EFFICIENT NEARLY ORTHOGONAL AND SPACE-FILLING EXPERIMENTAL DESIGNS FOR HIGH-DIMENSIONAL COMPLEX MODELS

Thomas M. Cioppa-Lieutenant Colonel, United States Army
B.S., United States Military Academy, 1985
M.S., Naval Postgraduate School, 1993
Doctor of Philosophy in Operations Research-September 2002
Supervisor: Thomas W. Lucas, Department of Operations Research
Committee Chair: Robert R. Read, Department of Operations Research
Committee Member: Gordon H. Bradley, Department of Operations Research
Committee Member: LTC Eugene P. Paulo, USA, Department of Operations Research
Committee Member: Craig W. Rasmussen, Department of Applied Mathematics
Committee Member: Susan M. Sanchez, Department of Operations Research

The Department of Defense uses complex high-dimensional simulation models as an important tool in its decision-making process. To improve our ability to efficiently explore larger subspaces of these models, this dissertation develops a set of experimental designs for searching over as many as 22 variables in as few as 129 runs. These new designs combine orthogonal Latin hypercubes and uniform designs to create designs having near orthogonality and excellent space-filling properties. Multiple measures are used to assess the quality of candidate designs and to identify the best one. For situations in which more than the minimum number of required runs are available, the designs can be permuted and appended to create additional design points that improve upon the design’s orthogonality and space-filling.

The designs are used to explore two surfaces. For a known 11 dimensional stochastic response function containing nonlinear and interaction terms, it is shown that the near orthogonal Latin hypercube is substantially better than the orthogonal Latin hypercube in estimating model coefficients. The other exploration uses the agent-based simulation MANA to analyze 22 variables in a complex military peace enforcement operation. The need for maintaining the initiative and speed of execution during these peace enforcement operations is identified.

KEYWORDS: Experimental Design, Latin Hypercube, Uniform Design, Agent-Based Simulation, Military Peace Enforcement Operations

RANDOMIZED ENSEMBLE METHODS FOR CLASSIFICATION TREES

Izumi Kobayashi-Japan Defense Agency
B.S., Ochanomizu University, 1990
M.S., Ochanomizu University, 1992
M.S., Naval Postgraduate School, 1999
Doctor of Philosophy in Operations Research-September 2002
Supervisor: Samuel E. Buttrey, Department of Operations Research
Committee Chair: Lyn R. Whitaker, Department of Operations Research
Committee Member: Robert F. Dell, Department of Operations Research
Committee Member: Robert A. Koyak, Department of Operations Research
Committee Member: Craig W. Rasmussen, Department of Applied Mathematics

Two methods of constructing ensembles of classifiers are proposed. One method directly injects randomness into classification tree algorithms by choosing a split randomly at each node with probabilities proportional to the measure of goodness for a split. This method is combined with a stopping rule which uses permutation of the outputs. The other method perturbs the output and constructs a classifier using the perturbed data. In both methods, the final classifier is given by an unweighted vote of the individual classifiers. These methods are compared with bagging, Adaboost, and random forests on thirteen commonly used data sets. The results show that our methods perform better than bagging, and comparably to Adaboost and random forests on average.

Additional computation shows that our perturbation method could improve its performance by perturbing both the inputs and with the outputs, and combining a sufficiently large number of trees. Plots of strength and correlation show an interesting relationship. Combining sampling subsets of the training set with proposed methods is also explored. The results of a few trials show that the performance of our proposed methods could be improved by combining sampling subsets of the training set.

KEYWORDS: Classification, Ensemble Methods