A Sensitivity Analysis Method about Power Grid Planning Indexes

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Abstract. Sensitivity analysis is a measure of the uncertainty of an analytical model inputs how to affect the outcome, many of the traditional technique uses probabilistic analysis model, this paper contains a subjective variable uncertainty and occasional uncertainty probabilistic sensitivity analysis with probably-box. Usually the traditional sensitivity analysis uncertain data directly, but used directly in some sensitivity analysis on uncertain data will ignore their data or the occasional uncertainty subjective uncertainty, making sensitivity analysis meaningless. In this paper, based on probability-box analysis and method of punching analysis sensitivity analysis of uncertain data. Finally, the algorithm is applied to verify its superiority grid regulation.

Introduction

This paper uses probability box (P-box) theory to fully consider the uncertain factors of uncertainty, combined with the analysis of influence on each index reduction scheme, the establishment of the power grid planning probabilistic sensitivity analysis index and sensitivity index calculation method of each index of characteristic analysis and calculation of the impact on the project.

Using traditional [1] the probability density distribution, analyze methods of calculation, the minimum cut sets, according to the characters of indicators into the known distribution, then calculate the sensitivity of various indicators. Although some indicators can be obtained through the transformation of the known probability distribution, but there are still some index after transformation, inevitably lose some characteristic indexes. Paper [2] used the P-box carry out the fault feature extraction.

The analysis method of [3][4] DST and P-box itself is a kind of sensitivity, can conduct a comprehensive analysis on various assumptions, effectively solve the problem of high comprehensive hypothesis. When the overall uncertainty variable is very small, some based on the use of derivatives as the traditional method of sensitivity analysis of local estimation, can be directly applied to DST and P-box in [5].

Probability-box Theory

One could construct a probabilistic uncertainty analysis of a probabilistic calculation. The resulting analysis would be a second-order probabilistic assessment. However, such studies can be difficult to conduct because of the large number of calculations that are required. It is also sometimes difficult to visualize the results in a way that is easily comprehensible. Alternatively, one could apply bounding arguments to the probabilistic calculation and arrive at interval versions of probability distributions. We call such calculations “probability bounds analysis” (PBA). This way said uncertainty probability distribution of cumulative distribution function fully in a border

between distribution function, is the box of "probability (P-box)".

In reality a lot of experimental data are not regular, but for the sake of convenient use, need statistics has the certain range. DST is an effective method of irregular data boundaries, the combination of P-box and DST has more advantages, especially in terms of uncertain data analysis. DST and P-box itself is established according to the features of uncertain data and an analysis model, has made important achievements in many projects. In simple terms, the probability of box is under the condition of unknown data distribution artificially, and obtained, for find out in the upper and lower range of the data.

Sensitivity Analysis Method Based on Probability-box

Several of the standard methods of sensitivity analysis employed for deterministic problems can also be used in the context of a probabilistic uncertainty assessment. Although some of these methods do not have apparent analogs in DST or PBA (e.g., correlation analysis), many can be immediately generalized to work with Dempster-Shafer structures and P-boxes. For instance, one of the most basic ways to evaluate sensitivity of an input variable is by computing the derivative of the output function with respect to it. For example, from the expression as Eq. 1:

$$x = (abc + de) / f \tag{1}$$

Sensitivity analysis is the x of value after partial derivatives. Assumptions used in conventional solution method such as:

Assuming that these parameters as the value of a variable

a=1, b=2, c=3, d=4, e=5, f=6

The values of partial derivative of the formula

$\partial X/\partial a = (b*c)/f$

Get the sensitivity change of X is

$(4\times5)/2 = 10$

The partial derivative of all variables, into the corresponding variable value, the sensitivity of the calculated value as shown in that:

a=1, b=1/2, c=1/3, d=5/6, e=2/3, f=-936

The range of P-box as input variables, then the formula derivation, the six variables of the input according to the change of its derivatives are uncertain semi analytical x output sensitivity calculation, without the use of Monte Carlo sampling, the results obtained are accurate range.

So as to obtain the biggest influence on x variables. The following consideration by punching method to reduce cognitive uncertainty for studying the sensitivity. So-called punch, is through the influence of control variables to test the results. Punch a parameter is to point to by reducing the uncertainty of the parameters, observation data will be changed. Measure of reduction effect is calculated uncertain input degree of contribution to the overall, contribution of estimate depends on the uncertain input the number of how many uncertainty exists, and how does it affect the uncertainty of the final result. Sensitivity can use formula as Eq. 2:

$$100\,(1 - unc\,(R) / unc\,(T))\% \tag{2}$$

In which T is the baseline values, R is the input value after the punch, UNC( ) is uncertainty measurement method, the result is that the input parameters be punch after uncertainty to reduce the percentage of the results. There are many ways to define UNC( ) is used to measure the uncertainty, such as the traditional analysis of variance, and P-box.

A punching method of case study, to explore this kind of influence on some simple synthesis,

Combined with sensitivity analysis method of P-box steps are as follows:

1. The analysis of the model input variables, find out the relationship between them.
2. The probability of input variables are box modeling;
3. Calculate the baseline value T;
4. Use the method of punching compute R, and the sensitivity coefficient.

DST and P-box can not only to punch of variables, it is concluded that a variable impact on the overall sensitivity, can also be punch on the dependencies between variables.

Examples

To province 500kv transmission network planning as an example, based on the theory of probability boxes punch sensitivity analysis method of uncertainty.

Probability box modeling needs a large amount of data, confined to the length, in this paper, some value of each index, are shown in Table 1 below.

Table 1. The value of indexes

C_1/%	C_2/(MW·h)	C_3/(MW)	C_4/Hectare	C_5/Million
0.361	15 538	41 335	8 801	9 703
0.296	16 287	44 436	7 345	9 844
…	…	…	…	…
0.175	20 385	58 443	6 980	9 990

Table 2. Punch the analysis results

Input variables	Range of influence (%)	
	The method of influence scope (%)	The scope of the traditional stochastic method (%)
C_1	12.1	17.7
C_2	15.5	13.36
C_3	10.36	12.31
C_4	16.13	25.8
C_5	45.01	30.83

Under the condition does not carry on any measure to punch out the baseline value, and then in turn to each index and index the dependencies between punch, after will punch value compared with the baseline case, the result as shown in table 2. The third column in table adopts the traditional Monte Carlo stochastic simulation method for sensitivity analysis results. As you can see, C_5 had the greatest influence on the result.

Conclusion

This article mainly uses the indicators of uncertainty probability box to solve the problem, will target fusion, decrease the number of indicators for more accurate analysis of sensitivity is the next target of this paper.

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