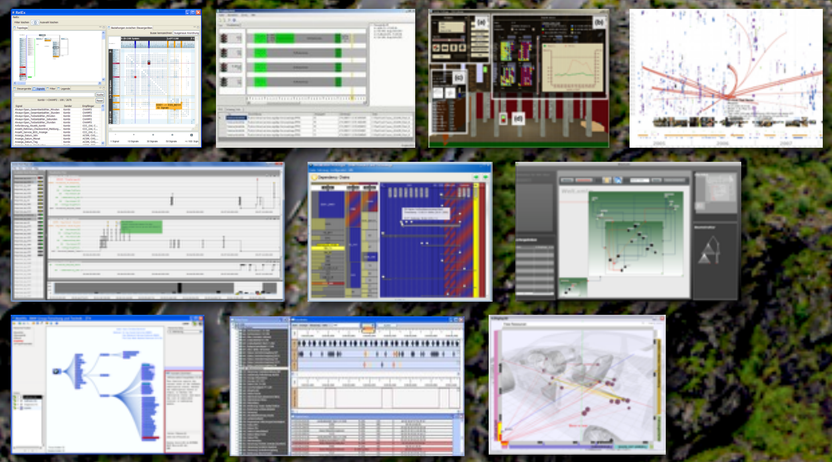
- 3-month post study
- 15+ engineers

Outline

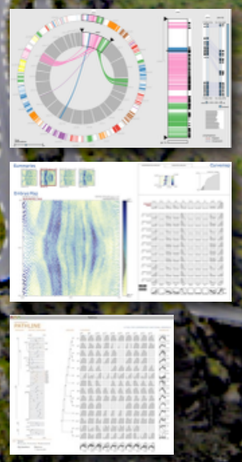
1. Technique-driven research
   - Trends in graph drawing
   - Trends in visualization — Related to graph drawing
2. Problem-driven research
   - Design Study Example — RelEx
   - Design Study Methodology
3. Summary

design studies:
long and winding road with many pitfalls!

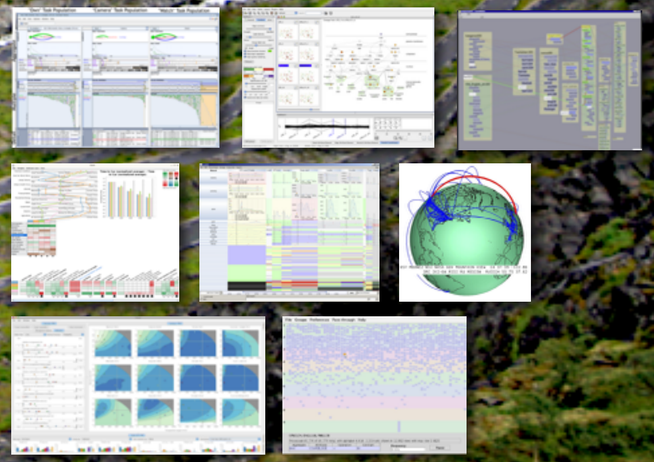
et al.



et al.

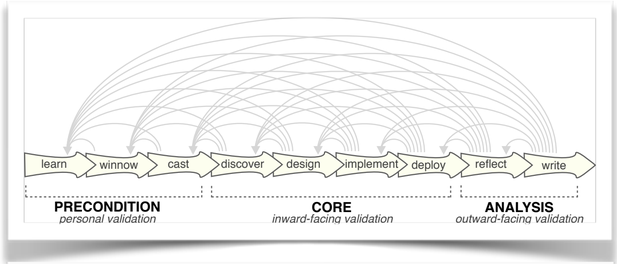


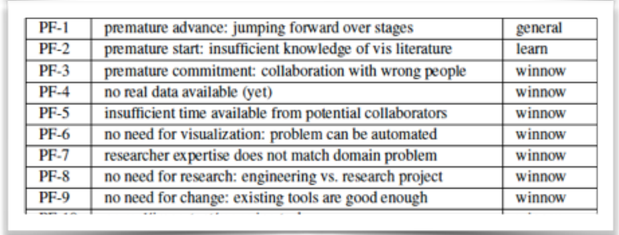
et al.



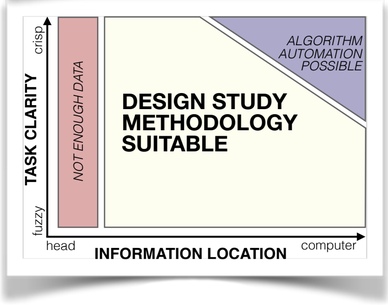
How to do design studies?

- 9-stage framework
- 32 pitfalls
- Why design studies



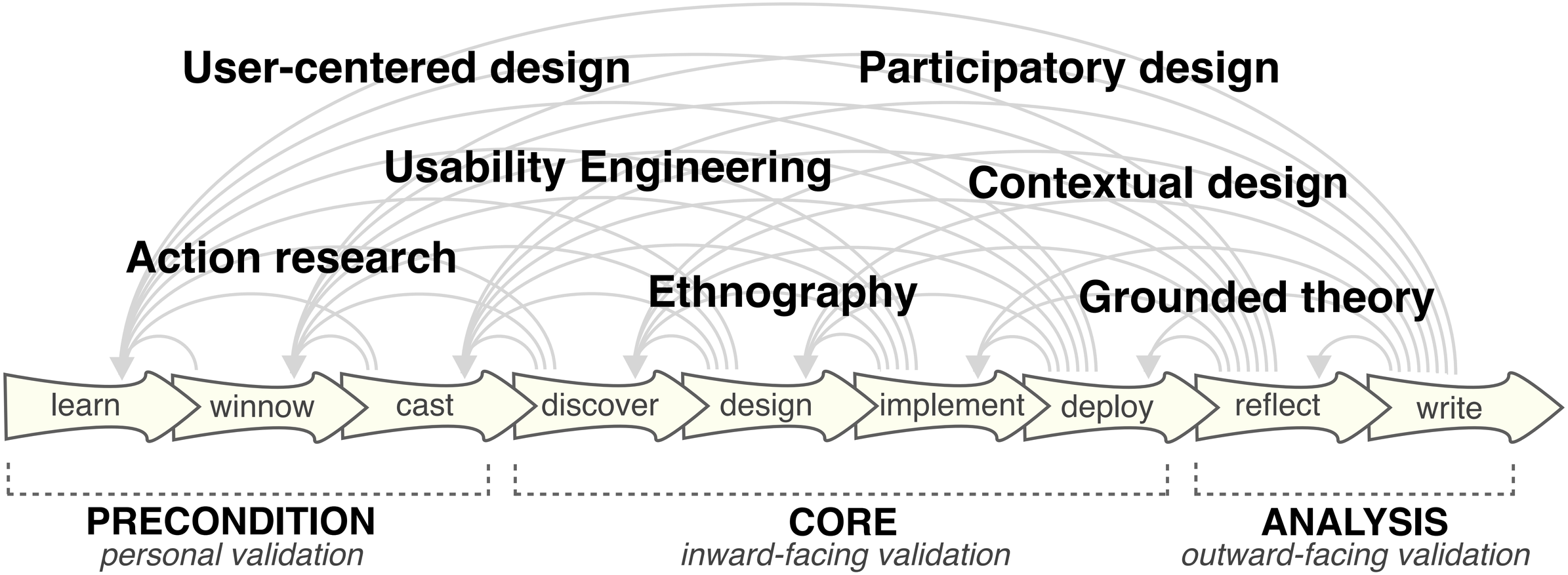


PF-1	premature advance: jumping forward over stages	general
PF-2	premature start: insufficient knowledge of vis literature	learn
PF-3	premature commitment: collaboration with wrong people	winnow
PF-4	no real data available (yet)	winnow
PF-5	insufficient time available from potential collaborators	winnow
PF-6	no need for visualization: problem can be automated	winnow
PF-7	researcher expertise does not match domain problem	winnow
PF-8	no need for research: engineering vs. research project	winnow
PF-9	no need for change: existing tools are good enough	winnow



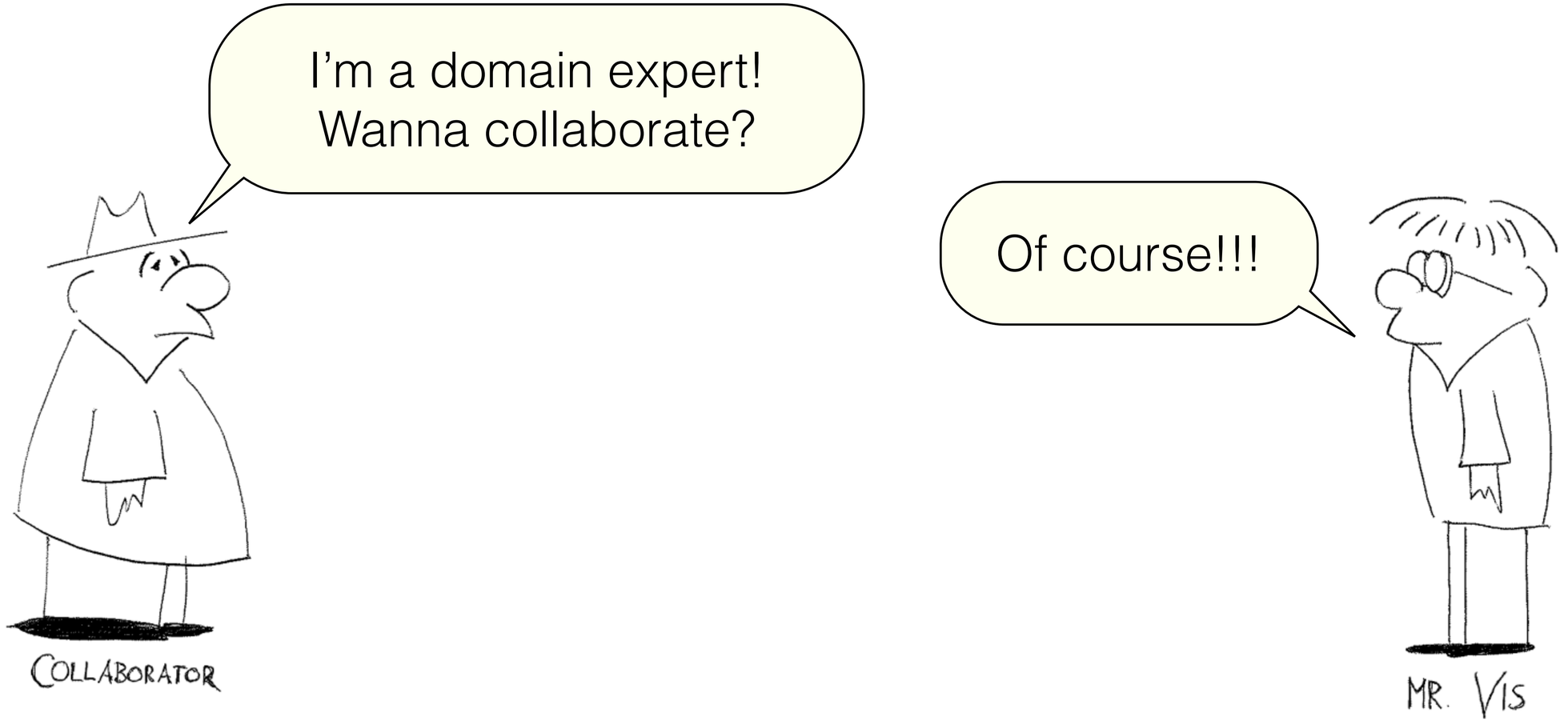
Michael Sedlmair, Miriah Meyer, Tamara Munzner.
Design Study Methodology: Reflections from the Trenches and the Stacks .
IEEE TVCG (Proc. InfoVis), 2012.

9-stage framework



32 pitfalls:

Example pitfall — premature collaboration



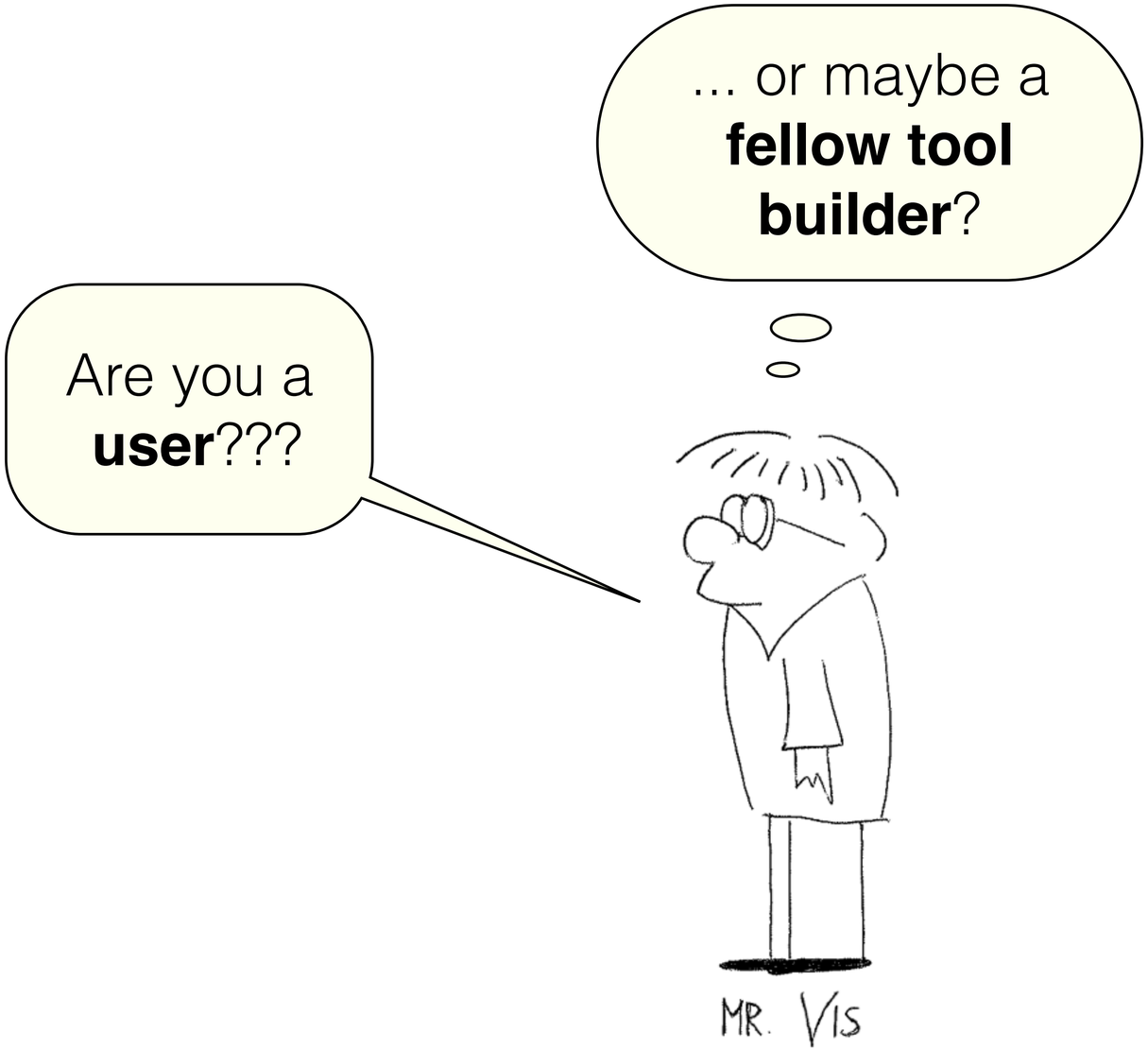
Considerations!

Have **data**?
Have **time**?
Have **need**?
...

Interesting **problem**?
...

Roles!


COLLABORATOR

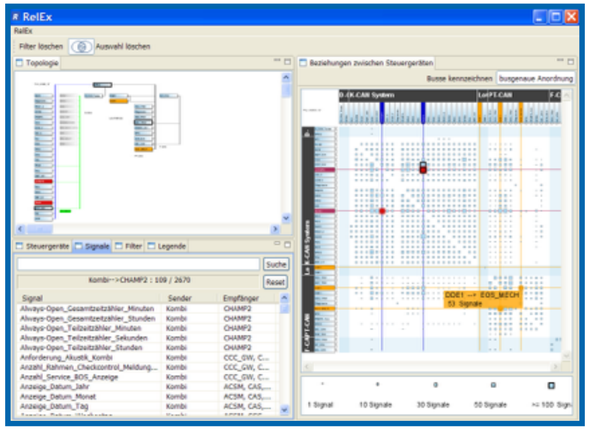

... or maybe a **fellow tool builder**?
Are you a **user**???
MR. VIS

32 pitfalls:
Example pitfall — no reflection

Reflection is where research emerges from engineering

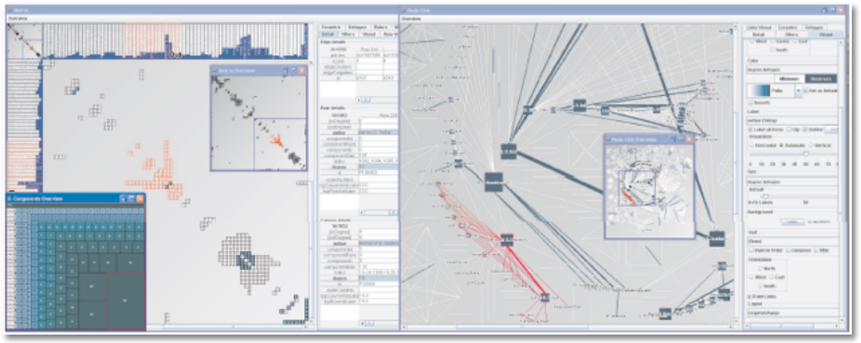
Transferability: relate to other design studies

RelEx: Reflection

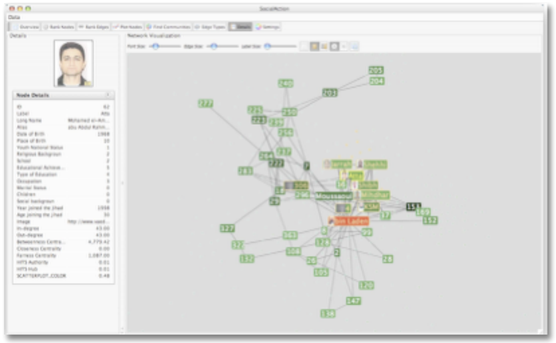


Previous work:
Focus on social network analysis

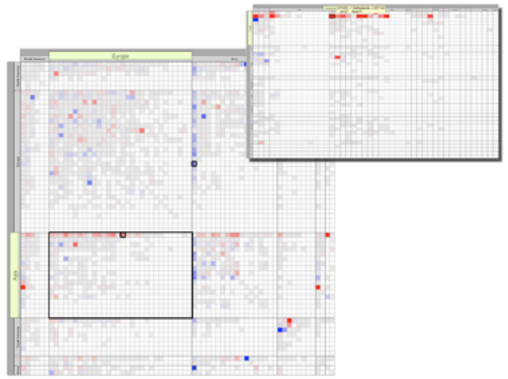
- radically different task and data abstractions



MatrixExplorer



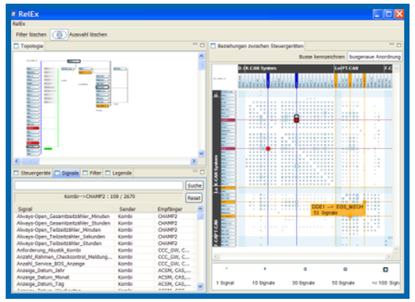
SocialAction



Honeycomb

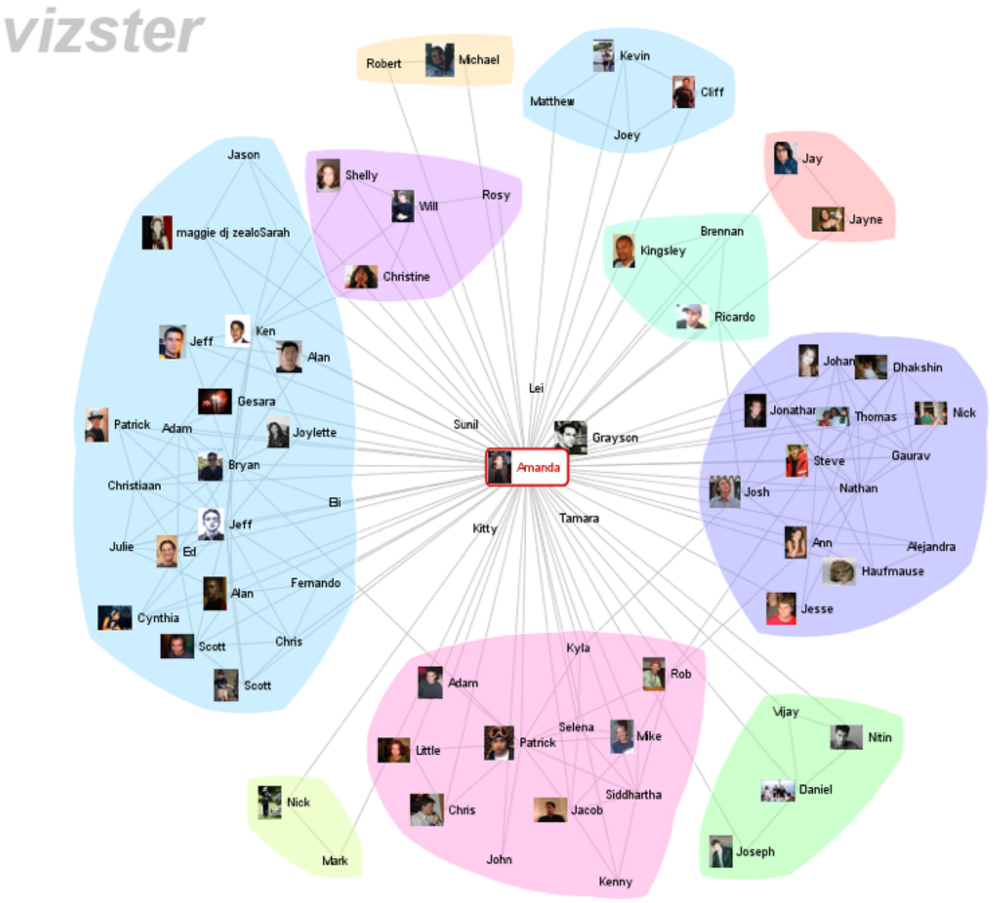
vizster

Previous work:
Social network analysis



Task abstraction:

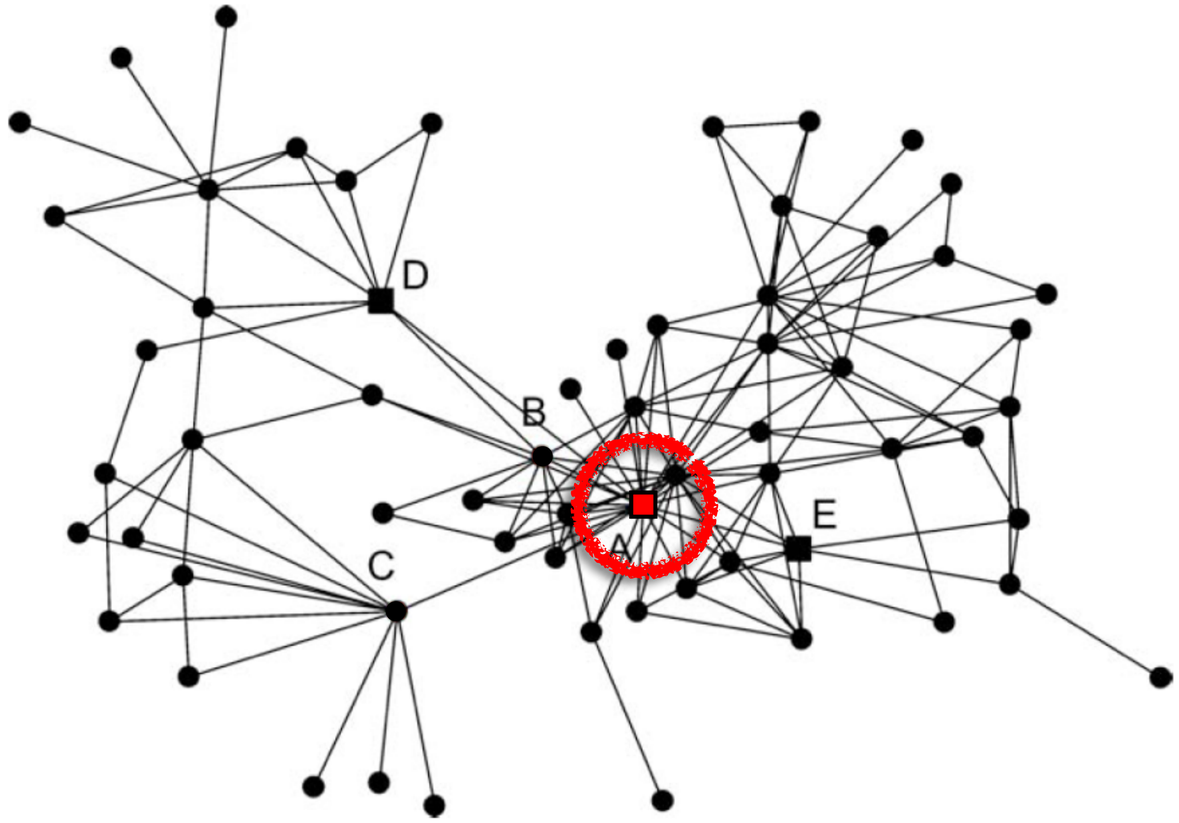
- find clusters



Previous work:
Social network analysis

Task abstraction:

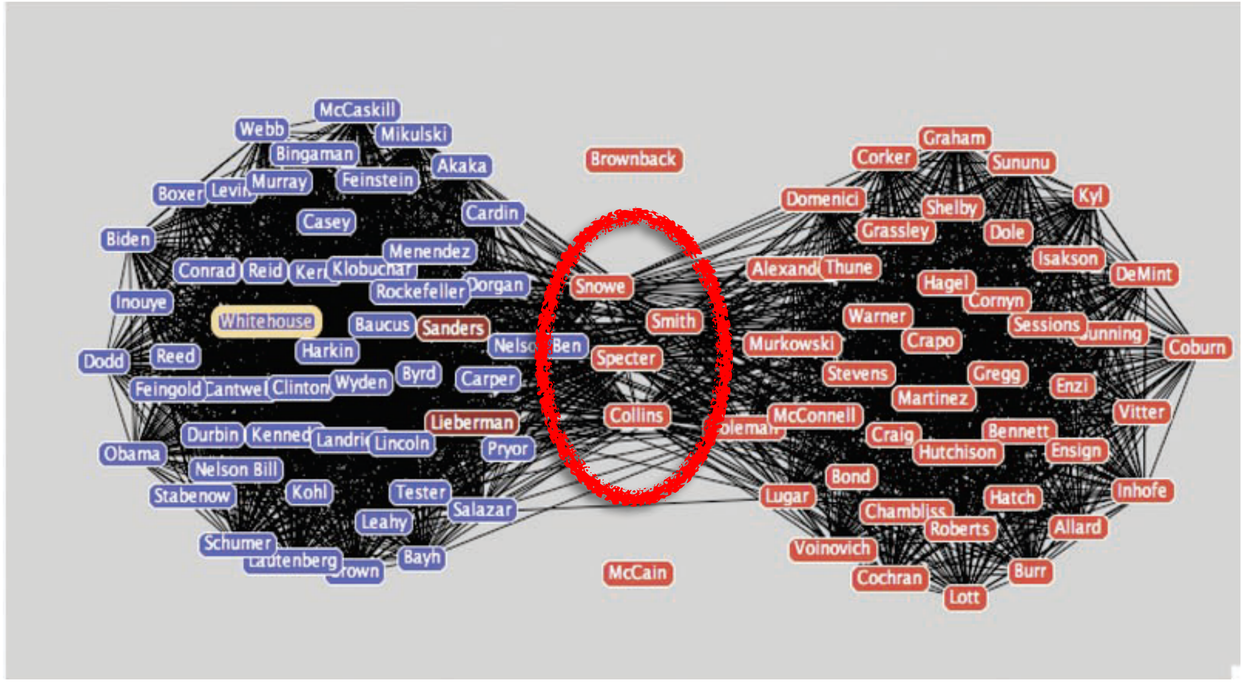
- find clusters
- find high-degree nodes



Previous work:
Social network analysis

Task abstraction:

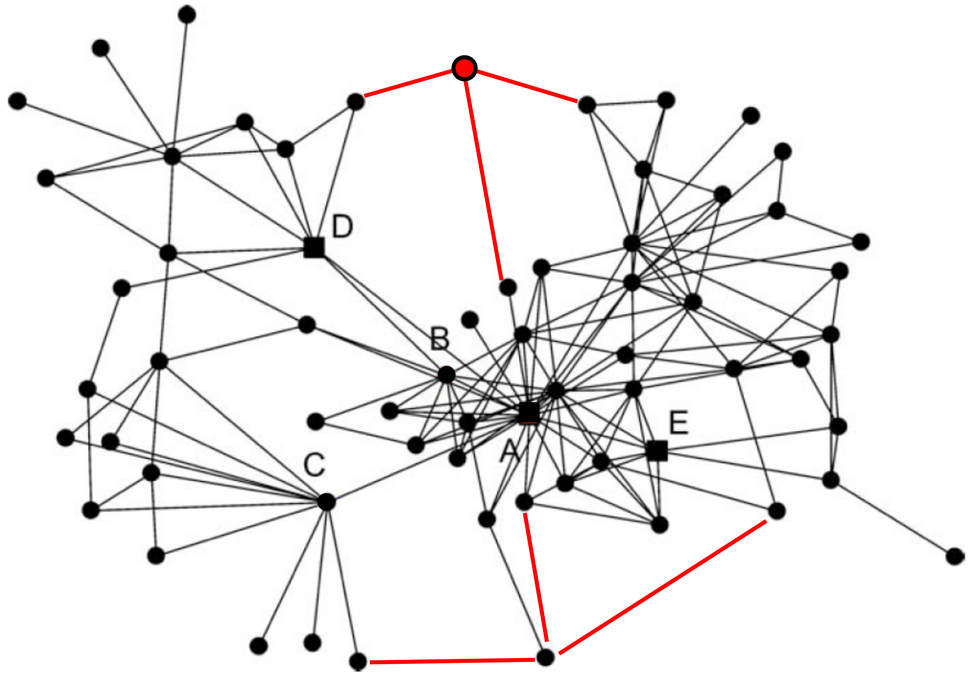
- find clusters
- find high-degree nodes
- find bridging nodes



Previous work:
Social network analysis

Task abstraction:

- find clusters
- find high-degree nodes
- find bridging nodes
- understand temporal dynamics
  - passively notice changes



Abstraction Innovation

Social network analysis

Tasks

- find clusters, high-degree/bridge nodes
- passive changes 

Data

- single network

- node scalability
  - sparse edges

Overlay network optimization

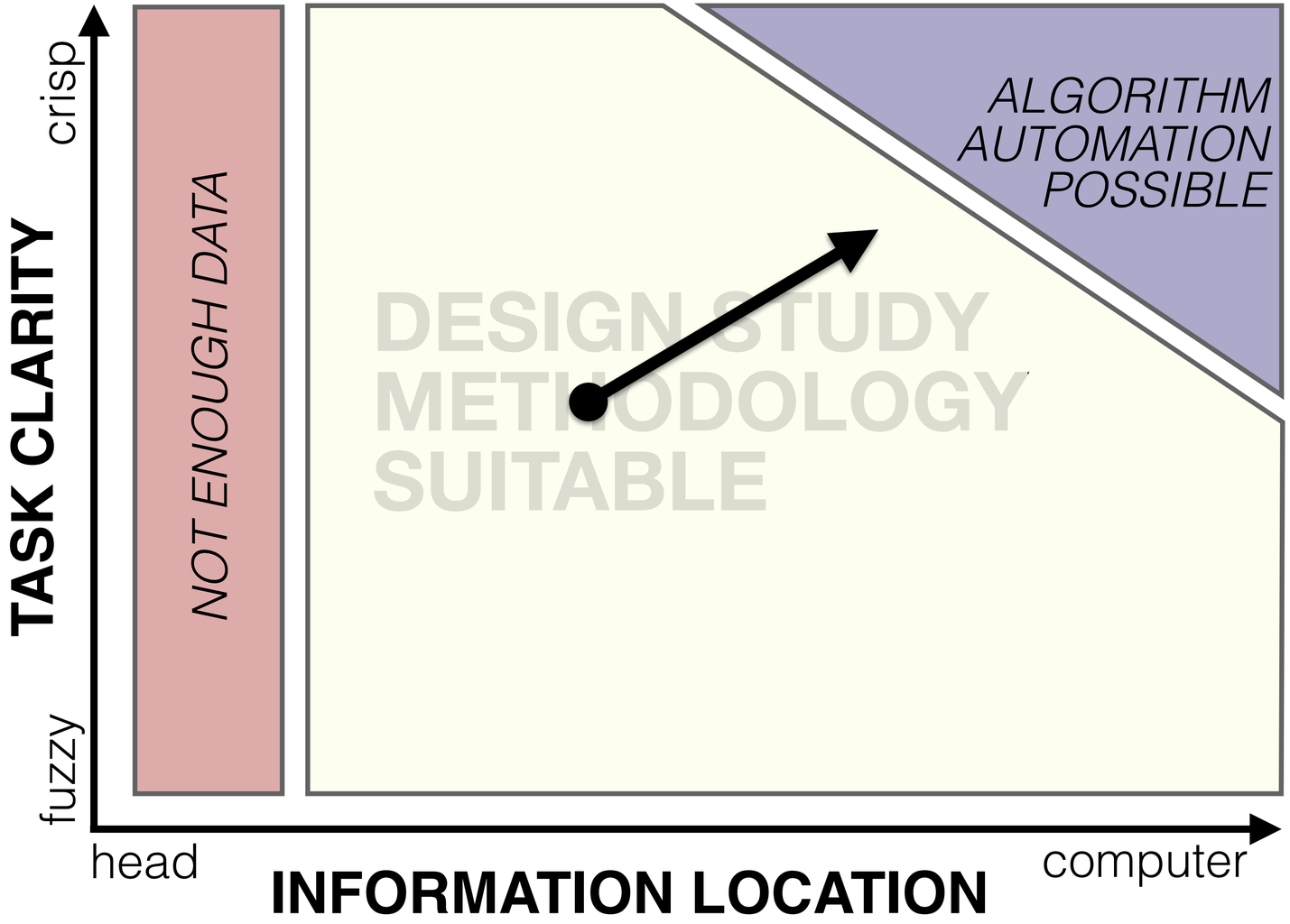
Tasks

- traffic optimization
- active changes 

Data

- three related networks
  - physical, logical, overlay
- path scalability
  - dense edges, few nodes

Why do design studies?

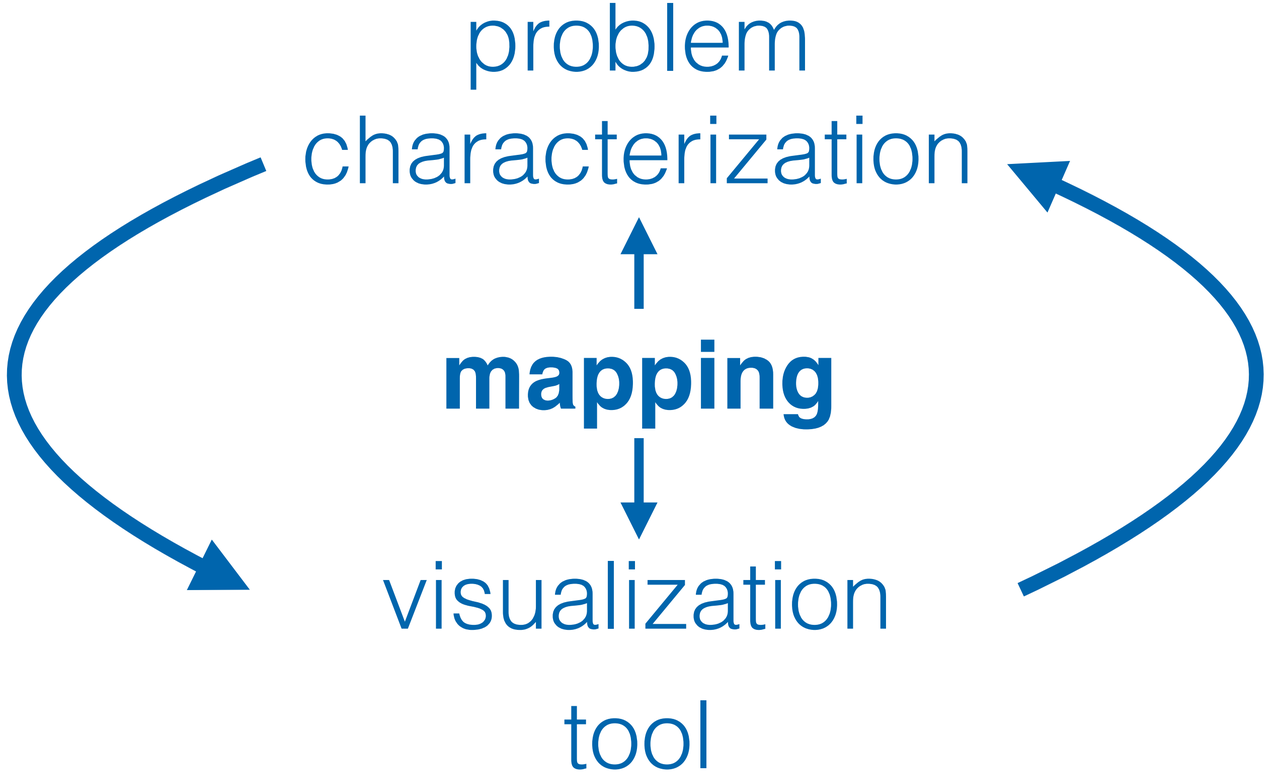


problem characterization

&

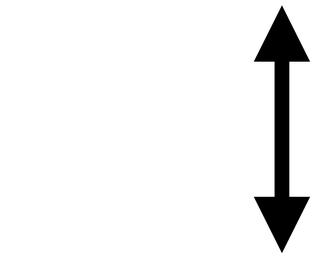
visualization tool

Why not just ask a social scientist?



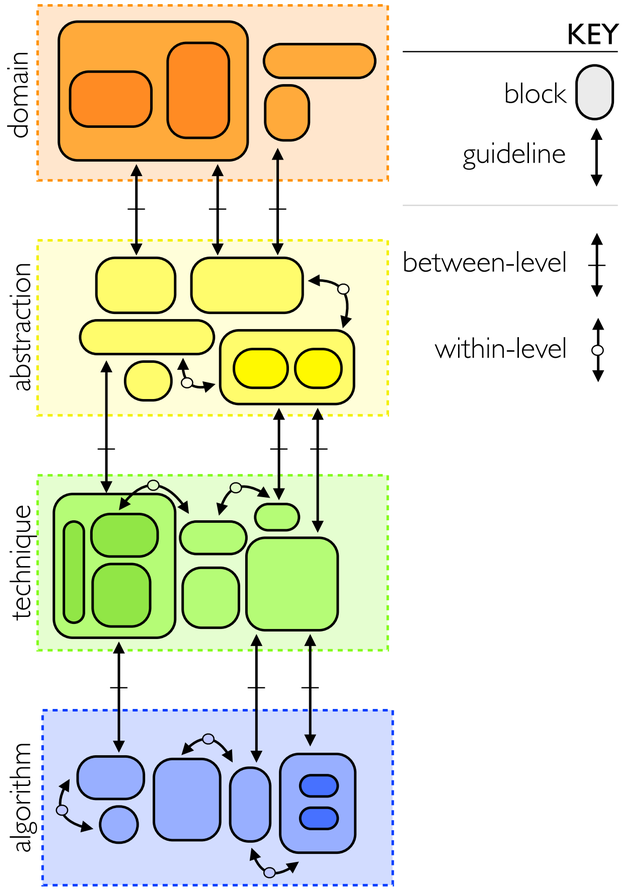
Challenge: “Visualization Cookbook”

abstract data & task



data analysis technique

Challenge: “Visualization Cookbook”



- Understand problems (user/task/data)
  - abstraction
  - taxonomies & theories
- Mapping
  - problems to techniques
  - combine visual & computational

Meyer, Sedlmair, Quinan, Munzner.
The Nested Blocks and Guidelines Model.
Information Visualization, 14(3): 234-249, 2015.

Challenge: “Visualization Cookbook”

vast amounts of research on human-centered data science necessary, e.g. design studies.

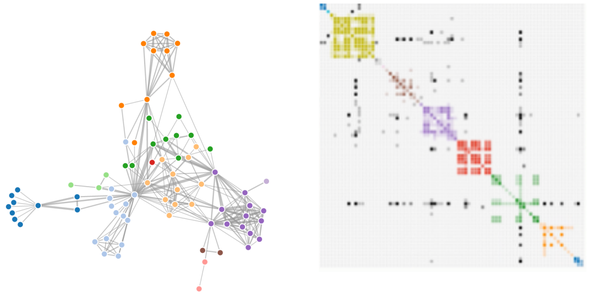
Sir Francis Bacon 1561-1626

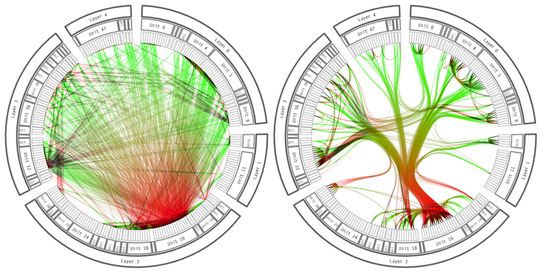
Outline

1. Technique-driven research
   - Trends in graph drawing
   - Trends in visualization — Related to graph drawing
2. Problem-driven research
   - Design Study Example — RelEx
   - Design Study Methodology
3. Summary

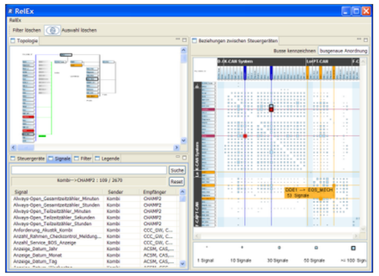
Summary

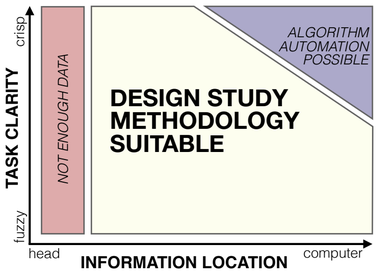
- Drawing networks
  - Challenge: Scaling up
  - Challenge: Graphs in Context



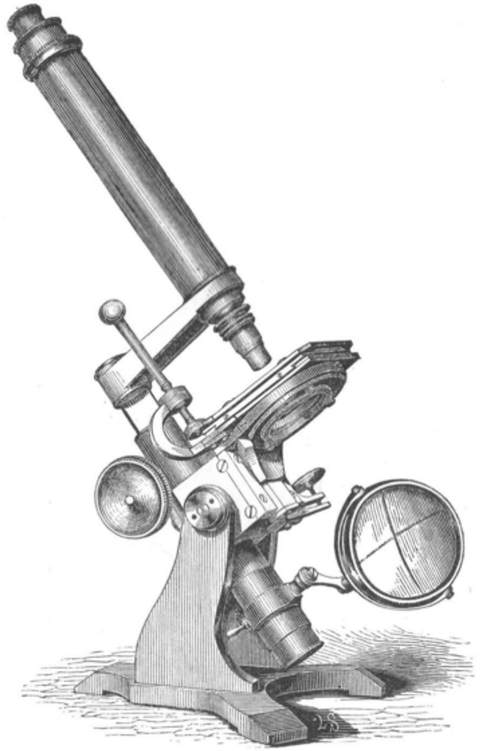


- Problems, Tasks, Users
  - Challenge: Understand problems
  - Challenge: Mapping to solutions





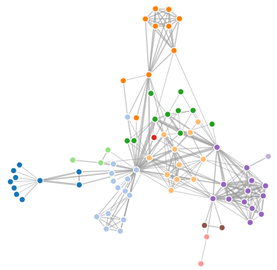
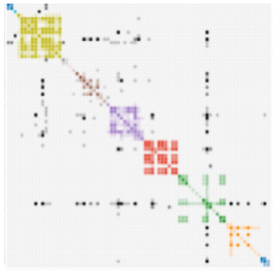
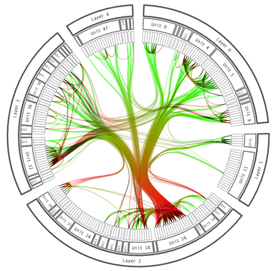
Visualization: The Human Lens to Networks/Data

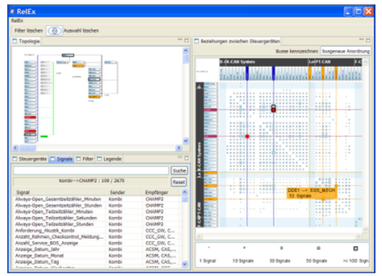
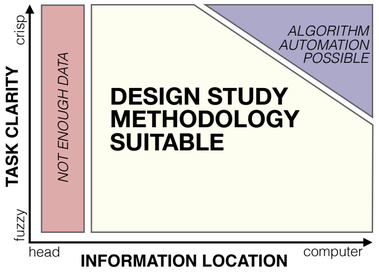


http://www.microscope-antiques.com/grunow.html

http://galileo.rice.edu/sci/instruments/telescope.html

Thank you!

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