Variants of Top-Down Tree Transducers with Look-Ahead

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Abstract. In this article we consider deterministic and strongly deterministic top-down tree transducers with regular look-ahead, with regular check, with deterministic top-down look-ahead, and with deterministic top-down check. We compare the transformational power of these tree transducer classes by giving a correct inclusion diagram of the tree transformation classes induced by them. Along with the comparison we decompose some of the examined classes into simpler classes and we introduce the concept of the deterministic top-down tree automata with deterministic top-down look-ahead. We show that these recognizers recognize a tree language class which is strictly between the class of regular tree languages and the class of tree languages recognizable by deterministic top-down tree automata. We also study the closure properties of the examined tree transformation classes. We show that some classes are closed under composition while others, for example the class of tree transformations induced by deterministic top-down tree transducers with deterministic top-down look-ahead, are not.

1. Introduction

Top-down tree transducers with regular look-ahead were introduced in [6]. It transpired that they have a number of nice properties, especially in the deterministic case. For example, the class of all deterministic top-down tree transformations with regular look-ahead contains the class of all deterministic bottom-up tree transformations, it is closed under composition, and, as was shown in [5], it contains the class of all functional top-down tree transformations.

Paper [6] was our motive for equipping a top-down tree transducer with deterministic top-down look-ahead capacity in [7]. It means that the look-ahead sets of this type of tree transducers are restricted to tree languages recognizable by deterministic top-down finite tree automata. The notion of determinism in the
sense of [6] was also specialized and was called strong determinism in [7]. As a result, it was shown that the class of all strongly deterministic top-down tree transformations with deterministic top-down look-ahead is also closed under composition and it is the closure of the class of deterministic top-down tree transformations under composition.

So it resulted from [7] that both strong determinism and deterministic top-down look-ahead are of theoretical interest. Therefore, in this paper, we combine these notions with the original concept of determinism and regular look-ahead (see [6]) and obtain new tree transducers such as the strongly deterministic top-down tree transducer with regular look-ahead, etc. We prove that some of these new tree transducers are nothing other than deterministic top-down tree transducers restricted to special recognizable tree languages. However, the transformational system of Rounds (see [9]), which is a deterministic top-down tree transducer restricted to a recognizable tree language, does not correspond to any tree transducer obtained in the above way. Therefore we introduce the concept of the regular check and also the deterministic top-down check, and combine them with determinism and strong determinism for top-down tree transducers. It transpires that the strongly deterministic top-down tree transducer with regular check is exactly the transformational system of Rounds.

The main goal of this paper is to introduce the above new tree transducer classes and compare their transformational power systematically by giving a correct inclusion diagram of the tree transformation classes induced by them. Along with the comparison it often seems to be useful to decompose the examined tree transformation classes into simpler classes and these decomposition results are then used to examine closure properties. It is also practical to introduce the concept of the deterministic top-down tree automaton with deterministic top-down look-ahead. We prove, and then use in the comparison, the result that these, as recognizers, recognize a tree language class which is strictly between the class of regular tree languages and the class of tree languages recognizable by deterministic top-down tree automata.

We also study the closure properties of the introduced tree transformation classes. We prove that the tree transformation class induced by deterministic top-down tree transducers with deterministic top-down look-ahead is not closed under composition. The tree transformation class induced by strongly deterministic top-down tree transducers with regular look-ahead is not closed under composition either and the closure of this class is the class of tree transformations induced by strongly deterministic top-down tree transducers with regular check. Apart from these two classes, all the other tree transformation classes considered are closed under composition.

The paper is organized as follows. In Section 2 we introduce or recall most of the basic notions and notations used in the paper. In Section 3 we consider the eight classes of tree transformations induced by deterministic and strongly deterministic top-down tree transducers with regular look-ahead, with deterministic top-down look-ahead, with regular check, and with deterministic top-down check. The basic inclusion relations and an inclusion diagram for the classes of tree transformations considered are also presented in this section.