Function Reference

Import data

function [dat] = readdat(fname, NGPTS, nchns, ngdtrls);

```
% READDAT Read data in binary format and convert them into Matlab data
%
% Syntax:
%   dat = readdat(fname,NGPTS,nchns,ngdtrls);
%
% Input(s):
%   fname   -   Binary data file path and name
%   NGPTS   -   Number of points to be read in each trial
%   nchns   -   Number of channels to be read
%   ngdtrls -   Number of trials to be read
%
% Output(s):
%   dat     -   Three dimensional Matlab data array
%               = Points x Channels x Trials
%
% Example:
%   dat = readdat('test71.bin',18,15,137);
%
% See also: writedat.
```

Export data

function writedat(fname, dat);

```
% write data in format that steve required
% dat: T x chans x Trial
% fname: file name of output file
```

Preprocessing

1. *function [data] = pre_sube(dat);*

```
% Subtract the ensemble mean
% Usage:
%  [data] = pre_sube(dat);
%  dat: input file;
%  data: output file after subtract the ensemble mean
```

2. *function [data] = pre_sube_divs(dat);*

```
% Subtract the ensemble mean and divide by standard deviation
% Usage:
%  [data] = pre_sube_divs(dat);
%  dat: input file;
%  data: output file after subtract the ensemble mean and divide by
%  standard deviation
```

3. *function [data] = pre_subt(dat);*
% Subtract the temporal mean
% Usage:
% [data] = pre_subt(dat);
% dat: input file;
% data: output file after subtract the temporal mean

4. *function [data] = pre_subt_divs(dat);*
% Subtract the temporal mean and divide by standard deviation
% Usage:
% [data] = pre_subt_divs(dat);
% dat: input file;
% data: output file after subtract the temporal mean and divide by
% standard deviation

AIC model order estimation

function [AIC]=aic_test(dat, window,maxorder)
% Compute the AIC
% dat: data set in Matlab format
% window: window length
% maxorder: the maximum model order you want to try.
% AIC: each row is the AIC coefficient for each window.
% Example:
% [AIC]=aic_test(data,10,8)

Whiteness test

function [resid]=whiteness_test(dat, window,order)
% Whiteness test
% dat: data set in Matlab format
% window: window length
% order: model order
% resid: residuals probabilities
% Example:
% [resid]=whiteness_test(data,10,5)

Consistency test

function [ratio]=consistencytest(dat,arcoeff,arnoise)
% Consistency test
% dat: data set in Matlab format
% arcoeff: AR coefficient
% arnoise: AR noise
% Ouput: ratio in Matlab format
% Example: [ratio]=consistencytest(data,A,Ve)

Stability test

function [LE] = lyap_batch(arcoeff, arnoise, T);

% a batch version to compute Lyapunov exponen
% Usage:
% [LE] = lyap_batch(arcoeff, arnoise, T);
% arcoeff: AR coefficient
% arnoise: AR noise
% T: burn-in period;
% Output:
% Le is the output of Stability test, which is a vector. The length of the vector is the same as the number of windows.
% Example:
% [LE]= lyap_batch(A, Ve, 1000);

AMAR modeling

1. One window (multivariate model)

function [A,Ve]=one_mul_model (dat, order, startp, window)

% One window for multivariate model
% Usage:
% [A,Ve]=one_mul_model (dat, order, startp, window);
% dat: input file in matlab format;
% order: model order
% startp: start position of the window
% window: window length
% Output: A is the name of AR coefficient file
% Ve is the name of AR noise file
% Example:
% [A,Ve]=one_mul_model (data, 5, 1, 10);

2. One window (bivariate model)

function one_bi_model (dat, order, startp, window)

% One window for bivariate model
% Usage:
% one_bi_model (dat, order, startp, window);
% dat: input file in matlab format;
% order: model order
% startp: start position of the window
% window: window length
% Output is in the bsmart/Onewindow_Coefficient directory
% Example:
% one_bi_model (data,5,1,10);

3. Moving window (multivariate models)

function [A,Ve]=mov_mul_model (dat, order, startp, endp, window)

% Moving window for multivariate model
% Usage:
% one_mul (dat, order, startp, endp, window);

% dat: input file in matlab format;
% order: model order
% startp: start position
% endp: ending position
% window: window length
% Output: A is the name of AR coefficient file
% Ve is the name of AR noise file
% Example:
% [A,Ve]=mov_mul_model (data, 5, 1, 18, 12);

4. Moving window(bivariate models)
function mov_bi_model (dat, order, startp, endp, window)
% Moving window for bivariate models
% Usage:
% mov_bi_model (dat, order, startp, endp, window);
% dat: input file in matlab format;
% order: model order
% startp: start position
% endp: ending position
% window: window length
% Output is in the bsmart/Movingwindow_Coefficient directory
% Example:
% [A,Ve]=mov_mul_model (data, 5, 1, 18, 12);

Analysis

Power

1. For multivariate model -- spectrum_analysis()

function [power] = autopower(aredat,arndat,n,fs);

% Compute the auto power
% Usage:
% [power] = autopower(aredat,arndat,n,fs);
% aredat: AR coefficient file
% arndat: AR noise file
% n: Number of frequency bins
% fs: Sampling rate
% Example:
% [power] = autopower(A,Ve,100,200);

2. For bivariate model -- power_pairwise()

function [power]= bi_power(directory, n , fs)

% Compute the auto power from the Bivariate models

% Usage:
% [power]= bi_power(directory, n , fs)
% directory: Onewindow_Coefficient or Movingwindow_Coefficient directory
% n: Number of frequency bins
% fs: Sampling rate

% Example:
%[power]=bi_power('C:\mar\bsmart\Movingwindow_Coefficient',100,200)

Coherence

1. For multivariate model -- coherence()

function [coherence] = paircoherence(aredat,arndat,n,fs);
% Compute the pair coherence
% Usage:
% [coherence] = paircoherence(aredat,arndat,n,fs);
% aredat: AR coefficient file
% arndat: AR noise file
% n: Number of frequency bins
% fs: Sampling rate
% Example:
% [coherence] = paircoherence(A,Ve,100,200);

2. For bivariate model -- pairwise_coherence()
function [coherence]= bi_coherence(directory, n , fs)

% Compute the pair coherence from the Bivariate models
% Usage:
% [coherence] = bi_coherence(directory, n , fs)
% directory: Onewindow_Coefficient or Movingwindow_Coefficient directory
% n: Number of frequency bins
% fs: Sampling rate
% Example:
%
[coherence]=bi_coherence('C:\mar\bsmart\Movingwindow_Coefficient',100,200)

Granger causality

1. For bivariate model -- pairwise_granger_causality()
   a. one window

function [Fx2y,Fy2x]= one_bi_ga(dat,startp,window,order,fs,freq)

% Compute the granger causality from the one window Bivariate models
% Usage:
% [Fx2y,Fy2x]= one_bi_ga(dat,startp,window,order,fs,freq)

```
%  dat: data set in Matlab format
%  starp: start position
%  window: window length
%  order: model order
%  fs: Sampling rate
%  freq: a vector of frequencies of interest, usually freq=0:fs/2
%   Fx2y is the causality measure from x to y
%   Fy2x is causality from y to x
%       the order of Fx2y/Fy2x is 1 to 2:L, 2 to 3:L,....,L-1 to L.  That is,
%       1st column: 1&2; 2nd: 1&3; ...; (L-1)th: 1&L; ...; (L(L-1))th:
%       (L-1)&L.
% Example:
%  [Fx2y,Fy2x]= one_bi_ga(data,1,10,5,200,[1:100])
```

b. moving window

```
function [Fxy,Fyx]= mov_bi_ga(dat,startp,endp,window,order,fs,freq)

% Compute the granger causality from the moving window Bivariate
models
% Usage:
% [Fx2y,Fy2x]= mov_bi_ga(dat,startp,endp,window,order,fs,freq)
%  dat: data set in Matlab format
%  starp: start position
%  endp: ending position
%  window: window length
%  order: model order
%  fs: Sampling rate
%  freq: a vector of frequencies of interest, usually freq=0:fs/2
%   Fx2y is the causality measure from x to y
%   Fy2x is causality from y to x
%       the order of Fx2y/Fy2x is 1 to 2:L, 2 to 3:L,....,L-1 to L.  That is,
%       1st column: 1&2; 2nd: 1&3; ...; (L-1)th: 1&L; ...; (L(L-1))th:
%       (L-1)&L.
% Example:
%  [Fxy,Fyx]= mov_bi_ga(data,1,18,10,5,200,[1:100])
```

Plot

Data view

Visualize data -- dataview()

a. chart view

```
function chartview (dat,channel,triali,trialj,pointi,pointj)

% chart view of data set
% dat: data set in Matlab format
% triali: start trial
% trialj: ending trial
```

```
% pointi: start point
% pointj: ending point
% Example:
% chartview (data,9,1,5,1,15)
```

b. grid view

```
function gridview (dat,channeli,channelj,trial,pointi,pointj)

% grid view of data set
% dat: data set in Matlab format
% channeli: start channel
% channelj: ending channel
% trial: specified trial
% pointi: start point
% pointj: ending point
% Example:
% gridview (data,1,6,5,1,15)
```

Coherence view

Visualize coherence -- coherence_view()

```
function co_view(coherence, fs, channeli, channelj, timen)

%  View coherence
%  coherence: coherence data set
%  fs: sampling rate
%  channeli: one channel
%  channelj: another channnel
%  timen(optional): view coherence at one time
%  Example:
%  co_view(paircoh,200,9,10); co_view(paircoh,200,9,10,2);
```

Granger causality view

Visualize granger causality -- granger_causality_view()

```
function ga_view(Fxy,Fyx, fs, channeli, channelj, timen)

%  View granger causality
%  Fxy, Fyx: granger causality data set
%  fs: sampling rate
%  channeli: one channel
%  channelj: another channnel
%  timen(optional): view coherence at one time
%  Example:
%  ga_view(Fxy,Fyx,200,9,10);ga_view(Fxy,Fyx,200,10,9,5);
```

Power view

Visualize power -- power_view()

```
function po_view(power, fs, channeli, timen)

%  View power
%  power: auto power data set
%  fs: sampling rate
%  channeli: specified channel
%  timen(optional): view coherence at one time
%  Example:
%  po_view(autospect,200,9); po_view(autospect,200,9,2);
```

Coherence network

Coherence network analysis -- coherence_network()

```
function conetwork(coherence,location,thre,time,fre1,fre2)
% Plot the coherence network
% coherence: pair coherence
% location: location of the sites
% thre: threshold
% time: specify the window number
% fre1: starting frequency
% fre2: ending frequency
% Example:
%   conetwork(coherence,location,0.25,5,1,50);
```

Granger causality network

Granger causality network analysis -- granger_causality_network()

```
function ganetwork(Fxy,Fyx,location,thre,time,fre1,fre2)
% Plot the Granger causality network
% Fxy,Fyx: Granger causality
% location: location of the sites
% thre: threshold
% time: specify the window number
% fre1: starting frequency
% fre2: ending frequency
% Example:
%   ganetwork(Fxy,Fyx,location,0.18,5,1,50);
```

Testco.m to test the command line use.

```
% read data
 dat = readdat('test71.bin',18,15,137);
% Preprocessing data (subtract ensemble mean)
 [data] = pre_sube(dat);
% AIC test
 [AIC]=aic_test(data,10,8);
% Build moving window multivariate AR model
 [A,Ve]=mov_mul_model (data, 5, 1, 15, 10);
% consistency test
```

```
 [ratio]=consistencytest(data,A,Ve);
% whiteness test
  [resid]=whiteness_test(data,10,5);
% stability test
  [LE]= lyap_batch(A, Ve, 1000);
% compute auto power
  [power] = autopower(A,Ve,100,200);
% compute pair coherence
  [coherence] = paircoherence(A,Ve,100,200);
% compute Granger causality
  [Fxy,Fyx]= mov_mul_ga(data,1,15,10,5,200,[1:100]);
% power view
  po_view(power,200,9); po_view(power,200,9,2);
% coherence view
  co_view(coherence,200,9,10); co_view(coherence,200,9,10,2);
% Granger causality view
  ga_view(Fxy,Fyx,200,9,10);ga_view(Fxy,Fyx,200,10,9,5);
% coherence network
  load location;
  conetwork(coherence,location,0.25,5,1,50);
% Granger causality network
  ganetwork(Fxy,Fyx,location,0.18,5,1,50);
```