Design of Experiments for Simulation Modeling: Factor Screening, Prediction, and Optimization

Simulation models often have many input factors and determining which ones have a significant impact on performance measures (responses) of interest can be a truly daunting task. The common approach of changing one factor at a time is very often **incorrect**, because for many models factors **interact** to impact on the responses. In this seminar, we give a comprehensive presentation of design of experiments (DOE) **specifically for simulation modeling**, whose major goal is to determine which factors have the greatest effect on the responses, and to do so with the least amount of simulating. Other important uses of DOE are to develop a response surface (or metamodel) based on the **important factors** to predict the model response for factor combinations that were not actually simulated due to time constraints or to find the factor-level combination that optimizes the simulation response.

We discuss a simple and widely applicable approach to performing DOE in the context of simulation modeling, whereas commonly used methods based on classical statistics (i.e., ANOVA) make unrealistic assumptions such as constant variances and normally distributed residuals. **Students will analyze experimental data in class using a leading DOE software package.** Versions of this seminar have been presented to Lockheed Martin, NSA, and Sasol Technology (South Africa).

What You Will Learn:

1. **Factorial Designs**
   - Determining which factors have the largest impact on the simulation responses *(factor screening* or *sensitivity analysis)*
   - Main effects and interaction effects and their correct interpretation
   - Why the ubiquitous one-factor-at-a-time approach is generally not recommended
   - Failure of classical statistical assumptions (constant variances and normally distributed residuals) and how to circumvent this in simulation modeling
2. **Fractional Factorial Designs**
   - Finding the important factors with less computational effort
   - Confounding of effects
   - Resolution III, IV, V, and higher-level designs
   - Minimum-run designs
3. **Metamodels and Response Surfaces**
   - Central composite designs for fitting second-order metamodels
   - *Predicting* model responses for factor combinations that were not simulated
   - Finding the factor-level combination that *optimizes* a simulation response
4. **Space-Filling Designs for Simulation Metamodels**
   - Dealing with complex, nonlinear model responses
   - Latin hypercube designs

5. **Commercial Software for DOE**
   - General-purpose statistical packages
   - DOE-specific software packages
6. **Numerous Examples to Illustrate the Mechanics and Applications of DOE**

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