Special sessions at ADPRL 2013

IEEE SSCI 2013, Singapore

## Special Session 1

**Title: "Online planning"**
**Organizers: Lucian Busoniu and Rémi Munos**

**Abstract:**
"Online planning methods are enjoying an intensified interest in the reinforcement learning field, where they are also known as optimistic planning and sparse sampling. In control and adaptive dynamic programming, these methods represent a new and very general paradigm for receding-horizon, predictive control. Moreover, in the planning community the unprecedented success of the Upper Confidence Trees algorithm in the game of Go has stimulated the development of the whole subfield of Monte Carlo Tree Search. Online planning combines classical planning ideas with insights from bandit theory, and has the crucial advantage of relative independence on the state space size. This is achieved by efficiently searching the policy space locally, for each encountered state of the environment.

The understanding of the behavior and power of online planning methods is only currently developing. In this special session, we therefore aim to bring together novel algorithms, analysis, and applications of online planning. Relevant contexts include among others optimal control, Markov decision processes and their partially-observable variant, Bayesian-optimal planning, and multi-agent systems. Applications are welcome e.g. in the areas of control, artificial intelligence, and game playing. We are also open to other, previously unexplored perspectives on planning methods."

## Special Session 2

**Title：Evolutionary Algorithms for ADPRL**

**Organizers：Hisashi Handa, Kindai University, JAPAN**
**Kazuhiro Ohkura, Hiroshima University, JAPAN**

**Abstract：**
Adaptive Dynamic Programming and Reinforcement Learning have attracted much attention by many researchers. Evolutionary Algorithms can play crucial rules in various aspects of the ADPRL domain due to its flexibility and capability. The EAs are not based on reward but on fitness usually given at the end of episodes. Hence, the EC can be regarded as a direct policy search with less reward information. Besides, because of the global search capability of the EC, the hybridization of EC and ADPRL may have great potential for constituting autonomous agents.

This special session aims to discuss the effective use of evolutionary algorithms in ADPRL domain. Topics for contributions include, but may not be limited to the varying forms of evolutionary computation to learn controllers or to constitute adaptive value functions for robots, simulations of robots, interactive video game agents, teams of agents, and predator/prey agents.

## Special Session 3

**Title：Finite-Approximate-Error Based Adaptive Dynamic Programming: Algorithms and Applications**

**Organizers：Yanhong Luo, Northeastern University, China**
**Qinglai Wei, Institute of Automation, Chinese Academy of Sciences, China**
**Zengguang Hou, Institute of Automation, Chinese Academy of Sciences, China**

**Motivation:**

Although iterative Adaptive Dynamic Programming (ADP) algorithms attract more and more attentions, for nearly all of the iterative algorithms, the iterative control of each iteration is required to be accurately obtained. These iterative ADP algorithms can be called “accurately iterative ADP algorithms”. For most real-world control systems, however, the accurately iterative control laws in the iterative ADP algorithms cannot be obtained. For example, during the implementation of the iterative ADP algorithm, approximation structures, such as neural networks and fuzzy structures, are used to approximate the iterative performance index functions and the iterative control laws. While we can see that no matter what kind of neural networks and fuzzy structures are used, and no matter what the approximate precisions are obtained, there must exist approximate errors between the approximate functions and the expected ones. This shows that the accurate performance index function and control laws can not be reached in the iterative ADP algorithms for the real-world control systems. When the accurately iterative control laws can not be obtained, the convergence properties in the accurately iterative ADP algorithms may be invalid. Till now, to the best of our knowledge, there are no discussions on the convergence and the stability properties of the iterative ADP algorithms when the iterative control can not be obtained, which limit the applications of ADP very much. This motivates our research.

**Abstract:**

In this special session, we aim to develop some new ADP schemes for infinite horizon optimal control problems. We will study the optimal control problems with finite approximation error using iterative ADP algorithms. It is expected to show that the proposed iterative ADP algorithms can make the iterative performance index functions converge to the finite neighborhood of the optimal performance index function if some convergence conditions are satisfied. Some new convergence analysis methods are proposed and the least upper bounds of the converged iterative performance index functions are expected to be presented. Furthermore, in order to make the results be more inclined to the real applications, some on-line adaptive iterative optimal control laws are derived with the satisfying results that the proposed controller can ensure that the obtained control input is close to the optimal control input within an adjustable small neighborhood.

The topics include, but are not limited to:

- Convergence and performance bounds of ADP
- Complexity issues in RL and ADP
- On-line iterative analysis for ADPRL
- Statistical learning and ADP
- Direct policy search, actor-critic methods
- Adaptive feature discovery
- Learning rules and architectures for ADP
- Sensitivity analysis for policy gradient estimation
- Distributed intelligent systems
- Multi-agent systems based on ADP
- Multi-level multi-objective optimization for ADPRL
- Kernel methods and value function representation
- Applications of ADP and RL

## Special Session 4

**Title：Data-driven Adaptive Dynamic Programming and Its Applications in Complex Systems**
**Organizers: Derong Liu, Haibo He, and Dongbin Zhao**

**Special Session Scope and Call-For-Paper:**

Over the past decades, adaptive dynamic programing (ADP) has attracted significantly increased attention from both theoretical development and practical applications in many complex networked systems. Recently, motivated by the latest observations and developments from multiple disciplines such as adaptive control, cognitive science, neuroscience, and psychology, it is widely recognized that ADP could be the core technology to help the research community to advance the foundations and principles of brain-like intelligence and develop powerful techniques and solutions for challenging engineering applications, such as electrical power systems, transportation systems, communication networks, financial industry, operations research, among many others.

While there are many important topics within ADP field, recent research suggested that data-driven models are critical for many real-world complex systems. In such situations, an accurate model is impossible, or difficult to obtain. Therefore, data-driven ADP models, architectures, and algorithms have attracted growing attention in the community.

To this end, we propose to organize a special session entitled "Data-driven Adaptive Dynamic Programming and Its Applications in Complex Systems" to be associated with the SSCI-ADPRL 2013 in Singapore. The purpose of this special session is to bring together world-wide researchers to present and discuss common topics on both theoretical studies and application developments of data-driven ADP research. We hope this special session will not only provide an opportunity for international researchers to exchange ideas and present the latest research results, but also create a unique platform to identify important future research topics and directions in this field.

# Special Session 5

**Topic: Special session on ADP and RL in real-time feedback systems**

**Organizers:**

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**Motivation:**

In the past two decades, there has been a great deal of interest in developing adaptive and learning controllers for uncertain nonlinear systems. Among the existing works, adaptive control using neural networks (NNs) has been one of the main areas of focus. Although there has been a lot of progress in NN-based adaptive control, there are still lots of learning issues to be studied in adaptive NN control and in feedback control of general uncertain dynamical systems. It is well known that learning is a very desirable characteristic of advanced control systems. Issues of learning have been discussed since the 1960s together with adaptive control, pattern classification, and self-organizing systems. As learning means "acquiring knowledge or skills", a feedback control system with learning properties is one that has the capabilities (i) to acquire knowledge through stable closed-loop interactions with the plant and its environment, (ii) to store the knowledge in memory, and (iii) to reuse the learned knowledge (also called past experience) when similar control situations reoccur towards stability and improved control loop performance. However, just to gain knowledge in dynamical closed-loop control processes, i.e., learning in a real-time dynamic environment, is a very difficult problem which has remained unsolved for a long period of time. Furthermore, how to store knowledge in dynamical closed-loop control processes, and how to exploit the learned knowledge in closed-loop control systems toward stability and performance are difficult problems that remain. Efforts to address these difficulties include the reinforcement learning (RL), approximate dynamic programming (ADP) methods studied in recent years. However, there are still many challenges in developing learning capabilities in real-time feedback control of general uncertain nonlinear systems.

**Goals:**

The main goal of this special session is to organize to highlight the on-going research in the field of learning and control for real-time systems, and in particular learning in dynamical or non-stationary environments with its applications to real-world problems. The special session will present to the adaptive control and the neural networks community and to others interested in learning and control systems, in general, a variety of new and challenging research directions and their proposed solutions, originating from real-world control problems.

**Scope:**

The scope of this special session mainly includes the following topics:

- Fast reinforcement learning for adaptive optimal control,
- Approximate dynamic programming and adaptive critics,
- Online learning control algorithms for real-time systems

- Feature representation for learning control in real-time systems
- Stability and performance analysis of learning control based on ADP/RL
- Applications of ADP and RL in real-time control systems