*Journal of Visual Languages and Computing* (1999) 10, 451–453
Article No. jvlc.1999.0139 available online at http://www.idealibrary.com on IDEAL®

# Special Issue on Formal Methods for Visual Interaction

## Guest Editor's Introduction

Interest in the design and development of interactive visual applications has increased considerably over the last few years. The underlying reason for this is the need to allow the maximum number of people to access software applications for the widest number of purposes and in the widest number of contexts.

There is also growing interest in the application of formal methods to visual interaction, as user-interface design and development is a rapidly emerging field, though sometimes without well-defined basic concepts and methods. This is a strong limitation, since at times designers provide only partially valid solutions which are often difficult to analyse and may contain inconsistencies.

The visual modality is still a key communication channel in user interactions, despite the spread of multimedia technology, which adds voice, audio, gestures and other media. Visual interactive interfaces represent a challenging application area for formal methods. Their internal structure is becoming increasingly more complex, as there is a continuous demand to have them support more and more interaction techniques, users, tasks, environments, with more and more dialogues active at the same time. After all, the approaches in this area must consider the most complex system in the world: the human user, whose behaviour cannot be described prescriptively.

The first problem in this special issue was to define the area of interest. Here we would like to understand how a formal approach can contribute to the design of interactions between users and applications through visual support. This is an area that has stimulated a good deal of effort in the past 15 years: a good example is the work of Cardelli on Squeak [1], while other early attempts were introduced in the book edited by Harrison and Thimblebly [2]. The work of Dix [3] was useful to provide precise definitions of the fundamental concepts of interactive systems. A more updated description of many approaches in this area can be found in the book on formal methods in human–computer interaction [4].

How visual environments can support formal approaches is an interesting, but rather different issue, which was considered irrelevant for this special issue. Our aim here is to understand how formal methods can be used to improve visual interaction, and not *vice versa*.

Another problem was to determine when a method can be considered formal. The answers offered to this question differ subtly depending on the authors' background (software engineering, human–computer interaction, artificial intelligence, etc.). For example, in cognitive sciences a formal method aims to model user behaviour. Such models can be used to make predictions and attempt to verify these predictions through empirical studies.

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Whatever the background we consider, there is a broad consensus that in a formal approach the aspects of interest are rigorously and precisely described, and this can be best achieved using notation whose semantics is likewise precisely defined.

The formal methods community in software engineering has encountered some significant difficulties in tackling visual interactions and, more generally, human–computer interactions. This is because of its structural complexity, stemming from the fact that functional aspects are only part of the concerns in interactive systems design: the other, interactive component, involves user issues, their tasks and the context of use, which are difficult to represent in a formal model.

In this special issue I have decided to take a broad view of the contributions to formal methods for visual interactions. Four papers have been selected that represent a good sampling of the possible approaches and results. Thus, this special issue will sketch out a meaningful picture of the current state of the work in this area: recent results and limitations. It is my hope that this will provide a fertile ground from which further studies may grow.

The paper by Butterworth, Blandford and Duke presents an approach for using formal models to explore display-based usability issues. It stems from the authors' work on how to integrate cognitive models with formal device models in order to evaluate the usability of a proposed system, and applies Lamport's temporal logic of actions to represent the system models.

In the paper by Bastide and Palanque a visual language, based on Petri nets, is proposed for designing the dialogue of interactive systems. The aim is to specify both activation and rendering aspects, on the one hand, and provide seamless integration with an object-oriented design of the user-interface components, on the other.

The paper by Fach addresses an equally interesting topic. It represents an original contribution proposing a game-theory-based method, using abstract interface descriptions as input. The method can be useful for checking the consistency of interface sequences and analysing the suitability to task performance, thus facilitating the transition from abstract description of a user interface to its concrete implementation.

The purpose of Miller's paper is to provide a formal representation able to capture the information needs associated with user tasks and the information conveying the capabilities of interface elements. This representation is applied by means of scoring techniques accounting for multiple aspects in order to evaluate the user-interface design.

All these works can also be viewed in a broader perspective, that of model-based design of interactive applications [5], a field whose purpose is to identify high-level models enabling designers to specify and analyse interactive software applications from a more semantic-orientated level, rather than starting out by directly attacking the implementation level. This allows them to concentrate on the more important aspects, without having to confront the bewildering array of implementation details. Moreover, approaches in this area often provide tools to update the implementation in conformity with high-level choices. Such model-based approaches usually include the use of both formal and informal techniques.

I fervently hope that the selected works will provide a useful basis for further research leading to innovative applications able to solve the many problems still open in this field.

Last, but not least, I would like to thank the reviewers from eight different countries, whose efforts in preparing this special issue have contributed greatly to our aim of making this as relevant as possible to the interests of a wide international audience.

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