Chapter 14
The Event Bush Method in the Light of Typed Graphs Illustrated by Common Sense Reasoning

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ABSTRACT
The event bush method being an efficient tool for representation and engineering of dynamic knowledge still lacks a strict mathematical foundation. Many of the syntactic properties of event bushes, however, seem compliant with directed graphs and can be described by typed graphs (i.e., by homomorphisms between directed graphs). This chapter explores an opportunity to formalize the syntactic structure of event bushes by means of typed graphs and shows useful implications of this approach for knowledge engineering and representation.

INTRODUCTION

Problem Area

Traditional knowledge representation tools (e.g., ontologies and conceptual graphs) operate with objects considered either as classes (i.e., types: concept types or relation types) or as individuals (Martin, 2002). This has proven to be efficient for a wide range of tasks like building data models and search algorithms or description of those domains of knowledge in which things, their properties and relations are con-
sidered fixed – e.g., production units of a factory or biological species. Nevertheless, there are tasks in natural-scientific and technical domains that require consideration of changing properties and relations and claim for formal description of scenarios and patterns of evolution. The knowledge relating to such tasks has been termed dynamic, and the tasks proper, dynamic environments (Pshenichny, 2011). Correspondingly, the knowledge about fixed relations between objects is termed static.

A number of methods – influence diagrams, Petri nets, event/probability trees, event bushes, Bayesian belief networks, causal loops, activity diagrams, sequence diagrams and other approaches (Pshenichny, 2014) addresses dynamic knowledge. Some of these methods can be used in a variety of ways, from a purely qualitative conceptualization to strict mathematical models (compare, e.g., event trees and probability trees). It may seem that these methods can operate with virtually everything – quantitative data, the objects of static knowledge, mathematical variables, images, and so forth. Nevertheless, as it was argued in (Pshenichny & Mouromtsev, 2015), in case of dynamic knowledge all these can be thought as designations, or abbreviations, of one specific kind of entity, which represents a relation between the objects in form of a statement. Such entities are defined as events (Pshenichny, 2014). An event is a statement of general form $S – P_1, P_2, \ldots, P_n$, where $S$ is subject, and $P_1, P_2, \ldots, P_n$ are predicates, with or without negation. These subject and predicate(s) are the objects of static knowledge. For the event, the following restrictions are put forth, (i) subject may be only one in a statement, (ii) subject may not be negated, (iii) all predicates may not be negated in a statement, at least one must be without negation (e.g., a statement $S – \sim P$, $\sim$ being the negation, is not allowed), (iv) presence of a predicate and its negation in one event is not admitted (Pshenichny, 2014). From event to event, there may change subject, or negation of predicates, or nothing. If the subject changes, predicate may change in whatever way unless violate the above restrictions, or remain the same.

For instance:

“Grass ($S_1$) bursts forth ($P_1$) and is not mowed ($\sim P_2$) – Grass ($S_1$) bursts forth ($P_1$) and is not mowed ($\sim P_2$)” (nothing changes);
“Grass ($S_1$) bursts forth ($P_1$) and is not mowed ($\sim P_2$) – Grass ($S_1$) bursts forth ($P_1$) and is mowed ($P_2$)” (change of negation of predicate);
“Grass ($S_1$) bursts forth ($P_1$) and is mowed ($P_2$) – Hay ($S_2$) is mowed ($P_2$) and is not burnt ($\sim P_3$)” (change of subject);
“Hay ($S_2$) is mowed ($P_2$) and is not burnt ($\sim P_3$) – Hay ($S_2$) is mowed ($P_2$) and is burnt ($P_3$)” (change of negation of predicate);
“Hay ($S_2$) is mowed ($P_2$) and is burnt ($P_3$) – Ash ($S_3$) is blown away ($P_4$)” (change of subject).

Thus, the difference between the two types of knowledge appears essentially semantic and is rooted in the meaning of its “building blocks” – objects in one case and events in the other. Therefore, naturally, it was semantics that was mainly concerned in the abovementioned discussion on types of knowledge (static versus dynamic), while the syntax of dynamic knowledge stayed in the shade. At the same time, in the earlier discourse on the syntax of visual languages used for knowledge representation this difference was not paid attention, and the existing reviews focus mainly on the tools for static knowledge but also mention some methods that are considered now as addressing essentially dynamic knowledge (e.g., Petri nets) without accentuating any specificity of these (Kremer, 1998).