SSM
Scuola Superiore Meridionale

MERC PhD Project Proposal

Title of the research project:

Towards a paradigm shift in probabilistic seismic hazard analysis

Keywords (up to five)

Ground motion models, seismic risk analysis, functional data, statistics

Supervisors (at least two from two different areas):

Supervisor 1 (I. Iervolino, iunio.iervolino@unina.it, http://wpage.unina.it/iuniervo, risk analysis)

Supervisor 2 (L. Sangalli, laura.sangalli@polimi.it, http://www1.mate.polimi.it/~sangalli/, functional data)

Project description (max 5000 characters)

Probabilistic seismic hzard analysis make use of ground motion prediction equations (GMPEs) to represent the propagation of seismic wases from the earthquake source to the site of interest. GMPEs are the critical components of seismic hazard and risk analysis as they carry the largest uncertainty in the risk components (i.e., source features, system vulnerability, exposure and consequences). Therefore, to significantly improve ground motion modelling would be a giant leap in seismic hazard and risk analysis.

Ground motion models provide the distribution of a scalar or vector valued intensity measure (IM) conditional to earthquake magnitude and source-to-site distance. The intensity measure is the interfacing random variable between the hazard and the vulnerability/loss. On the other hand, structural dynamics shows that the perfect intensity measure, at least for a linear system, would be the acceleration time-history recorded at the site where the system is located. Unfortunately, current knowledge does not enable to provide a probabilistic prediction of a signal, and this is why ground motion intensity measures and GMPEs are used as proxies.

GMPEs are usually based on regression analysis of a scalar IM versus covariates, most notably magnitude and distance. Recently a branch of statistics, that is functional data analysis, allows to develop probabilistic predictions of functions as well as regressions of functions. Therefore, the objective of the project is to extend the concept of GMPE to develop a prediction model of the full ground motion (e.g., acceleration) signal as a function of source to site distance, so that probabilistic seismic hazard analysis could produce predictions of waveforms rather than intensity measures.

Relevance to the MERC PhD Program (max 2000 characters)

The scope of the project, if successful, would represent the most relevant advancement in the field of hazard and risk analysis since is its development in the ‘60s. It would change the paradigm of risk analysis altogether.

Key references

Iervolino I., Giorgio M., Galasso G., Manfredi G. (2009). Uncertainty in early warning predictions of engineering ground motion parameters: what really matters? Geophysical research letters, 36, L00B06, doi:10.1029/2008GL036644, 2009.

Azevedo, L. (2022). Model reduction in geostatistical seismic inversion with functional data analysis. Geophysics, 87(1), M1-M11.

Joint supervision arrangements

Meetings with the first advisor will occur at least on a weekly basis, daily, if needed.

The project will involve substantial period of time spent at the Politecnico di Milano, and in particular in the Engineering Mathematics department.

Location and length of the study period abroad (min 12 months)

Stanford University is the planned destination. No arrangements have been made yet.

Any other useful information

ERC proposals are linked to this project.