

Visual Definition of Temporal Clinical Abstractions: A User Interface based on Novel Metaphors

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Abstract. In this paper, we describe a novel user interface for the visual definition of temporal abstractions based on a set of intuitive metaphors, which represent both temporal features and logical relations of abstractions.

1 Introduction

Visualizing and interactively exploring patient clinical information is a relevant need in the medical domain [1]. One of the problems that has attracted particular attention since the early '90s [4] has been the visualization of patient histories. Lifelines [5] is the most widely known visualization environment that deals with this problem. It displays facts as lines on a graphic time axis, according to their temporal location and extension; color and thickness are then used to represent categories and significance of facts. Subsequent proposals have basically followed the Lifelines approach, enriching it with additional elements. Although the proposals for visualizing medical histories deal with the representation of intervals and interval relations to some extent, they are not meant to facilitate the visual expression of more complex temporal relations such as those present in temporal abstractions [2].

In this paper, we describe a system for the visual definition of temporal abstractions by physicians with no special skills in computer science. The adopted metaphors were chosen by evaluating alternative designs on more than 30 physicians, strictly following the methods used in the field of Human-Computer Interaction, as described in [3].

2 Visual definition of temporal abstractions

In defining abstractions, we distinguish two different kinds of information: temporal and logical. *Temporal* aspects concern the definition of temporal relations between the components (e.g., “headache before analgesics”) and the definition of the interval associated to the abstraction (e.g., “3 days before the start of analgesics up to the end

of analgesics”). *Logical* aspects specify how the components have to be considered in the definition of the abstraction (e.g., “analgesics AND headache”, or “headache AND NOT analgesics”).

The proposed user interface supports the definition process by allowing the user to: (i) easily set the relative temporal positions among components, (ii) define the temporal interval associated to the abstraction on the basis of the intervals of components, and (iii) logically relate the components through the standard connectives AND, OR, NOT, which can be combined to define more complex expressions.

The interface has been designed with the following features in mind: (i) use of simple graphical metaphors related to the physical world, (ii) visual separation of temporal and logical aspects into two different graphic windows, (iii) point-and-click selection of the components and the various graphic operators (the abstraction can be interactively defined without resorting to the keyboard), (iv) use of different colors to highlight different kinds of abstractions, (v) clear connection among graphic objects in the temporal and logical parts of a given abstraction.

2.1 Temporal aspects: displaying intervals and temporal relations

Intervals for abstractions are visualized as paint strips. The temporal location of these strips can be specified in different ways (see Figure 1, part A):

- Paint strips can be represented plainly without any attached object (Figure 1, part A: strip *analgesics*). In this case, we want to represent intervals’ ends that have a precisely set position with respect to other intervals. The commonsense reasoning motivating this choice is that “the end of a paint strip cannot move by itself”.
- Alternatively, any end of a strip can be attached to a paint roller, connected to a weight by means of a wire. This notation expresses that the end of the interval can take different positions on the time axis: the roller can extend the end of the paint strip up to the wall, which stops the roller.
- Finally, a weight can be connected to more than one roller simultaneously to represent intervals’ ends which can move keeping their relative position (Figure 1, part A: strips *antidepressants* and *corticosteroids*).

2.2 Logical aspects: displaying expressions

To visualize and interactively compose logical expressions, each involved component is first graphically associated to a circle. Every circle is filled with the same color associated to the abstraction. Moreover, a numeric ID is used as an additional mean to relate a single abstraction to its two visual representations (one for its related temporal interval and one for the propositional part), as shown in the following section. The AND and the OR connectives are represented by elliptical areas, containing all the circles which have to be connected. The NOT operator is represented as a diagonal line which can be applied either to a circle or to an elliptical area. The edge of areas are either a continuous line or a dotted one, to distinguish between conjunctions and disjunctions, respectively. As an example, let us consider three different therapy-

related abstractions *antidepressants*, *corticosteroids*, and *analgesics*, identified by IDs 3, 5, and 8, respectively. Part D of Figure 1 depicts the expression (*analgesics* AND (*corticosteroids* OR *antidepressants*)).

2.3 The user interface

The user interface is organized into two parts: the first one is devoted to the visual specification of temporal relations among components, and the definition of the name and validity interval of the abstraction; the second one is devoted to the visual definition of the logical expression on the components. Figure 1 is a screenshot of the user interface during the definition of an abstraction involving three components.

In the first panel, displayed in the upper part of the screen (Figure 1, part A), the system displays the temporal intervals for the components, according to their relative positions, following the previously described metaphors. For a given abstraction, a label (e.g., *analgesics* in Figure 1) describing its propositional (atemporal) content is displayed at the beginning of the same line. The color of paint strips is related to the considered component. Insertion, modification, deletion, and connection of different graphic objects can be performed by switching among the different options either through the “Temporal” menu and its sub-items or through a suitable toolbar (Figure 1, element B). A scrollbar allows one to display different components, in case they cannot be displayed at the same time into the window. The lowest part of this panel (Figure 1, part C) is devoted to the definition of the features of the resulting abstraction: the user selects the color which has to be associated to the abstraction, inserts the name of the abstraction, and defines its temporal extent on the basis of the temporal extents of components. The endpoints of the interval associated to the abstraction can coincide with any of the endpoints of the components. These endpoints are displayed as vertical bars within the white strip in part C. When the extent is selected through the pointing device, the corresponding part of the strip assumes the chosen color. A further possibility is to add (subtract) some fixed time span to the chosen endpoints: e.g., with respect to the pattern in Figure 1, the user could define, through a dialog window, an abstraction interval starting three days before the start of analgesics. In this case, a small arrow (pointing to the left) would appear near the left endpoint of the abstraction interval.

The second panel (Figure 1, part D), allows one to define the logical expression. Abstractions are displayed as described in Section 2.2. Insertion, modification, and deletion of different graphic objects can be performed by switching among different options either in the “Logic” menu or through a toolbar (element E). As an example, in Figure 1, the OR between abstractions 3 and 5 is being selected, as highlighted by the dotted square containing the OR ellipsis. The same abstraction can appear more than once in the logical expression: this is graphically achieved by allowing to duplicate the circles associated to a specific ID. The expression under definition appears at the top of the panel in textual form using either IDs or abstraction labels. The two representations can be selected through a suitable button (element F).

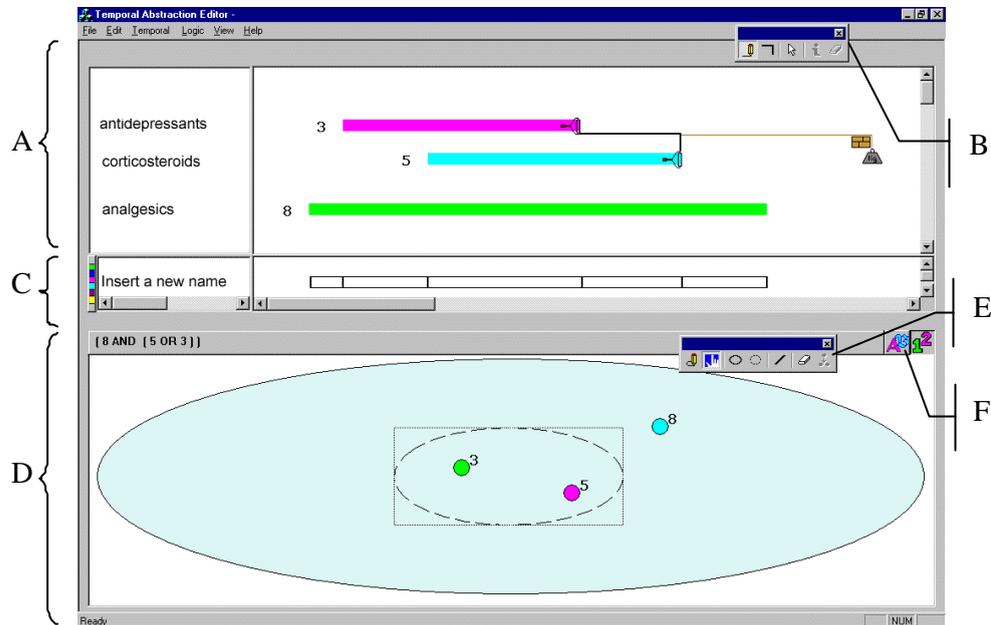


Fig. 1. The user interface for the visual definition of temporal abstractions.

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