GaussBetti

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CONTENTS

CHAPTER ONE

TOPOLOGICALFUNC

topologicalFunc.**GaussianFiltration**(*GaussianRandomField*, *type='lower'*)

Generates Filtration for the Gaussian Random Field.

Parameters

- **GaussianRandomField** (*array*) – numpy 2-D array. The Gaussian Random Field generated from the class using Gen_GRF method.
- **type** (*string*) – Takes ipnut either 'lower' or 'upper' for lower or upper filtration.
- **nsize** (*integer*) – Size of the Gaussian Random Fields grid.

Returns Filtration Diagram

Return type Dionysus object

topologicalFunc.**GenerateBettiP**(*Filtraion*, *thresholds_start*, *thresholds_stop*, *type='lower'*)

Generates the Betti numbers from the Filtration diagram.

Parameters

- **Filtration** (*Dionysus object*) – Output of GaussianFiltration.
- **thresholds_start** (*float*) – start value for generating superlevels of the Gaussian Random field .
- **thresholds_stop** (*float*) – stop value for generating superlevels of the Gaussian Random field.

Returns Multidimensaion array contaiing Betti numbers for different dimensions

Return type Numpy array

topologicalFunc.**GenerateGenus**(*Betti_array*)

Generates the Genus curve for gaussian random field using Betti arrays.

Parameters **array** (*Betti*) – Betti array from GenerateBettiP.

Returns 1-D array contaiing Genus curve for the Gaussian random field.

Return type Numpy array

CHAPTER TWO

UTILITIES

utilities.**Generate_BettiGenus_array**(*Nsize*, *power_index_null*, *power_index_test*, *average*, *iteration*, *filtration_threshold_start*, *filtration_threshold_stop*, *type1='lower'*)

Generate_Likelihood_Array

Generates the Betti and Genus curves for specified parameters.

Parameters

- **Nsize** (*integer*) – grid size of the Gaussian Random Field
- **power_index_null** (*float*) – Power spectral index of Null Hypothesis
- **power_index_test** (*float*) – Power spectral index of Test Hypothesis
- **average** (*integer*) – No. of times the betti curves need to be averaged
- **iteration** (*integer*) – Size of the arrays generated
- **filtration_threshold_start** (*float*) – Start value for generating filtraion from dionysus
- **filtration_threshold_stop** (*float*) – Stop value for generation filtration from dionysus
- **type** – Type of filtration accepted values are 'lower' 'upper

Returns array of Betti and Genus curves

Return type numpy array

utilities.**Generate_Likelihood_Array**(*Nsize*, *power_index_null*, *power_index_test*, *iteration*)

Generates the array of likelihood ratios for making ROC curves.

Parameters

- **Nsize** (*integer*) – grid size of the Gaussian Random Field
- **power_index_null** (*float*) – Power spectral index of Null Hypothesis
- **power_index_test** (*float*) – Power spectral index of Test Hypothesis
- **iteration** (*integer*) – Size of the likelihood ratio array generated

Returns array of likelihood ratios

Return type numpy array

utilities.**KLdivergence**(*x*, *y1*, *y2*)

Calculates the KL divergence for 2 different Gaussian Random Field.

Parameters

- **x** (*array*) –
- **y1** (*array*) – Gausian Random Field of null hypothesis as a 1-D array
- **y2** (*array*) – Gaussian Random Field of test hypothesis as a 1-D array

Returns KL divergence

Return type float

`utilities.plotROC(`*PFA*, *PD*, *nsize*, *num_iter*, *H0*, *H1*, *type1*, *Betti='default'*`)`

Plots the PFA and PD ROC graph with the labels provided through parameters.

Parameters

- **PFA** (*array*) – numpy vector. The PFA array generated during ROC gen.
- **PD** (*array*) – numpy vector. THe PD array generated during ROC gen.
- **nsize** (*integer*) – Size of the Gaussian Random Fields grid.
- **num_iter** (*integer*) – Number of iteration for which ROC gen is run.
- **H0** (*float*) – Power spectral index of Null Hypothesis.
- **H1** (*float*) – Power spectral index of Test Hypothesis.
- **type1** (*string*) – type1 of the ROC curve generated takes value 'likelihood','betti','genus
- **Betti** (*integer*) – Dimension of Betti curve not needed when type = likelihood

Returns None

Return type None

`utilities.readROC(`*nsize*, *num_iter*, *H0*, *H1*, *type1*, *Betti='default'*`)`

Reads the PFA and PD array from the files generated using saveROC.

Parameters

- **nsize** (*integer*) – Size of the Gaussian Random Fields grid.
- **num_iter** (*integer*) – Number of iteration for which ROC gen is run.
- **H0** (*integer*) – Power spectral index of Null Hypothesis.
- **H1** (*integer*) – Power spectral index of Test Hypothesis.
- **type1** (*string*) – type1 of the ROC curve generated takes value 'likelihood','betti','genus
- **Betti** (*integer*) – Dimension of Betti curve not needed when type = likelihood

Returns Returns PFA and PD arrays

Return type Numpy Array

`utilities.saveROC(`*PFA*, *PD*, *nsize*, *num_iter*, *H0*, *H1*, *type1*, *Betti='default'*`)`

SaveROC

Saves the PFA and PD array with the labels provided through parameters.

Parameters

- **PFA** (*array*) – numpy vector. The PFA array generated during ROC gen.
- **PD** (*array*) – numpy vector. THe PD array generated during ROC gen.
- **nsize** (*integer*) – Size of the Gaussian Random Fields grid.
- **num_iter** (*integer*) – Number of iteration for which ROC gen is run.

- **H0** (*float*) – Power spectral index of Null Hypothesis.
- **H1** (*float*) – Power spectral index of Test Hypothesis.
- **type1** (*string*) – type1 of the ROC curve generated takes value 'likelihood','betti','genus
- **Betti** (*integer*) – Dimension of Betti curve not needed when type = likelihood

Returns None

Return type None

CHAPTER

THREE

GAUSSCLASS

`class gaussClass.GaussianRandomField(`*Nsize*, *n*`)`

The class for making Gaussian random field with specified spectral index and size of grid.

`Nzise`

size of the grid.

Type int

`n`

Spectral index of the power law used to generate the Gaussian Random Field.

Type int

`k_ind`

Grid in the fourier space.

Type array

`PowerSpectrum`

The power spectrum grid made using the spectral index used to make the Gaussian Random Field.

Type array

`corr_s`

Correlation matrix in the fourier space.

Type array

`corr_f`

Correlation matrix in the spatial space.

Type array

`Gen_GRF(`*type='grid'*`)`

GenerateBettiP

Generates the Gaussian Random field with the specified paramters.

Parameters **`type`** (*`str`*) – Takes either ‘grid’ or ‘array’ in string format

Returns: Numpy array: Gaussian Random field

`PowerSpectrum_grid_generator()`

Generates the powerspectrum grid.

`fourier_space_ind()`

Generates the fourier space grid.

`gen_correlation()`

Generates the correlation matrices in fourier and spatial spcae.

CHAPTER

FOUR

ROCGEN

`rocGen.BettiROC(`*Betti_array0*, *Betti_array1*, *threshold_step*`)`

Generates PFA and PD values from Betti curves using the specified parameters

Parameters

- **`Betti_array0`** (*`array`*) – multiple Betti curves for null hypothesis generated from GenerateBetti function for a one dimension.
- **`Betti_array1`** (*`array`*) – multiple Betti curves for test hypothesis generated from GenerateBetti function for a one dimension.
- **`threshold_step`** (*`float`*) – Step value for generating threshold array.

Returns PFA and PD values

Return type Array

`rocGen.GenusROC(`*Genus_array0*, *Genus_array1*, *threshold_step*`)`

Generates PFA and PD values from Genus curves using the specified parameters

Parameters

- **`Genus_array0`** (*`array`*) – multiple Genus curves for null hypothesis generated from GenerateBetti function for a one dimension.
- **`Genus_array1`** (*`array`*) – multiple Genus curves for test hypothesis generated from GenerateBetti function for a one dimension.
- **`index`** (*`integer`*) – index at which the Genus value is calculated and compared with threshold.
- **`threshold_step`** (*`float`*) – Step value for generating threshold array.

Returns PFA and PD values

Return type Array

`rocGen.LikelihoodROC(`*likelihoodratio0*, *likelihoodratio1*, *threshold_step*`)`

Generates PFA and PD values from likelihood ratios of the Gaussian Random Field using the specified parameters

Parameters

- **`likelihoodratio0`** (*`array`*) – arrays containing likelihood ratios of the Gaussian Random field of type 1 see doc for likelihoodratio .
- **`likelihoodratio1`** – 2-D arrays containing likelihood ratios of the Gaussian Random field of type 2 see doc for likelihoodratio
- **`threshold_step`** (*`float`*) – Step value for generating threshold array.

Returns PFA and PD values

Return type Array

CHAPTER FIVE

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