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

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WHO AM I & WHAT AM I DOING

INTERDISCIPLINARY BACKGROUND

- Electrical Engineering
- Fine Arts Background
- Computer Science
How can we enrich the design of Information systems?

How can art make CS reach beyond CS audiences?
BIO

I design, develop and 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)
- Visualization is an external representation of data which replaces cognition with perception to help people to do tasks more effectively.
- Visualization is complementary to statistical analysis, helps people to explore and communicate insights.
WHO AM I & WHAT AM I DOING

DOMAINS

- Business Intelligence
- Intelligence Analysis
- Urban Planning
- Civil Engineering
MY RESEARCH APPROACH & METHODS

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

- Ethnography
- Observational User Study
- Case Study
- System Building
- Qualitative & Quantitative Evaluation
WHO AM I & WHAT AM I DOING

MY MAIN RESEARCH CONTRIBUTIONS

MSc., ICCC 2010

PhD, VAST 2010, InfoVis Journal 2012

PhD, HICS 2013, ITS 2011

PhD, VAST 2014, Best Paper Award

Postdoc, CSCW 2015, City Life

Postdoc, IEEE VIS 2015, Personal Vis
OUTLINE OF THE TALK

- Collaborative Visual Analytics
- A selection of my projects:
  - CLIP
  - Participatory Urban Design
- Contributions
- Vision & Future Directions
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>Users</th>
<th>Multiple backgrounds</th>
</tr>
</thead>
<tbody>
<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>
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</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.
- Scenario reveals the first clue. Then, analysts were challenged to find the most relevant documents.
- Similar to real life scenarios, there are distractors that could point analysts in the wrong direction.
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

Laura  Alex  Mary

George  Works  Club

Member  Meetings

ISPS  Plaza
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
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>Abbreviation</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

- Key Documents
- Score

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
FUTURE APPLICATIONS OF THIS PROJECT

▸ LCW for different domains, e.g. co-authoring documents

▸ LCW for different collaborative settings, e.g. distributed software development
PARTICIPATORY URBAN DESIGN


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.
GAPS IN CURRENT SUPPORTING TOOLS

- Early in the process where influential (and difficult to reverse) directions are considered with relatively little information
BEFORE I ARRIVED AT UBC: RESEARCH PROBLEM

- How to use visualization and collaboration technologies to increase public engagement?
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 | City Plan Indicators
--- | ---
Travel | Residential
Land Use | Commercial
Energy & Carbon | Population Density
Economy | Single attached
Dwellings | Rowhouse
Well Being | Apartment

- **Existing**
- **Current design**

- **Population Density**:
  - Residential: 83%
  - Commercial: 16%

- **Individual**
  - (tonnes CO2e per capita): 1.7

- **Household**
  - (annual average cost of energy): $3002

- **Building Density**: 1.9
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
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

- 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
- Revisit principles and guidelines for CSCW
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!

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