

SERA Magnitude Complexity Toolbox: Application: App_2B_v1: 'MM_MB_V1_8'

`[n,bval,Rmodes,hcrit_modes,Rbumps,hcrit_bumps,gau,gau_b,poch,poch2,zer1,zer2,x1,x2] = MM_MB_V3_1(M,Mc,m,n_boot,h,delta_h,MMmeth,MBmeth)`

COMPATIBLE with Matlab version 2017b or later

APPLICATION DESCRIPTION

This Application performs testing of hypothesis of multimodality and existence of multi-bumps in the distribution of a given random variable (e.g. a set of magnitudes). The input data can be any vector corresponding to a random variable, which can be uploaded e.g. from an ASCII file. This is a Hybrid Version, where the Application, can be performed in two different modes, allowing or not allowing interactivity with the User:

Mode 1 [Interactive Mode]: If only the input data vector is defined as input argument then the Application allows interactivity in a series of pop-up windows and graphs (*GUI enabled*):

`[n,bval,Rmodes,hcrit_modes,Rbumps,hcrit_bumps,gau,gau_b,poch,poch2,zer1,zer2,x1,x2] = MM_MB_V1_8(M) %for Interactivity ON`

Mode 1 [Function Mode]: If all parameters are set as input arguments then the Application behaves as a matlab function, returning the outputs (*GUI disabled*):

`[n,bval,Rmodes,hcrit_modes,Rbumps,hcrit_bumps,gau,gau_b,poch,poch2,zer1,zer2,x1,x2] = MM_MB_V1_8(M,Mc,m,n_boot,h,delta_h,MMmeth,MBmeth) %for Interactivity OFF`

A directory 'Outputs_MM_MB' is automatically generated by running the function. The description of input-output parameters can also be found within the source code as well:

Input DATA and PARAMETERS Information: The User is requested to select the data, parameters and attributes for the input data (e.g. magnitude) distribution analysis:

Parameter	Variable	Type	Format	Possible Values	Default
Input Data Vector	M	Vector	Double	-	-
Completeness Threshold	Mc	Scalar	Double	$\text{Min}(M) \leq Mc$	-
Number of points	m	Scalar	Integer	$10 \leq m \leq 10,000$ Recommended: 100-1000	100
Bootstrap Iterations	n_boot	Scalar	Integer	$1 \leq n_boot \leq 100,000$	100
Initial h	h	Scalar	Double	$0.0001 \leq h \leq 1$	0.01
h step	delta_h	Scalar	Double	$\text{delta_h} \leq h$	0.001
Method for MM testing	MMmeth	String	String	'Efron', 'Silverman'	'Efron'
Method for MB testing	MBmeth	String	String	'Silverman', 'Efron'	'Silverman'

Outputs: After the analysis is performed by the system and the following output results are produced and stored in the directory "Outputs_MM".

Output Parameters	Type	Format	Comments
n	Scalar	Double	Outputs included in the Report file (number of events used, GR b-value, p-value for MM hypothesis, critical h for MM, p-value for MB hypothesis, critical h for MB)
bval	Scalar	Double	
Rmodes	Scalar	Double	
hcrit_modes	Scalar	Double	
Rbumps	Scalar	Double	
hcrit_bumps	Scalar	Double	
gau	Vector	Double	PDF of Input Data for h=hcrit_modes
gau_b*	Vector	Double	PDF of Input Data for h=hcrit_bumps
poch*	Vector	Double	1st derivative of PDF for h=hcrit_bumps
poch2*	Vector	Double	2 nd derivative of PDF for h=hcrit_bumps
zer1*	Scalar	Double	Extremum
zer2*	Vector	Double	Inflection point(s)
x1*	Scalar	Double	minimum Input Data value after randomization
x2*	Scalar	Double	maximum Input Data value after randomization

* Parameters needed for visualization (see figure below)

Report: "REPORT_Multimodality.txt" is generated and stored, including a summary of the input parameters and data considered, as well as the results obtained from the analysis (Critical h's and p-values of null hypotheses for MM and MB analysis, respectively).

FIGURE: A figure is created and saved ("Multimodality_Output.jpg") showing the PDF of Input Data for h=h_{crit}, and also its 1st and 2nd derivatives. The location of the extremum and inflection points are also indicated in the plot (see figure below).

