名古屋大学自動制御研究施設

工・目録
工・情報

PROCEEDINGS
OF THE
FIFTH ANNUAL
PRINCETON CONFERENCE
ON
INFORMATION SCIENCES AND SYSTEMS

Papers Presented

March 25-26, 1971

Conference Chairman: M. E. Van Valkenburg

Program Directors: Kenneth Steiglitz
Peter J. Denning

名古屋大学図書
洋

Department of Electrical Engineering
Princeton University
Princeton, New Jersey 08540

名古屋大学図書
41421077

TEST FUNCTIONS FOR MULTI-MODAL SEARCH TECHNIQUES

Jacob Shekel

Department of Electrical Engineering
University of Maryland - College Park, Maryland 20742

Most problems in computer-aided design or optimization are solved by searching for an extremum (minimum or maximum) of a criterion function defined in multi-dimensional parameter space. The existence of an extremum is assumed, but not proven a-priori, and the search strategy is designed so as to find such an extremum if it exists. Moreover, there is no a-priori assurance that such an extremum is unique, so search strategies have to be constructed so as not to be satisfied by the first extremum detected, but to keep looking for other extrema, and hopefully detect the global one.

In the course of developing such a strategy, there always comes the point where it is to be tested or demonstrated. The usual practice is to test the strategy on an engineering problem, such as a chemical plant or an electrical network - - in fact, the problem that did motivate the development of the strategy in the first place. This type of test is quite satisfactory for methods that locate a local extremum, because the nature of the detected point can be verified independently (e.g., by computing the gradient and the Hessian); but if the strategy is designed to search for solutions on a multi-modal criterion function, there always remain some unanswered questions. If the search detected only a single extremum, did the strategy fail, or does the problem inherently have only one solution? And if more than one extremum were found how can we ever be sure that all the local extrema of the function have been detected?

Some workers in the field have designed special test functions for search strategies. Rosenbrock[1] has devised a function of 2 variables, with a minimum at the end of a narrow curved valley, to demonstrate the efficiency of his method. Hill[2] has proposed a set of multi-modal functions of a single variable to test methods of random search for a global minimum.

In this paper methods are shown to synthesize scalar functions with predetermined minima in multidimensional space. Two types of functions are described. In type 1 functions, only the number of the minima and their locations can be specified arbitrarily. In functions of type 2, the value of the function at each minimum, and the "shape" of the function in the vicinity of the minimum can also be specified, as well as the assymptotic behavior of the functions in regions remote from any local minimum. The functions can easily be programmed as separate procedures, and can be used to test, demonstrate and compare search strategies.

References

1. H. Rosenbrock, "An automatic method for finding the greatest or least value of a function", Computer J., vol. 3, pp. 175-184, October 1960.

2. J. C. Hill, "A hill-climbing technique using piecewise cubic approximation", Ph.D. Thesis, Purdue University, 1964.