Big Data Technology and Application Institute

SENSITIVITY ANALYSIS OF COMPUTER MODELS

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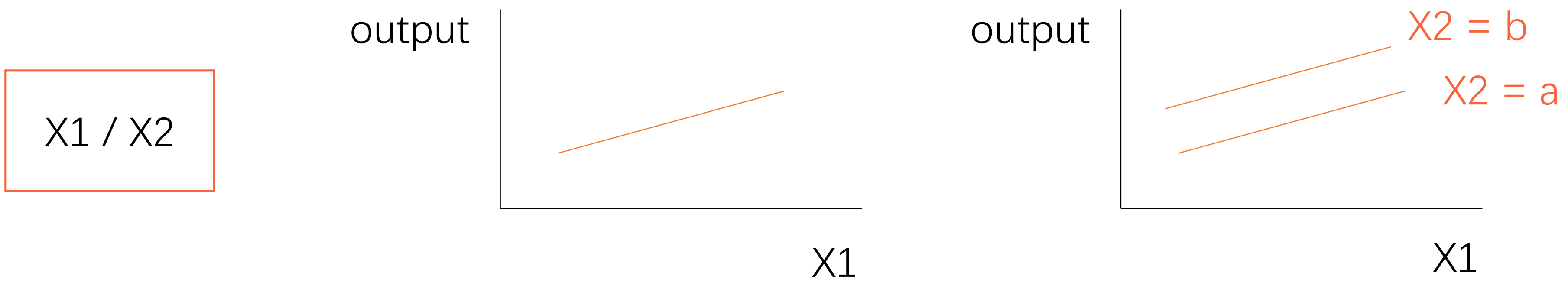
Outline

- Introduction
- Function
- Method

Introduction

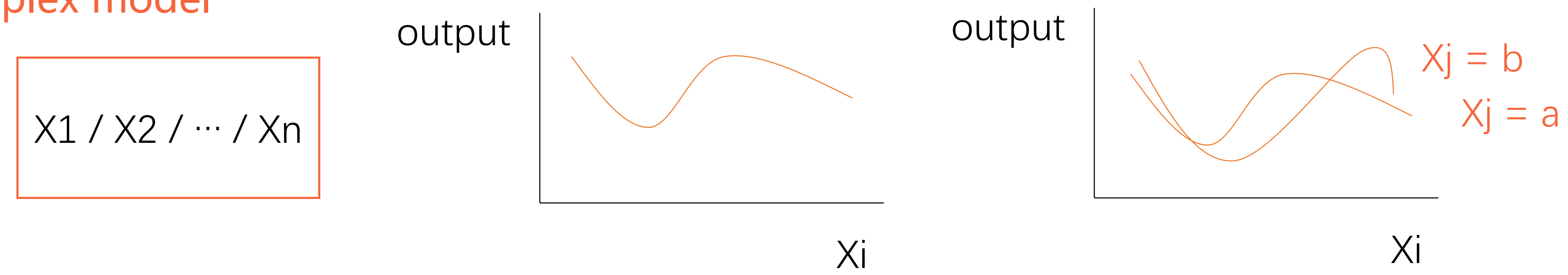
Sensitivity analysis is a research method to measure the influence of changes in input parameters, initial conditions and boundary conditions on model output

- simple model



It's easy to comclude Whether the model is sensitive to this parameter

- complex model



It's hard to draw a conclusion directly about the influence and importance of each parameters

Function

- simplifie model

  Get the relative importance of each parameter and find the redundant parameters

- Increasing the reliability of the model

  Analysis different parameter combinations to obtain the influence of parameters interaction

Method

Sensitivity analysis is divided into local sensitivity analysis and global sensitivity analysis

- local sensitivity analysis

  Only one parameter at a time is analyzed and ignore the interaction between parameters

  Such as： One-variable-at-a-time approach （OAT）

- global sensitivity analysis

  Consider the effect on the results when the combination of parameters changes, and analyze the interaction between the parameters.

  Such as： Regression analysis (RA) / Morris screening

OAT

- One-variable-at-a-time approach

The basic principle is to calculate the change rate of the output caused by small changes (eg increase or decrease by 10%) of each parameter near its best estimate.

The absolute value of the change rate represents the sensitivity of the parameter.

The sensitivity ranking of each parameters can be obtained easily

MS

Morris screening

Select one of the variables in the model and add a tiny disturbance within the range, while other variables remain unchanged, evaluate the output response caused by small changes in the variable

$$d_i(j) = (y^* - y)/\Delta_i$$

i： The ith parameter （i=1…n）

j： The jth factor combinations （j=1…t）

y： Output value before parameter i changed

y*： Output value after parameter i changed

Δ_i： the amplitude of parameter i

$$\mu_i^* = \frac{1}{t}\sum_{j=1}^{t} | d_i(j) |$$

The mean value is used to indicate the sensitivity and the sequence of the parameter.
The larger the value , the stronger the sensitivity of the parameters.

$$\sigma_i = \sqrt{\frac{1}{t-1}\sum_{j=1}^{t} [d_i(j) - \mu_i]^2}$$

The standard deviation is used to indicate the strength of the interaction between the parameters.
The higher the value , the stronger the interaction of the parameters.

RA

Regression analysis

$$Y_i = \beta_0 + \sum_{h=1}^{k} \beta_h x_{i,h} + E_i \qquad (i = 1, \ldots, n)$$

n : number of simulated factor combinations.

E_i : fitting error of the regression model for factor combination i

Y_i : simulation response of factor combination i

β_0 : regression intercept

β_h : effect of factor h

$x_{i,h}$: value of the standardized factor h in combination i

$$x_{ih} = (z_{ih} - b_h)/a_h$$

z_{ih} = value of non-standardized factor h

Set the range of lowest value l_h , and upper value u_h of z_{ih}

$$a_h = (u_h - l_h)/2$$

$$b_h = (u_h + l_h)/2$$

The relative importance of a factor is obtained by sorting the absolute values of the effects β_h

THANKS FOR

YOUR ATTENTION