DATA-DRIVEN ADAPTIVE HISTORY FOR IMAGE EDITING

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undo/redo/navigation: 9% of all user operations
Hierarchical history panel
varying granularity
Minimal change from prior UI
familiarity
semantic navigation
segment view
spatial filter
smart undo
OBSERVATION
Field study + interview with artists

Coarse level: files/layers to manage progress
  e.g. skin smoothing, hair coloring, eye sharpening

Fine level: frequent undo/redo/navigation
  exploratory nature of art works
Data-Collection
four portrait retouching tasks
10 freelancers on oDesk (now Upwork)

Belarus, Bulgaria, Serbia, Ukraine, Colombia, Philippines, United States

average work per artist

9.5 hours

852 operations
collected data: images, log and manual label
Data-Driven Approach
SEMANTIC SEGMENTATION
editing history
find **semantic segments**
SVM

Feature vector
\[ F = \{ O, P \} \]

operation vector

position vector

| selection | 1 |
| transform | 0 |
| layer op  | 1 |
| text      | 0 |

... 

\[
\begin{bmatrix}
0 & 0 & 0 & 0 \\
0 & 1 & 0 & 0 \\
0 & 0 & 1 & 0 \\
0 & 0 & 0 & 0 \\
\end{bmatrix}
\]

\[
\begin{array}{c}
\text{Op 1} \\
\text{Op 2} \\
\text{Op 3} \\
\text{Op 4} \\
\text{Op 5} \\
\text{Op 6} \\
\text{Op 7} \\
\text{Op 8} \\
\text{Op 9} \\
\text{Op 10} \\
\text{Op 11} \\
\text{Op 12} \\
\text{Op 13} \\
\text{Op 14} \\
\text{Op 15} \\
\text{Op 16} \\
\end{array}
\]

k entries
SVM

Feature vector
\[ F = \{ O, P \} \]

Operation vector
Position vector

<table>
<thead>
<tr>
<th>k entries</th>
</tr>
</thead>
<tbody>
<tr>
<td>Op 1</td>
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<td>Op 2</td>
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<td>Op 4</td>
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SVM

Feature vector

\[ F = \{ O, P \} \]

operation vector  position vector

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selection

\[
\begin{pmatrix}
1 \\
0 \\
1 \\
0
\end{pmatrix}
\]

transform

layer op

text

\[
\begin{pmatrix}
0 & 0 & 0 & 0 \\
0 & 1 & 1 & 0 \\
0 & 0 & 1 & 0 \\
0 & 0 & 0 & 0
\end{pmatrix}
\]
Extract Repeated Patterns
<table>
<thead>
<tr>
<th>Pattern</th>
<th>Count</th>
<th>User%</th>
</tr>
</thead>
<tbody>
<tr>
<td>Eraser, Master Opacity Change, Eraser</td>
<td>26</td>
<td>50%</td>
</tr>
<tr>
<td>Move, Free Transform, Move</td>
<td>11</td>
<td>50%</td>
</tr>
<tr>
<td>Master Opacity Change, Hue/Saturation Layer, Modify Hue/Saturation Layer</td>
<td>8</td>
<td>50%</td>
</tr>
<tr>
<td>Brush Tool, New Layer, Brush Tool</td>
<td>7</td>
<td>50%</td>
</tr>
<tr>
<td>Patch Tool, Patch Selection, Deselect</td>
<td>295</td>
<td>40%</td>
</tr>
<tr>
<td>Blending Change, Master Opacity Change, Blending Change</td>
<td>12</td>
<td>40%</td>
</tr>
</tbody>
</table>

n-gram algorithm
tiles and groups for smart undo
Evaluation
Photoshop

time-based clustering [Li et al. 10]

ours
LIMITATION AND FUTURE WORKS
Data Variety
Online learning
Auto segment
Nonlinear navigation
Evaluation in the wild
Related Works
back, an oval table in front of the sofa, a dressing-table with a looking-glass fixed on it between the windows, chairs along the walls and two or three half-penny prints in yellow frames, representing German damseis with birds in their hands— that was all. In the corner a light was burning before a small icon. Everything
Add a new layer

To add a new layer press the stylus on the current layer and flick towards the Add Layer Icon.
Viewpoint selection for 3D modeling
low-level repetitions
[Xing et al. 2014]
Conclusion
Adaptive history UI

*semantic navigation* and *smart undo* minimum change from traditional UI

Data-driven approach

user workflows

machine learning
THANK YOU!

data at
www.ht-timchen.com/research/data-driven-history-list-for-image-editing/