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Ensembles of Ground Motion Models

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Ground motion models (GMMs) are models of the distribution of ground motion e.g. peak ground acceleration and typically assume a log-Normal distribution. They constitute important components of probabilistic seismic hazard analysis which seeks to calculate the frequency of exceedence of certain destructive events. GMMs are elicited using regional datasets, and thus are limited to delivering predictions only for the respected regions. GMMs may also differ considerably in the functional form that they assume as they are elicited under different considerations, e.g. they may depend on different sets of predictor variables, and expert knowledge. It is often the case that one is interested in acquiring predictions about a new region for which no GMM has been developed. The common practice of a seismic analyst when faced with this type of problem is to consider a set of scenarios that result from each individual GMM using the framework of a logic tree. In this work we attempt to tackle this problem by combining GMMs into an ensemble.

An ensemble is a collection of models where each model has been set-up or trained to solve the same problem. Amongst their many advantages, the main motivation of employing ensembles is their superior performance in terms of generalization error that they exhibit, either in the context of a regression or classification task. Additional benefits include reduced computational times when inducing new models, fusion of data sources etc.

In the current context, the constituent models are GMMs. It is acknowledged that no single GMM can fully model a new target area; however, each single GMM may be able to partially capture the ground motion of the new area. In other words, each GMM may exhibit an "expertise" for a particular range of ground motion predictions. Thus, the goal is to form an ensemble where each GMM contributes its expertise. Such an ensemble resembles a committee of human experts that cooperate in order to reach a common decision. The data of the new region are used as a guide to dictate how the GMMs are to be combined in order to form the ensemble. The newly formed ensemble can then be used for predictive purposes.

In this work, we present a first investigation of using ensemble techniques in the context of GMMs. We consider some particular combinations of GMMs and illustrate their potential through numerical experiments.