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Title: The Principle of Maximum Entropy, from modeling to adaptive predictive control

Oral presentation

Abstract: This presentation addresses the use of the Principle of Maximum Entropy (PME) for the modeling of physical processes from incomplete process data, to adaptive predictive control in the presence of un-modeled dynamics. In general [1], the problem consists of finding an unknown function given an incomplete set of facts that concern its properties. Since the function is not completely determined, the PME asserts that one should look for a function that complies with the known data, while maximizing the entropy. As such PME leads to a variational problem in which the functional to minimnize is the entropy and the known facts are constraints. The PME was introduced by Jaynes [2] in order to relate information theory to statistical mechanics. Burg, [1], made a seminal and well succeeded application of PME to high resolution spectral analysis, that led to the well known Burg method. Since then, PME was used in a variety of problems in signal processing and machine learning [3]. The application of PME to continuous time control and robotics was suggested by Saridis [4,5], with discrete time control applications described in [6]. The presentation will review the PME with emphasis on its relation with Variational Calculus and will show how the conclusions drawn from it have an impact on the design of adaptive predictive controllers that are able to tackle highly uncertain processes such as energy production plants, as described in [7].

[1] J. P. Burg (1975). Maximum Entropy Spectral Analysis. Ph. D. Thesis, Stanford University, 1975.
[2] E. T. Jaynes (1957). Infomation theory an statistical Mechanics. *Physical Review*, 106(4): 620-630.
[4] G. N. Saridis (1988). Entropy formulation for optimal and adaptive control. IEEE Trans. Autom. Control, AC-33(8): 713-721.
[5] G. N. Saridis (1995). *Stochastic Processes, Estimation, and Control – The entropy approach.* John Wiley and Sons, Inc.
[6] Y. Tsai, F. Casiello and K. Loparo (1992). Discrete time entropy formulation of optimal and adaptive control problems. *IEEE Trans. Autom. Control*, 37:1083-1088.
[7] J. M. Lemos, R. Neves-Silva and J. M. Igreja (2014). *Adaptive Control of Solar Energy Collector Systems.* Springer.

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