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A Smart Elicitation Technique for Informative Priors in Ground-Motion Mixture Modelling

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In probabilistic seismic hazard analysis (PSHA) the ground motion at a particular site of interest is typically estimated as an empirically derived function of source, path and side related predictor variables. Due to the sparseness of observed seismic data these ground motion prediction equations (GMPEs) are not expected to provide entirely precise estimates or to reflect the full diversity of possible future ground motion, thus introducing epistemic uncertainties in the hazard estimates. This is particularly the case in regions for which no dedicated GMPE has been developed and appropriate foreign models have to be applied. We investigate the aggregation of GMPEs in order to infer a model that can deliver predictions for such a region. Instead of having a single model that tries to capture the possible ground motion at the site of interest, a standard mixture model combines several existing GMPEs.

The mixture weights will be estimated within a Bayesian statistical framework, in which they are considered to be distributed according to an a priori distribution. These weights capture a notion of appropriateness or relevance of GMPEs in the mixture. Subsequently the weights are updated as data is absorbed, which results in their a posteriori distribution. However, typically a priori distributions are chosen based on algebraic and/or computational convenience rather than attempting to actually capture domain expert's beliefs; this is in part because it is thought to be a non-trivial task to capture and elicit knowledge in terms of a distribution.

In this contribution, we illustrate a method based on experimental design theory enabling us to quantify, elicit and transfer expert knowledge into a prior distribution for the mixture modeling problem. We experiment with different scenarios simulating likely expert behaviors in the context of knowledge elicitation, and show the impact this has on the prior and posterior distributions. The overall aim is to generate a mixture model for Northern Chile, an area for which no indigenous GMPE exists. A set of 9 GMPEs developed for different subduction zones of the world are aggregated via a mixture and strong motion recordings from the target area will update the knowledge driven prior. The ability to describe ground motions in Northern Chile is finally compared between the mixture model and its constituent GMPEs.