Flexible Visual Authoring Using Operation History

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Digital authoring

Precise and complex editing

Collaboration, dissemination of content

Experimentation
  Undo lowers the cost of mistakes

Revisiting history
  Storing and retrieving state

Hierarchical authoring
  Grouping, structure, selections
Operations and selections today

Uses of **history**
- System activity logs, instrumentation (not our focus)
- Operation history, undo
- Version control
- Tutorials

Uses of **selections** and **grouping**
- Efficient editing of sets of items (multiple selections)
- Hierarchical modeling, CAD
Motivation

Address limitations of standard techniques
  Undo - sequential
  Selections - not persistent
  Grouping – rigid structure expensive to modify

Thesis:
Reusing operations, selections, and groups from a document’s history can improve interaction for the end user.
Enhancing authoring and review

Visualizing history for non-linear interaction
   **Storyboards**: Interactive Visual Histories

Reusing complex selections for efficiency
   History-Based **Selection Expansion**

Enabling bookmarking for flexible grouping
   **Soft Groups**: Multiple Selection Authoring and Reuse
Thesis context

Demonstrate techniques in context of **visual authoring**
Features in Inkscape vector graphics editor

Human component
- Evaluations with beginner- and intermediate-level users
- Iterative design
Talk outline

Interactive Storyboards
  Visualizing history for non-linear interaction

Selection Expansion
  Reusing complex selections for efficiency

Soft Groups
  Flexible authoring of multiple selections
Interactive Storyboards
Visualizing history for non-linear interaction

Selection Expansion

Soft Groups
Motivation: Visual histories

Enable flexible **browsing** of history
   Design a more intuitive interface to document’s editing history
   Show history in spatial context

Enable flexible **manipulation** of history
   Interface to selective undo
Related work: Undo

Undo
  Revisit history
  Undo arbitrarily far back
  Sequential

Selective undo
  Text
  Spreadsheets
  Graphics

[Kawasaki and Igarashi 2004]

[Amulet [Myers et al. 1997]]
Related work: Graphical histories

Snapshots
Editable graphical histories

Film and schematic storyboards
Assembly diagrams
Our storyboard visualization

Graphically represents user editing actions
  Assembly instructions for a document

Shows actions in context: action depictions
  Must be descriptive, intuitive, and easy to select
Our storyboard visualization

Graphically represent user editing actions

Show actions in context: **action depictions**

**Design considerations**
Discrete events
Before and after
In-place visualization
Summarization
Figure-ground separation
Applications

Selective undo
User selects an action to undo
Consider all later actions on the same object
Cancel only those that are dependent
  Spatial transforms: {translate, rotate}
  Appearance changes: {fill change, stroke change}
  Shape modifications: {scale, control point edit}

Collaborative editing
“Track changes”
Asynchronous editing by multiple users
Evaluation

Goals
Record users’ impressions after using storyboards for one hour
Evaluate selective undo interface

Design
12 beginner-level users of 2D drawing programs
Background interview, interactive tutorial
Recreate a “typical” drawing

User feedback
Strengths
Free experimentation
Spatial memory cues
Persistent history

Limitations
Clutter, scalability
Addressing clutter

Per-object history
  “Magic lens” limits storyboard view

Multi-frame storyboard
  Multiple frames in a storyboard
  Multiple actions per frame
Summary: Interactive Storyboards

Interactive storyboards for visualizing history
  Browsing history in spatial context

Composite, per-object, and multi-frame storyboards
  Selective undo application
  Collaborative editing

The user edits the illustration by rotating, translating, and changing the color of objects.
Selection Expansion

Reusing complex selections for efficiency
Motivation: Selection reuse

Multiple selections are fundamental in editing
  Edit the same set of objects together
  Reselecting the set can be repetitive, laborious
    Esp. with overlapping, occluding objects

Groups
  Intuitive, easy to build hierarchy
  An item cannot belong to more than one group at a time
  Ungrouping/regrouping expensive
Related work: Selecting content

Transparency filters

- Multiblending [Baudisch and Gutwin 2004]
- Context-aware free-space transparency [Ishak and Feiner 2004]

Physical interaction metaphors

- “Paper peeling” windows [Beaudoin-Lafon 2001]
- Exposé [Apple 2003]

![Magic Lens](image1)

Magic Lens [Bier et al. 1993]

![Splatter](image2)

Splatter [Ramos et al. 2006]
Related work: Complex selections

Generalizing selections
- Selection guessing [Miller and Myers 2002]
- Selection classifier [Ritter and Basu 2009]
- Interactive query relaxation [Heer et al. 2008]
Related work: Adapting user interfaces

Resize/rearrange menus to reduce target acquisition time
  Fisheye menus [Bederson 2000]
  Flexcel [Thomas and Krogsæter 1993]

Dynamically organizing menu items – frequency, recency
  [Greenberg and Witten 1985]
  [Mitchell and Shneiderman 1989]
  Split menus [Sears and Shneiderman 1994]
Selection expansion

**Hypothesis:**
Items that have been edited together are likely to be edited together again.

From an initial selection, *expand* to a larger set

Base the expansion on *frequency* of use
Greedy expansion strategy

User makes a selection (query)

Look in operation history for single best item to add
Candidates = items that have been edited with the query set
Pick the item appearing most frequently

Expand the selection by one

<table>
<thead>
<tr>
<th>operations</th>
<th>a</th>
<th>b</th>
<th>c</th>
<th>d</th>
<th>e</th>
<th>f</th>
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</tbody>
</table>
A simple example

User’s initial selection is \{e\}

Excerpt: Operations affecting \{e\}:

<table>
<thead>
<tr>
<th>operations</th>
<th>a</th>
<th>b</th>
<th>c</th>
<th>d</th>
<th>e</th>
<th>f</th>
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Compressing the matrix:

<table>
<thead>
<tr>
<th>operations</th>
<th>objects</th>
<th>a</th>
<th>b</th>
<th>c</th>
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</table>
**Query = \{e\}**

Candidate object d:
- Frequency = 5

<table>
<thead>
<tr>
<th>operations</th>
<th>objects</th>
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<tbody>
<tr>
<td></td>
<td>(a) 3</td>
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Candidate object f:
- Frequency = 2

<table>
<thead>
<tr>
<th>operations</th>
<th>objects</th>
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<tbody>
<tr>
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<td>(a) 3</td>
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</table>

Candidate object g:
- Frequency = 4

<table>
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<tr>
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<th>objects</th>
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</thead>
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</table>
Query = \{e,d\}

**Candidate object f:**
Frequency = 2

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**Candidate object g:**
Frequency = 2

<table>
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</tr>
</tbody>
</table>
Query = \{e,d,f\}

Candidate object g:
Frequency = 2

Three expansions:

\{e\} \rightarrow \{e,d\} \rightarrow \{e,d,f\} \rightarrow \{e,d,f,g\}
Larger expansion steps

For efficiency, merge steps when we can
Look for plateaus in maximum selection frequency

Two expansions:

\[ \{e\} \rightarrow \{e,d\} \rightarrow \{e,d,f\} \rightarrow \{e,d,f,g\} \]
Implementation: QuickSelect

selection size = 1 object
Evaluation of QuickSelect

Eleven subjects
   Recruited from general population
      All familiar with at least one 2D drawing program (not Inkscape)
Apparatus
   Controlled lab setting
   Modified version of Inkscape

Two-part study

1. Selection reuse with existing histories
   Evaluate how QuickSelect affects selection speed and accuracy
2. Selection reuse in free drawing
   Record users’ subjective preferences in unconstrained drawing
Study 1: Existing histories

Two **conditions**: standard selection, QuickSelect
20 **tasks**: edit existing drawings

**Procedure**: 

**Hypothesis**: QuickSelect will reduce time to complete the trials and reduce number of editing errors.
Results of Study 1

<table>
<thead>
<tr>
<th>Task</th>
<th>Control</th>
<th>QuickSelect</th>
<th>%Savings</th>
</tr>
</thead>
<tbody>
<tr>
<td>mickey</td>
<td>8.1</td>
<td>7.8</td>
<td>6.9%</td>
</tr>
<tr>
<td>mobile</td>
<td>12.1</td>
<td>9.4</td>
<td>22.9%</td>
</tr>
<tr>
<td>recycle</td>
<td>12.4</td>
<td>10.5</td>
<td>24.1%</td>
</tr>
<tr>
<td>melon</td>
<td>15.8</td>
<td>10.5</td>
<td>33.7%</td>
</tr>
<tr>
<td>seats</td>
<td>17.5</td>
<td>9.7</td>
<td>44.8%</td>
</tr>
<tr>
<td>giraffe</td>
<td>18.3</td>
<td>9.3</td>
<td>54.8%</td>
</tr>
<tr>
<td>clock</td>
<td>19.0</td>
<td>8.7</td>
<td>54.0%</td>
</tr>
<tr>
<td>truck</td>
<td>20.8</td>
<td>11.0</td>
<td>47.1%</td>
</tr>
<tr>
<td>protein</td>
<td>23.7</td>
<td>18.8</td>
<td>60.4%</td>
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<tr>
<td>card</td>
<td>24.5</td>
<td>23.3</td>
<td>61.5%</td>
</tr>
<tr>
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<td>78.3%</td>
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<td>runway</td>
<td>58.0</td>
<td>19.2</td>
<td>78.3%</td>
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<td>64.2</td>
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<tr>
<td>uranium</td>
<td>75.9</td>
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<tr>
<td>girls</td>
<td>83.4</td>
<td>19.8</td>
<td>78.5%</td>
</tr>
</tbody>
</table>

Increasing complexity of task
Study 2: Free drawing

Try selections in a more realistic setting

Procedure
Recreate “typical” drawing described during interview
Unstructured drawing with prompts to try different selections
No measure of success

Feedback
Easy to learn and use
Perceived improvement in speed
Perceived improvement in accuracy
Study 2 more convincing about applicability
Observations

**Strengths** of QuickSelect

- Performance savings larger for more complex designs
- Re-selecting occluded content
- Re-selecting objects of differing size

**Limitations**

- Predictability and error handling
- Combining selection tools
- Additional expansion heuristics
Summary: Selection Expansion

Reuse of multiple selections
Simple yet effective history-based strategy

Easy to learn and apply
Selection reuse can increase efficiency
   Greater savings for more complex designs

Expansion behavior can be difficult to predict → soft groups
Interactive Storyboards

Selection Expansion

Soft Groups
Flexible authoring of multiple selections
Motivation: Flexible grouping

Groups
  Easy to use, membership in only one group at a time

Selections
  Membership created as needed, ephemeral

Selection expansion
  Reuse selections from history, lacks predictability

Related work
  Selecting, grouping, tagging
  Flexible grouping - ScanScribe [Saund et al. 2003]
  Relation building from history [Pedersen and McDonald 2008]
Soft groups

Users **bookmark** multiple selections they wish to reuse. Like groups, soft groups are **persistent** and **reusable**.

An item can belong to more than one soft group.

Like selections, soft groups appear **on demand**. Retrieval interaction similar to selection expansion. Expansion steps determined by user.
Group creation
Group creation

Create Soft Group
Group retrieval
Exploratory evaluation

Goals
- Get user feedback on ease of learning and use
- Compare soft groups to standard selection and grouping
- Compare soft groups to selection expansion

Nine beginner- to intermediate-level users of 2D software

Procedure:
- Recreate “typical” drawing described during interview
- Unstructured drawing with no measure of success
- First, asked to try soft groups
- Second, introduced to selection expansion
Observations from user study

**Strengths** of soft groups
- Straightforward use, easy to learn
- Spatial memory cues: “visual reminder”
- Improves efficiency of authoring
  - Fixed cost to creating soft groups but faster retrieval

**Limitations**
- Error handling
- Visibility, responsiveness

**Comparison** to selection expansion
- QuickSelect “seems faster” than soft groups
- Intermediate users concerned about cost of correcting QS
- SG offer more control
Summary: Soft Groups

Bookmarking selections for reuse
Complementary alternative to standard selection and grouping
Persistent like standard groups
Appear on demand like standard selections

Easy to learn and use
Users preference divided by experience
  Beginners: efficiency of selection expansion
  Intermediate-level users: control of soft groups
Summary of thesis contributions

Presented three uses of **history for the end user**
- **Interactive Storyboards**
- **Selection Expansion** (QuickSelect)
- **Soft Groups**

Demonstrated in the context of **vector graphics editing**

User evaluations suggest **increased efficiency and flexibility** in editing
Applications and open challenges

Prototyping
  Selection reuse for faster prototyping and testing of variations
  Storyboards lower the cost of experimentation

Collaboration
  Recorded history for collaborators

Education
  Storyboards as tutorials

Future work
  Other domains
  Expert users
    Longer-term observation
    Keystroke-level modeling
Conclusions

Bigger picture:

**Mining operation history** to enhance HCI

Demonstrated history-based techniques for improving **authoring** and **review** processes
Acknowledgments

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