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NONLINEAR PROGRAMMING: ALGORITHMS, PROGRAMME, NUMERICAL RESULTS *

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Practice has shown that the linear models are incapable of sufficiently reflecting the complexity of real phenomena. The tackling of the phenomena with the aid of nonlinear models has proved more fruitful from the qualitative point of view but, owing to difficulties which may occur, much more difficult to solve both from the theoretical and numerical points of view, even when powerful electronic computers are used. V. Dumitru's work is part of the themes of the present studies for solving the problems of nonlinear mathematical programming, stress being laid on the numerical solving of problems with the aid of the electronic computer. The studies on the efficiency of various algorithms in solving the problems of mathematical programming are rather recent on a world plane and in our country V. Dumitru obviously does a pioneering work. The great difficulties which are occuring are, on the one hand, linked with the broad mathematical horizon of these problems and on the other hand, to the necessity of mastering the mathematical knowledge with that of informatics, with the experience in the field of computer programming. Such a study requires passion and patience in a work whose outcomes are obtained with scrupulousness and in a longer period of time, due to a continuous conversation between the mathematician and the computer.

The work contains four chapters, each of them well structured in a certain direction to which is added an appendix rich and unique in our country, comprising 18 FORTRAN subroutines for various algorithms of nonlinear programming.

The first chapter briefly defines the nonlinear programming problem and mentions the most important theoretical results characterizing the solutions to such a problem. Rosen's algorithm is presented as an example of algorithm for solving problems of nonlinear programming with a special structure. Among his own results the author presents a technique of parametric programming applied in solving a problem of "linear programming", in which the vector resources and (or)the elements of a column vector of the matrix of coefficients are polynominals of the 2nd degree. The chapter concludes with considerations on the simultaneaous study of the extrems of two quasireciprocal quadratic forms and with some consequences on the determination of certain boundary intervals of the extremum values.

The study of the methods of optimizing the functions of n variables without the evaluation of the derivatives, an important problem

*) With an appendix of computer programme in collaboration with Florica Luban, Sigrid Moga and Radu Şerban.

in practical applications because the analytical expression of the function is either very often unknown or the calculus of the derivatives requires a big volume of time for man or(and) machine, forms the object of the second chapter. At the end of the chapter, numerical results are given for the efficiency all algorithms considered.

The next chapter tackles the same problems but in connection with the gradient algorithms.

We also mention a method of using the Davidon-Fletcher-Powell algorithm for problems of maximum, when the unidimensional optimizing subroutine provides the direction maximum as well as the study of the Fletcher-Reeves algorithm when the uni-dimensional optimization is made with approximation. Numerical results are also presented.

The last chapter presents the SUMT method of sequential optimization as a natural method of using the algorithms presented in chapters two and three in solving the problems of constrained nonlinear programming. The complex method of J.M. Box is also presented here. Efficiency results are also given by comparing either the efficiency of the various unconstrained optimizing algorithms in the SUMT technique or the efficiency of the SUMT technique to that of other algorithms, such as for example Rosen or Complex. The chapter ends with a brief description of several applications in which the author has effectively used the methods and programs presented in the book, such as for example: the solving of a problem of applied geophysics, the designing of an irrigation antenna, the establishment of the efficient character of an investment, a problem of constrained regression, the solving of nonlinear problems of gasoline blending.

The appendix written in collaboration with Florica Luban, Sigrid Moga and Radu Şerban presents in FORTRAN IV, as subroutines and/or programs a series of algorithms.

The programs and the subroutines contain in comments in English the necessary instructions and information for their running on the computer, together with examples. We also note the fact that the unconstrained optimizing programs and subroutines have been adapted so that the constrained problem can be solved through the SUMT technique.

The field of nonlinear mathematical programming is difficult and vast. From this vast domain, the author presents only those questions in which he has, in one way or another, his own experience and this confers one more quality on the book.

The study of the efficiency of various algorithms, unitarily presented, some of his own theoretical results as well as the presentation and programming of a large number of algorithms, make of V. Dumitru's book a remarkable work both from the theoretical and practical points of view, the more so as it uses a clear exposition and an elaborate editing.

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