On Expressing Observation and Interpretation through Visual Interaction

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Analytics is poised to become the next **general-purpose** methodological science.

Interactive visualization is the face of analytics. **Visualization** helps us share ideas about data. **Interaction** helps us express and explore them.

It doesn’t matter whether data is **quantitative** or **qualitative**, **simple** or **complex**, **big** or **small**. Is it **interesting** or **useful** for human understanding?

Visual analytics research is increasingly focusing on deeply **textured** data and **structured** information.

How can interactive visualization support a comprehensive digital workspace for humanities scholarship?
the visualization and humanities communities are still looking at the design of digital tools primarily in terms of

representation

interaction

process

we need to ask two new, big questions about interaction

how does the visual representation of data affect how we can interact with it?

how can interaction allow us to express our ideas as data?
there are many well-known ways to visually encode individual data items, visually represent entire data collections, and interactively gesture to navigate the resulting views.

almost all interaction with data items is either: selecting items (in views) adjusting values (in widgets) labeling items (using a text box)

richer ways of interacting with data items are app-specific: paint an item with color drop a pin on a map type text in a form

how can we generalize this?
how does the visual representation of data affect how we can interact with it?

form follows function follows form...

objects offer affordances for sensible interaction

graphical characteristics constrain effecting movements

bounds of motion determine possible changes to data

but not necessarily via literal geometry
how does the visual representation of data affect how we can interact with it?

this is more than literal drawing
actions always change visual characteristics **indirectly** through data
objects and actions need not have corresponding geometries
to design an action, one must define a **decoding** function to sensibly “invert” the **encoding**
inversions are often ambiguous and sometimes impossible to solve in closed form
automatic algorithms can often solve them in practice by relaxing assumptions (as in the constraint-based UIs of the 80’s)

indirectness provides design flexibility
encoding and decoding need not be exact inverse functions
it’s enough if users can learn and use them together effectively
we’re working on a declarative language for defining **both**
how can interaction allow us to express our ideas as data?

**entities**

*actions express characteristics*

Drag things on a map to adjust location.

Nudge events to reorder them on a timeline.

Pinch to associate uncertainty with a measurement.

Click and type to name, label, or annotate.

**relationships**

*actions express connections*

Draw, move, erase arrows to edit links between items.

Press modifier keys to group or ungroup selected items.

Wheel scroll over an item to classify all items in its group.

Draw a path to sequence a set of locations over time.
how can interaction allow us to express our ideas as data?

**reasoning**

**actions express comprehension**

Change column values to record observations. Create multiple columns to record other interpretations. Define columns that transform, filter and sort others. Aggregate and define categories using linked tables.

**open-ended editing by defining and populating columns dynamically**

<table>
<thead>
<tr>
<th>Intrinsic g(defined)</th>
<th>Imported f(data source)</th>
<th>Calculated f(columns)</th>
<th>Grouped g(column)</th>
<th>Variant g(column, h(parameters))</th>
<th>Annotated h(user data entry)</th>
<th>Ampliated f(columns, h⁻¹(events, encoding))</th>
</tr>
</thead>
<tbody>
<tr>
<td>record ID (unique)</td>
<td>inverse index</td>
<td>database</td>
<td>project (boolean)</td>
<td>sort (comparator)</td>
<td>encode (glyph)</td>
<td>select (boolean)</td>
</tr>
<tr>
<td>...</td>
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<td>...</td>
<td>sorted data values in indexed buckets</td>
<td>...</td>
<td>previous state A</td>
<td>previous state B</td>
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</tbody>
</table>

**sharing**

**actions express collaboration**

Associate columns with users, times, and purposes. Specify access and editing options for each column. Define columns that adjudicate multiple interpretations. Snapshot copies of columns for recall and export.
annotation shouldn’t be an endpoint

we think of annotation as
writing in the margin
adding a mark to a map
drawing an arrow to connect things

but in digital tools, annotations are really data
in which writing is hand-formatted text
and symbols encode quantities
and arrows imply relationships

and in a sense, all data is annotation
because whether by writing it down directly
or recording it with designed instruments

it ultimately comes from us...
...interpreting the world
ampliation
open-ended, interpretation-driven
extension and modification of data
directly within visual representations

annotation as a part of open-ended interaction
to question, observe, reason, conclude, and share

Ampliative
from Latin ampliare, "to enlarge"
used in logic to mean “extending” or “adding to that which is already known.”

In Norman law, an “ampliation” was a postponement of a sentence to obtain further evidence.
Interactive Gesture-Based Data Manipulation and Visualization for Exploratory Learning and Research with a variety of DH collaborators at OU and Stanford
National Science Foundation

Emily Grimes
forms of data interaction in existing visualization tools

Jeyachandran Rathnam
a data editing architecture for web-based visualization

Library of Digital Latin Texts with Sam Huskey (Classics) and June Abbas (SLIS) at OU
Andrew W. Mellon Foundation

Bharathi Asokarajan
pixel-based visualization of classical critical editions

Shejuti Silvia
storyline visualization of classical critical editions

Vamshi Krishna Sunchu
relational querying of TEI documents

Sudarshan Reddy Vangala
high-level provenance of interactive visual analysis
Our software workbench for creating visualizations is called Improvise.

To see more, visit www.cs.ou.edu/~weaver/improvise

The next major version of Improvise is in planning. New features will include a data editing specification language and end-user ampliation capabilities.

Stay tuned!