A Multi-Level Typology of Abstract Visualization Tasks

Matthew Brehmer and Tamara Munzner

IEEE InfoVis ’13
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Contributions
Contributions

Framework for analyzing tasks, a conceptual typology bridging low and high levels of abstraction
Contributions

**Framework** for analyzing **tasks**, a conceptual **typology** bridging **low** and **high** levels of abstraction

**Integrating** and **extending** previous work
Contributions

**Framework** for analyzing **tasks**, a conceptual **typology** bridging **low** and **high** levels of abstraction.

**Integrating** and **extending** previous work.

Visual notation for describing **sequences** of **tasks** → clarify **means** and **ends**.
Motivation

specific

broad
Motivation

• **describe** for field study
• **generate** for design study
• **evaluate** for both

“I hit a wall. I need a better way to analyze my data.”
Motivation

- **describe** for field study
- **generate** for design study
- **evaluate** for both

---

**specific**

“I hit a wall. I need a better way to analyze my data.”

**broad**

“What does the visualization community know about tasks?”

---

**describe** for textbook analysis framework
Previous Work

Classifying Tasks, Goals, Intentions, Objectives, Activities, Interactions
interaction & visual encoding techniques

low level of abstraction
e.g. “retrieve value”

Previous Work

Classifying Tasks, Goals, Intentions, Objectives, Activities, Interactions
Previous Work

Classifying Tasks, Goals, Intentions, Objectives, Activities, Interactions

interaction & visual encoding techniques

low level of abstraction
e.g. “retrieve value”

high level of abstraction
e.g. “integration of insight”

Amar, Eagan, & Stasko (2005)
Andrienko & Andrienko (2006)
Buja et al. (1996)
Casner (1991)
Chi & Riedl (1998)
Chuah & Roth (1996)
Dix & Ellis (1998)
Gotz & Zhou (2008)
Keim (2002)
Lee et al. (2006)
Raskin (1990)
Roth & Mattis (1990)
Shneiderman (1996)
Tweedie (1997)
Valiati et al. (2006)
Wehrend & Lewis (1990)
Yi, Stasko, et al. (2007)

Card, Mackinlay, Shneiderman (1999)
Klein, Moon, & Hoffman (2006)
Liu & Stasko (2010)
Pirolli & Card (2005)
Spence (2007)
Previous Work

Classifying Tasks, Goals, Intentions, Objectives, Activities, Interactions

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low level of abstraction
  e.g. “retrieve value”

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A mid-level gap?
Meyer, Sedlmair, & Munzner (BELIV 2012)
interaction & visual encoding techniques

low level of abstraction
e.g. “retrieve value”

high level of abstraction
e.g. “integration of insight”

Previous Work

Classifying Tasks, Goals, Intentions, Objectives, Activities, Interactions

A mid-level gap?

Meyer, Sedlmair, & Munzner (BELIV 2012)
Means and Ends

DERIVE
## Derive as End

### Means and Ends

<table>
<thead>
<tr>
<th>Dim 1</th>
<th>Dim 2</th>
<th>Dim 3</th>
<th>...</th>
<th>Dim m</th>
</tr>
</thead>
<tbody>
<tr>
<td>Item 1</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Item 2</td>
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</tr>
<tr>
<td>Item n</td>
<td></td>
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</tr>
</tbody>
</table>

Reduce Dimensionality
Means and Ends

Derive as Means

Reduce Dimensionality

Derive as Means
Means and Ends

DERIVE
Means and Ends

- Navigate
- Derive
- Record
- Aggregate
- Sort
- Filter
Means and Ends

NAVIGATE  AGGREGATE

DERIVE  SORT

RECORD  FILTER
Means and Ends

- NAVIGATE
- DERIVE
- RECORD
- AGGREGATE
- SORT
- FILTER

Inputs and Outputs
Our Method

1. read and think
2. code: arrange and abstract
3. simplify and repeat…

coding of literature rather than empirical study with expert visualization users
1. read and think
2. code: arrange and abstract
3. simplify and repeat…

coding of literature rather than empirical study with expert visualization users
Our Method

1. read and think
2. code: arrange and abstract
3. simplify and repeat…

coding of literature rather than empirical study with expert visualization users
A task-based cognitive model for user-network interaction: defining a task taxonomy to guide the interface designer

Mullins and Treu (Interacting with Computers, 1993)
**Iteration**

- Why? Ends / objectives / goals
  - Present / share / guide / comm.
  - Produce
  - Discover
  - Generate / verify
  - Enjoy

- What? Abstract data and views
  - what? Abstract tasks
  - how? Methods

- How? Domain problem characterization
  - Abstract data and views
  - Abstract tasks

- Which? Domains
  - Cleanse / wrangle
  - Derive / inter., extra., folate

- Record
  - Look

- Produce
  - Produce

- Annotate
  - Label / classify / categor.

**27 terms**

- CODING / LINK
- OVERVIEW / SUMMARIZE
- LOCATE, IDENTIFY, REFINE, SUMMARIZE
- SELECT / TRACK, HIGHLIGHT / MAN.
- SPATIAL NAVIGATION
- TEMPORAL NAVIGATION
- 40 PANES/LEVELS OF DET.

**InfoVis'13 8 Matthew Brehmer**
**Table 1:** lookup table of task vocabulary

### Our 27 terms (left column)

<table>
<thead>
<tr>
<th>Term</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>focus</td>
<td>\textit{focus} (5), \textit{task} (9), \textit{task analysis} (3), \textit{task description} (2), \textit{interactive} (2)</td>
</tr>
<tr>
<td>context</td>
<td>\textit{context} (5), \textit{contextual} (2), \textit{contextualization} (2), \textit{contextualization} (1), \textit{contextual} (1)</td>
</tr>
<tr>
<td>strategy</td>
<td>\textit{strategy} (5), \textit{strategy analysis} (3), \textit{strategy description} (2), \textit{interactive} (2)</td>
</tr>
<tr>
<td>technique</td>
<td>\textit{technique} (5), \textit{technique analysis} (3), \textit{technique description} (2), \textit{interactive} (2)</td>
</tr>
<tr>
<td>method</td>
<td>\textit{method} (5), \textit{method analysis} (3), \textit{method description} (2), \textit{interactive} (2)</td>
</tr>
<tr>
<td>approach</td>
<td>\textit{approach} (5), \textit{approach analysis} (3), \textit{approach description} (2), \textit{interactive} (2)</td>
</tr>
<tr>
<td>framework</td>
<td>\textit{framework} (5), \textit{framework analysis} (3), \textit{framework description} (2), \textit{interactive} (2)</td>
</tr>
<tr>
<td>evaluation</td>
<td>\textit{evaluation} (5), \textit{evaluation analysis} (3), \textit{evaluation description} (2), \textit{interactive} (2)</td>
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<tr>
<td>interpretation</td>
<td>\textit{interpretation} (5), \textit{interpretation analysis} (3), \textit{interpretation description} (2), \textit{interactive} (2)</td>
</tr>
<tr>
<td>visualization</td>
<td>\textit{visualization} (5), \textit{visualization analysis} (3), \textit{visualization description} (2), \textit{interactive} (2)</td>
</tr>
</tbody>
</table>

### Terms from 30 extant classification systems + 20 additional references (right column)

- \textit{focus}
- \textit{context}
- \textit{strategy}
- \textit{technique}
- \textit{method}
- \textit{approach}
- \textit{framework}
- \textit{evaluation}
- \textit{interpretation}
- \textit{visualization}

---

### Mapping our Vocabulary to Previous Work

**Way:**
- present
- discover
- generate
- verify
- generate
- predict

**Input:**
- source
- source
- source
- explore
- identify
- compare

**Output:**
- output
- output
- output
- output
- output
- output

**Mapping our Vocabulary to Previous Work**

- \textit{focus} (5), \textit{task} (9), \textit{task analysis} (3), \textit{task description} (2), \textit{interactive} (2)
- \textit{context} (5), \textit{contextual} (2), \textit{contextualization} (2), \textit{contextualization} (1), \textit{contextual} (1)
- \textit{strategy} (5), \textit{strategy analysis} (3), \textit{strategy description} (2), \textit{interactive} (2)
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- \textit{method} (5), \textit{method analysis} (3), \textit{method description} (2), \textit{interactive} (2)
- \textit{approach} (5), \textit{approach analysis} (3), \textit{approach description} (2), \textit{interactive} (2)
- \textit{framework} (5), \textit{framework analysis} (3), \textit{framework description} (2), \textit{interactive} (2)
- \textit{evaluation} (5), \textit{evaluation analysis} (3), \textit{evaluation description} (2), \textit{interactive} (2)
- \textit{interpretation} (5), \textit{interpretation analysis} (3), \textit{interpretation description} (2), \textit{interactive} (2)
- \textit{visualization} (5), \textit{visualization analysis} (3), \textit{visualization description} (2), \textit{interactive} (2)
Mapping our Vocabulary to Previous Work

### Our 27 terms

- **navigate** [23, 64, 75]*[40, 44, 52, 76, 80], **focus** [10, 15]* [13], **details-on-demand** [11, 61]*, [13], **flip through** [13]

### Terms from 30 extant classification systems

- **zoom** [10, 11, 15, 19, 29, 42, 50, 57, 61, 82]*[13, 44, 80], **pan** [10, 19, 42, 50, 57, 82]*[80], **elaborate** [50, 82]*, **abstract** [50, 82]*, **change (range)** [19]*, **drill down** [15]*, **maneuver / navigate** [66]*, **rotate** [13, 80] revisit [19, 37]*
Mapping our Vocabulary to Previous Work

**Our 27 terms** (left column)

**Terms from 30 extant classification systems**

### Table 1: lookup table of task vocabulary

<table>
<thead>
<tr>
<th>Our 27 terms (left column)</th>
<th>Terms from 30 extant classification systems (right column)</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>compare</strong></td>
<td>map, zoom, select, sort, filter, group, detail, summary,</td>
</tr>
<tr>
<td><strong>navigate</strong></td>
<td>drag, spin, crosshair, close up, reset, change, zoom in,</td>
</tr>
<tr>
<td></td>
<td>zoom out, pan, drag, rotate, spin, pan, drill down,</td>
</tr>
<tr>
<td></td>
<td>focus, details-on-demand, flip through, close up, rotate,</td>
</tr>
<tr>
<td></td>
<td>pan, abstract, change (range), maneuver / navigate,</td>
</tr>
<tr>
<td></td>
<td>rotate, revisit</td>
</tr>
</tbody>
</table>
Constructing a Typology

**Bottom-Up**
- previous classification systems

**Top-Down**
- theoretical lenses
Constructing a Typology

Bottom-Up
- previous classification systems

Top-Down
- theoretical lenses

Stages of Action
- Gulf of Goal Formation
- Distributed Cognition
- Sensemaking
- Play Theory, Nested Model

1 Norman (1988)
2 Lam (TVCG 2008)
3 e.g. Hollan et al. (2000)
4 e.g. Pirolli and Card (2005)
6 Munzner (TVCG 2009)
Constructing a Typology

1 Norman (1988)
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Bottom-Up
previous classification systems

Top-Down
theoretical lenses

Stages of Action $^1$ +
Gulf of Goal Formation $^2$,
Distributed Cognition $^3$, Sensemaking $^4$,
Play Theory $^5$, Nested Model $^6$
Constructing a Typology

Bottom-Up
previous classification systems

Top-Down
theoretical lenses

Stages of Action
Gulf of Goal Formation
Distributed Cognition
Sensemaking
Play Theory
Nested Model

1 Norman (1988)
2 Lam (TVCG 2008)
3 e.g. Hollan et al. (2000)
4 e.g. Pirolli and Card (2005)
6 Munzner (TVCG 2009)
Constructing a Typology

Stages of Action

Why is a task undertaken?  
What are the Inputs and Outputs?  
How is the task supported?

Bottom-Up
previous classification systems

Top-Down
theoretical lenses

1 Norman (1988)  
2 Lam (TVCG 2008)  
3 e.g. Hollan et al. (2000)  
4 e.g. Pirolli and Card (2005)  
6 Munzner (TVCG 2009)
Purpose of Typology
Purpose of Typology

- Bridge **high** and **low**
- Clarify **means** and **ends**
- Describe **sequences**
Purpose of Typology

Bridge **high** and **low**

Clarify **means** and **ends**

Describe **sequences**
Multi-Level Typology of Abstract Visualization Tasks
Multi-Level Typology of Abstract Visualization Tasks

why?
- present
- discover
- enjoy

search
- target known
  - lookup
- target unknown
  - browse
- location known
  - location unknown
  - locate
  - explore
- query

produce
- consume
- produce
- encode

how?
- manipulate
  - select
  - navigate
  - arrange
  - change
  - filter
  - aggregate
- introduce
  - annotate
  - import
  - derive
  - record

what?
- [ input ]
- [ output ]

Sensor
- identify
- compare
- summarize
Multi-Level Typology of Abstract Visualization Tasks

{ why, what, how }

why?
- consume
  - why?
    - present
    - discover
    - enjoy

search
- target known
  - location known
    - lookup
  - location unknown
    - locate
- target unknown
  - browse
  - explore

query
- identify
- compare
- summarize

what?
- input
- output

how?
- encode
  - how?
    - manipulate
      - select
      - navigate
      - arrange
      - change
      - filter
      - aggregate
    - introduce
      - annotate
      - import
      - derive
      - record

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Multi-Level Typology of Abstract Visualization Tasks

\{ why, what, how \}
Multi-Level Typology of Abstract Visualization Tasks

\{ \textit{why}, \textit{what}, \textit{how} \}

1. Choose either \textbf{Consume} or \textbf{Produce}

i. if \textbf{Consume} \rightarrow choose between: \textit{Present} or \textit{Discover} or \textit{Enjoy}

[Diagram showing the typology with options for why, what, and how]

\textbf{why?}
- consume
  - present
  - discover
  - enjoy

\textbf{what?}
- location known
  - lookup
  - browse
- location unknown
  - locate
  - explore

\textbf{how?}
- manipulate
  - import
  - derive
  - record
- arrange
- change
- filter
- aggregate

[Input] [Output]
Multi-Level Typology of Abstract Visualization Tasks

\{ \textit{why}, \textit{what}, \textit{how} \}

1. Choose either \textbf{Consume} or \textbf{Produce}
   
   i. if \textbf{Consume} \rightarrow choose between: \textit{Present} or \textit{Discover} or \textit{Enjoy}
   
   ii. then \textbf{Search} \rightarrow choose between: \textit{Lookup} or \textit{Browse} or \textit{Locate} or \textit{Explore}

\begin{itemize}
  \item \textbf{why?}
  \item \textbf{present}
  \item \textbf{discover}
  \item \textbf{enjoy}
  \item \textbf{produce}
  \item \textbf{search}
  \item \textbf{target known}
    \begin{itemize}
      \item \textbf{lookup}
      \item \textbf{browse}
    \end{itemize}
  \item \textbf{target unknown}
    \begin{itemize}
      \item \textbf{locate}
      \item \textbf{explore}
    \end{itemize}
  \item \textbf{query}
    \begin{itemize}
      \item \textbf{identify}
      \item \textbf{compare}
      \item \textbf{summarize}
    \end{itemize}
\end{itemize}
Multi-Level Typology of Abstract Visualization Tasks

\{ \text{why, what, how} \}

1. Choose either \textbf{Consume} or \textbf{Produce}

   i. \textbf{if Consume} \rightarrow \text{choose between: Present or Discover or Enjoy}

   ii. \textbf{then Search} \rightarrow \text{choose between: Lookup or Browse or Locate or Explore}

   iii. \textbf{then Query} \rightarrow \text{choose between: Identify or Compare or Summarize}
Multi-Level Typology of Abstract Visualization Tasks

\{ why , what , how \}

I. Choose either **Consume** or **Produce**

  i. if **Consume** → choose between: **Present** or **Discover** or **Enjoy**

  ii. then **Search** → choose between: **Lookup** or **Browse** or **Locate** or **Explore**

  iii. then **Query** → choose between: **Identify** or **Compare** or **Summarize**
Multi-Level Typology of Abstract Visualization Tasks

\{ *why*, *how*, *what* \}

**why?**
- present
- discover
- enjoy

**how?**
- consume
- produce
- encode

- manipulate
  - select
  - navigate
  - arrange
  - change
  - filter
  - aggregate

- introduce
  - annotate
  - import
  - derive
  - record

**what?**
- location known
  - look up
  - browse

- location unknown
  - locate
  - explore

- identify
- compare
- summarize

**input**

**output**
2. Choose a combination of **Encode** and / or **Manipulate** and / or **Introduce** methods
Multi-Level Typology of Abstract Visualization Tasks

\{ why, how, what \}
Multi-Level Typology of Abstract Visualization Tasks

\{ \text{why}, \text{how}, \text{what} \}

3. Fill in: \textbf{Input} and \textbf{Output} with nouns

- why?
  - consume
  - discover
  - enjoy

- how?
  - produce
  - encode
  - select
  - navigate
  - arrange
  - change
  - filter
  - aggregate

- what?
  - [input]
  - [output]

- target known
  - target unknown

- location known
  - location unknown

- query

- manipulate
  - introduce
  - annotate
  - import
  - derive
  - record

[Input] and [Output] with nouns:
[Input] [output]
Multi-Level Typology of Abstract Visualization Tasks

**Why:** choose from alternatives. **What:** fill in *Input* and *Output*. **How:** choose combination.

- **why?**
  - consume
    - present
    - discover
    - enjoy
  - search
    - target known
      - lookup
    - target unknown
      - browse
  - location known
    - locate
  - location unknown
    - explore
- **how?**
  - manipulate
    - select
    - navigate
    - arrange
    - change
    - filter
    - aggregate
  - introduce
    - annotate
    - import
    - derive
    - record

**what?**

- [input]
- [output]
Example:

“presenting a path between nodes”

1 Grosjean et al. (InfoVis 2002)
2 Munzner et al. (SIGGRAPH 2003)
Example: “presenting a path between nodes”

1 Grosjean et al. (InfoVis 2002)
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Example: “presenting a path between nodes”

1 Grosjean et al. (InfoVis 2002)

2 Munzner et al. (SIGGRAPH 2003)
Example:
“presenting a path between nodes”

1 Grosjean et al. (InfoVis 2002)

2 Munzner et al. (SIGGRAPH 2003)
**SpaceTree**

Example: “presenting a path between nodes”

1 Grosjean et al. (InfoVis 2002)

**TreeJuxtaposer**

2 Munzner et al. (SIGGRAPH 2003)
Example:

**Task Sequence**

“verifying a hypothesis regarding the existence of clusters of items in a scatterplot of dimensionally reduced data, then labelling clusters of points.”
Example:

Task Sequence

“verifying a hypothesis regarding the existence of clusters of items in a scatterplot of dimensionally reduced data, then labelling clusters of points.”
Example: Task Sequence

“verifying a hypothesis regarding the existence of clusters of items in a scatterplot of dimensionally reduced data, then labelling clusters of points.”

Dimensionality Reduction  Visual Encoding
Example: Task Sequence

“verifying a hypothesis regarding the existence of clusters of items in a scatterplot of dimensionally reduced data, then labelling clusters of points.”
“verifying a hypothesis regarding the existence of clusters of items in a scatterplot of dimensionally reduced data, then labelling clusters of points.”

Example: Task Sequence

<table>
<thead>
<tr>
<th>Item 1</th>
<th>Item 2</th>
<th>...</th>
<th>Item n</th>
</tr>
</thead>
<tbody>
<tr>
<td>dim 1</td>
<td>dim 2</td>
<td>...</td>
<td>dim m</td>
</tr>
</tbody>
</table>

Dimensionality Reduction

Visual Encoding

Labelling
```
<table>
<thead>
<tr>
<th>dim 1</th>
<th>dim 2</th>
<th>dim 3</th>
<th>...</th>
<th>dim m</th>
</tr>
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<tbody>
<tr>
<td>Item 1</td>
<td>Item 2</td>
<td>...</td>
<td>...</td>
<td>Item n</td>
</tr>
<tr>
<td>Item 1</td>
<td>Item 2</td>
<td>...</td>
<td>...</td>
<td>Item n</td>
</tr>
</tbody>
</table>
```

**2D data**

- **Clusters and Points**
  - **Encode** + **Navigate** + **Select**
  - **Discover**, **Explore**, **Identify**
  - **Produce**
  - **Annotate**

```
"verifying a hypothesis regarding the existence of clusters of unlabelled items in a scatterplot of dimensionally reduced data, then labelling clusters of points."
```
“verifying a hypothesis regarding the existence of clusters of unlabelled items in a scatterplot of dimensionally reduced data, then labelling clusters of points.”
“verifying a hypothesis regarding the existence of clusters of unlabelled items in a scatterplot of dimensionally reduced data, then labelling clusters of points.”
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Similarities and Differences from Schulz et al., Roth (InfoVis ‘13)
Similarities and Differences from Schulz et al., Roth (InfoVis ‘13)
**Similarities** and **Differences** from Schulz et al., Roth *(InfoVis ‘13)*

**why?**
- present
- discover
- consume
- search
- target known
  - location known
    - lookup
  - location unknown
    - locate
- target unknown
- query
- identify
- compare
- summarize

**enjoy**

**produce**
- produce
- encode
- manipulate
- select
- introduce
- annotate
- import
- derive
- record

**how?**

**what?**
- [ input ]
- [ output ]
- filter
- aggregate
- navigate
- arrange
- change

**Enjoy: Casual Visualization usage**
Multi-Level Typology of Abstract Visualization Tasks
Brehmer & Munzner (2013)

Design Space of Visualization Tasks
Schulz et al. (2013)

Taxonomy of Cartographic Interaction Primitives
Roth (2013)
Multi-Level Typology of Abstract Visualization Tasks
Brehmer & Munzner (2013)

Design Space of Visualization Tasks
Schulz et al. (2013)

Taxonomy of Cartographic Interaction Primitives
Roth (2013)
Bring Your Own “What”:

• values, extremum, ranges, distributions, clusters, …
  [Amar, Eagan, & Stasko (InfoVis 2005)]

• nodes, links, paths, graphs, clusters, …
  [Lee et al.'s Graph-Specific Objects (BELIV 2006)]

• points, intervals, spans, patterns, sequences, …
  [Aigner et al.'s Time-Oriented Primitives (2011)]

• pixels, data values, attributes, vis. structures, …
  [Ward and Yang's Interaction Operands (InfoVis 2004)]
**Bring Your Own “What”:**

- values, extremum, ranges, distributions, clusters, …  
  [Amar, Eagan, & Stasko (InfoVis 2005)]

- nodes, links, paths, graphs, clusters, …  
  [Lee et al.’s Graph-Specific Objects (BELIV 2006)]

- points, intervals, spans, patterns, sequences, …  
  [Aigner et al.’s Time-Oriented Primitives (2011)]

- pixels, data values, attributes, vis. structures, …  
  [Ward and Yang’s Interaction Operands (InfoVis 2004)]
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Design Space of Visualization Tasks
Schulz et al. (2013)

(dependency)

"Overview first, zoom and filter, details on demand"

(legend: (goal, means, characteristics, target, cardinality))

see Schulz et al. (2013) §3.3.3 on Workflows
Multi-Level Typology of Abstract Visualization Tasks

Brehmer & Munzner (2013)

Design Space of Visualization Tasks

Schulz et al. (2013)

(exploratory, summarize, *, *, all) \Rightarrow (exploratory, elaborate|filter; *, *, multiple)⁺ \Rightarrow (exploratory|confirmatory, gather, look-up, *, single)

"Overview first, zoom and filter, details on demand"

legend:
(goal, means, characteristics, target, cardinality)

see Schulz et al. (2013) §3.3.3 on Workflows
Multi-Level Typology of Abstract Visualization Tasks

Brehmer & Munzner (2013)

Design Space of Visualization Tasks

Schulz et al. (2013)

(exploratory, summarize, *, *, all) \(\Rightarrow\)
(exploratory, elaborate|filter; *, *, multiple)\(^+\) \(\Rightarrow\)
(exploratory|confirmatory, gather, look-up, *, single)

“Overview first, zoom and filter, details on demand”
Overview First

(exploratory, summarize, *, *, all) \Rightarrow (exploratory, elaborate|filter; *, *, multiple) + \Rightarrow (exploratory|confirmatory, gather, look-up, *, single)

“Overview first, zoom and filter, details on demand”

Overview
consume
encode
explore
summarize
overview
style
all items

Design Space of Visualization Tasks
Schulz et al. (2013)
Multi-Level Typology of Abstract Visualization Tasks

Brehmer & Munzner (2013)

Zoom and Filter

Design Space of Visualization Tasks

Schulz et al. (2013)

how? what? why?

how? what? why?

how? what? why?

how? what? why?

dependency

“Overview first, zoom and filter, details on demand”

Overview first, zoom and filter, details on demand

Overview

consumed

encode

explore

summarize

Overview

consumed

navigate

+ filter

identify

Overview

subset of items

Overview

subset of items

Overview

subset of items

consumed

navigate

+ select

identify

item of interest

Legend:
(goal, means, characteristics, target, cardinality)

see Schulz et al. (2013) §3.3.3 on Workflows
Multi-Level Typology of Abstract Visualization Tasks
Brehmer & Munzner (2013)

Design Space of Visualization Tasks
Schulz et al. (2013)

Details on Demand

(exploratory, summarize, *, *, all) ⇒
(exploratory, elaborate|filter, *, *, multiple)⁺ ⇒
(exploratory|confirmatory, gather, look-up, *, single)

"Overview first, zoom and filter, details on demand"
Multi-Level Typology of Abstract Visualization Tasks
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Schulz et al. (2013)

(exploratory, summarize, *, *, all) \Rightarrow
(exploratory, elaborate|filter; *, *, multiple)^+ \Rightarrow
(exploratory|confirmatory, gather, look-up, *, single)

“Overview first, zoom and filter, details on demand”
Take-Home Points:
Using the Typology

1 Beaudouin-Lafon (AVI 2004)

2 Sedlmair, Meyer, & Munzner (TVCG 2012)
Take-Home Points:
Using the Typology

1 Beaudouin-Lafon (AVI 2004)

2 Sedlmair; Meyer, & Munzner (TVCG 2012)

Describe: analyze and compare task sequences at multiple levels, clarify means and ends
Take-Home Points: Using the Typology

**Describe:** analyze and compare task sequences at multiple levels, clarify means and ends

**Generate:** lens for requirements gathering and abstraction in design studies

---

1 Beaudouin-Lafon (AVI 2004)

2 Sedlmair, Meyer, & Munzner (TVCG 2012)
Take-Home Points: Using the Typology

Describe: analyze and compare task **sequences** at **multiple levels**, clarify **means** and **ends**

Generate: lens for requirements gathering and abstraction in **design studies**

Evaluate: a code set for field studies + external validity for lab study tasks

---

1 Beaudouin-Lafon (AVI 2004)

2 Sedlmair, Meyer, & Munzner (TVCG 2012)
A Multi-Level Typology of Abstract Visualization Tasks

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@mattbrehmer

cs.ubc.ca/labs/imager/tr/2013/MultiLevelTaskTypology/
A Multi-Level Typology of Abstract Visualization Tasks

cs.ubc.ca/labs/imager/tr/2013/MultiLevelTaskTypology/

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Thanks: Ron Rensink, François Guimbretière, Miriah Meyer, Michael Sedlmair, Colin Ware, Joanna McGrenere, Stephen Ingram, Jessica Dawson, Joel Ferstay

a place of mind
THE UNIVERSITY OF BRITISH COLUMBIA

NSERC CRSG
Supplemental
Example:

“presenting a path between nodes”

1 Grosjean et al. (2002)
2 Munzner et al. (2003)
Multi-Level Typology of Abstract Visualization Tasks

\{ \textit{why}, \textit{how}, \textit{what} \}
Multi-Level Typology of Abstract Visualization Tasks

\{ why , how , what \}
Multi-Level Typology of Abstract Visualization Tasks

\{ \text{why}, \text{how}, \text{what} \}

1. Choose either \textbf{Consume} or \textbf{Produce}

   a. If \textbf{Consume}, implies \textbf{Search, Query}
Multi-Level Typology of Abstract Visualization Tasks

\{ why, how, what \}
Multi-Level Typology of Abstract Visualization Tasks

\{ \textit{why} , \textit{how} , \textit{what} \}

2. Choose a combination: \textbf{Encode} and / or \textbf{Manipulate} and / or \textbf{Introduce}
Multi-Level Typology of Abstract Visualization Tasks

\{ why, how, what \}

why?
- consume
  - search
    - query
- produce

how?
- encode
- manipulate
- introduce

what?
- [ input ]
- [ output ]
Multi-Level Typology of Abstract Visualization Tasks

\{ why, how, what \}

3. Fill in:

**Input** and **Output**

- why?
  - consume
  - produce

- how?
  - encode
  - manipulate
  - introduce

- what?
  - [input]
  - [output]
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Roth (2013)

why?
what?
how?
methods

inputs and outputs

Goals
Means
Characteristics
Targets
Cardinality

Goals
Objectives
Operators
Operands
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Roth (2013)

why?
inputs and outputs
what?
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Goals
Means
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why?
what?
how?
inputs and outputs

Methods

Goals
Means
Characteristics
Targets
Cardinality

Goals
Objectives
Operators
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Methods
Inputs and Outputs
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why?
what?
how?

Methods

Goals
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Taxonomy of Cartographic Interaction Primitives
Roth (2013)

why?

what?

how?

inputs and outputs

methods

Goals
Means
Characteristics
Targets
Cardinality

Goals
Objectives
Operators
Operands

InfoVis’13

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Brehmer & Munzner (2013)

Design Space of Visualization Tasks
Schulz et al. (2013)

Taxonomy of Cartographic Interaction Primitives
Roth (2013)

**Goal**
- Exploratory Analysis
- Confirmatory Analysis
- Presentation

**Goals**
- Procure
- Predict
- Prescribe
Multi-Level Typology of Abstract Visualization Tasks
Brehmer & Munzner (2013)

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Schulz et al. (2013)

Taxonomy of Cartographic Interaction Primitives
Roth (2013)

Goal
- Exploratory Analysis
- Confirmatory Analysis
- Presentation

Goals
- Procure
- Predict
- Prescribe

why?
consume
present
discover
enjoy
produce

discover
consume
produce

why?

goals

why?
Multi-Level Typology of Abstract Visualization Tasks
Brehmer & Munzner (2013)

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Schulz et al. (2013)

Taxonomy of Cartographic Interaction Primitives
Roth (2013)

**Goals**
- Procure
- Predict
- Prescribe

**Goal**
- Exploratory Analysis
- Confirmatory Analysis
- Presentation

**why?**
- present
- discover
- enjoy
- produce

**consume**
- why?
- present
- discover
- enjoy
- produce

**Goals**
- Procure
- Predict
- Prescribe

**Goals**
- Exploratory Analysis
- Confirmatory Analysis
- Presentation
Multi-Level Typology of Abstract Visualization Tasks
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Schulz et al. (2013)

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Goal
- Exploratory Analysis
- Confirmatory Analysis
- Presentation

Goals
- Procure
- Predict
- Prescribe

why?

present discover enjoy produce

consume

goals

why?

present discover enjoy produce

consume

goals

why?

present discover enjoy produce

consume

goals

why?

present discover enjoy produce

consume

goals

why?

present discover enjoy produce

consume

goals

why?

present discover enjoy produce

consume

goals

why?

present discover enjoy produce

consume

goals

why?

present discover enjoy produce

consume

goals
Multi-Level Typology of Abstract Visualization Tasks
Brehmer & Munzner (2013)

Goals
- Procure
- Predict
- Prescribe

Design Space of Visualization Tasks
Schulz et al. (2013)

Taxonomy of Cartographic Interaction Primitives
Roth (2013)

Goal
- Exploratory Analysis
- Confirmatory Analysis
- Presentation

why?
- present
- discover
- enjoy
- produce

consume
- produce
- derive
- high-dim. data
- 2D data
**Multi-Level Typology of Abstract Visualization Tasks**
Brehmer & Munzner (2013)

- why?
  - consume
    - present
    - discover
    - enjoy
  - produce

**Design Space of Visualization Tasks**
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Multi-Level Typology of Abstract Visualization Tasks
Brehmer & Munzner (2013)

why?

consume

present discover enjoy produce

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**Multi-Level Typology of Abstract Visualization Tasks**
Brehmer & Munzner (2013)

- **why?**
- consume
  - present
  - discover
  - enjoy
- produce
- search
  - target known: lookup, browse
  - target unknown: locate, explore
- query
  - identify
  - compare
  - summarize

**Design Space of Visualization Tasks**
Schulz et al. (2013)

**Taxonomy of Cartographic Interaction Primitives**
Roth (2013)
Multi-Level Typology of Abstract Visualization Tasks

Brehmer & Munzner (2013)

Goal
Directed Search
Undirected Search

Means
Navigation

Operators
Search
Retrieve
Filter

Why?

present
discover
enjoy

consume
produce

search

location known
location unknown

target known
target unknown

lookup
browse
locate
explore

identify
compare
summarize

Goal
Search
Retrieve
Filter

Design Space of Visualization Tasks

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Goal
Directed Search
Undirected Search

Means
Navigation
Relation
Cardinality
Single Instance
Multiple Instances
All Instances

Operators
Search
Retrieve
Filter

Objectives
Identify
Compare
Associate
Delineate

why?
consume

present
discover
enjoy

produce

search
target known
target unknown

location known
lookup
browse

location unknown
locate
explore

query

identify
compare
summarize

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Multi-Level Typology of Abstract Visualization Tasks
Brehmer & Munzner (2013)

- Design Space of Visualization Tasks
  - Means
    - Navigation
    - (Re)-Organization
      - Extraction
      - Abstraction
      - Deriving
      - Gathering
    (extend as needed)
  - Meta-Tasks
    - Annotate

- Taxonomy of Cartographic Interaction Primitives
  - Roth (2013)
Multi-Level Typology of Abstract Visualization Tasks
Brehmer & Munzner (2013)

- encode
  - how?
    - manipulate
      - select
      - navigate
      - arrange
      - change
      - filter
      - aggregate
    - introduce
      - annotate
      - import
      - derive
      - record

Design Space of Visualization Tasks
Schulz et al. (2013)

Means
Navigation
(Re)-Organization
- Extraction
- Abstraction
- Deriving
- Gathering
(extend as needed)

Meta-Tasks
Annotate

Enabling Operators
- Re-express
- Re-symbolize Pan
- Re-project Zoom
- Sequence Filter
- Arrange Calculate
- Overlay

Work Operators
- Import Edit
- Export Annotate
- Save
Multi-Level Typology of Abstract Visualization Tasks

Brehmer & Munzner (2013)

Design Space of Visualization Tasks

Schulz et al. (2013)

Taxonomy of Cartographic Interaction Primitives

Roth (2013)

Means

Navigation

(Re)-Organization

• Extraction

• Abstraction

• Deriving

• Gathering

(extend as needed)

Meta-Tasks

Annotate

Enabling Operators

Re-express
Re-symbolize
Re-project
Sequence
Arrange
Overlay
Pan
Zoom
Filter
Calculate

Work Operators

Import
Export
Save
Edit
Annotate
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Taxonomy of Cartographic Interaction Primitives
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Means
Navigation
(Re)-Organization
  • Extraction
  • Abstraction
  • Deriving
  • Gathering
  (extend as needed)

Meta-Tasks
Annotate

Enabling Operators
Re-express
Re-symbolize  Pan
Re-project  Zoom
Sequence  Filter
Arrange  Calculate
Overlay

Work Operators
Import  Edit
Export  Annotate
Save
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Means

Navigation

(Re)-Organization

• Extraction
• Abstraction
• Deriving
• Gathering
(extend as needed)

Meta-Tasks

Annotate

Enabling Operators

Re-express
Re-symbolize
Re-project
Pan
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Sequence
Filter

Arrange
Calculate

Overlay

Work Operators

Import
Export
Save
Edit

Annotate
Multi-Level Typology of Abstract Visualization Tasks
Brehmer & Munzner (2013)

Design Space of Visualization Tasks
Schulz et al. (2013)

Taxonomy of Cartographic Interaction Primitives
Roth (2013)

→ change

calculate (parameters) [15]* [13], change (metaphor) [19]*, change (representation) [15]*, change (vis. encoding) [44], transform [56]*[40, 80], transform (mapping), shift, scale, set (graphical value) [14]*, rotate, scale [13], configure [73]*, animate [13, 80], distort [29, 75]* [13], orient / transform [66]*, (object) manipulation: transform, stretch, shape [42]*, re-express, re-symbolize, re-project [57]*, edit [42, 57]*, activate [56]*

(Re-)Organization

• Extraction
• Abstraction
• Deriving
• Gathering
(extend as needed)

Meta-Tasks

Annotate [all data] log scale outliers
linear scale

Means

Zoom Filter Calculate
Import Export
Save
Edit Annotate

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Matthew Brehmer
### Multi-Level Typology of Abstract Visualization Tasks

*Brehmer & Munzner (2013)*

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### Design Space of Visualization Tasks

*Schulz et al. (2013)*

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### Taxonomy of Cartographic Interaction Primitives

*Roth (2013)*

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1 References from §5.
2 References from §2.
3 References from §2.

7 References cited by all 3
12 References in common with Schulz et al., 22 cited by Schulz et al., not by us
12 References in common with Roth + Roth (2012/2013), 19 cited by Roth, not by us
8 References in common between Schulz et al. and Roth, 1 of these not cited by us
23 References cited only by us
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