Infinity Computing
Foundations and Practical Computations with Numerical Infinities and Infinitesimals

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Abstract

In this lecture (that is self-contained, does not require any special high-level mathematical preparation and is oriented on a broad audience), a recent computational methodology is described. It has been introduced with the intention to allow one to work with infinities and infinitesimals numerically in a unique computational framework and in all the situations requiring these notions (recall that traditional approaches work with infinities and infinitesimals only symbolically and different notions are used in different situations related to infinity, e.g., infinity in mathematical analysis, ordinals, cardinals, etc.). The methodology is based on the Euclid's Common Notion no. 5 "The whole is greater than the part" applied to all quantities (finite, infinite, and infinitesimal) and to all sets and processes (finite and infinite).

One of the strong advantages of this methodology consists of its computational power in practical applications (broadly discussed at these conferences by numerous colleagues). The methodology uses as a computational device a new kind of supercomputer called the Infinity Computer patented in several countries. It works numerically with a variety of infinite and infinitesimal numbers that can be written in a positional system with an infinite radix using floating-point representation. Numbers written in this system can have several infinite and infinitesimal parts. On a number of examples, it is shown that the new approach can be useful from both computational and theoretical points of view. In particular, the accuracy of computations increases drastically, and all kinds of indeterminate forms and divergences are avoided. The accuracy of the obtained results is continuously compared with results obtained by traditional tools used to work with mathematical objects involving infinity. It is argued that traditional numeral systems involved in computations limit our capabilities to compute and lead to ambiguities in certain theoretical assertions, as well. It is shown that the new methodology allows to avoid several classical paradoxes related to infinity and infinitesimals.

The Infinity Calculator working with infinities and infinitesimals numerically is shown during the lecture. Supporting materials, videos of lectures, more than 60 papers of authors from several research areas using this methodology in their applications, and a lot of additional information can be found at the page https://www.theinfinitycomputer.com The web page https://www.numericalinfinities.com developed at the University of East Anglia, UK is dedicated to teaching this methodology.