

## Keynote I

### The Changing Face of Adaptive Control

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**Abstract:** Every biological system is faced with a multiplicity of choices at any instant of time. As its environment changes, the set of choices and objectives of the system change with it. Having a wide repertoire of behavior suited to the different situations learned through experience), possessing the ability to recognize the specific situation that has arisen and taking the appropriate action, is what "adaptation" means to the average person.

In contrast to the above paradigm, much of the analytical work on adaptive control reported in the literature in the past four decades deals primarily with time-invariant systems with unknown parameters. The latter are estimated as the system is in operation and, based on the estimates, the parameters of a controller are adjusted incrementally, so that the characteristics of the overall nonlinear system evolve towards that of a linear reference model.

Even as adaptive principles are being extended to more complex systems in widely different areas, it is becoming increasingly clear that we need to replace the sterile metaphor of a fixed environment with a dynamic and constantly changing one. Providing a mathematical framework for the analysis and synthesis of such systems is the challenge for the adaptive control theorist.

The lecture will trace the history of adaptive control, discuss recent developments in hybrid and switching systems, and describe how judiciously combining switching and tuning will change the future face of adaptive control.

**Biography:** Professor K.S. Narendra received his Bachelor of Engineering degree with honors in Electrical Engineering from the University of Madras in 1954, and the M.S. and PhD degrees from Harvard University in 1955 and 1959 respectively. He received an honorary M.A. degree from Yale University in 1968 and an honorary Doctor of Science degree from his alma mater (now Anna University in Madras) in 1995. Currently, he is Professor of Electrical Engineering and Director of the Center for Systems Science at Yale University.

Professor Narendra's research since 1961 has addressed four different areas: Stability Theory (1961-1972), Learning Automata (1968-1987), Adaptive Control (1970-present) and Artificial Neural Networks (1988-present). Concurrent with research he has directed forty doctoral students at Harvard and Yale Universities, and collaborated with over fifty postdoctoral and visiting fellows.

Professor Narendra is the author of four books on stability, learning automata, adaptive systems and neural networks (in preparation), and the editor of four others. He is the recipient of the Franklin V. Taylor Award (1972) of the IEEE Systems,

Man, and Cybernetics Society, the George S. Axelby best paper award (1988) of the Control Systems Society, and the Outstanding Paper Award (1991) of the Neural Network Council. He is a Life Fellow of the IEEE, a Fellow of IEE (U.K.), a Fellow of the American Association of the Advancement of Science, and a member of the Connecticut Academy of Science and Engineering in (1995). He was awarded the American Automatic Control Council Education Award in 1990, the Leadership Award of the Neural Network Society in 1994, and the Bode Prize in 1995.

Professor Narendra has served on Numerous National and International Committees as well as the advisory boards of various Institutes and Universities around the world. His current interests are in the control of complex systems in the presence of large time-varying uncertainties.