Streamgraphs & Gestalt Psychology

Holton Rower
“Sometimes I Have to Look in the Mirror to See if I'm Still There”
2011

http://theberry.com/2015/02/16/painting-time-lapses-by-holton-rower-video/

http://seaburyschoolnavigators.blogspot.com
Today

- Reminder: Quiz on Friday
- **Reading for Today:**
  “Stacked Graphs – Geometry & Aesthetics”
- Research Example: Gestalt & User Studies
- Crayon Exercise
- Readings for Tuesday
Readings for Today

• “Stacked Graphs – Geometry & Aesthetics”
  Lee Byron & Martin Wattenberg, IEEE TVCG 2008

• Internet feedback was a large part of paper
  – Unnecessary?
  – started off as a story or documentary rather than an academic paper, strange
  – vulgar language :(, seemed unprofessional (?)
  – Cannot measure “organic and emotionally pleasing”, proper analysis of comments beyond ‘some people liked it/ some did not’ was not attempted/difficult/impossible

• Like other art... it is controversial, and that’s ok!
  – Eye magnets

• Layout
  – Tufte’s macro/micro: show both the sum and the individual values
  – Minimize “wiggle” of extremes & middle curves, thicker layers weighted more highly (but does not display data as accurately?)
  – Keep graph centered (don’t drift up or down)
  – Border/space between layers? If required by media
  – Labels are important
  – Interaction is good
  – Looks like mountains, foreground/background, perceived overlap implies some data is bigger than just the visible area
• Colors
  – Natural & pleasing, not too loud or distracting, (boring?)
  – For a particular dataset is it necessary to match disjoint regions by color?
  – Choose color from relevant 2D axes mapped to color & saturation
  – Don’t all need to be unique, aren’t limited by # of distinguishable colors

• Local contrast
  – Display data, e.g., time of onset, popularity,
  – Bias color selection to keep image balanced

• Order
  – Lack of prescribed ordering is unsettling
  – Sort by time of offset or “measure of volatility”
  – Generally alternating top & bottom seems to be best
  – Entrance position discussion interesting

• This is not a black box one-size-fits-all visualization technique. It requires thought to
  choose colors & tweak layout. It won’t work for all data. Could be done badly...
  – Difficult for newbies - no clear, straightforward solution/guidance for layout or color
  – Waviness of output appropriate for music data
  – Handles massive amount of data
  – This should be a graph option in Excel!

• Legend mandatory to understand and interpret a particular streamgraph
  (no conventions)
  – The plots are so interesting you are motivated to figure it out

• Abstract was awkward talking about an image that wasn’t right there

• Insufficient comparison images within the paper
  (copyright thing? page limit? assumed to be “common knowledge”?)

• Didn’t explain improvements streamgraph vs. theme river

• Personalized visualizations are cool

• Purpose of this visual: to look cool & be engaging & draw interest or to
  scientifically measure & conclude things?

• Some sloppy figure callouts/captions/labels. Some captions too short.
  Why was this image included? Need to do more than just describe the
  source of the data

• Vertical vs horizontal: horizontal most appropriate for time data.

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Interpreting Physical Sketches as Architectural Models

Barbara Cutler and Joshua Nasman
Department of Computer Science
Rensselaer Polytechnic Institute
“Virtual Heliodon” for Daylighting Analysis

- Camera to detect geometry
- 4 projectors to display solution
- Design sketched with foam-core walls

Tangible Interface for Architectural Design

- Exterior & interior walls
- Tokens for:
  - Windows
  - Wall/floor colors
  - North arrow

- Overhead camera
- Projection geometry
- Inferred design
Our Contributions

• Algorithm for automatic interpretation of interior space vs. exterior space
• Construction of a watertight 3D mesh
• User study collected >300 example designs
• Validation of algorithm
  – Compare to annotations by the original designer
• Quantify design ambiguity
  – Compare annotations of a design by other users
Related Work

- Tangible User Interfaces [e.g., Ben-Joseph et al. 2001]
- Sketch-based Modeling User Interfaces
  [Zeleznik et al. 1996; Igarashi et al. 1999; Dorsey et al. 2007]
- Pen-based Sketch Recognition [e.g., Wacom 2010]
- Automated Recognition of CAD Drawings
  [Aoki et al. 1996; Llados et al. 1997; Ah-Soon and Tombre 2001; Kulikov 2004; Lu et al. 2005]
- Human Vision, Perception, & Gestalt Psychology
  - Seek the simplest explanation for an incomplete diagram
  - Closure, proximity, symmetry, continuity, collinearity, & parallelism

Gestalt Psychology: Reification

- Constructive or generative aspect of perception

Pragnanz: Gestalt Laws of Grouping

- Proximity
- Similarity
- Closure
- Symmetry
- Common fate
- Continuity
- “Good” gestalt (regular, simple & orderly, eliminate complexity & unfamiliarity)
- Past experience

http://en.wikipedia.org/wiki/Gestalt_psychology

Overview of Algorithm

- Image Processing (our earlier publications)
- Link tangent walls to form continuous chains that divide space into zones
- Determine interior vs. exterior
- Generate floor plan diagram & watertight mesh geometry (more details in our paper)
Tolerance Example: Collinearity

- Detected Geometry
- Designer’s Intention
- Favor Collinearity
- Favor Skew Lines

Other Users’ Interpretations

Linking Elements to Form Chains

- If A→B and B→A are best matches for tangent, then the walls are joined into a chain

Detected Geometry

Wall Chains, Extended to Infinity
Halfspace Zones & Enclosure

- Further subdivided using GraphCuts (if needed)

Interior/Exterior Enclosure Threshold

- Unfortunately, there is no universal threshold
- Varies design-to-design, and *within-a-design*

Compare to Designer’s Intention
Interior/Exterior Optimization

- Analyze histogram of point-sampled enclosure values
- Maximize usage of lengths of real wall elements
- Minimize length of inferred (added) walls
- Minimize area assigned in opposition of simple threshold metric

Complex Boundaries & Varying Gaps

Open Courtyards & Multiple Buildings
Our Goals in Conducting User Studies

• Understand **range of designs** possible
• Improve physical sketching user interface
• Improve algorithm for sketch recognition of interior/exterior space
  – Learn common human interpretation “rules”
  – Quantify design ambiguity
• Measure effectiveness of **Virtual Heliodon** as an architectural daylighting design tool

User Study 1: Open-Ended Design

• 30 participants (15 architects)
• 20 mins of sketching
• 329 unique designs (154 by architects)
• After design session:
  • Designer annotates each design
  • Then, we reveal our automatic interpretation
Identify/Quantify Ambiguous Designs

User Study 2: Re-Interpretation

- 114 designs from Study 1
  - All ambiguous designs included
  - Some clear designs (as controls)
- 15 participants
- Re-interpreted by another user
  - 3-6 new annotations for each
  - 346 total (124 by architects)
- Then compare to original designer’s annotation
- And finally, to our automatic interpretation
Re-Interpretation Results

<table>
<thead>
<tr>
<th></th>
<th>clear</th>
<th>ambiguous</th>
<th>total</th>
</tr>
</thead>
<tbody>
<tr>
<td>matches original</td>
<td>155</td>
<td>74</td>
<td>229</td>
</tr>
<tr>
<td>designer’s intention</td>
<td>78%</td>
<td>56%</td>
<td>70%</td>
</tr>
<tr>
<td>correct</td>
<td>17</td>
<td>35</td>
<td>52</td>
</tr>
<tr>
<td>mostly correct</td>
<td>26</td>
<td>22</td>
<td>48</td>
</tr>
<tr>
<td>incorrect</td>
<td>13%</td>
<td>17%</td>
<td>15%</td>
</tr>
<tr>
<td>total</td>
<td>198</td>
<td>131</td>
<td>329</td>
</tr>
</tbody>
</table>

- No correlation found between background (architecture/arts/none) & interpretation accuracy
- We will continue to improve the robustness of our software

Domain-Specific Knowledge Required

- Standard vocabulary of architectural forms (e.g., cruciform, portico, etc.)
Future Work

- Improve/robustify interpretation algorithm
  - Detect symmetry & repetition
  - Multi-zone interiors & circulation paths
- Incorporate domain-specific knowledge
- Enhance user interface
  - Additional tokens, more complex element shapes
  - Alternative to sketching in plan:
    sketch (double height, multi-floor) vertical sections
- Apply to pen-based sketch interpretation

Thanks!

- Yu Sheng, Ted Yapo, & Andrew Dolce
- Our user study volunteer participants
- Funding from NSF & IBM
• https://oasis.cs.rpi.edu

• Please make models...
  (go ahead, try to break things)

• Please give us feedback 😊

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Crayon Exercise: Shapes!

- Team up with another student, **someone sitting on the opposite side of the room, someone you did not know before class and haven’t worked with yet**
- Come up with a simple, time-based dataset
  - `time` spent in a typical week on
    - sleep/class/homework/eat/sports/tv
  - `lines of code` written during your time at RPI
    - in different programming languages (python, c++, java, etc)
  - `money` spent over a typical month/year on
    - tuition/apartment/food/travel/clothing/movies
  - `?`
- You may want to idealize or exaggerate the similarities and differences in the data for the 2 team members
- First, draw the data using a “boring” bar or stacked bar graph over time
  (2 separate plots, 1 for each person, using the same design/colors)
- Then, sketch a streamgraph version of this data
  (also 2 separate plots, 1 for each person, using the same design/colors)

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Reading for Tuesday  (pick one)

• "Error Bars Considered Harmful: Exploring Alternate Encodings for Mean and Error", Correll & Gleicher, TVCG 2014

![Graphs of error bars with descriptions](image1)

Reading for Tuesday  (pick one)


![Graphs of uncertainty with descriptions](image2)

Fig. 1: Six different visual encodings of start/end uncertainty of temporal intervals used in the user study: (a) gradient plot, (b) violin plot, (c) accumulated probability plot, (d) error bars, (e) centered error bars, and (f) ambiguity. We designed encodings (a)–(c) to encode statistical uncertainty and encodings (d)–(f) to encode bounded uncertainty. All encodings were used to estimate earliest start, latest start, earliest end, and latest end, as well as minimum, maximum, and average interval duration. Moreover, encodings (a)–(c) were used to estimate the probability that the interval has already started/ended at a marked position in time.