Wed, November 11, 9:30am – 10:30am
DIMEAS, sala Ferrari - II piano, Politecnico di Torino.

Forecasting Bifurcations in Engineered and Natural Systems

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Abstract:

Multiple stable dynamics exist in systems that have thresholds and breaking points. Predicting these breaking points or bifurcations before they happen is a crucial challenge for monitoring engineered systems and for understanding natural systems such as ecosystems. Unfortunately, such bifurcations can now be predicted only if an accurate model of the entire system is available. Recent model-less methods analyze the critical slowing down phenomenon which occurs in the dynamics as a critical transition is approached. However, these existing methods provide only qualitative information and cannot accurately identify when the breaking point will occur or how the system will behave after the critical transition. We show that it is possible to predict breaking points as well as the system behavior after those points without a model of the system. We use a novel technique to analyze the systems response to large perturbations well in advance of the critical transition. Such perturbations can be due to natural events or human interference. We apply the new method to vibration-based mass sensors, to aeroelastic systems, to a vegetation grazing ecosystem, and to a feedback system between macrophytes and phytoplankton in a lake.

Bio:
Bogdan I. Epureanu is a Professor of mechanical engineering at the University of Michigan. He received his Ph.D. from Duke University in 1999. His research blends theories in nonlinear dynamics, structural health monitoring, aeroelasticity and computational dynamics, with applications relevant to aerospace structures, sensors, turbomachinery, and biological systems. In particular, Professor Epureanu develops reduced order models of complex structures, system identification and control methodologies for structures and fluid-structural systems, and the next generation of highly-sensitive structural health monitoring techniques. He has earned several awards, including the 2004 American Academy of Mechanics Junior Achievement Award, an NSF Career Award in 2004, the 2003 ASME/Pi Tau Sigma Gold Medal Award, the 2001 Young Innovator Award from Petro-Canada, and the 2005 Beer & Johnston Outstanding Mechanics Educator Award by the American Society for Engineering Education.