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"Compressive Sensing – Theory, Techniques, and Applications to Inverse Scattering"

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Compressive sensing presents a new way of dealing with information retrieval and signal processing. Instead of the fine sampled version of a signal, computing a full set of transform coefficients (although most of them are negligible), it is possible to directly measure a compressed representation of the signal thanks to the observation that most signals that arise in nature are sparse with relatively few nonzero coefficients.

Compressive sensing exploits this sparsity allowing the information retrieval process (i.e., the reconstruction of the original signal) from far fewer linear measurements than the size of the signal. The task of recovering a sparse signal from relatively few measurements then becomes the problem of finding the sparsest solution of a severely underdetermined linear system of equations. Although NP-hard, it can be solved by means of efficient algorithms in many useful circumstances.

The discovery of the “compressive sensing” paradigm has led to the explosion of research worldwide in applied mathematics, engineering, and computer science since its impact goes far beyond compression and it applies whenever acquiring data is difficult, dangerous, or expensive. Thus, it has been rapidly exploited in several and different ranges of practical electromagnetic problems almost always leading to striking results that significantly advance the state-of-the-art.

The objective of the short-course is therefore to provide the attendees an overview of CS as well as on its applications to electromagnetics and, more specifically, to inverse scattering. More in detail, after reviewing basics and fundamentals of CS, the course will focus on state-of-the-art and mostly recently introduced CS-based techniques and algorithms, discussing capabilities, limitations, and perspectives in Inverse Scattering and Microwave Imaging. Applicative examples including exercises and speeches regarding specific applications will corroborate the developed concepts.

The Short Course includes 9 hours of classes spanning over 3 days.

Andrea Massa (IET Fellow, Electromagnetic Academy Fellow, IEEE Senior Member) 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 with a staff of more than 40 researchers located in the network of federated laboratories [ELEDIA@UTB in Bandar Seri Begawan (Brunei), ELEDIA@UESTC in Chengdu (China), ELEDIA@USIL in Lima (Perù), ELEDIA@UniNAGA in Nagasaki (Japan), ELEDIA@L2S in Paris (France), ELEDIA@CTU in Prague (Czech), ELEDIA@UniTN in Trento (Italy), ELEDIA@Innov'COM in Tunis (Tunisia)]. Moreover, he is Adjunct Professor at Penn State University (USA), Professor @ CentraleSupélec, and holder of a Senior DIGITEO Chair developed in co-operation between the Laboratoire des Signaux et Systèmes in Gif-sur-Yvette and the Department "Imagerie et Simulation for the Contrôle" of CEA LIST in Saclay (France) from December 2014, and he has been Visiting Professor at the Missouri University of Science and Technology (USA), the Nagasaki University (Japan), the University of Paris Sud (France), the Kumamoto University (Japan), and the National University of Singapore (Singapore). Recently, it has been appointed IEEE AP-S Distinguished Lecturer (2016-2018).

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”, a permanent member of the “PIERS Technical Committee” and of the “EuMW Technical Committee”, and a ESoA member. 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). Moreover, he has been appointed in 2011 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 for the period 2004-2010. Furthermore, he has been elected 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 inverse problems, analysis/synthesis of antenna systems and large arrays, radar systems synthesis and signal processing, cross - layer optimization and planning of wireless/RF systems, semantic wireless technologies, system-by-design and material - by - design (metamaterials and reconfigurable - materials), and theory/applications of optimization techniques to engineering problems (tele-communications, medicine, and biology).

Prof. Massa published more than 600 scientific publications (partial list available at: <http://eledia.science.unitn.it/index.php/ricerca/pubblicazioni>) among which about 270 on international journals and more than 350 in international conferences where he presented more than 70 invited contributions. He has organized more than 50 scientific sessions in international conferences and has participated to several technological projects in the European framework (20 EU Projects) as well as at the national and local level with national agencies (more than 100 Projects/Grants).