学术报告会

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New Reinforcement Learning Structures for Real-Time Feedback Control and Differential Graphical Games: Applications to Distributed Energy Microgrids, Robotics, and Communication Graphs

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Abstract:

This talk brings together automatic feedback control, Computational Intelligence neural networks and bio-inspired learning, and efficient communication networks modeled using graph topologies.   Recent developments bringing these three fields together are reviewed, and new efficient feedback controllers are designed that rely on technologies drawn from each of them.   Applications are made to electric power microgrids and human-robot interaction systems.

Automatic Feedback Control Systems have a long modern history starting with James Watt's controller which made the steam engine a useful prime mover.   Optimal and Adaptive feedback control design have been responsible for much of the successful performance of engineered systems in aerospace, electric power systems, industrial processes, vehicles, ships, robotics, and elsewhere since the 1960s. Optimal control solutions provide robustness and performance guarantees.   Differential multi-player game theory provides rigorous techniques for optimizing the performance of multiple interacting agents in communication systems, economics, formations, and microgrids. However, these optimal and game theory solutions are computed offline and require full knowledge of the system dynamics.

Recent developments in Computational Intelligence in neural networks, artificial intelligence, and bio-inspired learning show how to design new high-performance feedback control structures for learning online the solutions to optimal control problems and multi-player differential games. We review developments that use computational intelligence to enhance feedback controllers, including neural networks that enhance adaptive controllers, and new Reinforcement Learning methods that enhance optimal and game theoretic controllers.

Future energy distribution networks are composed of interconnected small-scale microgrid systems. Microgrids, including smart building energy systems, rely on the intercommunication between multiple distributed generators and

loads. To bring together distributed control of multi-agent systems and real-time optimal learning, we present a new family of distributed multi-agent games on sparse and efficient Communication Graphs that allows frequency synchronization and voltage balance of multiple interacting systems by using highly efficient distributed learning algorithms between individual dynamical agents.

Biography:

Biosketch F.L. Lewis: Member, National Academy of Inventors. Fellow IEEE, Fellow IFAC, Fellow U.K. Institute of Measurement & Control, Fellow AAAS, PE Texas, U.K. Chartered Engineer. UTA Distinguished Scholar Professor, UTA Distinguished Teaching Professor, and Moncrief-O'Donnell Chair at The University of Texas at Arlington Research Institute. Qian Ren Thousand Talents Consulting Professor, Northeastern University, Shenyang, China. Distinguished Foreign Scholar, South China University of Technology. IEEE Control Systems Society Distinguished Lecturer. Bachelor's Degree in Physics/EE and MSEE at Rice University, MS in Aeronautical Engineering at Univ. W. Florida, Ph.D. at Ga. Tech. He works in feedback control, reinforcement learning, intelligent systems, and distributed control systems. He is author of 7 U.S. patents, 363 journal papers, 418 conference papers, 23 books, 60 chapters, and 26 journal special issues. H-index is 95. He receive`d the Fulbright Research Award, NSF Research Initiation Grant, ASEE Terman Award, Int. Neural Network Soc. Gabor Award 2009, U.K. Inst. Measurement & Control Honeywell Field Engineering Medal 2009. Received IEEE Computational Intelligence Society Neural Networks Pioneer Award 2012 and AIAA Intelligent Systems Award 2016. Received Liaoning China Friendship Award 2017. Distinguished Foreign Scholar at Huazhong University of Science and Technology. Distinguished Foreign Scholar at Chongqing Univ. China. Received Outstanding Service Award from Dallas IEEE Section, selected as Engineer of the Year by Ft. Worth IEEE Section. Listed in Ft. Worth Business Press Top 200 Leaders in Manufacturing. Received the 2010 IEEE Region 5 Outstanding Engineering Educator Award and the 2010 UTA Graduate Dean's Excellence in Doctoral Mentoring Award. Elected to UTA Academy of Distinguished Teachers 2012. Texas Regents Outstanding Teaching Award 2013. He served on the NAE Committee on Space Station in 1995.