Pseudospectral Methods in Optimal Control

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In an optimal control problem, the performance of a dynamical system is optimized with respect to parameters that enter into the dynamics. Examples range from a satellite or a rocket or an air plane where the controls might be fuel burn rate or the orientation of control surfaces, to the human body or a biological population where the controls could be dosage rates of medications. In these problems, the state of the system is described by a differential equation, and the goal is find controls that optimize the system performance subject to constraints on either the state or the controls. Problems of this nature are usually too complex to solve analytically. Computationally, we need to replace the continuous infinite dimensional problem by a finite dimensional discrete problem. The talk will survey classical discretization techniques based on a Runge-Kutta approximation to the differential equations (an h-method) and then introduce recent approximations based on collocation at the roots of orthogonal polynomials (a p-method). The best approximations are often achieved using an hp-framework that combines the best features of both approaches.