Stochastic Systems, Control, Optimization, and Applications (Part I)

Invited Session

CoDIT 2026 - July 13-16, 2026 | Bari, Italy

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I. Introduction and Motivation

Taking the great opportunities provided by the IEEE 12th International Conference on Control, Decision, and Information Technologies (Co-DIT 2026), following our success in the IEEE 12th Co-DIT 2025), we propose to organize a special session devoted to stochastic systems, control, optimization, and applications. We will bring together researchers from multi-disciplinary communities in control and systems theory, control engineering, applied stochastic processes, financial economics, actuarial sciences, applied mathematics, applied probability, biology, electrical engineering, ecology, and networked science, to review, and to substantially update the most recent progress on systems theory and control. We plan to invite researchers from different areas covering a wide range of areas from theoretically oriented talks to application intensive presentations. A number of colleagues have accepted our invitations.

The motivations for putting together the proposed special session stem from facing the significant challenges from new and existing applications in control systems, communication networks, signal processing, queueing systems, production planning, biological systems, ecosystems, financial engineering, large-scale systems involving mean-field interactions, hybrid systems under the influence of random environments, and machine learning and neural network applications to control and systems theory.

II. Coverage of the invited Session

The proposed talks will reflect some of the most interests in a focused area namely stochastic control. They will touch upon many cutting edge research topics with a wide range of applications. The proposed session will prove to be invaluable to the scientific community. It will contribute to the subsequent development of stochastic systems theory and practice, and will have broader impacts to a wide variety of inter-disciplinary fronts.

III. More Details

The proposed speakers and the titles of their presentations are given below. The abstracts are included in the appendix.

1) Hamidou Tembine
2) Hamidou Tembine
3) Fuke Wu
4) Chao Zhu
5) Dominique Duncan
6) Cristina Stoica

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Appendix

Speakers, Titles, and Abstracts of the Proposed Talks

- Speaker: Hamidou Tembine (University of Quebec in Trois-Rivieres)

  Title: Agentic World Models as Mean-Field-Type Games

  Authors: Hamidou Tembine and Daryl Noupa Yongueng (University of Quebec in Trois-Rivieres)

  Abstract: Current machine intelligence models, whether generative or discriminative, largely treat the world as a static dataset, failing to capture the continuous, interactive, and risk-laden dynamics of real-world environments. In this work, we introduce Agentic World Models formulated as mean-field-type games, explicitly integrating measurement, observation, and perception processes with agent-level decision-making under heterogeneous risk preferences. By leveraging measure-valued histories and expectile-based risk metrics, our framework quantifies uncertainty propagation across sensing, cognition, and interaction layers, enabling both atomic and non-atomic agents to optimize performance in multi-agent, closed-loop systems. This approach bridges the gap between classical statistical machine intelligence models and the continuous, interactive, and high-stakes nature of industrial and physical environments. keywords: partially observable control, incomplete information, game theory

- Speaker: Hamidou Tembine (University of Quebec in Trois-Rivieres)

  Title: The Price of Oblivion: On the Non-Validity of Classical Hamilton-Jacobi-Bellman in Mean-Field-Type Control

  Authors: Hamidou Tembine (University of Quebec in Trois-Rivieres), Julian Barreiro-Gomez (Khalifa University), Tyrone E. Duncan, Bozenna Pasik-Duncan (University of Kansas)

  Abstract: We quantify the exact optimal cost gap that arises when a controller solves the classical Hamilton-

Jacobi-Bellman (HJB) equation while treating the population law as exogenous (by freezing it), an approach we call oblivious control, instead of solving the true mean-field-type control problem in which the running cost depends nonlinearly on the state law. Working in a simple but fully representative deterministic setting, we (i) derive closed-form expressions for both the oblivious and the mean-field-type optimal feedback laws, (ii) compute the corresponding optimal costs, and (iii) establish a closed-form, nonnegative expression for the cost gap. The formula highlights precisely how the law-dependence controls the suboptimality of oblivious HJB control. It also proves non-validity of the standard HJB in mean-field-type control which requires a new HJB in the space of measures. [keywords: control, oblivious strategy, Bellman systems]

- Speaker: Fuke Wu (Huazhong University of Technology)

  Title: Near-Optimality in Two-Time-Scale Stochastic Optimal Control Systems with Infinite Integral-type Delays

  Authors: Meilin Tang, Fuke Wu

  Abstract: This paper focuses on near-optimal controls for a class of fully-coupled, two-time-scale stochastic functional differential equations (SFDEs). The coefficients of the system involve infinite integral-type delays in both the slow and fast components, which induces a loss of the Markov property. To overcome this challenge, the original system is first transformed into a higher-dimensional system without delay via state augmentation. The core of the analysis is an averaging principle. To ensure its successful application, the ergodicity of the resulting higher-dimensional fixed-X equation and its continuous dependence on parameters are established. A key result is the convergence of the value function of the original system to that of a simplified, limiting system, whose coefficients are averages with respect to the invariant measure of the fixed-X equation. Finally, a two-time-scale optimal control problem for an advertising model is presented as an illustrative example. [Key words: Stochastic optimal control ; Singular perturbation; Averaging principle; Infinite delay; Relaxed control; Weak convergence.]

- Speaker: Chao Zhu (University of Wisconsin, Milwaukee)

  Title: Euler-Maruyama Algorithm for State-Dependent Regime-Switching Diffusions

  Author: Chao Zhu

  Abstract: This paper is devoted to numerical approximation methods for state-dependent regime-switching diffusion processes in which the switching component has an infinite state space. It proposes an explicit Euler-Maruyama numerical scheme and establishes a strong convergence rate for the algorithm. This is a joint work with George Yin.

- Speaker: Dominique Duncan

  Title: The Human Brain as a Complex Stochastic System: Integrating Statistical Modeling, AI, and Neuroimaging for Decision-Making in Neurological Disorders

  Author: Dominique Duncan, Neurology, Bioengineering, and Neurosurgery University of Pennsylvania

  Abstract: Abstract The human brain is among the most complex stochastic systems encountered in nature, characterized by high-dimensional dynamics, uncertainty, nonlinearity, and multiscale interactions. This work presents recent advances in modeling, analysis, and prediction of brain dynamics using statistical, computational, and data-driven approaches, with a focus on clinical applications in neurological disorders. The brain serves as a compelling platform for integrating stochastic systems theory, optimization, artificial intelligence, and decision-making under uncertainty.
  We highlight how probabilistic modeling, mathematical statistics, and machine learning methods can be combined with multimodal neuroimaging data to characterize brain states and transitions. In particular, we discuss frameworks for modeling variability, noise, and uncertainty in neural signals, emphasizing that randomness is not merely a nuisance but a fundamental feature that can reveal underlying system structure. These methods enable prediction and risk stratification tasks, such as seizure forecasting in epilepsy, while supporting interpretable and clinically actionable decision-making.
  The work further addresses challenges related to data heterogeneity, limited sample sizes, and ethical considerations in medical AI, including transparency, bias, and trust in algorithmic decision support. By viewing the brain through the lens of stochastic systems and control, this research illustrates how interdisciplinary collaboration across mathematics, statistics, engineering, neuroscience, and medicine can advance both theory and real-world impact. The results underscore the growing importance of rigorous statistical foundations and ethical awareness in AI-driven analysis of complex biological systems.

- Speaker: Cristina Stoica

  Title: Outreach activities for introducing basic Control notions using an educational robot

  Authors: Irina Bran, Omar Hamou Tahra, Tomas Jeria, Hadrian Lorand, Aarsh Thakker, Cristina Stoica

  Abstract: This paper reports insights from outreach activities implementing basic control engineering notions on educational robots. These interactive workshops allow children to program and control mobile robots, converting abstract concepts into engaging challenges adapted to their age. The developed activities are designed to motivate children and to inspire them in pursuing with engineering curriculum.

CONCLUSION

Our sessions bring awareness to the importance of integrating research with learning and teaching, innovations and

technology, at every level of students' studies including K-12. We are enthusiastic and passionate about the power, beauty and excitement of interdisciplinary and cross- boundaries nature of stochastic systems and control. We also believe that good understanding of probability and mathematical statistics will help to deal with ethical concerns in data science when AI and ML are used.

SUBMISSION GUIDELINES

Papers must be submitted electronically for peer review through PaperCept by **February 07, 2026:** **http://controls.papercept.net/conferences/scripts/start.pl**. In PaperCept, click on the **CoDIT 2026 link "Submit a Contribution to CoDIT 2026" and follow the steps.**

IMPORTANT: All papers must be written in English and should describe original work. The length of the paper is limited to a maximum of 6 pages (in the standard IEEE conference double column format).

DEADLINES

February 07, 2026: deadline for paper submission

April 30, 2026: notification of acceptance/reject

May 20, 2026: deadline for final paper and registration