

IDL Library for affine-invariant MCMC Ensemble Sampler

API Documentation for idl-emcee

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Part I

Overview

Overview

idl_emcee is an Interactive Data Language (IDL)/GNU Data Language (GDL) implementation of the affine-invariant Markov chain Monte Carlo (MCMC) ensemble sampler, based on sl_emcee by M. A. Nowak, an S-Lang/ISIS implementation of the MCMC Hammer proposed by Goodman & Weare (2010), and then implemented in Python (emcee) by Foreman-Mackey et al. (2013).

Dependencies

- * This package requires the following packages:
 - The IDL Astronomy User's Library
- * To get this package with all the dependent packages, you can simply use git command as follows:

```
git clone --recursive https://github.com/mcfit/idl_emcee.git
```

GDL Installation

- * The GNU Data Language (GDL) can be installed on
 - Linux (Fedora):


```
sudo dnf install gdl
```
 - Linux (Ubuntu):


```
sudo apt-get install gnudatalanguage
```
 - OS X (brew):


```
brew tap brewsci/science
brew install gnudatalanguage
```
 - OS X (macports):


```
sudo port selfupdate
sudo port upgrade libtool
sudo port install gnudatalanguage
```
 - Windows: using the GNU Data Language for Win32 (Unofficial Version) or compiling the GitHub source with Visual Studio 2015 as seen in appveyor.yml.
 - * To setup idl_emcee in GDL, add its path to .gdl_startup in the home directory:

```
!PATH=!PATH + ':/home/idl_emcee/pro/'
```

Set `''GDL_STARTUP''` in `''bashrc''` (bash):

```
export GDL_STARTUP=~/.gdl_startup
```

or in .tcshrc (cshrc):

```
setenv GDL_STARTUP ~/.gdl_startup
```

* This package needs GDL version 0.9.8 or later.

IDL Installation

* To install `idl_emcee` in IDL, add its path to your IDL path. For more information about the path management in IDL, read the IDL path management by Harris Geospatial or the IDL library installation by David Fanning.

* This package needs IDL version 7.1 or later.

Project statistics

Directories:	1
.pro files:	7
.sav files:	0
Routines:	19
Lines:	258

Part II

API

Directory: ./

Overview

emcee__define.pro

Class description for emcee

Fields

CLEVEL 0.00000
ITERATION_NUM os
USE_GAUSSIAN os
WALK_NUM os

EMCEE::INIT

"Unit for affine-invariant MCMC Hammer (emcee)": This object library can be used to create the affine-invariant Markov chain Monte Carlo (MCMC) ensemble sampler, which can be used to propagate uncertainties into the given function.

```
result = emcee::init()
```

Examples

For example:

```
IDL> mc=obj_new('emcee')  
IDL> mcmc_sim=mc->hammer('myfunc', input, input_err_m, input_err_p, output)  
IDL> output_error=mc->func_errors(output, mcmc_sim)
```

Author

Ashkbiz Daneshkar

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History

12/05/2020, A. Danehkar, Create object-oriented programming (OOP).

Version

0.2.0

EMCEE::FREE

```
result = emcee::free()
```

EMCEE::HAMMER

This function runs the affine-invariant MCMC Hammer, and returns the MCMC simulations

```
result = emcee::hammer(fcn, input, input_err_m, input_err_p, output, walk_num=walk_num,
    iteration_num=iteration_num, use_gaussian=use_gaussian, FUNCTARGS=parameter)
```

Returns

type=arrays. This function returns the results of the MCMC simulations.

Parameters

fcn IN REQUIRED TYPE=string
the calling function name

input IN REQUIRED TYPE=float
the input parameters array used by the calling function.

input_err_m IN REQUIRED TYPE=float
the lower limit uncertainty array of the parameters for the calling function.

input_err_p IN REQUIRED TYPE=float
the upper limit uncertainty array of the parameters for the calling function.

output IN REQUIRED TYPE=arrays
the output array returned by the calling function.

Keywords

walk_num
iteration_num
use_gaussian
FUNCTARGS IN TYPE=parameter
 the function arguments (not used for MCMC)

Examples

For example:

```

IDL> mc=obj_new('emcee')
IDL> mcmc_sim=mc->hammer('myfunc', input, input_err, output, $
IDL>                               walk_num=walk_num, iteration_num=iteration_num, $
IDL>                               use_gaussian=use_gaussian)
  
```

Author

Ashkbiz Danehkar

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History

15/03/2017, A. Danehkar, IDL code written Adopted from
 emcee() of sl_emcee by M.A. Nowak included in isisscripts
 01/05/2020, A. Danehkar, function arguments added
 12/05/2020, A. Danehkar, Move to object-oriented program-
 ming (OOP).

Version

0.2.0

EMCEE::FUNC_ERRORS

This function returns the uncertainties of the function outputs based on the confidence level.

```

result = emcee::func_errors(output, mcmc_sim, clevel=clevel [, /do_plot] [, image_output_path
=string])
  
```

Returns

type=arrays. This function returns uncertainties.

Parameters

output IN REQUIRED TYPE=arrays

the output array returned by the calling function.

mcmc_sim IN REQUIRED TYPE=arrays

the results of the MCMC simulations from `emcee_hammer()`.

Keywords

clevel

do_plot IN OPTIONAL TYPE=boolean

set to plot a normalized histogram of the MCMC chain

image_output_path IN OPTIONAL TYPE=string

the image output path

Examples

For example:

```
IDL> mc=obj_new('emcee')
IDL> mcmc_sim=mc->hammer('myfunc', input, input_err, output)
IDL> output_error=mc->func_errors(output, mcmc_sim, clevel=clevel)
```

Author

Ashkbiz Danehkar

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History

15/03/2017, A. Danehkar, IDL code written Adopted from `chain_hist()` of `sl_emcee` by M.A. Nowak included in `isisscripts`

12/05/2020, A. Danehkar, Move to object-oriented programming (OOP).

Version

0.2.0

EMCEE::SET_WALK_NUM

`emcee::set_walk_num, walk_num`

Parameters

walk_num

EMCEE::GET_WALK_NUM

```
result = emcee::get_walk_num()
```

EMCEE::SET_ITERATION_NUM

```
emcee::set_iteration_num, iteration_num
```

Parameters

iteration_num

EMCEE::GET_ITERATION_NUM

```
result = emcee::get_iteration_num()
```

EMCEE::SET_USE_GAUSSIAN

```
emcee::set_use_gaussian, use_gaussian
```

Parameters

use_gaussian

EMCEE::GET_USE_GAUSSIAN

```
result = emcee::get_use_gaussian()
```

EMCEE::SET_CLEVEL

```
emcee::set_clevel, clevel
```

Parameters

clevel

EMCEE::GET_CLEVEL

```
result = emcee::get_clevel()
```

EMCEE__DEFINE

`emcee__define`

emcee_func_errors.pro

EMCEE_FUNC_ERRORS

This function returns the uncertainties of the function outputs based on the confidence level.

```
result = emcee_func_errors(output, mcmc_sim, clevel [, /do_plot] [, image_output_path=
string])
```

Returns

type=arrays. This function returns uncertainties.

Parameters

output IN REQUIRED TYPE=arrays
the output array returned by the calling function.

mcmc_sim IN REQUIRED TYPE=arrays
the results of the MCMC simulations from `emcee_hammer()`.

clevel IN REQUIRED TYPE=float
the confidence level for the the lower and upper limits.
clevel=0.38292492 ; 0.5-sigma, clevel=0.68268949 ; 1.0-sigma, clevel=0.86638560 ; 1.5-sigma, clevel=0.90 ; 1.645-sigma, clevel=0.95 ; 1.960-sigma, clevel=0.95449974 ; 2.0-sigma, clevel=0.98758067 ; 2.5-sigma, clevel=0.99 ; 2.575-sigma, clevel=0.99730020 ; 3.0-sigma, clevel=0.99953474 ; 3.5-sigma, clevel=0.99993666 ; 4.0-sigma, clevel=0.99999320 ; 4.5-sigma, clevel=0.99999943 ; 5.0-sigma, clevel=0.99999996 ; 5.5-sigma, clevel=0.99999998 ; 6.0-sigma.

Keywords

do_plot IN OPTIONAL TYPE=boolean
set to plot a normalized histogram of the MCMC chain

image_output_path IN OPTIONAL TYPE=string
the image output path

Examples

For example:


```
IDL> output_error=emcee_func_errors(output, mcmc_sim, clevel)
```

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History

15/03/2017, A. Danehkar, IDL code written Adopted from chain_hist() of sl_emcee by M.A. Nowak included in isisscripts

Version

0.1.0

emcee_hammer.pro

EMCEE_HAMMER

This function runs the affine-invariant MCMC Hammer, and returns the MCMC simulations

```
result = emcee_hammer(fcn, input, input_err_m, input_err_p, output, walk_num, iteration_num
, use_gaussian, FUNCTARGS=parameter)
```

Returns

type=arrays. This function returns the results of the MCMC simulations.

Parameters

fcn IN REQUIRED TYPE=string
the calling function name

input IN REQUIRED TYPE=float
the input parameters array used by the calling function.

input_err_m IN REQUIRED TYPE=float
the lower limit uncertainty array of the parameters for the calling function.

input_err_p IN REQUIRED TYPE=float
the upper limit uncertainty array of the parameters for the calling function.

output IN REQUIRED TYPE=arrays
the output array returned by the calling function.

walk_num IN REQUIRED TYPE=integer
the number of the random walkers

iteration_num IN REQUIRED TYPE=integer
the number of the MCMC iteration

use_gaussian IN REQUIRED TYPE=boolean
if sets to 1, the walkers are initialized as a gaussian over the specified range between the min and max values of each free parameter, otherwise, the walkers are initialized uniformly over the specified range between the min and max values of each free parameter.

Keywords

FUNCTARGS IN TYPE=parameter
the function arguments (not used for MCMC)

Examples

For example:

```
IDL> mcmc_sim=emcee_hammer('myfunc', input, input_err, output, $
IDL>                               walk_num, iteration_num, use_gaussian)
```

Author

Ashkbiz Danehkar

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History

15/03/2017, A. Danehkar, IDL code written Adopted from emcee() of sl_emcee by M.A. Nowak included in isisscripts
01/05/2020, A. Danehkar, function arguments added

Version

0.1.0

*emcee_initialize.pro**EMCEE_INITIALIZE*

This function returns the initialized walkers for each free parameter.

```
result = emcee_initialize(fcn, param, param_err_m, param_err_p, walk_num, output_num,
    use_gaussian, FUNCTARGS=parameter)
```

Returns

type=arrays. This function returns the initialized walker.

Parameters

fcn IN REQUIRED TYPE=string
the calling function name

param IN REQUIRED TYPE=arrays
the input parameters array used by the calling function.

param_err_m IN REQUIRED TYPE=arrays
the lower limit uncertainty array of the parameters for the calling function.

param_err_p IN REQUIRED TYPE=arrays
the upper limit uncertainty array of the parameters for the calling function.

walk_num IN REQUIRED TYPE=integer
the number of the random walkers.

output_num IN REQUIRED TYPE=integer
the number of the output array returned by the calling function.

use_gaussian IN REQUIRED TYPE=boolean
if sets to 1, the walkers are initialized as a gaussian over the specified range between the min and max values of each free parameter, otherwise, the walkers are initialized uniformly over the specified range between the min and max values of each free parameter.

Keywords

FUNCTARGS IN TYPE=parameter
the function arguments (not used for MCMC)

Examples

For example:

```
IDL> x_walk=emcee_initialize(fcn, input, input_err, walk_num, $
IDL>                          output_num, use_gaussian))
```

Author

Ashkbiz Danehkar

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History

15/03/2017, A. Danehkar, IDL code written Adopted from
emcee() of sl_emcee by M.A. Nowak included in isisscripts
01/05/2020, A. Danehkar, function arguments added

Version

0.1.0

*emcee_inv_tot_dist.pro**EMCEE_INV_TOT_DIST*

This function returne the inverse Cumulative Distribution Function: $1/\sqrt{z}$ if the random number generator z is between $1/z_a$ and z_b , is used to generate for a $1/\sqrt{z}$ probability distribution.

```
result = emcee_inv_tot_dist(z, z_a, z_b)
```

Returns

type=arrays. This function returns the lower and higher linear histogram grids (hist_lo, hist_hi)

Parameters

z IN REQUIRED TYPE=float
the a random number generator for the probability distribution $1/\sqrt{z}$.

z_a IN REQUIRED TYPE=float
the inverse lower limit for the random number generator z : $1/z_a \leq z$.

z_b IN REQUIRED TYPE=float
 the higher limit for the random number generator z: $z \leq b$.

Examples

For example:

```
IDL> z = emcee_inv_tot_dist(random_num, adjust_scale_low, adjust_scale_high);
```

Author

Ashkbiz Danehkar

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History

15/03/2017, A. Danehkar, IDL code written Adopted from
 icdf() of sl_emcee by M.A. Nowak included in isisscripts

Version

0.1.0

emcee_linear_grid.pro

EMCEE_LINEAR_GRID

This procedure generates a linear grid of histogram bins.

```
emcee_linear_grid, x_min, x_max, nbins, hist_lo, hist_hi
```

Parameters

x_min IN REQUIRED TYPE=float
 the lower limit.

x_max IN REQUIRED TYPE=float
 the higher limit.

nbins IN REQUIRED TYPE=float
 the bins number.

hist_lo OUT REQUIRED TYPE=arrays
 returns the lower linear histogram grid,

hist_hi OUT REQUIRED TYPE=arrays
 returns the higher linear histogram grid.

Examples

For example:

```
IDL> x_min=1
IDL> x_max=20
IDL> nbins=1000
IDL> emcee_linear_grid, x_min, x_max, nbins, lo, hi
```

Author

Ashkbiz Danehkar

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History

15/03/2017, A. Danehkar, IDL code written Adopted from the S-Lang function `linear_grid()` in `isis`.

Version

0.1.0

emcee_update_walk.pro

EMCEE_UPDATE_WALK

This function creates the trial walker, examines whether it is acceptable, and returns the updated walker.

```
result = emcee_update_walk(fcn, random_num, x_a, x_b [, FUNCTARGS=parameter])
```

Returns

type=arrays. This function returns the updated walker.

Parameters

fcn IN REQUIRED TYPE=string
 the calling function name.

random_num IN REQUIRED TYPE=integer
 the random number.

x_a IN REQUIRED TYPE=arrays
the vector of the parameters for a specific walker.

x_b IN REQUIRED TYPE=arrays
the array of the walker parameters.

Keywords

FUNCTARGS IN OPTIONAL TYPE=parameter
the function arguments

Examples

For example:

```
IDL> x_output[j,*]=emcee_update_walk(fcn,a_random[random_num[j],*],$
IDL>                                array_xwalk,x_walk[*,b_walk])
```

Author

Ashkbiz Danehkar

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History

15/03/2017, A. Danehkar, IDL code written Adopted from
update_walker() of sl_emcee by M.A. Nowak included in
isisscripts

01/05/2020, A. Danehkar, function arguments added

Version

0.1.0