Sufficient Conditions for Strong Local Optimality with Applications to Biomedical Problems

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Abstract

We consider optimal control problems over a fixed interval for multi-input bilinear dynamical systems with both L_1 and L_2-type objectives in the presence of control constraints. Problems of this type arise as mathematical models for cancer chemotherapy over an a priori specified fixed therapy horizon. The extremals resulting from an application of the Pontryagin maximum principle are analyzed. Conditions are given that allow to embed extremals into a field of broken extremals leading to easily verifiable sufficient conditions for strong local optimality. In the case of an L_1-type objective, flows of extremal bang-bang trajectories arise for which a simple algorithmic procedure to verify local optimality will be formulated. In the case of an L_2-type objective, sufficient conditions for strong local optimality that are based on the existence of a bounded solution to a matrix Riccati differential equation will be formulated. The theory is illustrated with a 3-compartment model for multi-drug cancer chemotherapy with cytotoxic and cytostatic agents.

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