Using Intermediate Representation Systems to Interact with Concept Lattices

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Abstract. Automated layout of line diagrams for concept lattices is a hard problem as it requires not only asthetical but also semantic considerations. While many layout approaches have been proposed to produce line diagrams that are perceived as good for many applications, a general approach that suits all applications has not yet been found. Instead of proposing another specific layout approach we propose a framework that allows modelling layout constraints that are not only applied for automated layout, but also during manipulation of the diagram layout.

1 Introduction

Laying out concept lattices is a complex problem since there not only asthetical considerations, but the layout of the diagram can also be considered the rhetorical structure of the lattice presentation, an aspect which can be very important for understanding of the underlying information.

Additionally the need for means to interact with the diagrams arises in computer-based tools. For example, the tool ANACONDA offers the user to change diagram layout with the mouse by moving either single nodes, or the nodes representing the corresponding concept's downset or upset.

The program CERNATO introduced the notion of using an intermediate representation to offer manipulation methods that ensure certain layout properties are retained [Bec01]. Experience has shown that the restrictions induced by these constraints were rarely perceived as negative by the intended target audience (business analysts), while people experienced in FCA perceived some of the constraints as too limiting.

This paper gives an overview of the model behind the TOSCANAJ suite [BH04], which is based on the notion of representation systems. It allows modelling different constraints for the manipulation of the diagrams. Basic knowledge of Formal Concept Analyis is assumed throughout the paper.

2 Issues in Lattice Layout

While one can consider a number of asthetical goals for lattice layout, this paper is focused on semantic considerations. The layout of a concept lattice can be

B. Ganter and R. Godin (Eds.): ICFCA 2005, LNAI 3403, pp. 265–268, 2005.

seen as a rhetorical structure, emphasizing certain aspects and de-emphasizing others. In the worst case a wrong layout can be strongly misleading.

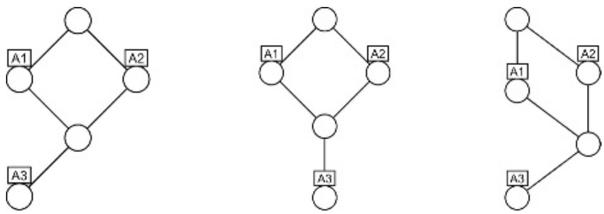

Fig. 1. Three different diagram layouts for the same lattice

Consider Figure 1, where three diagrams represent the same lattice. While they are technically equivalent and all attribute-additive, the left diagram emphasizes the $A3 \rightarrow A2$ implication, the center one the $A3 \rightarrow A1 \wedge A2$ implication and the rightmost diagram does not emphasize any particular implication.

We believe that in many cases finding a suitable rhetorical structure is beyond the capabilities of an automated system. But an automated system can provide some guidance in the process.

3 Representation Systems

Ganter and Wille present a framework to model additive line diagrams using set representations and grid projections [GW99]. To create an attribute-additive line diagram of a concept lattive, the set representation used is a mapping from the concept onto the power set of the irreducible attributes, i.e. the attributes of the purified context. These attributes then get projected using a grid projection.

The general approach to manipulate such a diagram without breaking attribute additivity is to map every movement of a node into a change of the grid projection such that the new position of the node matches the target position. A simple approach to achieve this in the attribute-additive case is to distribute the movement evenly through the projection vectors of all irreducible attributes matching the corresponding upset.

Sometimes additional constraints on the layout should be enforced, especially when additional information is available, such as an order on the attributes. Consider an interordinal scale as an example, where the two ordinal scales should be represented by only two directions in the diagram, not more.

The core idea of our approach is to project the set representation into the target space $\mathbb{R}^2$ by going through two independent steps: first projecting into $\mathbb{R}^n_+$, then applying a parallel projection onto the plane. While this is equivalent to a direct projection in the static case, it allows us to distinguish modifiable and unmodifiable aspects in the interactive case. We split the projection into one part we consider to be fixed and another which we allow the user to change. The intermediate representation in $\mathbb{R}^n_+$ allows us to model a notion of *dimensionality*