New Developments in PASCAL-SC

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Abstract: PASCAL-SC is an efficient programming language for scientific computation which was developed at the beginning of the eighties as an extension of standard PASCAL. It provides arithmetical operations with controlled rounding and an optimal scalar product. Functions with arbitrary result type and an operator concept permit the realization of higher arithmetical operations, such as matrix-vector operations. The application of PASCAL-SC for the development of reliable numerical software raised several wishes for further extension. These extensions have been incorporated in the language.

A new data type dotprecision together with arithmetic operations is introduced permitting scalar product expressions to be evaluated with maximum accuracy in a convenient manner. Dynamic arrays and a module concept support the definition of numeric libraries. Overloading of functions and procedures improve the readability of scientific programs. A program for the verified solution of linear systems illustrates the strength of the new language.

1. Current state of PASCAL-SC

State of the art floating-point processors provide the four arithmetic operations +, -, *, / with different rounding modes. The directed roundings (towards plus or minus infinity) allow the computation of true bounds for the result of each operation on a computer. These bounds are necessary for the implementation of interval arithmetic. Thus a programming language for scientific computation has to support these operations.

PASCAL-SC (a PASCAL Extension for Scientific Computation) provides the following arithmetic operators: +, -, *, /; +<, -<, *<, /<; +>, ->, *>, />; where the suffix < or > indicates downwardly or upwardly directed rounding resp.

Vector and matrix operations are considered more and more as indivisible operations which have to fulfill the same accuracy properties as the basic real operations. For these operations the scalar product is an essential tool. Therefore it is mandatory to implement an optimal scalar product. PASCAL-SC provides the function scalp with three parameters: two vector variables and one integer rounding control.

Together with the operator concept and functions with arbitrary result type it is possible to implement arithmetic packages for all higher numerical data types in PASCAL-SC.

In the first implementation of PASCAL-SC the language was kept as close as possible to standard PASCAL which means that only the extensions mentioned above were incorporated. In this version PASCAL-SC has been used widely for the development of reliable numerical software.

Some deficiencies of that version were detected during this phase of application:
- Programs had to consist of one compilation unit.
- Management of external routines was clumsy and error prone.
- Static bounds of arrays prevent the formulation of conformable routines for matrix

August 1988