HOLA: Human-like Orthogonal Network Layout
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In a Nutshell...
Let’s analyze human-drawn networks to improve automatic [orthogonal] network layout algorithms.

Orthogonal Networks
- An orthogonal network is a type of node-link diagram
- It is a visual encoding idiom
  - a how? in the what-why-how triad
- The layout is the arrangement of edges and nodes in a specific instance

Contributions of Study
1. A new methodology for developing network layout algorithms based on user studies
2. The first user study on aesthetic criteria for orthogonal network layouts
3. A new algorithm called HOLA developed using this methodology

Automatic Network Layout Algorithms
- Have been an area of study since the 1960s
- Aesthetic principles historically determined based on
  - Designer intuition and perceptual principles
  - Algorithmic availability and convenience
- Several of these principles have been validated by user studies:
  - Edge Crossing:
  - Bend Points:
  - Symmetry:
  - Orthogonality:

Uses
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Technique-driven work

"Human-centred" Methodology for Automatic Network Layout Algorithm Design
1. Conduct user studies to determine aesthetic criteria that people value
2. Develop an algorithm that encodes these aesthetics
3. Evaluate the layouts produced by this algorithm against manually-created layouts and the best automatic layouts

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User Study - Stage A
- Seventeen participants were given eight orthogonal networks to manually edit using online tool
- Instructed to edit each network until it “looked good” and the connections were clear

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State-of-the-Art

- yFiles uses an approach called Topology-Shape-Metrics
- Strategy:
  1. Minimize edge crossings
  2. Minimize bend points
  3. Maximize compactness
- Does not care about symmetry or edge-length regularity

Alternative

- Force-directed layout algorithms minimize stress
- Good balance between minimizing edge crossings, compactness, symmetry, and edge-length regularity
HOLA Design Principles

P1: Use force-directed approach first to untangle network
  ○ Compactness (R3)
  ○ Symmetry (R5)
  ○ Minimize edge crossing (R6)
  ○ Edge length regularity (R8, R9)

P2: Apply incremental improvements like a human would
  ○ Tune bend points (R2)
  ○ Enforce gridiness (R4)

P3: Treat acyclic subcomponents (trees) independently
  ○ Enforce placement of trees outside of cycles (R1)
  ○ Encourages symmetry of subcomponents (R5)

HOLA Steps

1. Decompose layout into “core” and subtrees
2. Layout the core
3. Layout and place the subtrees
4. Fine tune

Evaluation of Algorithm - Large Networks

Criticisms

Algorithm:
- No empirical support provided for relationships between design principles (the Ps) and aesthetic values (the Rs)

Evaluation:
- No comparison of outputs by metric (compactness, etc.)
- Would be nice to see metrics for outputs at each stage of the algorithm - can we change the order of tasks and get better results?
- No pairwise comparisons of task performance on large networks
- What about networks with non-uniform distance between nodes?

Evaluation of Algorithm - Small Networks

Synthesis

- What it a success? All in all, Yes!
- They made a couple new discoveries about what people like in network layouts and validated old discoveries
- They developed an automatic orthogonal layout algorithm that is competitive with human-made layouts
- More nuanced than TSM or force-directed approaches alone
- Nicely balances characteristics people value in networks
- They established a framework for others to follow
- They did an excellent job relating the various sections to each other (e.g. the Rs and Ps)

User Study:
- “Select the layout others would like” → stick to conventions?
- Pretty elbow links not possible in editing tool… could give HOLA an unfair advantage
- Fail to discuss another potential value: convey hierarchy

Mean Error

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<th>yFiles</th>
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<td>Neighbours</td>
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Mean Speed

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Reference