

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_{5-95}) 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”.

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:

GGMPM_Predictions.exe F M_w R_{rup} Z_{TOR} R_x R_{JB} D_{Hyp} V_{s30} T^*

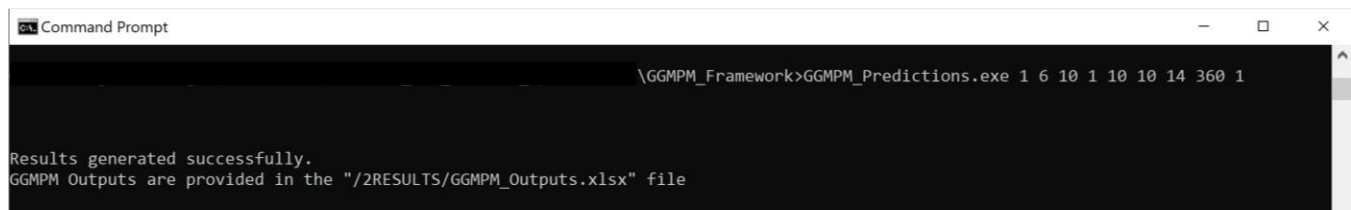


Figure 1: Calling “GGMPM_Predictions.exe”

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”.

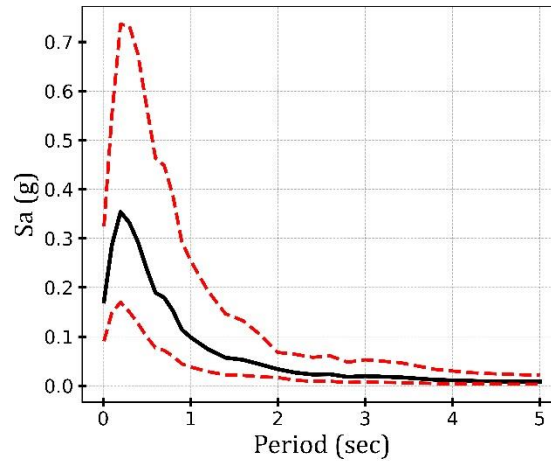


Figure 2: Estimated RotD50 S_a output

Reference

Jawad Fayaz, Yijun Xiang, and Farzin Zareian (accepted). "Generalized Ground Motion Prediction Model (GGMPM) using Hybrid Neural Networks". *Structural Dynamics and Earthquake Engineering*.