

UW Card Sort Analyzer: Version 1.0

1. Introduction


This manual contains an introduction to the use of the UW Card Sort Analyzer and the various tools it provides. This application is designed for quantitative analysis of results from card sorting experiments [3]. The core of its analysis method is the edit distance metric described in the work by Anderson, Anderson, and Deibel [1]. While the metric was developed for analyzing the results of the Bootstrapping experiment [2], this application is designed to handle card sorts from any experiment that used this knowledge elicitation technique.

2. Loading and Closing Card Sorts

Figure 1 shows the analyzer when initially started. One window is auto-created and present: the *Card Sort Manager*. The manager is in charge of loading card sorts and the selection of sorts for use by the analysis tools (see Section 3 for more on selecting).

2.1. The Card Sort Loader

To load card sorts, the user has four options:

1. Pressing the Load Sorts button found on the manager
2. Pressing the  button on the toolbar
3. Selecting 'Load Sorts' from the File Menu
4. Pressing Ctrl-L

Upon doing this, the *Card Sort Loader* window will appear (see Figure 2). The loader contains three tabs for the loading of card sorts, card descriptions, and probe sorts (probe sorts are not currently implemented in this version).

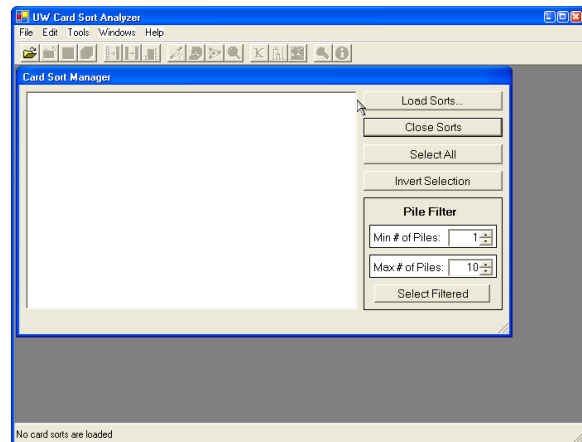


Figure 1. The Analyzer on startup

2.1.1. The Card Sorts Tab

Figure 2 shows the card sorts tab. Three format options are available on the left. Each of these is indicated if the files contain Sorter IDs, pile labels, and/or sort criterion (the overarching theme for a sort). The number of cards is also adjusted here.

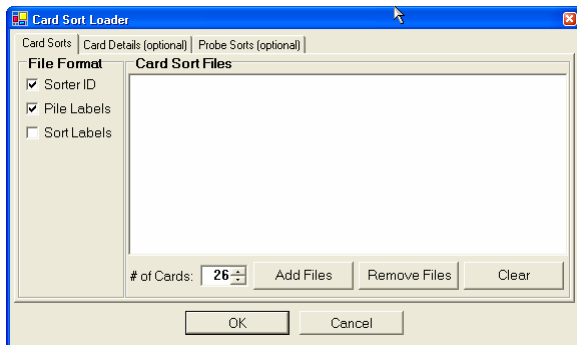


Figure 2. The Card Sort Loader Window

To select the files to load from, the user presses the 'Add Files' button. This opens up a file browser dialog that allows multiple file selection.

Once the user returns from the dialog, the selected files appear in the list box. The user can choose to add more files or remove any of the chosen files. To remove one or several files, select them and then press ‘Remove Files.’ The ‘Clear’ Button will remove all files listed.

2.1.2. The Card Details Tab

Figure 3 shows the card details tab. The use of this tab is optional, but it does enhance the use of two tools: the Key Tool and the Information Tool (see Sections 5.1 and 5.2). The card description/details are a mapping of the card numbers to descriptions of the cards. Choosing a details file (see Section 6.2 for details on the file format) is done through a simple file browser.

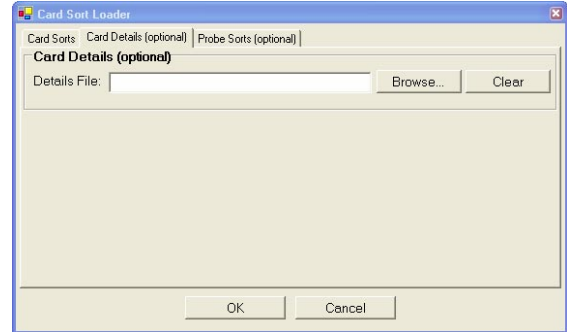


Figure 3. The Card Details Tab

2.1.3. The Probe Sorts Tab


This tab is used for loading sorts that are specifically for the probing analysis method described in [1]. Currently, the probing tool is not fully implemented, so this tab can be ignored for now.

2.1.4. Exiting the Card Sort Loader

Only upon pressing the ‘OK’ button will the card sorts and card descriptions actually be loaded. If you choose to not load any cards, you may press the ‘Cancel’ button or the close window button on the loader. Note that there might be a small delay when loading many card sort files.

2.2. Closing Card Sorts

There are effectively two ways of closing card sorts. The first is to use the card sort loader and remove various files from being loaded. This is the only way to close only a few files. To close all the loaded sorts, there are three options:

1. Pressing the ‘Close Sorts’ button on the manager.
2. Pressing the  button on the toolbar.
3. Selecting ‘Close Sorts’ from the File Menu.

It should be noted that closing and/or changing what sorts are loaded effectively disables all analysis tools that are currently open. See Sections 4 and 5 for more details on this.

3. Selecting Card Sorts

Figure 4 shows a card sort manager that has been loaded with several card sorts. Five of these sorts have been selected already. Notice that more of the toolbar buttons are now activated. The act of selection is what enables the use of the various analysis tools.

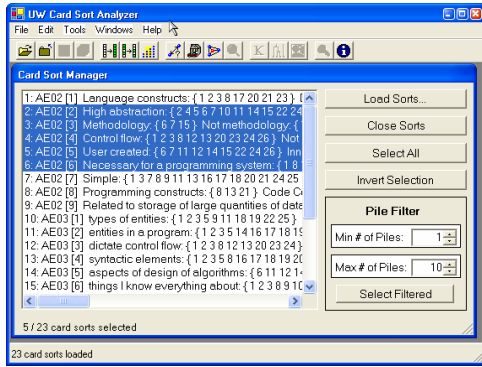


Figure 4. A loaded card sort manager


3.1. Selecting With the Mouse

Selecting with the mouse is the simplest way of selecting sorts. The selection method works just like other multi-selection interfaces found in other Windows applications. Pressing down the left mouse button and dragging the cursor selects large swaths of sorts. To select sorts that are discontinuous from each other, press the control button while clicking the mouse button.

To unselect a sort, press the control key and click on a selected sort. If multiple sorts are selected, clicking on any sort will unselect all but the clicked on sort.


3.2. Select All Command

The ‘select all’ aid automatically selects every card sort that has been loaded into the manager. It is operable through three means:

1. Pressing the ‘Select All’ button on the manager.
2. Pressing the  button on the toolbar.
3. Selecting the ‘Select All’ menu item in the Edit Menu.

3.3. Invert Selection Command

The invert selection flips the selection currently in the manager. Card sorts that were selected are unselected and vice versa. As with all selection aids, this command can be executed through three means:

1. Pressing the ‘Invert Selection’ button on the manager.
2. Pressing the  button on the toolbar.
3. Selecting the ‘Invert Selection’ menu item in the Edit Menu.

3.4. Selection by Pile Counts Command

One common selection method in card sort analysis is to only look at card sorts with certain numbers of piles. The user can select the minimum and maximum number of piles through the ‘Pile Filter’ interface found on the card sort manager (see Figure 5).

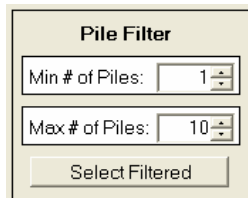



Figure 5. Pile tool

Once the minimum and maximum number of piles has been inputted, the user can then select the sorts that meet this restriction by:

1. Pressing the ‘Select Filtered’ button on the manager.
2. Pressing the  button on the toolbar.
3. Selecting the ‘Select Filtered by Piles’ menu item in the Edit Menu.

4. Exploration Tools

In the Analyzer application, there are several types of tools. This section looks at the exploration type of tools. These tools, as the name implies, allows the researcher to discover and examine the relationships between different card sorts through the use of the edit distance metric. These tools include the methods described in [1].

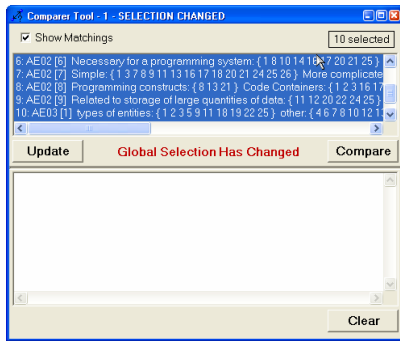


Figure 6. A Comparer Tool after a selection change in the manager

4.1. How Exploratory Tools Work

When card sorts are selected in the manager window, this enables the user to spawn various tools. This allows the researcher to have multiple tool windows open at any time. Moreover, each tool can work with its own non-empty subset of the sorts contained in the card sort manager. One tool window might be a comparer tool looking at all the sorts produced by sorter MS86, while a clique-finder tool is working on sorts containing only three piles.

This multi-tasking approach does create a few issues. If a tool is open and the selection changes in the manager, the tool is made aware of the change (see Figure 6). However, its local copy of the sorts is not changed. The tool will continue to function normally. If the user so desires, the local set of card sorts can be updated to be the manager’s current selection (by pressing the update button in Figure 6).

However, if the user changes the sorts that are loaded, the exploratory will become disabled due to changes in the distance calculation engine. Although the tools functions are disabled, the tool’s calculation results remain available for perusal and saving (once saving is implemented).

4.2. Comparer Tool

The comparer tool, shown in Figure 7, is used for calculating the edit distance between two or more card sorts. It is currently working with three card sorts, two of which have been selected and compared.

The top scroll region contains the local set of card sorts for this tool. When two or more sorts are selected, the ‘Compare’ button gets enabled. When pressed, the distance between the selected sorts is computed and displayed in the bottom scroll bar region. The size of both the top and bottom regions can be adjusted through the use of the dark gray splitter just above the results text box.

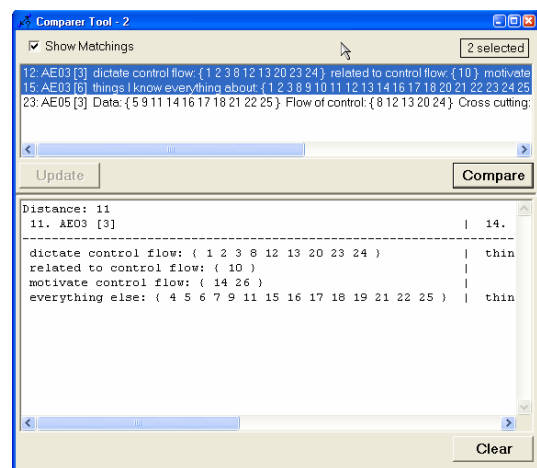



Figure 7. The Comparer Tool

The comparer tool provides one option for the display of results. When ‘Show Matchings’ is selected, the tool displays the maximum weighted matching used to calculate the edit distance. Shown in a two column format, each column is made up of the piles that make up one card sort, while the rows represent the piles that were matched up between the two card sorts.

1. The comparer tool can be spawned through two means:
2. Press the  button on the toolbar.
3. Select the ‘Comparer Tool’ item in the Tools menu.

4.3. Neighborhood Tool

The Neighborhood Tool shown in Figure 8 is used to discover the set of card sorts that are within a threshold distance of Δ (delta) from a selected sort. Even more generally, this tool gives a list, in increasing distance, of how far all sorts are from a specific sort.

Like with the Comparer Tool, the Neighborhood tool consists of two regions: a selection box and a results box. The relative sizes of these two can be shaped by a similar splitter. However, the ‘Find Neighborhood’ is only activated when exactly one sort is selected.

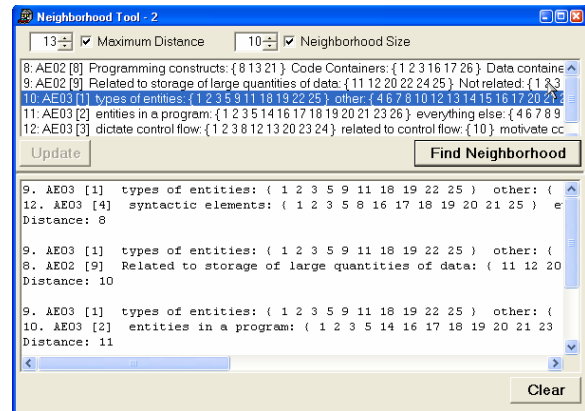



Figure 8. The Neighborhood Tool

Two options are provided for the user. The first is the ‘Maximum Distance’ checkbox and number box. If the checkbox is checked, the tool will only display sorts that are within that distance (inclusive) from the selected sort. The other option is the ‘Neighborhood Size’ checkbox and number box. When the check box is checked, the result box will only display the N closest sorts to the selected sort, where N is the number in the number box.

The neighborhood tool can be spawned through two means:

1. Press the  button on the toolbar.
2. Select the ‘Neighborhood Tool’ item in the Tools menu.

4.4. Clique Finder Tool

The Clique-Finder Tool is shown in Figure 9. As described in [1], the Clique-Finder Tool is used for finding sets of sorts such that the mutual distance between all of them is less than or equal to some specified threshold distance. In this tool, a single card sort is selected as the ‘center’ of the clique.

Like with the other exploration tools, the Clique-Finder tool consists of two regions: a selection box and a results box. The relative sizes of these two can be shaped by a splitter as with the other tools.

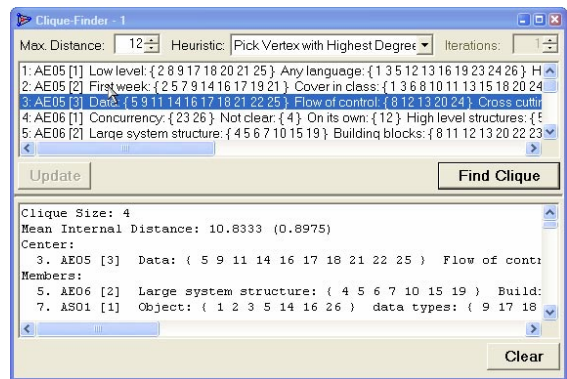



Figure 9. The Clique-Finder Tool

The clique finder provides multiple options. The first and most important is the ‘Maximum Distance’ number box that determines the threshold distance. The other two options allow the user to fine tune the approximation algorithm that finds the cliques. The drop-down list allows the user to choose which heuristic the clique-finding algorithm uses. When finding a clique, the algorithm continually chooses a vertex (i.e. card sort) to add to the clique until there are no more to choose. Currently, the clique-finder tool provides four heuristics for choosing the vertex:

1. “Pick Vertex with Highest Degree in Reduced Graph (D)”:
The vertex chosen is the one with the highest degree in the graph being looked at. If there are ties, the algorithm chooses a vertex in a deterministic fashion.
2. “Pick Vertex with Highest Degree in Reduced Graph (R)”:
This heuristic is the same as the first except that ties are broken in a randomized fashion.
3. “Pick with Uniform Probability (R)”:
In this heuristic, the vertices are selected at random using a uniform probability distribution.
4. “Pick with Degree-Weighted Probabilities (R)”:
Vertices are assigned probabilities based on the degrees in the graph, and then one is randomly selected for inclusion in the clique.

The ‘Iterations’ number box becomes activated whenever a randomized heuristic (those ending with ‘(R)’) is chosen. The number in this box indicates how many times the algorithm will run. All results will be displayed.

The clique-finder tool can be spawned through two means:

1. Press the  button on the toolbar.
2. Select the ‘Clique-Finder Tool’ item in the Tools menu.

5. Information Tools

Another sort of tool provided in the Analyzer are the information tools. Information tools perform automatic operations that help the user understand individual card sorts.

5.1. Key Tool

The Key Tool is shown in Figure 10. When a card sort description file is loaded, the key tool becomes enabled. This tool simply contains the mapping of card numbers to card descriptions.

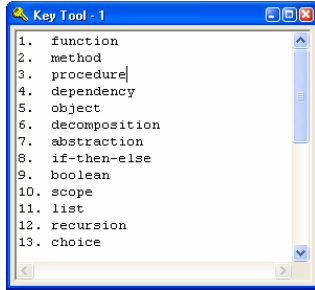



Figure 10. The Key Tool

The key tool is immune to selection changes in the card sort manager, but it will be deactivated if the card sort description file changes.

The key tool can be spawned through two means:

1. Press the  button on the toolbar.
2. Select the 'Key Tool' item in the Tools menu.

5.2. Information Tool

In contrast to the Key Tool, the Information Tool provides considerably more information. Shown in Figure 11, the information tool consists of two regions: the selection box/find region at the top and the sort information/distance information/card piles region at the bottom.

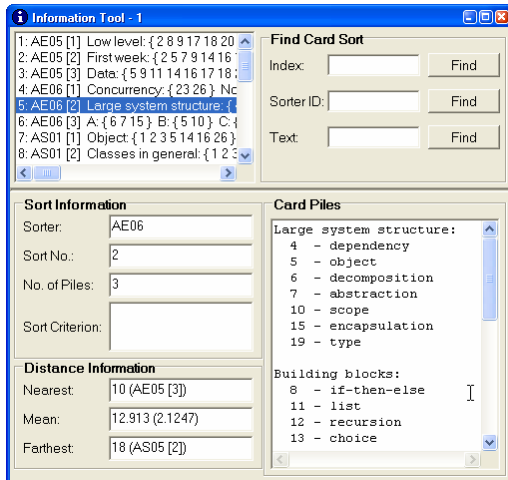


Figure 11. The Information Tool


The selection box in the upper-left corner contains all the card sorts currently loaded into the card sort manager. Each time a sort is selected, the lower region is updated. The 'Sort Information' region gives general details about the card sort. To help the research understand the distance properties of the selected sort, the 'Distance Information' region displays some distance statistics. Finally, the 'Card Piles' region displays the card piles in a more human-readable format. If a card description file has been loaded, the card descriptions are also shown.

One final region is the 'Find Card Sort' region in the upper-right. This region provides three search options for exploring the loaded card sorts:

1. **Index Find:**
This find lets you quickly select any card sort index.
2. **Sorter ID Find:**
This find will select the first card sort created by the desired sorter.
3. **Text Find:**
This find performs a general text search of the loaded card sorts. After initially searching for a specific text, the search can be repeated to move on to the next sort containing that text.

The information operates independently of the selection in the manager. However, changes to the set of load card sorts will disable the tool.

The information tool can be spawned through two means:

1. Press the  button on the toolbar.
2. Select the 'Information Tool' item in the Tools menu.

6. File Formats

Although the Analyzer is fairly flexible in terms of input, there is a general structure to its input files that should be maintained.

6.1. Card Sort File Format

A card sort file may contain multiple sorts, but it is presumed that all sorts to be analyzed are in the same format. The four key format properties are number of cards, sorter IDs, sort criterion, and pile labels. Figures 12 and 13 show two example card sort files. Note that in both figures, individual sorts are separated by a blank line and that individual lines list the cards found in a pile. While a comma is required, it is permissible to have spaces after the comma.

Figure 12 is a file that uses only pile labels. The syntax for a pile label is the label followed by a colon.

```
A: 1,2,3
B: 5,6,7
C: 4,8
```

```
Pile 1: 1,5,7
Pile 2: 3,4,6,8
```

Figure 12. An example card sort file

Figure 13 uses both a sorter ID and sort criterions. The sorter ID is the first line of the file and must be followed by a blank line. Sort criterions, a.k.a. descriptions of the sorts, are the first lines of each individual sort. The next lines after a criterion are that sort's piles.

```
ME

My first sort
1,2,3
5,6,7
4,8
```

```
My second sort
1,5,7
3,4,6,8
```

Figure 13. An example card sort file

In many cases, the loader will humbly ignore a malformed file entry. For example, if a sort does not contain all the cards, that sort will not be loaded. Do not rely on this behavior, though. There is no guarantee that malformed input will load in a clean or sensible way. Remember: garbage in, garbage out.

```
1-function
2-method
3-procedure
4-class dependency
5-object
6-decomposition
```

Figure 14. An example description

6.2. Description File Format

The description file is the file that maps card numbers to card descriptions. This file has a strict format but is overall very simple. Figure 14 shows an example file. As one can see, the format is the card number, a hyphen, and the card description. The card numbering is assumed to start at 1.

7. References

- [1] Anderson, R., Anderson, R., and Deibel, K., Analyzing Concept Groupings of Introductory Computer Programming Students. Technical Report, University of Washington, November, 2004.
- [2] Petre, M., Fincher, S., Tenenber, J., et al., “My criterion is: Is it a Boolean?”: A Card Sort Elicitation of Students’ Knowledge of Programming Constructs. Technical Report, University of Kent, 2003.
- [3] Rugg, G., and McGeorge, P., The Sorting Techniques: A Tutorial Paper on Card Sorts, Picture Sorts and Item Sorts. *Expert Systems*, May 1997, 14, 2, 80-93.