Sensitivity Analysis

- Definition
  - Influence of uncertainty in input on the uncertainty of the output

- Applications
  - Robustness test in the presence of uncertainty
  - Increased understanding on the relations between input and output variables
  - Uncertainty reduction

Sensitivity Analysis (con.)

- Main methods
  - One-at-a-time (OAT)

Sensitivity Analysis (con.)

- Main methods
  - Scatter plots

Sensitivity Analysis (con.)

- Main methods
  - Design of experiments
    - Full factorial design
    - Fractional factorial design

Sensitivity Analysis (con.)

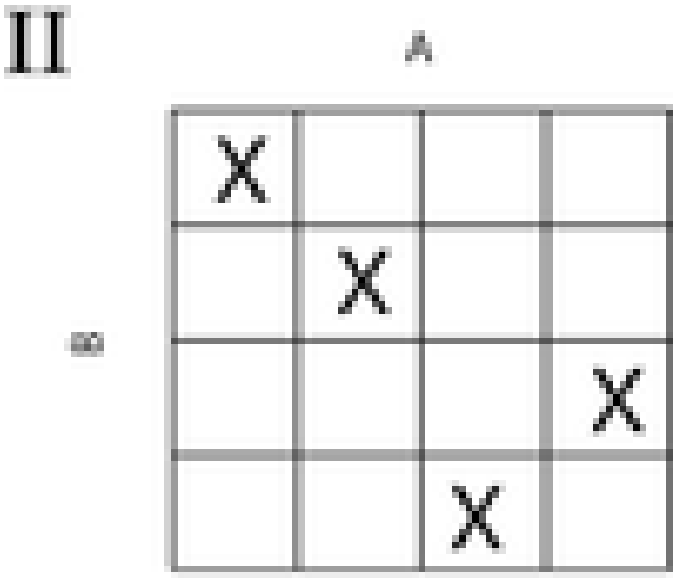
- Main methods
  - Design of Experiments (DOE)
    - Plackett-Burman design (1946)

Plackett–Burman design for 12 runs and 11 two-level factors[2] For any two X_i, each combination (--, -+, +-, ++) appears three - i.e. the same number of times.

Run	X_1	X_2	X_3	X_4	X_5	X_6	X_7	X_8	X_9	X_{10}	X_{11}
1	+	+	+	+	+	+	+	+	+	+	+
2	−	+	−	+	+	+	−	−	−	+	−
3	−	−	+	−	+	+	+	−	−	−	+
4	+	−	−	+	−	+	+	+	−	−	−
5	−	+	−	−	+	−	+	+	+	−	−
6	−	−	+	−	−	+	−	+	+	+	−
7	−	−	−	+	−	−	+	−	+	+	+
8	+	−	−	−	+	−	−	+	−	+	+
9	+	+	−	−	−	+	−	−	+	−	+
10	+	+	+	−	−	−	+	−	−	+	−
11	−	+	+	+	−	−	−	+	−	−	+
12	+	−	+	+	+	−	−	−	+	−	−

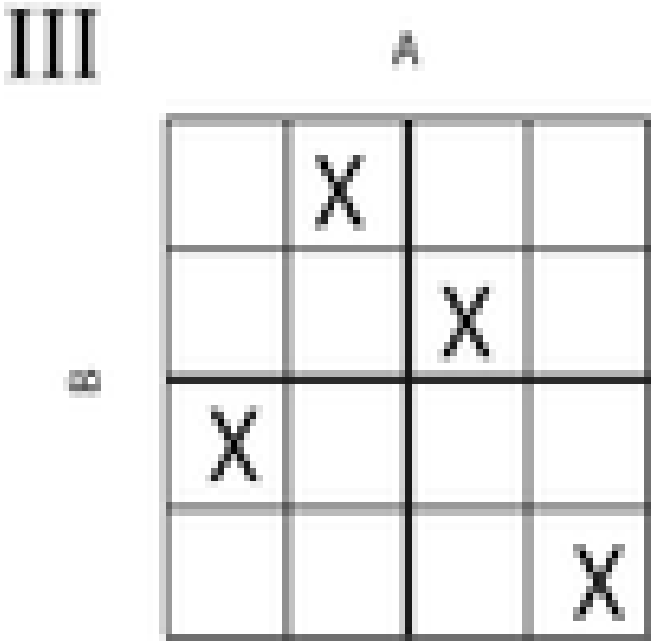
Sensitivity Analysis (con.)

- Main methods
  - Design of Experiments (DOE)
    - Latin Hypercube sampling (LHS)



Sensitivity Analysis (con.)

- Main methods
  - Design of Experiments (DOE)
    - Orthogonal sampling



General SA Methods

- Constraints in selecting SA methods
  - Computational expense
  - Correlated inputs
  - Nonlinearity
  - Interactions among factors
  - Complicated output

General SA Methods

- General SA methodology
  1) Quantify the uncertainty in each input factor, including ranges, probability distribution
  2) Identify the model output to be analyzed
  3) Run the model using the sampled cases
  4) Analyze the sensitivity measures

General SA Methods

- General SA results
  - The most and least influential factors
  - Uncertainty in output associated with the uncertainty in inputs
  - Possible interaction of varied factors

Reading Material for SA

- SA on HM:

  https://www.onepetro.org/download/conference-paper/SPE-6102-MS?id=conference-paper%2FSPE-6102-MS

- SA methods:

  http://web.engr.oregonstate.edu/~hambydm/papers/senscomparison.pdf

  http://dpannell.fnas.uwa.edu.au/dpap971f.htm

- DOE methods

  https://en.wikipedia.org/wiki/Design_of_experiments