

## 4d Global Optimization of Dynamic Systems

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Many problems can be formulated as optimal control or pure optimization problems in chemical processes. In both cases, global optimization techniques are very demanding, which are the main focus of my research. Specially, we study the following problems: unconstrained and constrained nonlinear optimal control, global optimization of periodically operated reactors, global solution of two points boundary value problems resulting from optimal control. We also bring up the case studies on the application of these optimization techniques to chemical processes and supply chains.

The unconstrained infinite time nonlinear quadratic optimal control problem is first studied intensively. A Taylor series based approximation approach is proposed to solve the associated Hamilton-Jacobi-Bellman equation. This approach involves solution of the Riccati equation of the linearized problem, followed by sequential solution of a series of linear algebraic equations. It is then applied to the corresponding constrained problem to establish regions in which the constrained and the unconstrained optimal control problems have identical solutions. By identifying this region, the constrained infinite time optimal control problem can then be solved by solving a constrained finite time optimal control problem and an unconstrained infinite time optimal control problem.

The nonlinear optimal control problem over a finite time interval is usually translated into a two points boundary value problem (TPBVP). One of my research interests lies in identifying all of the solutions of a TPBV problem. In the approximate numerical approach, we use high-order Runge-Kutta method to get the approximate numerical solution of the ODE for given initial condition. The initial states of interested TPBV problem are chosen belonging to some intervals, then, the intervals of final states are calculated by using some interval analysis techniques, which in turn is easy to judge if the required final states are in these calculated intervals. The branch-and-bound algorithm is then applied to revise the initial intervals until the intervals shrink and converge to the solution.

We apply the proposed approaches and other related techniques to deal with optimization of some chemical processes, for instance, the non-isothermal CSTR control, the global optimization of periodically operated reactors, and the optimization of drying processes. Comprehensive simulations and experiments show significant benefits of these techniques.

Supply chain optimization is another ongoing research topic. Typical problem formulation results in a mixed integer linear program (MILP) or a mixed integer nonlinear program (MINLP). These algorithms demonstrate some limits to large-scale optimization problems. We apply ideas of linear and nonlinear programming and optimal control to solve these supply chain optimization problems, with which the supply chain optimization problem can be formulated as a linear or mixed integer linear programming to facilitate online implementation