APPLICATIONS OF GEOMETRIC OPTIMAL CONTROL TO PROBLEMS IN BIOMEDICINE AND ENGINEERING

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Abstract: This talk deals with a branch of applied mathematics that, although rooted in the classical calculus of variations, emerged in its modern form only in the late fifties and sixties answering the needs of space exploration: optimal control theory. In a typical optimal control problem the motion of an object that is described by a system of differential equations that depend on an external input, the control, is optimized relative to some chosen objective. The solutions to an optimal control problem consist of a family of optimal controls and corresponding trajectories known as a regular synthesis.

In this talk we shall show how geometric methods can be utilized to construct a regular synthesis of optimal controls and trajectories. The procedure will be employed to solve some practical problems analytically. We illustrate it with two examples, one a mathematical model for cancer treatment, the other an engineering problem from electronics. In cancer therapy we consider a mathematical model for treatment when traditional methods like radio- or chemotherapy are combined with anti-angiogenic therapy, a novel cancer treatment approach. Similar constructive methods are being used to give an optimal solution for the problem of determining the base doping profile that minimizes the base transit time in homojunction bipolar transistors, an optimal control problem with state space constraints. Some open problems and challenges will be discussed.