Efficiency estimation—Controlling search in program synthesis

by ELAINE KANT
Stanford University
Stanford, California

People should be able to specify a program in a high level language and let the computer take care of finding an efficient target language implementation. One way to do this is by program synthesis. LIBRA is a system designed to guide the application of synthesis rules in the PSI program synthesis system. In the PSI system, there is a structured programming style of organization of programming knowledge. High level concepts such as sets may go through an arbitrary number of levels of refinement before target language concepts such as lists or arrays are produced. Refinement rules make the transformations between these concepts. If given such a set of refinement rules, LIBRA can guide the transformation of a high level program specification to a target language program. The target program is made efficient in two ways: by clever choice of refinements and by the application of optimizing transformations at any levels that are appropriate.

LIBRA uses the technique of efficiency estimation to guide a heuristic tree search of some of the possible refinement sequences. Efficiency estimation takes into consideration: a user-specified program cost evaluation function, resources allowed for program writing, data structure sizes, and conditional branching probabilities. An estimate of the cost of the program descriptions in the tree is maintained for comparison between alternatives, for identification of the most important decisions, and to trade off final program performance with the cost of writing the program. To simplify the decision making process, decisions are grouped into related sets or cost-independent blocks. Heuristic knowledge about efficient implementations for certain circumstances is also integrated into the system. A version of LIBRA has been written in INTERLISP; it has been used to guide the implementation of several LISP programs.

This work is described in more detail in The Selection of Efficient Implementations for a High-Level Language in Proceedings of the Symposium on Artificial Intelligence and Programming Languages, Rochester, New York, August 1977.