DESIGNING COLLABORATIVE VISUAL ANALYTICS TOOLS: FROM SUPPORTING EXPERTS TO ENGAGING THE PUBLIC

Narges Mahyar
University of British Columbia
May 16, 2016 @ York University
How can we enrich the design of Information systems?

How can art make CS reach beyond CS audiences?
I design, develop & evaluate novel visualization & interaction techniques to help people solve complex problems.
WHO AM I & WHAT AM I DOING

RESEARCH INTERESTS

▸ Human-Computer Interaction (HCI)

▸ Collaborative Visual Analytics (CVA)

▸ Visual Analytics (VA): focuses on analytical reasoning facilitated by interactive visual interfaces.

▸ Visualization is complementary to statistical analysis, helps people to explore and communicate insights.
OBSERVATIONAL STUDY


COSPACES (COLLABORATIVE WORKSPACES)


Understanding the domain specific problems
- Designing visualization & interaction technologies
- Evaluating & analyzing the effect

Ethnography
- Observational User Study
- Case Study
- System Building
- Qualitative & Quantitative Evaluation
OUTLINE OF THE TALK

- Collaborative Visual Analytics
- A selection of my projects:
  - CLIP
  - Participatory Urban Design
- Contributions
- Vision & Future Directions
Why this is an exciting research direction?

- The future will see collaboration with digital information became a central aspect of use of computational technology.

- Now exciting visual representations need to be enriched and augmented to better support collaborative setting.
WHY COLLABORATE VISUAL ANALYTICS?

- Collaboration:
  - Diverse backgrounds/expertise
  - Quality of work
  - Individual bias
  - Task Load

- Visual Analytics:
  - Visual representation & interactive exploration
# Collaborative Visual Analytics: Challenges

<table>
<thead>
<tr>
<th>Category</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Users</td>
<td>Multiple backgrounds</td>
</tr>
<tr>
<td>Cognition</td>
<td>Foraging &amp; sensemaking</td>
</tr>
<tr>
<td>Analysis results</td>
<td>Consensus, shared insight</td>
</tr>
<tr>
<td>Evaluation</td>
<td>Social interaction around data</td>
</tr>
<tr>
<td>Visual representations</td>
<td>Multiple displays, novel I/O</td>
</tr>
</tbody>
</table>

Isenberg et al., Infovis, 2012
SUPPORTING COMMUNICATION AND COORDINATION IN COLLABORATIVE SENSEMAKING


CLIP (COLLABORATIVE INTELLIGENT PAD)

CLIP is a collaborative thinking space that helps people to record, organize, and share their externalizations.
CONTEXT: ANALYSIS OF LARGE SET OF DOCUMENTS

- VAST 2006 challenge dataset
- 240 documents, news articles, maps, images and etc.
- Finding a hidden chemical weapon production.
RESEARCH PROBLEMS

- How to support collaborative sensemaking?
- How to support externalizations?
  - organize, record, and share findings, hypotheses, and evidence.
- Evaluate the effect on awareness, communication & coordination?
CAMBIERA: FOR COLLOCATED VISUAL ANALYTICS OF DOCUMENT COLLECTIONS

Isenberg & Fisher, 2012
LINKED COMMON WORK (LCW)

- **LCW**: automatically identifying and visually representing similarities between collaborators’ work
  - Partial merging
  - Full merging
PARTIAL VS. FULL MERGING
CLIP: VIDEO

CLIP: A Collaborative Visual Thinking Space to Support Joint Sensemaking
EVALUATION OF LINKED COMMON WORK (LCW)

- Experimental comparison of CLIP to a baseline tool
- Baseline tool: CLIP without LCW
BASELINE TOOL

Laura Alex Mary

George
Works

Club

George
Member
Meetings
Plaza

ISPS
Club
USER STUDY & DATA GATHERING

- 48 participants: 16 groups of 3, 8 groups in each condition
  - Worked for 90 minutes
  - Used CLIP or Baseline
- Followed by semi-structured interview
- Logged interactions
- Video recorded all the sessions
HYPOTHESES

- Linked Common Work will improve:
  - H1: Performance
  - H2: Communication
  - H3: Coordination
  - H4: Awareness
METRICS AND ANALYSIS

- Performance
  - Scoring scheme (from Isenberg et al., 2012):
    - Positive points for finding and connecting relevant facts
    - Negative points for incorrect hypotheses
  - Number of key documents found (out of 10)
METRICS AND ANALYSIS: DEVELOPING NEW METRICS

- Conversation analysis
  - Classified and counted statements of 7 different types
  - 2 coders, Krippendorff’s alpha = 0.91
- Spent around 520 hours on data analysis
## METRICS SCHEME

<table>
<thead>
<tr>
<th>Code</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>DH</td>
<td>Discussion / generating Hypotheses</td>
</tr>
<tr>
<td>RV</td>
<td>Referring to Visualization</td>
</tr>
<tr>
<td>CO</td>
<td>Coordination</td>
</tr>
<tr>
<td>SA</td>
<td>Seeking Awareness</td>
</tr>
<tr>
<td>VF</td>
<td>Verbalizing Findings</td>
</tr>
<tr>
<td>QF</td>
<td>Question about Findings</td>
</tr>
<tr>
<td>RU</td>
<td>Related but uncategorized</td>
</tr>
</tbody>
</table>
HYPOTHESES

H1: Better performance

![Bar chart showing key documents and scores with p-values less than 0.001]

Key Documents
- BT
- CLIP

Score
- BT
- CLIP

p < 0.001
Hypotheses

H4: Less reliance on verbal communications for awareness

- QF: p<0.06
- VF: p<0.04
- SA: p<0.01

Legend:
- BT
- CLIP
PARTICIPATORY URBAN DESIGN


CONTEXT

- Break-out group work session at a public workshop or design charrette.

- E.g. “designing” a neighbourhood centre for a suburban neighbourhood with intent of increasing the neighbourhood walkability.

- Indicators: increased population, population density, housing mix, amount of commercial floor area, new jobs.
Early in the process where influential (and difficult to reverse) directions are considered with relatively little information
DEPLOYED VERSION

- Multi-touch tabletop
- Large-screen wall displays
- Visualization for sustainability metrics
MY ROLE IN THIS PROJECT: METHODS

- Observed the system in action
- Interviewed and closely worked with experts
- Led the design and mentored 2 students to develop new features
- Evaluation: heuristic evaluation, internal test, pilot, user study
MY ROLE IN THIS PROJECT: NEW RESEARCH PROBLEMS

- What are the limitations of a single shared interactive display in supporting collaborative analysis scenario?
- What are the ways which we can design multi-display eco-system to better support multi-users’ interactions?
DESIGN OBJECTIVES: INTEGRATING INDIVIDUAL DISPLAYS

- iPad 3D viewer app
  - Improve interactions with the 3D wall display

- iPad indicator app
  - Improve interactions with metrics
# PERSONAL DISPLAY

## Select Category

| Travel | Land Use | Energy & Carbon | Economy | Dwellings | Wellbeing |

## City Plan Indicators

<table>
<thead>
<tr>
<th>Category</th>
<th>Indicator</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Travel</td>
<td>Current design</td>
<td>5000</td>
</tr>
<tr>
<td>Travel</td>
<td>Existing</td>
<td>12842</td>
</tr>
<tr>
<td>Population Density</td>
<td>Residential</td>
<td>83%</td>
</tr>
<tr>
<td>Population Density</td>
<td>Commercial</td>
<td>16%</td>
</tr>
<tr>
<td>Single attached</td>
<td>Households</td>
<td>6%</td>
</tr>
<tr>
<td>Rowhouse</td>
<td>Households</td>
<td>17%</td>
</tr>
<tr>
<td>Apartment</td>
<td>Households</td>
<td>76%</td>
</tr>
<tr>
<td>Household</td>
<td>Cost of Energy</td>
<td>$3002</td>
</tr>
<tr>
<td>Building Density</td>
<td>DE</td>
<td>1.9</td>
</tr>
</tbody>
</table>

### Notes
- Residential: 83%
- Commercial: 16%
- Single attached: 6%
- Rowhouse: 17%
- Apartment: 76%
- Household: $3002
- DE: 1.9

---

**CLIP, URBAN DESIGN**

**CONTRIBUTIONS | VISION & FUTURE DIRECTIONS**
USER STUDY

- 40 participants: 8 groups of 5
- 2 conditions: paper vs. multidisplay tabletop
- Data gathering:
  - videos
  - pre and post session surveys
  - focus group
  - two independent observers’ notes
CVA | PROJECTS: CLIP, URBAN DESIGN | CONTRIBUTIONS | VISION & FUTURE DIRECTIONS

PAPER-BASED
TABLETOP DISPLAY
WALL DISPLAY
COLLABORATIVE CONTRIBUTIONS AND CO-CREATION OF DESIGN
ROLE OF 3D IN UNDERSTANDING THE DESIGN
ANALYSIS IN PROGRESS

- Study a multi-display interactive tabletop system in action
- Evaluate the effects on:
  - learning
  - engagement
  - collaboration dynamics
MY MAIN RESEARCH CONTRIBUTIONS

- Proposing a framework for CVA + role of note taking
- The effects of integrating record keeping into a CVA tool
- Introducing LCW method, new metrics for CVA
- Metrics for engagement
- Investigating a multi-display CVA tool for engagement
VISION: TOWARDS MORE ENGAGING DESIGNS

- Make information accessible and usable even to most unskilled users
- Develop effective & engaging visualization techniques & collaboration technologies
- Develop theories about engagement
- Bring more design elements to CS
- Explore potentials of multi-touch surfaces for engaging novice users
SHORT-TERM RESEARCH GOALS

- Collaborative note taking in different settings and domains
- LCW for different domains, e.g. co-authoring documents
- Use of multi-display eco-system for public engagement
SHORT-TERM RESEARCH GOALS

- Visualization design for public engagement

- Infographics & donut charts based on domain experts’ suggestions
SHORT-TERM RESEARCH GOALS

- Understanding user engagement

Low engagement

Expose

Involve

Analyze

Synthesize

Decide

High engagement

LONG-TERM RESEARCH GOALS

- Multimodal interaction for collaboration
- Novel displays to engage novice users
- Visual storytelling
- Visualization for personal discovery, e.g. health data
- Evaluation methods for InfoVis & CSCW
- Bridging between computational/analytics & design
THANKS TO MANY
THANK YOU!

NARGES MAHYAR

nmahyar@cs.ubc.ca

Slides, papers, and more:
www.cs.ubc.ca/~nmahyar
BACK UP SLIDES