Constraints in Diagram Authoring Tools

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Talk overview

- History: Notable constraint-based authoring tool research
- HCI Challenges: Human-Constraint Interaction

Our research
- Usability of constraint-based authoring tools
- Interactive network layout for diagrams
- Video demonstration
Good layout is hard...
... or at least tedious
Diagrams are abstract
Structure is specified, layout is often not
  So, freedom of placement
Certain desired aesthetics
Sketchpad (Sutherland, 1963)

- The first interactive constraint-based system
- Graphical view
- Pen input
- Manipulation
- “Abstractions”
- Copying instances
METAFONT (Knuth, 1979)

- Language for specifying vector fonts
- Various parameters: font slant, stroke width, etc
- Must be ordered to appear linear
- Never really became popular
  - Font designers are not mathematicians!
IDEAL (Van Wyk, 1982)

- Declarative constraint language for drawing pictures
- Box primitives, error if unsatisfiable

```plaintext
put first: rect {
    sw = 0;
    ht = wd = 1;
}
put next: rect {
    nw = first.se;
    ht = wd = first.ht;
}
put last: rect {
    sw = first.ne;
    se = next.ne;
    ht = wd;
}
```
Chimera
(Kurlander & Feiner, 1993)

- Graphical editor
- Avoids manual specification of constraints
- Infers geometric constraints from one or more snapshots
- Direct manipulation with constraints enforced
- Correct unexpected behaviour with constraints turned off, then capture another snapshot
- Subtractive: better for heavily constrained diagrams
Juno (Nelson, 1985)
Juno-2 (with Heydon, 1994)

- “Double-view editing”
- Direct manipulation
- Underconstrained issues, frozen points, hints
- “Daunting to novice users.”, “requires careful thinking”
Briar (Gleicher, 1992)

- Augmented snap-dragging, avoids state-jumps and conflicts
- Ripping, rather than interacting with indicators
- Alignment objects
- Clutter
GLIDE (Ryall, et al., 1997)

- High-level Visual Organisation Features (VOFs)
- VOFs modelled as springs, so may be satisfied to varying degrees
- User guides optimisation
- VOF indicators
  - Highlight
  - Remove

Figure 4: User adds an Alignment VOF to each row.
Microsoft Visio

- Previous examples were CAD-centric
- Visio is a commercial diagram editor
- With diagramming features
  - Shape library, connectors, etc
- Has constraint-based placement tools too
  - One-way constraints for alignment and distribution
Some of the challenges

- Good metaphor
  - Familiar, obvious, real-world mapping
  - High-level: shouldn’t require understanding of the underlying constraints

- Predictable behaviour
  - Under-constrained
  - “That’s because its implemented with...”

- Visual representation
  - Clutter
Some of the challenges II

- **Flexibility**
  - Order shouldn’t matter
  - Add/remove from constraint relationships, override

- **Responsive**
  - Direct manipulation, exploration
  - Solver technology not scaling, computer power

- **Recovery**
  - Unsatifiable constraints
  - Over constrained - “why does this move?”
Usability of constraint-based authoring tools

- Usefulness of multi-way vs. one-way constraint-based placement tools
- Approaches for avoiding the clutter issue
- Value of immediate feedback in constraint-based tools
Dunnart
(Wybrow, Dwyer & Marriott)
Interactive network layout

- High-level layout relationships
  - non-overlap, distribution, downward-pointing edges, etc
  - Implemented with separation constraints

- User-guided continuous network layout
  - Topology preserving, via edge straightening techniques
  - User can override
Conclusions

- Collaboration between human and computer is important for good layout
  - Computers are good at certain types of layout improvement
  - Humans can provide powerful insights/hints
- Good layout is hard to specify mathematically
- Constraints can capture desired layout styles or features
- Interface is really important
Video demonstration