

SOUNDAR KUMARA

Allen E., and Allen, M., Pearce Professor of Industrial Engineering

310 Leonhard Building
The Pennsylvania State University
University Park, PA 16802
Tel: (814)863-2359
Fax: (814)863-4745
e-mail: skumara@psu.edu

Soundar Kumara is the Allen, E., and Allen, M., Pearce Professor of Industrial and Manufacturing Engineering at Penn State. He also holds a joint appointment with the Department of Computer Science. He holds an affiliate appointment with the school of Information Sciences and Technology. He serves as an Adjunct Professor at the C.R. Rao Institute of Advanced Mathematics, Statistics and Computer Science, University of Hyderabad, India. He is also an overseas expert (2014-2016) for Northwestern University, Xian, China. Dr. Kumara held visiting professorships at some of the leading institutions in the world including; Massachusetts Institute of Technology, University of Tokyo, City University of Hong Kong, Korea Institute of Science, Technology, Beihaang University (China) and North Western Polytechnic University (China). His Erdős number is 3.

Dr. Kumara has a Bachelor of Engineering degree in Mechanical Production engineering from Sri Venkateswara College of Engineering, Tirupati; Master of Technology in Industrial Engineering from the Indian Institute of Technology Madras and Ph.D., from Purdue University.

His primary research interests are in Sensor data representation, smart manufacturing, supply chain logistics, Network Science, and Graph Analytics applied to retail and healthcare

Research Accomplishments

Kumara is a leader in industrial engineering for his pioneering and visionary interdisciplinary research in logistics and manufacturing. His unique approaches integrate mathematics, AI, pattern recognition, advanced computing, statistical physics and operations research, to solve problems in complex networks, product design and real time monitoring of manufacturing and logistics systems. Kumara's research in applying pattern recognition techniques to facilities layout planning (1985) initiated a new stream of research in production systems. His work in sensor data representation through wavelets (1994) revolutionized real-time condition based maintenance. He is among the first to prove the existence of chaos in machining (1995). His work in real-time sensing laid the foundation for the subsequent work by the Quality Systems and Reliability (QSR) group in INFORMS on sensor based data driven manufacturing and quality control. Kumara, as a PI on the DARPA ultralog project, implemented sensing and prediction in the largest ever, distributed agent based military logistics platform with 10,000 agents (2005). The near linear-time network clustering algorithm developed by his team (2007) (<http://journals.aps.org/pre/abstract/10.1103/PhysRevE.76.036106>) is currently among the fastest algorithms in clustering large scale networks. This algorithm was extended to overlapping clusters, and by using game theory his group proved the one-to-one correspondence between the robust clusters generated by his algorithm and Nash equilibria (INFORMS J. of C, 2014). Kumara's interdisciplinary research in agents, game theory and IT has laid the foundation for the futuristic information intensive manufacturing systems (2006).

Impact on Industry and Practice

Kumara has revolutionized industrial engineering field with his interdisciplinary approaches, creating several new streams of research in manufacturing, logistics and production systems. He pioneered the use of advanced IT, pattern recognition, neural networks and AI techniques in Intelligent Manufacturing

Systems research. His contributions in wavelets and chaos theory led to new techniques in real-time monitoring and in optimizing sensor network life. His work in clustering complex networks is a key technology in big data analytics. Kumara's research under DARPA ultralog forms an integral part of distributed agent based military logistics platforms. He is a Co-PI on the DARPA Advanced Vehicle Manufacturing program (3 year, \$48 million) to build the next generation information intensive manufacturing systems for DoD. He has 3850 citations in Google Scholar (h-index 30, i-10 index 81). He has implemented a real-time process monitoring and diagnostics system for Owen-Corning Fiberglas Company in Huntingdon, PA (1989) which was in operation in the company till the facility moved to Belgium in early 2000s. He has designed and implemented a FMS for Ford-New Holland Farm equipment Company in PA in the early 1990s which was used effectively till 2000. His work with Real Time Location System and real time truck loading algorithm developed in mid 2000s is still being utilized by GM. His sensing work has become an integral part of the Cougaar (agent platform) software, which is extensively used by many DoD facilities. The Label Propagation Algorithm (LPA) for clustering developed by his team is a part of igraph package(<http://igraph.org/>), python language packages, and R programming modules. The tests by Cornell CS graduates point to the fact that LPA works very fast even with networks of 500 million nodes (<http://bickson.blogspot.com/2011/05/label-propagation-using-graphlab.html>).

Management and Leadership Roles

As a fellow of CIRP, ASME, IIE and AAAS Professor Kumara has provided leadership to the IE profession towards research in Data Driven Manufacturing. His work has laid the groundwork for the future to work in sensor based real-time quality control that is being currently followed by many researchers in QSR division of INFORMS. He is a Co-founder of the ASME sponsored conference, "Artificial Neural Networks in Engineering (ANNIE)," in 1991 which is still going strong under the name "Complex Adaptive Systems." He is a proven leader with his interdisciplinary work – with publications in diverse journals such as – OR, INFORMS J. of C, Physics Reviews, IEEE Transactions, IIE Transactions, Applied Mathematics and Signal Processing. In today's world where analytics has become important, he is among the first to start working in this direction in 1989.

Contributions to Education, Pedagogy and Mentorship

Professor Kumara is among the few Industrial Engineering faculty who recognized the importance of combining computing, modeling and analysis, and introducing courses to that effect. His undergraduate course in AI in IE (1992) morphed into IT for IE and Manufacturing (2005) and in 2013 was redesigned into "Engineering Analytics." In this course he started teaching programming and analysis and currently is completely devoted to analytics (analysis and data mining). This is one of the first courses of its kind in the IE departments across the world. His course syllabus is being used by several institutions. In the same spirit he has introduced Advanced IT in IE (2000), which is currently taught under the name "Advanced Engineering Analytics." Both his courses contain real life retail analytics project. He has advised 45 Ph.D., and 53 MS students as an advisor or co-advisor. More than 16 faculty members from abroad has worked with him as visiting faculty. Most of the visiting faculty have taken his courses to teach them at their parent institutions. Of the 45 Ph.D., students who were mentored by him, 11 have joined as faculty members in various organizations. Many of his students work with federal agencies (FBI, CIA, NSA, US Army) and industries (ex: Google, IBM, CISCO, Starbucks, American Airlines, and Tripadvisor).

Professional Service

Dr. Kumara is a Fellow of Institute of Industrial Engineers (IIE), Fellow of the International Academy of Production Engineering (CIRP), Fellow of American Society of Mechanical Engineers (ASME), and a Fellow of the American Association for the Advancement of Science (AAAS). Through these organizations he has been actively promoting the integration of AI-IT-Statistics and Optimization in to the domain problems. He has organized a cluster on Complex Systems/Networks during the INFORMS

Annual Meeting at Austin, Texas (2010). He is on the program committee of several conferences and workshops worldwide. He served on several editorial boards. Currently he is organizing as a Co-Chairman, The fourth conference on Internet of Things conference at MIT (<http://www.iot-conference.org/iot2014/>) during October 2014.