

“Interval Analysis – Fundamentals and (Electromagnetic) Engineering Applications”

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Abstract

Interval Analysis (IA) consists of a set of rules and tools for the analysis and optimization of functions where the variables at hand are intervals of numbers and not single values as in classical arithmetical/optimization problems. For example, an interval of real values (a real interval) can be defined as a one-dimensional compact set (a segment) between two extreme points, namely the minimum and maximum interval values. Also complex intervals exist and ad-hoc rules are defined within IA for the arithmetical operations between them.

Currently, the use of IA has been limited to some pioneering works in Engineering even though it has several attractive features that can overcome some limitations of current state-of-the-art approaches and theories.

Let us consider the following issues:

- IA has an intrinsic capability to deal with uncertainties, always present when experimental measurements are at hand;
- analytical equations and relationships can be easily reformulated and addressed by including intervals of numbers once the fundamentals of IA are known;
- the bounds of a function when evaluated over an interval are determined in a straightforward manner without the need of evaluating the function on all (infinite) points of the interval;
- IA offers ad-hoc global optimization techniques able to identify the global optimum with the desired level of accuracy.

The objective of the short-course is to provide the attendees the fundamentals of Interval Analysis, starting from intuitive explanations to rigorous mathematical and methodological insights.

Recent applications of IA in Electromagnetics will be finally illustrated with particular emphasis on inverse scattering problems, antenna array synthesis, and material-by-design (including meta-materials).

References

Tutorials

[1] R. Moore, *Interval Analysis*. Prentice-Hall, Englewood Cliffs: New Jersey, USA, 1966.

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Andrea Massa received the “laurea” degree in Electronic Engineering from the University of Genoa, Genoa, Italy, in 1992 and Ph.D. degree in EECS from the same university in 1996. From 1997 to 1999, he was an Assistant Professor of Electromagnetic Fields at the Department of Biophysical and Electronic Engineering (University of Genoa). From 2001 to 2004, he was an Associate Professor at the University of Trento. Since 2005, he has been a Full Professor of Electromagnetic Fields at the University of Trento, where he currently teaches electromagnetic fields, inverse scattering techniques, antennas and wireless communications, wireless services and devices, and optimization techniques. At present, Prof. Massa is the director of the ELEDIA Research Center at the University of Trento with a staff of more than 25 researchers. Moreover, he is Adjunct Professor at Penn State University (USA) and he has been Visiting Professor at the Missouri University of Science and Technology (USA), at the Nagasaki University (Japan), at the University of Paris Sud (France), at the Kumamoto University (Japan), and at the DigiTEo (Paris – France).

Prof. Massa serves as Associate Editor of the “IEEE Transaction on Antennas and Propagation” and Associate Editor of the “International Journal of Microwave and Wireless Technologies” and he is member of the Editorial Board of the “Journal of Electromagnetic Waves and Applications”, and a permanent member of the “PIERS Technical Committee” and of the “EuMW Technical Committee”. He has been appointed in the Scientific Board of the “Società Italiana di Elettromagnetismo (SIEm)” and elected in the Scientific Board of the Interuniversity National Center for Telecommunications (CNIT). Recently Prof. Massa has been appointed by the National Agency for the Evaluation of the University System and National Research (ANVUR) as a member of the Recognized Expert Evaluation Group (Area 09, ‘Industrial and Information Engineering’) for the evaluation of the researches at the Italian University and Research Center in the period 2004-2010. Moreover, he has been appointed as the Italian Member of the Management Committee of the COST Action TU1208 “Civil Engineering Applications of Ground Penetrating Radar”.

His research activities are mainly concerned with direct and inverse scattering problems, propagation in complex and random media, analysis/synthesis of antenna systems and large arrays, design/applications of WSNs, cross-layer optimization and planning of wireless/RF systems, semantic wireless technologies, material-by-design (metamaterials and reconfigurable-materials), and theory/applications of optimization techniques to engineering problems (telecommunications, medicine, and biology).

Prof. Massa published more than 500 scientific publications among which about 250 on international journals and more than 270 in international conferences where he presented more than 50 invited contributions. He has organized 45 scientific sessions in international conferences and has participated to several technological projects in the European framework (10 EU Projects) as well as at the national and local level with national agencies (40 Projects/Grants).