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THE LQRE COMPUTATIONAL METHOD IN OPTIMAL CONTROL THEORY

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A number of iterative algorithms for solving unconstrained continuous-time optimal control problems is developed. The method, named LQRE is modelled locally on the linear quadratic problem and treats a whole family of algorithms in a unified manner. The proposed approach is similar to the philosophy underlying Newton's, the conjugate gradient and the quasi-Newton methods in the function minimization theory, where the function being minimized is approximated locally by a quadratic function.

In addition to the development of a unified theory of algorithms, the thesis contains several first-order implementable algorithms, the convergence speed of which is comparable to that of second-order methods.

A proof of the reduction of the cost at each iterative step of the LQRE algorithms, a convergence analysis in the L_∞^m space and a proof of the convergence in the space of relaxed controls are included.

The power of the adopted approach lies in the use of the Riccati matrix differential equation which in the context of the LQRE method always has a bounded solution. Within the general framework of the analysis it is possible to obtain both first-order and second-order algorithms. The emphasis is however placed on the first-order LQRE

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algorithms which are simpler and computationally less demanding per iterative step; their computational effectiveness is compared with the performance of known methods.

There is a noticeable degree of similarity in the form of the differential equations used by the LQRE algorithms and the differential equations in the well-known second order methods; in fact, it is possible to derive LQRE variants of the second variation and differential dynamic programming methods.

The LQRE algorithms converge in one step on the linear quadratic problem and are well suited for solving non-linear problems with linear constraints via the penalty function methods. Their application in the computation of the singular optimal control, by adding and subtracting a quadratic term to the cost is suggested.

The method has been extended to handle problems with terminal equality constraints, control constraints (LQRE-projection technique) and a class of state and control equality constraints (sequential LQRE-restoration algorithm). The LQRE method for discrete-time unconstrained systems has also been developed.

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