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Summary: An example of conducting probabilistic seismic hazard analysis (PSHA) using OpenSHA and selecting multicomponent ground motions (GMs) using Matlab is provided as an electronic supplement to the ICOLD short course held on Sept. 12, 2019 in Milan, Italy; more documentation on selecting 3-component GMs to agree with CMS-UHS Composite Spectra can be found at:

Kwong, N.S., and A.K. Chopra. (2020). "Selecting, scaling, and orienting three components of ground motions for intensity-based assessments at far-field sites." Earthquake Spectra, 36(3), 1013-1037.

Notes: Both input and output files of a specific example are provided (though some output files are removed to save space). To conduct PSHA and select multicomponent GMs from the NGAW2 database, please follow the ordered steps described below (names of Matlab scripts or variables are given in `Courier font`). To use hazard results (e.g., hazard curves, disaggregation) from another PSHA software, please replace example hazard results.

Step-by-step instructions:

1. Run OpenSHA command-line application:
    a. Revise input file for your site
    b. Launch terminal and run jar file (see README file for OpenSHA)
2. Launch Matlab
    a. In Matlab, set path for two folders for Matlab functions:
        i. Ground motion prediction model (GMPM)
        ii. Ground motion selection and modification (GMSM)
3. To compute and save hazard curves, run scripts inside PSHA folder in the following sequence:
    a. Obtain earthquake scenarios and corresponding annual rates of occurrence
        i. `getERFfromOpenSHA.m`
    b. Implement GMPM for each earthquake scenario; specify intensity measure types (IMTs)
        i. `getGMPMoutput.m`
    c. Compute hazard curves for specified IMTs
        i. `getHazardCurves.m`
4. Make new folder for target spectra (same directory as PSHA folder); all target spectra correspond to the same return period (e.g., RetPer2475)
5. Inside folder for target spectra, compute target spectra:
    a. Compute and save UHS:
        i. `getUHS.m`
        ii. Note: The input return period should be the same as that in name of folder
    b. Compute and save CMSs:
        i. `getCMS_givenAh.m` (or `getCMS_givenAv.m`)

ii. Specify Tmin for T* and run script
iii. Specify Tmax for T* and run script

c. Compute and save Composite Spectrum:
i. `getCompositeSpec_givenAh.m` (or `getCompositeSpec_givenAv.m`)
ii. Specify Tmin and Tmax and then run script
iii. Note: CMSs should have already been computed before running script for Composite Spectrum

6. Inside folder for target spectra, create sub-folder for specific target spectrum (e.g., Composite_givenAh):
a. Inside sub-folder for specific target spectrum:
i. Specify GMSM inputs in the following scripts:
1. `GMSMinput.m`
2. `selectGMs.m`
ii. Select GMs from NGAW2 database:
1. Run `selectGMs.m` to output NGAid.txt file
a. Note: NGAid.txt file is located in sub-folder corresponding to specific case of GM selection, which is under GMSMout folder
2. Copy NGA Record Sequence Numbers (RSNs) from NGAid.txt file
3. Go to PEER NGAW2 website (https://ngawest2.berkeley.edu/):
a. Click on "NGAW2 enter" button
b. Sign in with your credentials
c. Select "No scaling" for target spectrum
d. Provide RSNs of selected GMs and search for corresponding time series (Search Records button)
e. Download zip folder of time series (metadata+spectra+traces button)
4. Move zip folder into same directory containing NGAid.txt file
5. Unzip to PEERNGARecords_Unscaled; this folder is in the same directory containing NGAid.txt file
iii. Extract time series from AT2 files into Matlab:
1. `getTimeSeriesFromPEER.m`
iv. Compute optimal orientations of as-recorded GMs (angles are in units of degrees and are used to rotate as-recorded GM pairs counter-clockwise in plan-view):
1. `getOptimalAzimuths.m`
v. Confirm hazard consistency of selected, scaled, and rotated multicomponent GMs; final GMSM output (i.e., NGA RSNs, scale factors, angles) is displayed in the Matlab variable `GMSMtable`
1. `confirmHazardConsistency.m`