Interaction

There is an apparent challenge that computational artifacts pose to the longstanding distinction between the physical and the social, in the special sense of those things that one designs, builds, and uses, on the one hand, and those things with which one communicates, on the other.

“Interaction” – in a sense previously reserved for describing a uniquely interpersonal activity – seems appropriately to characterize what goes on between people and certain machines as well.

Lucy Suchman, Plans and Situated Actions

Interaction between people and machines requires mutual intelligibility or shared understanding.

Gulfs of Execution & Evaluation

[Norman 1986]
**Gulf of Execution**
The difference between the user’s intentions and the allowable actions.

**Gulf of Evaluation**
The amount of effort that the person must exert to interpret the state of the system and to determine how well the expectations and intentions have been met.

[Norman 1986]
Gulf of Execution

Conceptual model:
Draw a scatterplot

Real world:
Move 90 30
Rotate 35
Pen down
...

Real world

Gulf of Execution

Conceptual model:
Draw a scatterplot

Execution

Topics

- Brushing and linking
- Dynamic queries
- Generalized selection
- Rearrangements

Brushing and Linking
Highlighting

Direct attention to a data subset within a graph [Wills 95]

Brushing and Linking

Interactively select subset of data
See selected data in other views
Two components (normally views) must be linked to allow for brushing

Baseball Statistics [from Wills 95]

Linking Assists to Positions
GGobi: Brushing

http://www.ggobi.org/

Dynamic Queries

Query and Results

```
SELECT house FROM east bay
WHERE price < 1,000,000 AND bedrooms > 2
ORDER BY price
```

Issues

1. For programmers
2. Rigid syntax
3. Only shows exact matches
4. Too few or too many hits
5. No hint on how to reformulate the query
6. Slow question-answer loop
7. Results returned as table
**Direct Manipulation**

1. Visual representation of objects and actions
2. Rapid, incremental and reversible actions
3. Selection by pointing (not typing)
4. Immediate and continuous display of results
Cellphones

http://www.myrateplan.com/cellphones/

Zipdecode

http://benfry.com/zipdecode/
**NameVoyager**

http://www.babynamewizard.com/voyager

**Attribute Explorer** [Spence and Tweedie 98]
- Video Clip

**TimeSearcher** [Hochheiser & Shneiderman 02]

Based on Wattenberg’s [2001] idea for sketch-based queries of time-series data.

**3D dynamic queries** [Akers et al. 04]
3D dynamic queries [Akers et al. 04]

Pros and Cons

Pros
- Controls useful for both novices and experts
- Quick way to explore data

Cons
- Simple queries
- Lots of controls
- Amount of data shown limited by screen space

Who would use these kinds of tools?

Generalized Selection

Visual Queries

Model selections as declarative queries.

\[ (-118.371 \leq \text{lon} \leq -118.164) \land (33.915 \leq \text{lat} \leq 34.089) \]
Visual Queries

Model selections as declarative queries over the domain of visualized data.

Applicable to dynamic, time-varying data

Retarget selection across visual encodings

Perform operations on query structure

“Select items like this one.”

Generalized Selection

Point to an example and define an abstraction based on one or more properties [Clark, Brennan]

“This is not a sentence.”

“Blue like this”

“The same shape as

Abstraction may occur over multiple levels
**Generalized Selection**

Provide generalization mechanisms that enable users to expand a selection query along chosen dimensions of interest

Expand selections via **query relaxation**

---

**Query Builder**

**Click:** Select Items
(id = ‘China’)

**Drag:** Select Range
(2000 < gni AND gni < 10000) AND (.1 < internet AND internet < .2)

**Legend:** Select Attributes
(region = ‘The Americas’)
Query Relaxation

Generalize an input query to create an expanded selection, according to:

1. A semantic structure describing the data
2. A traversal policy for that structure

Relaxation using Hierarchies

Relax using abstraction hierarchies of the data
Traverse in direction of increasing generality

Examples

A Priori: Calendar, Categories, Geography
Data-Driven: Nearest-Neighbor, Clustering

Relaxation using Attributes

If no explicit semantic structure is available, treat data itself as a “flat” hierarchy
Select all items with matching values along the attributes chosen for relaxation
Relaxation of Networks

Rearrangements

(Graphics and Graphic Information Processing, Bertin 81)
TableLens [Rao & Card 94]


Trellis Display [Becker, Cleveland, and Shyu 96]

Panel variables
- type, yield

Condition variables
- location, year

Alphabetical ordering

Main-effects ordering
Summary

Most visualizations are interactive
- Even passive media elicit interactions

Good visualizations are task dependent
- Choose the right space
- Pick the right interaction technique

Human factors are important
- Leverage human strengths
- Assist to get past human limitations