

Confidence Bounds for Probability Density Evolution Method

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Context

The so-called Probability Density Evolution Method (PDEM) has positioned itself as one of the most popular tools for uncertainty quantification in the broad areas of mechanical and civil engineering. One of the reasons that explains the popularity of PDEM is its non-intrusive nature, which facilitates its implementation with existing software for deterministic analysis. In addition, PDEM provides not only point estimates but also complete reliability information (that is, cumulative density function) on the performance of an engineering system.

While PDEM possesses attractive features, it may not provide confidence bounds that quantify the accuracy of the estimates that it produces. Addressing such issue is of utmost importance, for example, to design numerical strategies that allow improving the accuracy of PDEM on the fly.

Objectives

The purpose of this project is to develop a numerical strategy to quantify confidence bounds of the estimates produced by the Probability Density Evolution Method which can be applied to practical problems of mechanical engineering. To achieve this broad goal, the following specific objectives must be fulfilled:

- Implement the probability density evolution method in a non-intrusive fashion [1].
- Examine existing alternatives for quantifying confidence bounds in a black-box fashion [2].
- Apply the previous developments to a case study pertinent to mechanical engineering.

Required Skills

To develop this project, the following skills are considered a plus.

- Strong mathematical background.
- Knowledge of software for numerical analysis (e.g. Matlab) and simulation (e.g. Abaqus).
- Reading and writing skills in English.

Application

In case that you are interested in this project, please follow these steps.

1. Read the associated bibliography (see below).
2. Prepare a short motivation letter addressing the following issues:
 - a. Your interest in developing this project.
 - b. The reasons that make you a good candidate for developing this project.
 - c. Intended dates for working in the project.
3. Send the motivation letter to the supervisors via E-mail and ask for an exploratory meeting.

Bibliography

1. J. Li, "Probability density evolution method: Background, significance and recent developments," *Probabilistic Engineering Mechanics*, vol. 44, pp. 111–117, 2016.
2. M. B. Salem, O. Roustant, F. Gamboa, and L. Tomaso, "Universal Prediction Distribution for Surrogate Models," *SIAM/ASA Journal on Uncertainty Quantification*, vol. 5, Art. no. 1, 2017.