SERA Magnitude Complexity Toolbox:
Application: App_2B_v2: 'MM_MB_V2_8'

[n,bval,Rmodes,hcrit_modes,Rbumps,hcrit_bumps,gau,gau_b,poch,poch2,zer1,zer2,x1,x2] = **MM_MB_V2_8**(M,Mc,m,n_boot,h,delta_h,MMmeth,MBmeth)

COMPATIBLE with Matlab version 2017b or later

APPLICATION DESCRIPTION

Script to Run: ***"MM_MB_Wrapper.m"***

This Application performs testing of hypothesis of multimodality and existence of multi-bumps in a given random variable (e.g. magnitude) distribution. The Application is performed as a series of steps and the input arguments are defined by the User in the wrapper script, ***"MM_MB_Wrapper.m"***. The input arguments are 1) any vector corresponding to a random variable, which can be uploaded e.g. from an ASCII file, and 2) selected parameter values for data filtering and analysis. These arguments are set by the User in the wrapper script ***MM_MB_Wrapper.m*** and are used as input to the main **MM_MB** function. NOTE that any vector (M) can be introduced and used as input data.

STEP 1. DATA upload: The User is requested to select an input vector, found in an ASCII file, located in the 'Sample_Data' directory. The user may modify the lines 13-14 of the Wrapper Script in order to import any vector that he/she wishes to analyze *[argument M]*.

STEP 2. Completeness Threshold Selection: The User is requested to select the minimum threshold of data completeness *[argument Mc]*.

STEP 3. Number of points: The User is requested to enter number of points to divide the input data sample (magnitude vector) *[argument m]*.

STEP 4. Bootstrap iterations: The User is requested to define the number of bootstrap iterations for MM as well as MB testing *[argument n_boot]*.

STEP 5. Initial h: The User is requested to select the initial value of the smoothing factor to apply in defining the critical h for the MM testing process *[argument h]*.

STEP 6. h step: The User is requested to define the step (accuracy of hcrit) in defining the critical h for the MM and MB testing processes *[argument delta_h]*.

STEP 7. MMmeth: The User is requested to select the method for MM testing *[argument MMmeth]*.

STEP 8. MBmeth: The User is requested to select the method for MB testing *[argument MBmeth]*.

STEP 9. Run 'MM_MB' function

STEP 10. Visualization: Plotting results (optional, the User may activate/deactivate this option).

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	Min(M)≤Mc	-

Number of points	m	Scalar	Integer	10≤m≤10,000 Recommended: 100-1000	100
Bootstrap Iterations	n_boot	Scalar	Integer	1≤n_boot≤100,000	100
Initial h	h	Scalar	Double	0.0001≤h≤1	0.01
h step	delta_h	Scalar	Double	delta_h≤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".

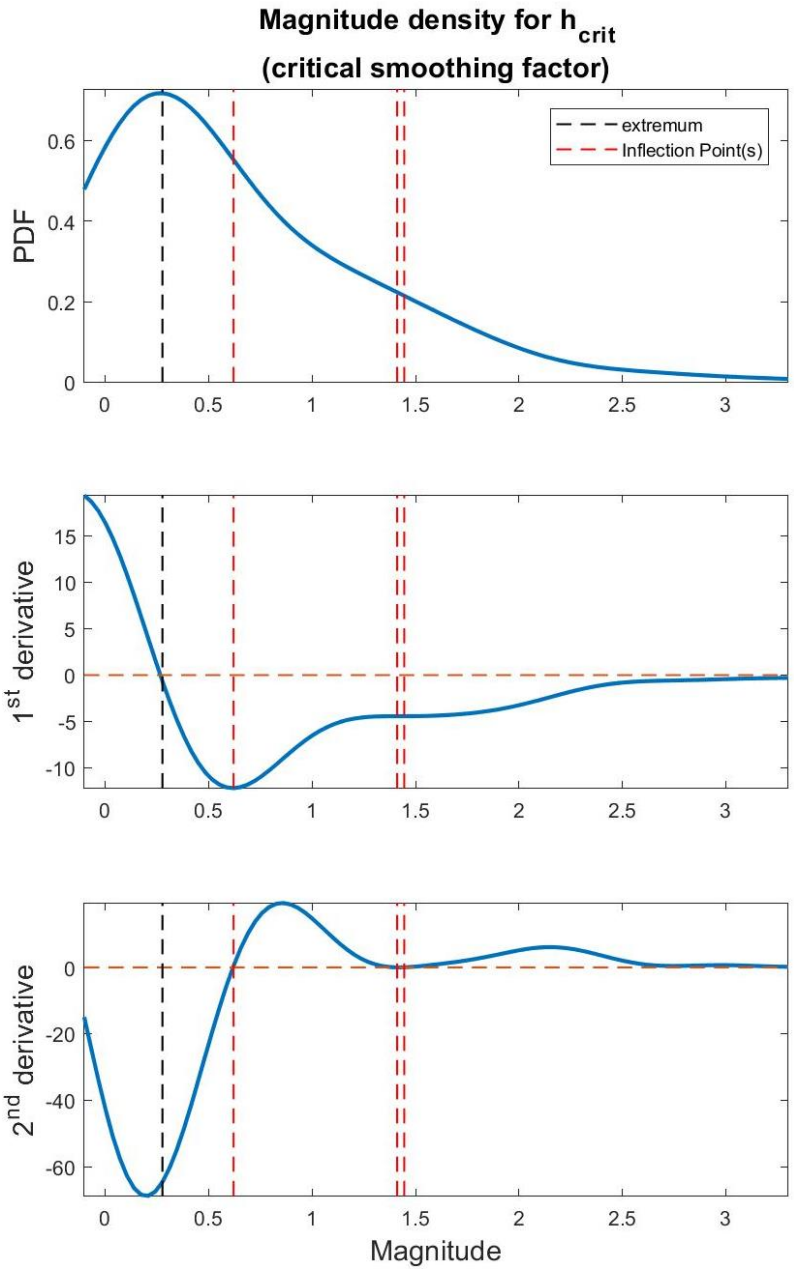
Output Parameters	Type	Format	Comments
n	Scalar	Double	Outputs included in the Report file *(number of events used, GR b-value, p-value for MM hypothesis, critical h for MM, p-value for MB hypothesis, critical h for MB*)
bval	Scalar	Double	
Rmodes	Scalar	Double	
hcrit_ modes	Scalar	Double	
Rbumps	Scalar	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	2nd 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: Request for a figure to be created as in the standalone version v1 of the Application 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). Auxiliary script is provided to create such plot:

MM_MB_Plot(M,Mc,x1,x2,m,zer1,zer2,gau_b,poch,poch2)


Magnitude density for h crit
(critical smoothing factor)
extremum
Inflection Point(s)
PDF
1st derivative
2nd derivative
Magnitude