Research Project Highlight

Ground Motions and Selection Tools for PEER Research Program

Project # 1116-NCTRBJ

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Abstract

This project developed an algorithm to efficiently select ground motions from a database while matching a target mean and variance of response spectral values at a range of periods. The approach improves an earlier algorithm by Jayaram et al. (2011). Key steps in the process are to screen a ground motion database for suitable motions, simulate response spectra from a target distribution, find motions whose spectra match each simulated response spectrum, and then perform an optimization to further improve the consistency of the selected motions with the target distribution. The computational expense of the algorithm has been greatly improved relative to the previous algorithm. An example selection exercise has been performed, to illustrate the type of results that can be obtained. Source code for the algorithm has been provided (https://github.com/bakerjw/CS_Selection), along with metadata for several popular databases of recorded and simulated ground motions, which will facilitate a variety of future exploratory and research studies.

Additionally, as part of this project, the PI performed an extensive set of ground motion selection in support of PEER research projects relating to tall buildings and nuclear power plants. Ultimately, 16 sets of 20 ground motions were developed, representing two locations, a number of hazard levels, and satisfying various design standard requirements.

Deliverables

An in-review journal article documenting the selection algorithm. Source code for the selection algorithm (https://github.com/bakerjw/CS_Selection), 16 sets of 20 ground motions to be used in other PEER projects.

Research Impact

Selection of ground motions is a topic of great interest as dynamic structural analysis, which requires ground motions as inputs, grows more prevalent. This selection typically involves searching a ground

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motion database to find time series produced under appropriate seismological conditions (e.g., earthquake magnitude and source-to-site distance), and that have appropriate response spectral values. In some cases, ground motions are selected based on their individual match to a target spectrum; that is, an optimal set of ground motions would have spectra that all perfectly match the target spectrum. In other cases, however, it is important that the ground motions have variability in response spectra that accurately represents target distributions from predictive models. As such, a number of algorithms have been proposed to select ground motions with some form of specified response spectral variability.

This project developed an efficient algorithm for selecting ground motions from a database that match a target response spectrum distribution (e.g., a Conditional Spectrum). The motivation for this work is that when the target spectrum has a distribution, rather than a single value, it is not possible to evaluate individual ground motions for selection without considering them as part of a suite of ground motions that collectively represent the distribution. But evaluating all possible suites of ground motions is impossible when considering large ground motion databases typical in practice today. This algorithm utilizes several practical strategies to quickly identify ground motion sets with close match to the target spectrum.

Project Image

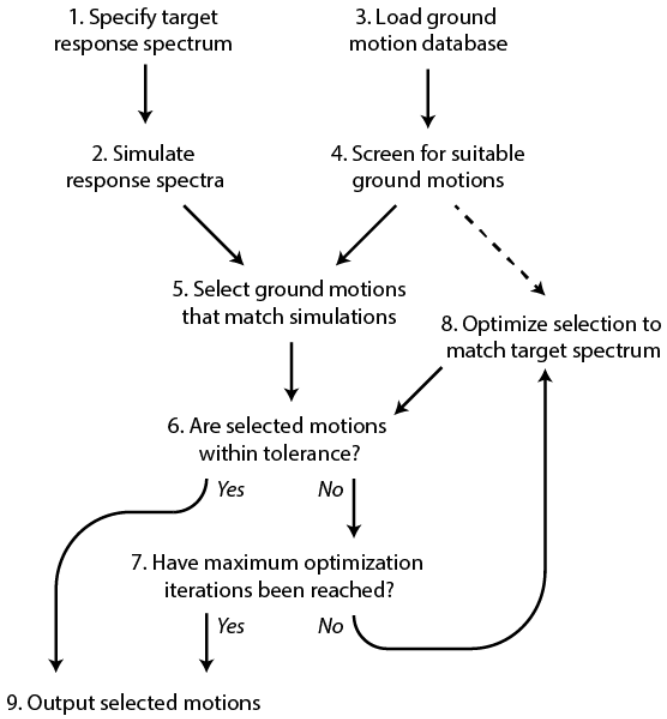

Figure 1. Flow chart of major steps in the ground motion selection algorithm.

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