TU Clausthal

Oberseminar Wirtschaftsinformatik
des Instituts für Informatik

Using weighted constraints to build a tutoring system for Logic Programming

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Programming problems constitute a significant challenge for the development of tutoring systems, because they can be solved in many different ways. To help the student solve a programming problem effectively, the tutoring system must be able to cover a large space of possible solutions. If a student solution has shortcomings, the system must be able to identify the reason why that solution is not correct. In the state of the art, one of the most promising approaches to modelling knowledge for tutoring systems is the constraint-based technique. This approach describes a solution space using constraints, rather than enumerating all possible correct solutions. The goal of this thesis is to investigate the research question: *Is the constraint-based approach applicable to develop tutoring systems for programming?* Logic programming is used as a study case.

In this thesis, we present a *two-stage coaching strategy* as a tutoring model which is intended to support the student in analysing a programming task prior to the implementation itself. For both coaching stages, the solution space is modelled on the basis of *constraints* in combination with a *semantic table* which is used to represent semantic requirements for a specific programming problem. In addition, transformation rules are used to extend the space of possible implementations. To be able to provide qualitative feedback on the student solution, hypotheses about the student's intention need to be evaluated with respect to their plausibility. For this purpose, we propose to enrich each constraint with a *weight* value indicating the importance of that constraint. Our error diagnosis approach is driven by constraint weights which are used to hypothesize the student's intention and to decide on the most plausible error explanation among alternatives. As an additional positive side effect, constraint weights serve to prioritize the severity of diagnostic information.

To explore the capability of weighted constraints and the usefulness of the two-stage coaching model, we have implemented a web-based tutoring system for logic programming and conducted two evaluation studies. The first one showed that the system achieves a high diagnostic accuracy. In 90.8% of the student implementations the solution strategy could be hypothesized correctly and in 92.7% of cases, in which the solution strategy could be determined, errors were diagnosed correctly. The second study provided the evidence that the system did contribute to the improvement of the programming skills of the students. The students who used the system outperformed their peers of the control group by an effect size between 0.23 and 0.33 standard deviations.

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