Regional Undo for Spreadsheets

Yoshinori Kawasaki[1] *and Takeo Igarashi*[1, 2]
[1]Department of Computer Science, The University of Tokyo / [2]PRESTO, JST
7-3-1 Hongo, Bunkyo, Tokyo 113-0033, Japan
E-mail: {kwsk, takeo}@ui.is.s.u-tokyo.ac.jp

ABSTRACT
This paper describes a regional undo technique for spreadsheets that enables the user to fix an error by directly designating a region that contains the error. A number of recent systems have provided rich undo facilities. Most of them have adopted an interface that uses a temporal operations history. However, it can be difficult to find a target error in the operations history. Our technique enables the user to correct an error by specifying the location directly.

KEYWORDS: spreadsheet, undo, error recovery, spatial information

INTRODUCTION
Spreadsheets are one of the applications most widely used to solve problems or analyze data. These activities require frequent trials and errors, making an undo facility essential.

Various undo models have been proposed. The most basic linear undo model allows the user to undo operations already executed in inverse chronological order. This allows the user to undo only the last operation in the operations history and the user needs to repeat undos until the target operation is undone. As a result, the user loses all correct operations after the target operation.

Selective undo [1, 8] is one way to approach this problem. This model allows the user to specify an operation to undo in the operations history. Therefore, the user can undo the operation that caused the mistake selectively. In selective undo, the way to select the operation to undo is important from the user's perspective. Several GUI toolkits present the operations history as a list of text strings, such as GINA [1] and Amulet [7]. Each operation is described as text, and the user chooses operations from a list in a dialog box. Another way is to visualize the history graphically using snapshots. Chimera has an editable graphical history [4] that consists of a series of panels that depict the results of the user's operation. Meng *et al*. [6] use snapshots to extend the selective undo dialog of Amulet.

Nevertheless, there are cases where it is difficult to fix errors with the user interfaces mentioned above. We tend to overlook a mistake and continue to do other work. When we realize the mistake, we have often completely forgotten when the mistake was caused and what operation caused the mistake. In such cases, it is bothersome to determine the adequate operations in the history.

This problem arises from the fact that the user knows only *where* the mistake was made, not *when* (Figure 1). In this paper, we propose a regional undo technique that allows the user to specify the region to apply the undo operation directly.

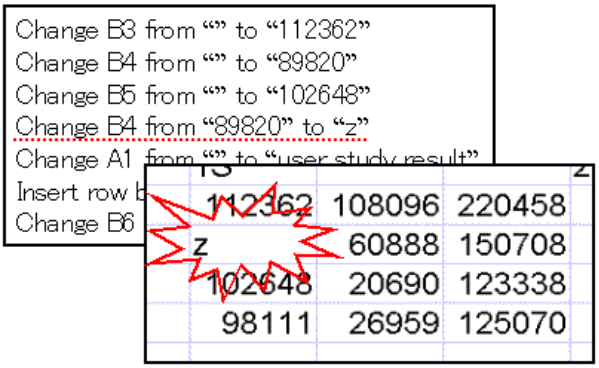

Figure 1: Temporal vs. spatial information. The traditional selective undo requires the user to find the target operation in a history, while our regional undo allows the user to specify it directly on the screen.

RELATED WORK
Several text editors (*e.g*., DistEdit [8], Emacs version 20.3 or later) support selective undos by using a specified region as the selection criterion. Li *et al*. [5] discussed regional undo for text editing in detail.

Flatland [2], a pen-based electronic whiteboard, enables the user to handle the timeline of individual segments. Flatland segments are created automatically when the user draws a stroke, and the user can split and merge segments. The user can undo and redo within segments.

The main idea of a regional undo is not new, but no studies have examined the domain of a spreadsheet to the best of our knowledge.

UIST '04, October 24–27, 2004, Santa Fe, New Mexico, USA
ACM 1-58113-962-4/04/0010

REGIONAL UNDO FOR SPREADSHEETS

The concept of a regional undo is simple; the user who realizes that an error has been made need only specify the region, and perform a "regional undo". Then, the user gets the desired document state. Once the user designates a region, the system automatically selects an operation that affects the specified region and undoes the operation. After undoing, the target operation is removed from the operations list. Figure 2 shows a simple example of the use of regional undo.

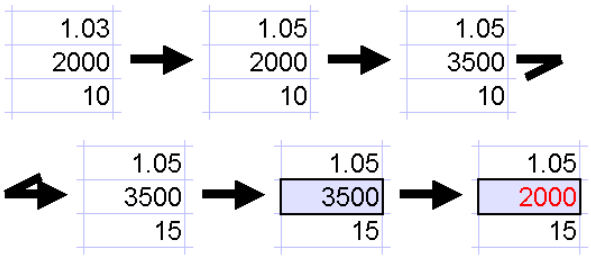

Figure 2: Undoing a change in a particular cell

Slider

The undo and redo can be controlled using a slider. After the user selects a region, the slider appears when the right mouse button is clicked. Then, the user can perform regional undos and redos continuously by moving the slider back and forth.

Clue

It is difficult for the user to specify the proper region when there are hidden rows or columns. While the user remembers that he or she deleted rows or columns, it is easy to forget where the hidden rows or columns were.

The ability to visualize past operations is supported to help the user in such situations. The user can see marks of past operations by using a toggle button on the menu bar (labeled "Clue"). The marks are shown as red lines between headers or as red cell borders (Figure 3).

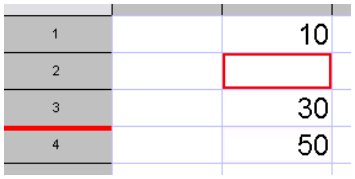

Figure 3: Clues are marked as red lines and rectangles

Partial Undo

In some cases, an operation affects items inside and outside a specified region. Our solution is a partial undo, splitting such an operation into two operations, those inside and outside the region. Figure 4 illustrates an example of a partial undo.

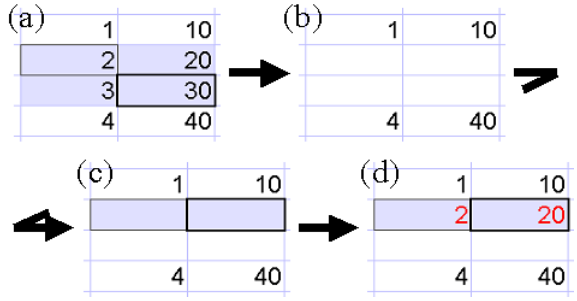

Figure 4: An example of a partial undo. (a) Select a region to delete. (b) Delete cells within a region. (c) Select a region to undo. (d) The regional undo.

Reference Problem

If a cell outside the specified region refers to a cell within the region, an undo within the region causes a change outside the region. Even worse, undoing an insert of rows or columns can result in a reference to cells that currently do not exist. These are common spreadsheet problems due to the hidden structure of the dataflow graph. One possible solution is to provide appropriate feedback to the user using some animation technique of visualizing graph structure [3]. In our current implementation, the system treats a reference as a pointer like commercial spreadsheet applications, not as a simple text. Thus it keeps dataflow graph and automatically adjust textual representations of references in formulas when insert/delete of rows/columns happen.

CONCLUSION AND FUTURE DIRECTION

We have described the regional undo technique for spreadsheets, discussed problems arouse with regional undo and proposed interaction techniques as solutions. We plan to conduct a user study to show benefits and tradeoffs of regional undo compared to selective undo.

REFERENCES

1. Thomas Berlage. A selective undo mechanism for graphical user interfaces based on command objects. *ACM Transactions on Computer-Human Interaction*, 1(3):269-294, 1994.

2. W. Keith Edwards, Takeo Igarashi, Anthony LaMarca, and Elizabeth D. Mynatt. A temporal model for multilevel undo and redo. In *Proc. ACM UIST 2000*.

3. Takeo Igarashi, Jock D. MacKinlay, Bay-Wei Chang, and Polle T. Zellweger. Fluid visualization of spreadsheet structures. In *Proc. the IEEE Symposium on Visual Languages*, 1998.

4. David Kurlander and Steven Feiner. A visual language for browsing, undoing, and redoing graphical interface commands. In S.-K. Chang, editor, *Visual Languages and Visual Programming*, pages 257-275. 1990.

5. Rui Li and Du Li. A regional undo mechanism for text editing. In *The 5th International Workshop on Collaborative Editing Systems*, 2003.

6. Chii Meng, Motohiro Yasue, Atsumi Imamiya, and Xiaoyang Mao. Visualizing histories for selective undo and redo. In *Third Asian Pacific Computer & Human Interaction*, pages 459-464, 1998.

7. Brad A. Myers, *et al*., The amulet environment: New models for effective user interface software development. *Software Engineering*, 23(6):347-365, 1997.

8. Atul Prakash and Michael J. Knister. A framework for undoing actions in collaborative systems. *ACM Transactions on Computer-Human Interaction*, 1(4):295-330, 1994.