Chapter V
Extended Positional Grammars: A Formalism for Describing and Parsing Visual Languages

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ABSTRACT

Much recent research is focusing on formal methods for the definition and implementation of visual programming environments. Extended positional grammars (XPGs) naturally extend context-free grammars for string languages to grammars for visual languages by considering new relations in addition to string concatenation. Thanks to this analogy, most results from LR parsing can be extended to XPGs while preserving their well-known efficiency. XPGs include mechanisms for handling contextual information enabling us to model a broader class of visual languages, which includes the diagrammatic notations used in software engineering. Moreover, the XPG grammar formalism can be effectively used for modeling both visual and textual notations in a seamless way. The XPG model is the underlying formalism of the VLDesk system for the automatic generation of visual programming environments. VLDesk inherits and extends to the visual field, concepts, and techniques of compiler generation tools like YACC.

INTRODUCTION

In the 80’s, visual languages have been introduced in computers as a means to facilitate human-machine interaction for non-expert users. The availability of powerful personal computers motivated the development of visual iconic languages for operating systems, which led to two successful implementations: MacOs and Windows. These results encouraged the development of more so-
phisticated visual languages, using the concept of spatial relation among icons, which led to the development of syntactic and semantic frameworks for them (Marriott & Meyer, 1998). The aim was to extend the use of visual languages to new application domains such as database definition and manipulation, programming, etc. However, it has been long debated whether visual languages could enhance the activities in many of these application fields. Especially in programming tasks, experienced users would find the visual language cluttering and of no relief. Nevertheless, some years later visual languages have been successfully applied to many other application fields such multimedia databases and software design methodologies. The latter could hardly be exploited in the past because of the complexity of the many diagrammatic notations to be sketched on paper, and to be continuously revised along the development process.

During the last years, formal methods are achieving increasing importance in the context of visual languages. Indeed, much effort is presently put to develop formal techniques for specifying, designing, and implementing visual (programming or modeling) languages (Marriott et al., 1998; Minas, 2002; Rekers & Schürr, 1997). In general, the broader the class of languages to be treated is, the less efficient the parsing algorithm is. Due to this, big efforts are being made to characterize a class, which is expressive enough and, at the same time, efficient to parse. In addition, some efforts are being made in order to classify grammar models according to characteristics such as their expressive power, the way they represent the input, and the parser technology they support.

The research on this topic has been heavily influenced by the work in the formal language theory. The main motivation of this is the aim of exploiting the well-established theoretical background and techniques developed for string languages in the setting of visual languages. As a result, most of the methods proposed for visual language specification are grammar-based, even if in the last years other different approaches have been proposed and investigated such as logic-based (Helm & Marriott, 1990) and algebraic approaches (Uskudarli & Dinesh, 1997).

In this chapter, we present an overview of extended positional grammars (XPG, for short), a grammar formalism for modeling visual notations, which represents an extension of context-free grammars, and we describe the XpLR parsing methodology (Costagliola, Deufemia, & Polese, 2004). XPG and XpLR extend positional grammars (PG) (Costagliola, De Lucia, Orefice, & Tortora, 1997) and the associated pLR parsing methodology. The extensions have enabled us to model a wide class of notations and to efficiently parse them. The associated parsing algorithm is the XpLR parser, which is based on the well-known LR parsing technique. The benefits that can be derived from providing a specification of a visual language in terms of such formalism include facility of customization and modifications, as well as the maintenance and the debugging of the language, generation of code and reports by defining suitable semantic productions, implementation of visual and textual languages within a common framework.

The extended positional grammar model is the underlying formalism of the visual language desk (VLDesk) system (Costagliola et al., 2004) for the automatic generation of visual programming environments. VLDesk uses XPG to define a visual language and XpLR-based methodology to generate visual language compilers. It adopts concepts and techniques of compiler generation tools like YACC (Johnson, 1978) and extends these to the visual field. The final result of the generation process consists of an integrated environment comprising a visual editor and a compiler for the defined visual language.

**DESCRIBING VISUAL LANGUAGES**

In this section, we present an approach to formally describe visual notations, which can be used to describe many different classes of visual languages (Costagliola, De Lucia, Orefice, & Polese, 2002).
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