MascotNum2021 conference - Propagation of epistemic uncertainties in seismic risk assessment

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Abstract:

In seismic probabilistic risk assessment (SPRA), one wants to quantify the failure of a structural system when subjected to seismic ground motions. Nowadays, regulation authorities prescribes industrials to penalize their modelizations by injecting uncertainties on the model parameters itself. These uncertainties are called epistemic: they can be reduced with a cost corresponding to a certain effort (gathering more data, eliciting expert's knowledge...). This effort could be interpreted as a gain in knowledge of the mechanical model studied. The Uncertainty Quantification (UQ) framework [2] is well adapted to perform SPRA with epistemic uncertainties. The specificity of SPRA comes in two ways: First of all, the quantity of interest is a conditional probability of failure, and estimating such quantities requires lots of calls of the computer model, this issue is tackled using a parametric assumption for the fragility curve and the statistical learning framework [3]. Planification of experiments such as active learning [5] has also to be made to reduce computer simulation calls while keeping confidence in our estimation. Second, the computational burden just mentioned restrained the full characterization of the sources of uncertainties: since the early work of [4], engineers did not take into account the uncertainties coming from the mechanical model. New sources of uncertainties will be put into the SPRA framework and one introduces a new Sensitivity Analysis (SA) paradigm coined conditional reliability-oriented sensitivity analysis (CROSA), which can be viewed as an extension of the reliability-oriented sensitivity analysis (ROSA) paradigm introduced in [1]. Moreover, the fragility curve is tainted by sampling uncertainty, due to its estimation using a finite dataset. This supplementary uncertainty has to be taken into account.

References

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[4] R.P. Kennedy, C.A. Cornell, R.D. Campbell, S. Kaplan, and H.F. Perla. Probabilistic seismic safety study of an existing nuclear power plant. *Nuclear Engineering and Design*, 59(2):315 – 338, 1980.

[5] Rémi Sainct, Cyril Feau, Jean-Marc Martinez, and Josselin Garnier. Efficient methodology for seismic fragility curves estimation by active learning on support vector machines. *Structural Safety*, 86:101972, 2020.

Short biography – After 3 years in a French engineering school and a Master of Statistics and Machine Learning at Université Paris Sud, I did my end of study internship in EDF R&D Chatou in uncertainty quantification. Because this research topic fits me well, I choose this Ph.D thesis at CEA Saclay. My funding comes from the SEISM Institute, its purpose is to federate several research and academic institutions on the very topic of seismic risk assesment.