ABSTRACT

A system of techniques is presented for proving termination of computer programs using Z transformation theory.

First the given program is considered as a graph called program graph. All programs can be categorised into various classes depending on the three basic structures, namely Direct type, Conditional type and Loop type. Program graph for a given program may not be in form of above three basic structures. Interval analysis, node splitting and permutation of certain nodes are performed to make the program to fall within the three basic types. A simple program is defined and will have the following properties

1. The program contains linear assignment statement;
2. The predicate is simple;
3. The domain of interpretation is taken to be set of real numbers; and
4. It contains only single loop

The simple program is used as the basic model for program termination studies.
The simple program can be represented by a system of recurrence equations with the number of loop iterations as independent variable. The predicate of the simple program is converted into an assignment statement by introducing a slack variable. The slack variable is also represented by a recurrence equation.

The recurrence equations represent a set of linear discrete equations. Z transform techniques are well suited for analysing discrete equations. The discrete time in Z transform is treated equivalent to the number of loop iterations and the program recurrence equations are analysed using Z transformation techniques. Based on the relational operator in the predicate term of the program, a domain of termination is defined. The left shifting property is used for transforming recurrence equations of program to Z transform equations. The initial and final value theorems are applied to find the asymptotic behaviour of the slack variable. In general the slack variable can be represented by Z transform function of poles and zeros.

In the program containing single pole the termination is decided based on the location of the pole. The inverse Z transform is applied to the slack variable and the response of the slack variable is obtained.
The response and domain of termination decide the termination of the program.

The following special classes of programs are defined and their termination properties are studied.

1. Multipredicate simple programs;
2. Multilevel simple programs;
3. Multiassignment simple programs; and
4. Nonlinear simple programs