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VISUAL ANALYTICS
TO EVALUATE INFERENCE AFFORDANCE FROM ANIMATED MAP DISPLAYS

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Scott Prindle & Adeline Dougherty

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**WHEN, HOW AND WHY DO ANIMATIONS WORK?**

- **inference affordance** (Fabrikant et al., 2008)
  - informational equivalence (amount and quality of information content)
  - computational equivalence (quality and efficiency of inference making)

- research question:

  *How does design facilitate or hinder inference affordance from animated displays?*
EXPERIMENTAL DESIGN

• independent variables (controlled)
  – animation types (between-subject)
    – simple (tweened, non-tweened)
    – interactive (tweened, non-tweened)
  – inference tasks (within-subject)
    – simple questions: location, theme, & time
    – complex questions: general patterns, what-if scenarios

• dependent variables (measured)
  – eye movement pattern: AOIs, gaze paths
  – user interactions
  – verbal protocols
  – (accuracy of) response for inference task
  – response time (RT) for task completion
• “gaze plot” maps (fixations & saccades)
**EYE MOVEMENT DATA**

- “gaze plot” maps (fixations & saccades)
ANALYSIS OF EYE MOVEMENTS

• questions:
  – *where* on the animation?
  – *when* looked at first, second...?
  – *for how long* in a particular location?

• measures (Goldberg & Kotval 1999)
  – fixation location
  – fixation: duration (e.g., >100 ms)
  – *sequence/order* of fixations
  – gaze path *similarities*
  – etc.
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VISUAL ANALYTICS OF EYE MOVEMENTS

• information affordance is a *process*!
  - bottom line measures: accuracy & speed of response not enough

• pattern detection and analysis as a classic data mining problem!
  - fixation data (>173,000 records, ~10 MB)
  - interaction data (>8,000 records, ~1 MB)
  - bottom line data: accuracy/speed, and user background information

• development of data handling solutions
  - scripted visual stimuli (control of every single drawn element)
  - database storage and access (Oracle, MySQL with PHP)

• development of visual front-ends
  - play-back of user-interactions and visualizations of eye movements
VISUAL ANALYTICS OF EYE MOVEMENTS

- database-driven visualization & exploration of eye movements & interactions

MySQL/PHP

eyview (Flash)

Grossmann (2007)
VISUAL ANALYTICS ALL THE WAY DOWN
Preliminary Results

qualitative analysis:

- inference making patterns influenced by:
  - design & task

overall pattern question
THERE ARE SEVERAL PAGES OF THE DOCUMENT THAT NEED TO BE CONCATENATED INTO ONE PAGE. PAGES ICONS CANNOT BE PULLED FROM THE DOCUMENT AND PLACED ONTO THE OTHER PAGES. THIS IS A MOMENT WHERE THE DOCUMENT HAD TO BE JUMPED FORWARD TO FIND THE NEXT PAGE. WHEN ADDING TEXT TO THE PAGE, MAKE SURE TO INCLUDE ALL NECESSARY INFORMATION. THIS INCLUDES ANY HIGHLIGHTED TEXT OR POINTS THAT ARE MENTIONED IN THE NEXT PAGE. WHEN ADDING IMAGES TO THE PAGE, ENSURE THAT THEY ARE ACCURATELY REPRESENTED AND PROVIDE ENOUGH INFORMATION TO UNDERSTAND THE CONTEXT OF THE IMAGE.
PRELIMINARY RESULTS: INTERACTION PATTERNS

- direction & speed of animation

*significant

<table>
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<tr>
<th>Tween</th>
<th>No-Tween</th>
<th>Tween Simple</th>
<th>No-Tween Simple</th>
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</thead>
<tbody>
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<tr>
<td>No-Tween</td>
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</table>

proportions (%)
PRELIMINARY RESULTS: INTERACTION PATTERNS

- direction & speed of animation

* significant
GENERALIZATION OF GAZE PLOTS

Monthly Ice Cream Consumption
GENERALIZATION OF GAZE PLOTS
SUMMARY & OUTLOOK

• empirical evaluation of inference affordance from animated map displays

• inference affordance influenced by inference tasks & display designs
  – i.e., simple or complex tasks
  – i.e., interactivity, animation speed, or tweening

• animation types cannot be informationally / computationally equivalent
  – context dependent trade-off!

OUTLOOK

• further quantitative analyses
  – i.e., sequence analysis of AOIs
  – summarizations across participants based on similarity measures
  – verbal protocol analysis
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¿ Questions ?

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