Chapter III
A Transformation-Based Metamodel Approach to the Definition of Syntax and Semantics of Diagrammatic Languages

Paolo Bottoni
University of Rome “La Sapienza”, Italy

Dino Frediani
University of Rome “La Sapienza”, Italy

Paolo Quattrrocchi
University of Rome “La Sapienza”, Italy

Luigi Rende
University of Rome “La Sapienza”, Italy

Goran Sarajlic
Araneum Srl, Italy

Domenico Vetriglia
Elemedia Spa, Italy

ABSTRACT

The definition of visual languages, of their semantics, and of the interactions with them can all be referred to a notion of transformation of multisets of resources. Moreover, the concrete syntax for a particular language can be obtained in a semi-automatic way, by declaring the conformity of the language to some family of languages, specified by a metamodel. In a similar way, the generation of the associated semantics can take advantage of the identification of the variety of the semantics being expressed. According to the associated metamodel, one can obtain an abstract view of the semantic roles that visual elements can play with respect to the process being described. We propose here an integrated framework and interactive environment based on a collection of metamodels, in which to express both syntactical characterizations of diagrammatic sentences and their semantic interpretations.

Copyright © 2008, IGI Global, distributing in print or electronic forms without written permission of IGI Global is prohibited.
INTRODUCTION

Metamodeling frameworks for the definition and management of diagrammatic languages allow the implementation of visual environments based on some abstract notion of visual entities and of relations among them. Such diagrammatic languages, and the associated environments, are typically exploited to model structural or behavioral aspects of systems ranging from formal devices such as finite state automata to biological entities through mechanical plants or communication networks.

The spatial relations between the entities depicted in a diagram express constraints on the possible evolutions of the system being modeled (e.g., state transitions, communication protocols, or activation of computations). In this view, the dynamics expressible with such diagrammatic languages are typically discrete ones. Conversely, a diagram can undergo different types of transformations. Examples are diagram evolution due to user editing activities, animation to reflect the progress of some symbolic execution of the computation specified by the diagram, or representation of the transformations in a real system to which the diagram is causally connected. Moreover, animation can be used to integrate the transition from a diagram configuration to another, offering a smooth visualization of the underlying discrete transformation.

When integrated in a graphical user interface, such diagrammatic sentences can also be used as support for user interactions, typically aimed at composing or editing correct visual sentences, querying the state of the system or process components depicted by diagrammatic elements, or activating local or global processes on these components or on the diagram as such. In this chapter, we consider that the admissible transformations of the diagram, independently of their origin, can be specified through some formal device. In particular, we consider the integration of the syntactic definition of a language with the specification of its associated (operational) semantics and of the admissible interactions with it. We discuss two types of semantics: one in which the diagram models a discrete system and describes its possible evolutions, and one in which the diagram defines the structure of a communication network, over which messages can be delivered according to some well defined protocol.

We argue that for a significant class of diagrammatic languages all these aspects (i.e., the definition of the language itself, of its semantics, and of the interactions with them) can be expressed by resorting to a notion of transformation of multisets of resources. In particular, the characterization of the correct sentences in a diagrammatic language is given in terms of a rewriting system based on an alphabet of visual resources. These multisets are then transformed under the effect of rewriting rules modeling the dynamics of the depicted system, while user interaction is modeled within the same framework by considering user actions as special types of resources, either providing data for parameterized transformations, or triggering specific transformations of the underlying visual resources.

Moreover, the definition of a rewriting system—defining the concrete syntax for a particular language—is obtained in a semi-automatic way, by declaring the conformity of the language under definition to some family of languages, specified by a metamodel. In a similar way, the generation of the associated semantics can take advantage of the identification of the variety of the semantics being expressed. According to the metamodel definition of such a variety, one can obtain an abstract view of the semantic roles that visual elements can play with respect to the process being described.

We propose here an integrated framework and interactive environment, based on a collection of metamodels, in which to express both syntactical characterizations of diagrammatic sentences and their semantic interpretations. This is based on a