Suggested Interactivity: Seeking Perceived Affordances for Information Visualization

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Tony Abbott was prime minister for fewer days than Gillard or Rudd – chart

This graph shows total days in office (including multiple, non-consecutive terms) for all Australian prime ministers, from the longest-serving, Robert Menzies, to the eight days of Francis Forde. Having just been ousted by Malcolm Turnbull, Tony Abbott has had the 10th shortest time in office.

Australian prime ministers: total days in office

<table>
<thead>
<tr>
<th>Prime Minister</th>
<th>Days in Office</th>
</tr>
</thead>
<tbody>
<tr>
<td>Robert Menzies</td>
<td>6,718</td>
</tr>
<tr>
<td>John Howard</td>
<td>4,184</td>
</tr>
<tr>
<td>Robert Hawke</td>
<td>1,586</td>
</tr>
<tr>
<td>Malcolm Fraser</td>
<td>2,577</td>
</tr>
<tr>
<td>William Hughes</td>
<td>2,343</td>
</tr>
<tr>
<td>Joseph Lyons</td>
<td>2,243</td>
</tr>
<tr>
<td>Stanley Bruce</td>
<td>1,487</td>
</tr>
<tr>
<td>Alfred Deakin</td>
<td>1,771</td>
</tr>
<tr>
<td>Andrew Fisher</td>
<td>1,912</td>
</tr>
</tbody>
</table>
How can we attract these users’ attention to a visualization and suggest its interactivity through design?
Background

• Affordances
  • **Real affordances**: the actual physical properties of an artifact that call for action
  • **Perceived affordances**: the perception and/or understanding a person has of the actions that can be performed with that artifact

• **Feedforward**: tells users what the result of their action will be
Breakdown

**Study #1:**
Testing Interaction Propensity

**Study #2:**
Design Space for Suggested Interactivity

**Study #3:**
Testing Three SI Cues on Bar Charts

**Analysis and Critique**
Study #1:
Testing Interaction Propensity
Setup

- **7 simulated articles with text and visualizations**
- **Layout:** Wikipedia
- **Data and Text:** OECD Better Life Index website
- **Task:** simple fact-checking task
  - Multiple choice extraction task
  - Possible to do task with text and with visualization
Setup

- Participants from Amazon Mechanical Turk
  - Native English speakers
- Coding
  - Brush interactions
  - Decisive brushes
  - Number of subsequent trials decisive brushes were used
  - Participant’s answers
- Analysis
  - Point estimates and 95% CI based on 10 000 percentile bootstrap replicates
Experiment #1:

Are people inclined to interact with charts to carry out fact-checking tasks?

• **H1.1**: A majority of participants will not know that the charts are interactive, and therefore they will not use them to complete trials.

• **H1.2**: A majority of participants who ‘discover’ the interactivity of the charts will use them throughout all subsequent trials.
Experiment #1: Important Results

• Only used participants with score > 0
  • 59 participants
• H1.1 & H1.2 confirmed
• Layout contribution
• Charts perceived as efficient

<table>
<thead>
<tr>
<th>Measure</th>
<th>Percentage</th>
</tr>
</thead>
<tbody>
<tr>
<td>&gt; 1 Brush</td>
<td>42.4 %</td>
</tr>
<tr>
<td>&gt;1 Decisive</td>
<td>28.8%</td>
</tr>
<tr>
<td>(Decisive</td>
<td>Brush)</td>
</tr>
<tr>
<td>(Brush in all 7 trials</td>
<td>&gt;1 Brush)</td>
</tr>
<tr>
<td>(Brush in subsequent trials</td>
<td>Brush)</td>
</tr>
<tr>
<td>(Decisive in all 7 trials</td>
<td>&gt;1 Decisive)</td>
</tr>
<tr>
<td>(Decisive in subsequent trials</td>
<td>Decisive)</td>
</tr>
</tbody>
</table>
Experiment #2:

Are charts more efficient than text?

• Trials 3,4,5 were replaced with just charts

• **H2.1:** all participants will interact with the charts in trials [3-5]
• **H2.2:** majority of participants will use the charts in trials [6-7]
• **H2.3:** there will be good evidence that more participants interact with the charts in trials [6,7] than in [1,2]
• **H2.4:** participants should complete trials [6,7] faster than [1,2]
Experiment #2: Important Results

- **H2.1** failed: not all participants interacted with charts
  - Visualization literacy
- Needed to get used to charts
- **H2.2, H2.3, H2.4** confirmed
- Charts are more efficient
- Conclusion: charts are more efficient
Experiment #3 + Results:

*Is Wikipedia layout choice biasing results?*

• Ran experiment #1 again without Wikipedia styling attributes

• **H3:** results will be consistent with **Experiment #1**, meaning Wikipedia styling did not bias participants’ behaviour

• **Results:** consistent with Experiment #1
Study #1: Conclusions

• Lack initial propensity to interact with charts embedded with text
• Visualization literacy problems
• Charts are more efficient
• People can be motivated to interact with visualizations if they are shown the possibility
• Highlights the need for suggested interactivity
Study #2:
Design Space for Suggested Interactivity
Definitions

Suggested Interactivity (SI) : set of methods for indicating that a graphical area can be interacted with by subtly directing a user’s attention so as not to impede too heavily on this person’s focus or on the rest of the interface design

SI cues : specific graphical elements or attributes that are used for suggesting interactivity
Design Space for Suggested Interactivity

• **Attractor:** the object that attracts attention to the interactive area
  • Object of interest
  • External object

• **Animation:** the state of the attractor over time
  • Staged: blink
  • Interpolation: unique or looped
  • Dynamic

• **Trigger:** the event that initiates the animation
  • System event
  • User event

• **Visual attributes:** the specific visual variables and/or marks the animation is applied to

• **Persistence:** the ongoing display or not of the cue once the interaction has been performed
<table>
<thead>
<tr>
<th>Attractor</th>
<th>Object of interest</th>
</tr>
</thead>
<tbody>
<tr>
<td>Animation</td>
<td>None</td>
</tr>
<tr>
<td></td>
<td>Staged</td>
</tr>
<tr>
<td></td>
<td>Blink</td>
</tr>
<tr>
<td></td>
<td>Unique</td>
</tr>
<tr>
<td></td>
<td>Looped</td>
</tr>
<tr>
<td></td>
<td>Interpolated</td>
</tr>
<tr>
<td></td>
<td>Unique</td>
</tr>
<tr>
<td></td>
<td>Looped</td>
</tr>
<tr>
<td></td>
<td>Dynamic</td>
</tr>
<tr>
<td></td>
<td>System</td>
</tr>
<tr>
<td>Trigger (event)</td>
<td>Pageload/update</td>
</tr>
<tr>
<td>User</td>
<td>Mousedown</td>
</tr>
<tr>
<td></td>
<td>Mouseover</td>
</tr>
<tr>
<td></td>
<td>Click</td>
</tr>
<tr>
<td></td>
<td>Drag</td>
</tr>
<tr>
<td>Variable</td>
<td>Mousewheel</td>
</tr>
<tr>
<td>Visual attribute</td>
<td>Extra</td>
</tr>
<tr>
<td></td>
<td>mark</td>
</tr>
<tr>
<td></td>
<td>Non-textual</td>
</tr>
<tr>
<td></td>
<td>Textual</td>
</tr>
<tr>
<td>Persistence</td>
<td>Mouseover</td>
</tr>
<tr>
<td>Intended interaction</td>
<td>Click</td>
</tr>
<tr>
<td></td>
<td>Drag</td>
</tr>
<tr>
<td></td>
<td>Mousewheel</td>
</tr>
</tbody>
</table>

http://peopleviz.gforge.inria.fr/trunk/SI_cues/
Study #2: Results and Observations

• SI cues are mostly applied to object of interest
• Animation is determined by what triggers it
  • Staged animation-> system events
  • Dynamic animation -> user-events
• Combinations: interest attractor and external object attractor
  • Feedforward

Dimensions useful for analyzing current visualizations but too complex when it comes to creating new ones
Design Considerations

• Visualisations as attractors
  • Already depend on visual marks
  • Should not play with free visual attributes
  • Required animation:
    • staged: organic motion: heart beat
    • dynamic: attractive motion: orienting, squeezing, stretching depending on how far mouse is

• Icons as attractors
  • Focal icon
  • Identifier icon
  • Demonstrator icon
Study #3:
Testing Three SI Cues on Bar Charts
Suggested Interactivity #1

• **Attractor:** visualization
• **Animation:** staged, looped
  - organic motion- heartbeat
• **Trigger:** page-load
• **Persistent:** no
Suggested Interactivity #2

- **Attractor:** focal icon
- **Animation:** no
- **Trigger:** page-load
- **Persistent:** yes
  - Visible when out of focus
Suggested Interactivity #3

- **Attractor:** visualization and demonstrator icon
- **Animation:** looped staged
- **Visual mark:** text label
- **Trigger:** page-load
- **Persistent:** no
Follow up study results

- Conducted follow-up study on AMT
- Reproduced **Experiment #1** three times applying each SI
- between subjects design
- **H4**: more participants will perform brush interactions and decisive brushes when an SI cue is applied to the charts
- **Results**: H4 failed
  - No evidence that SI1 or SI2 had any effect
  - SI3 had an effect
Analysis and Critique
**Analysis: What, Why, How**

<table>
<thead>
<tr>
<th>What</th>
<th>Any Visualization embedded in text</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Why</strong></td>
<td>Suggested Interactivity</td>
</tr>
<tr>
<td><strong>How</strong></td>
<td>SI1 Motion</td>
</tr>
<tr>
<td></td>
<td>SI2 Overlay Focal icon</td>
</tr>
<tr>
<td></td>
<td>SI3 Motion + external icon</td>
</tr>
</tbody>
</table>
Critique

• Small scope
  • Only visualizations embedded in text
  • Only considered 3 SI options
  • Specific task
• Only focused on hovering on bar charts
• Didn’t consider age or experience of users
• Only a transition phase
Overall Conclusion

• Lack initial propensity to interact with charts
• Low interaction literacy
• Suggested Interactivity is necessary
• Subtle cues are not effective
• Feedforward is crucial
Questions?