
GaussBetti

Release 2.0.0

Siddharth

Aug 10, 2021

CONTENTS

1	gaussClass	1
2	rocGen	3
3	testsFunc	5
4	topologicalFunc	7
5	Utilities	9
6	Indices and tables	13
	Python Module Index	15
	Index	17

GAUSSCLASS

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

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

Nsize

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.

ROCGEN

`rocGen.BettiROC(Betti_array0, Betti_array1)`

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)`

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)`

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

TESTSFUNC

`testsFunc.MultitestAllROC(Nsize, power_null, power_test, average, num_iter)`
`testBettiGenusROC`

Plots all ROC curve for multiple values of null and test power spectral index and saves them in a folder.

Parameters

- **nsize** (*integer*) – Size of the Gaussian Random Fields grid.
- **power_null** (*array*) – Power spectral indices of Null Hypothesis.
- **power_test** (*array*) – Power spectral indices of Test Hypothesis.
- **average** (*integer*) – Number of times topological curves are averaged
- **num_iter** (*integer*) – Number of iteration for which ROC gen is run.

Returns None

Return type None

`testsFunc.testAllROC(Nsize, power_null, power_test, average, num_iter)`
Plots all ROC curve for single value of null and test power spectral index.

Parameters

- **nsize** (*integer*) – Size of the Gaussian Random Fields grid.
- **power_null** (*float*) – Power spectral index of Null Hypothesis.
- **power_test** (*float*) – Power spectral index of Test Hypothesis.
- **average** (*integer*) – Number of times topological curves are averaged
- **num_iter** (*integer*) – Number of iteration for which ROC gen is run.

Returns None

Return type None

`testsFunc.testBettiGenus(Betti, Genus, nsize, power)`
Plots the Betti and Genus curves.

Parameters

- **Betti** (*array*) – Betti array
- **Genus** (*array*) – Genus array

Returns None

Return type None

`testsFunc.testBettiGenusROC(Nsize, power_null, power_test, average, num_iter)`

Plots the Betti and Genus ROC curve for multiple values of null and test power spectral index.

Parameters

- **nsize** (*integer*) – Size of the Gaussian Random Fields grid.
- **power_null** (*array*) – Power spectral indices of Null Hypothesis.
- **power_test** (*array*) – Power spectral indices of Test Hypothesis.
- **average** (*integer*) – Number of times topological curves are averaged
- **num_iter** (*integer*) – Number of iteration for which ROC gen is run.

Returns None

Return type None

`testsFunc.testCorrelationMatrix(Gauss_class_object)`

Prints info about the original and modified correlation matrix of for an instance of GaussianRandomField.

Parameters **Gauss_class_object** (*object*) – its an instance of GaussianRandomField object

Returns None

Return type None

`testsFunc.testGaussianRandomField(Gauss_class_object)`

Plots the Gaussian Random field.

Parameters **Gauss_class_object** (*object*) – its an instance of GaussianRandomField object

Returns None

Return type None

`testsFunc.testLikelihoodROC(nsize, power_null, power_test, num_iter)`

Plots the likelihood ROC curve for multiple values of null and test power spectral index.

Parameters

- **nsize** (*integer*) – Size of the Gaussian Random Fields grid.
- **power_null** (*array*) – Power spectral indices of Null Hypothesis.
- **power_test** (*array*) – Power spectral indices of Test Hypothesis.
- **num_iter** (*integer*) – Number of iteration for which ROC gen is run.

Returns None

Return type None

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 input either 'lower' or 'upper' for lower or upper filtration.
- **nsiz** (*integer*) – Size of the Gaussian Random Fields grid.

Returns Filtration Diagram

Return type Dionysus object

`topologicalFunc.GenerateBettiP(Filtration, 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 Multidimensional array containing 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 containing Genus curve for the Gaussian random field.

Return type Numpy array

UTILITIES

`utilities.GenerateBettiGenus_array(Nsize, power_index_null, power_index_test, average, iteration, filtration_threshold_start=-4, filtration_threshold_stop=4, 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.GenerateLikelihood_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*) – Gaussian 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

INDICES AND TABLES

- `genindex`
- `modindex`
- `search`

PYTHON MODULE INDEX

g

gaussClass, [1](#)

r

rocGen, [3](#)

t

testsFunc, [5](#)

topologicalFunc, [7](#)

u

utilities, [9](#)

INDEX

B

BettiROC() (in module rocGen), 3

C

corr_f (gaussClass.GaussianRandomField attribute), 1
corr_s (gaussClass.GaussianRandomField attribute), 1

F

fourier_space_ind() (gauss-
Class.GaussianRandomField method), 1

G

gaussClass
module, 1

GaussianFiltration() (in module topologicalFunc), 7

GaussianRandomField (class in gaussClass), 1

gen_correlation() (gauss-
Class.GaussianRandomField method), 1

Gen_GRF() (gaussClass.GaussianRandomField method),
1

Generate_BettiGenus_array() (in module utilities),
9

Generate_Likelihood_Array() (in module utilities),
9

GenerateBettiP() (in module topologicalFunc), 7

GenerateGenus() (in module topologicalFunc), 7

GenusROC() (in module rocGen), 3

K

k_ind (gaussClass.GaussianRandomField attribute), 1

KLdivergence() (in module utilities), 9

L

LikelihoodROC() (in module rocGen), 3

M

module

gaussClass, 1

rocGen, 3

testsFunc, 5

topologicalFunc, 7

utilities, 9

MultitestAllROC() (in module testsFunc), 5

N

n (gaussClass.GaussianRandomField attribute), 1

Nzise (gaussClass.GaussianRandomField attribute), 1

P

plotROC() (in module utilities), 10

PowerSpectrum (gaussClass.GaussianRandomField at-
tribute), 1

PowerSpectrum_grid_generator() (gauss-
Class.GaussianRandomField method), 1

R

readROC() (in module utilities), 10

rocGen
module, 3

S

saveROC() (in module utilities), 10

T

testAllROC() (in module testsFunc), 5

testBettiGenus() (in module testsFunc), 5

testBettiGenusROC() (in module testsFunc), 5

testCorrelationMatrix() (in module testsFunc), 6

testGaussianRandomField() (in module testsFunc), 6

testLikelihoodROC() (in module testsFunc), 6

testsFunc

module, 5

topologicalFunc

module, 7

U

utilities

module, 9