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Sign Methods for Imprecise Problems

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Abstract

Tackling problems with imprecise (not exactly known) information occur in different scientific fields including mathematics, physics, astronomy, meteorology, engineering, computer science, biomedical informatics, medicine and bioengineering among others. In many applications, precise function values are either impossible or time consuming to obtain. For example, when the function values depend on the results of numerical simulations, then it may be difficult or impossible to get very precise values. Or in other cases, it may be necessary to integrate numerically a system of differential equations in order to obtain a function value, so that the precision of the computed value is limited. Furthermore, in many problems the accurate values of the function are computationally expensive.

Ideas from the topological degree theory and combinatorial topology (algebraic topology) have led to the introduction of iterative root-finding and fixed point methods as well as numerical optimization methods for tackling problems with imprecisions. We call these methods *sign methods* since the only computable information required is the algebraic sign of the function that is the smallest amount of information (one bit of information) necessary for the purpose needed, and not any additional information. In this contribution, some of these methods are reviewed and applications to computational mathematics and computational intelligence are presented.

Key words: Sign Methods, Root-finding Methods, Fixed Point Methods, Numerical Optimization Methods, Imprecise Problems