A Decimal Multiple-Precision Interval Arithmetic Library

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We describe the mechanisms and implementation of a library that define a decimal multiple-precision interval arithmetic. The aim of such a library is to provide guaranteed and accurate results in decimal. This library contains correctly rounded elementary operations and some transcendental functions such as *sin*, *cos* or *exp*.

The application fields of such a library are wide from financial calculation to aeronautic engineering. In those fields, complex algorithms are generally designed in high level with decimal numbers. Thus there is a need for correctly rounded decimal arithmetic multiple-precision library. The IEEE 754-2008 [2] revision introduced the definition of decimal floating-point format, with the purpose of providing a basis for a robust and correctly rounded decimal arithmetic.

Apart from being IEEE 754-2008 compliant, our library holds several useful properties, such as correct rounding for decimal arbitrary precision. The correctness of some functions will be proven. Furthermore the interval arithmetic will be compliant with the new IEEE 1788-2015 *Standard for Interval Arithmetic* [3].

Studies of implementation of decimal arithmetic libraries have shown that one of the simplest and efficient way to implement decimal functions is to use their binary counterparts [1]. This method makes it possible to rely on the efficiency of the binary arithmetic and focus

more effort only on some critical points. The implementation of this library is based on GMP and MPFR libraries.

References

[1] J. Harrison, *Decimal Transcendentals via Binary*, Proceedings of the 19th IEEE Sympoisum on Computer Arithmetic, 2009, pp. 187-194.

[2] IEEE Std 754-2008, *IEEE Standard for Floating-Point Arithmetic*, 2008.

[3] IEEE Std 1788-2015, *IEEE Standard for Interval Arithmetic*, 2015.

[4] GNU MPFR Library, *multiple-precision floating-point computations with correct rounding based on GMP.*

[5] MPFI Library, *A multiple precision interval arithmetic library based on MPFR.*