AAI Advanced Analytics Seminar Series on 04/06/2012

Seminar Title: Soft Computing in Prognostics and Health Management (PHM) Applications: A Case Study in Anomaly Detection
Speaker: Piero P. Bonissone, Ph.D., IEEE Fellow, Chief Scientist, Coolidge Fellow, GE Global Research, Software Sciences and Analytics.
Date and Time: 1:30pm to 3:00pm, the 4th of June 2012 (Monday)
Seminar Room: UTS City Campus Building 10 CB10.02.410 (2 minutes walk from Tower Building CB01 of UTS)
Seminar Chairman: Prof Longbing Cao (longbing.cao@uts.edu.au)

Abstract: Soft Computing (SC) is a term that has evolved, since its inception in 1991, to represent a methodology and a set of techniques covering the aspects of data-driven models design, domain knowledge integration, model generation, and model tuning. We distinguish between offline Meta-heuristics (MH's), used for model design and tuning, and online MH's, used for models selection or aggregation. This view suggests the use of hybrid SC at each MH's level as well as at the object level. We manage model complexity by finding the best model architecture to support problem decomposition, generate local models with high-performance in focused applicability regions, provide smooth interpolations among local models, and increase robustness to imperfect data by aggregating diverse models.

Within the broad spectrum of Soft Computing (SC) applications, we will focus on Prognostics & Health Management (PHM) for assets such as locomotives, medical scanners, aircraft engines, etc. The main goal of PHM is to maintain these assets' operational performance over time, improving their utilization while minimizing their maintenance cost.   This tradeoff is typical of long-term service agreements offered by OEM's to their valued customers. Typical PHM functions range from anomaly detection, to anomaly identification, failure mode analysis (diagnostics), estimation of remaining useful life (prognostics), on-board control, and off board logistics actions.

We illustrate this concept with a case study in anomaly detection for a fleet of physical assets (such as an aircraft engines or a gas turbines). Anomaly detection typically uses unsupervised learning techniques to extract the underlying structural information from the data, define normal structures and regions, and identify departures from such regions. We focus on one of the most common causes for anomalies: the inadequate accuracy of the anomaly detection models, which are prone to create false alarms. To address this issue, we propose a hybrid approach based on a fuzzy supervisory system and an ensemble of locally trained auto associative neural networks (AANN's.) The design and tuning of this hierarchical model is performed using evolutionary algorithms. In our approach we interpolate among the outputs of the local models (AANN's) to assure smoothness in operating regime transition and provide continuous condition monitoring to the system. Experiments on simulated data from a high bypass, turbofan aircraft engine model demonstrated promising results.

Short biography of the speaker: Dr. Piero P. Bonissone is a Chief Scientist at GE Global Research. Dr. Bonissone has been a pioneer in the field of fuzzy logic, AI, soft computing, and approximate reasoning systems applications since 1979. Recently he has led a Soft Computing (SC) group in the development of SC application to diagnostics and prognostics of processes and products, including the prediction of remaining life for each locomotive in a fleet, to perform efficient assets selection.   His current interests are the development of multi-criteria decision making systems for PHM and the automation of intelligent systems lifecycle to create, deploy, and maintain SC-based systems, providing customized performance while adapting to avoid obsolescence.

He is a Fellow of the Institute of Electrical and Electronics Engineers (IEEE), of the Association for the Advancement of Artificial Intelligence (AAAI), of the International Fuzzy Systems Association (IFSA), and a Coolidge Fellow at GE Global Research. He is the recipient of the 2012 Fuzzy Systems Pioneer Award from the IEEE Computational Intelligence Society. Since 2010, he is the President of the Scientific Committee of the European Centre of Soft Computing.   In 2008 he received the *II Cajastur International Prize for Soft Computing* from the European Centre of Soft Computing. In 2005 he received the *Meritorious Service Award* from the IEEE Computational Intelligence Society. He has received two *Dushman Awards* from GE Global Research. He served as Editor in Chief of the *International Journal of Approximate Reasoning* for 13 years. He is in the editorial board of five technical journals and is Editor-at-Large of the *IEEE Computational Intelligence Magazine.* He has co-edited six books and has over 150 publications in refereed journals, book chapters, and conference proceedings, with an H-Index of 30 (by Google Scholar). He received 63 patents issued from the US Patent Office (plus 15 pending patents). From 1982 until 2005, he has been an Adjunct Professor at Rensselaer Polytechnic Institute, in Troy NY, where he has supervised 5 PhD theses and 33 Master theses. He has co-chaired 12 scientific conferences and symposia focused on Multi-Criteria Decision-Making, Fuzzy sets, Diagnostics, Prognostics, and Uncertainty Management in AI. Dr. Bonissone is very active in the IEEE, where is has been a member of the Fellow Evaluation Committee from 2007 to 2009. In 2002, while serving as President of the IEEE Neural Networks Society (now CIS), he was also a member of the IEEE Technical Board Activities (TAB). He has been an Executive Committee member of NNC/NNS/CIS society since 1993 and an IEEE CIS Distinguished Lecturer since 2004.

Overview to This Seminar Series
The Advanced Analytics Seminar Series presents the latest theoretical advancement and empirical experience in a broad range of interdisciplinary and business-oriented analytics fields. It covers topics related to data mining, machine learning, statistics, bioinformatics, behavior informatics, marketing analytics and multimedia analytics. It also provides a platform for the showcase of commercial products in ubiquitous advanced analytics. Speakers are invited from both academia and industry. It opens

regularly on every Friday afternoon at the garden-like UTS Blackfriars Campus. You are warmly welcome to attend this seminar series.

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