USER-MANUAL

GENERALIZED GROUND MOTION PREDICTION MODEL (GGMPM)

This tool, named as Generalized Ground Motion Prediction Model (GGMPM), uses a hybrid Recurrent Neural Network (RNN) framework to estimate a 29×1 correlated vector (denoted as **IM**) of RotD50 Spectral Acceleration (S_a) at 26 periods and geometric means of Arias Intensity (I_a), Significant Duration ($D_{5\text{-}95}$) and Cumulative Absolute Velocity (CAV) using a set of seismic source and site parameters as inputs. The source and site inputs to the RNN framework include a vector of 12 values including *F*, *M*, R_{rup}, R_x, R_{JB}, D_{Hyp}, Z_{TOR}, V_{s30},. The discrepancy between the **IM** vector predicted using the RNN framework and the computed from recorded ground motions is further minimized by using the Covariance Matrix Adaptation Evolution Strategy (CMA-ES). The residuals of the RNN framework are used to construct the inter-event and the intra-event covariance matrices to account for the inter-event and intra-event variabilities of the ground motions. Hence, given the source and site parameters, this tool returns a median prediction of the **IM** and estimated inter-event and intra-event covariance matrices. The executable is developed by Jawad Fayaz (https://jfayaz.github.io/layouts/codeandsoft.html/) and research team at University of California- Irvine (UCI). The program is named as "Generalized Ground Motion Prediction Model (GGMPM)". For further details please read the article mentioned in the "Reference".

https://www.dropbox.com/scl/fo/sr9ev6y2ggeg69fctxiiv/AIuJIWrRGeJX7HT1Bns9uS4?rlkey=xzxxziqvd52q4ozvhlkcahnfc&dl=0

1. GGMPM Inputs (in order)

i. Fault Mechanism (*F*)

Mechanism (*F*)	Value
Strike Slip	1

Normal	2
Reverse	3
Reverse Oblique	4
Normal Oblique	5

ii. Magnitude (M_w)

iii. Closest Rupture Distance (R_{rup}) in kilometers (km)

iv. Depth to Top of Rupture (Z_{TOR}) in kilometers (km)

v. Distance Measure (R_x) in kilometers (km)

vi. Joyne-Boore Distance (R_{JB}) in kilometers (km)

vii. Hypocentral Distance (D_{Hyp}) in kilometers (km)

viii. Shear-Wave Velocity (V_{s30}) in meters per second (m/s)

ix. Conditional Period (T^*) in seconds (s)

2 Calling GGMPM

The tool package consists of the executable application "GGMPM_Predictions.exe" which can be easily called from any command line or programming language/software. An example to run the GGMPM program is given in Figure 1 where the inputs are in the same order as mentioned in above section "GGMPM Inputs". The generalized syntax to run the executable is as follows:

$$\text{GGMPM\_Predictions.exe} \quad F \quad M_w \;\; R_{rup} \;\; Z_{TOR} \;\; R_x \;\; R_{JB} \;\; D_{Hyp} \;\; V_{s30} \;\; T^*$$

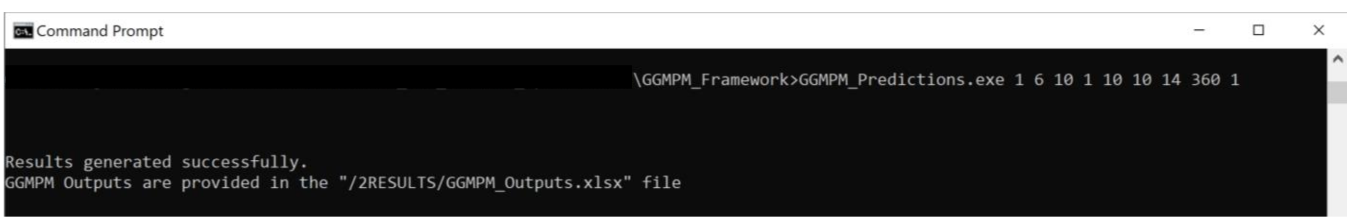

Figure 1: Calling "GGMPM_Predictions.exe"

3 GGMPM Outputs

The tool provides outputs in "RESULTS" folder (name of the "RESULTS" folder is preceded by a serial number, as can be seen from Figure 1: "2RESULTS") within the framework folder. The outputs consist of two files: 1) "GGMPM_Outputs.xlsx" excel file containing the estimated predictions and 2) "GGMPM_Sa_Spectra.jpg" picture file showing the median and sigma bands of the estimated RotD50 spectral acceleration (as shown in Figure 2). The excel file "GGMPM_Outputs.xlsx" includes three sheets 1) "Conditional_Predictions_log" provides the median and correlated sigma predictions of the 29 IMs in log-scale (note: the estimated median vector is correlated without any conditional period; estimated sigma vector is correlated with conditional period T^* inputted by the user), 2) "IntraEvent_SigmaCov_log" provides Within-Event covariance matrix of the predictions in log-scale, and 3) "InterEvent_TauCov_log" provides Between-Event covariance matrix of the predictions in log-scale. The Intra-Event and Inter-Event variabilities are combined to provide the overall sigma vector in sheet "Conditional_Predictions_log".

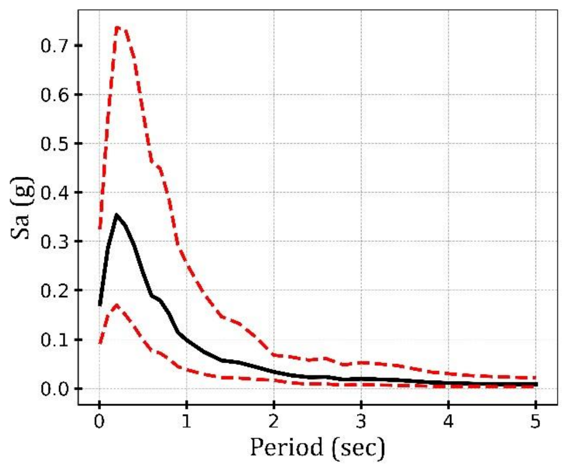

Figure 2: Estimated RotD50 S_a output

Reference

Jawad Fayaz, Yijun Xiang, and Farzin Zareian (2020). "Generalized Ground Motion Prediction Model (GGMPM) using Hybrid Neural Networks". *Structural Dynamics and Earthquake Engineering*. https://onlinelibrary.wiley.com/doi/abs/10.1002/eqe.3410?af=R