the pleasure one might have had in reading this book.

H. N.

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26[60-02, 49D37, 60G15, 60G17, 60G35, 60G60, 62C10].—JONAS MOCKUS, *Bayesian Approach to Global Optimization—Theory and Applications*, Mathematics and Its Applications (Soviet Series), Kluwer Academic Publishers, Dordrecht, 1989, xiv + 254 pp., 24 $\frac{1}{2}$ cm. Price \$59.00 /Dfl 190.00.

In the Bayesian approach to global optimization an objective function f is a priori modelled as a realization of a stochastic process (also called random function), which can be viewed as a probability distribution on a class of functions. The objective function is evaluated in certain points, and the posterior stochastic process is computed, conditional on the observed function values. The posterior information is used to determine the location of the next point where f will be evaluated.

The stochastic processes are taken to be Gaussian. A Gaussian process is characterized by a mean and covariance function. The covariance function specifies how the correlation of the function values $f(x)$ and $f(y)$ depends on the originals x and y. Gaussian stochastic processes have the very attractive property that the posterior process, conditional on a number of observed function values, is Gaussian as well. However, the determination of the posterior mean and covariance function involves the time-consuming operation of the inversion of a matrix, whose size is equal to the number of observations.

On page 12 the author argues that the Bayesian approach and a stochastic model of f were first applied to global optimization in his reference of 1963. However, H. J. Kushner already in 1962 published a paper on this subject [1].

The author first defines an optimal n-step optimization strategy which minimizes the expected deviation from the global optimum. The strategy can be computed by solving n Bellman equations. However, it is well known that serious problems arise from a practical point of view, even for moderate values of n. Therefore, a one-step approximation is introduced, where the next observation is considered as the last one. Even this approximation, however, is hard to implement, since at each step the matrix referred to above has to be inverted, and since the next observation point is the optimum value of a function, say ϕ, which also will have different local optima. Several simplifications are carried out to achieve a method which is able to process a reasonable number of function evaluations. Unfortunately, these simplifications all ruin the consistency of the model. It also has to be remarked that no exact result is known about the distribution of the global maximum of a Gaussian random function. This means that, unless the number of function evaluations is fixed in advance, the question of how to evaluate the error of an approximation to the global optimum cannot be answered satisfactorily.

An outline of the book is as follows. Chapter 1 contains a discussion of the main advantages of the Bayesian approach. Chapter 2 presents a general definition of Bayesian methods of global optimization. Chapter 3 contains an axiomatic justification of the Bayesian approach. In Chapter 4 the Gaussian class of prior random functions is derived from the conditions of homogeneity, independence of partial differences, and continuity of sample functions. Chapter 5 provides the expressions for the one-step approximation of the dynamic programming equations. This chapter also discusses the replacement of the Kolmogorov consistency conditions by the weaker condition of the risk function continuity. Chapter 6 discusses methods to reduce the dimensionality of global optimization problems. In Chapter 7 the Bayesian approach is applied to find local optima of objective functions with noise. In Chapter 8 a number of real-life applications is described. Chapter 9 provides a description of the portable FORTRAN package which is contained in the book.

Although the Bayesian approach to global optimization, in my opinion, did not yet yield efficient algorithms which are fully theoretically justified, this new book shows that the approach is very appealing, and that the approximations work well. Also, the book contains all the relevant theorems, proofs, and computer programs. Hence, although the book is not very clearly written, and contains very many typos (7 in the preface), it can serve well for investigators who want to pursue the approach. In addition, the programs of the methods, which are based on approximations, can be used by practitioners to solve real-life problems.

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In 1964 the National Bureau of Standards (now the National Institute of Standards and Technology) issued a massive handbook of formulas, graphs and numerical tables of the elementary mathematical functions and the so-called