Interactive Layout Techniques for Conceptual Schema Editors

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INTRODUCTION

Automatic layout algorithms of graphs are a widely studied topic. A good survey for the literature of the area was presented by Di Battista *et al.* (1994). In principle, the automatic methods can work well and produce clear and beautiful schemas. However, they cannot take into account semantic information in the schema – at least it would be very difficult.

Conceptual schemas are usually connected graphs. The best known of these is the ER model by Chen (1976). In syntactical point of view, all models have at least two primitives: an entity and a relationship between entities. In some models entities can be called concepts, objects, object sets, or entity sets. However, from the viewpoint of the graphical editor we only have different graphs, i.e., some objects and connections between them.

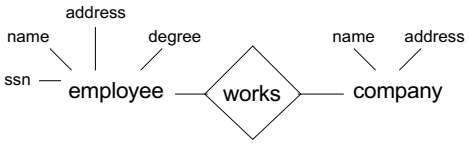

Figure 1. A desirable arrangement of an ER schema.

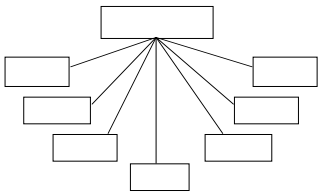

Figure 2. An example of arrangement of child nodes in a hierarchical schema.

It is a common way to place the attributes of an entity in a circular form around the entity, or place the child nodes along an arc below the parent node in hierarchical schemas, as in Figure 2.

It is not the same in which order the objects are presented in the schema. For example, an often-used style is to set the most important objects horizontally to the left and vertically up. It is very difficult to an automatic algorithm to decide which solution is the best or at least acceptable.

A major problem with automatic layout algorithms is that the user cannot know in advance how the operation will change the schema. While designing a schema the designer learns to remember how the schema is organized, that is, he or she begins to remember where a particular concept is placed. Therefore, it is not desirable that the schema is automatically reorganized after adding a new object. How to focus a layout operation can also be difficult, since in many situations only a small part of the schema has to be reorganized.

INTERACTIVE TOOLS FOR MODIFYING SCHEMA LAYOUTS

We suggest that applying novel direct manipulation techniques (Raisamo and Räihä 2000) in conceptual schema drawing makes modifying the layout easier and more understandable. This means that we do not only provide traditional algorithm based layout methods but also interactive tools that suit well for both large-scale and fine-grained layout changes. The rough layout can first be done with a layout algorithm, after which the user can tune the layout with our tools.

The direct manipulation techniques that we apply here to conceptual drawing editors are based on our earlier research that introduced stick-shaped tools in the context of object-oriented drawing programs. Initially, *the*

alignment stick (Raisamo and Räihä 2000) was designed as a direct way to align objects. When using the stick the user directly pushes the objects in the alignment that he or she wants. Every object that the tool touches is added in the alignment operation. There is no need to select a command to carry out the alignment; the user just pushes the objects with the tool when it has been activated. Figure 3 shows how three ovals can be aligned according to their bottom sides when the stick is moved upwards while touching the objects. The length of the stick can be changed and it can be rotated to any angle.

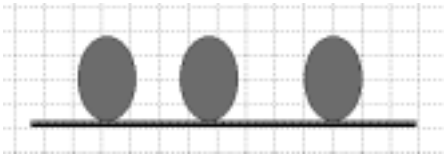

Figure 3. Aligning three ovals with the alignment stick.

The alignment stick has been found to suit well for the kind of alignment tasks that do not involve manipulating many overlapping objects (Raisamo and Räihä 2000). These kinds of tasks are common in schema editors. However, many conceptual schema editors require other than linear alignment. For example, ER schemas usually present the attributes of the objects around the entities. For these tasks, the alignment stick is not enough since it only provides linear alignment, even if this can be done in any angle. That is why we have implemented a new similar kind of tool, *the alignment arc* that can be used to align objects along with a round shape. Figure 4 shows an example of its use in an ER diagram editor, where several attributes are being placed around an entity. The arc can be freely resized and rotated to get the required alignment.

Both types of tools are controlled with a two-handed user interface. The tools can be used with a minimal amount of operating modes resulting in modeless and natural interaction. It is also possible to use the system with only one hand if the second hand is not available for some reason.

In the two-handed user interface the mouse in the dominant hand controls the position of the tool, and the left mouse button is used to activate the tool. The middle mouse button is used to switch between horizontal and vertical directions, or to rotate the tool to the nearest 90° angle if it has been freely rotated. A trackball in the non-dominant hand is used to modify the tool itself. This supportive operation is selected with the middle mouse button: if it is not pressed the trackball changes the size of the tool and if it is pressed the trackball rotates the tool around its middle point to any angle.

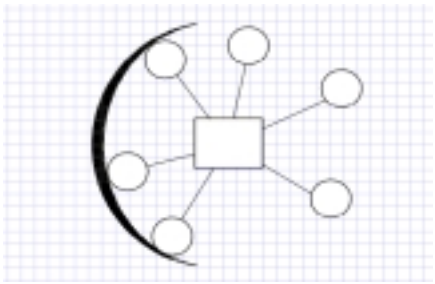

Figure 4. The alignment arc is used to arrange ovals around a rectangle

DISCUSSION

Our direct manipulation techniques are a step towards more easily controllable layouts in conceptual schema editors. When we compare them to alignment commands and automatic layout algorithms, there is at least one major benefit: the metaphors that we are using are close to the real world. The similar tasks could be carried out with a physical stick or arc-shaped tool and physical objects on the desk.

However, it is clear that all the users do not want to do every layout task manually. This is why automatic layout algorithms will probably be used together with the new tools. The layout task would start by applying some layout algorithm in the schema. The tools would then be used to fine-tune the layouts. We believe that the tools are better suited for that than automatic layout algorithms, because the user is in direct control of the operation and knows which parts of the schema are affected by the operation.

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