Evaluation strategies for term rewriting systems

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Abstract

Term rewriting systems are widely used in computer science as a model of computation to relate syntax and semantics. In order to implement term rewriting system we need to use a strategy since there are many reduction sequences from a term in general. A strategy chooses one from such sequences. It is a function that takes a term to be rewritten and returns a term obtained by rewriting from the input term. There are two well-known strategies: eager evaluation and lazy evaluation. Eager evaluation can be implemented much more efficiently than outermost ones, while lazy evaluation often has a better termination behavior than innermost ones. The evaluation strategy (the E-strategy) is one of the compromises between them, which is adopted by the family of OBJ algebraic specification languages. The E-strategy is more flexible than other fixed order of evaluation because each function symbol can have its own local strategy. In this thesis we investigate methods to define suitable local strategies for a given term rewriting system. In recent year, context-sensitive rewriting has been proposed by Lucas and studied actively by many researchers. Some useful properties have been studied for context-sensitive rewriting. We can obtain some useful properties for the E-strategy by combining our results with properties of context-sensitive rewriting: termination, confluence and so on. We especially focus a shape of evaluated terms because an evaluated term is not always in normal form in the E-strategy. We define a notion of μ-correctness for the E-strategy. An E-strategy is μ-correct if each evaluated term is always in normal form of context-sensitive rewriting, called μ-normal form. We analyze which arguments can be evaluated lazily with keeping μ-correctness. From our analysis of correctness we obtain an E-strategy which have a better termination behavior. We also investigate an extension of the E-strategy, called the on-demand E-strategy. It is known that true lazy evaluation cannot be defined by the ordinary E-strategy. Thus we need a new function to realize on-demand matching by the E-strategy. By on-demand matching we can appoint an argument to be not evaluated until so forced. Evaluation may be forced when the arguments are involved in matching. We formalize the E-strategy with on-demand matching and show some examples that we can treat well owing to on-demand matching. In conclusion we show how to apply our results in this thesis to the verification system, such as the CafeOBJ algebraic specification language

Key Words: **Evaluation Strategy, Lazy Evaluation, Term Rewriting, Equational Reasoning, Algebraic Specification Language**