DESIGN OPTIMIZATION BASED ON GENETIC PROGRAMMING

Approximation model building for design optimization using the response surface methodology and genetic programming

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ABSTRACT

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This thesis addresses two problems arising in many real-life design optimization applications: the high computational cost of function evaluations and the presence of numerical noise in the function values. The response surface methodology is used to construct approximations of the original model. A major difficulty in building highly accurate response surfaces is the selection of the structure of an approximation function.

A methodology has been developed for the approximation model building using genetic programming. It is implemented in a computer code introducing two new features: the use of design sensitivity information when available, and the allocation and evaluation of tuning parameters in separation from the evolutionary process. A combination of a genetic algorithm and a gradient-based algorithm is used for tuning of the approximation functions. The problem of the choice of a design of experiments in the response surface methodology has been reviewed and a space-filling plan adopted.

The developed methodology and software have been applied to design optimization problems with numerically simulated and experimental responses, demonstrating their considerable potential. The applications cover the approximation of a response function obtained by a finite element model for the detection of damage in steel frames, the creation of an empirical model for the prediction of the shear strength in concrete deep beams and a multicriteria optimization of the process of calcination of Roman cement.

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