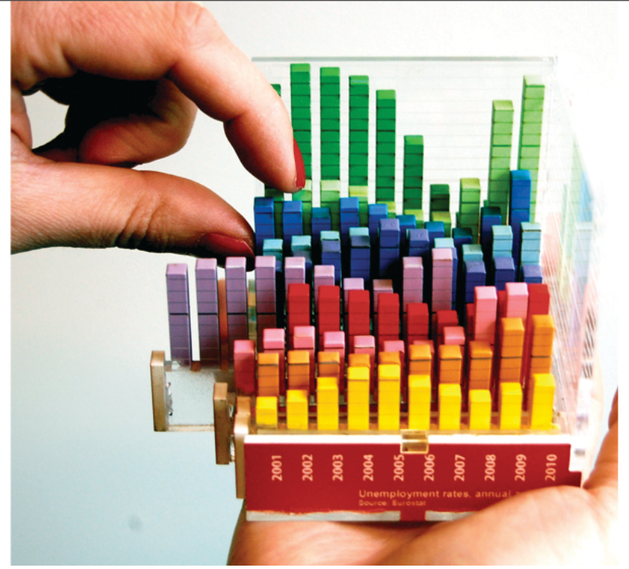
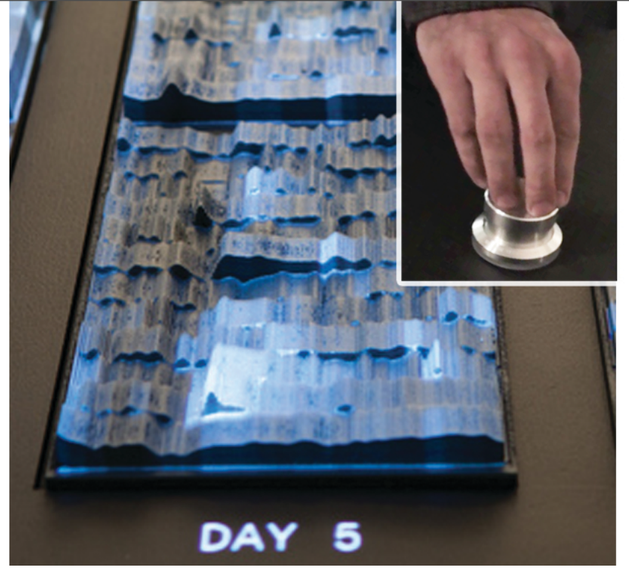
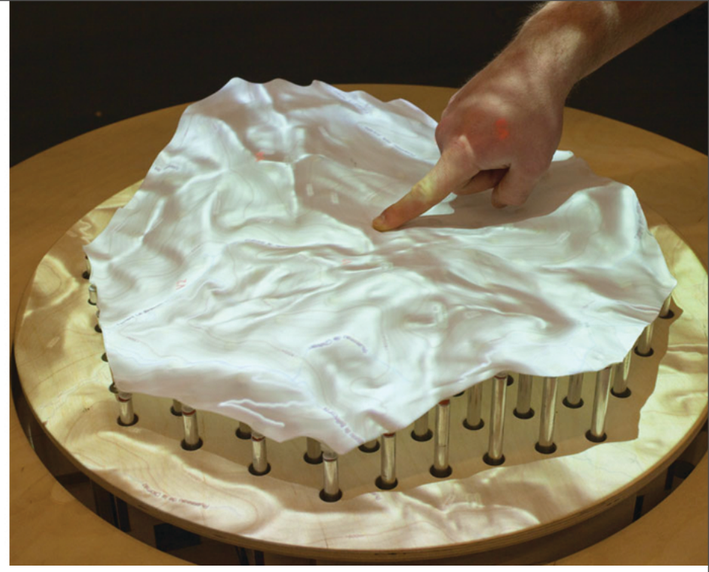
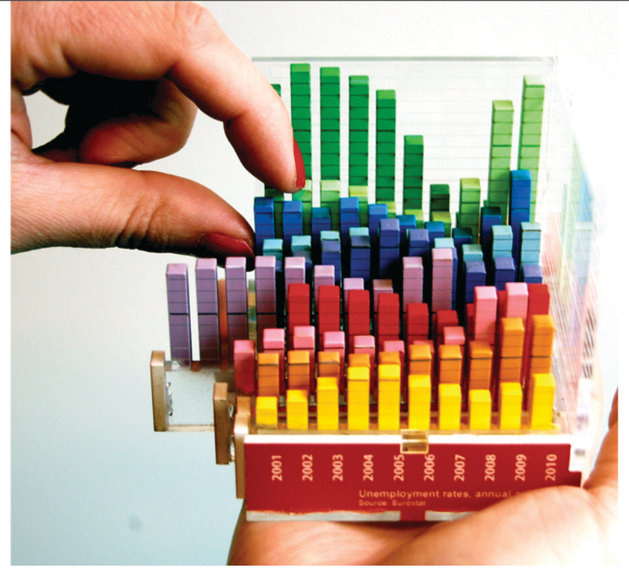



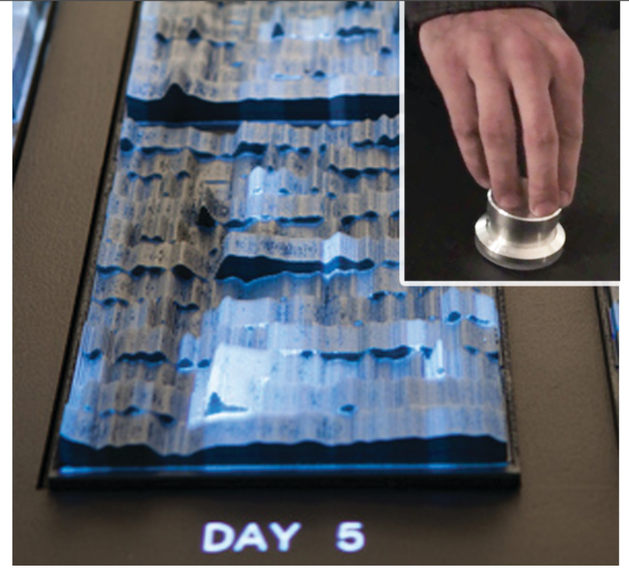


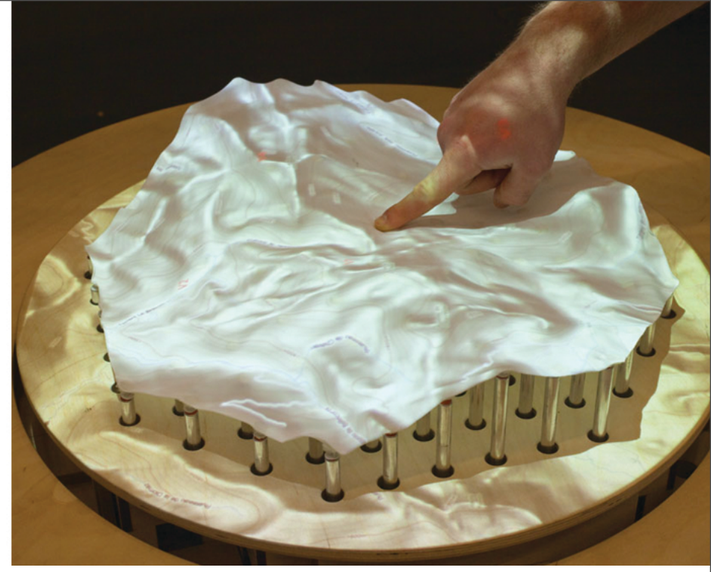


An Interaction Model for Visualizations Beyond The Desktop

Yvonne Jansen, Inria & UPSud
Pierre Dragicevic, Inria





An Interaction Model for Visualizations Beyond The Desktop

Yvonne Jansen, Inria & UPSud
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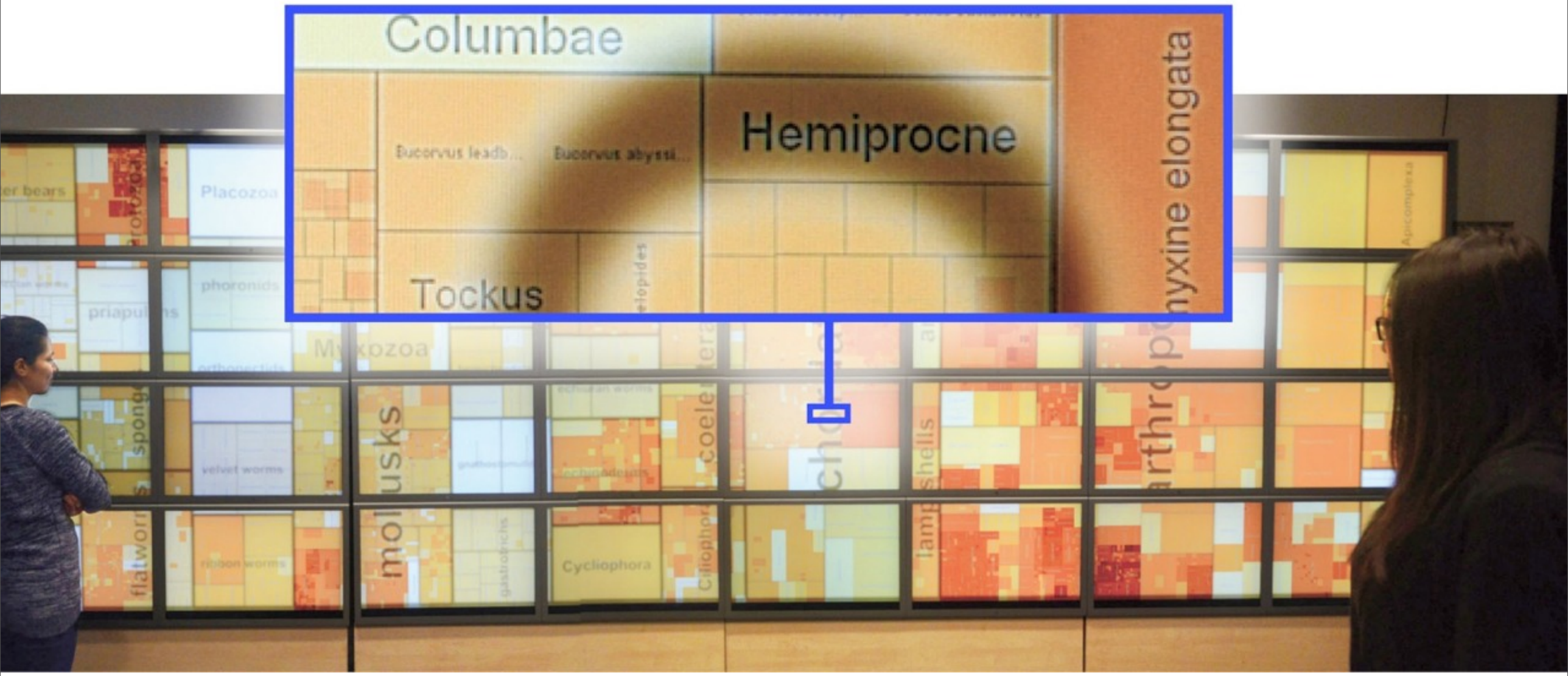
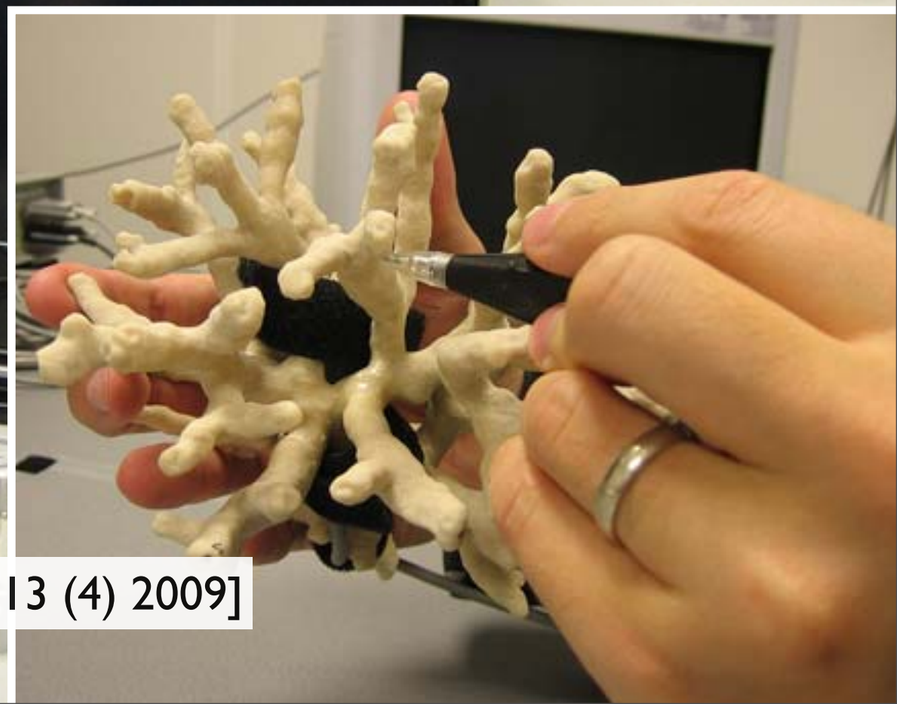
wall-sized displays



[Isenberg, Dragicevic, Willett, Bezerianos, Fekete.
Hybrid-Image Visualization for Large Viewing Environments, InfoVis'13 (earlier today)]


[Jansen, Dragicevic, Fekete. Tangible Remote Controller for Wall-sized Displays. CHI'12]

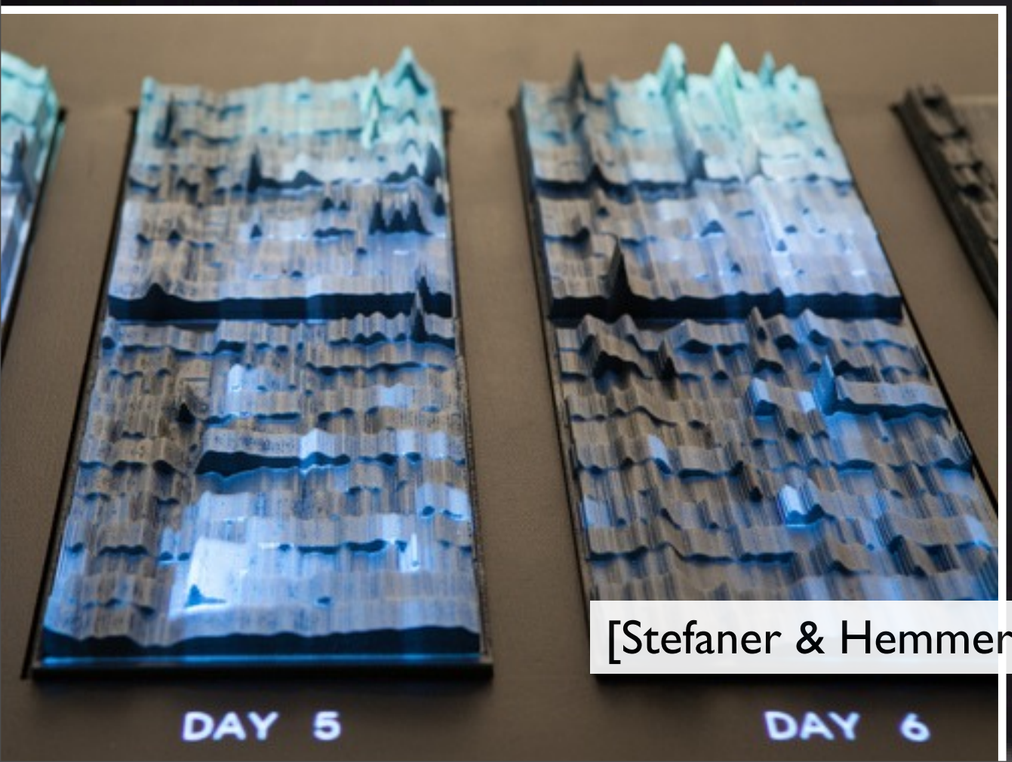
tangible props



[Kruszynski & van Liere, Tangible Props for Scientific Visualization, Virtual Reality 13 (4) 2009]

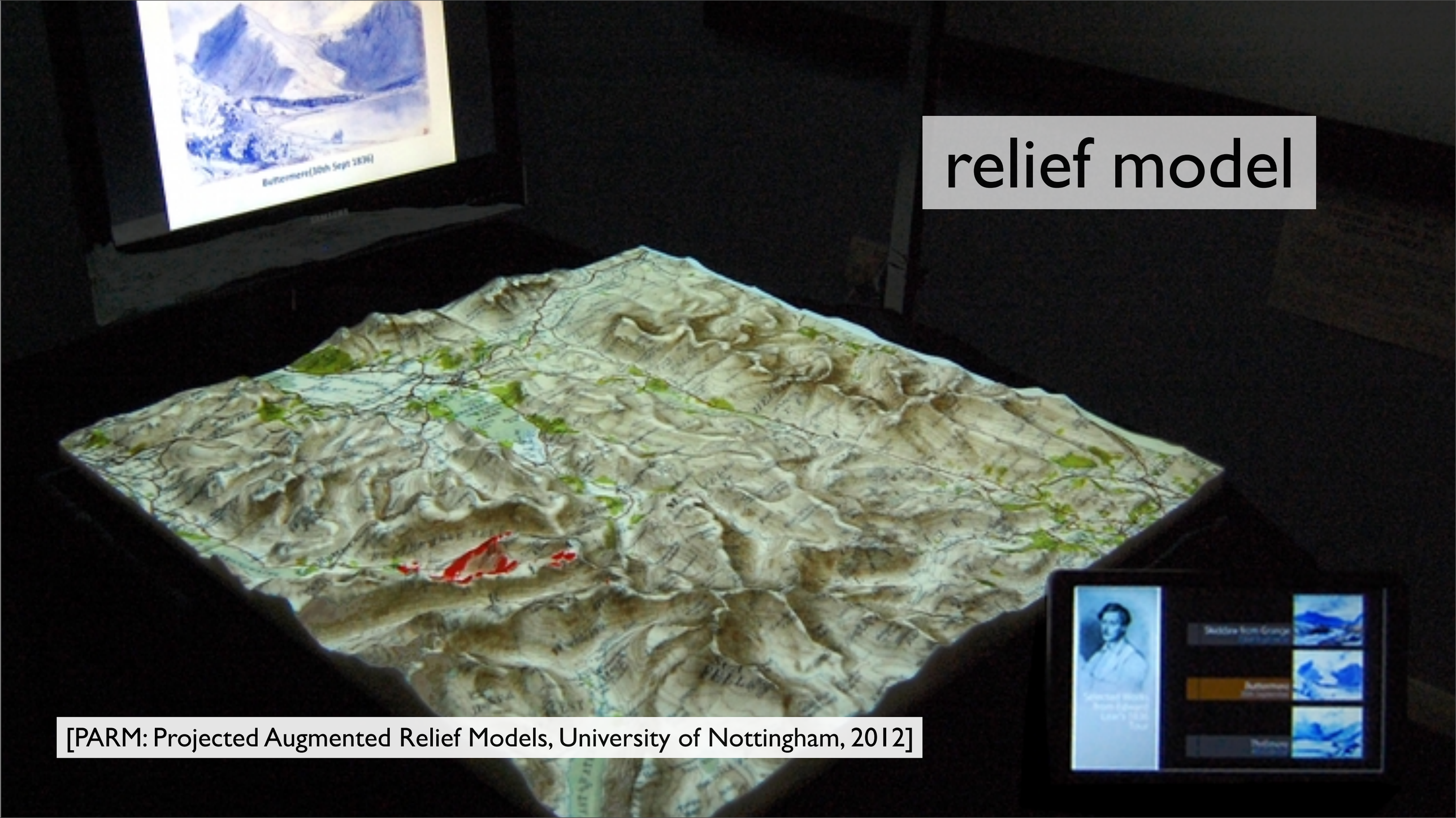
[Leithinger, Lakatos, DeVincenzi, Blackshaw, Ishii. Relief: a 2.5D shape display. UIST'11]

shape displays

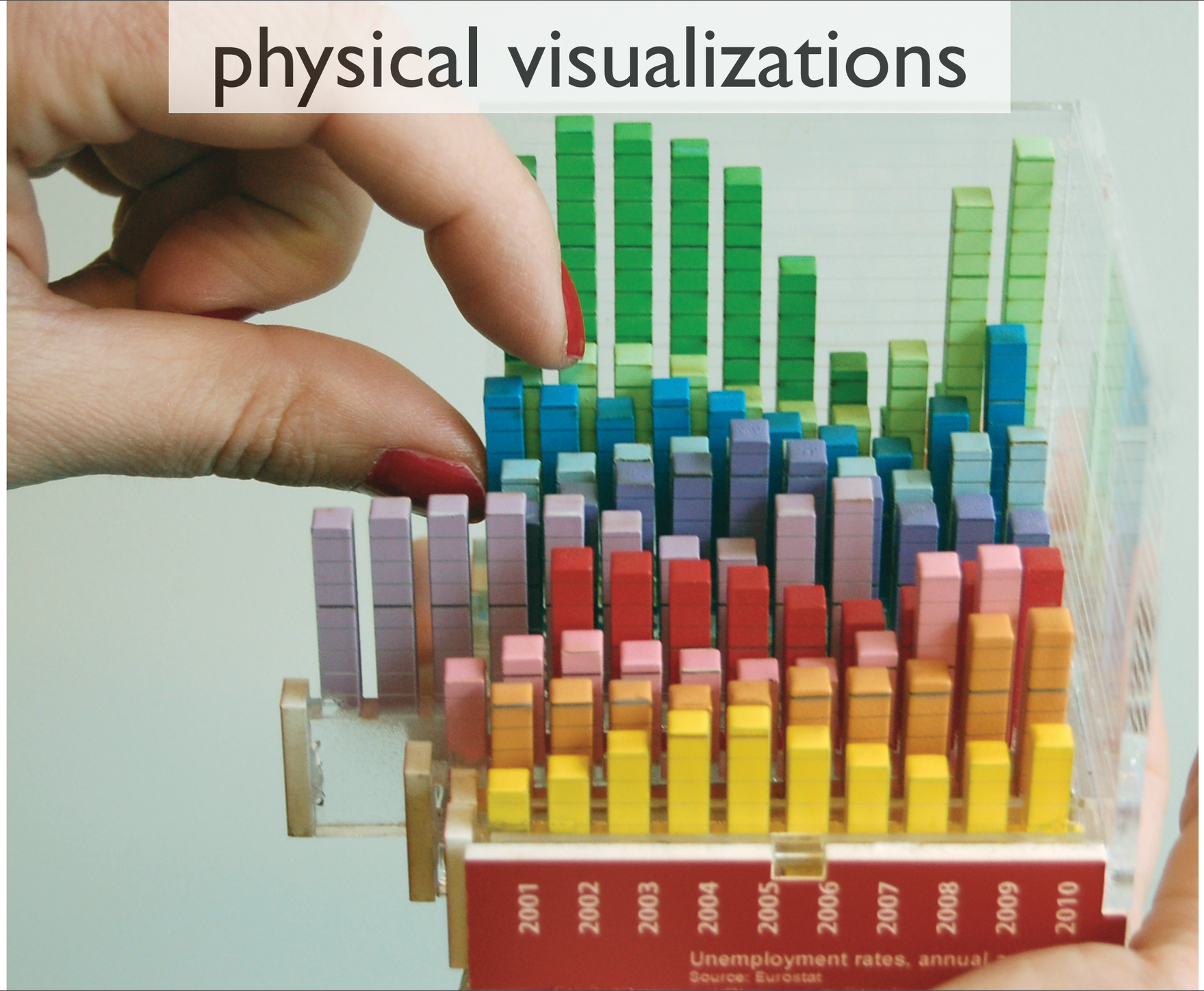


large scale installations

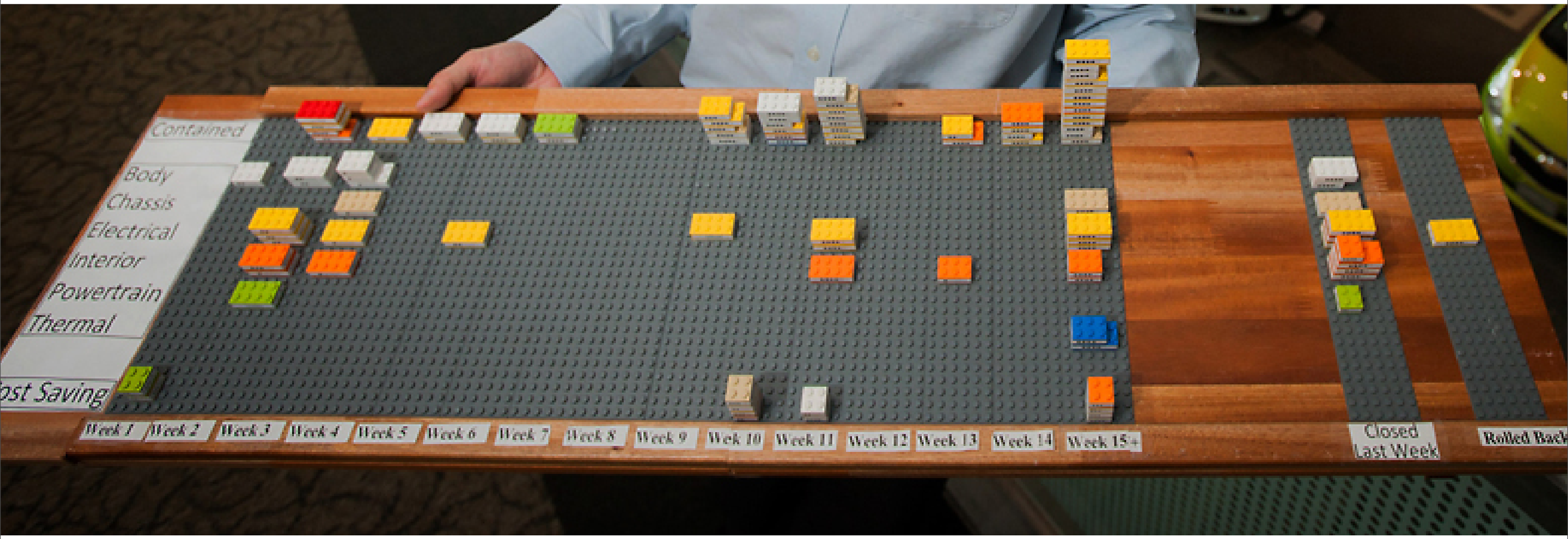
[Stefaner & Hemmert, emoto data sculpture, http://www.nand.io/visualisation/emoto-installation]


relief model
[PARM: Projected Augmented Relief Models, University of Nottingham, 2012]

physical visualizations



physical visualizations



[Mark Wilson. How GM is saving cash using legos as a data viz tool. http://tinyurl.com/mwilson2012, April 2012]

Problem

Problem

- wide range of different system designs studied in isolation

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  - curated lists: tinyurl.com/physvis

Problem

- wide range of different system designs studied in isolation
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Problem

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  - curated lists: tinyurl.com/physvis
- how can they inform new designs for interaction?
- visualization reference model useful for conventional vis but not expressive enough here
- need for an updated model with stronger focus on **how** users interact with visualizations

Contributions

Contributions

- an extended infovis pipeline model

Contributions

- an extended infovis pipeline model
- explicit inclusion of users

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- description of interactions as to their goals, effects, and means

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Contributions

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- explicit inclusion of users
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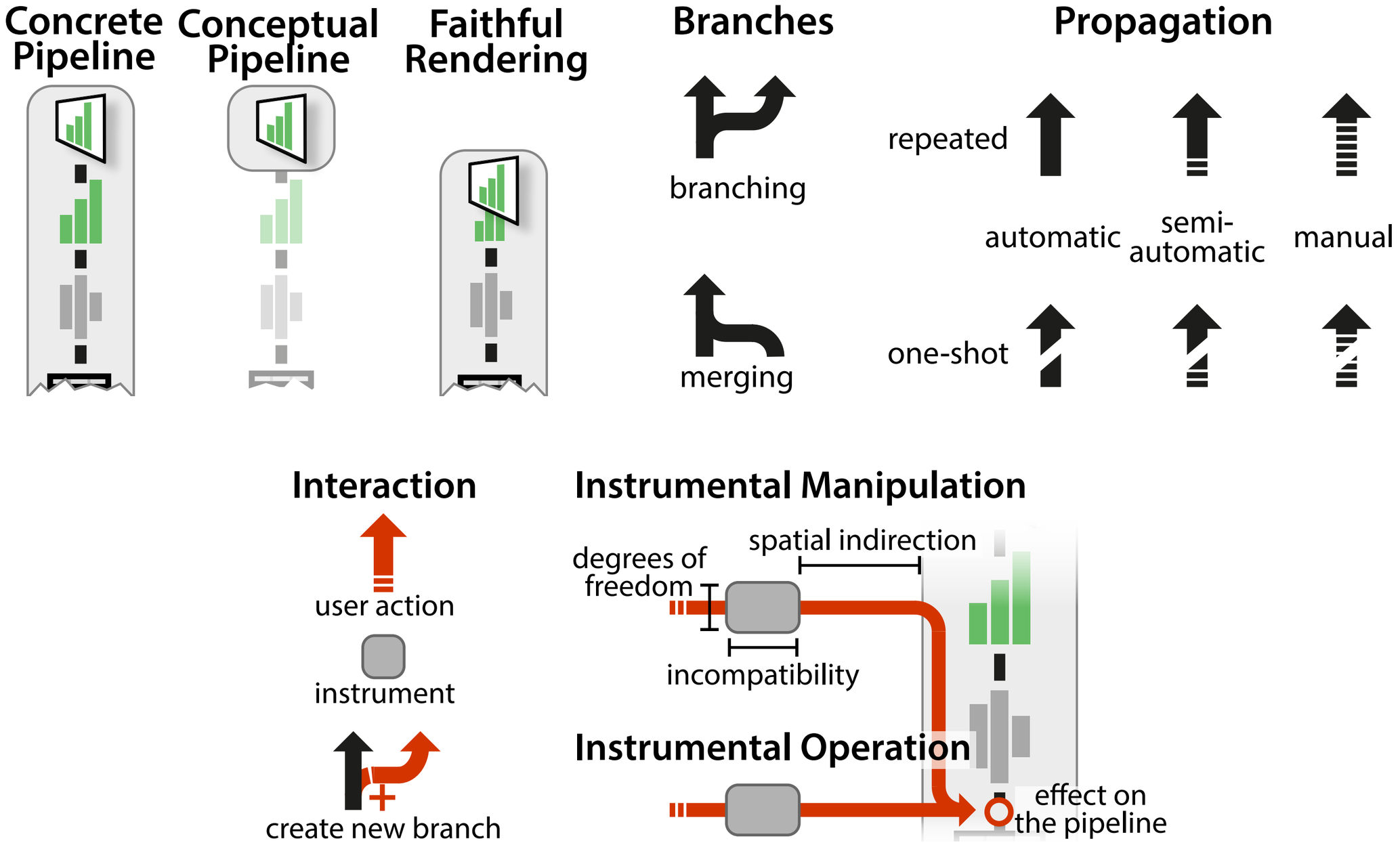
  - from the system's perspective
  - from the user's perspective
- visual notation system


Concrete Pipeline
Conceptual Pipeline
Faithful Rendering
Branches
branching
merging
Propagation
repeated
automatic
semi-automatic
manual
one-shot
Interaction
user action
instrument
create new branch
Instrumental Manipulation
degrees of freedom
spatial indirection
incompatibility
Instrumental Operation
effect on the pipeline

Contributions

- an extended infovis pipeline model
- explicit inclusion of users
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Contributions

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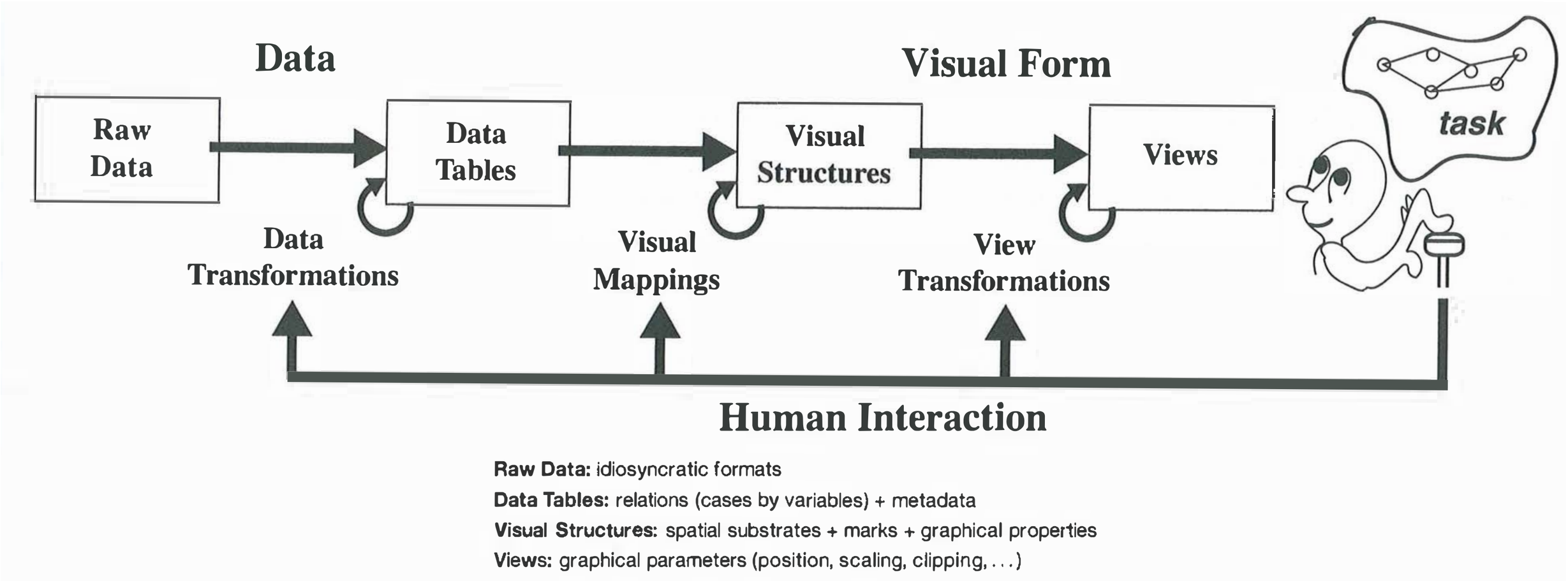
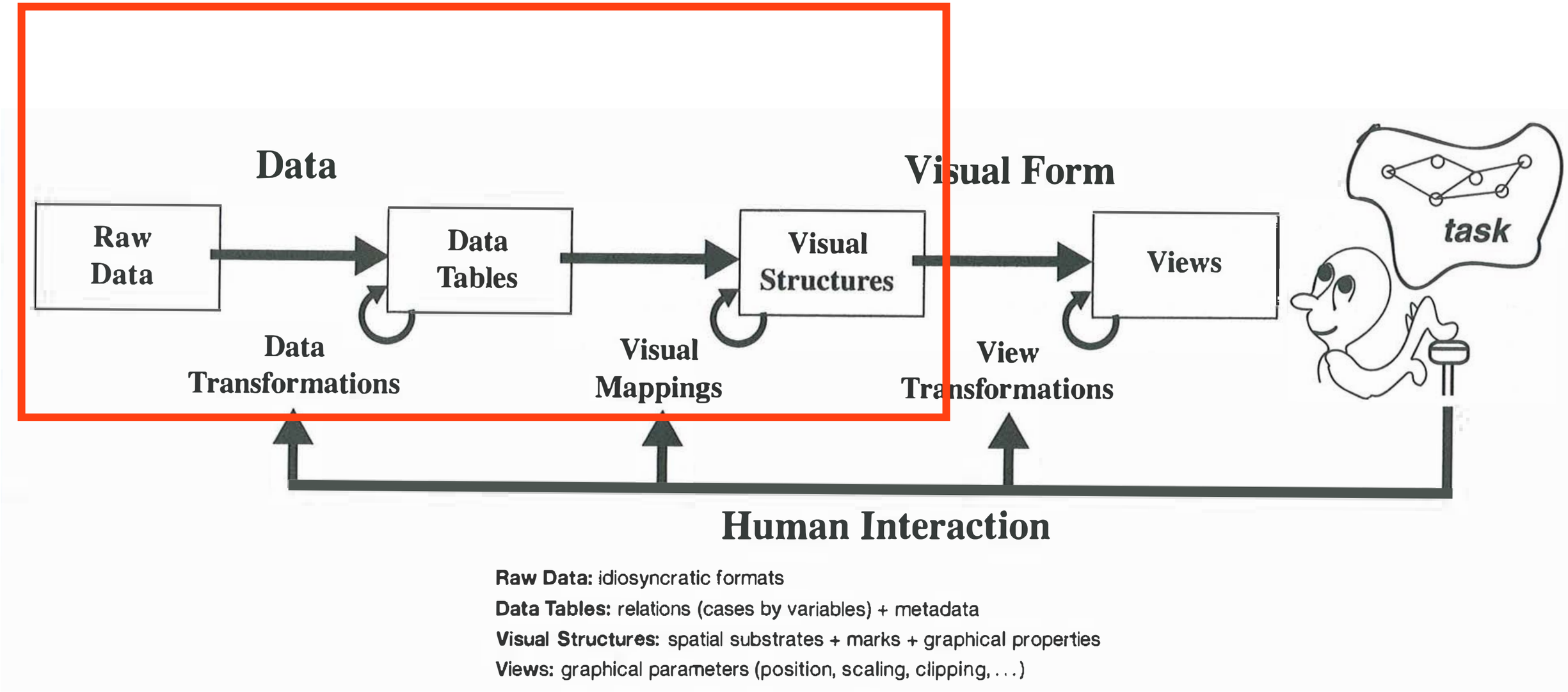
- description of interactions as to their goals, effects, and means
  - from the system's perspective
  - from the user's perspective
- visual notation system
- 8 case studies illustrating the model

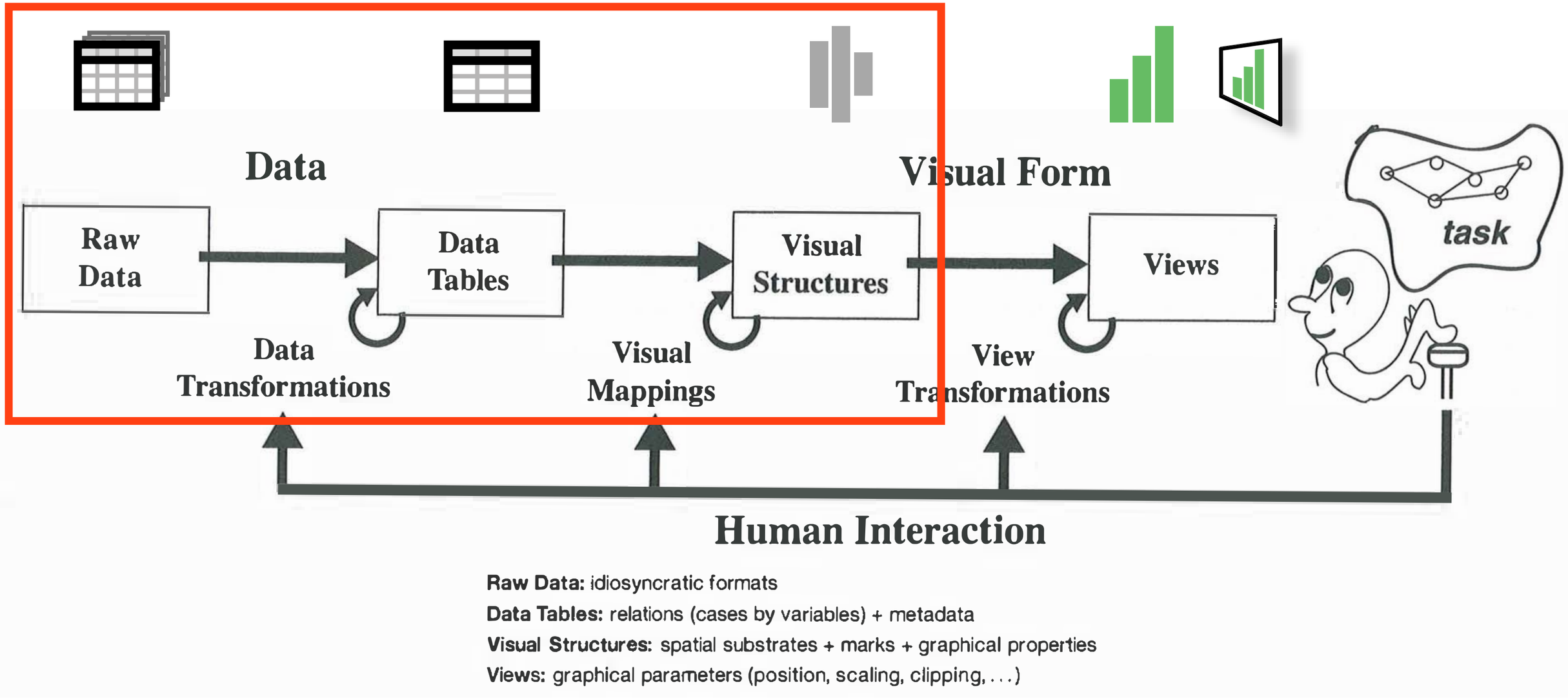
extended pipeline model



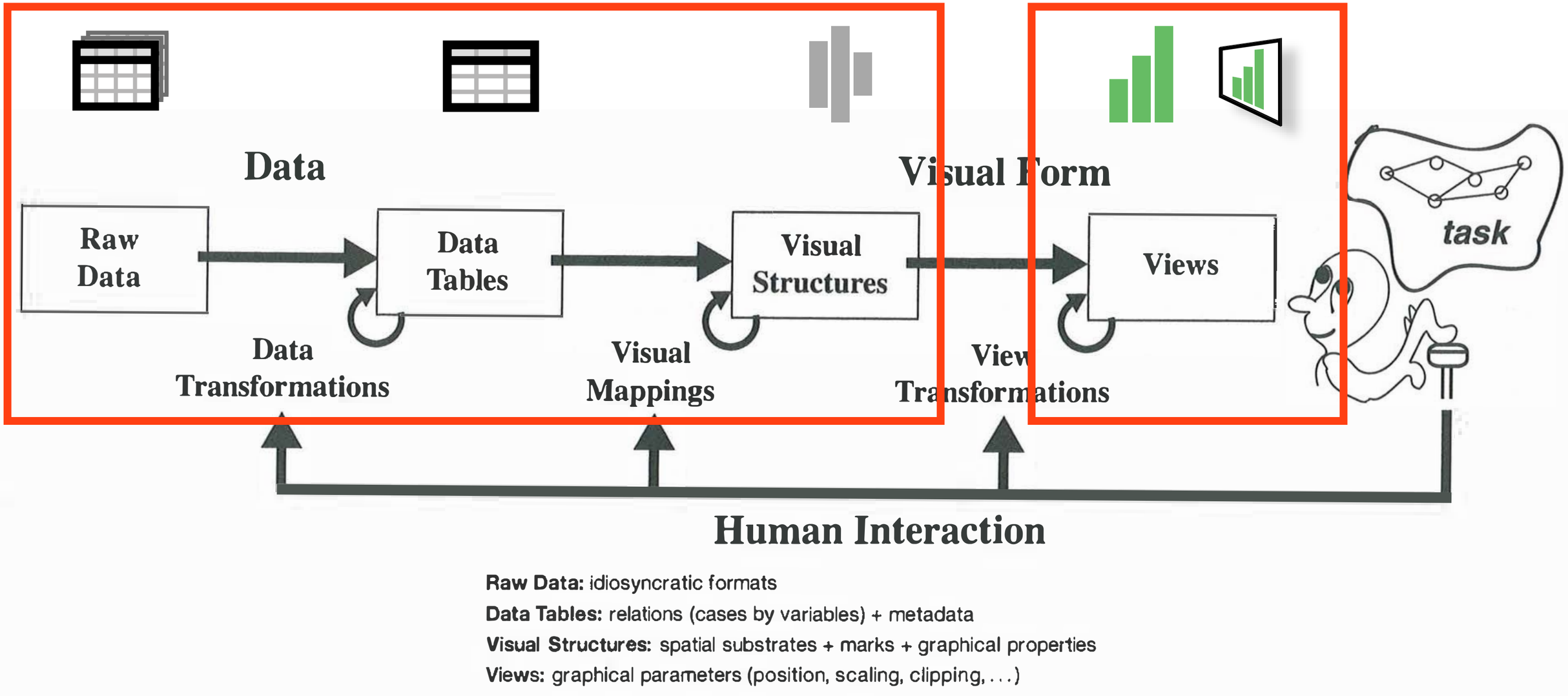
[Card, Mackinlay, Shneiderman, Readings in Information Visualization: Using Vision to Think, 1999]



[Card, Mackinlay, Shneiderman, Readings in Information Visualization: Using Vision to Think, 1999]



[Card, Mackinlay, Shneiderman, Readings in Information Visualization: Using Vision to Think, 1999]



[Card, Mackinlay, Shneiderman, Readings in Information Visualization: Using Vision to Think, 1999]

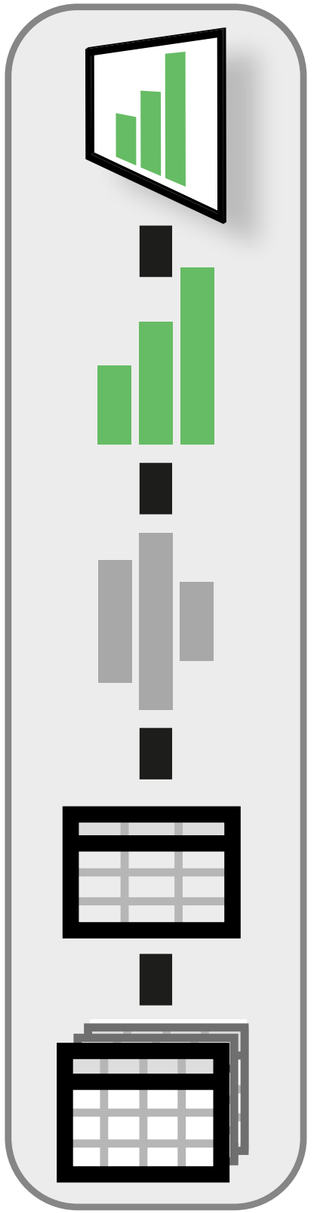
physical presentation

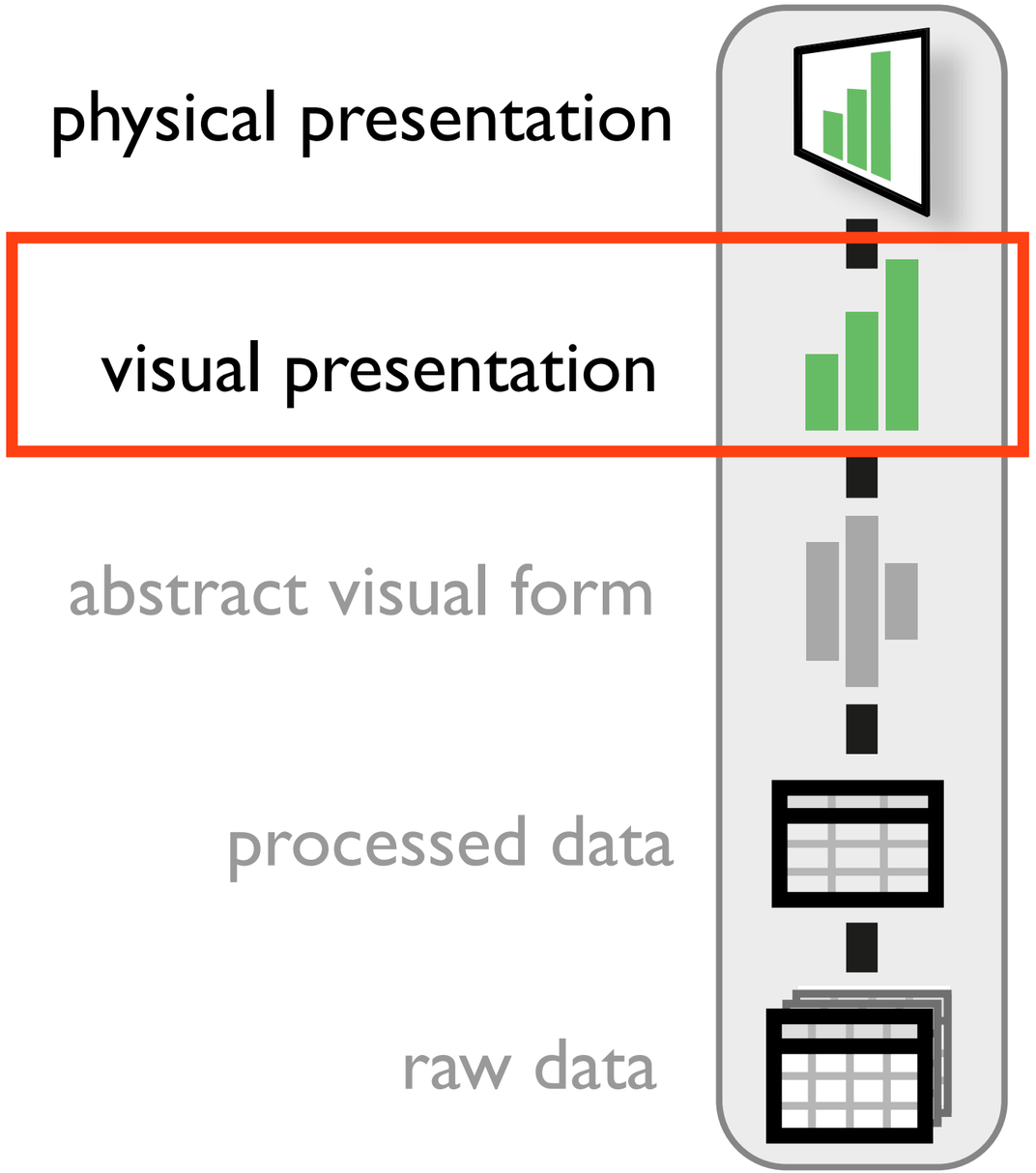
visual presentation

abstract visual form

processed data

raw data




physical presentation
visual presentation
abstract visual form
processed data
raw data

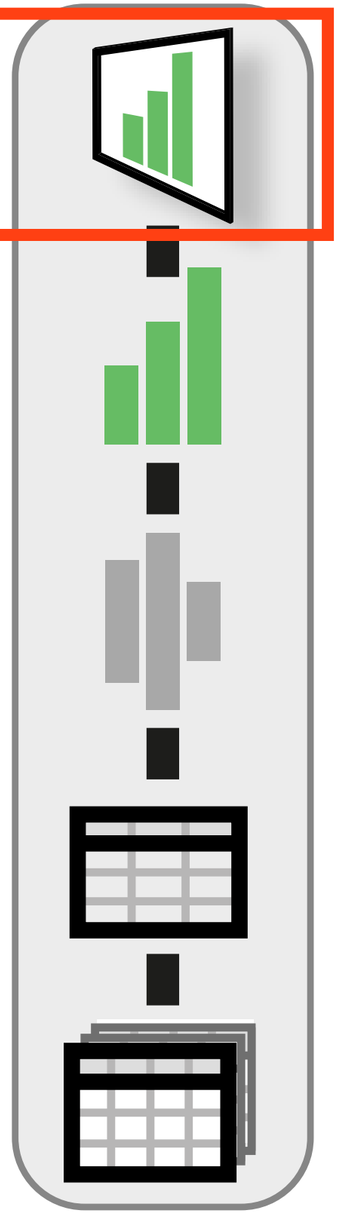
physical presentation

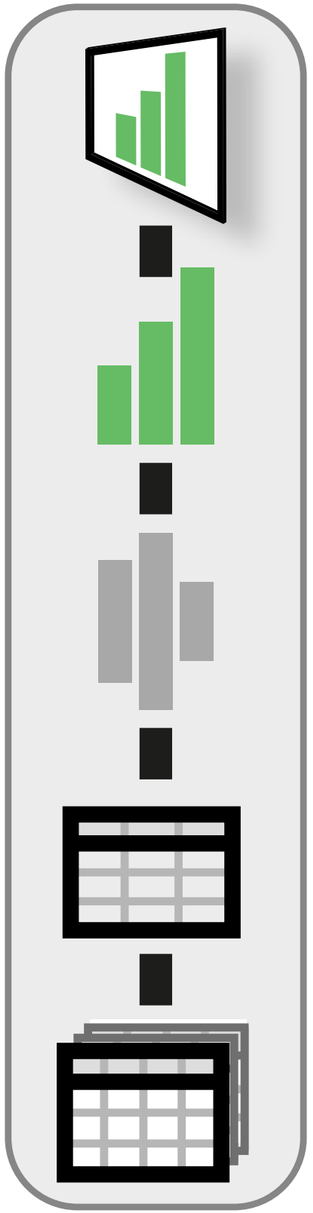
visual presentation

abstract visual form

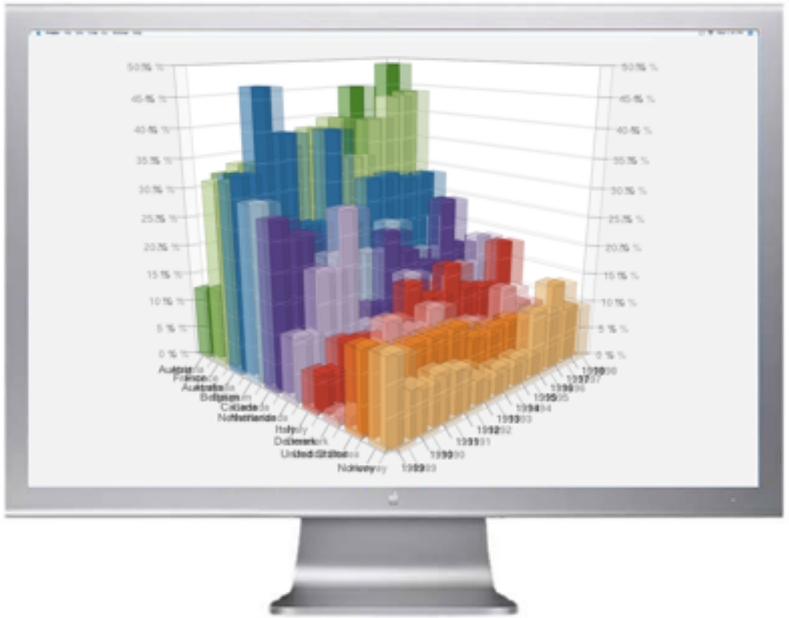
processed data

raw data





[Jansen, Dragicevic, Fekete. Evaluating the Efficiency of Physical Visualizations. CHI'13]

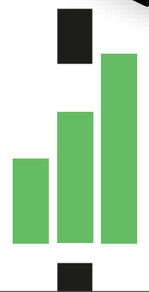


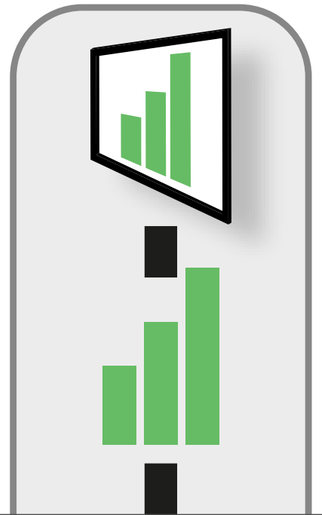
physical visualization

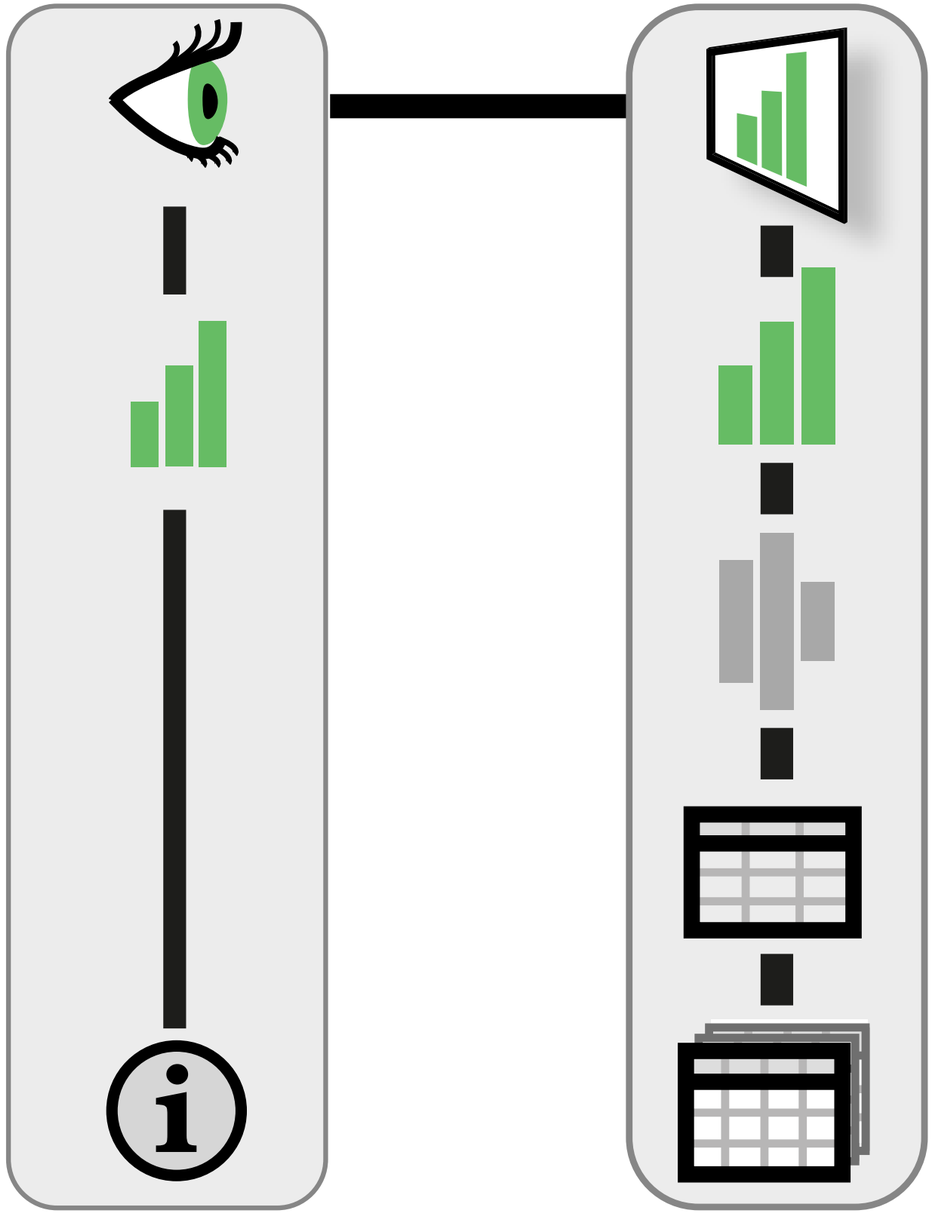
2D screen

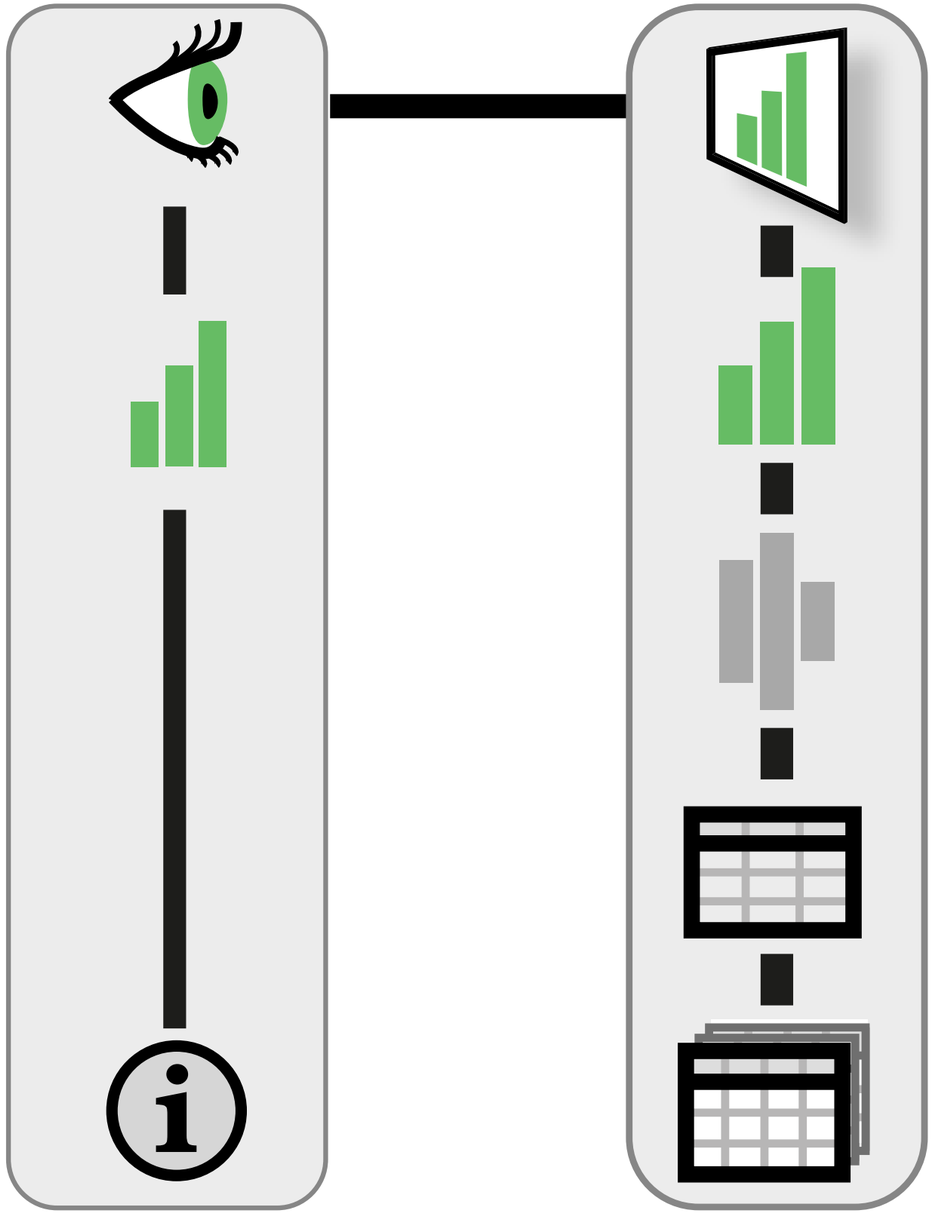
stereoscopic screen

3D bar chart

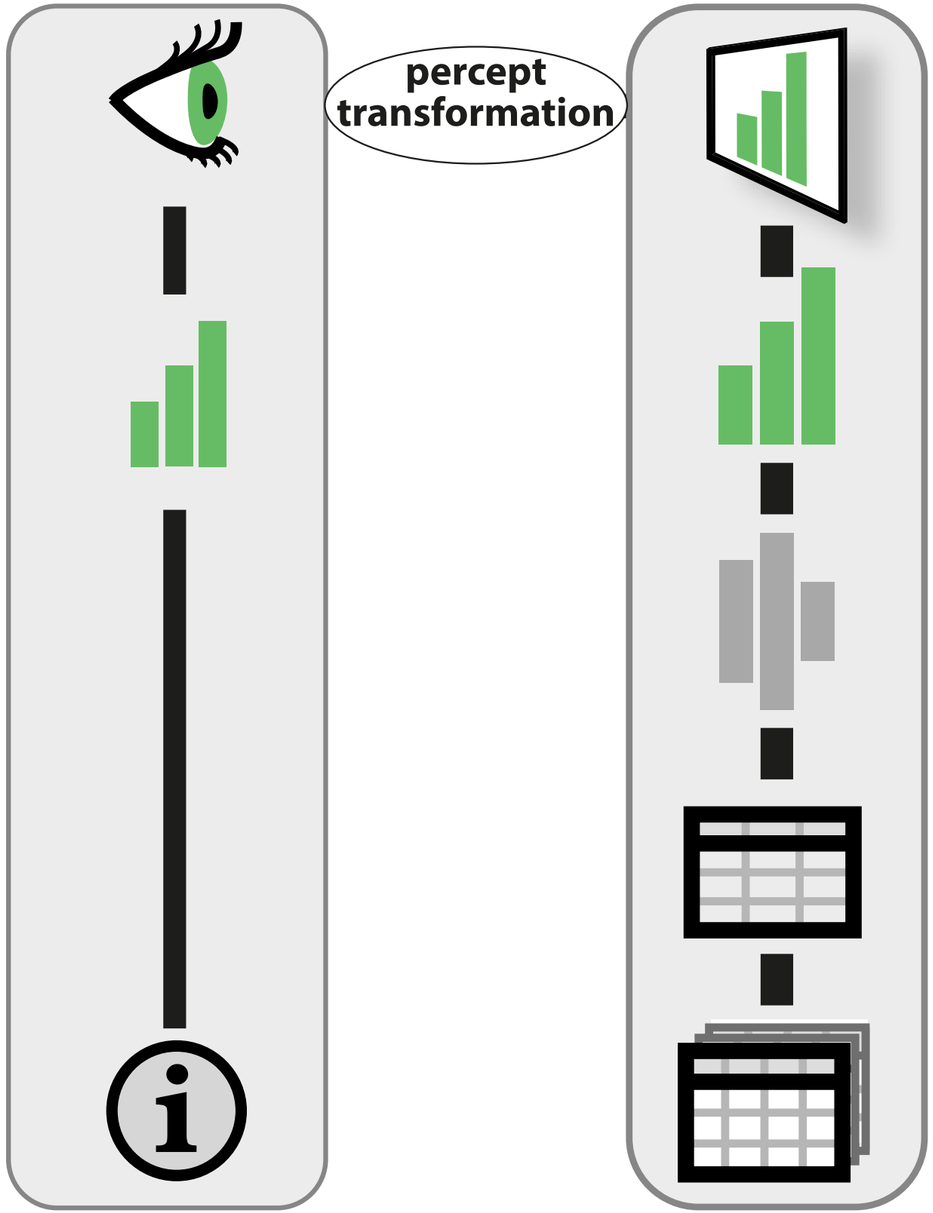




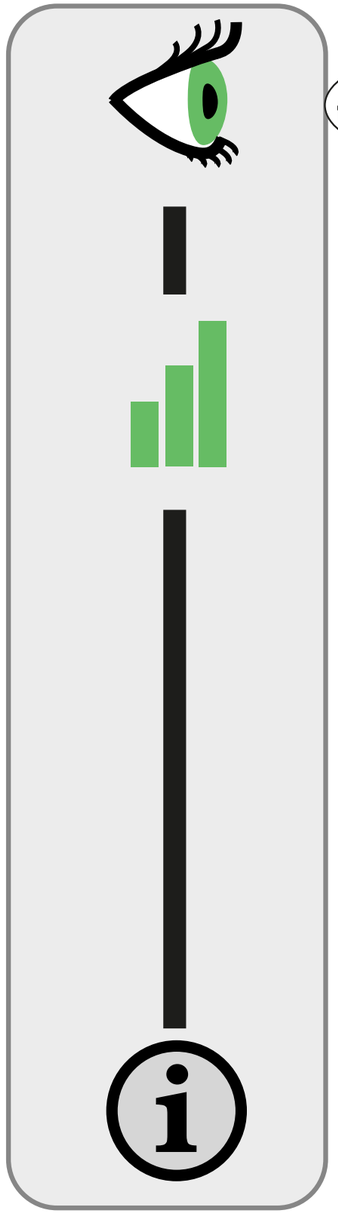

user
visualization
system



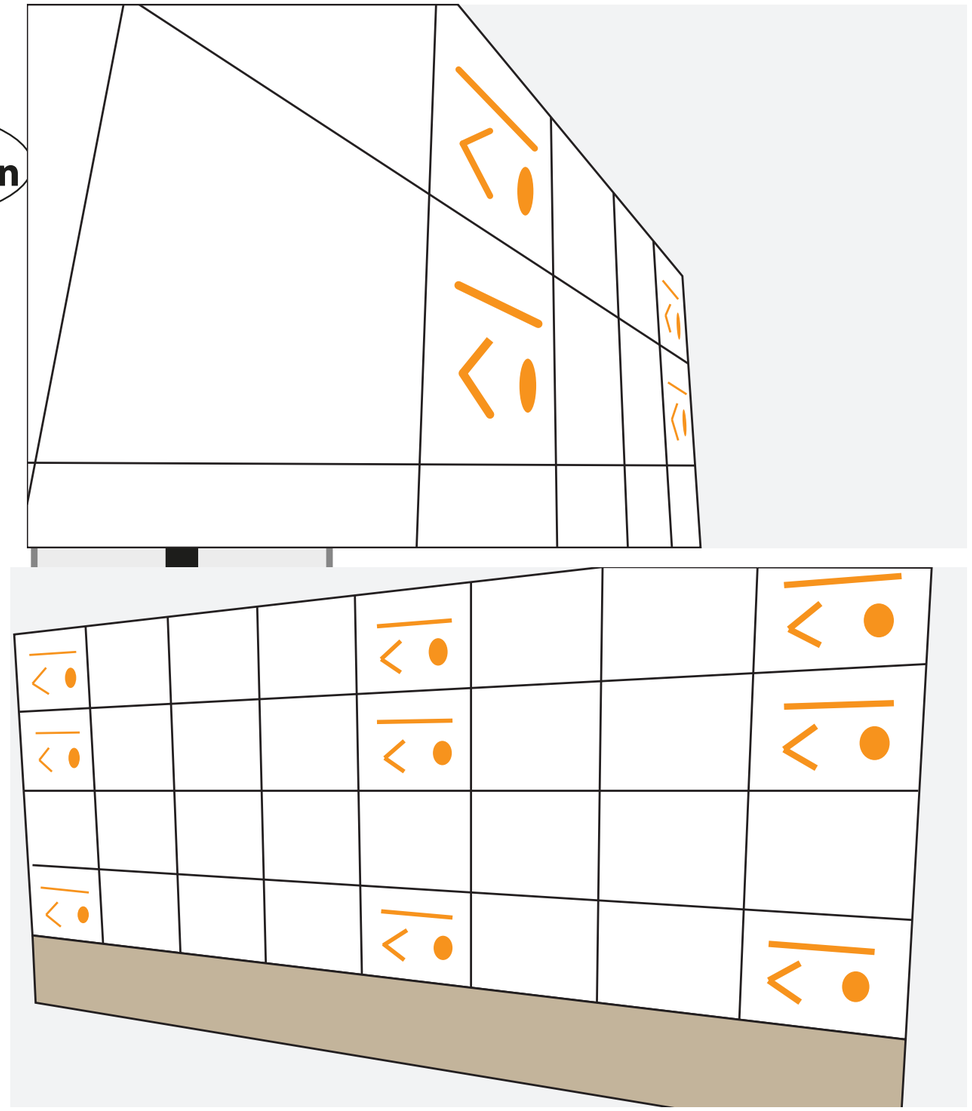
percept



percept

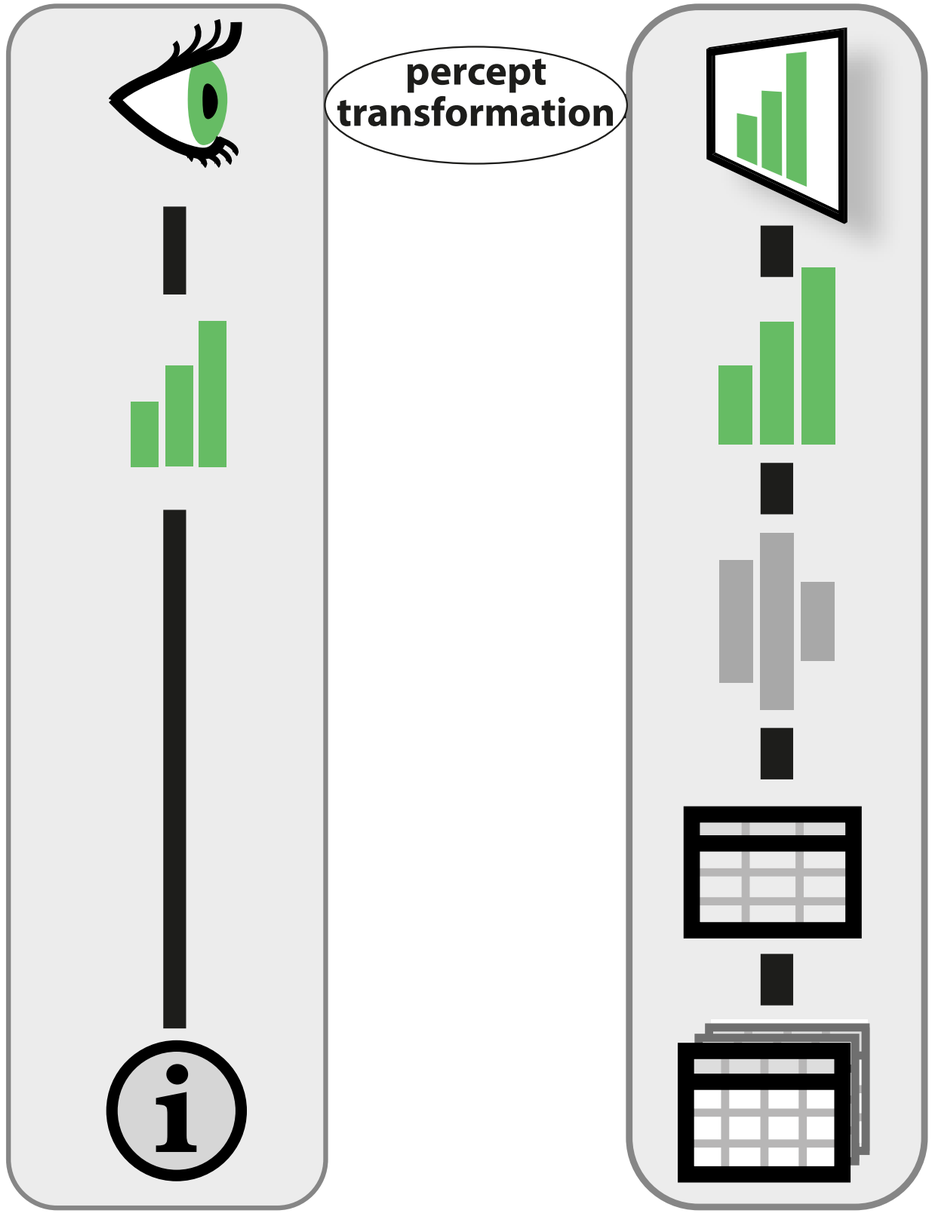


percept transformation

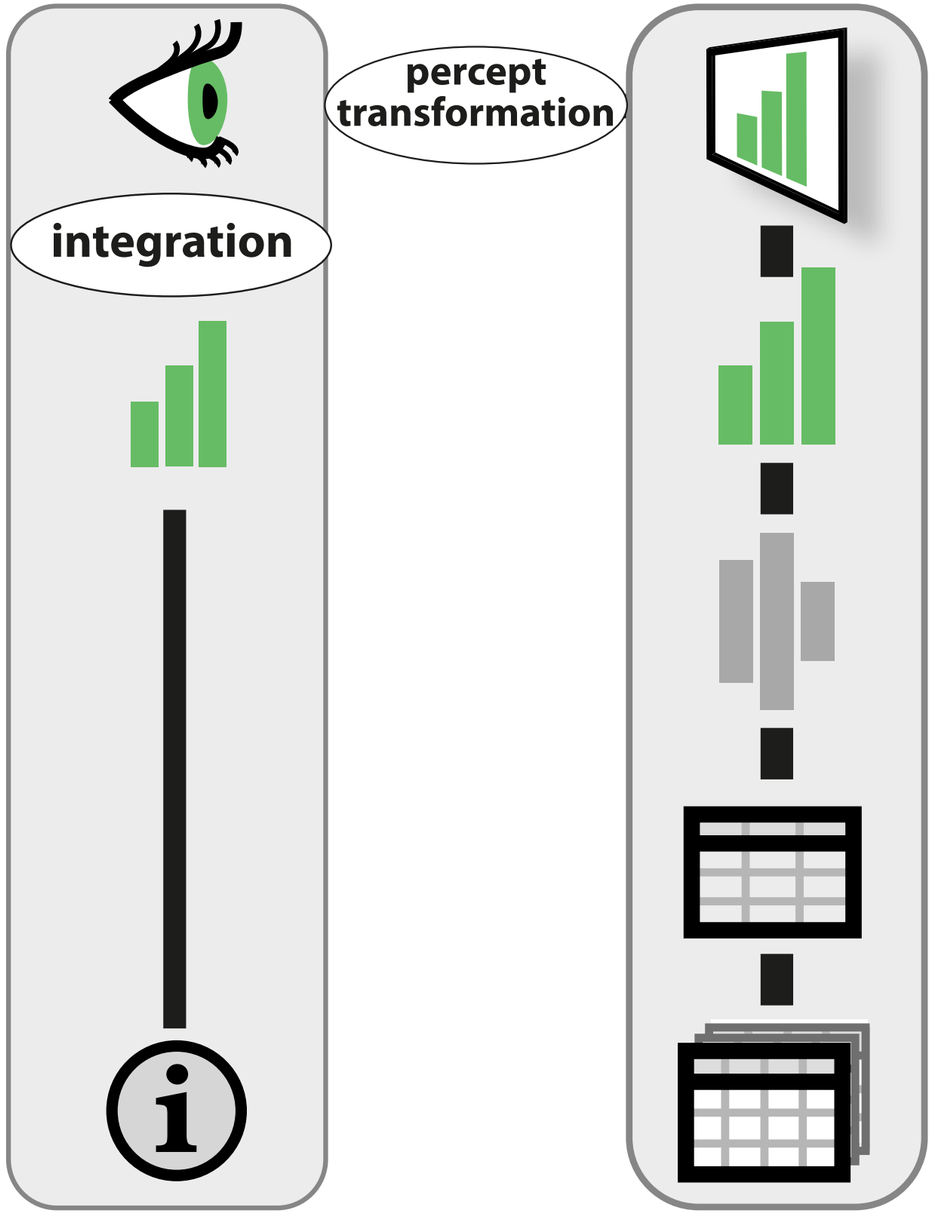


[Bezerianos & Isenberg, Perception of Visual Variables on Tiled Wall-Sized Displays for Information Visualization Applications, TVCG 18, 12 (2012).

percept

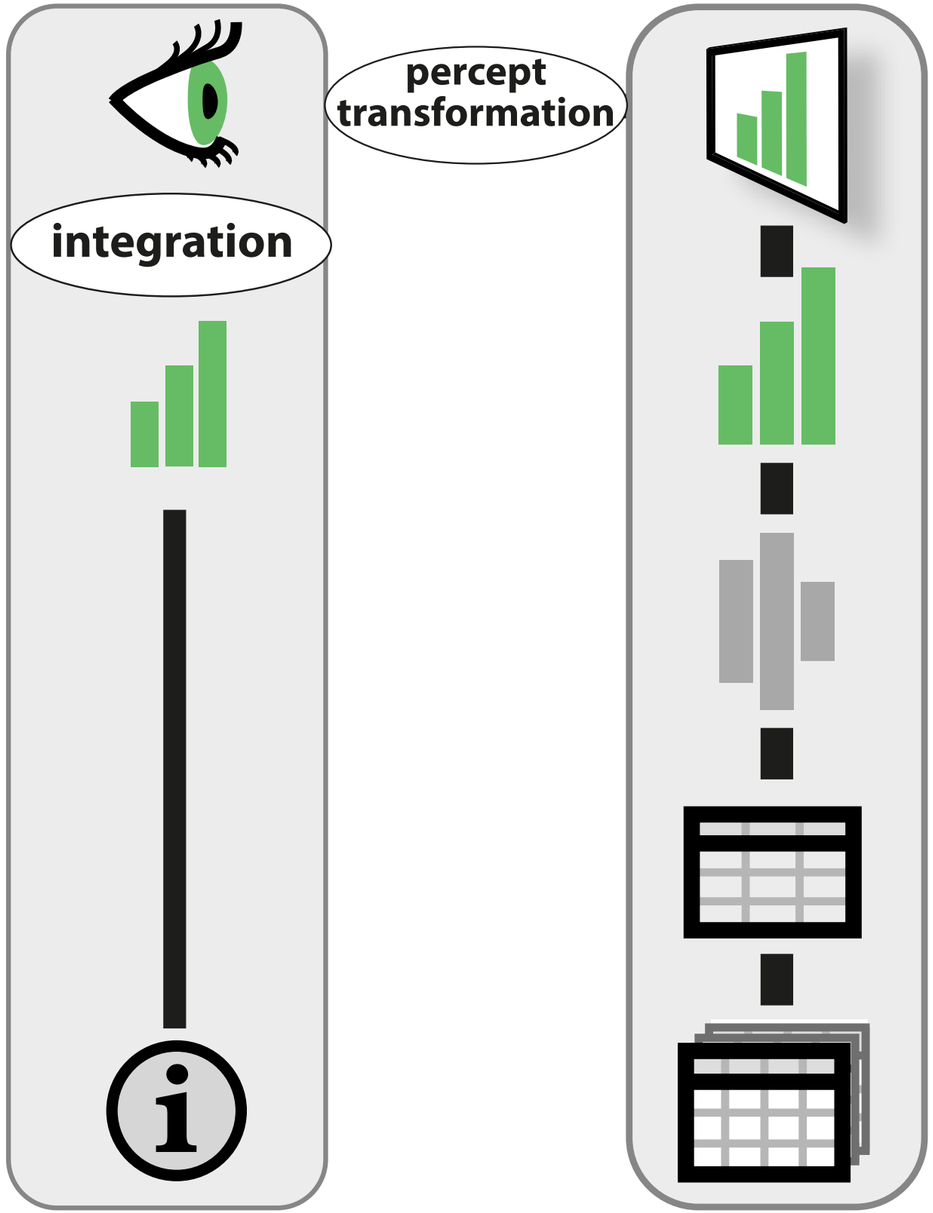


percept



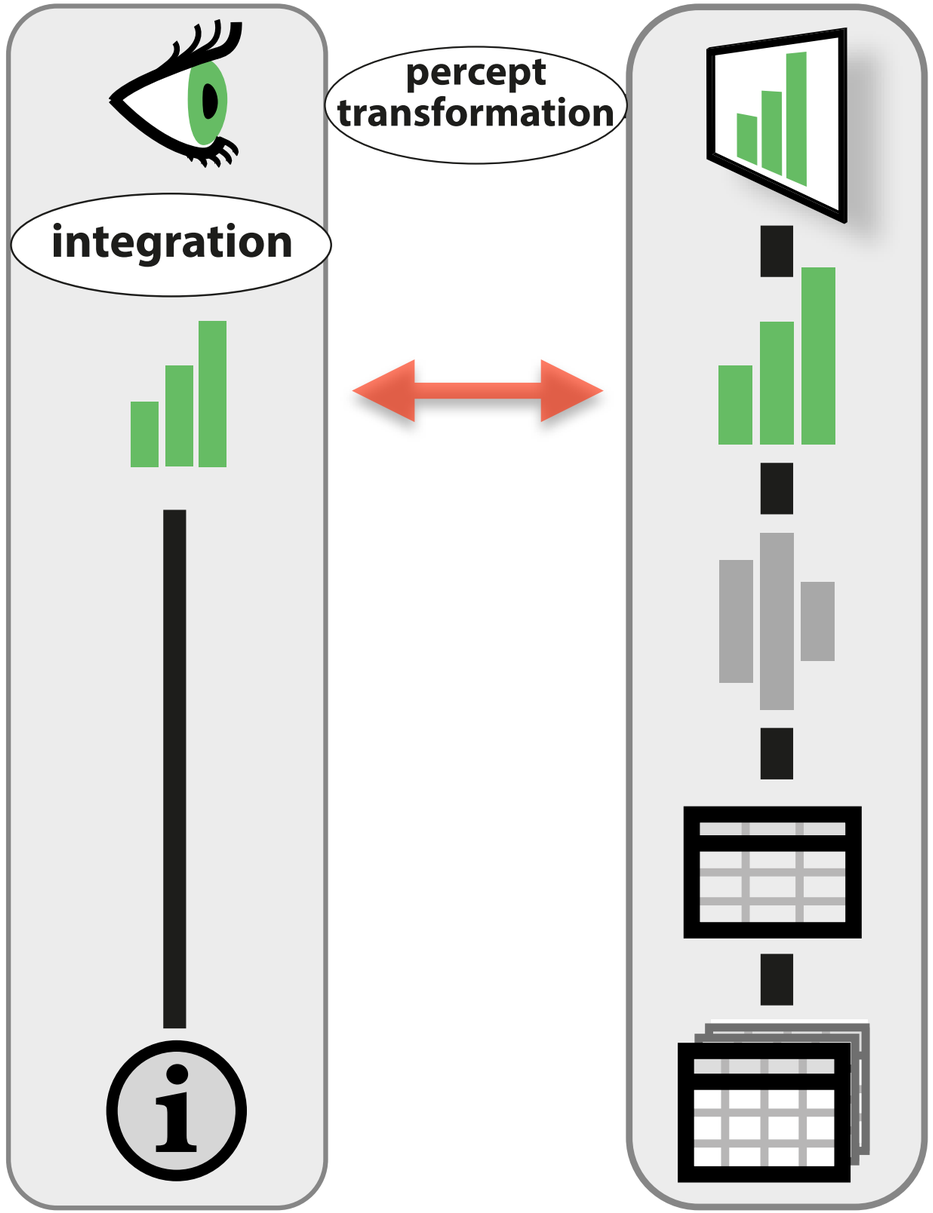
percept

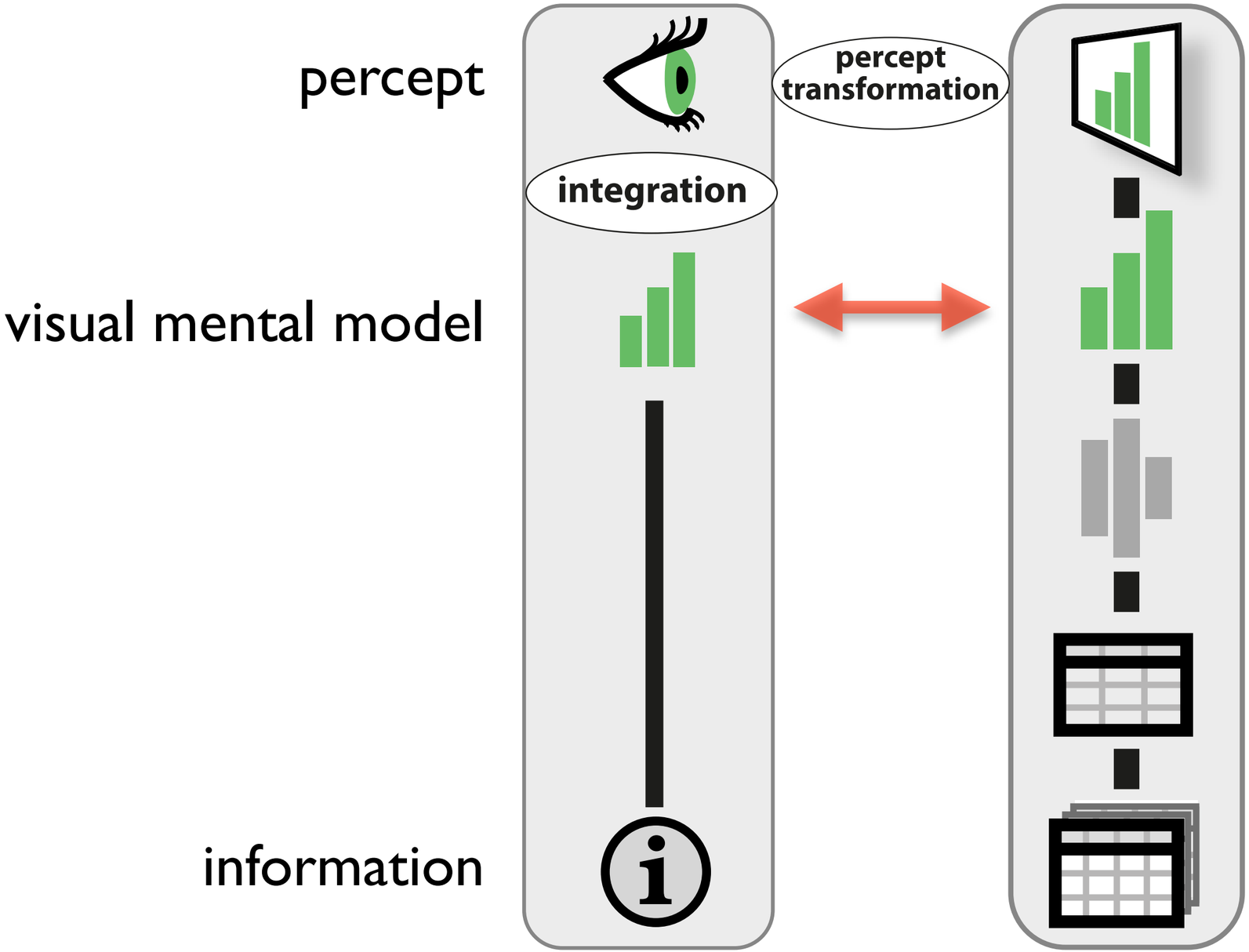
visual mental model

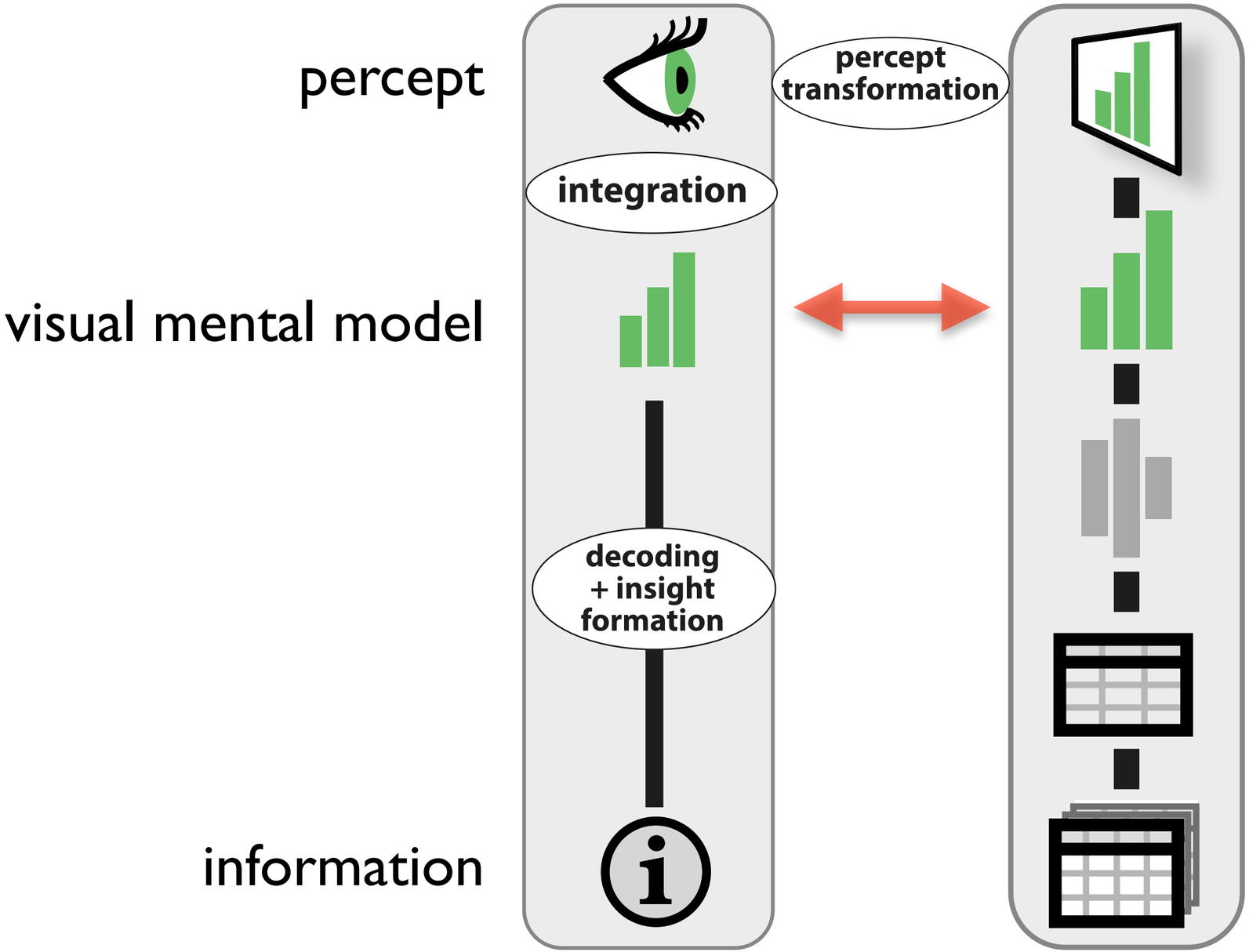


percept

visual mental model




percept
visual mental model
information
integration
percept
transformation


percept
visual mental model
information
integration
decoding
+ insight
formation
percept
transformation

Interactivity

effect: **what** is the user doing?

Interactivity

Interactivity

effect: **what** is the user doing?

goal: **why** is she doing it?

Interactivity

effect: **what** is the user doing?

goal: **why** is she doing it?

means: **how** does she do it?

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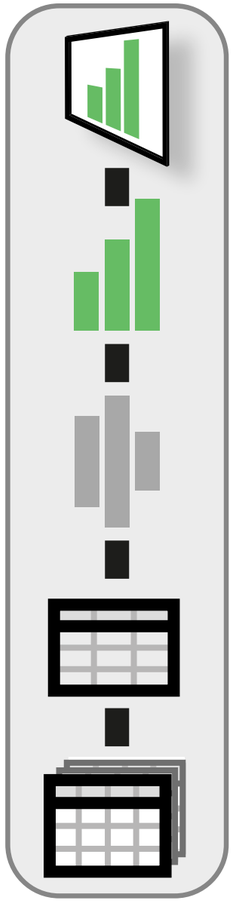
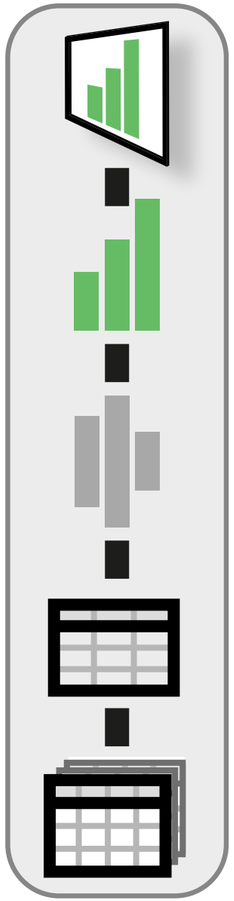
Effect

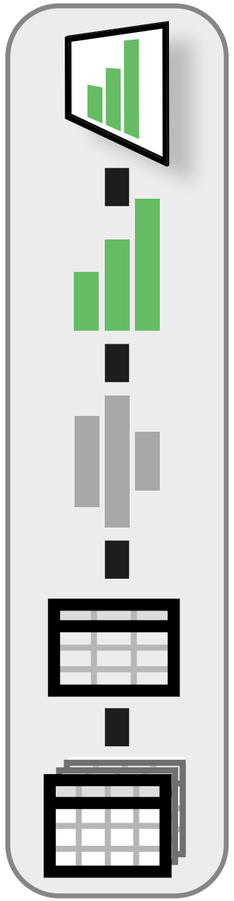


Effect



Means

Instrumental Interaction

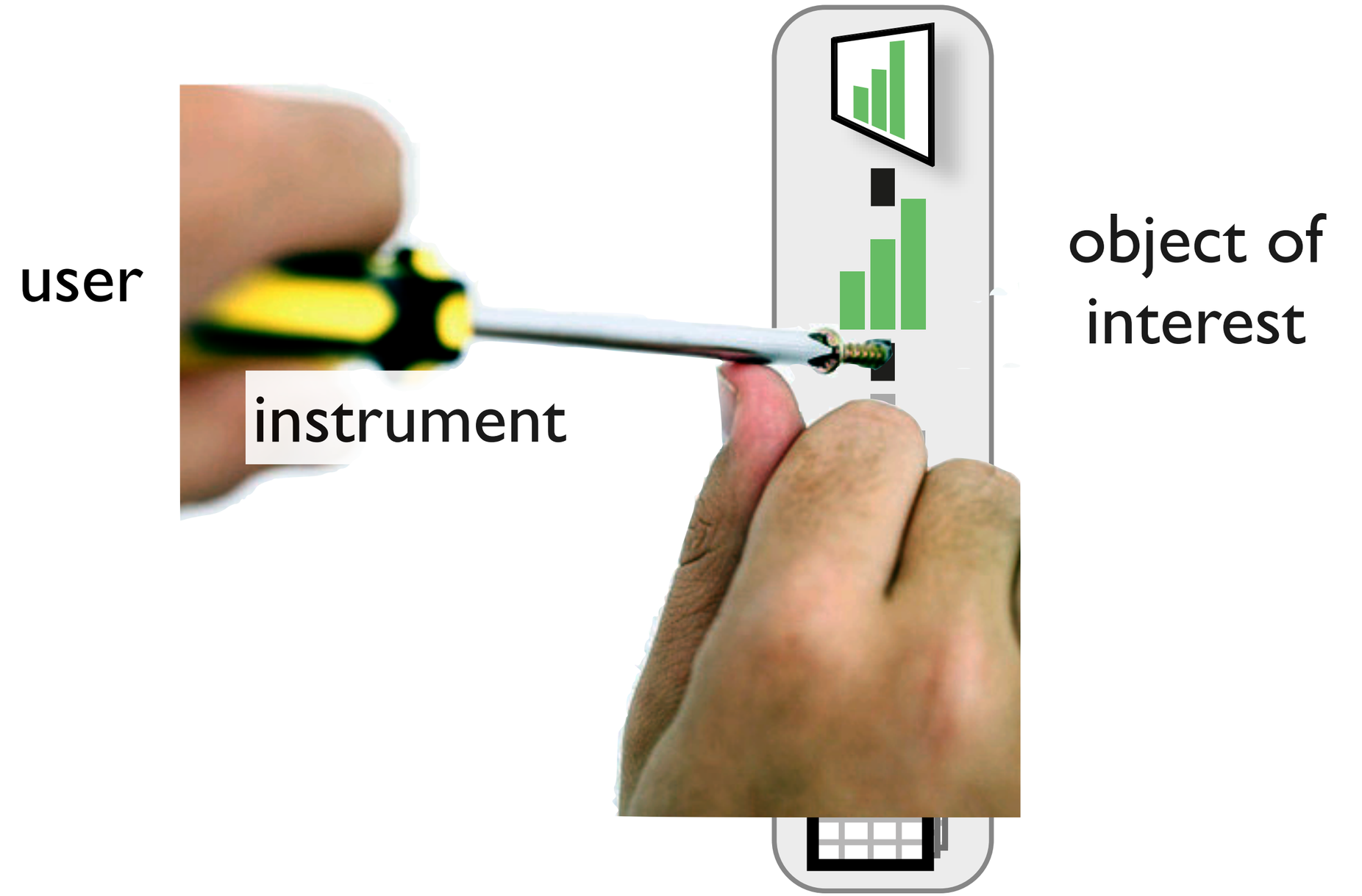


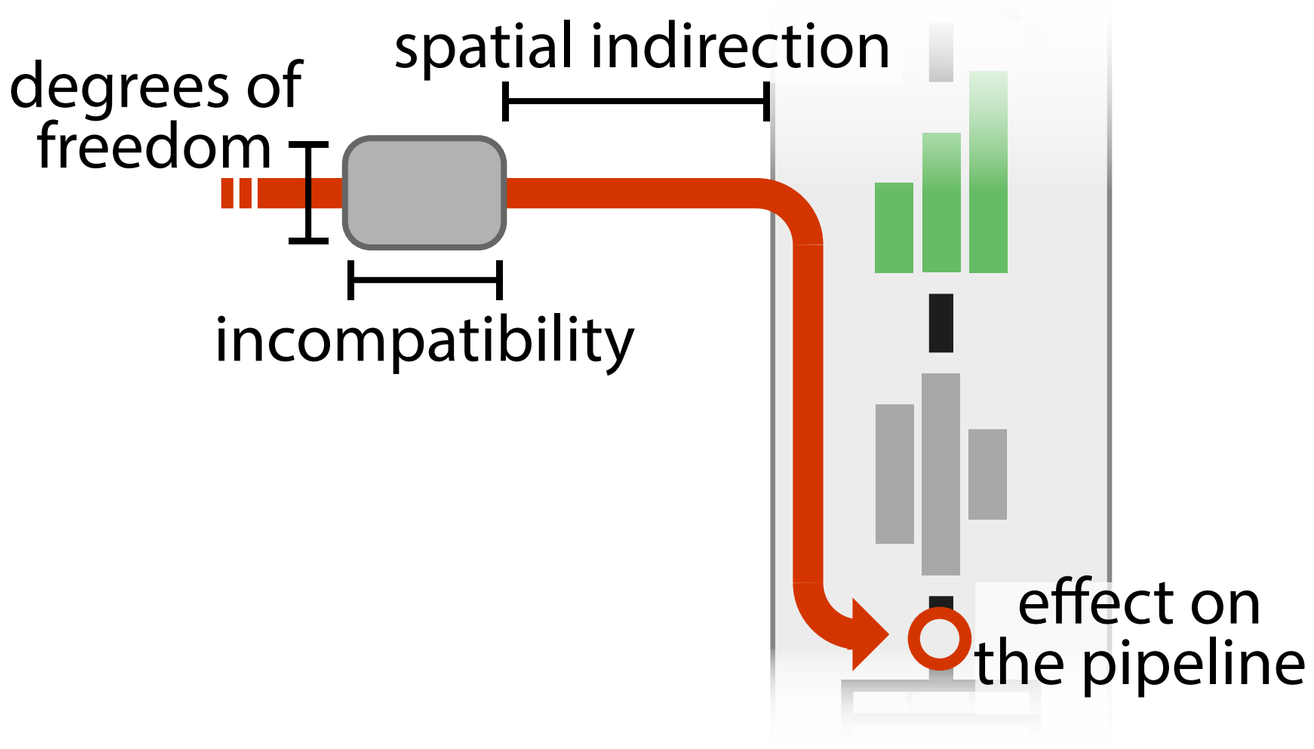
[Beaudouin-Lafon, Instrumental Interaction: An Interaction Model for Designing Post-WIMP User Interfaces, AVI 2000]

user

instrument

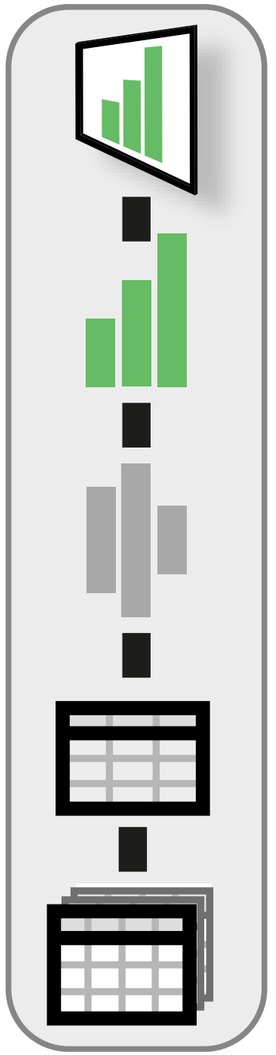
object of interest


user
instrument
object of interest


spatial indirection
degrees of
freedom
incompatibility
effect on
the pipeline

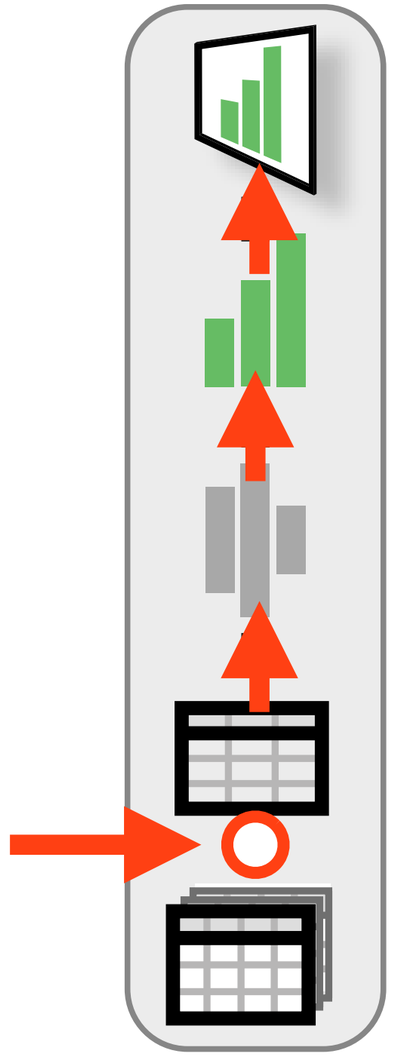
Propagation

forward propagation



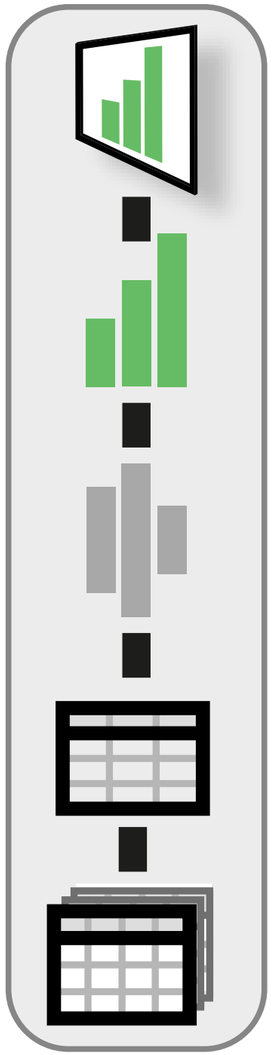
Propagation

forward propagation



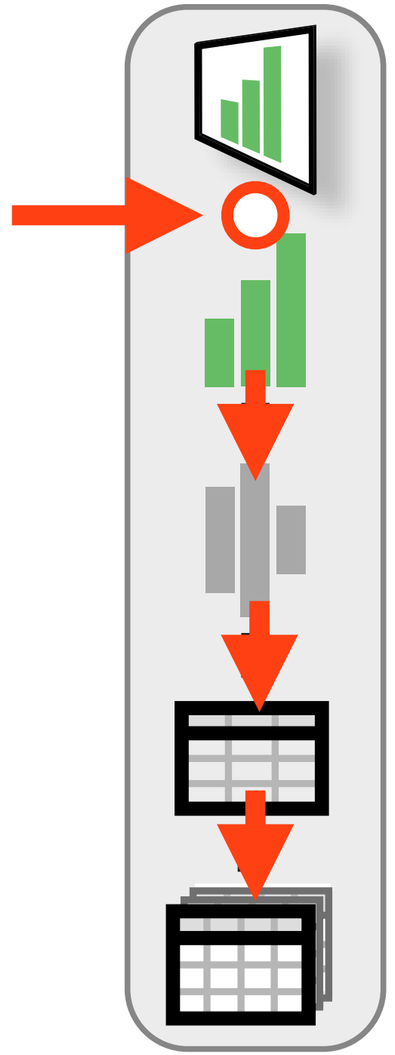
Propagation

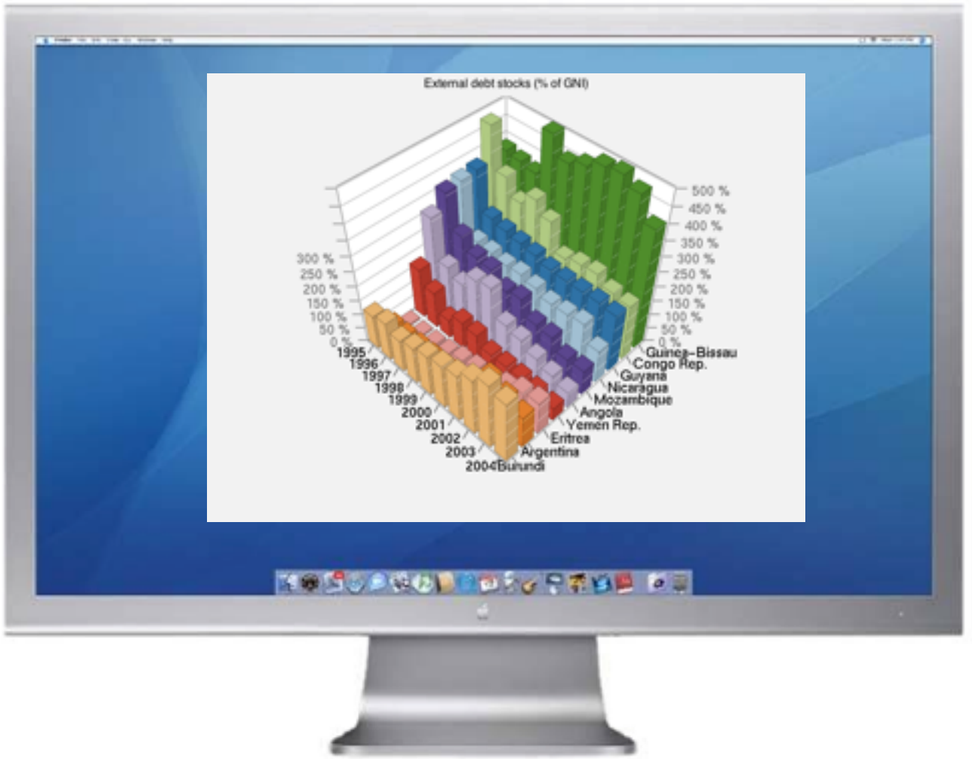
back propagation



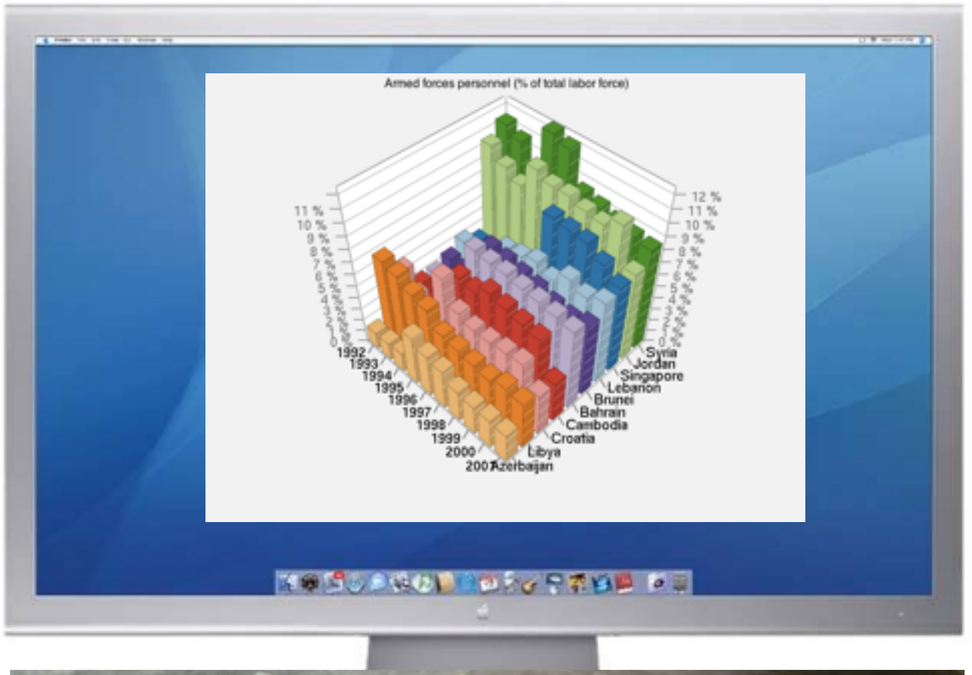
Propagation

back propagation

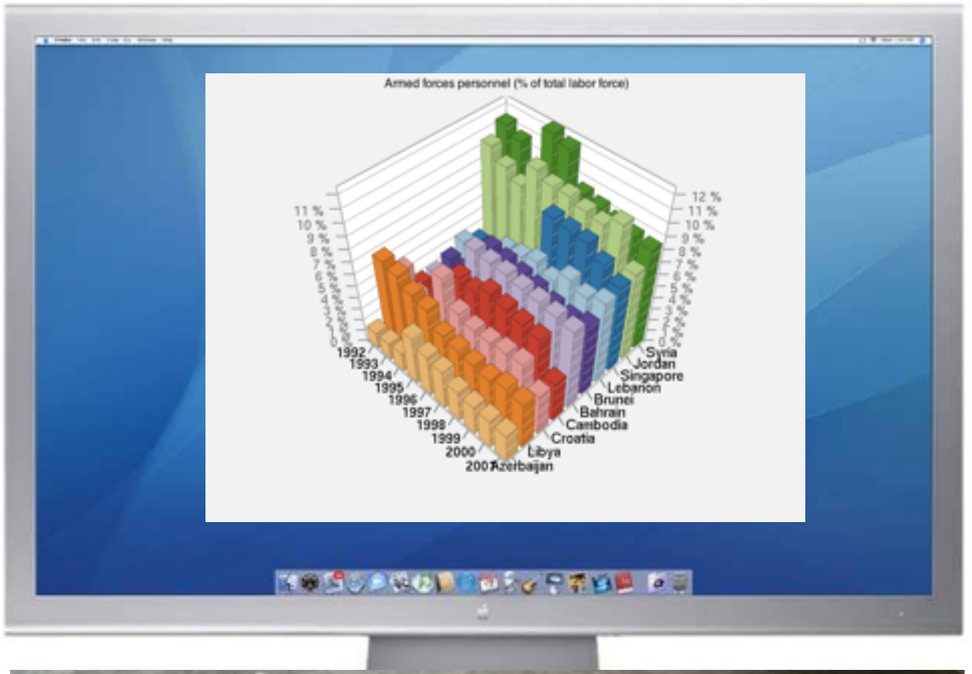



External debt stocks (% of GNI)
500 %
450 %
400 %
350 %
300 %
250 %
200 %
150 %
100 %
50 %
0 %
300 %
250 %
200 %
150 %
100 %
50 %
0 %
1995
1996
1997
1998
1999
2000
2001
2002
2003
2004
Burundi
Argentina
Eritrea
Yemen Rep.
Angola
Mozambique
Nicaragua
Guyana
Congo Rep.
Guinea-Bissau

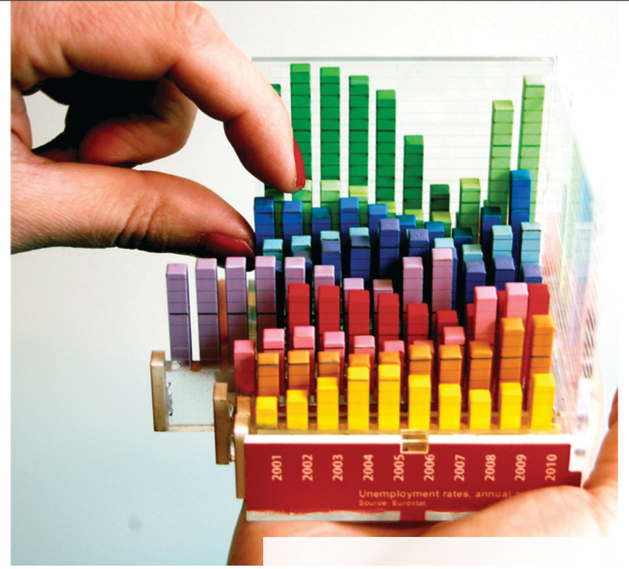

Armed forces personnel (% of total labor force)
12 %
11 %
10 %
9 %
8 %
11 %
10 %
9 %
1992
1993
1994
1995
1996
1997
1998
1999
2000
2001
Azerbaijan
Libya
Croatia
Cambodia
Bahrain
Brunei
Lebanon
Singapore
Jordan
Syria

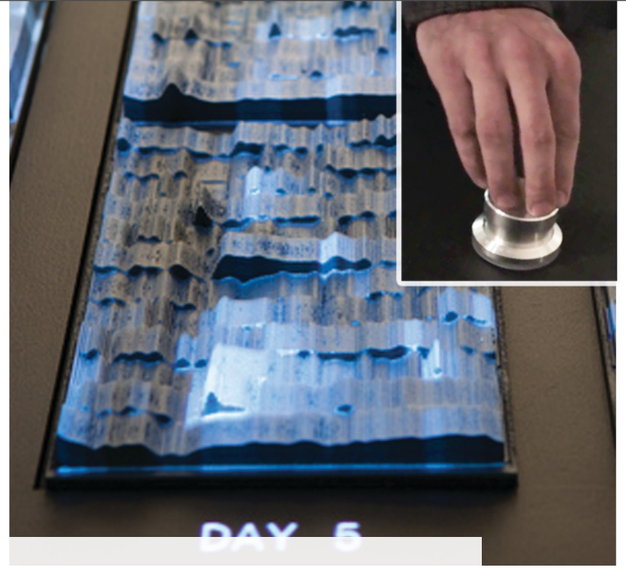

Armed forces personnel (% of total labor force)
12 %
11 %
10 %
9 %
8 %
7 %
6 %
5 %
4 %
3 %
2 %
1 %
0 %
1992
1993
1994
1995
1996
1997
1998
1999
2000
2001
Azerbaijan
Libya
Croatia
Cambodia
Bahrain
Brunei
Lebanon
Singapore
Jordan
Syria

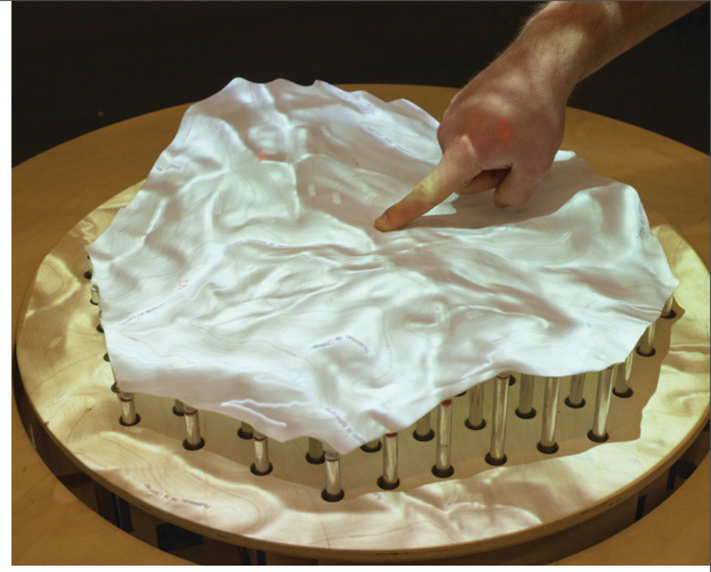
repeated



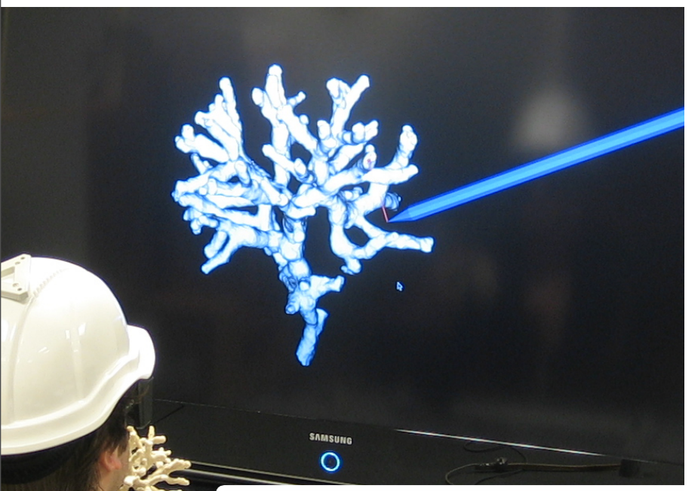
one-shot

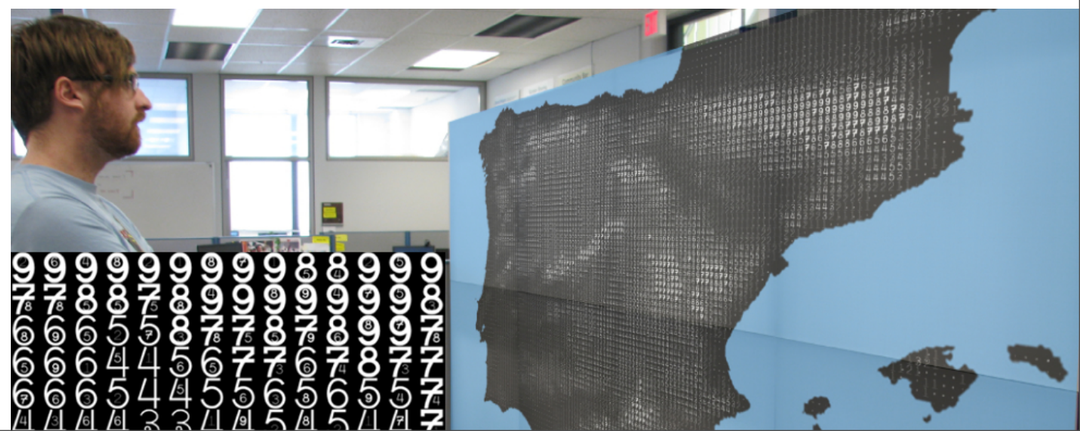


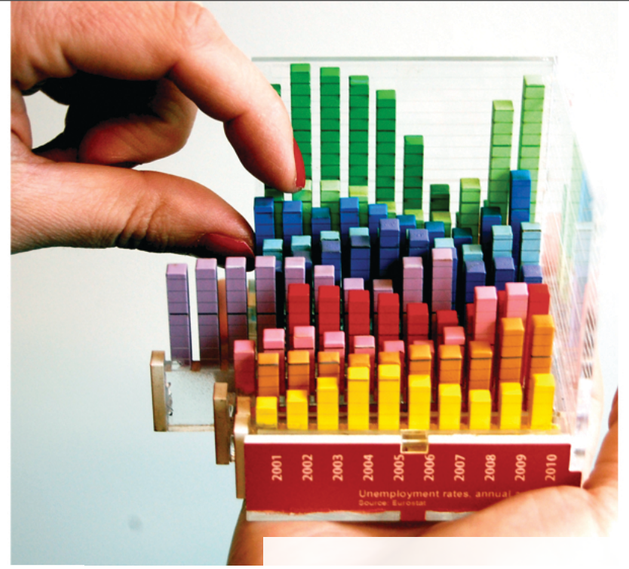


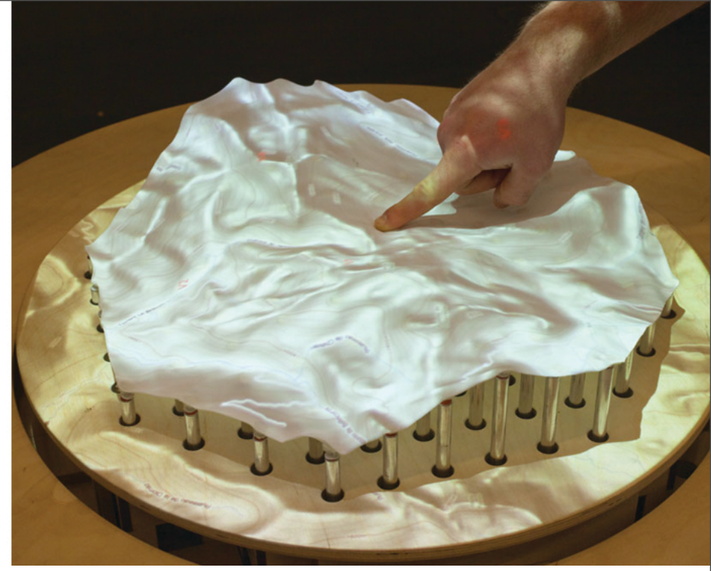


Case Studies

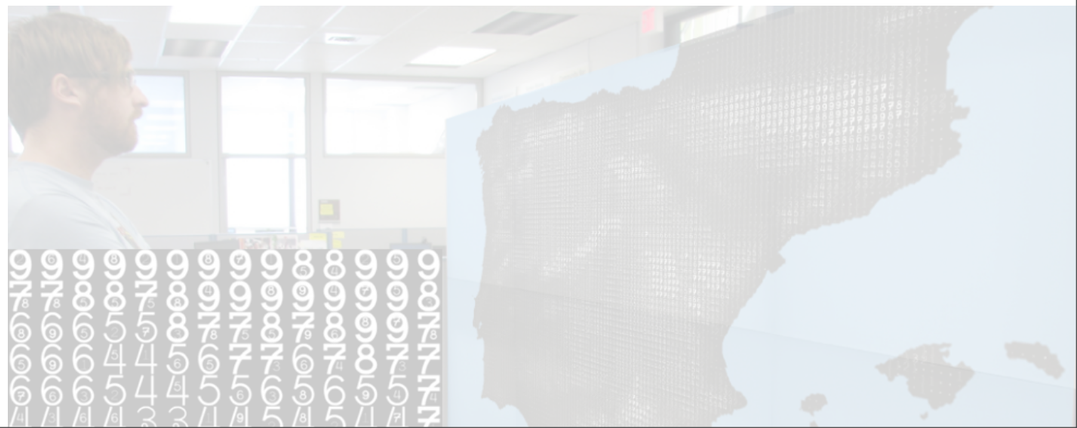






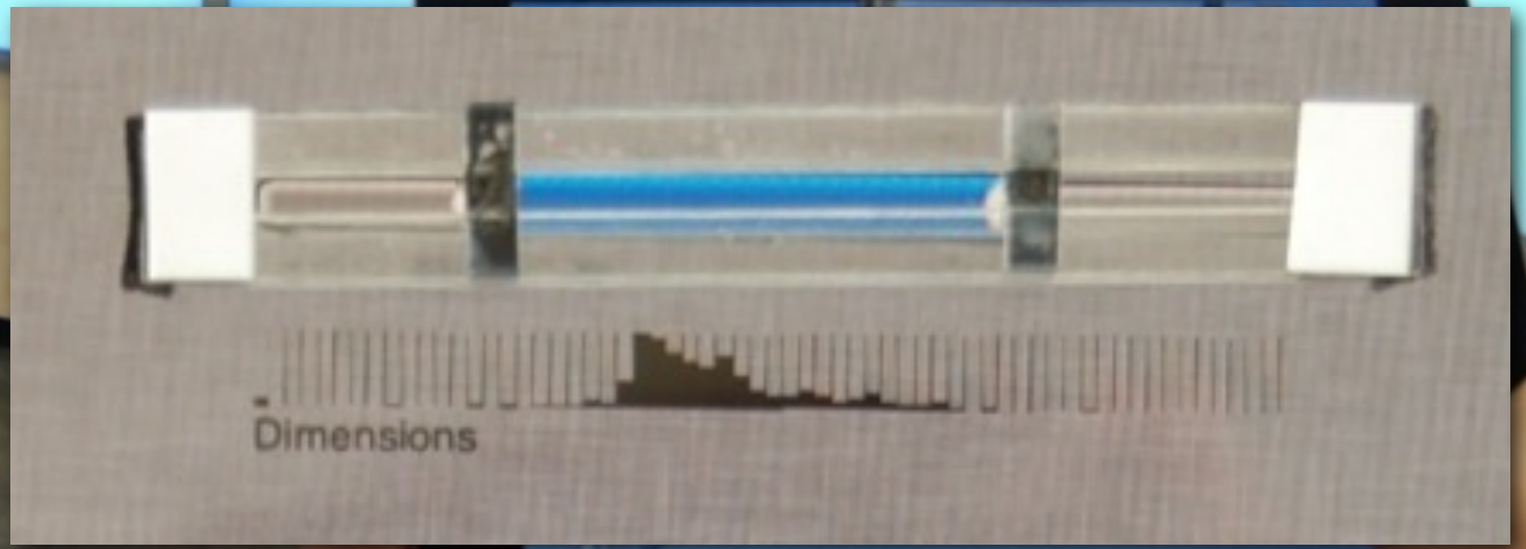


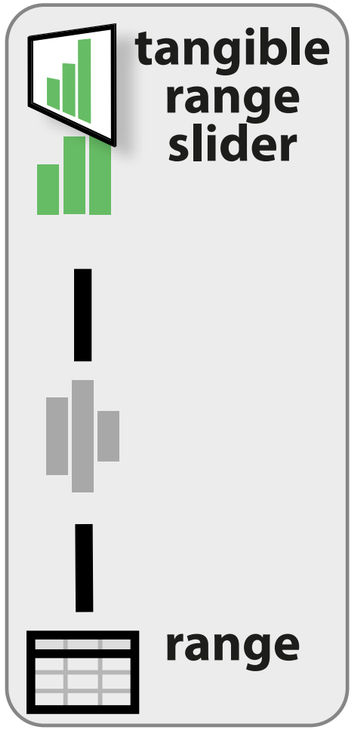
Case Studies




[Jansen, Dragicevic, Fekete. Tangible Remote Controllers for Wall-sized Displays. CHI'12]

[Jansen, Dragicevic, Fekete. Tangible Remote Controllers for Wall-sized Displays. CHI'12]

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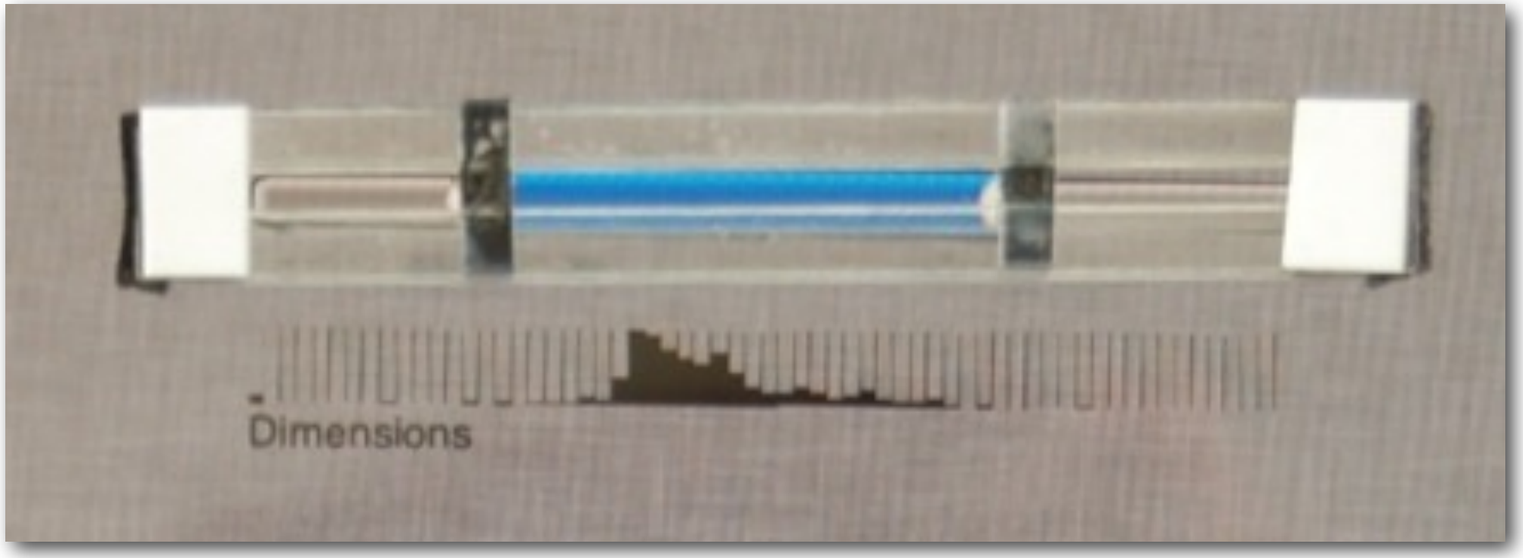
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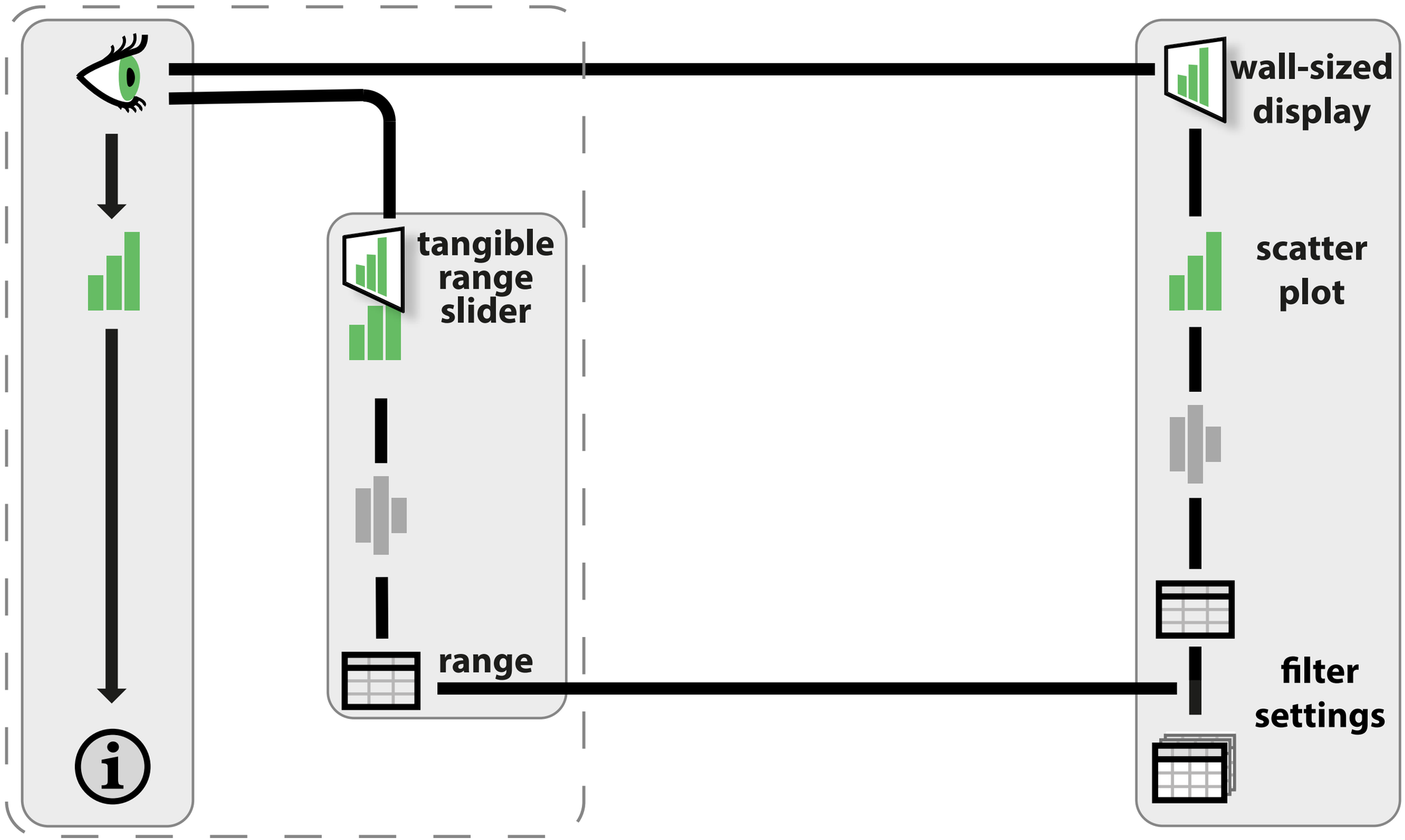
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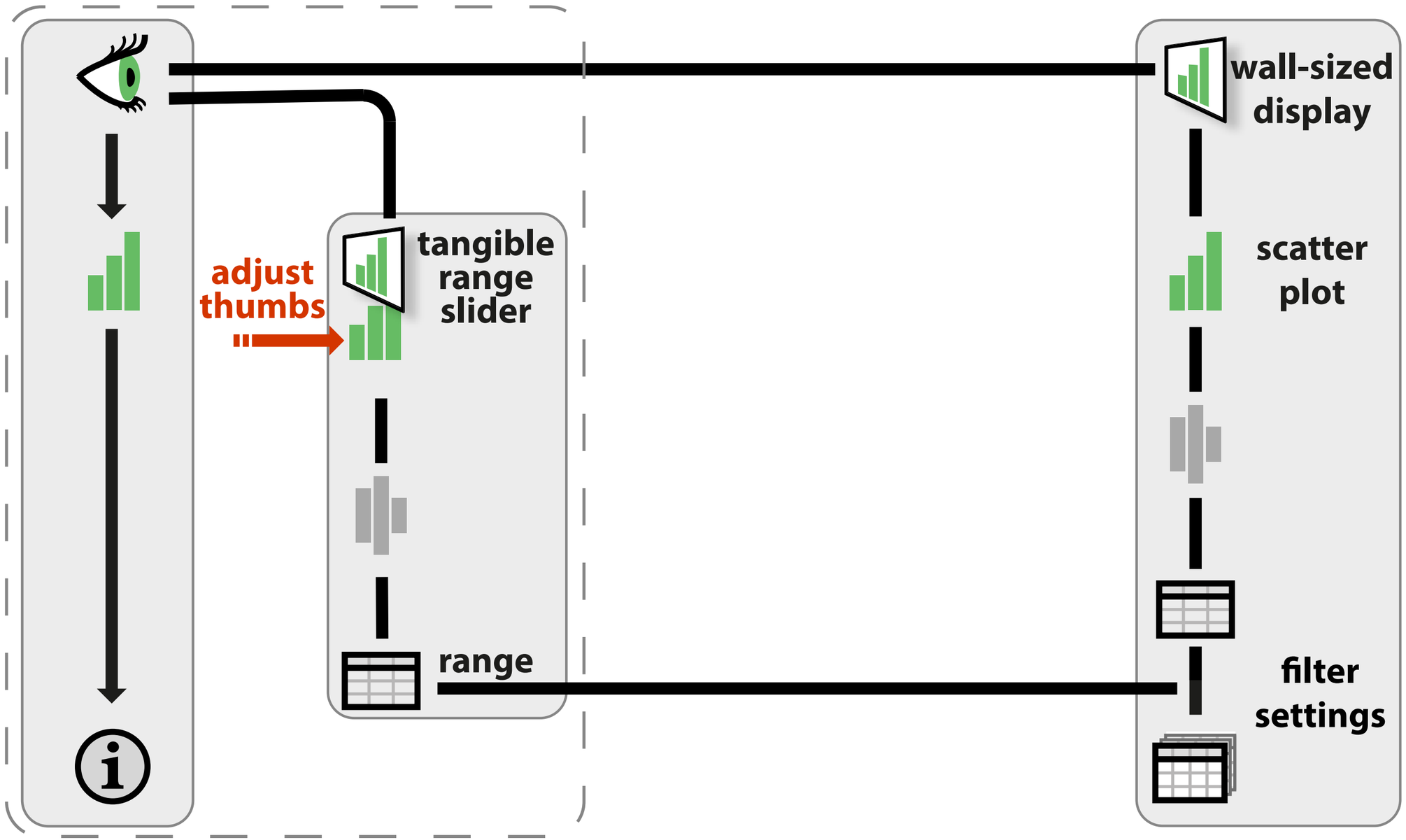
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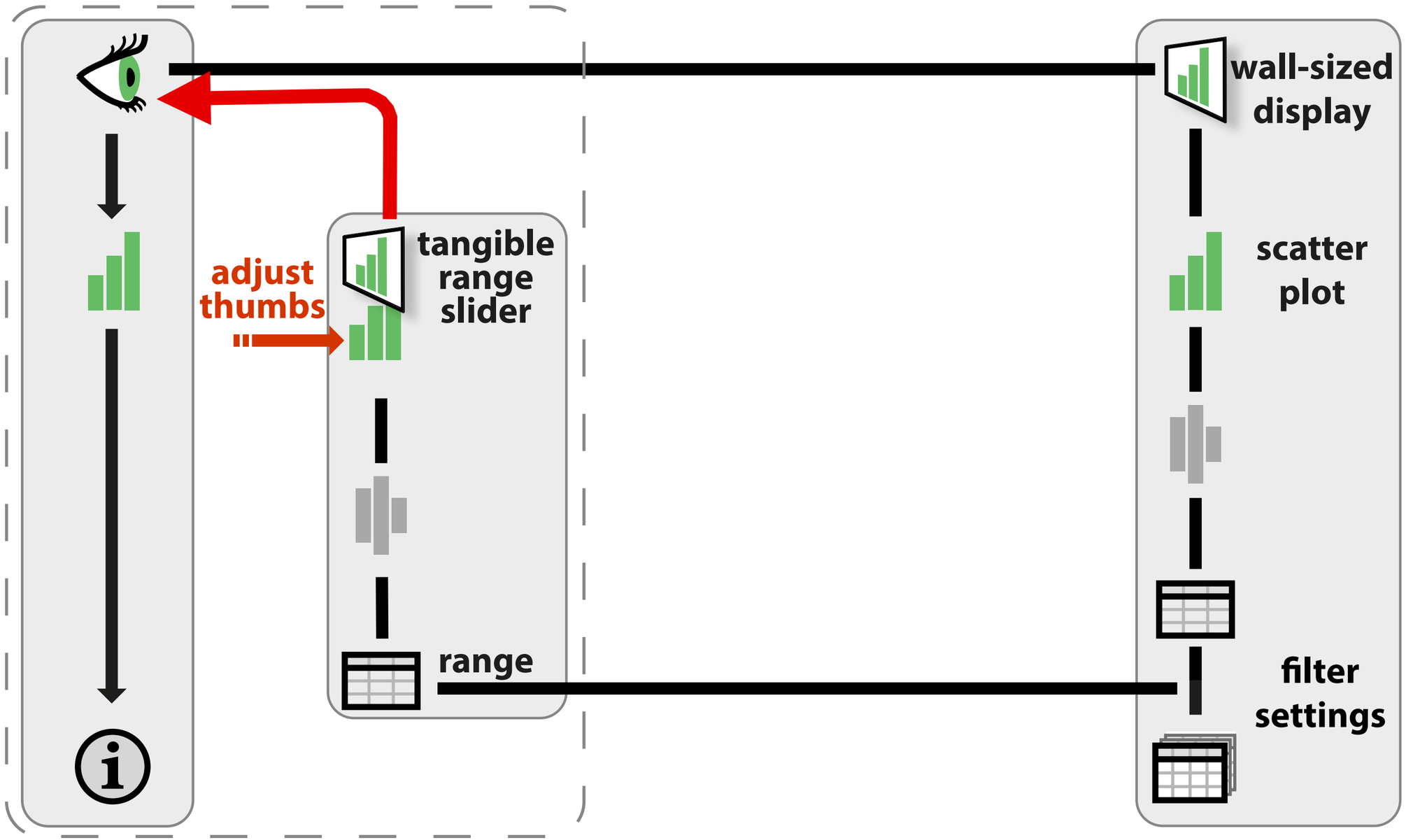
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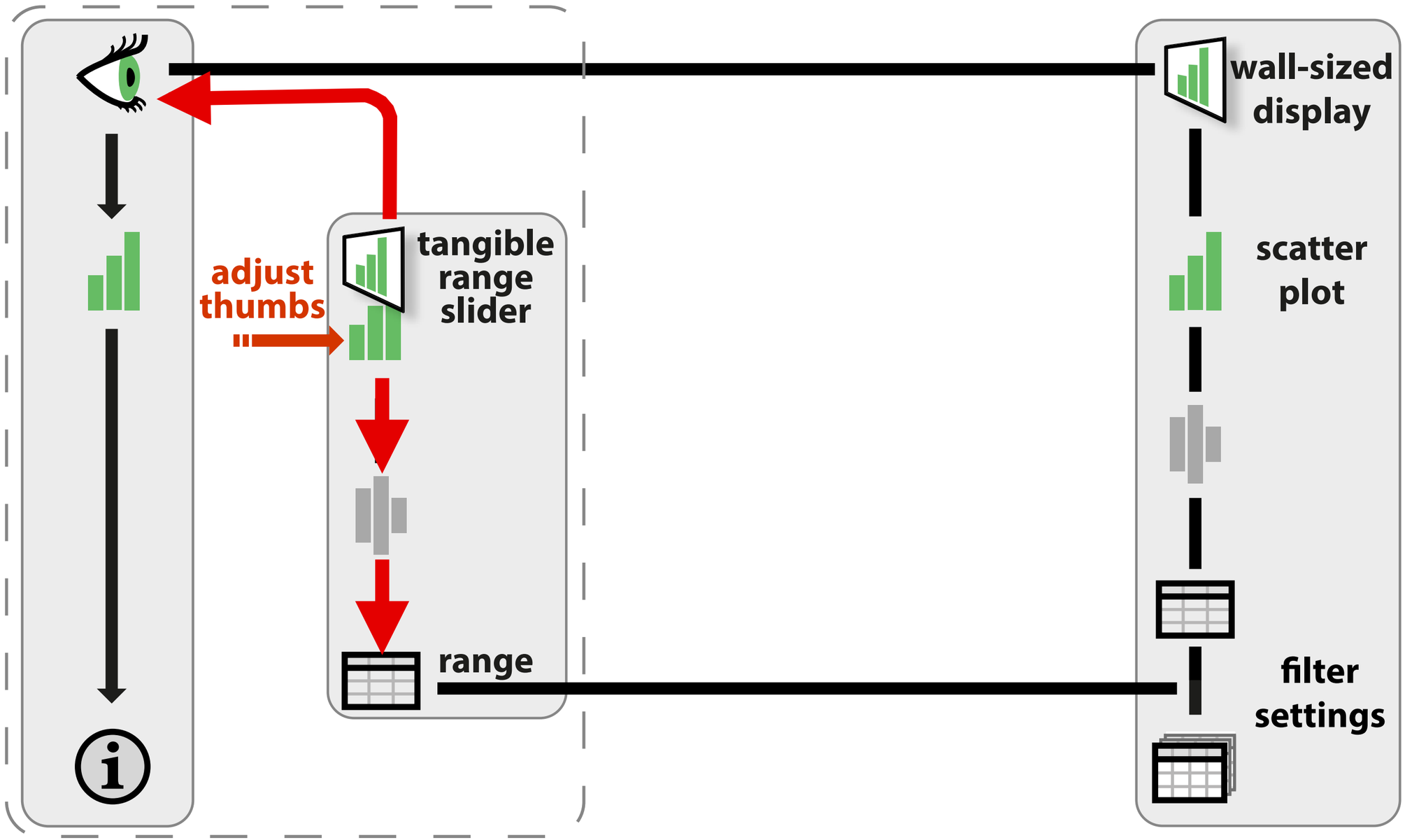
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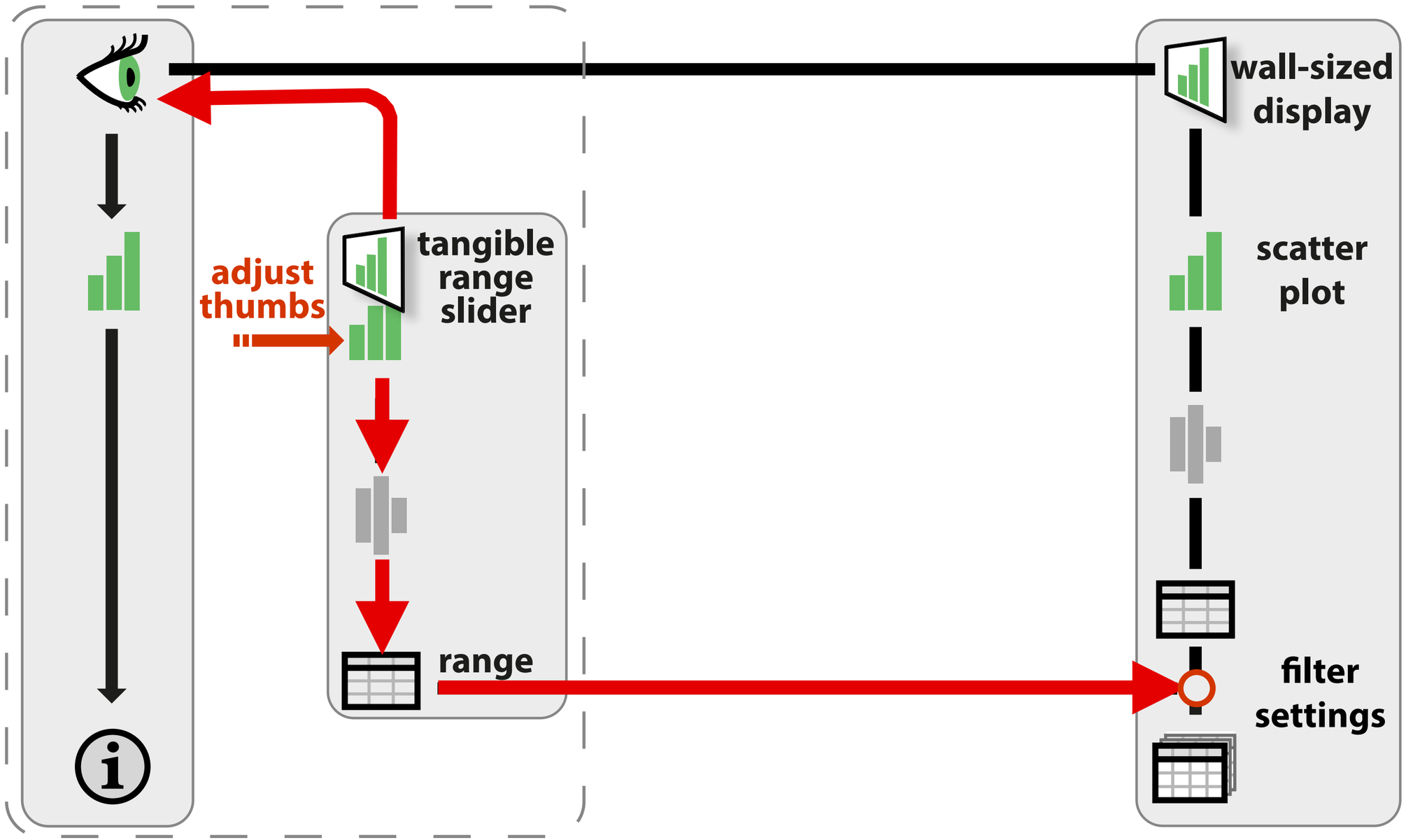
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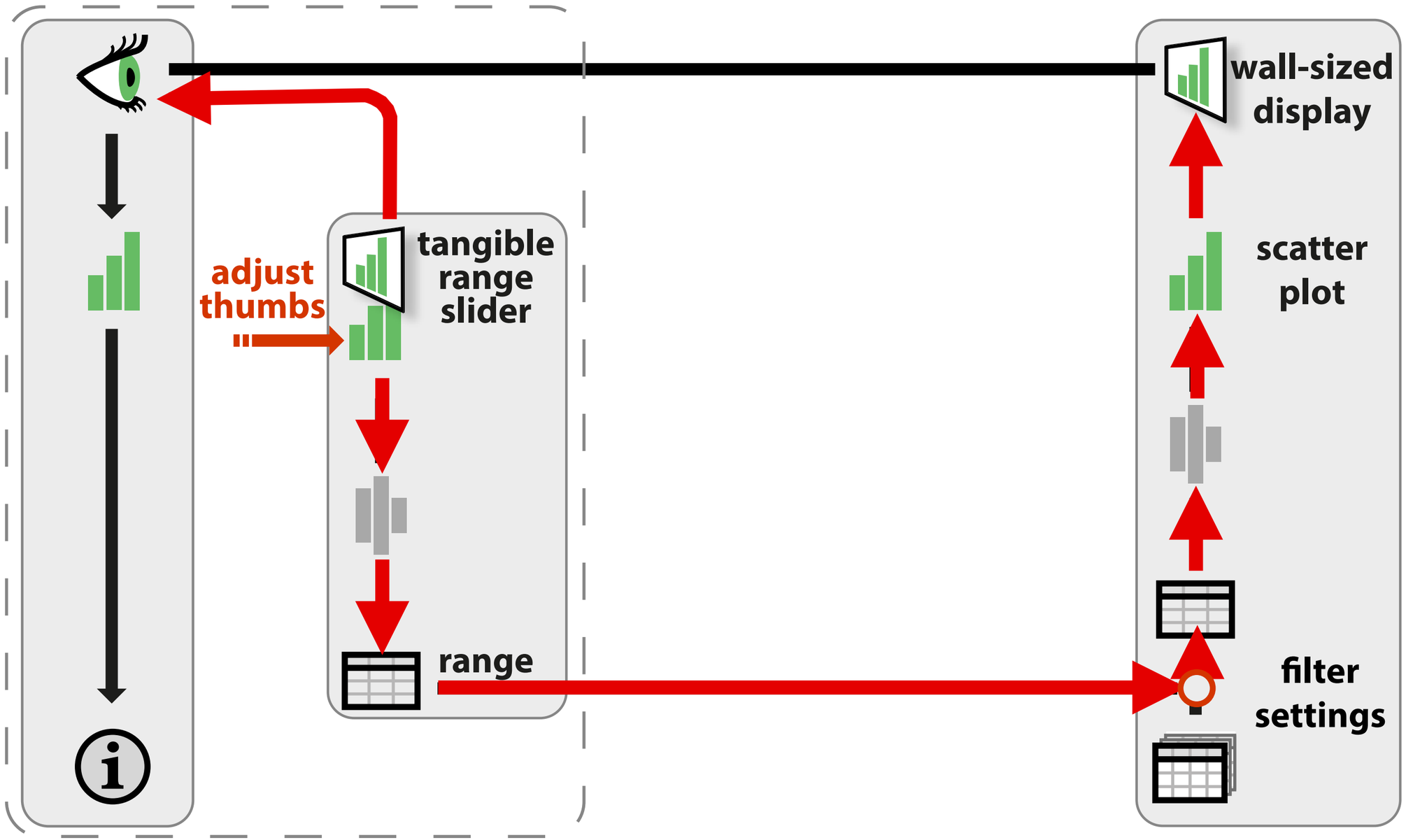
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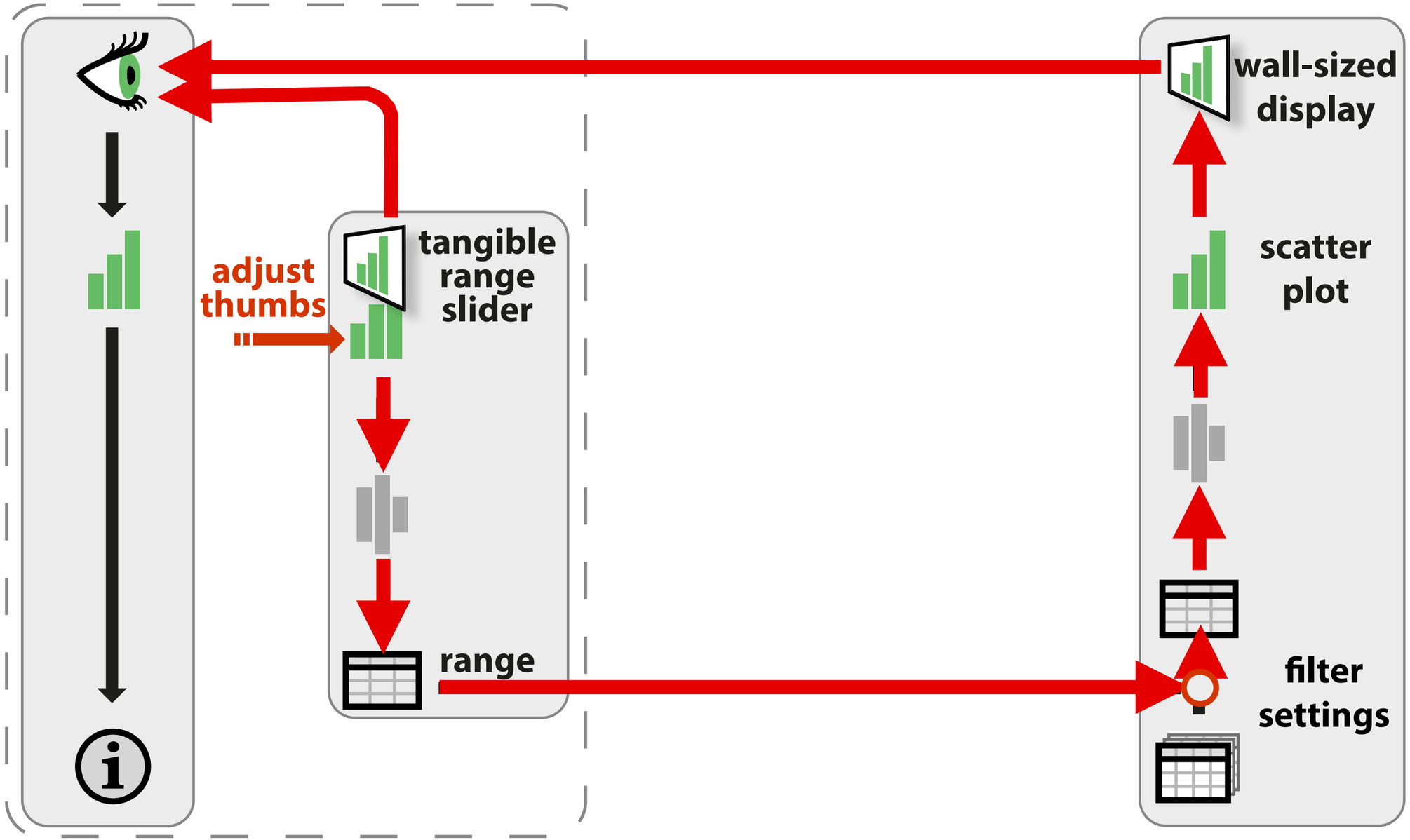
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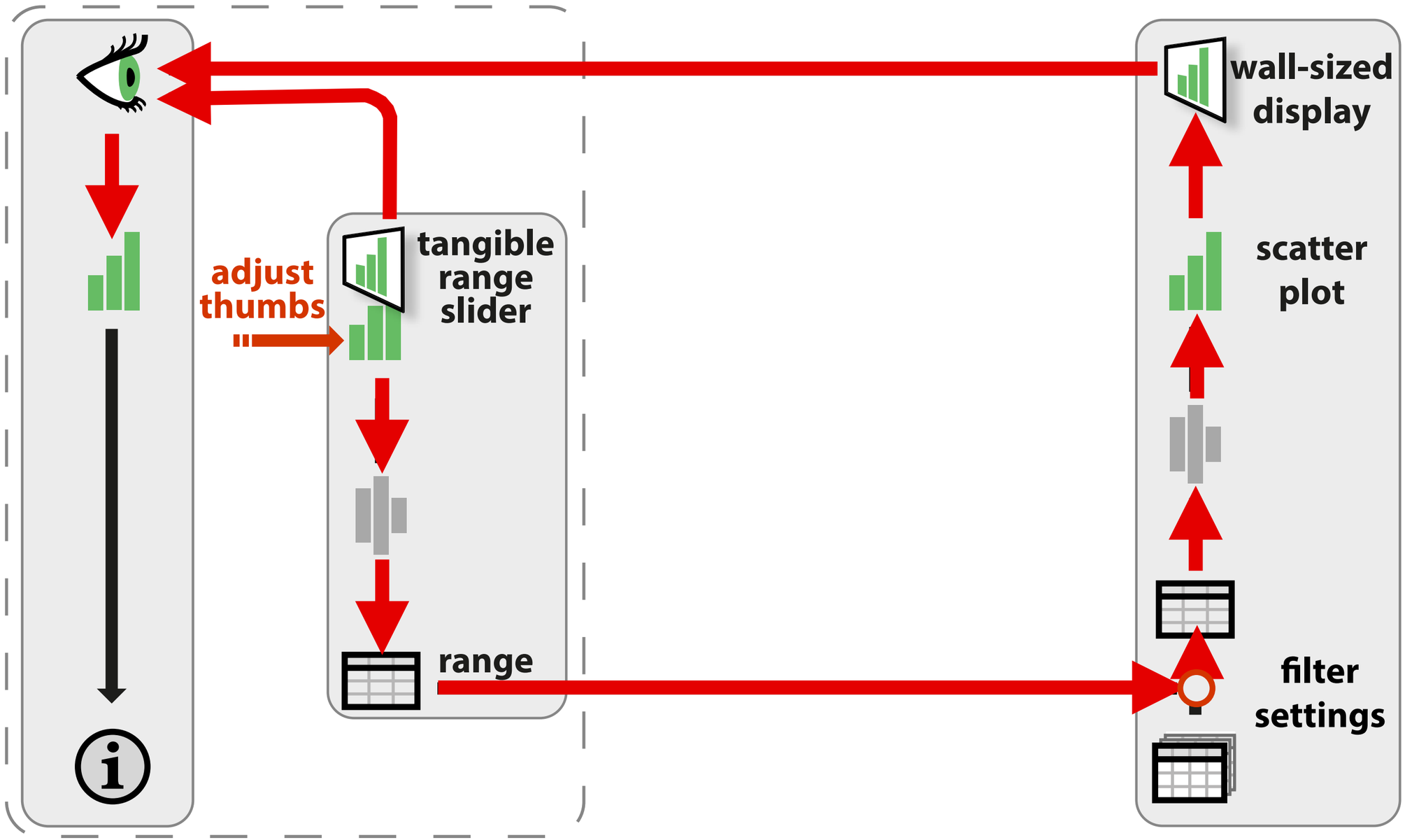
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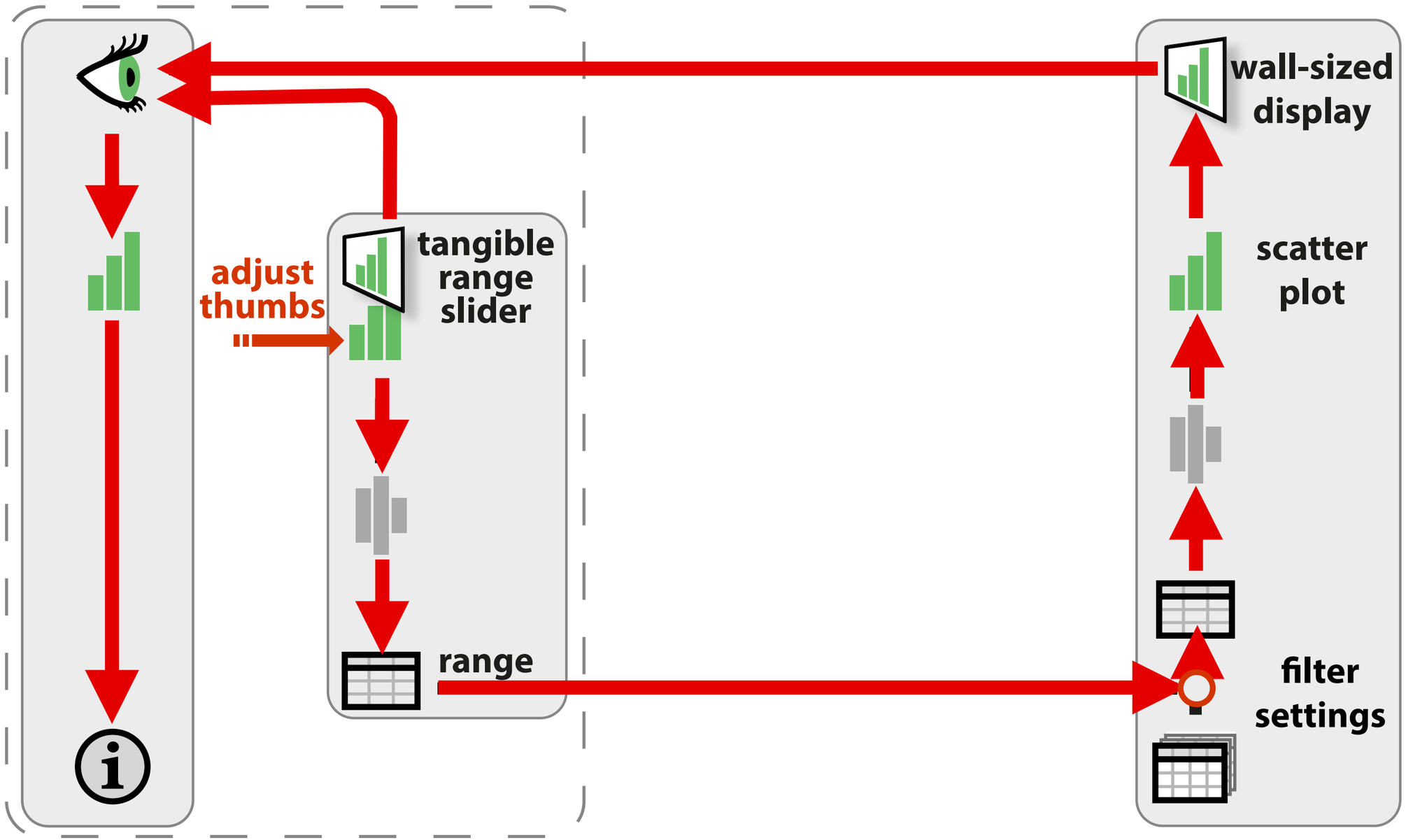
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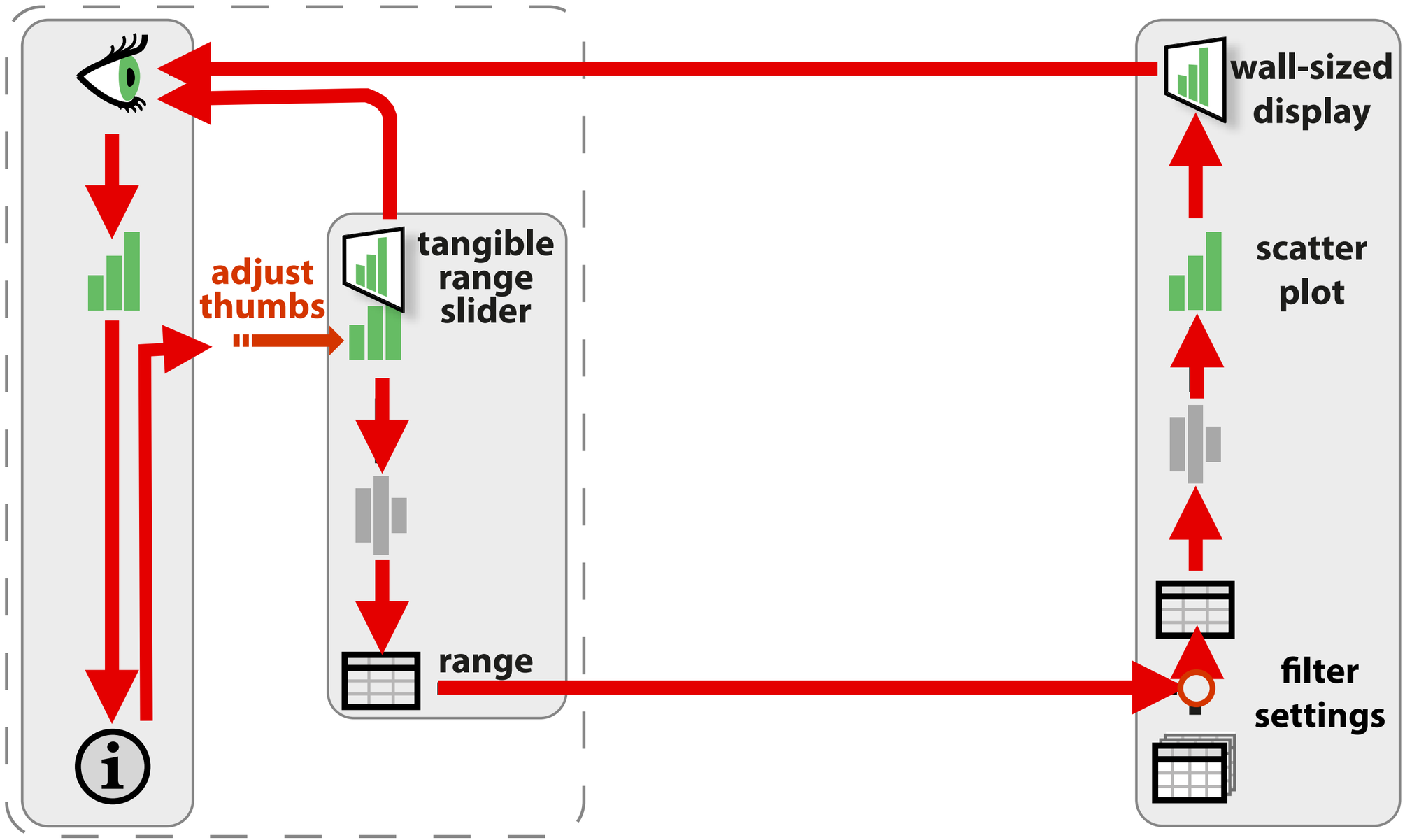
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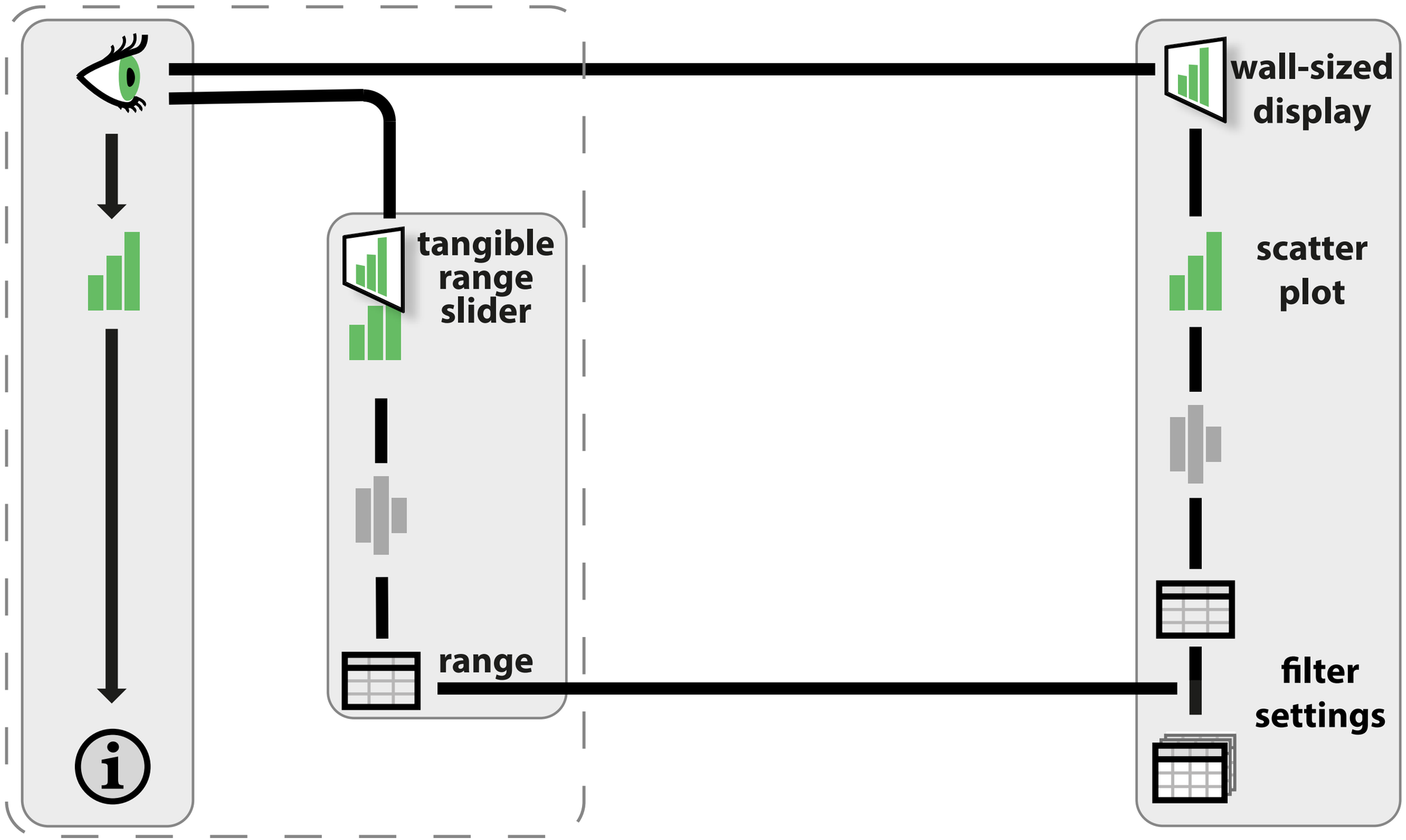
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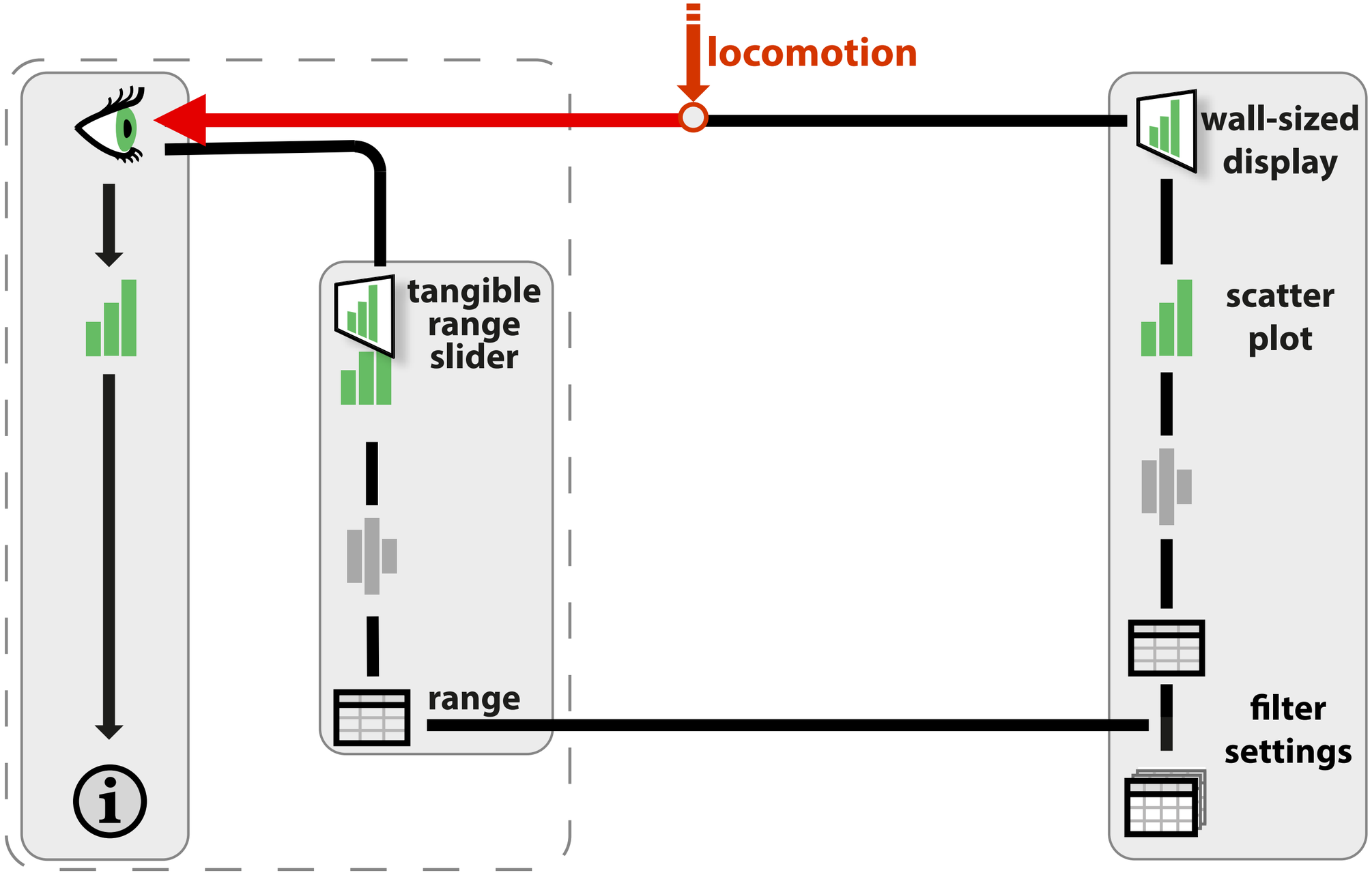
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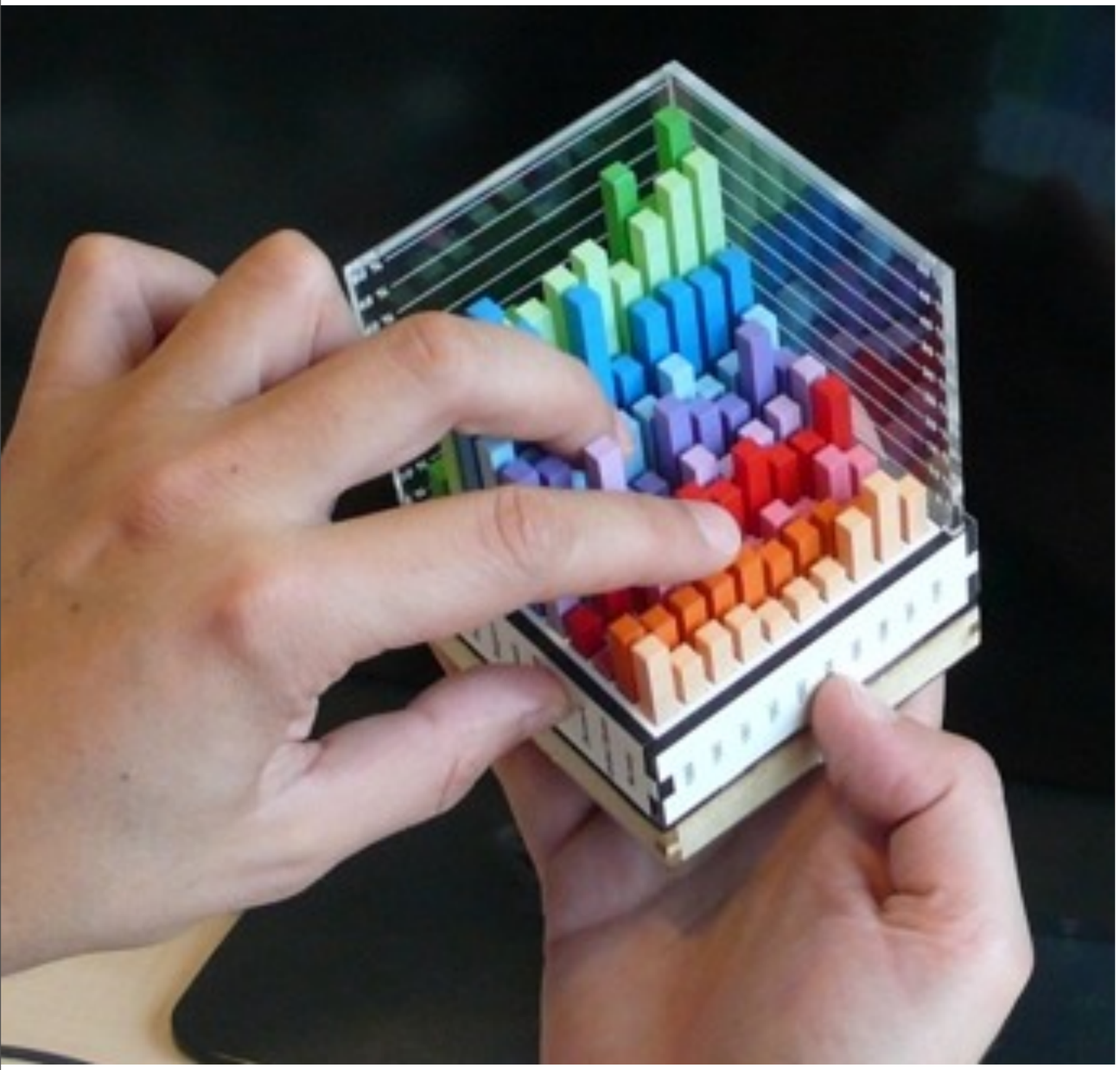

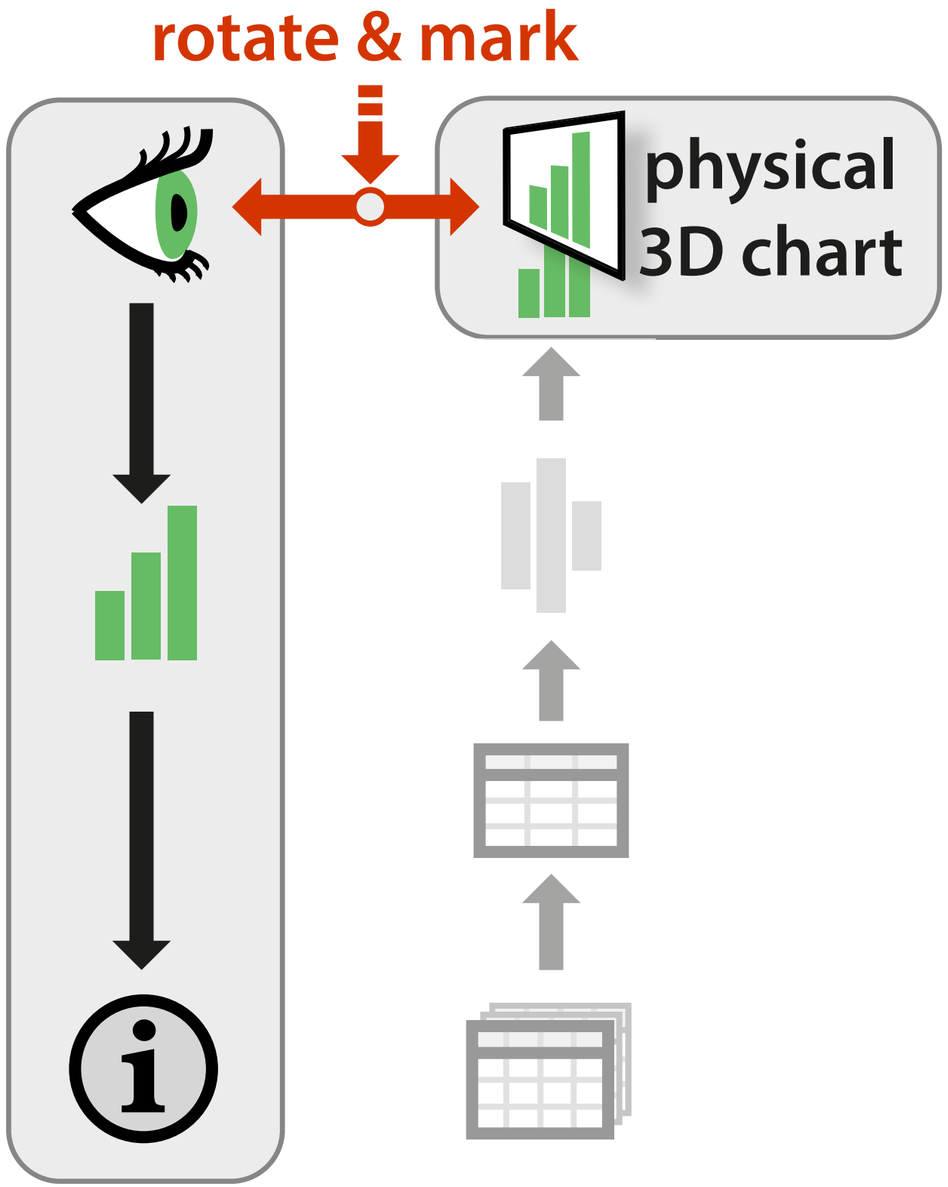
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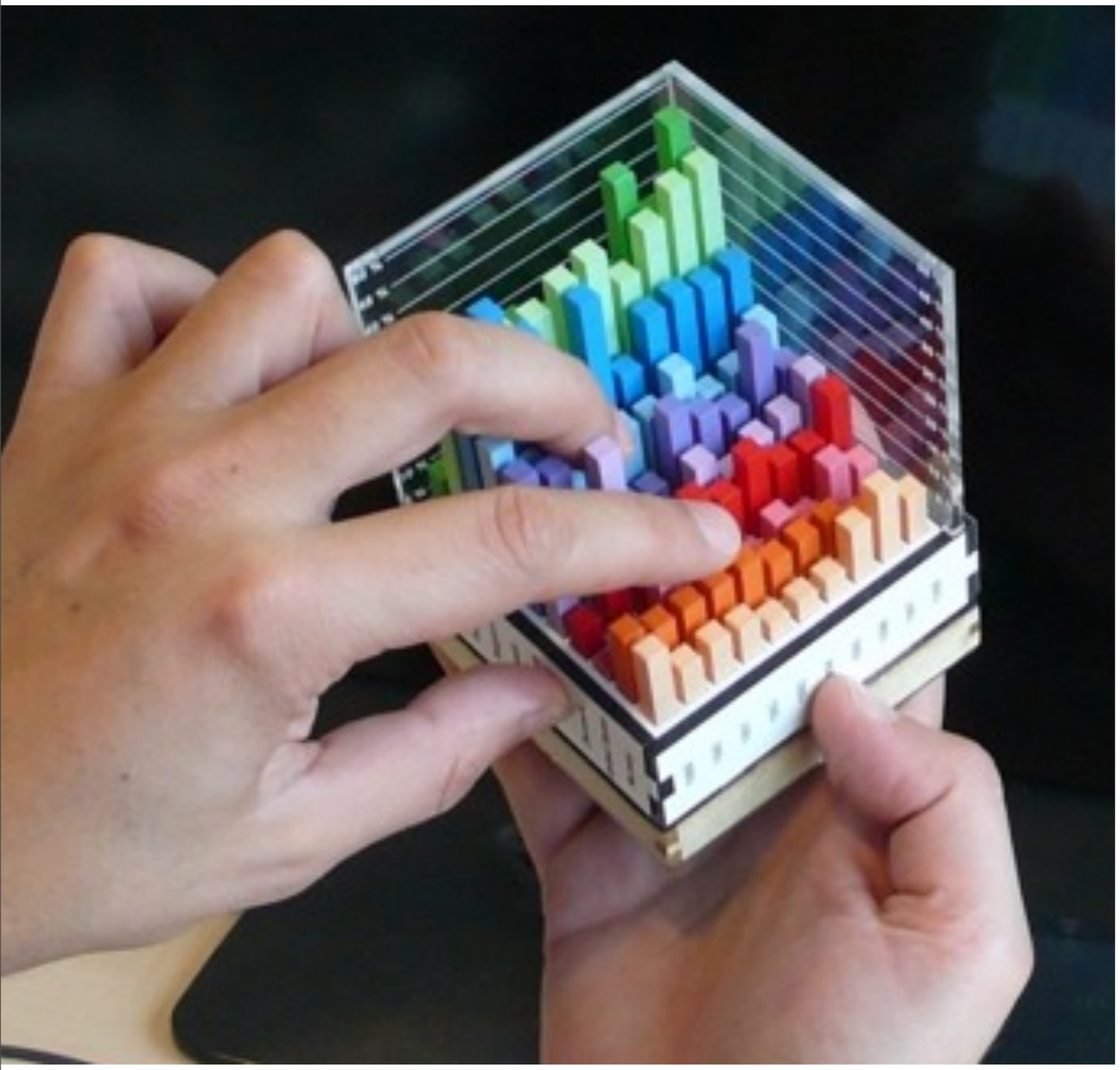

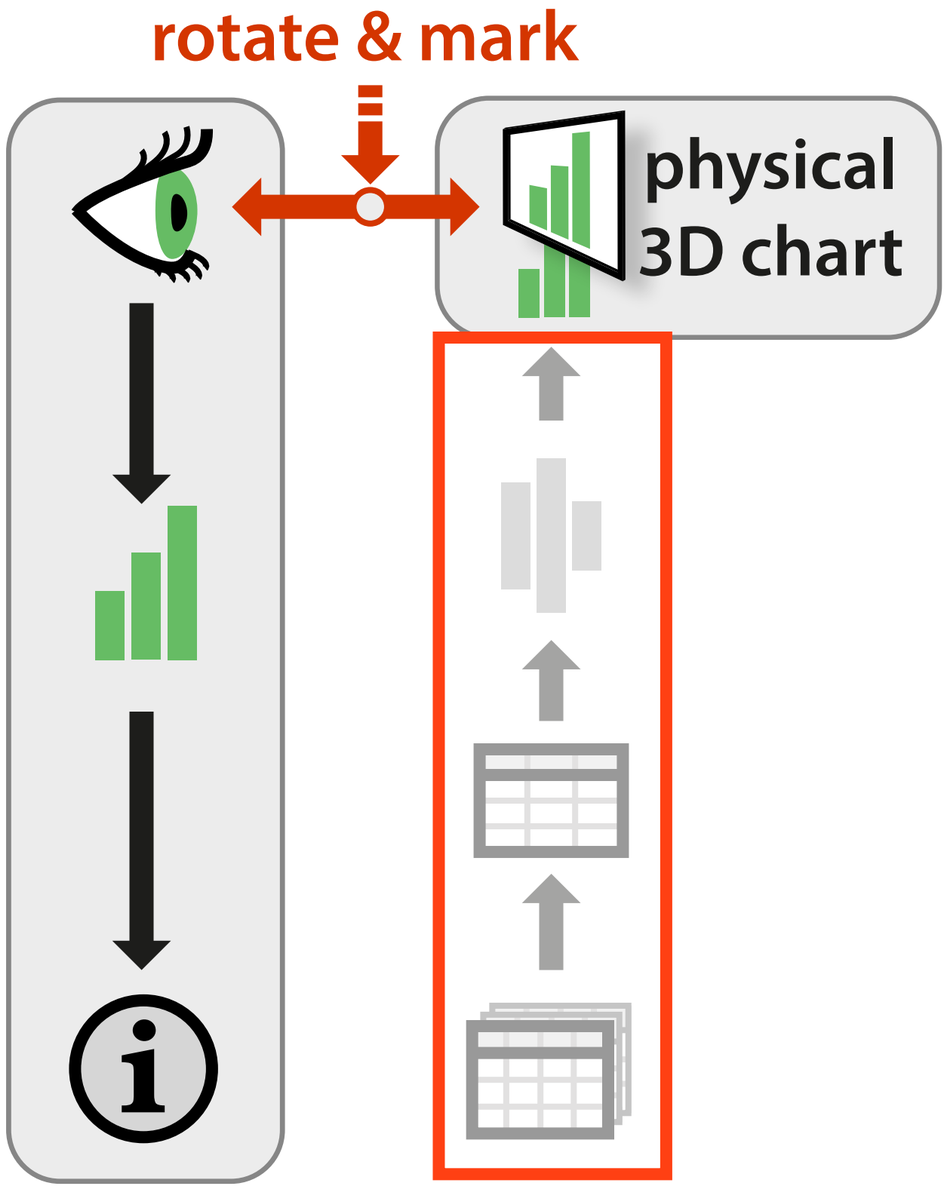
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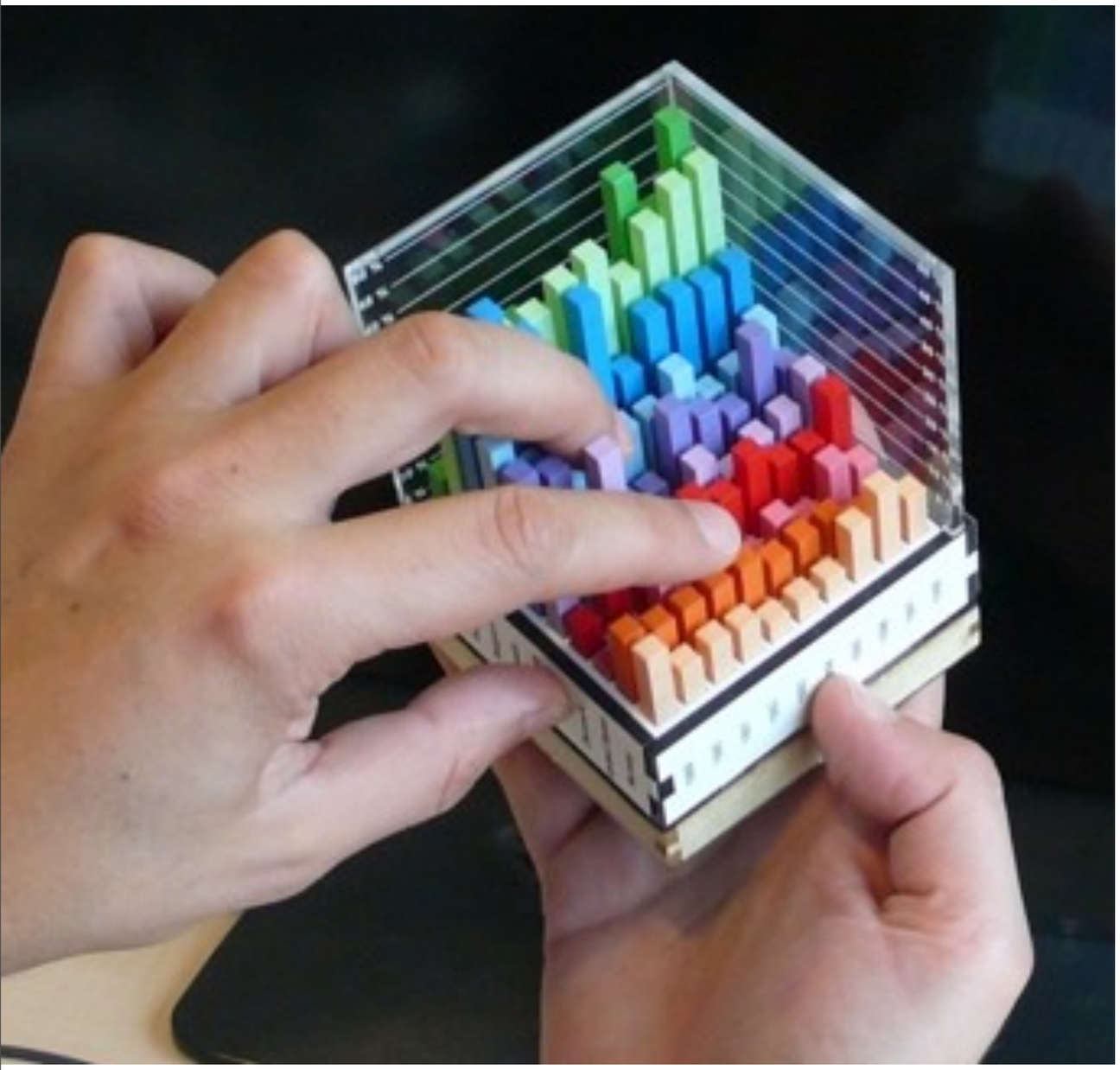

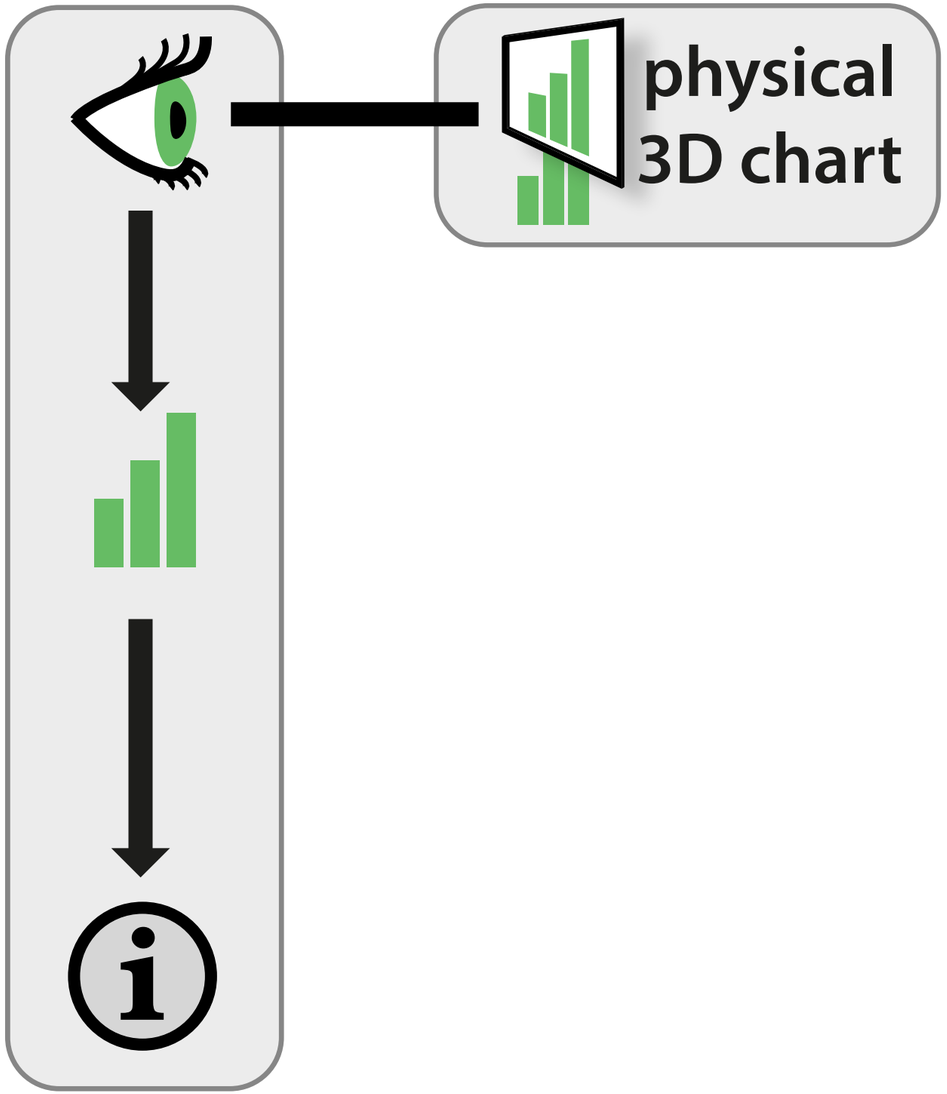
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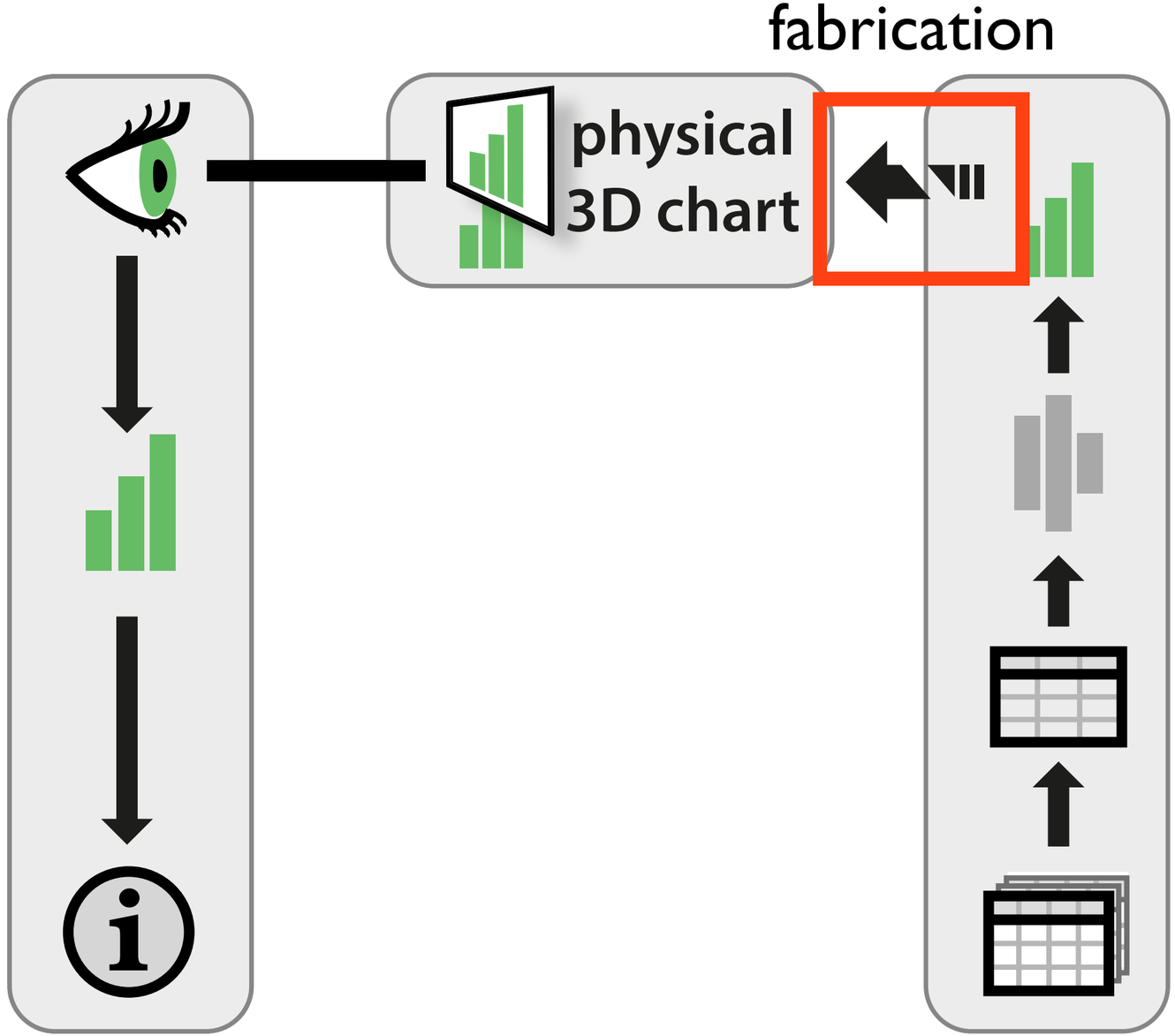
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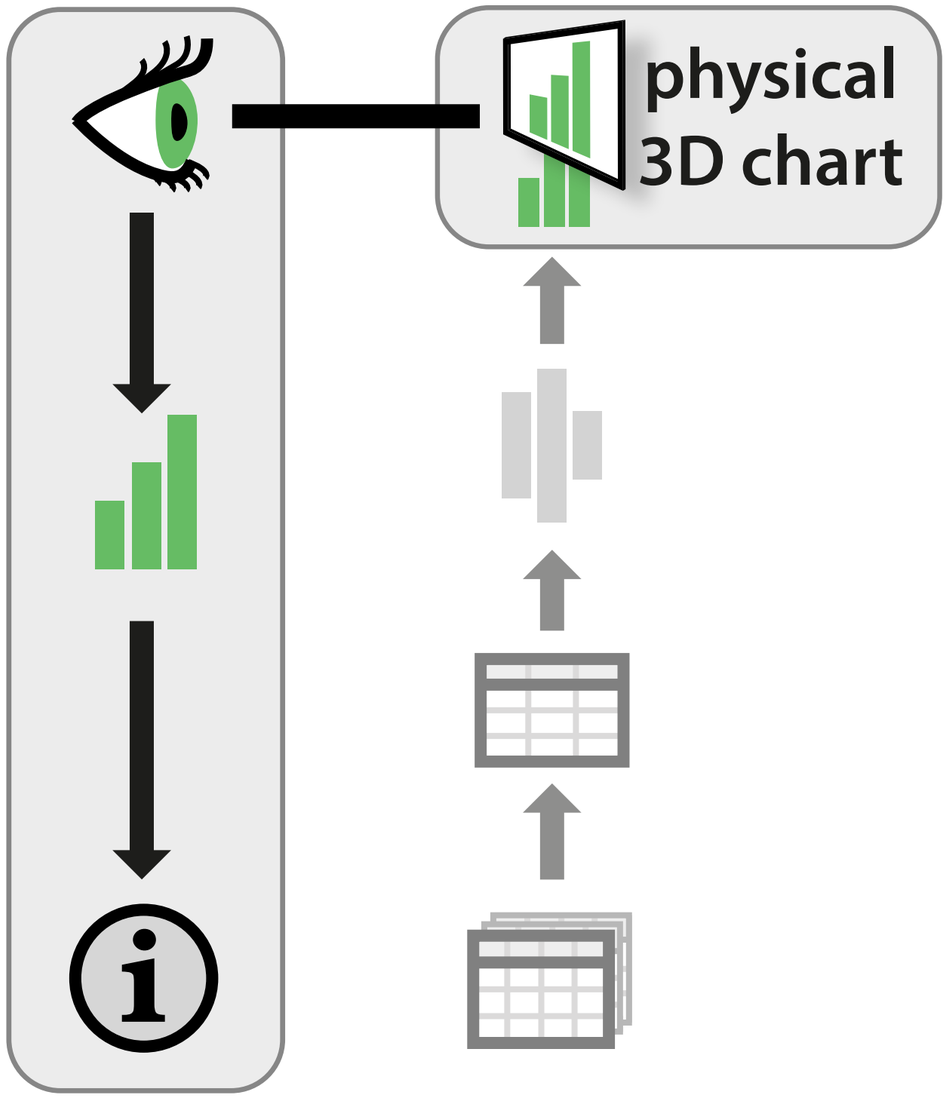
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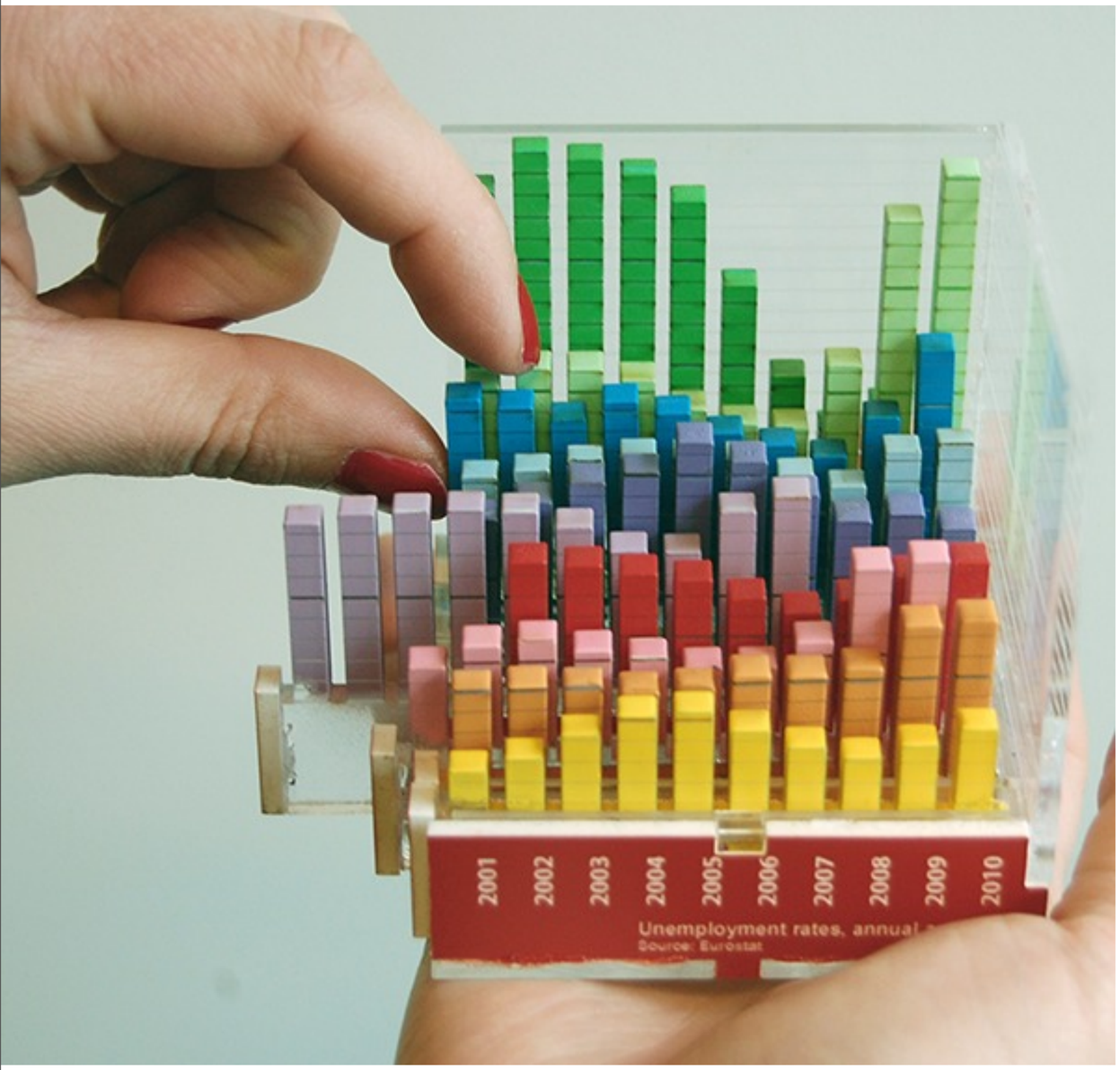
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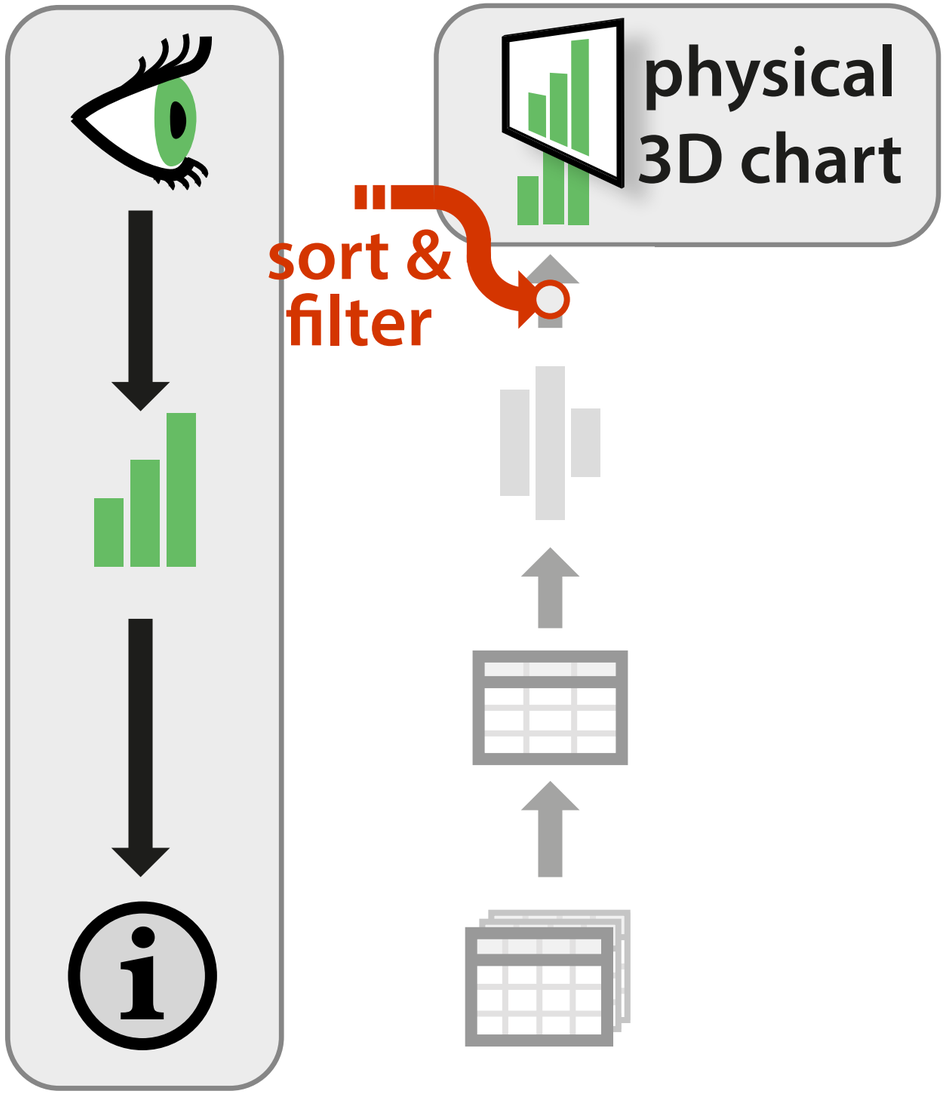
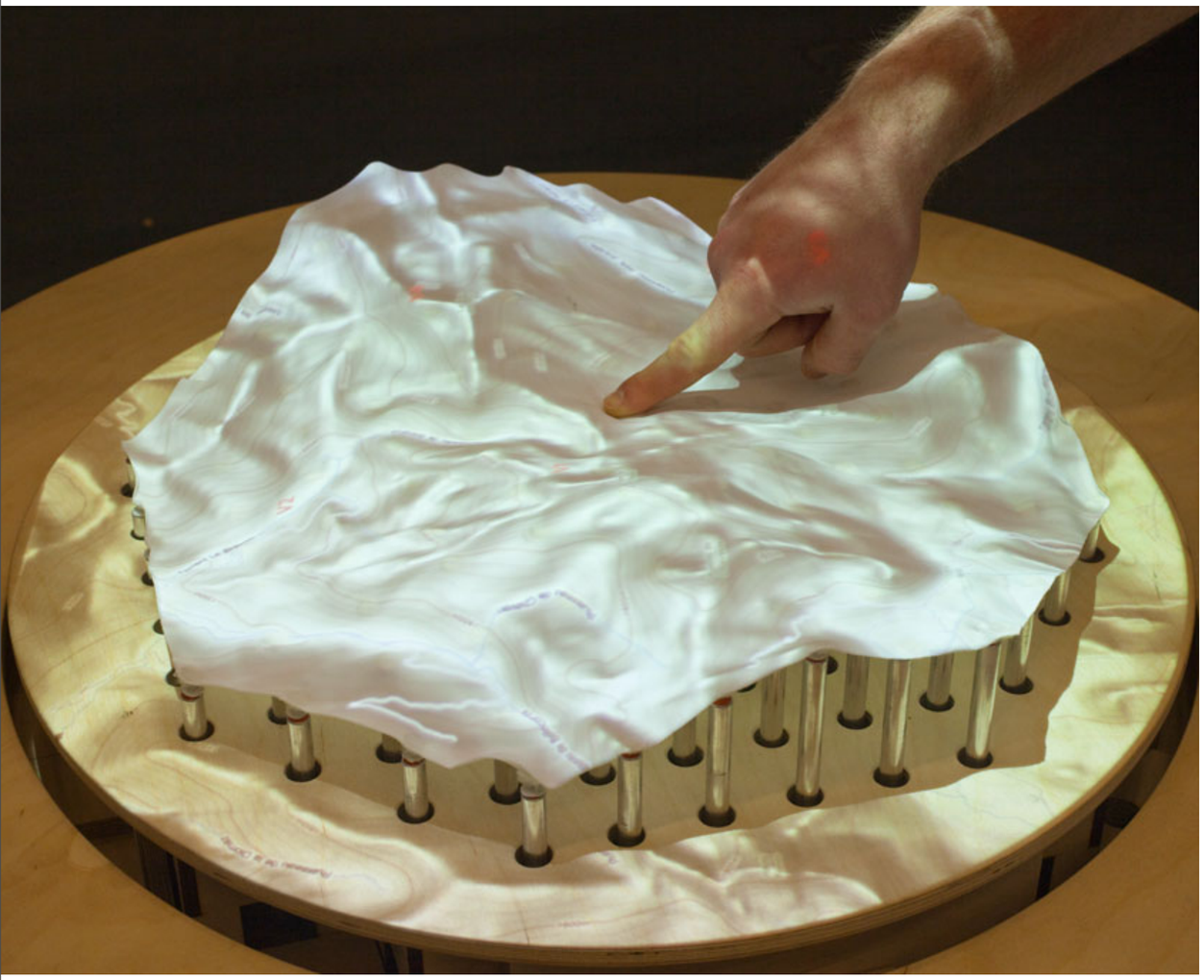
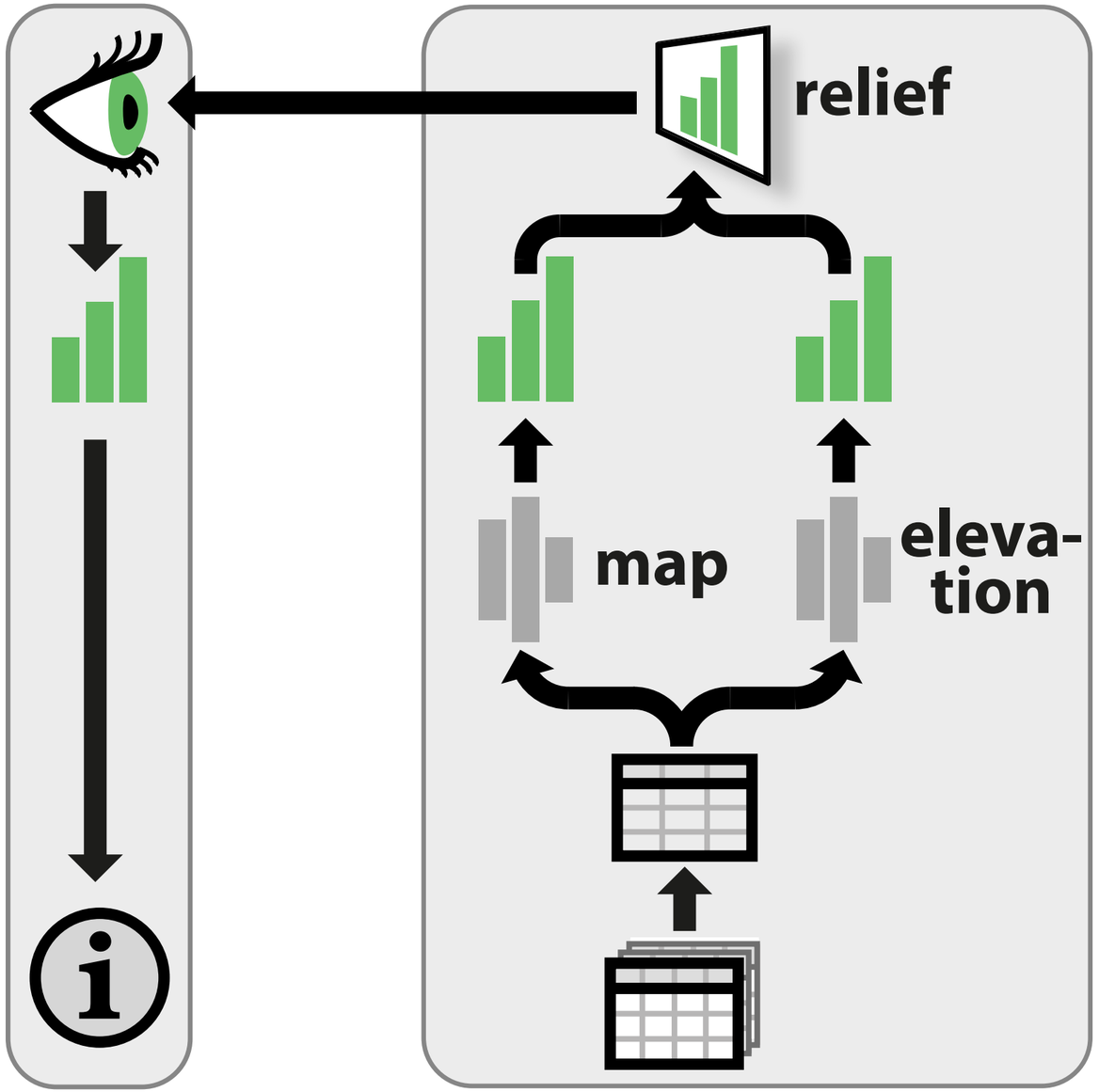
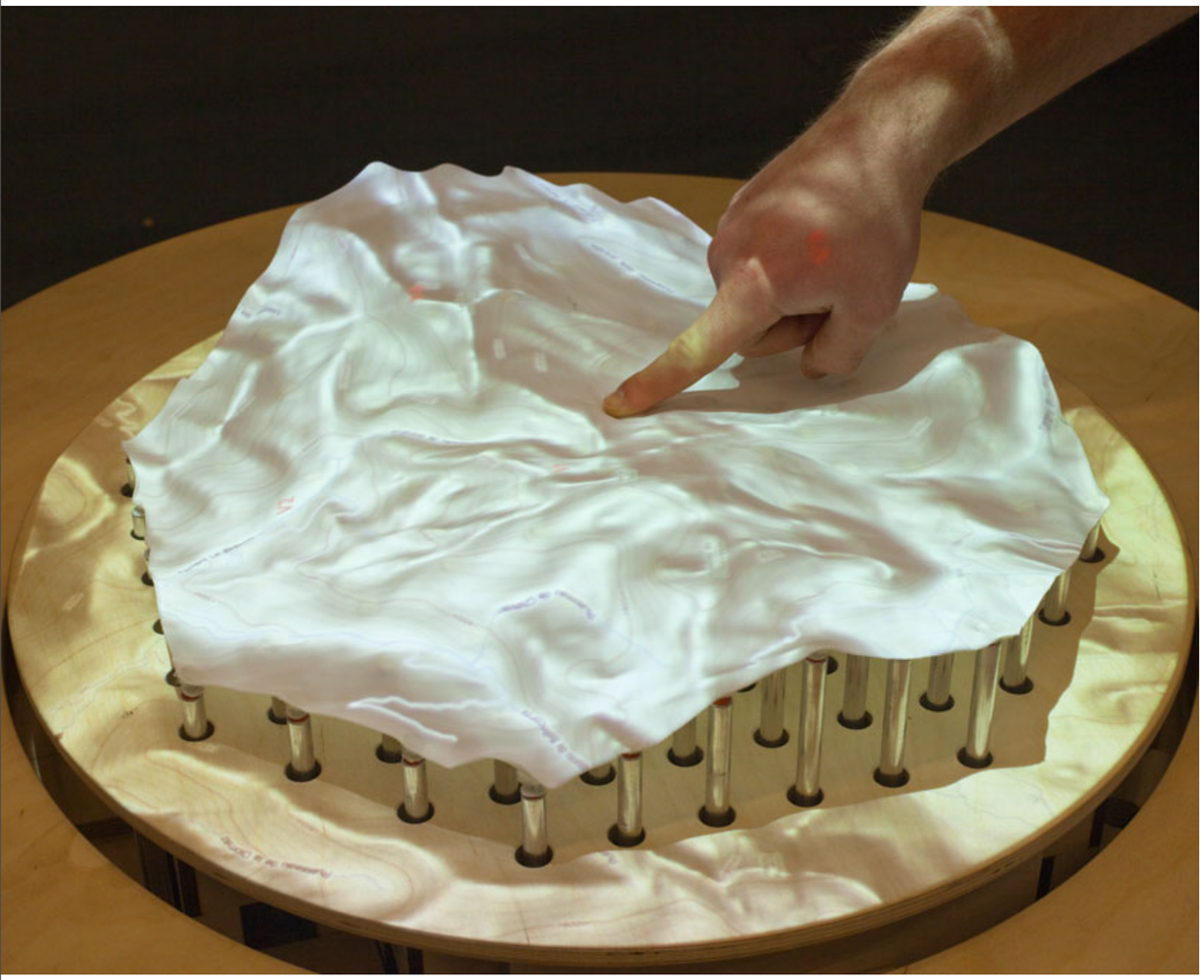
2003
2004
2005
2006
2007
2008
2009
2010
Unemployment rates, annual
Source: Eurostat

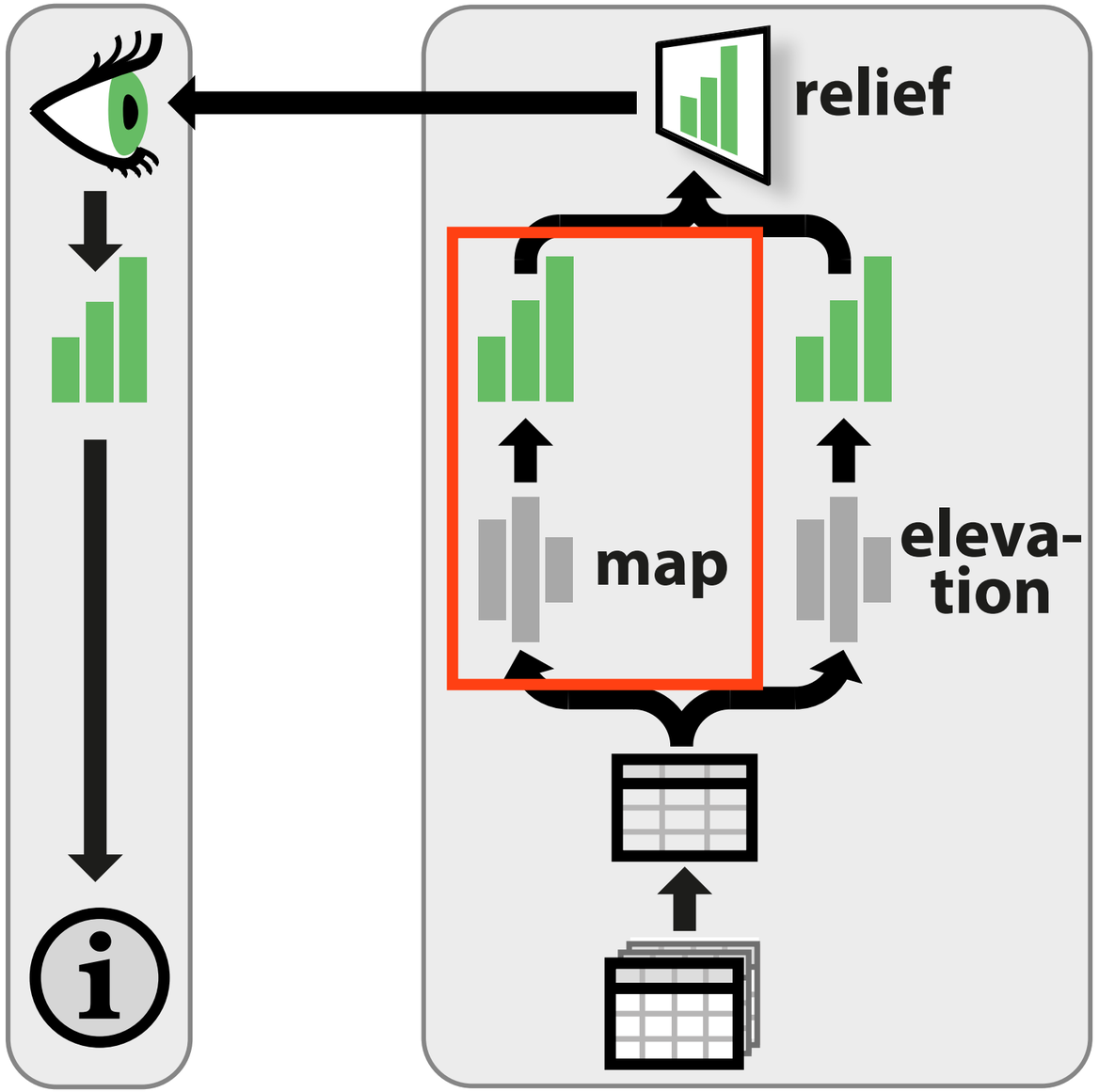

physical
3D chart
sort &
filter





[Leithinger et al. Relief: a 2.5D shape display. UIST'11]





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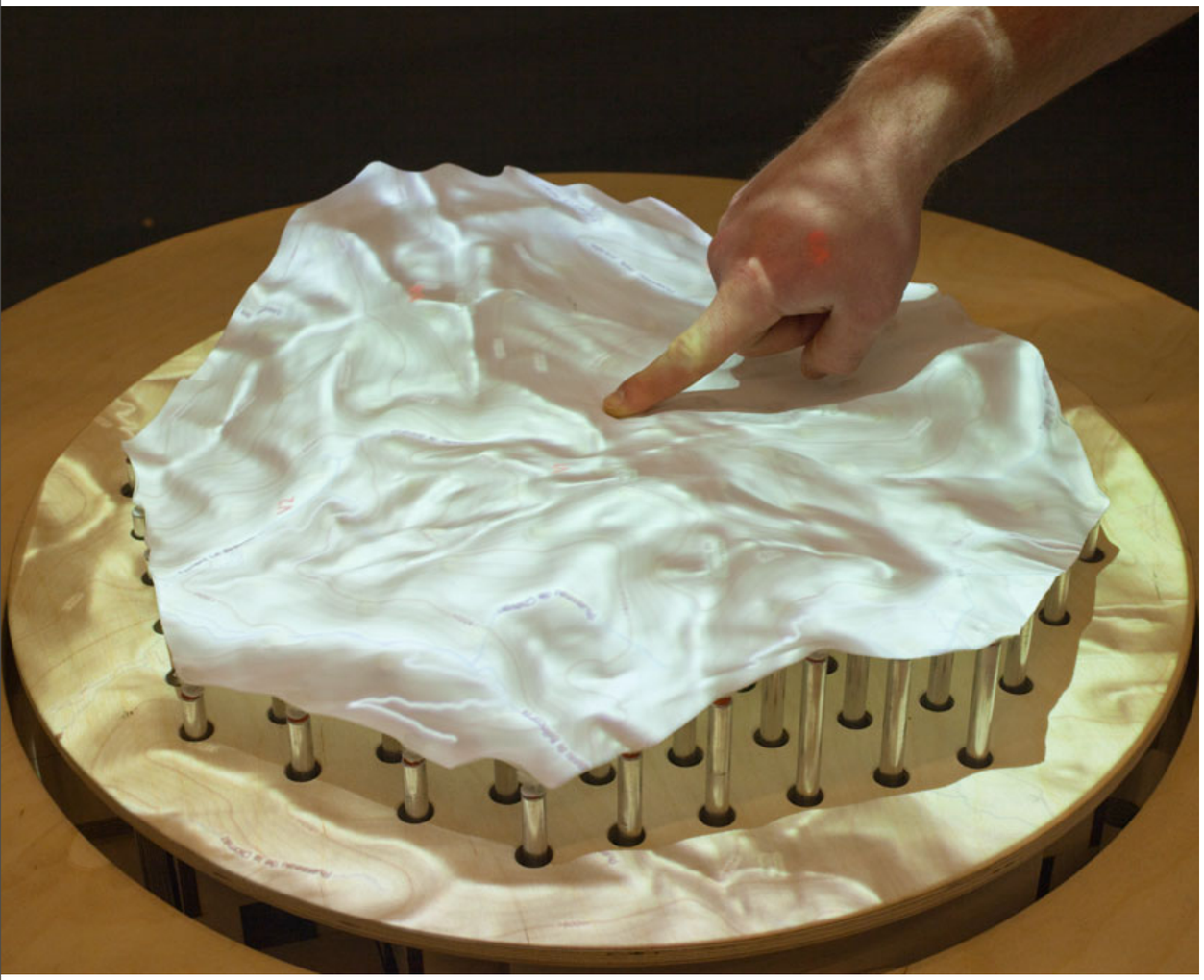

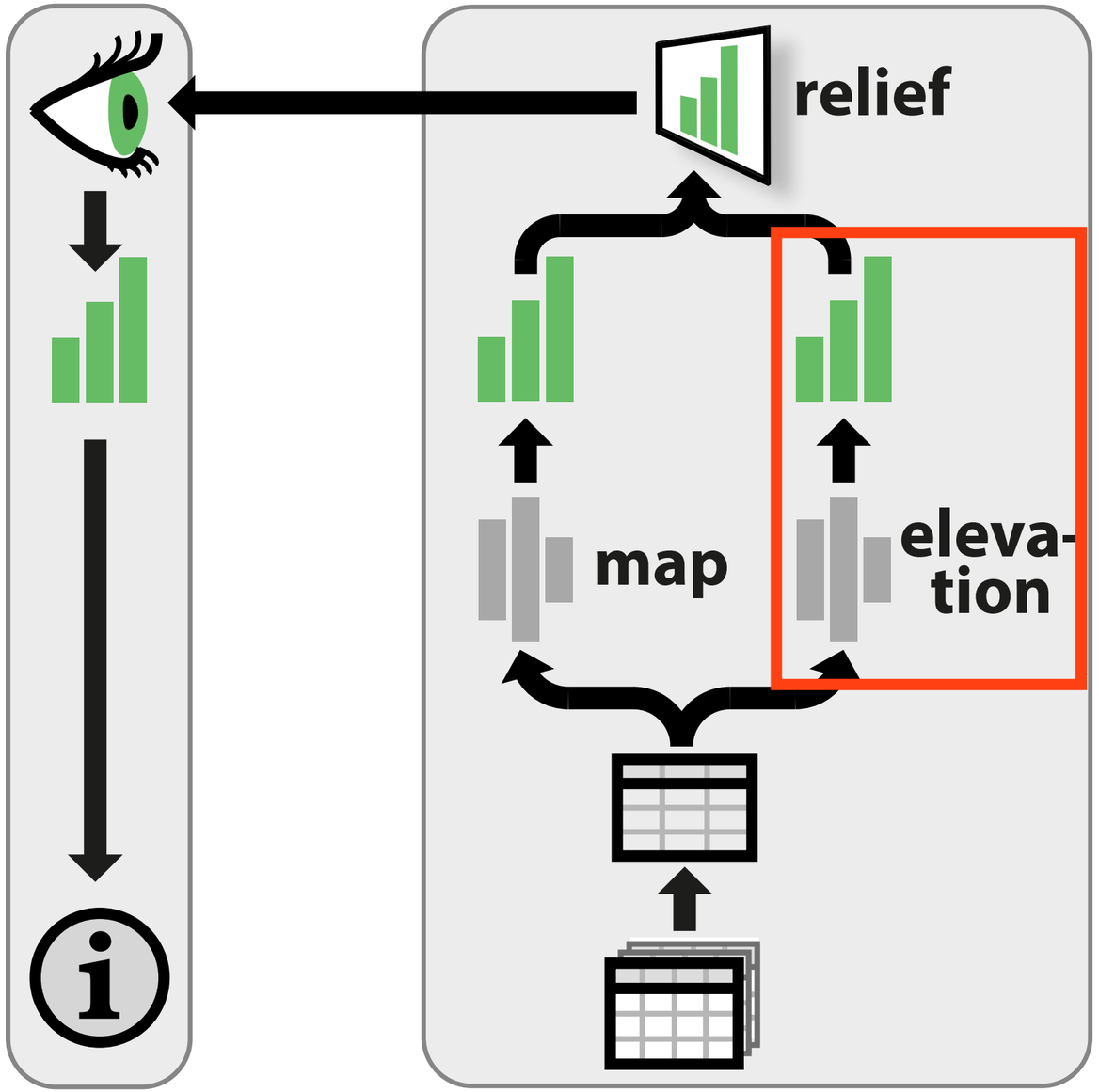

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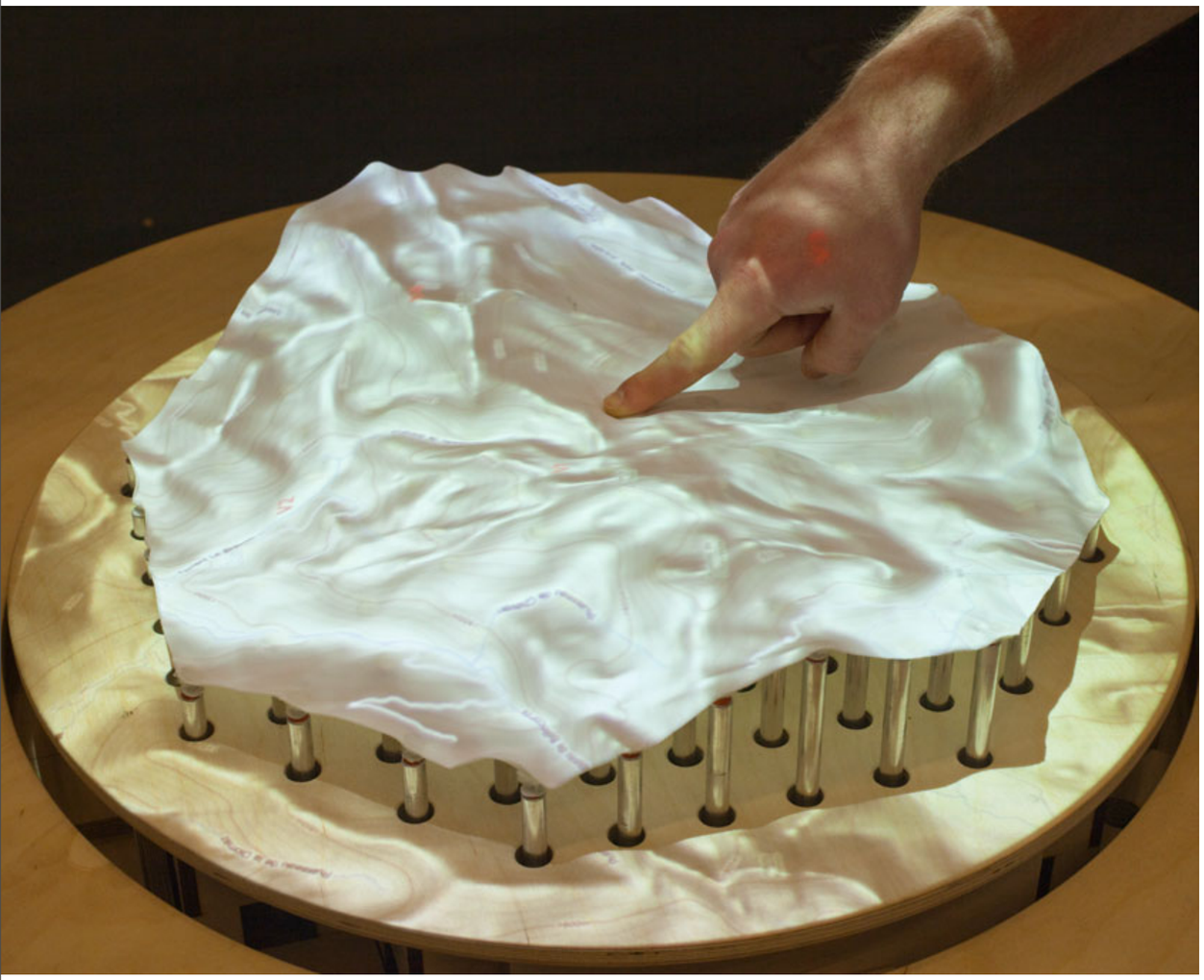

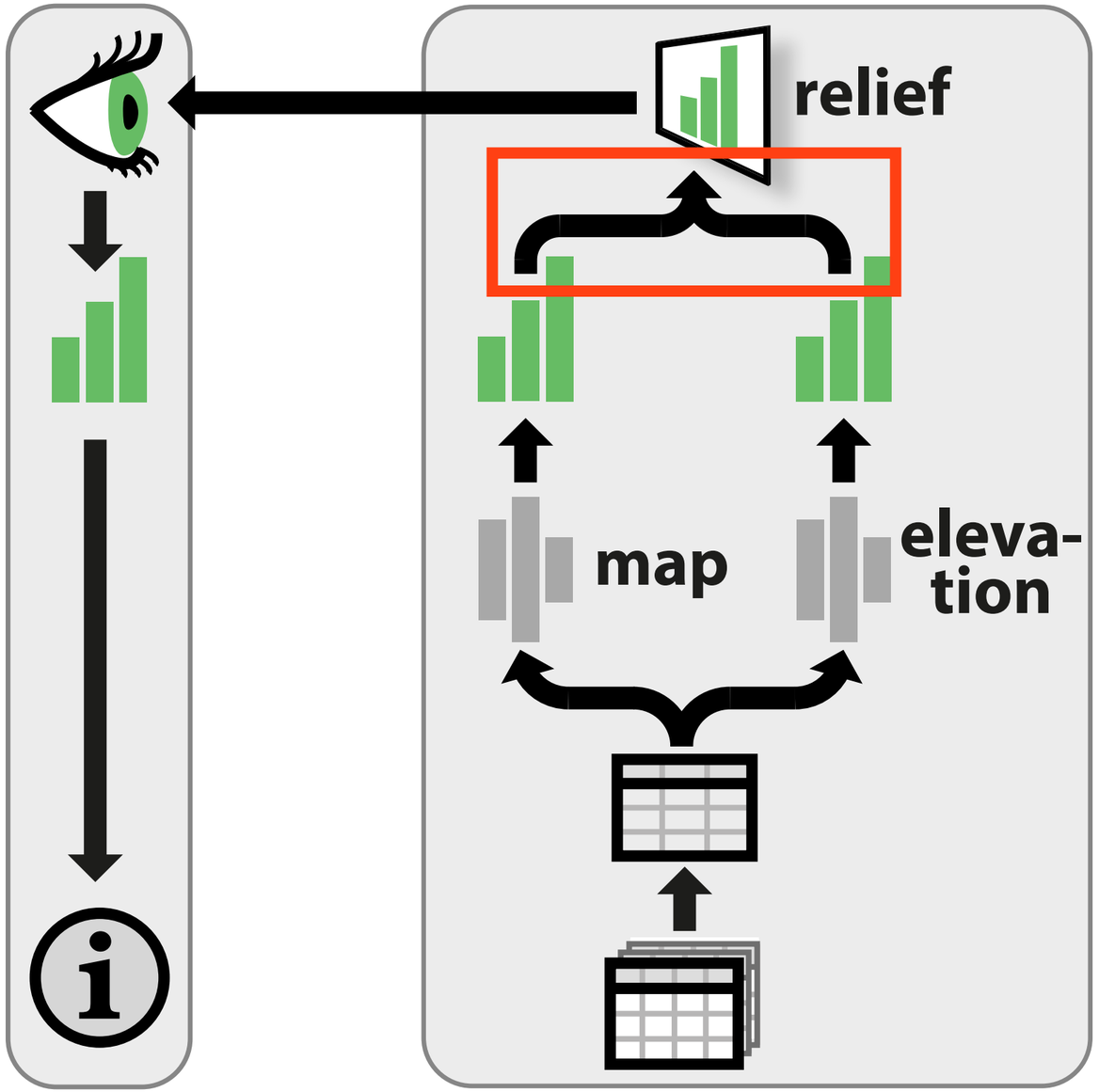

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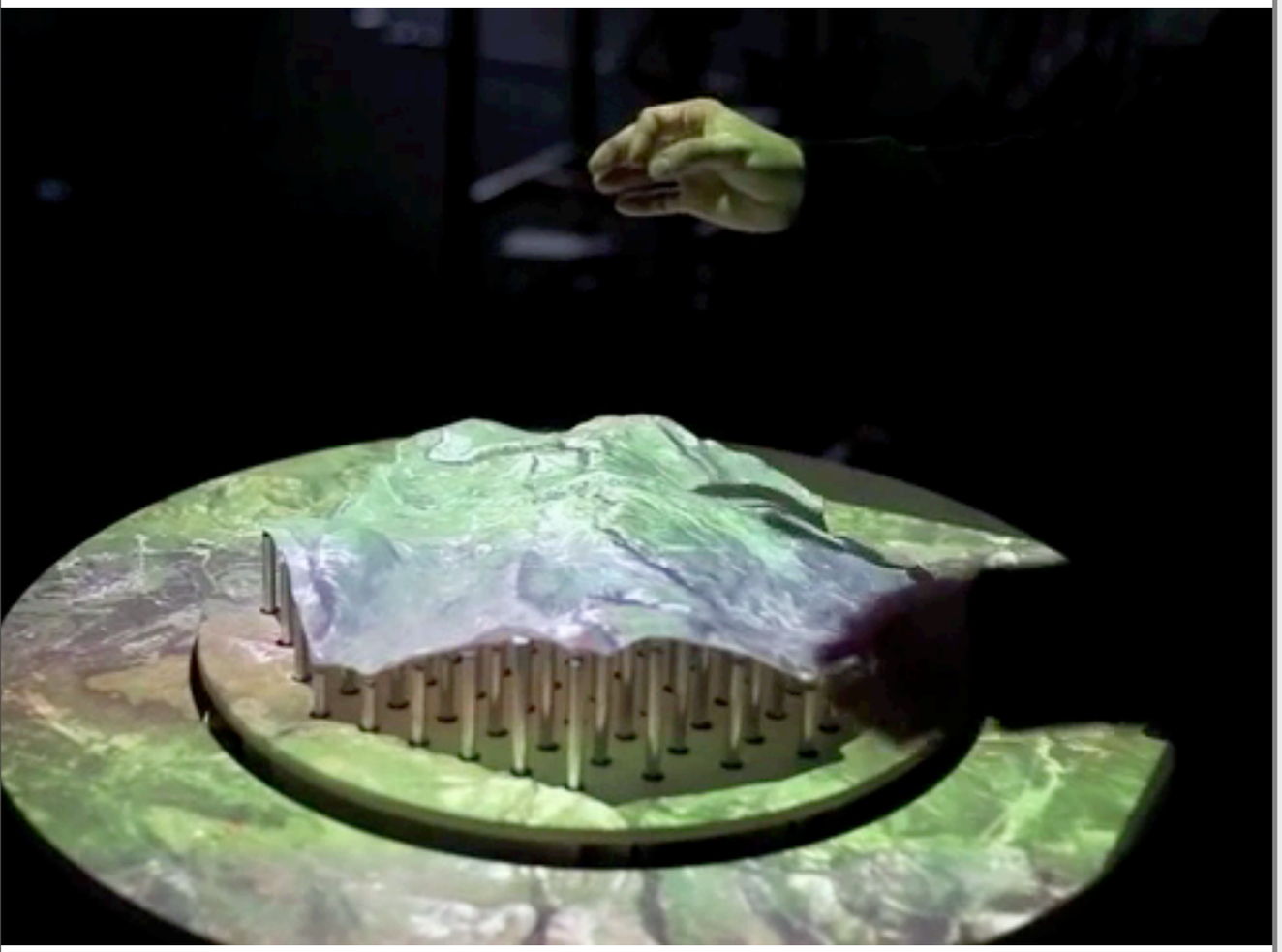

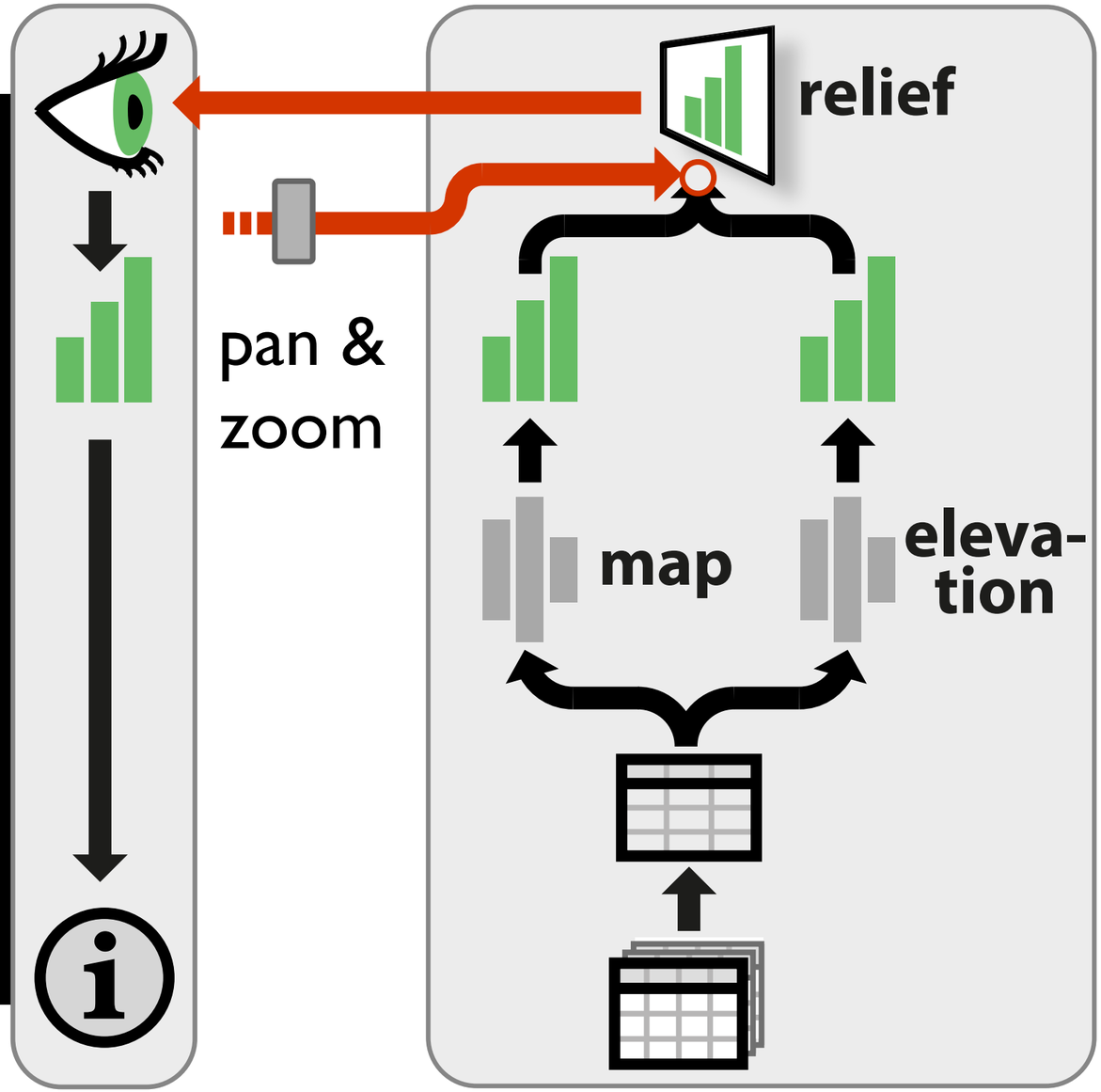
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pan &
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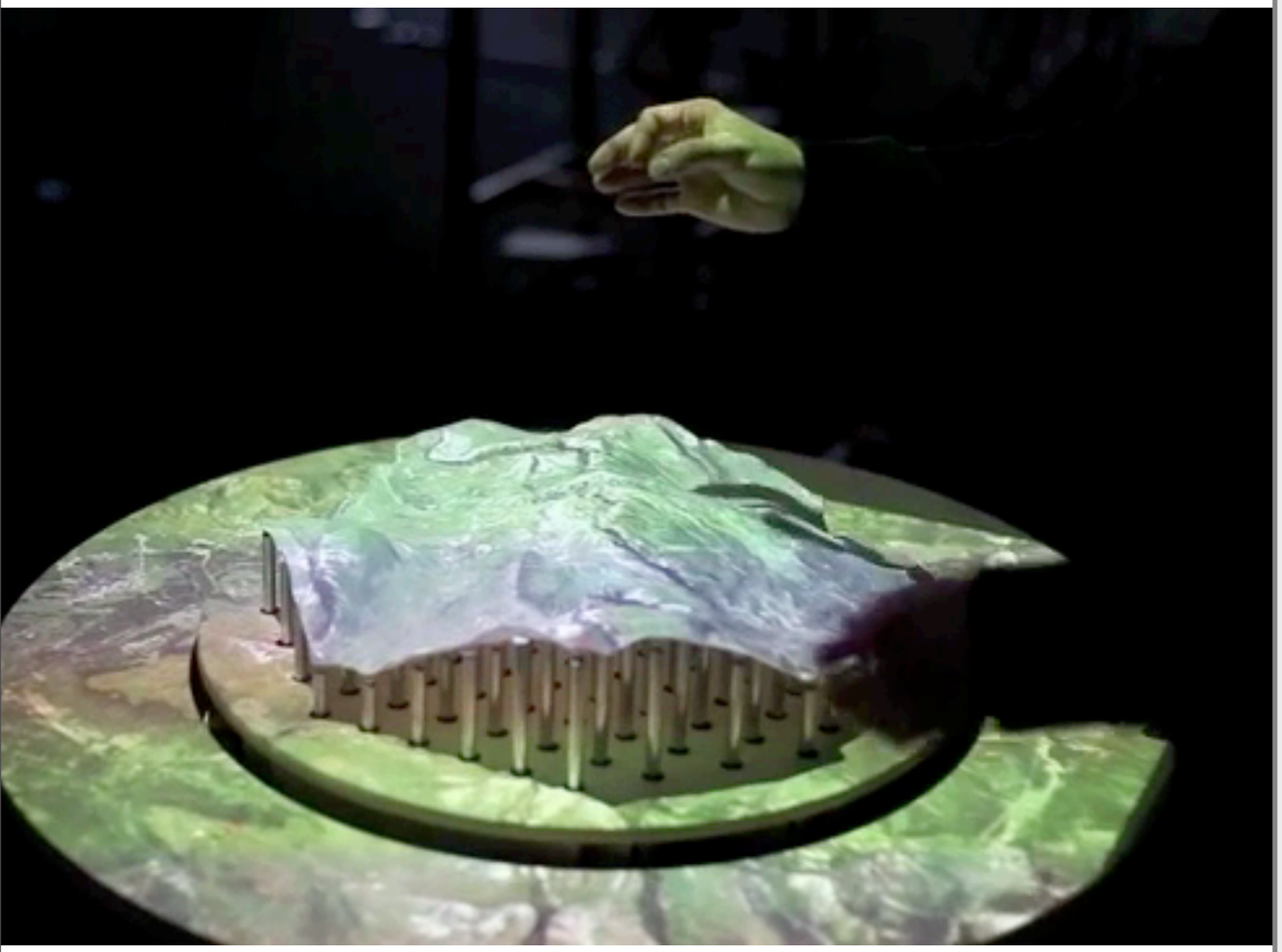

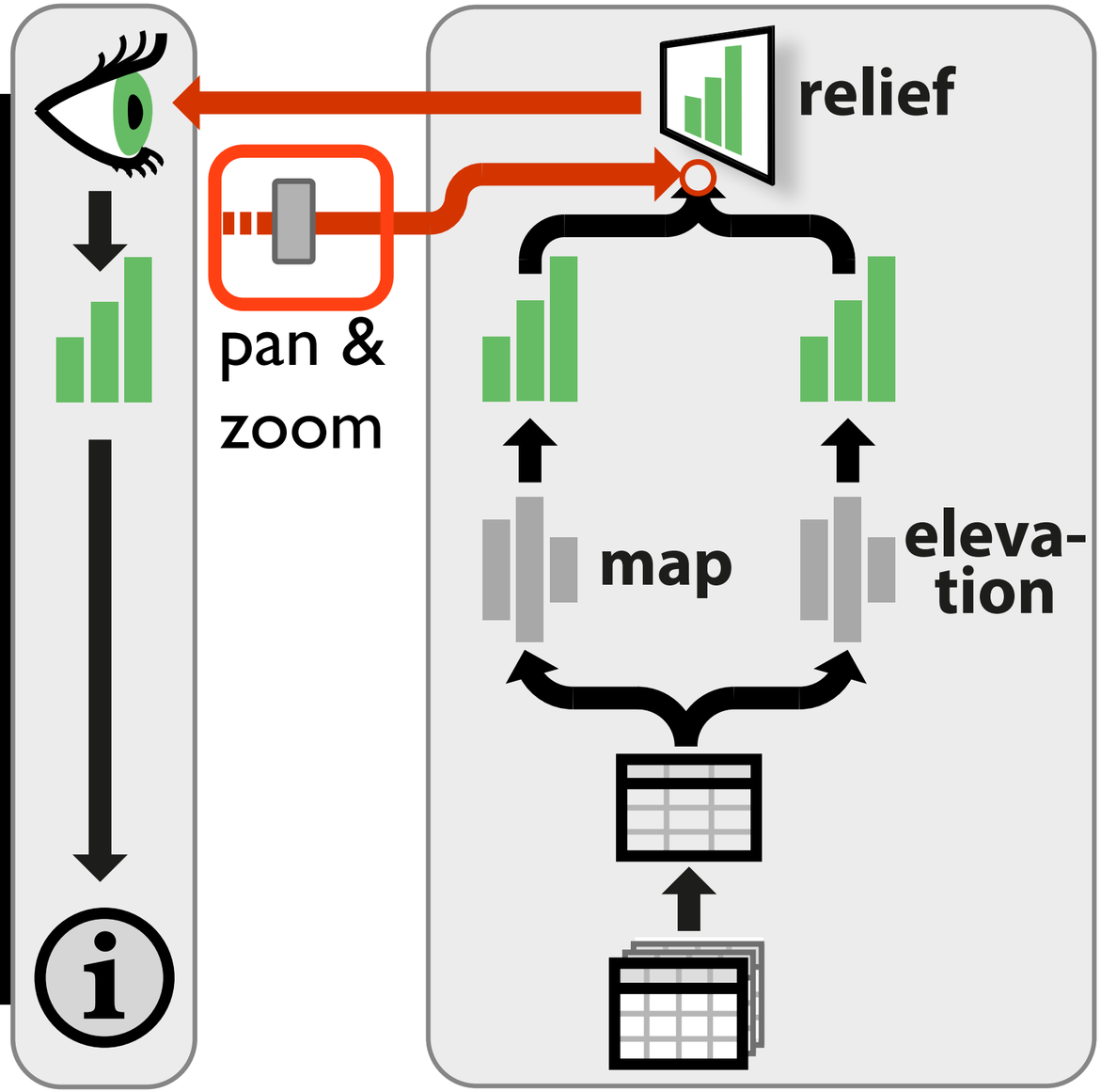
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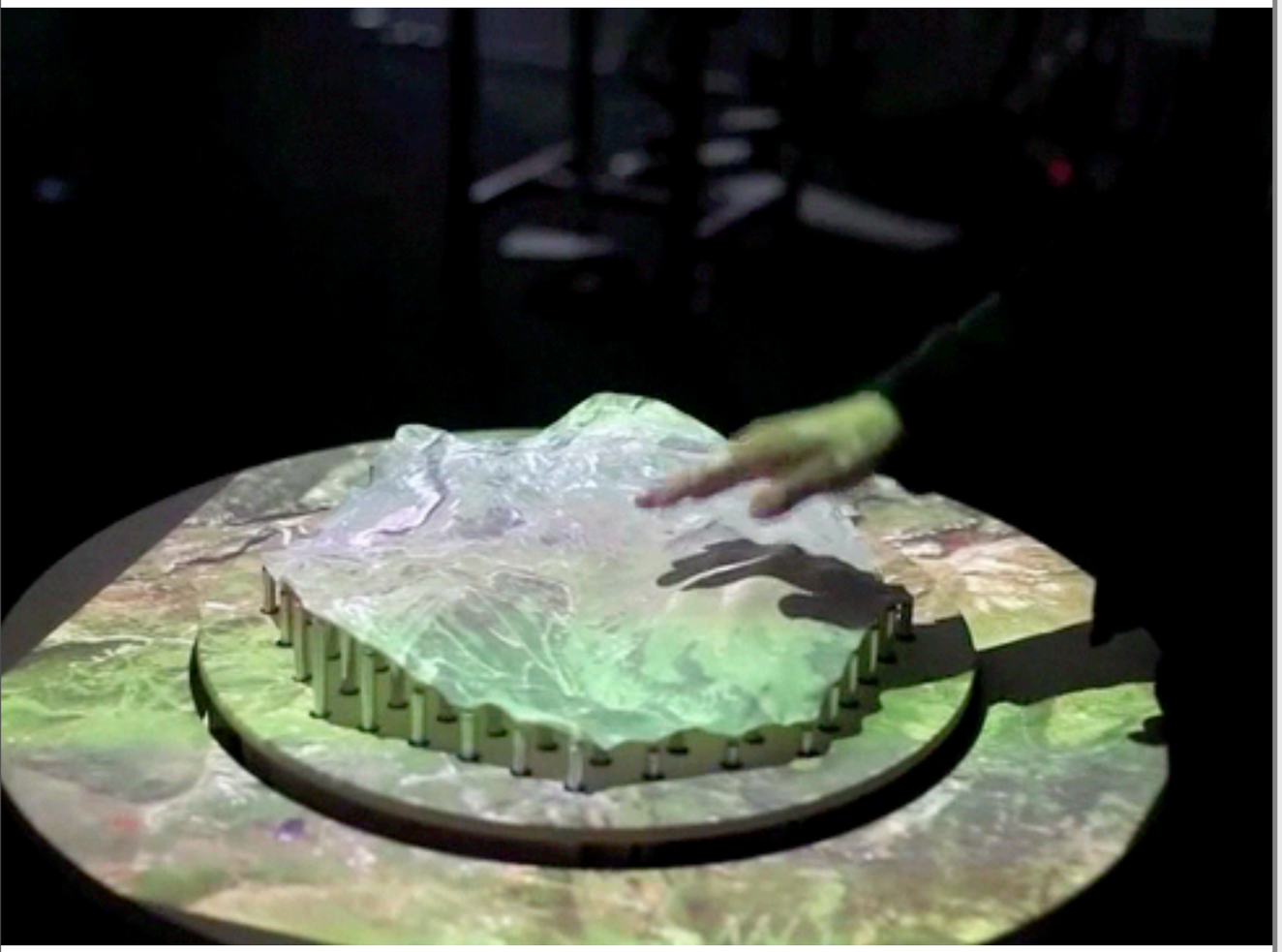

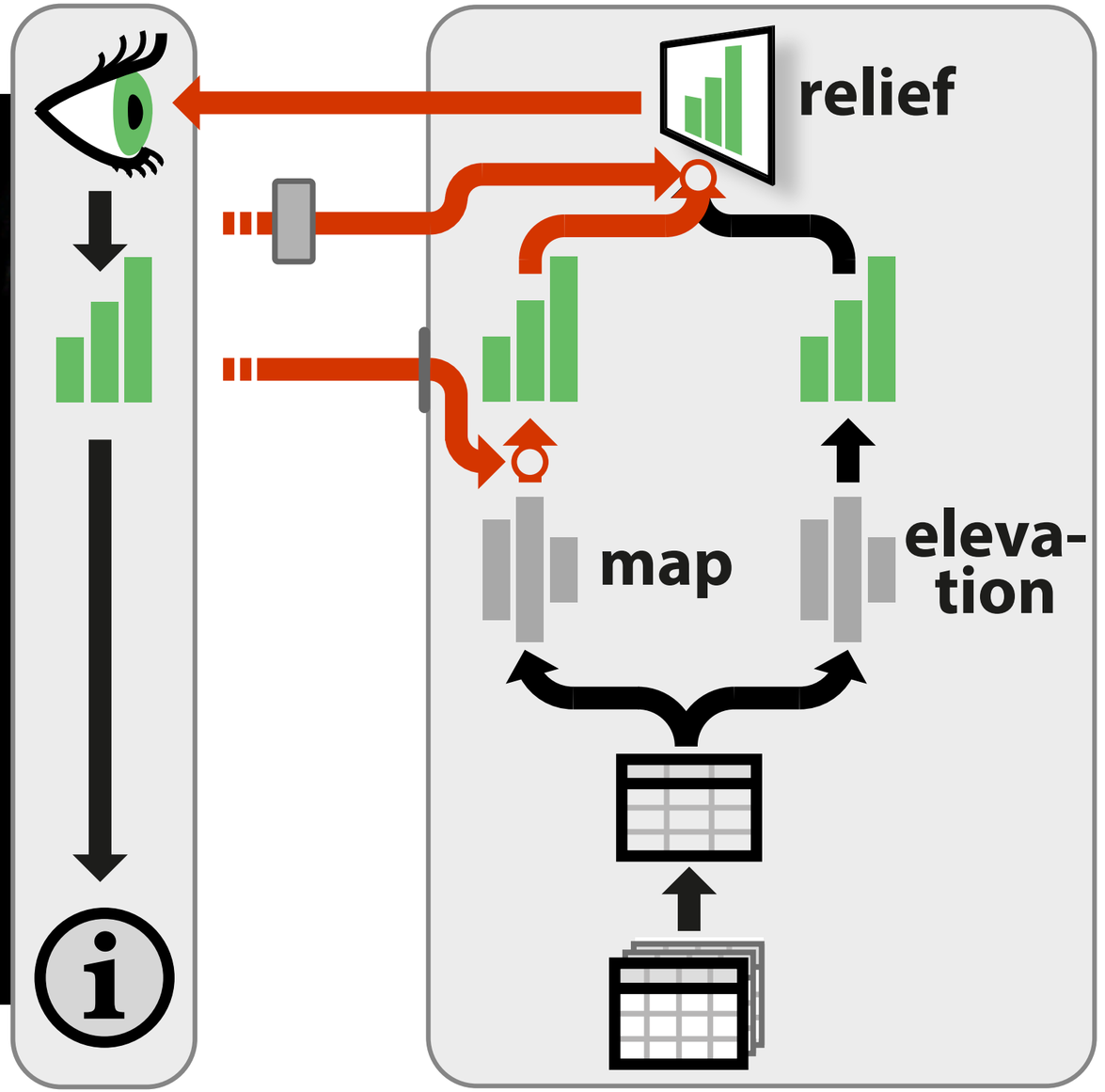
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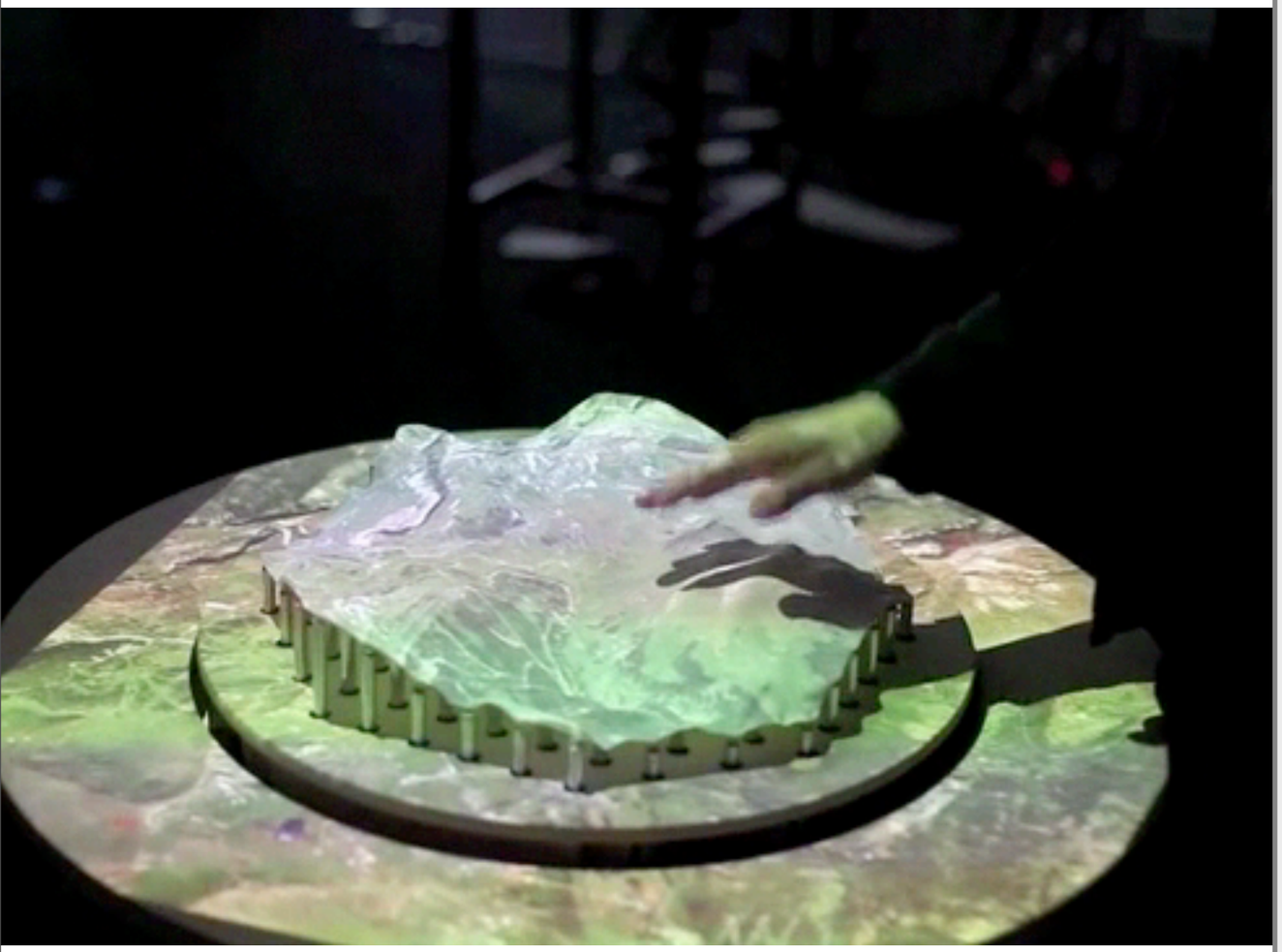

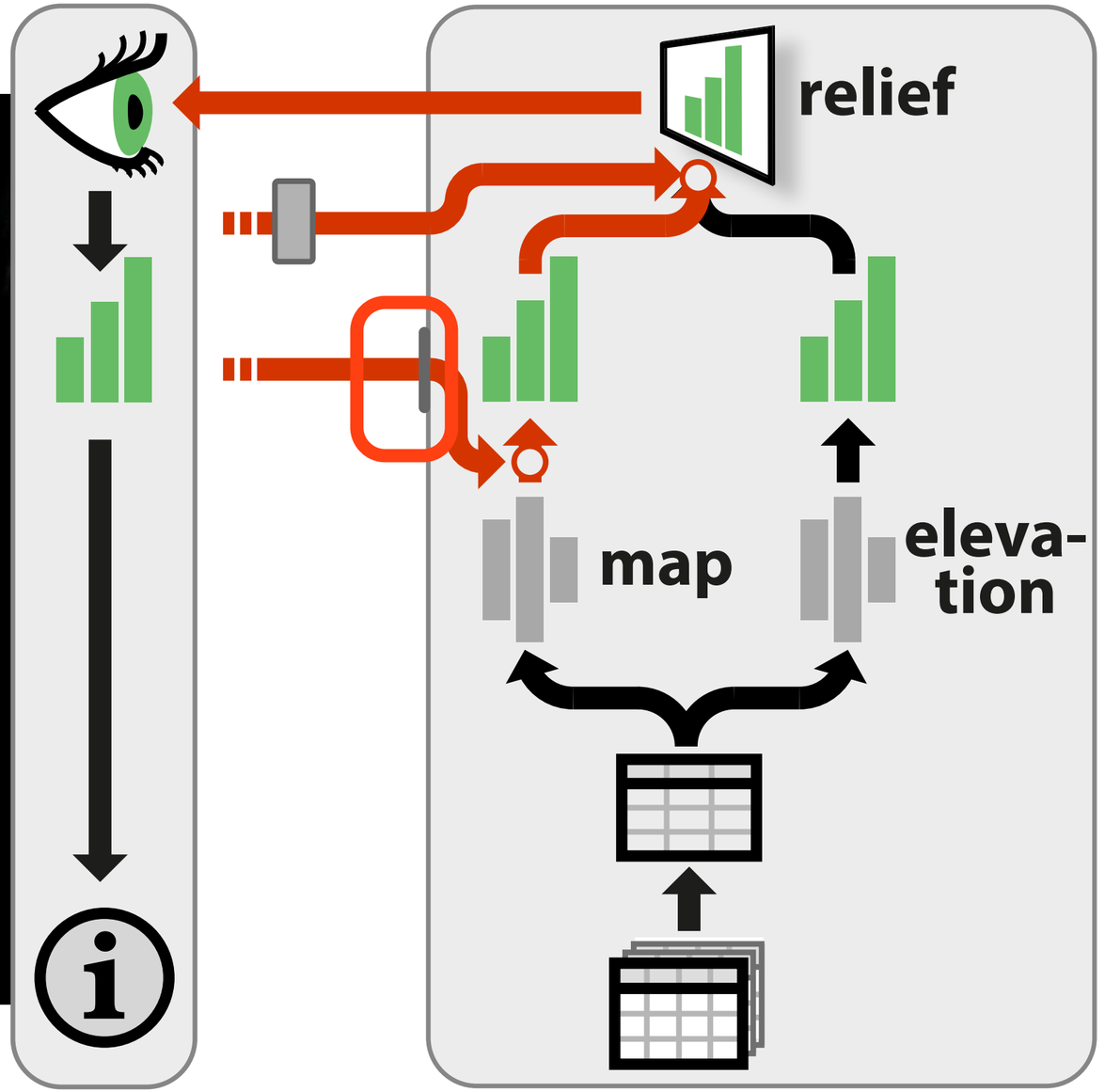
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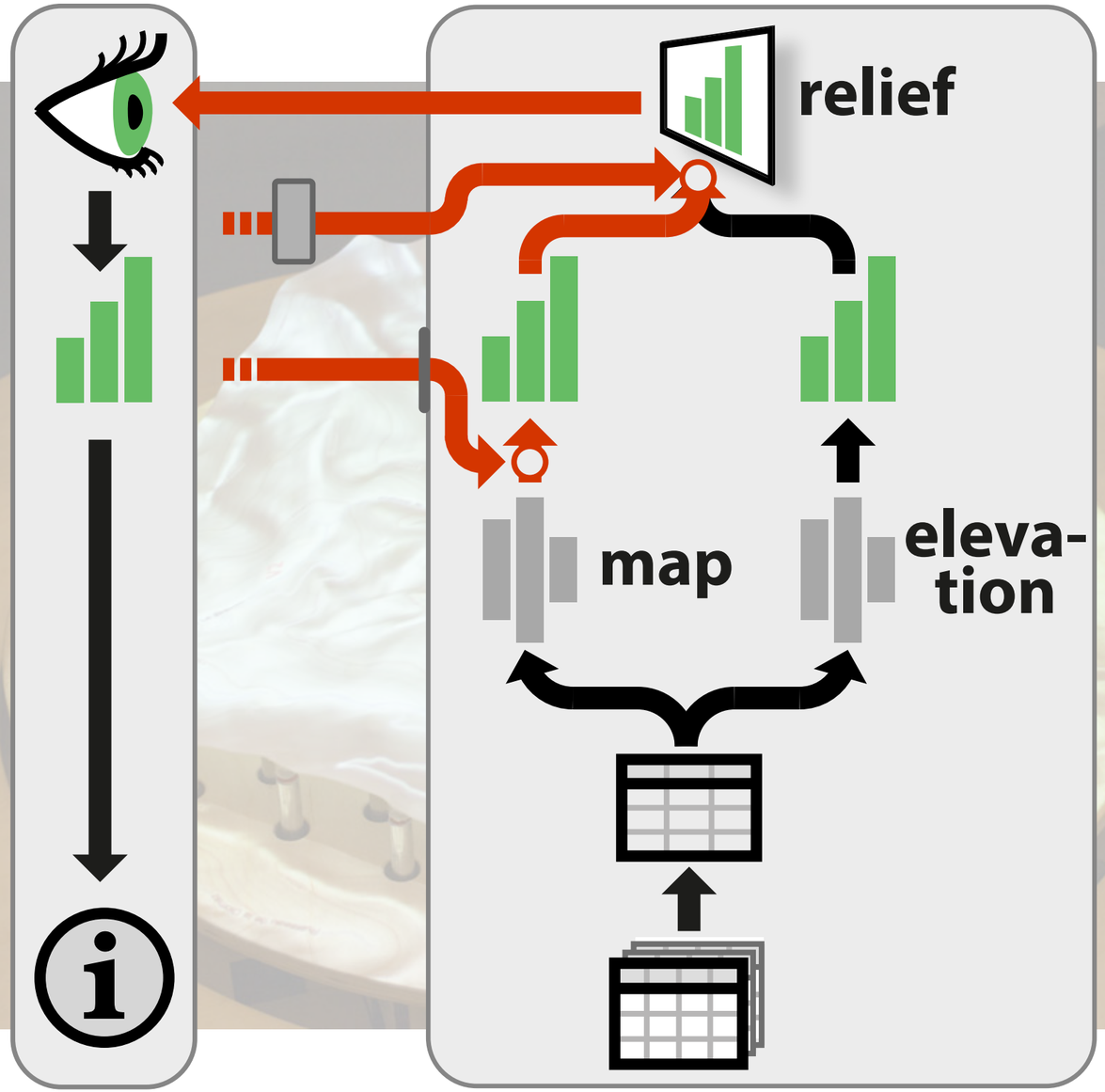
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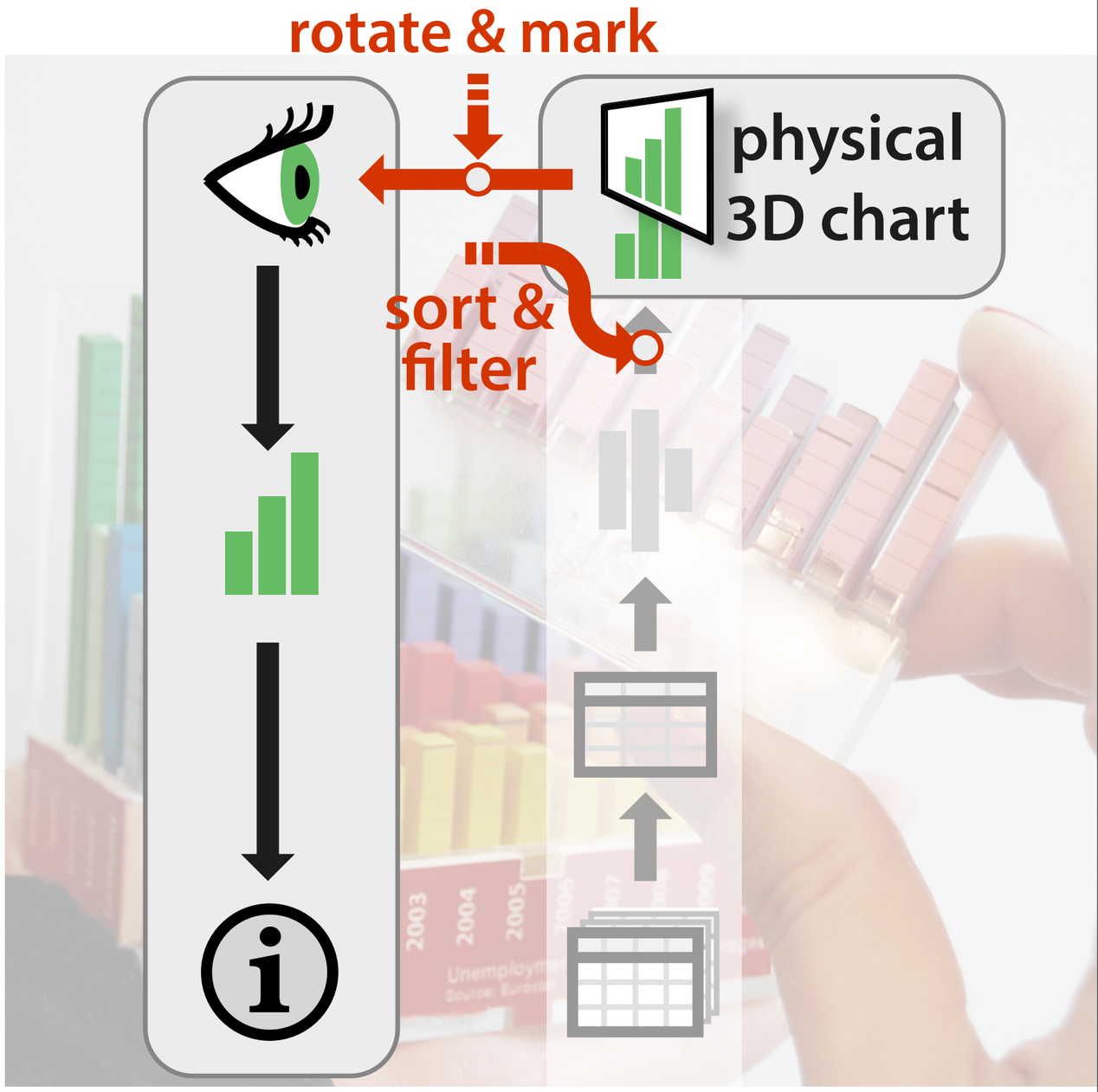
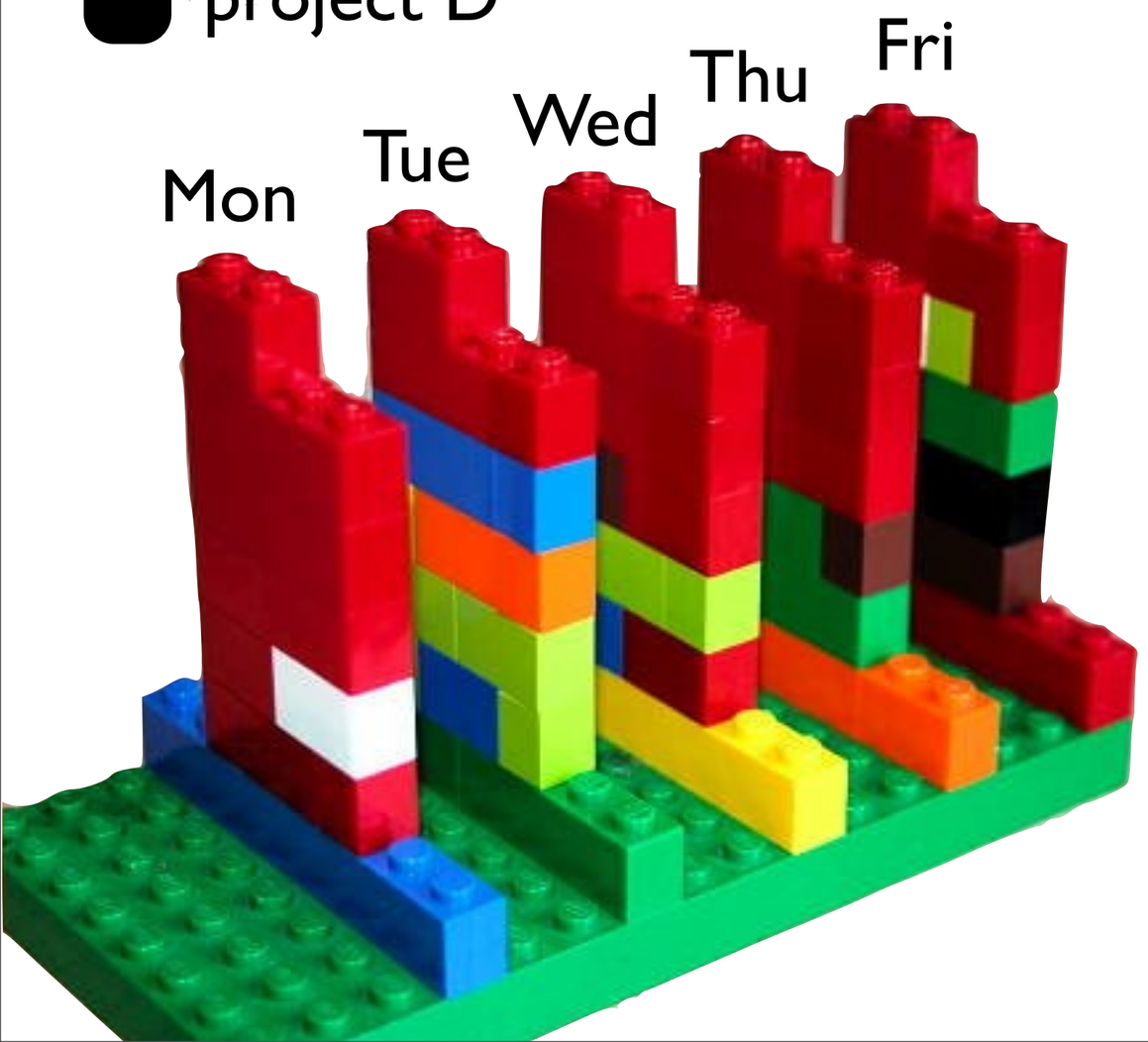
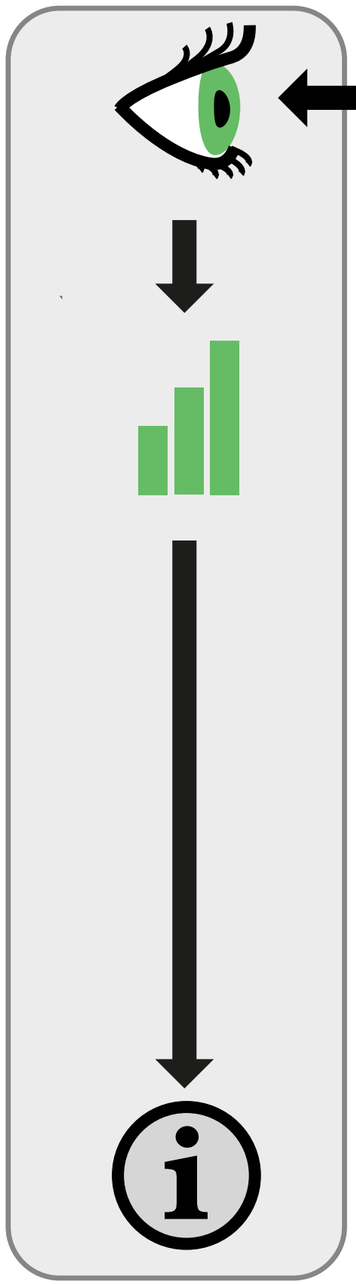
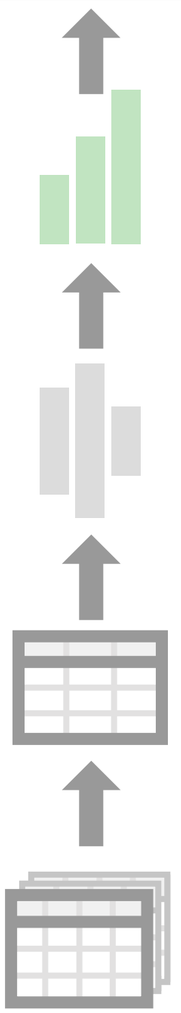

rotate & mark
physical
3D chart
sort &
filter

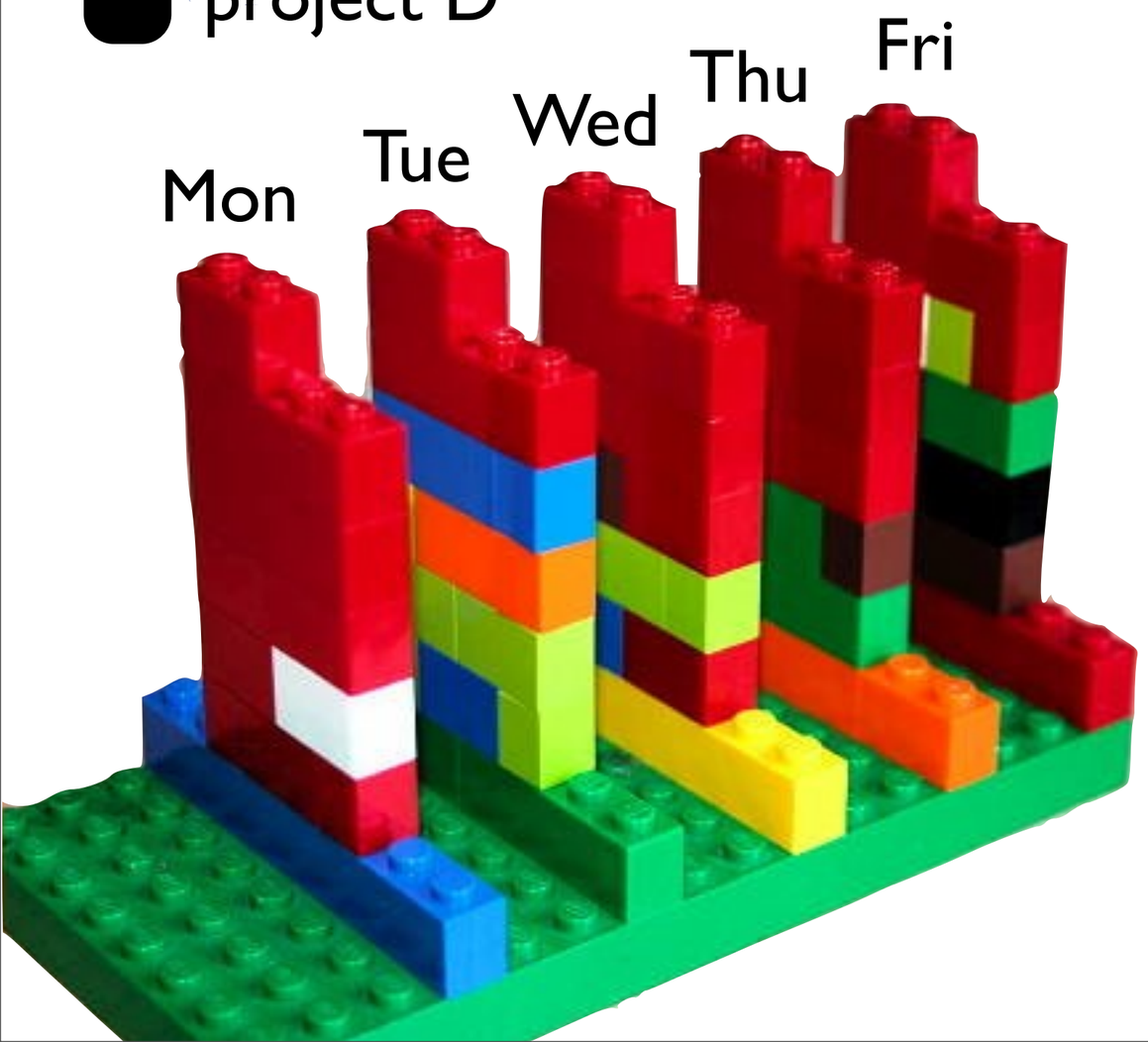
project A
project B
project C
project D

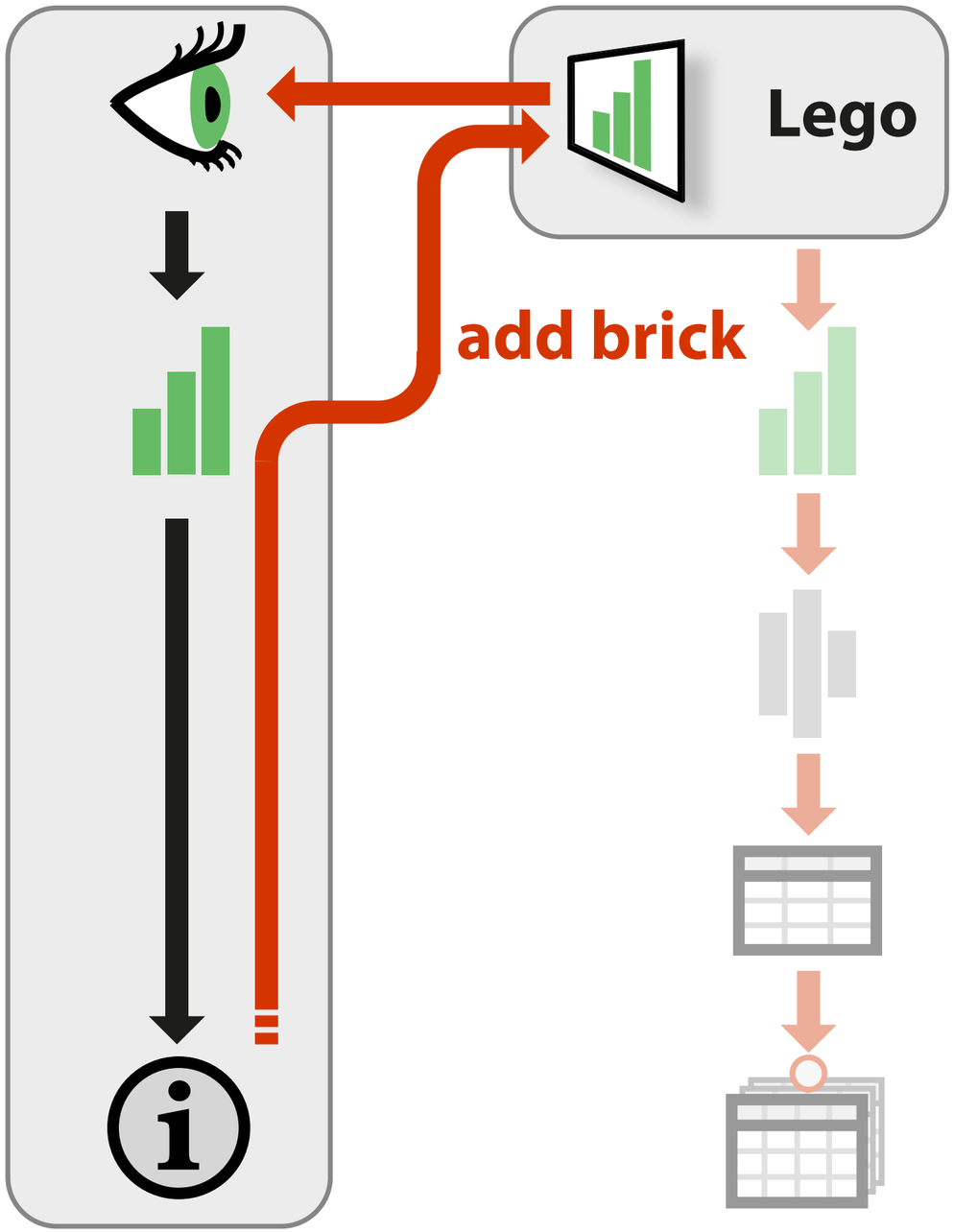






project A
project B
project C
project D





Discussion

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- interactions in the physical world can be powerful

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- useful source of inspiration to design *any* instrument

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- largely unexplored design space of beyond-desktop visualizations

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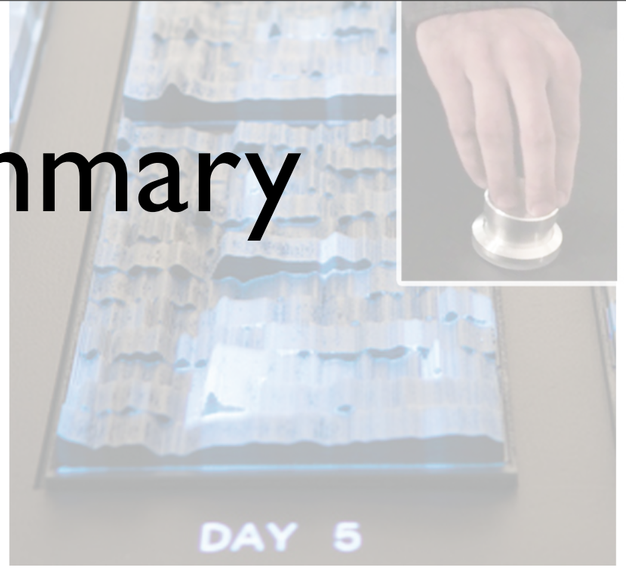
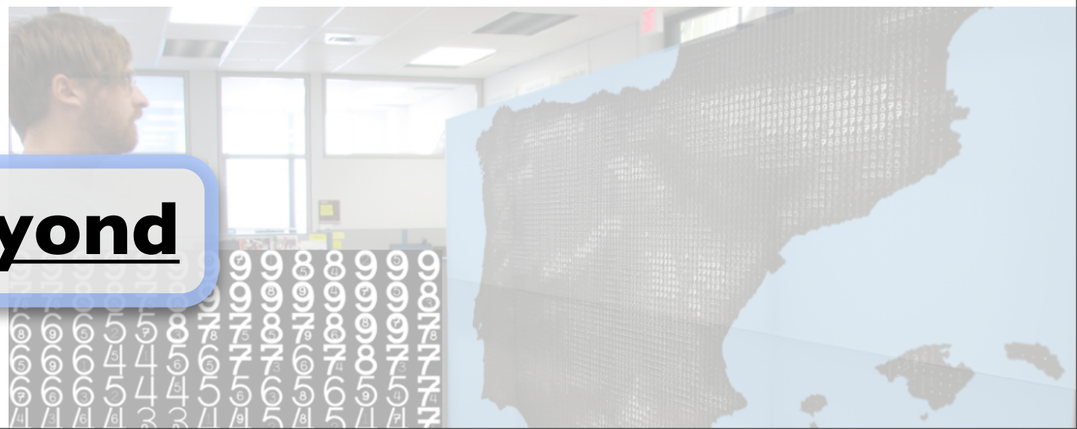
- interactions in the physical world can be powerful
- useful source of inspiration to design *any* instrument
- largely unexplored design space of beyond-desktop visualizations
- blend of physical and computing elements
- first step to comprehensive model

Summary





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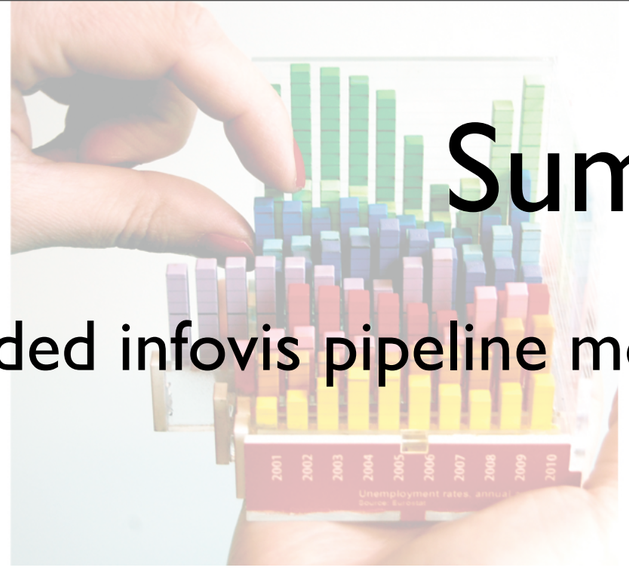
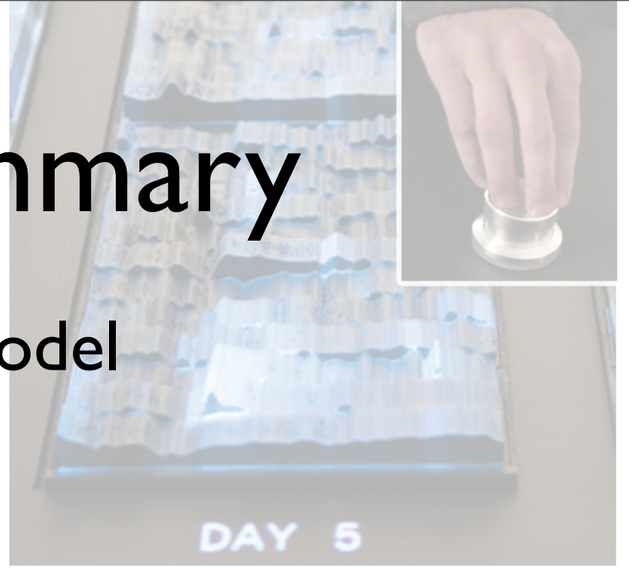
Summary

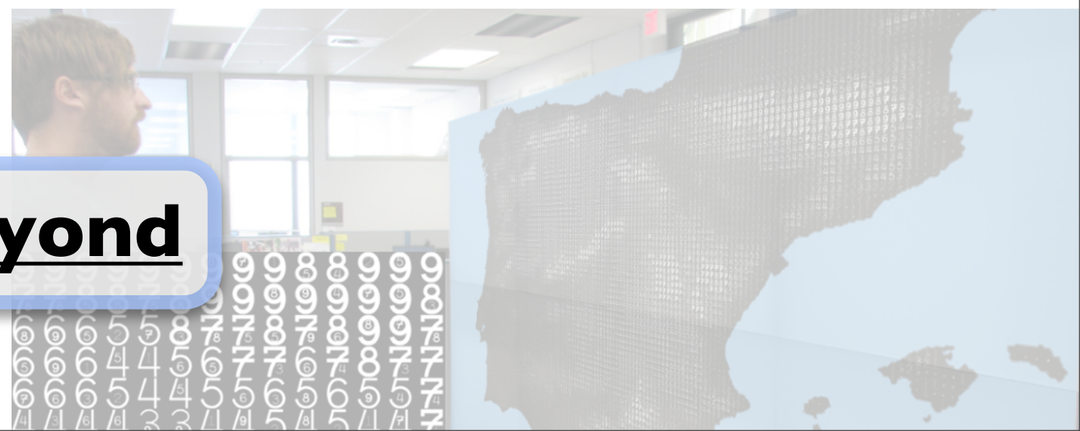
- an extended infovis pipeline model



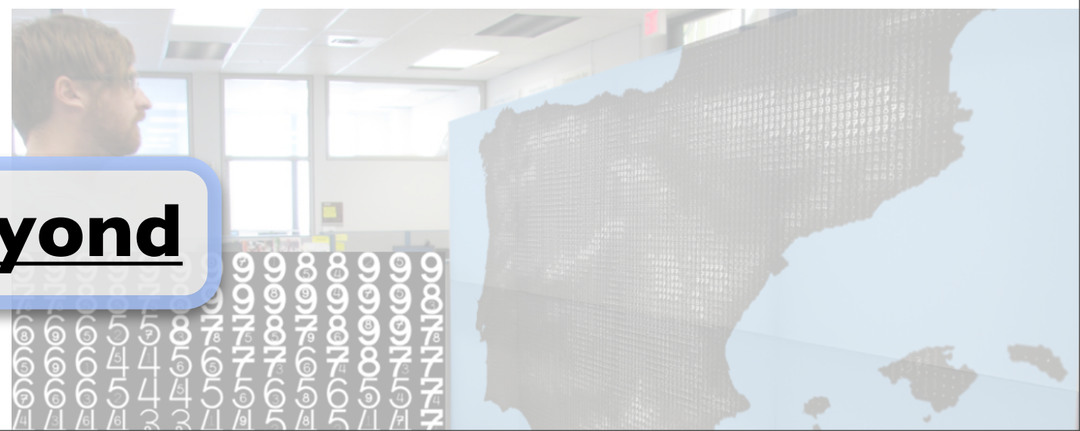






Summary

- an extended infovis pipeline model
- a description of interactions as what (effects), why (goals), how (means)



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- (paper only) a characterization of user experiences of manipulation and directness
- visual notation for compact description and comparisons
- 8 case studies to discuss and model existing examples

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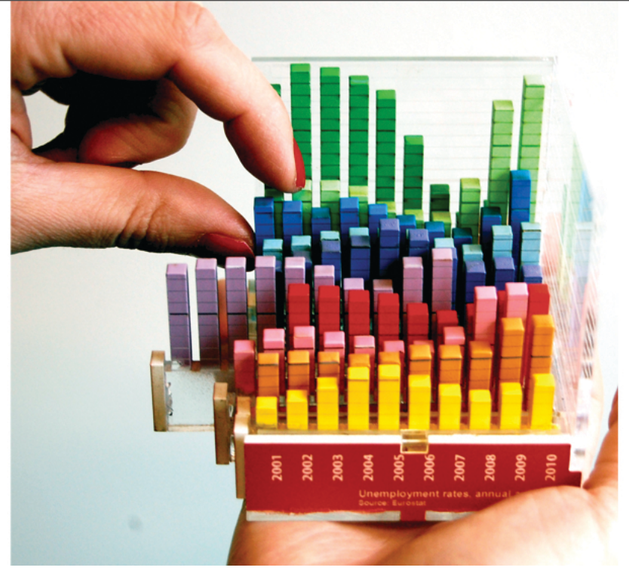
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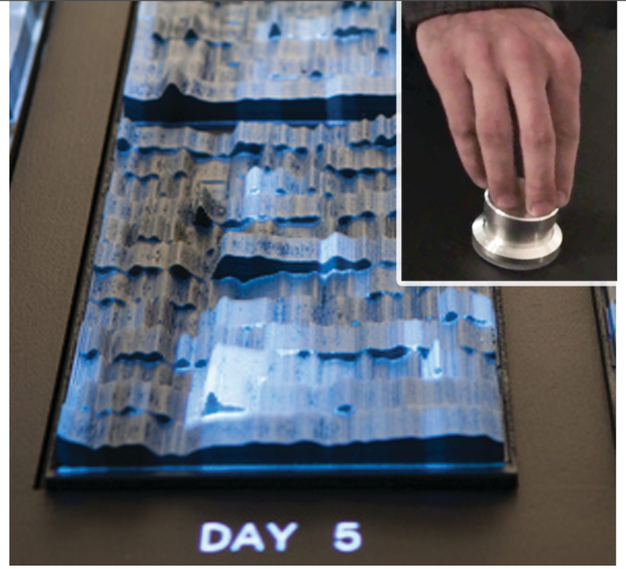
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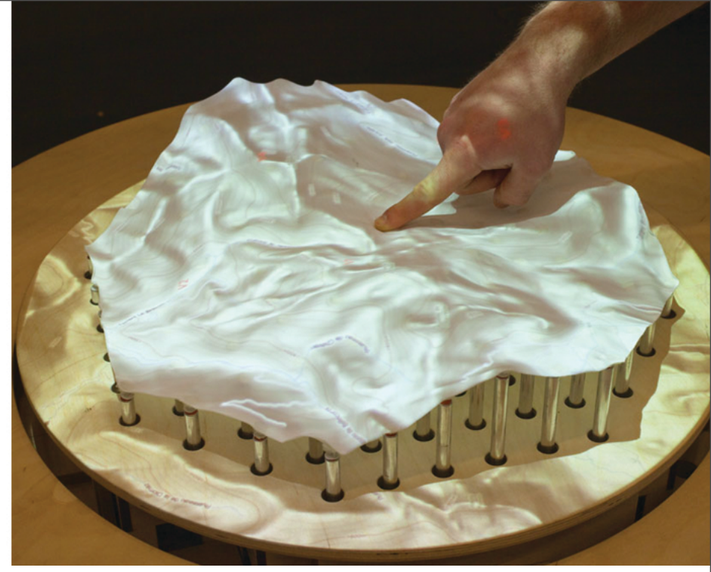

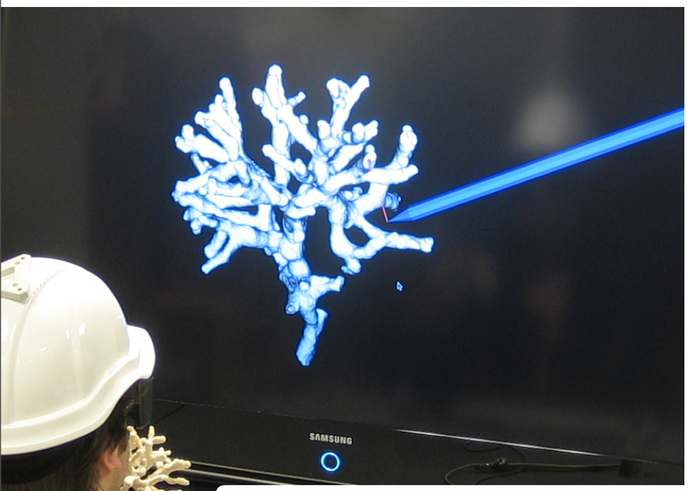
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