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Numerical Non-standard Calculus: Applications and Software Implementation

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Non standard analysis and engineering applications have long remained two separate things. More recently, new computational paradigms have been proposed that seem able to close this gap. One of them is the non standard model built upon Benci and Di Nasso's Alpha Theory, within which in 2021 Benci and Cococcioni introduced a fixed length binary encoding (along with truncation operators) for non standard numbers [1]. This achievement paved the way for an efficient implementation of non standard computations within computers, that is the numerical representation and manipulation of non standard numbers. Even if the journey through numerical, non standard computations is still at the beginning, the research has already showed encouraging benefits of their application, especially in the context of deterministic and stochastic multi objective lexicographic optimization. The present talk will provide an overview of them, focusing on two relevant engineering applications where the efficacy of a non standard computational framework has already been tested: multi objective convex quadratic programming based on the interior point method [2] and deep reinforcement learning.
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[1] Benci, V. and Cococcioni, M. (2021) "The Algorithmic Numbers in Non Archimedean Numerical Computing Environments", Descrete And Continuous Dynamical Systems Series S, 14(5):1673 1692, https://doi.org/10.3934/dcdss.2020449
[2] Fiaschi, L. and Cococcioni, M. (2022) "A Non Archimedean Interior Point Method and Its Application to the Lexicographic Multi Objective Quadratic Programming", Mathematics, 10(23):4536, https://doi.org/10.3390/math10234536

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