Computer Program Descriptions

A Program Using the Successive Extrapolated Relaxation (SER) Method to Solve Laplace's Equation

PURPOSE: This program determines fields satisfying Laplace's equation with Dirichlet and/or Neumann boundary conditions. Subroutine SER may be applied to other iterative methods.

LANGUAGE: Fortran IV.

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AVAILABILITY: ASIS–NAPS Document No. NAPS-02035. Copies of a source deck package may be purchased through the authors at $15.00 (U.S.), within three years of publication.

DESCRIPTION: This program calculates the two-dimensional field satisfying Laplace's equation within an arbitrary shape boundary subject to Dirichlet and/or Neumann boundary conditions. The program utilizes the successive extrapolated relaxation method [1] superimposed on the successive overrelaxation method using the five-point difference operator. The required inputs are: the boundary conditions, the desired accuracy of the solution, the maximum number of iterations, and the initial values for the problem. The output includes the printed numerical results and an equipotential map of the solution.

The subroutine BOUND reads and generates the boundary conditions. The subroutines RASTER, DIAGON, REDBLK, SPIRAL, and CONOPT contain algorithms for scanning the array; the user can choose one of them from the main part of the program. DINE determines the position of the Dirichlet and Neumann boundary conditions with respect to the interior of a given problem, and hence it simplifies the logic of the iteration process. INVA inserts initial values into the array. PRES prints the numerical results to seven significant figures, and MAP prints the contour map of equipotentials within given limits on the line printer.

A routine, available from the author, permits the output to be drawn by a Benson–Lehner plotter. This routine is not included in this package since it is not in standard Fortran, but will only run on a CDC 6000 series computer.

The subroutine SERMET produces the desired solution. It calls the subroutine SER which contains the algorithm for the SEOR method [1] and the algorithm for solving the partial differential equation. The subroutine SERMET computes the error of the solution using Carré's criterion [2] and it terminates computation either when a given accuracy is achieved or when a preset maximum number of iterations is exceeded. This subroutine optimizes the upper limit of extrapolation. Since optimization is used, if this subroutine is extracted from the program and applied to accelerate convergence of an iterative process, the coefficient matrix of the system equations must possess Young's Property A.

The program has been tested on a CDC 6400 computer. Storage requirements are approximately 30 K words for a problem with 20×20 lattice points and 53 K words for a problem with 50×50 lattice points. Running time depends on the presence of Neumann boundary conditions, scanning techniques, the size of a problem to be solved, as well as required accuracy. Typical values of running time are 4 s and 20 s for problems with 20×20 and 50×50 mesh points, respectively.

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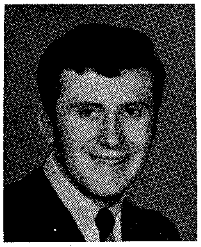
References

[1] E. Della Torre and W. Kinsner, "A successive extrapolated relaxation (SER) method for solving partial differential equations," Preliminary Rep. Included in the NAPS.
[2] B. A. Carré, "The determination of the optimum acceleration factor for successive over-relaxation," *Comput. J.*, vol. 4, pp. 73–78, 1961.

Contributors



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