The interplay between Big Data and Sparsity in System Theory.

Prof. Mario Sznaier
Northeastern University, U. S. A.

Venue: Amphitheater **EA1,** North Tower, Alameda campus, IST, **18 May 2017, 16h00**

Abstract: Arguably, one of the hardest challenges faced now by the systems community stems from the exponential explosion in the availability of data, fueled by recent advances in sensing and actuation capabilities. Simply stated, classical techniques are ill equipped to handle very large volumes of (heterogeneous) data, due to poor scaling properties and to impose the structural constraints required to implement ubiquitous sensing and control.

The goal of this talk is to explore how this "curse of dimensionality" can be potentially overcome by exploiting the twin "blessings" of self-similarity (high degree of spatio-temporal correlation in the data) and inherent underlying sparsity. While these ideas have already been recently used in machine learning (for instance in the context of dimensionality reduction and variable selection), they have hitherto not been fully exploited in systems theory. By appealing to a deep connection to semi-algebraic optimization, rank minimization and matrix completion we will show that, in the context of systems theory, the limiting factor is given by the ``memory'' of the system rather than the size of the data itself, and discuss the implications of this fact. These concepts will be illustrated by examining examples of "easy" and "hard" problems, including the synthesis of filters and controllers subject to information flow constraints, and identification of classes of non-linear systems.

The talk will conclude with an application of these ideas to the non-trivial problem of extracting actionable information from very large data streams. In particular, we will show how exploiting sparsity leads to tractable, scalable solutions to the problems of anomaly detection and activity analysis from video streams.

Biographic note: Mario Sznaier received the Ph.D degrees from the University of Washington. In 1993 he joined the Pennsylvania State University, where he was promoted to Associate Professor in 1997 and to Professor of Electrical Engineering in 2001. In July 2006 he joined the Electrical and Computer Engineering Department at Northeastern University, Boston, MA, as the Dennis Picard Trustee Professor. He has also held visiting appointments at the California Institute of Technology in 1990 and 2000 and currently holds an appointment at Penn State as Adjunct Professor of Electrical Engineering. His research interest include Multiobjective Robust Control; Dynamic Vision and Imaging, Control Oriented Identification, Robust Model (In) Validation and Application of Dynamical Systems Theory to Physics. He is currently serving as an Associate Editor for the journal Automatica and as a member of the board of governors of the IEEE Control Systems Society.

FCT Fundação para a Ciência e a Tecnologia
MINISTÉRIO DA CIÊNCIA, TECNOLOGIA E ENSINO SUPERIOR