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School of ECE
Georgia Institute of Technology

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A Bilinear Optimal Control Problem with Application in Bee Colony Population Dynamics

Abstract We show that for a class of bilinear systems the optimal control for a reward that is linear in the states can be solved by a simple change of variables. Sufficient conditions are given for the optimal control to be of bang-bang type. This is applied to the modeling of the population dynamics of eusocial bees, originally discussed by Macewicz and Oster. Next we give an extension to the maximum principle for optimal control with delayed action and revisit the allocation problem. With μ the natural depletion or decay rate of the resource, ν the natural death rate of bees, T the length of the season and τ the bee maturation delay, we show that the solution remains of bang-bang type with a single switch at an analytically expressible time generalizing the delay-free solution by Macevicz and Oster, and matching the field data obtained by ecologists.

$$t_s = T - \frac{\mu}{\mu - \nu}\,\tau - \frac{1}{\nu - \mu}\ln\left[e^{\nu\tau} - (\mu - \nu)\right].$$

Biography Erik I. Verriest is a Professor of Electrical and Computer Engineering at the Georgia Institute of Technology and director of the Mathematical System Theory Laboratory (MASTLab). He received the Burgerlijk Electrotechnisch Ingenieur degree from the State University of Ghent, Belgium, and the MSc and PhD degrees from Stanford University. He spent three years at the satellite campus, Georgia Tech Lorraine in Metz, France, and had visiting positions at the KU Leuven, Leuven, Belgium, the Université catholique de Louvain, Louvain-la-Neuve, Belgium, the Julius Maximilian Universität in Würzburg, Germany, the University of Ballarat, Victoria, Australia, the University of South Florida, Tampa, Florida, and Stanford University. He served on several IPCs and is a member of the IFAC Committee on Linear Systems. He is a Fellow of the IEEE and an elected member of the Royal Flemish Academy of Belgium for Science and the Arts.