

# Preface

Compressed sensing is a new technique for nonadaptive compressed acquisition, which takes advantage of signal sparsity and allows signal recovery starting from few linear measurements. Distributed scenarios commonly arise in many applications, where data are inherently scattered across a large geographical area. This applies, for example, to sparse event detection in wireless networks, distributed indoor localization, and distributed tracking in sensor networks. Also distributed sources naturally arise in wireless sensor networks, where sensors may acquire over time several readings of the same natural quantity, e.g., temperature, in different points of the same environment. Such data can be transmitted to a fusion center for joint processing. In this case, a centralized reconstruction system employs joint recovery algorithms exploiting the correlations among the signals coming from the various sensors to enhance the reconstruction fidelity. A drawback of this model is that, particularly in large-scale networks, gathering all data to a central processing unit may be inefficient, as a large number of hops have to be taken, requiring a significant amount of energy for communication over the wireless channel. Moreover, this may also introduce delays, severely reducing the sensor network performance. In this case, distributed protocols are required so that the reconstruction can be performed in-network. In both centralized and distributed scenarios, a common element is the necessity of limiting computations and memory usage, making compressed sensing very appealing as a cost-constrained representation in order to exploit data redundancies. This book presents a survey of the state of the art of *Compressed Sensing for Distributed Systems*. It has to be noted that, while compressed sensing has been studied for some time now, its distributed applications are relatively new. Remarkably, such applications are ideally suited to exploit all the benefits that compressed sensing can provide. The objective of this book is to provide the reader with a comprehensive survey of this topic, from the basic concepts to different classes of centralized and distributed reconstruction algorithms, as well as a comparison of these techniques. This book collects different contributions on these aspects. It presents the underlying theory in a complete and unified way for the first time, presenting various signal models and their use cases. It contains a theoretical part collecting latest results in rate-distortion analysis of

distributed compressed sensing, as well as practical implementations of algorithms obtaining performance close to the theoretical bounds. It presents and discusses various distributed reconstruction algorithms, summarizing the theoretical reconstruction guarantees and providing a comparative analysis of their performance and complexity. In summary, this book will allow the reader to get started in the field of distributed compressed sensing from theory to practice. We believe that it can find a broad audience among researchers, scientists, or engineers with very diverse backgrounds, having interests in mathematical optimization, network systems, graph-theoretical methods, linear systems, stochastic systems, and randomized algorithms. To help the reader become familiar with the theories and algorithms presented, accompanying software is made available on the authors website ([www.crisp-erc.eu](http://www.crisp-erc.eu)), implementing several of the algorithms described in the book.

Turin  
March 2015

Giulio Coluccia  
Chiara Ravazzi  
Enrico Magli

Compressed Sensing for Distributed Systems

Coluccia, G.; Ravazzi, C.; Magli, E.

2015, X, 97 p. 23 illus., 14 illus. in color., Softcover

ISBN: 978-981-287-389-7