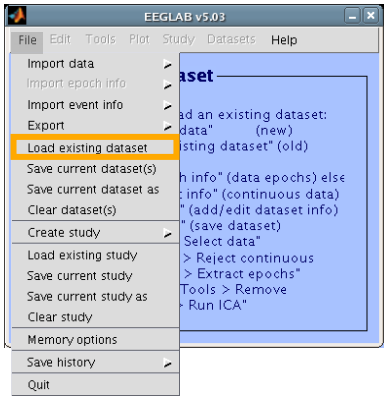
Command line tools

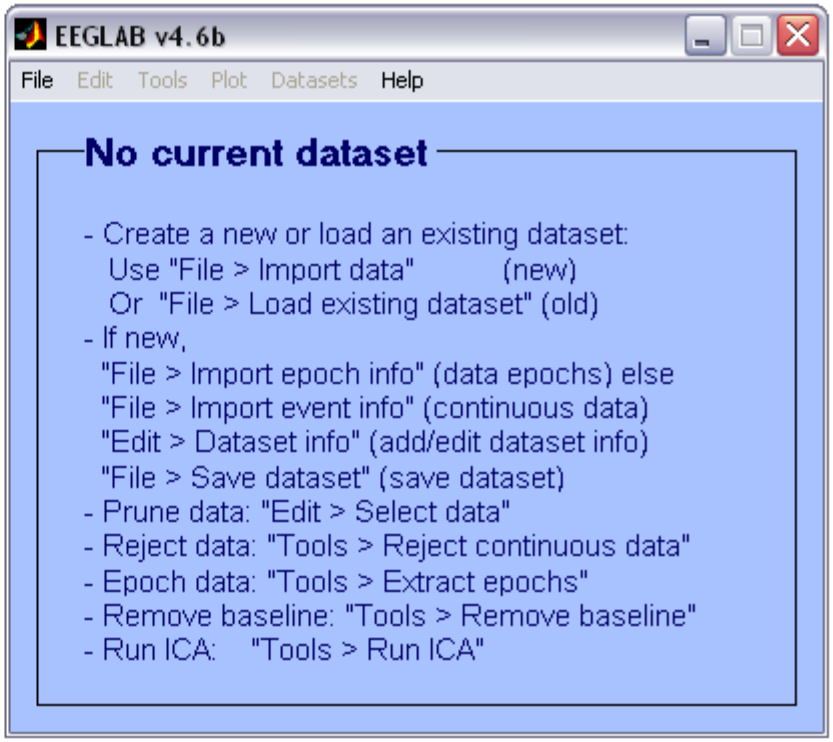


(Menus write both dataset and global history)

- Automated processing on groups of subjects (possibly on several processors).
- Richer options for plotting and processing functions (time-frequency decompositions, …)
- Selecting data/epoch based on event context
- Custom processing…

Starting EEGLAB

```
>> eeglab
eeglab: options file is /Volumes/donnees/data/STUDYste
Adding path to all EEGLAB functions
Adding path to eeglab/external/bioelectromagnetism_ligt
Adding path to eeglab/external/biosig-partial
Adding path to eeglab/external/fieldtrip-partial
Adding path to eeglab/external/fieldtrip-partial subfolders
EEGLAB: adding plugin function "eegplugin_VisEd"
EEGLAB: adding "eepimport1.02" plugin (see >> help ee
EEGLAB: adding "bdfimport" plugin (see >> help eegplu
EEGLAB: adding "brainmovie0.1b" plugin (see >> help e
EEGLAB: adding "ctfimport1.03" plugin (see >> help eeg
EEGLAB: adding "dipfit2.2" plugin (see >> help eegplugi
EEGLAB: adding "EEG toolbox ERP plotting" plugin (see >> help eegplugin_eeg_toolbox)
EEGLAB: adding "erpssimport1.00" plugin (see >> help eegplugin_erpssimport)
EEGLAB: adding "fmrib1.21" plugin (see >> help eegplugin_fmrib)
EEGLAB: adding "iirfilt1.01" plugin (see >> help eegplugin_iirfilt)
EEGLAB: adding "eepimport1.02" plugin (see >> help eegplugin_ascinstep)
EEGLAB: adding "loreta1.0" plugin (see >> help eegplugin_loreta)
EEGLAB: adding "Butter1.0" plugin (see >> help eegplugin_ERPLAB_filters)
EEGLAB: adding "Measure_Product1.0" plugin (see >> help eegplugin_mp_clustering)
EEGLAB: adding plugin function "eegplugin_miclust"
EEGLAB: adding "4dneuroimaging1.00" plugin (see >> help eegplugin_4dneuroimaging)
>>
```

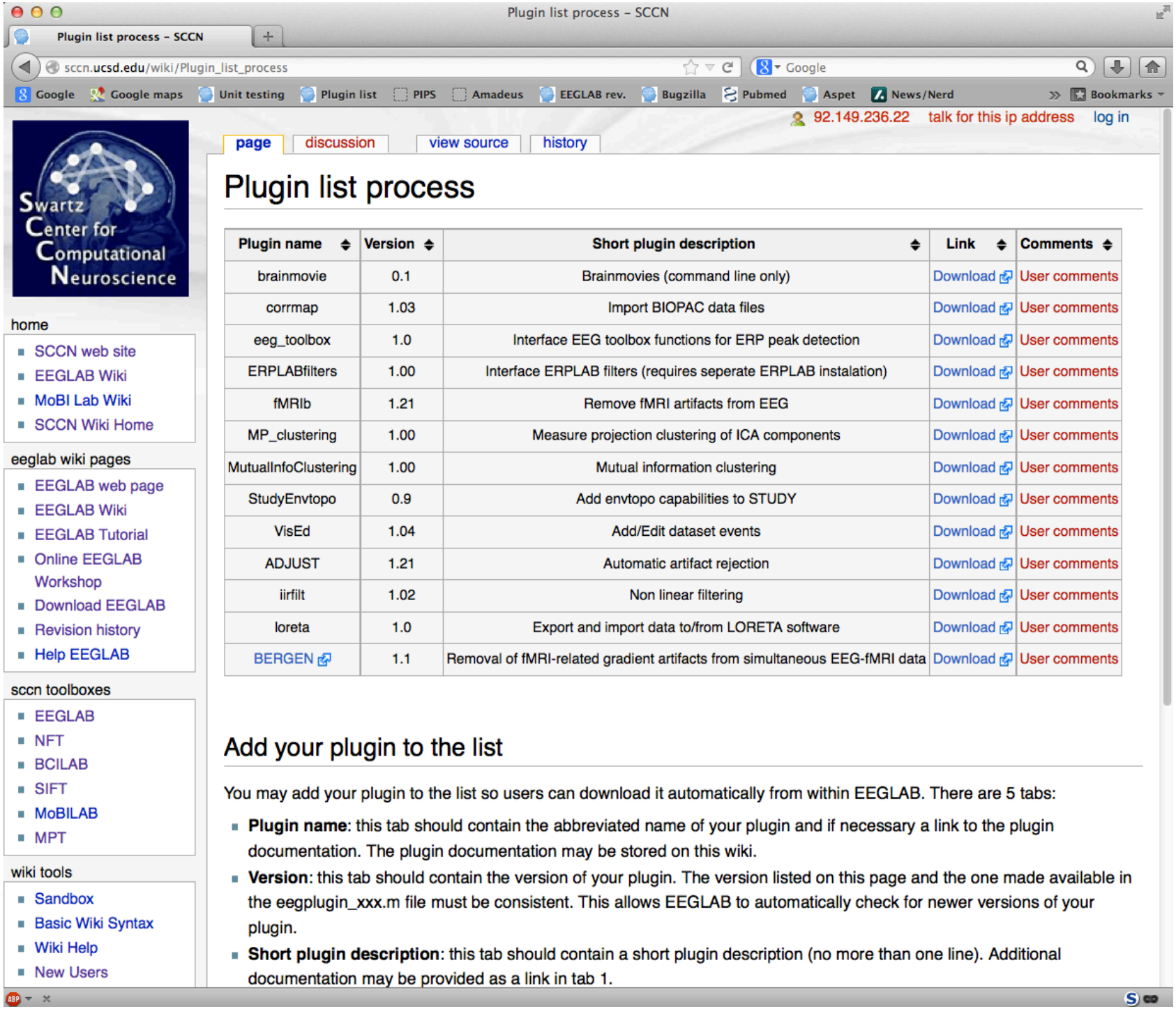


Proper EEGLAB plugins

eepimport1.02	Data importing for EEprobe data (Oostenved & ANT company)
bva_io1.30	Brain vision analyzer import/export plugin (Widmann & Delorme)
ctfimport1.01	MEG CTF import plugin (Carver, Weber & Delorme)
dipfit2.0	4-shell and BEM (Oostenveld & Delorme)
fmrib1.2b	Removal of artifact from simultaneously EEG/fMRI recording (Niazi)
iirfilt1.0	Non-linear IIR filtering (Pozdin)
loreta2.0	Interface to LORETA-KEY (Delorme)

Matlab toolboxes interfaced as plugins

BIOSIG	Data importing for rare data binary format (Schloegl)
File-IO	Data importing (Oostenveld)
Fieldtrip	Source localization and time-freq. decompositions (Oostenveld)
LIMO-EEG	General linear model and EEG
SIFT	Source information flow toolbox



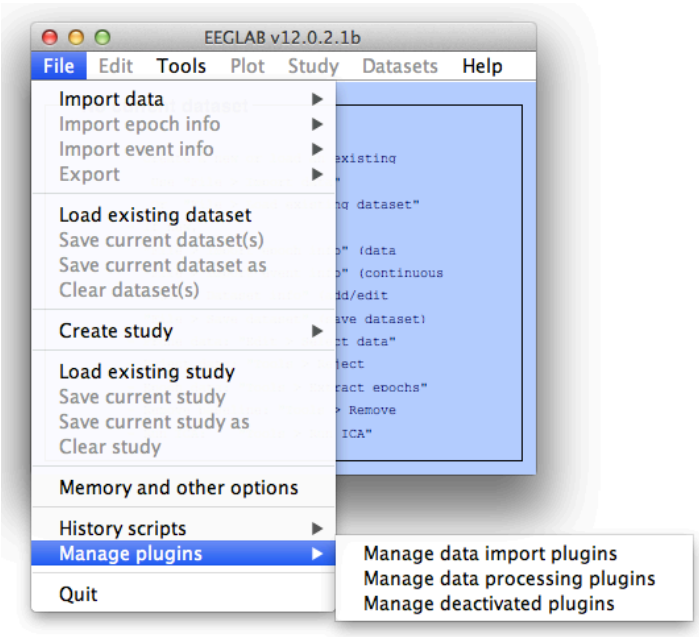
Plugin list process

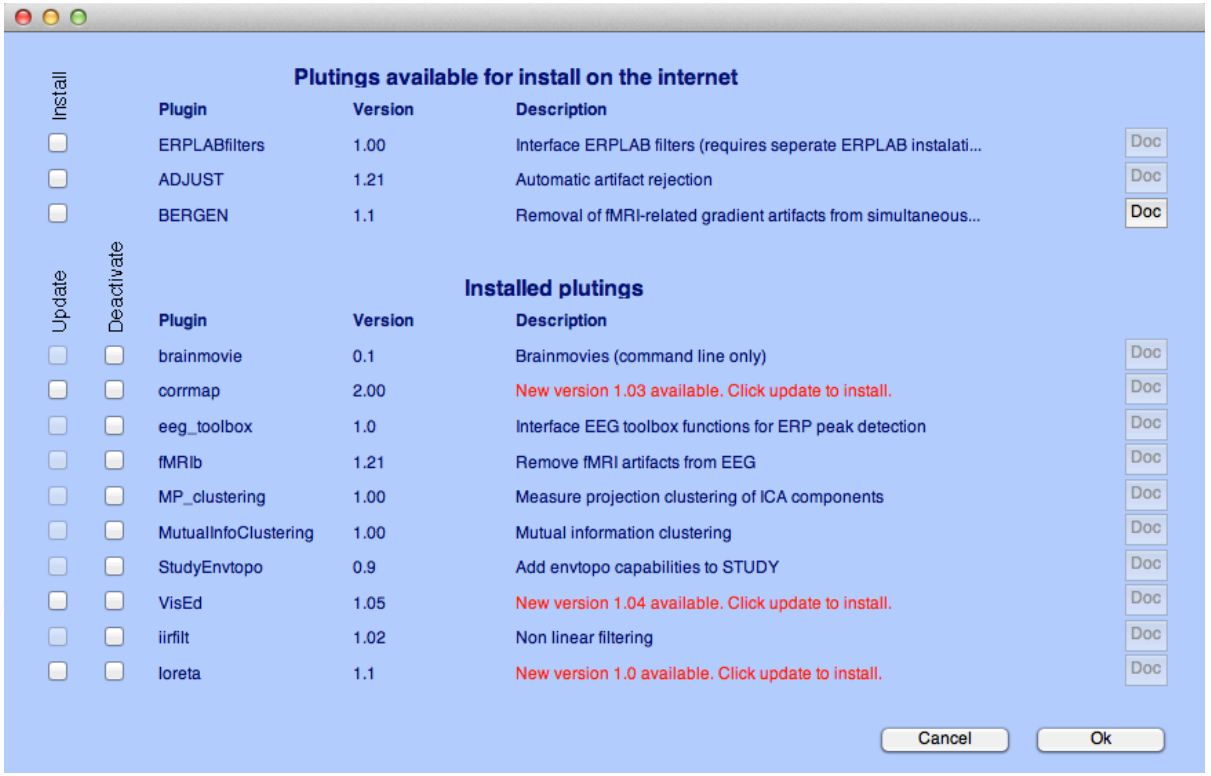
Plugin name	Version	Short plugin description	Link	Comments
brainmovie	0.1	Brainmovies (command line only)	Download	User comments
corrmap	1.03	Import BIOPAC data files	Download	User comments
eeg_toolbox	1.0	Interface EEG toolbox functions for ERP peak detection	Download	User comments
ERPLABfilters	1.00	Interface ERPLAB filters (requires seperate ERPLAB instalation)	Download	User comments
fMRIb	1.21	Remove fMRI artifacts from EEG	Download	User comments
MP_clustering	1.00	Measure projection clustering of ICA components	Download	User comments
MutualInfoClustering	1.00	Mutual information clustering	Download	User comments
StudyEnvtopo	0.9	Add envtopo capabilities to STUDY	Download	User comments
VisEd	1.04	Add/Edit dataset events	Download	User comments
ADJUST	1.21	Automatic artifact rejection	Download	User comments
iirfilt	1.02	Non linear filtering	Download	User comments
loreta	1.0	Export and import data to/from LORETA software	Download	User comments
BERGEN	1.1	Removal of fMRI-related gradient artifacts from simultaneous EEG-fMRI data	Download	User comments

Add your plugin to the list

You may add your plugin to the list so users can download it automatically from within EEGLAB. There are 5 tabs:

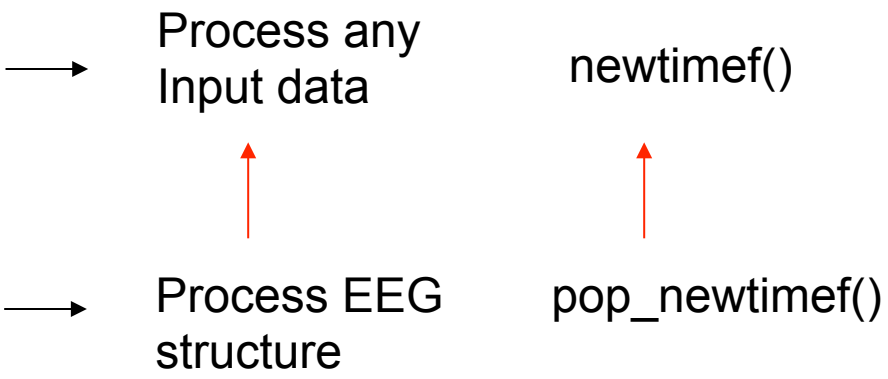
- **Plugin name**: this tab should contain the abbreviated name of your plugin and if necessary a link to the plugin documentation. The plugin documentation may be stored on this wiki.
- **Version**: this tab should contain the version of your plugin. The version listed on this page and the one made available in the eegplugin_xxx.m file must be consistent. This allows EEGLAB to automatically check for newer versions of your plugin.
- **Short plugin description**: this tab should contain a short plugin description (no more than one line). Additional documentation may be provided as a link in tab 1.


EEGLAB v12.0.2.1b
File
Edit
Tools
Plot
Study
Datasets
Help
Import data
Import epoch info
Import event info
Export
Load existing dataset
Save current dataset(s)
Save current dataset as
Clear dataset(s)
Create study
Load existing study
Save current study
Save current study as
Clear study
Memory and other options
History scripts
Manage plugins
Quit
Manage data import plugins
Manage data processing plugins
Manage deactivated plugins


Plutings available for install on the internet
Install
Plugin
Version
Description
ERPLABfilters
1.00
Interface ERPLAB filters (requires seperate ERPLAB instalati...
ADJUST
1.21
Automatic artifact rejection
BERGEN
1.1
Removal of fMRI-related gradient artifacts from simultaneous...
Doc
Installed plutings
Update
Deactivate
brainmovie
0.1
Brainmovies (command line only)
corrmap
2.00
New version 1.03 available. Click update to install.
eeg_toolbox
1.0
Interface EEG toolbox functions for ERP peak detection
fMRIb
1.21
Remove fMRI artifacts from EEG
MP_clustering
1.00
Measure projection clustering of ICA components
MutualInfoClustering
1.00
Mutual information clustering
StudyEnvtopo
0.9
Add envtopo capabilities to STUDY
VisEd
1.05
New version 1.04 available. Click update to install.
iirfilt
1.02
Non linear filtering
loreta
1.1
New version 1.0 available. Click update to install.
Cancel
Ok

Writing EEGLAB plugins

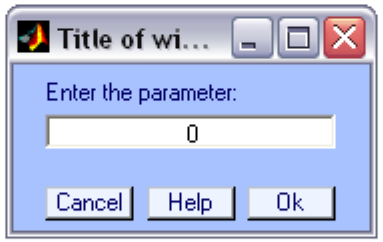
- Assuming that you have a signal processing function called xxxxx
- a pop_xxxxx function will interface your signal processing function
- a eegplugin_xxxxx function will add the menu to the main interface (and history etc…)



Pop functions

- Called with the EEG structure only pop_xxxxx(EEG), they pop-up a GUI asking for more arguments
- Called with enough arguments, the simply call the signal processing function

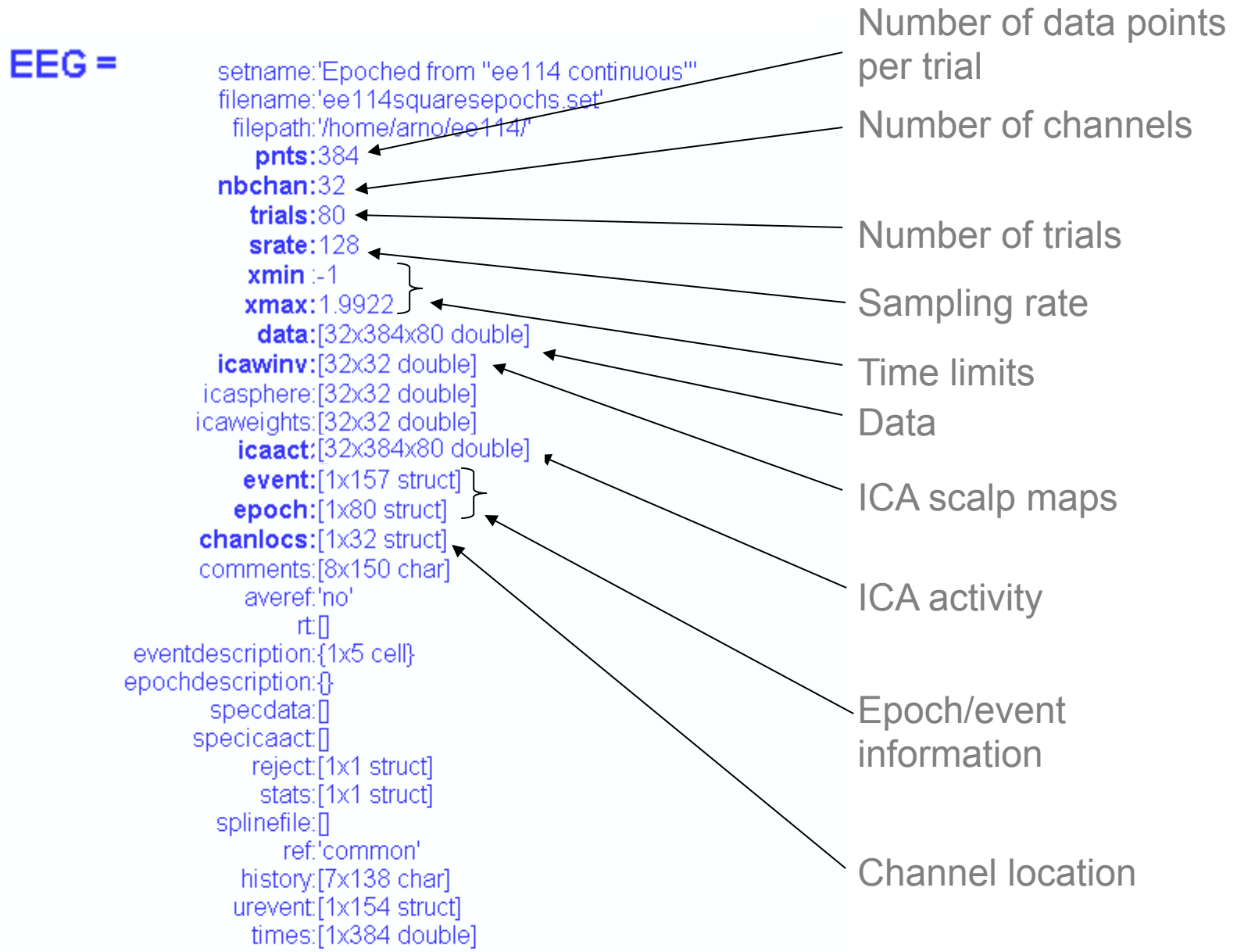
```
function [EEG, com] = pop_sample( EEG,  param1 );

com = ''; % empty history
if nargin < 2
      % pop up window if less than 2 arguments
      result       = inputdlg({ 'Enter the parameter:' }, 'Title of window', 1, { '0' })
      if length( result ) == 0 return; end;

      param1  = eval( [ '[' result{1} ']' ] ); % the brackets allow to process matlab arrays
end;

sample( EEG.data, param1); % run sample function

com = sprintf('pop_sample(EEG, %d );', param1); % return history
```



EEGLAB Data Structures

1. EEG - root 'dataset' structure
   - .data - the dataset data (2-D, 3-D matrix)
   - .chanlocs - channel locations substructure
   - .event - data events substructure
   - .epoch - data epochs substructure
2. ALLEEG - vector of loaded EEG datasets
3. CURRENTSET - index in ALLEEG of current EEG dataset
4. STUDY - root 'studyset' structure
   - .cluster - component clustering substructure

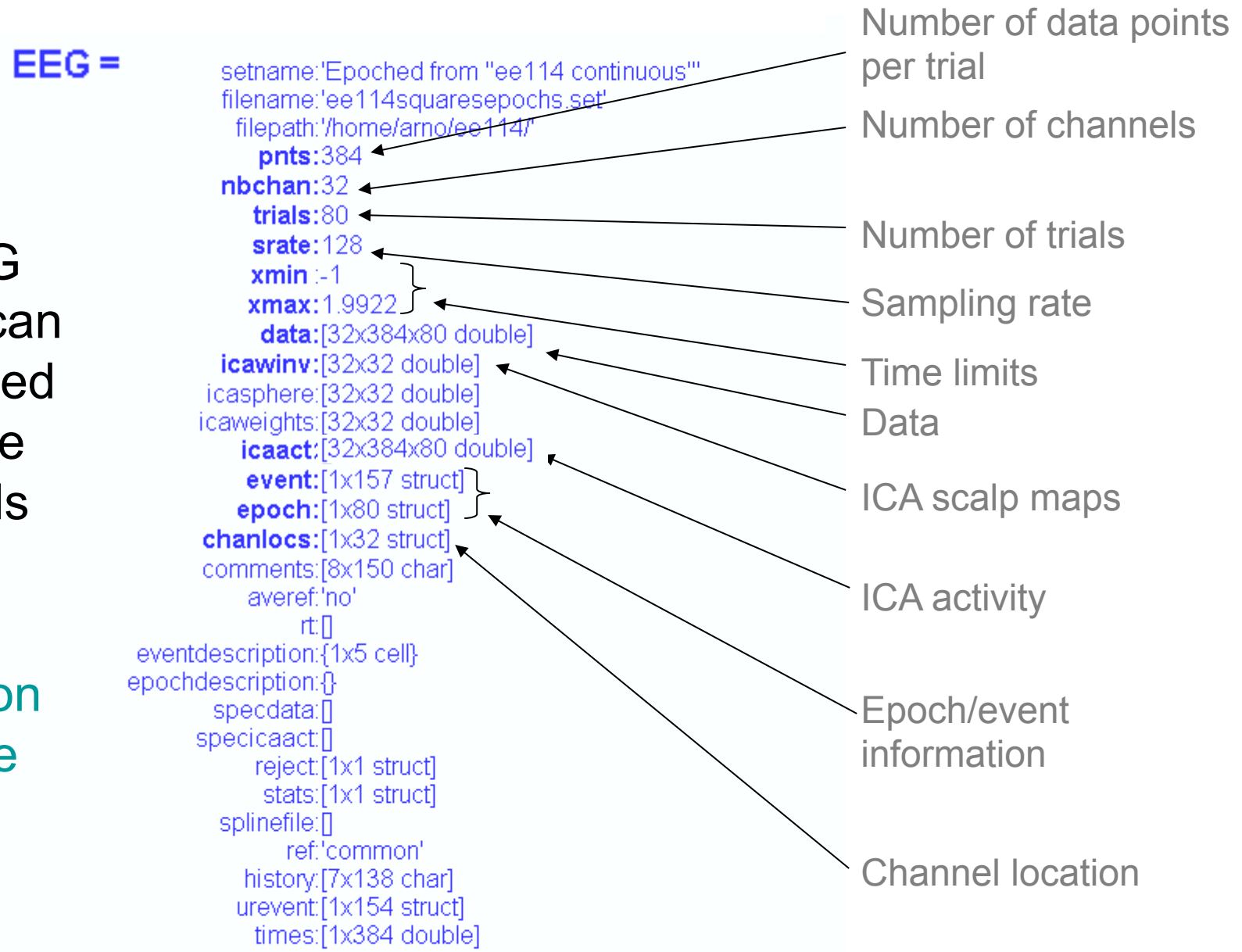
EEG structure



EEG structure

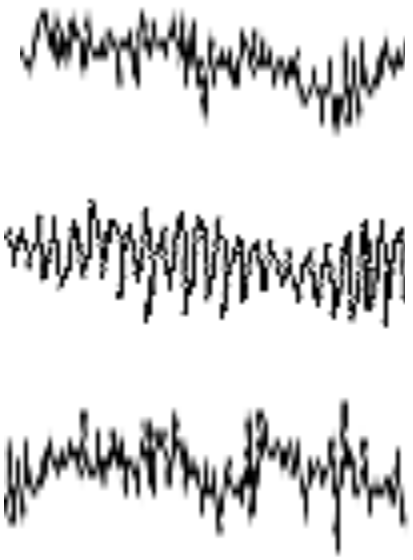
The EEG structure can be extended to include new fields

store information for future access



Continuous data

$$\textbf{EEG.data} = \begin{bmatrix} 2.1 & 3.8 & 4.9 & 5.1 & 4.8 & 3.9 & \\ -1.3 & -2.4 & -0.5 & -0.3 & 1.4 & 2.5 & ... \\ 5.2 & 4.7 & 3.3 & 1.2 & 0.7 & 1.3 & \end{bmatrix}$$



Data epochs

EEG.data $= \begin{bmatrix} 2.1 & 3.8 & 4.9 & 5.1 & 4.8 & 3.9 & \\ -1.3 & -2.4 & -0.5 & -0.3 & 1.4 & 2.5 & ... \\ 5.2 & 4.7 & 3.3 & 1.2 & 0.7 & 1.3 & \end{bmatrix}$ Trials 1: EEG.data(:,:,1)

$\begin{bmatrix} 2.1 & 3.8 & 4.9 & 5.1 & 4.8 & 3.9 & \\ -1.3 & -2.4 & -0.5 & -0.3 & 1.4 & 2.5 & ... \\ 5.2 & 4.7 & 3.3 & 1.2 & 0.7 & 1.3 & \end{bmatrix}$ Trials 2: EEG.data(:,:,2)

$\begin{bmatrix} 2.1 & 3.8 & 4.9 & 5.1 & 4.8 & 3.9 & \\ -1.3 & -2.4 & -0.5 & -0.3 & 1.4 & 2.5 & ... \\ 5.2 & 4.7 & 3.3 & 1.2 & 0.7 & 1.3 & \end{bmatrix}$ Trials 3: EEG.data(:,:,3)

Plot ERP for your data

```
>> figure; plot(mean(EEG.data,3)');
>> figure; plot(EEG.times, mean(EEG.data,3)');
```

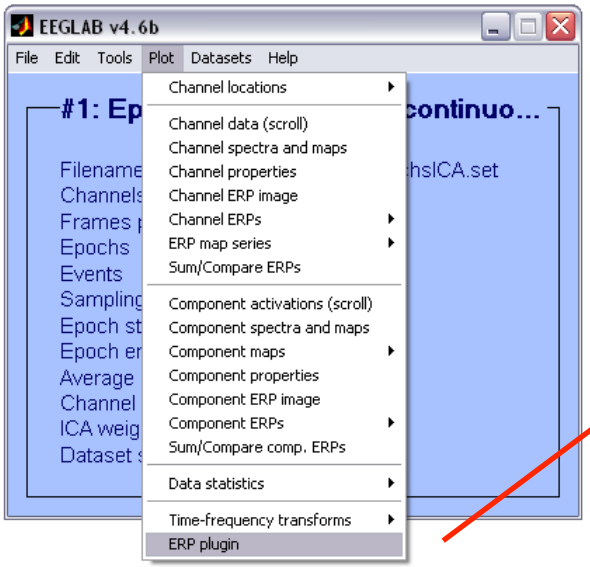
eegplugin functions

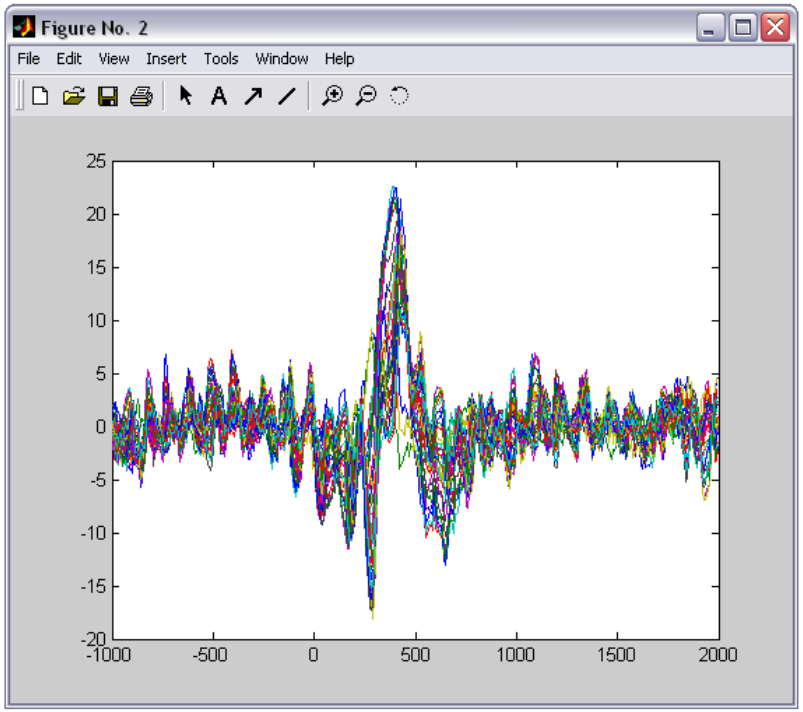
- eegplugin_xxxx function

```
% eegplugin_erp() - plot ERP plugin

function eegplugin_erp( fig, try_strings, catch_strings)

% create menu
plotmenu = findobj(fig, 'tag', 'plot'); % find plot menu

% create submenu
uimenu( plotmenu, 'label', 'ERP plugin', ...
     'callback', 'figure; plot(EEG.times, mean(EEG.data,3));');
```

eegplugin functions

```
>> eeglab
eeglab: adding "BIOSIGv0.86" plugin
eeglab: adding "eepimport1.02" plugin (see >> help eegplugin_eepimport)
eeglab: adding "bva_io1.30" plugin (see >> help eegplugin_bva_io)
eeglab: adding "ctfimport1.01" plugin (see >> help eegplugin_ctfimport)
eeglab: adding "dipfit2.0" plugin (see >> help eegplugin_dipfit2_0)
eeglab: adding plugin function "eegplugin_erp"
eeglab: adding "fmrib1.2b" plugin (see >> help eegplugin_fmrib)
eeglab: adding "icaclust1.00" plugin (see >> help eegplugin_icaclust)
eeglab: adding "iirfilt1.0" plugin (see >> help eegplugin_iirfilt)
eeglab: adding "loreta1.0" plugin (see >> help eegplugin_loreta)
eeglab: adding "newtimefreq1.00" plugin (see >> help eegplugin_ne
>>
```





PCA plugin

```
function vers = eegplugin_pca(fig, trystrs, catchstrs)

   vers = 'pca1.00';

   % find tools menu
   menu = findobj(fig, 'tag', 'tools');

   % PCA command
    cmd = [ '[~ EEG.icawinv] = runpca(EEG.data(:,:));' ];
    cmd = [ cmd 'EEG.icaweights = pinv(EEG.icawinv);' ];
    cmd = [ cmd 'EEG.icasphere = eye(EEG.nbchan);' ];

   % create menu
   uimenu( menu, 'Label', 'Run PCA', 'CallBack', cmd, 'separator', 'on');
```

'import data' -> File > import data menu
'import epoch' -> File > import epoch menu
'import event' -> File > import event menu
'export' -> File > export
'tools' -> tools menu
'plot' -> plot menu

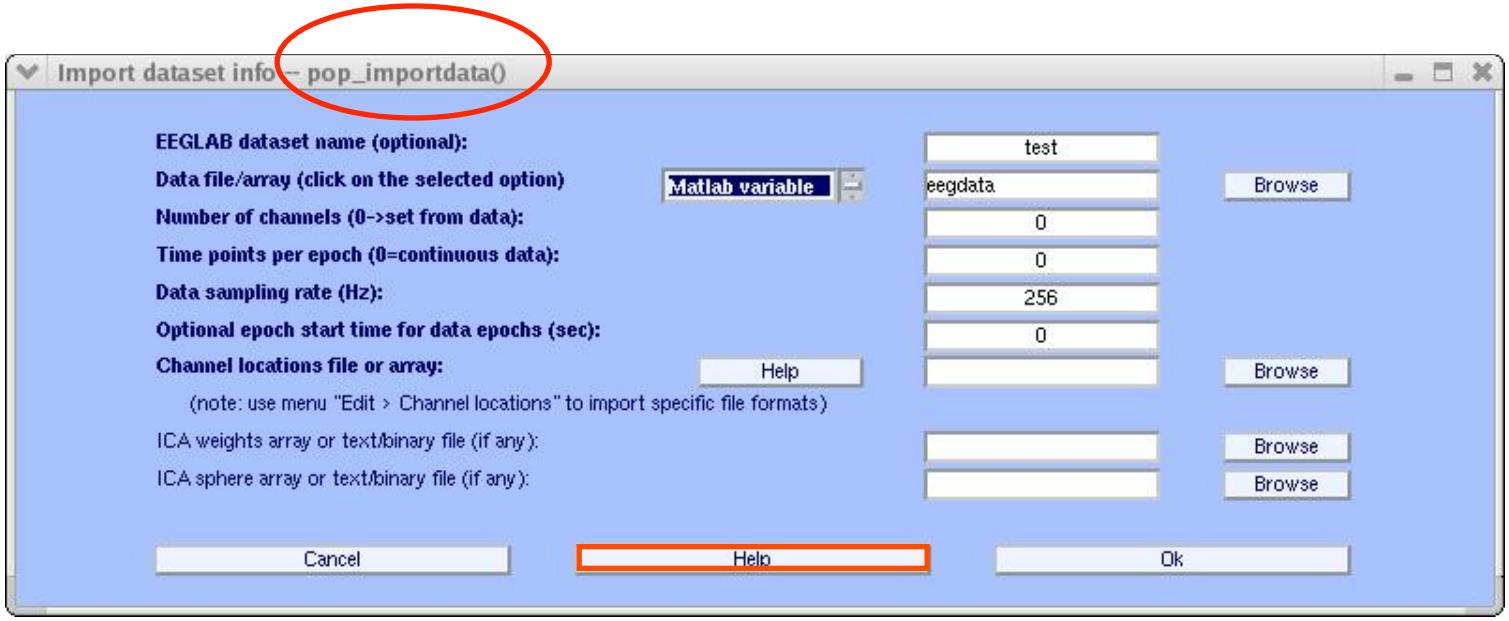
EEGLAB documentation

EEGLAB Home Page sccn.ucsd.edu/eeglab/

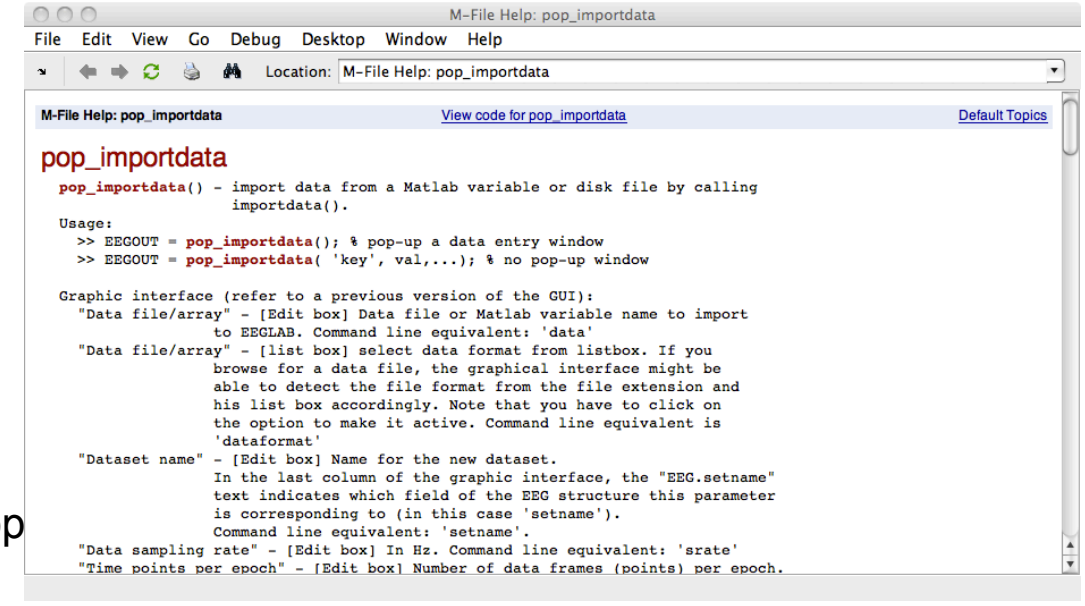
EEGLAB Tutorial Index sccn.ucsd.edu/wiki/EEGLAB

- 200 pages of tutorial (including “how to” for plugins) WEB or PDF
- Function documentation (next slide)
- Send questions to the mailing list eeglablist@sccn.ucsd.edu
  (or search mailing list archive using google)
- Bug submission http://sccn.ucsd.edu/eeglab/bugzilla
- Email us (suggestions) eeglab@sccn.ucsd.edu
- Workshop with practicum every year

Help message



>> help pop



Exercice

Write a plugin to plot ERPs

1. Save eegplugin_erp.m in the *plugins* folder of EEGLAB
2. Restart EEGLAB
3. Load epoched EEGLAB dataset
4. Use plugin menu

Using EEGLAB history for basic scripting

Task 1

Create a script from ‘eegh’ output

Task 2

Adapt your script with variables

Task 3

Create a Matlab function

Task 4

Exercise...

Using EEGLAB history for basic scripting

Task 1

Create a script from ‘eegh’ output

Task 2

Adapt your script with variables

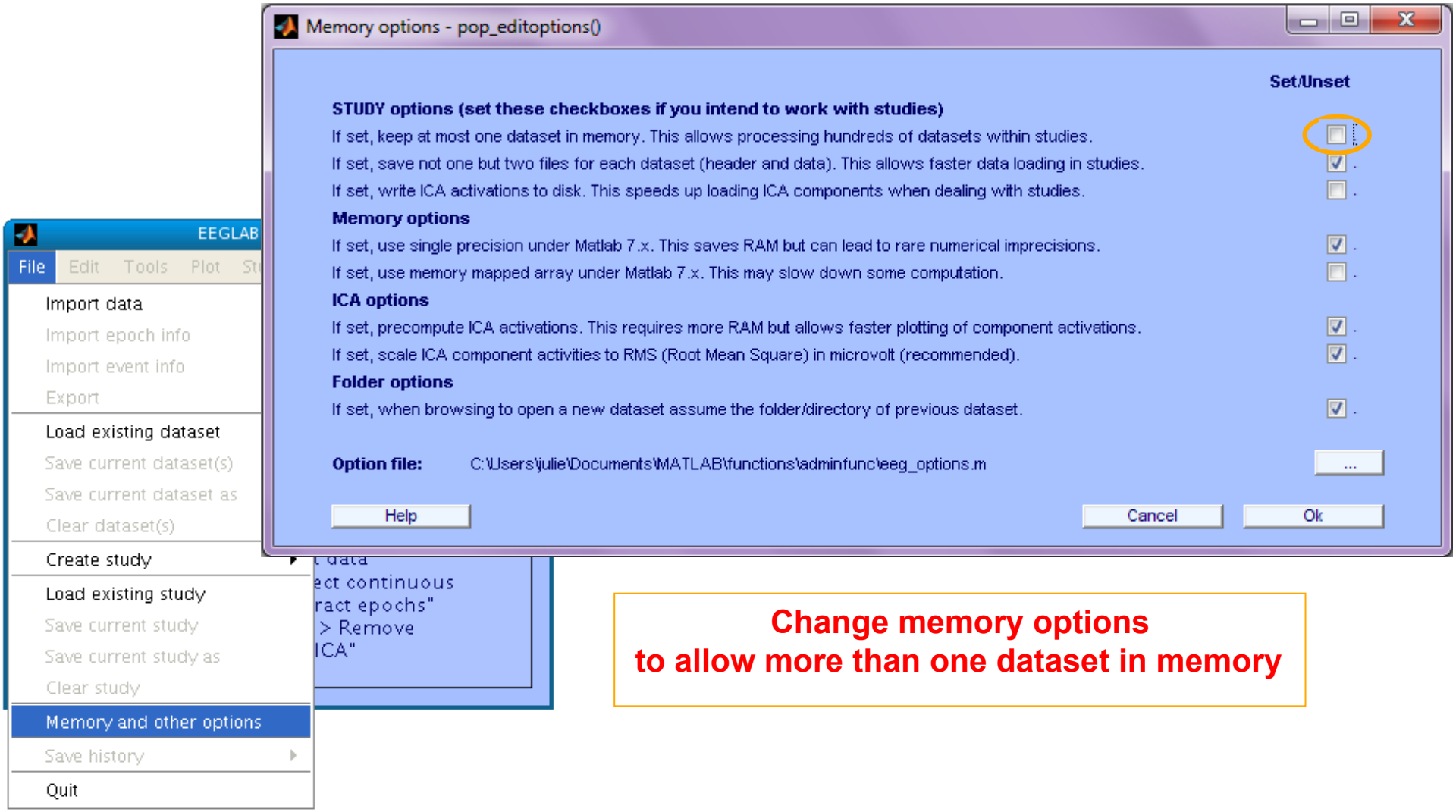
Task 3

Create a Matlab function

Task 4

Exercise…

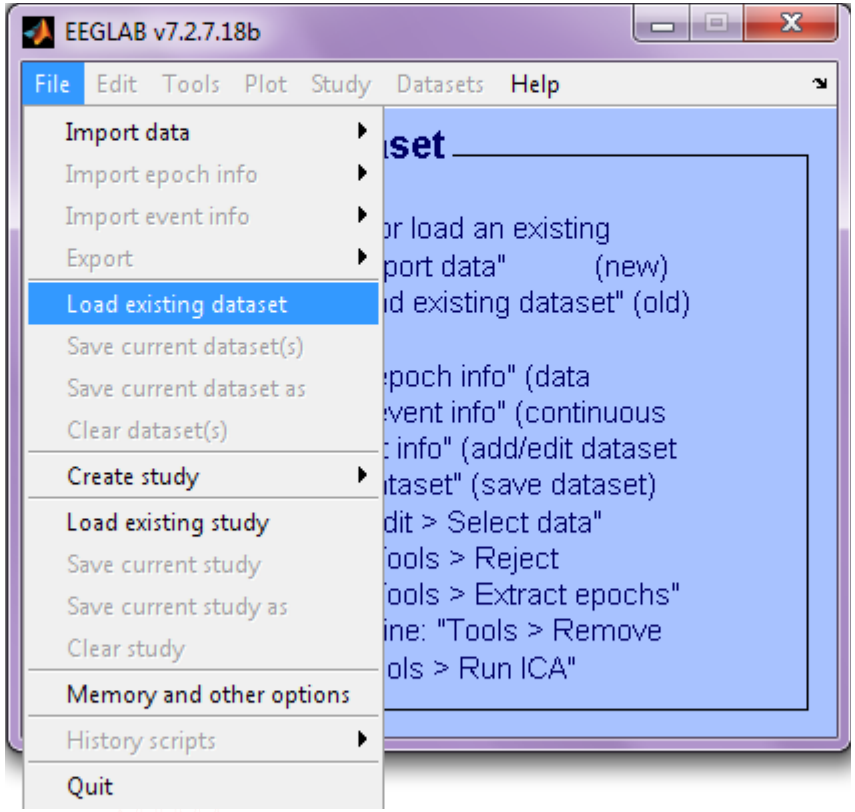
Memory options

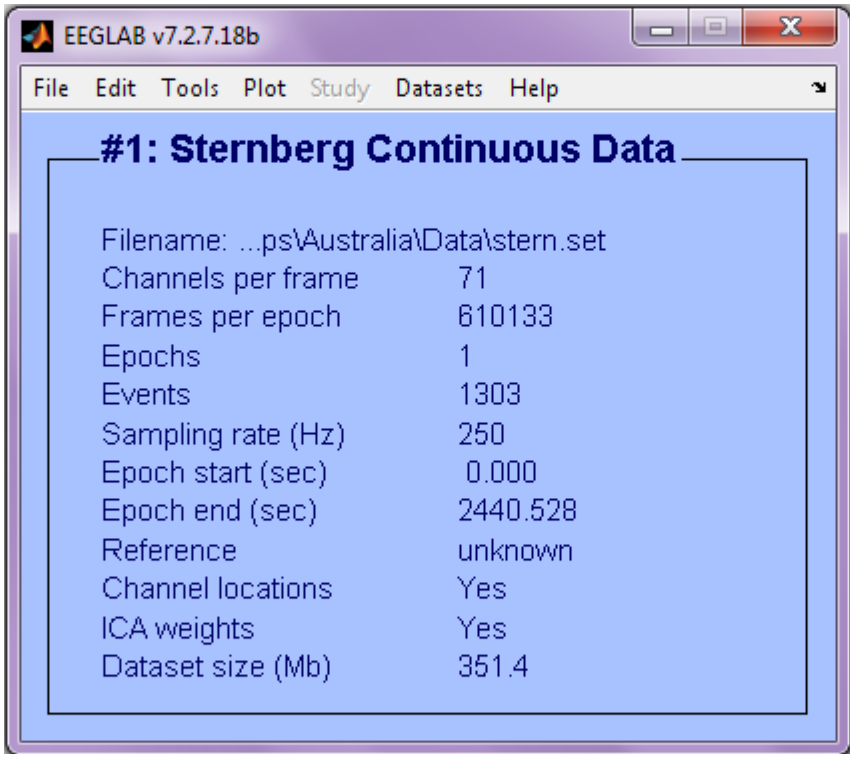


Change memory options
to allow more than one dataset in memory

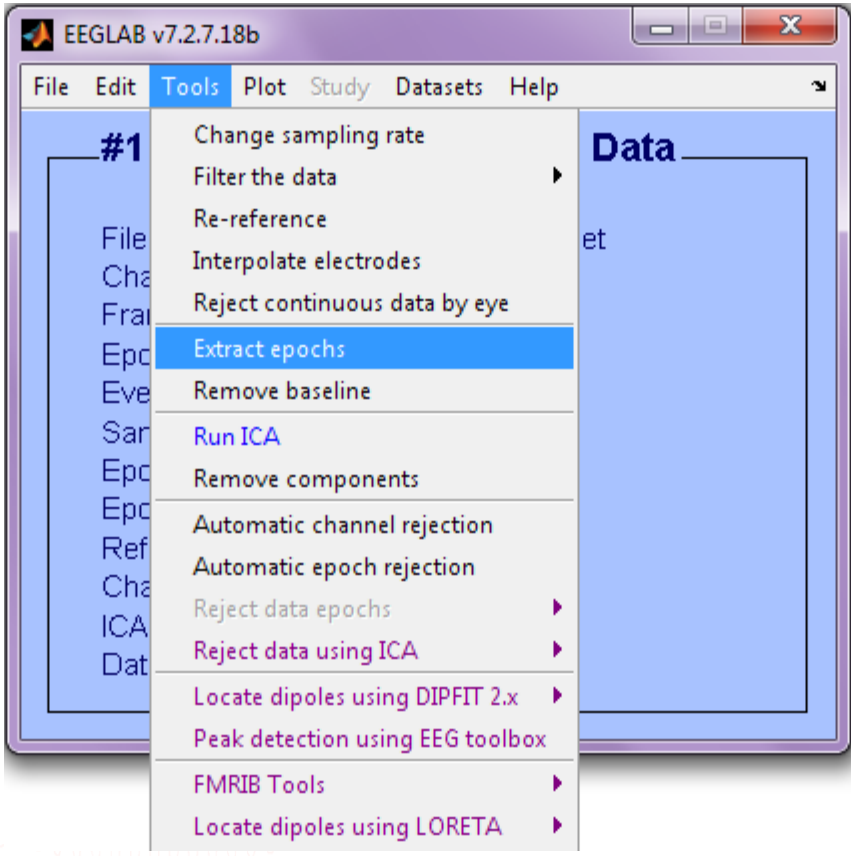
Create a script from ‘eegh’ output

Start by loading a continuous dataset

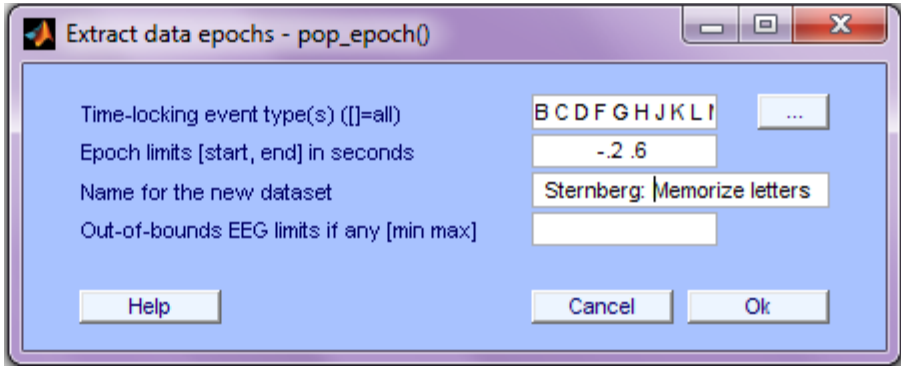




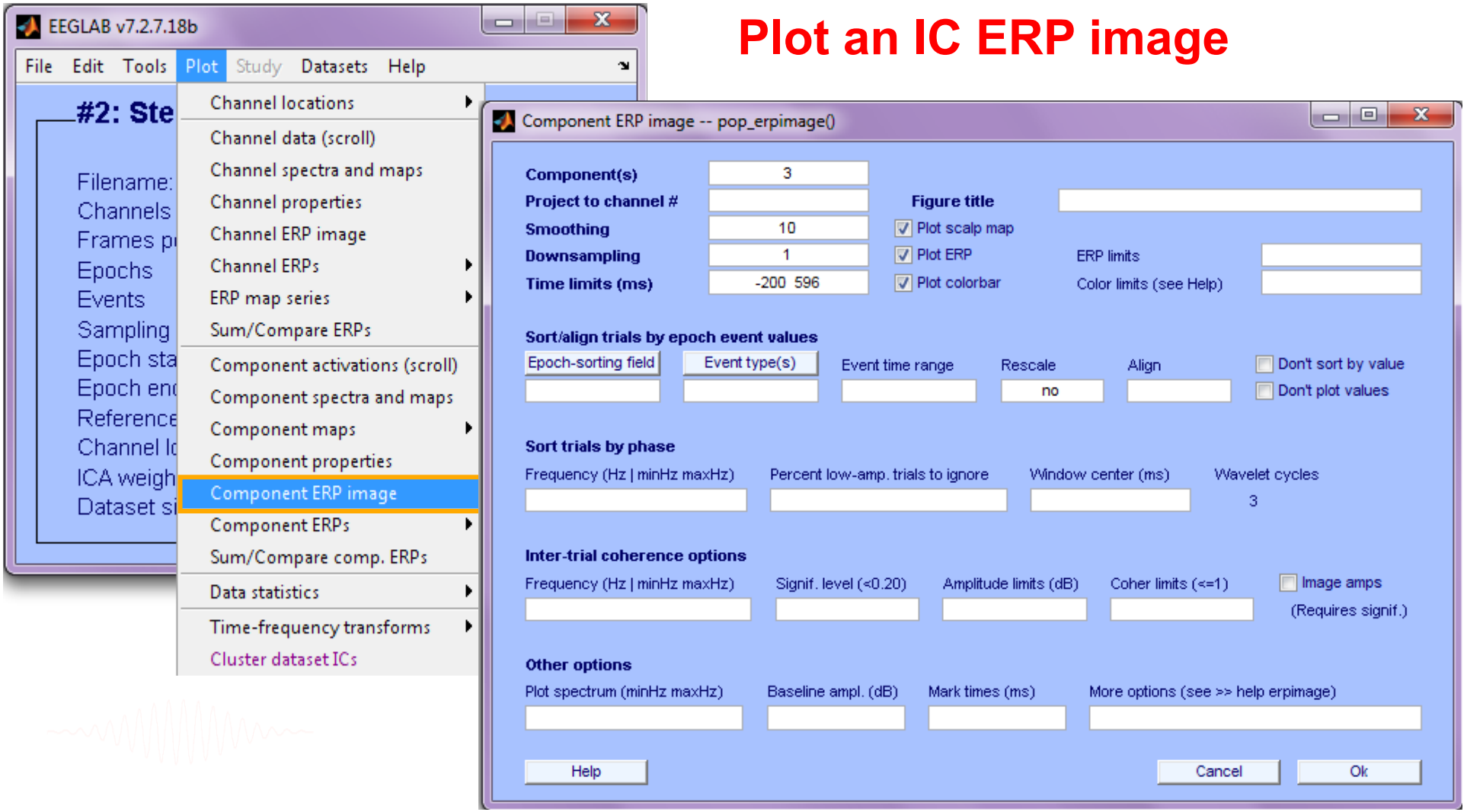
Create a script from ‘eegh’ output



Epoch on Memorize letters

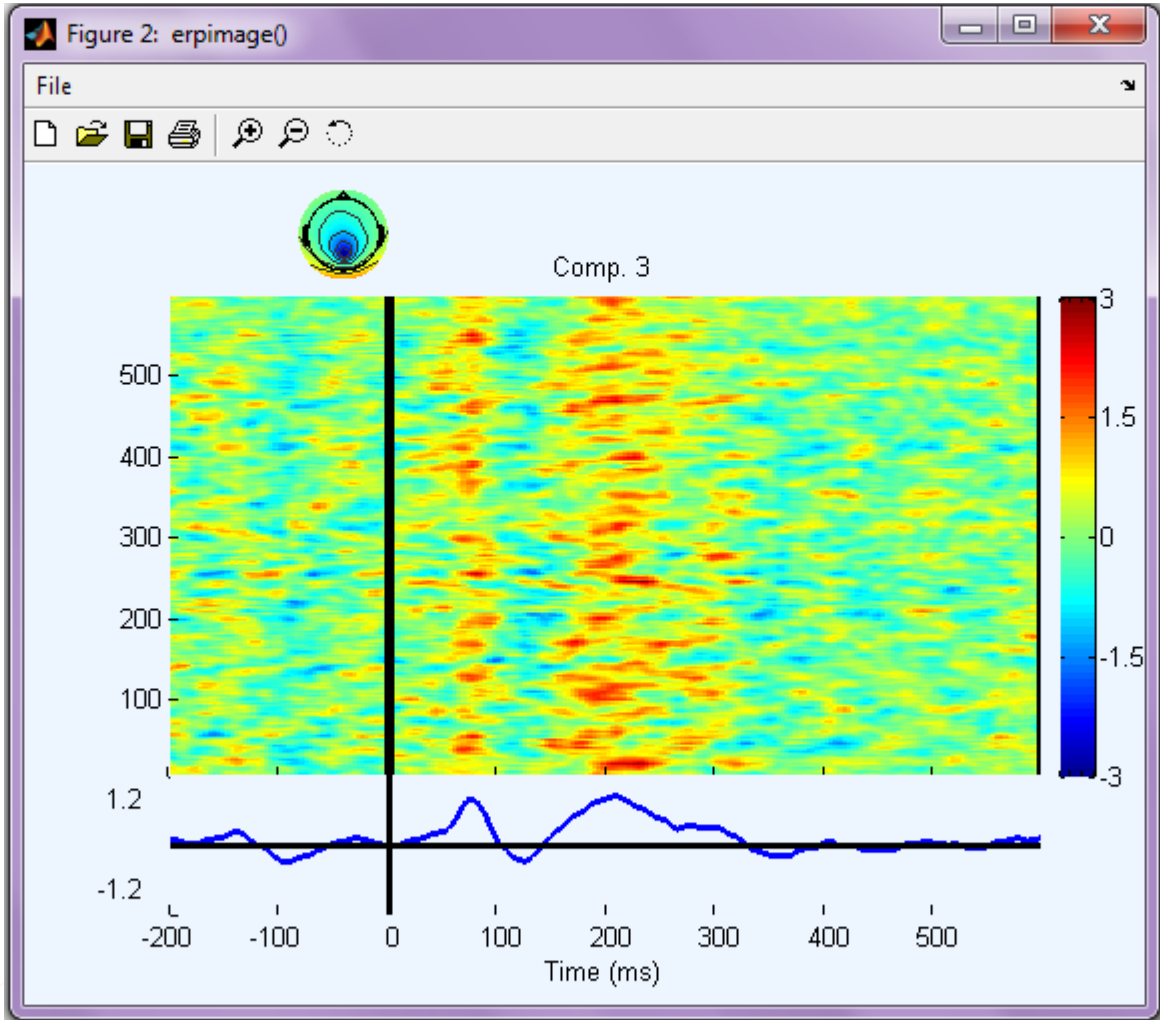


Create a script from ‘eegh’ output



Plot an IC ERP image

Create a script from ‘eegh’ output



Exporting figures

Transparency and complex figures

To export figures for publication, use .eps format (postscript) and edit for instance with adobe illustrator. Use "*set(gcf, 'renderer', 'painter')*" before exporting complex figures. Note that these cannot handle transparency and 3-D graphics.

Transparency: Use the "plot2svg" matlab toolbox to export figure for transparency.

Retrieve commands from eegh

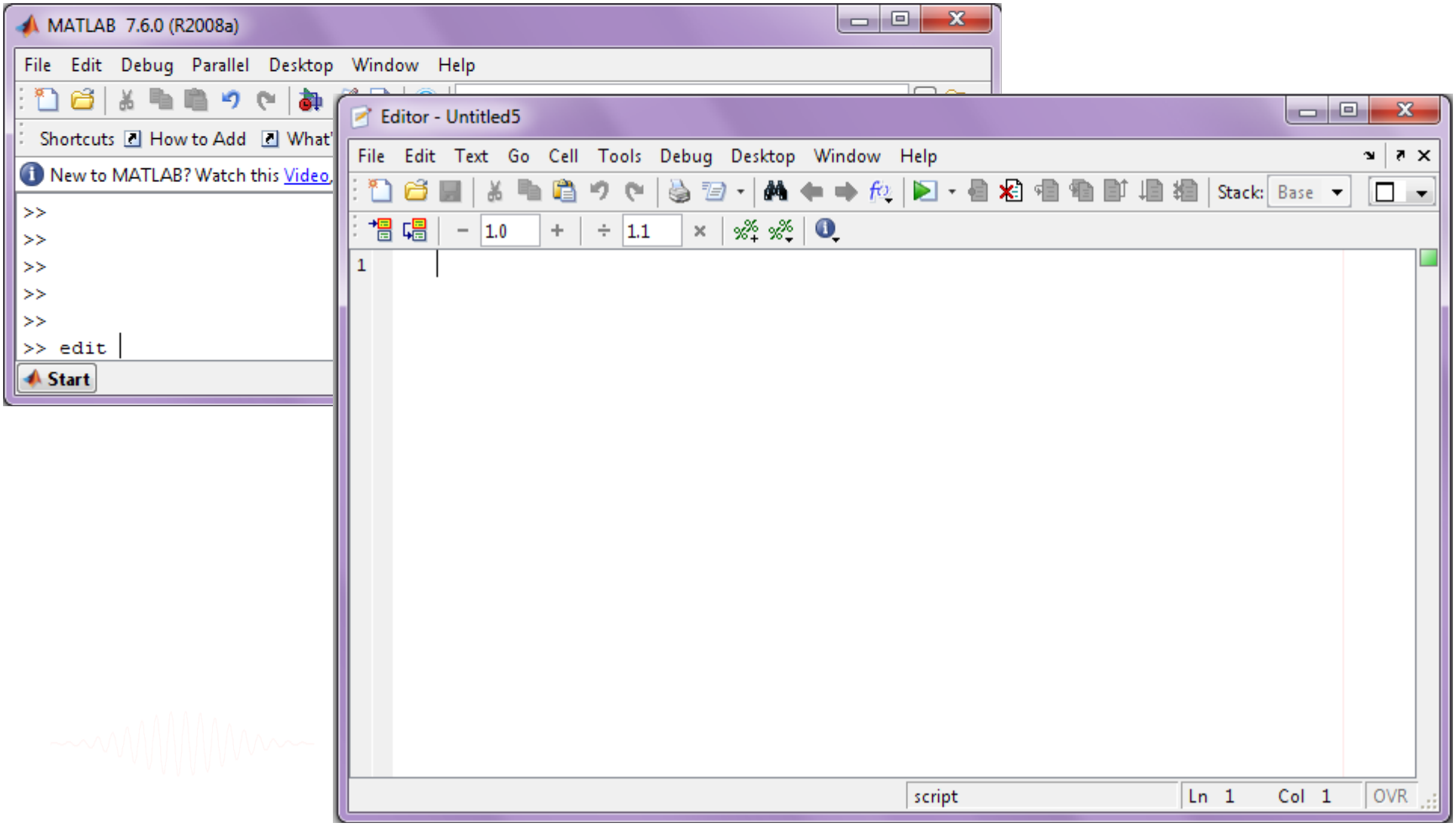
Write a script to do this:

```
>> eegh
```

Retrieve commands from eegh

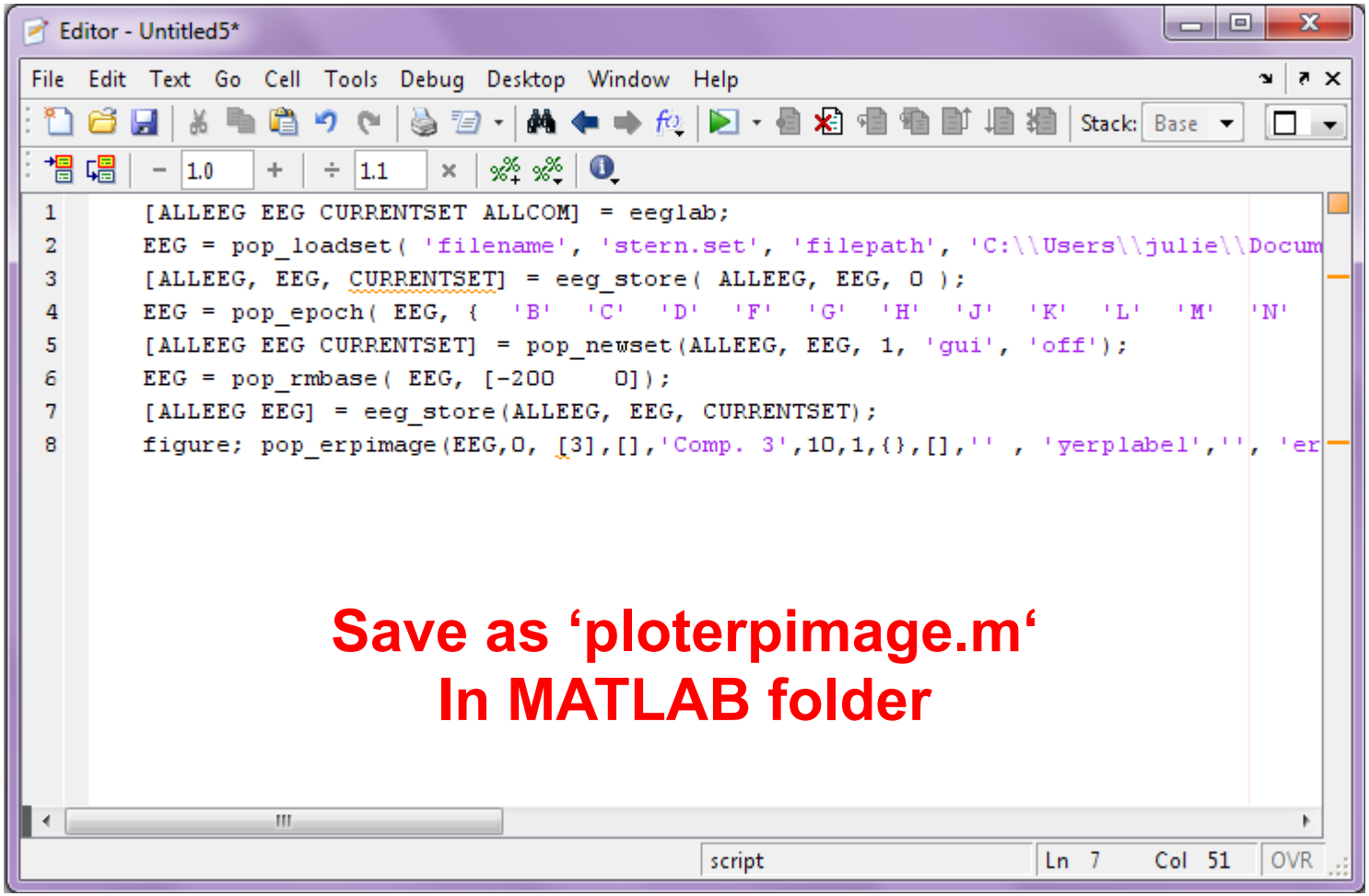
```
>> eegh
[ALLEEG EEG CURRENTSET ALLCOM] = eeglab;

EEG = pop_loadset('filename', 'stern_125Hz.set');
[ALLEEG EEG CURRENTSET] = eeg_store(ALLEEG, EEG, 0);

EEG = pop_epoch( EEG, {'B'  'C'  'D' ... }, [-0.2 0.6], 'newname',
'Memorize epochs', 'epochinfo', 'yes');
[ALLEEG EEG CURRENTSET] = eeg_store(ALLEEG, EEG, 1);
EEG = pop_rmbase( EEG, [-200 0]);
[ALLEEG EEG] = eeg_store(ALLEEG, EEG, CURRENTSET);

figure; pop_erpimage(EEG,0, [3],[],'Comp. 3',10,1,{},
[],'','yerplabel', '', 'erp', 'on', 'cbar', 'on','topo',
{mean(EEG.icawinv(:,[3]),2) EEG.chanlocs EEG.chaninfo });
```

Create a Matlab script



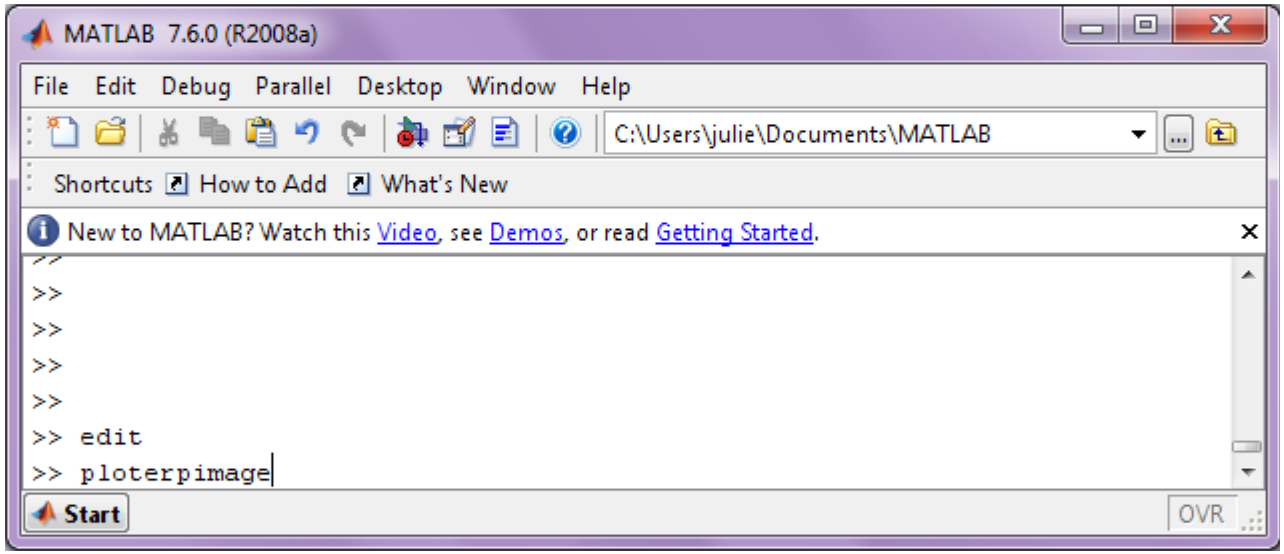
Create a Matlab script

Copy and paste from Matlab window:



Save as ‘ploterpimage.m‘
In MATLAB folder

Run your new script

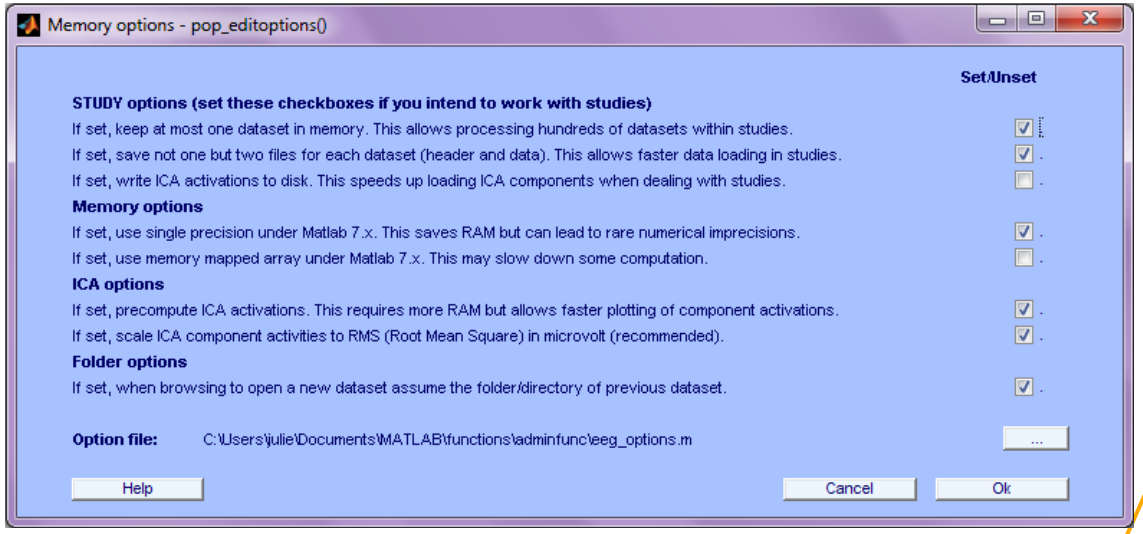


Exercise page 1

```
>> eeglab

% load dataset,
% epoch on 'memorize letter' B, C, etc...
% plot erpimage for component 3

>> eegh

% open Matlab editor

>> edit

% copy & paste eegh results into a new
% file and save it (ploterpimage.m)

>> clear
>> close all
>> ploterpimage
>> eeglab redraw
```

Advanced Scripting in EEGLAB

STUDY scripts

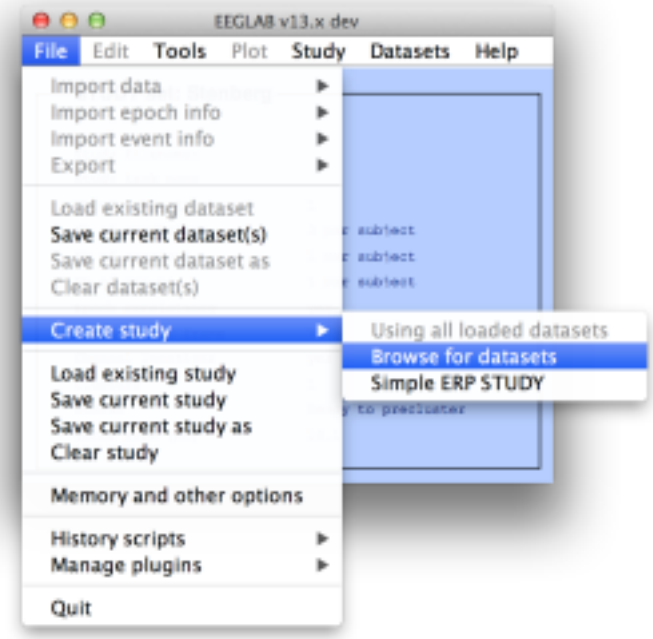


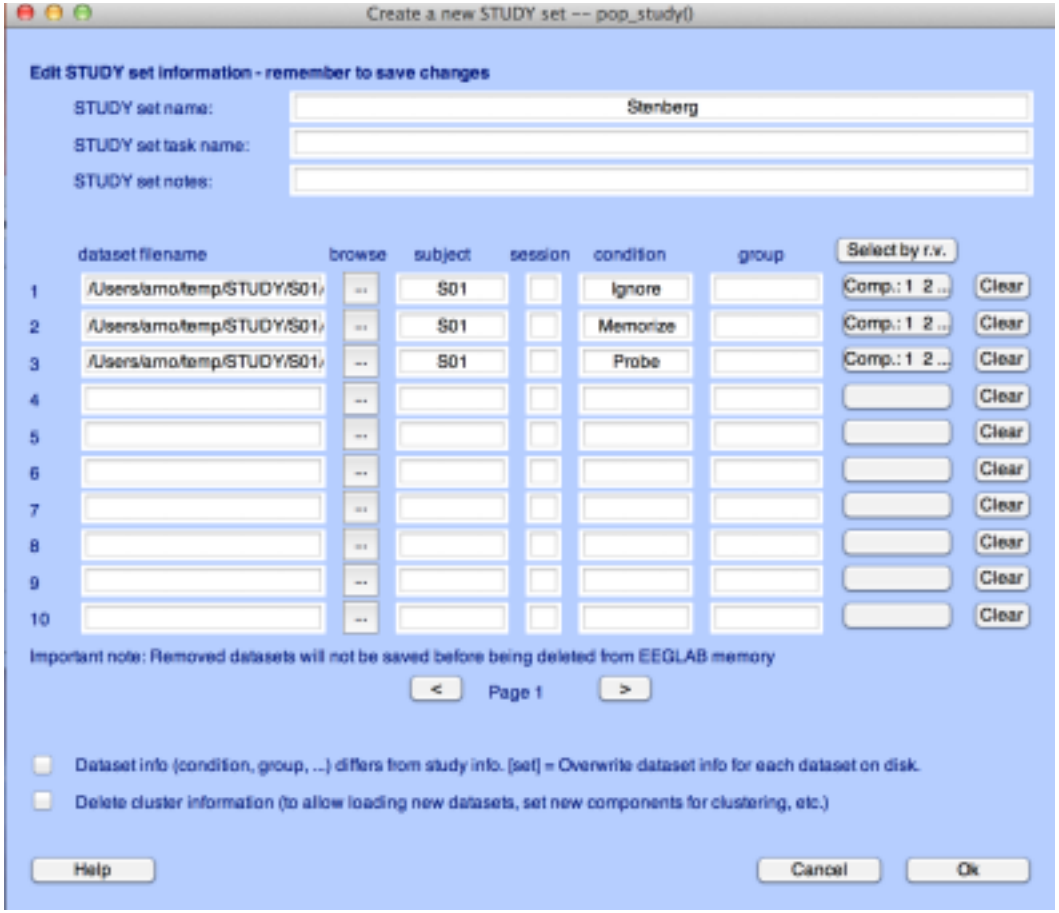
Most important option:

- Allows only one dataset to be loaded at once.
- Most STUDYs are too big to have all data loaded at once.

```
% Set memory options:
pop_editoptions( 'option_storedisk', 1);
```

Edit dataset info






```
[STUDY ALLEEG] = std_editset( STUDY, ALLEEG, 'name','Stenberg','commands',{{'index' 1
'load' '/data/STUDY/S01/Ignore.set'} {'index' 2 'load' '/data/S01/Memorize.set'}
{'index' 3 'load' '/data/S01/Probe.set'} {'index' 1 'subject' 'S01'} {'index' 2
'subject' 'S01'} {'index' 3 'subject' 'S01'} {'index' 1 'condition' 'Ignore'} {'index' 2
'condition' 'Memorize'} {'index' 3 'condition' 'Probe'}},'updatedat','off' );
```

Looking a the function that create STUDY

```
[STUDY ALLEEG] = std_editset( STUDY, ALLEEG, 'name','Stenberg','commands',
     {{'index' 1 'load' '/data/STUDY/S01/Ignore.set'} …
     {'index' 2 'load' '/data/S01/Memorize.set'} …
     {'index' 3 'load' '/data/S01/Probe.set'} …
     {'index' 1 'subject' 'S01'} …
     {'index' 2 'subject' 'S01'} …
     {'index' 3 'subject' 'S01'} …
     {'index' 1 'condition' 'Ignore'} …
     {'index' 2 'condition' 'Memorize'} …
     {'index' 3 'condition' 'Probe'}},'updatedat','off' );
```

```
[STUDY ALLEEG] = std_editset( STUDY, ALLEEG, 'name','Stenberg','commands',
     {{'index' 1 'load' '/data/STUDY/S01/Ignore.set' 'subject' 'S01' 'condition' 'Ignore'} …
     {'index' 2 'load' '/data/S01/Memorize.set' 'subject' 'S01' 'condition' 'Memorize'} …
     {'index' 3 'load' '/data/S01/Probe.set' 'subject' 'S01' 'condition' 'Probe'} …
     },'updatedat','off' );
```

Exercice

```
[STUDY ALLEEG] = std_editset( STUDY, ALLEEG, 'name','Stenberg','commands',
     {{'index' 1 'load' '/data/STUDY/S01/Ignore.set' 'subject' 'S01' 'condition' 'Ignore'} …
     {'index' 2 'load' '/data/S01/Memorize.set' 'subject' 'S01' 'condition' 'Memorize'} …
     {'index' 3 'load' '/data/S01/Probe.set' 'subject' 'S01' 'condition' 'Probe'} …
     },'updatedat','off' );
```

If not present, add it by hand because some dataset might not have it

1- Start EEGLAB and import the 3 datasets for Subject 1 (Ignore.set, Memorize.set and Probe.set) in a STUDY (menu Tools > Create STUDY > Browse for datasets)

2- Look in the history

3- Copy to a script, add “eeglab redraw” at the end of your script

4- Restart Matlab, execute the script, look at your STUDY info and design (menu *STUDY > Edit STUDY* info and *STUDY > Select/Edit STUDY design*)

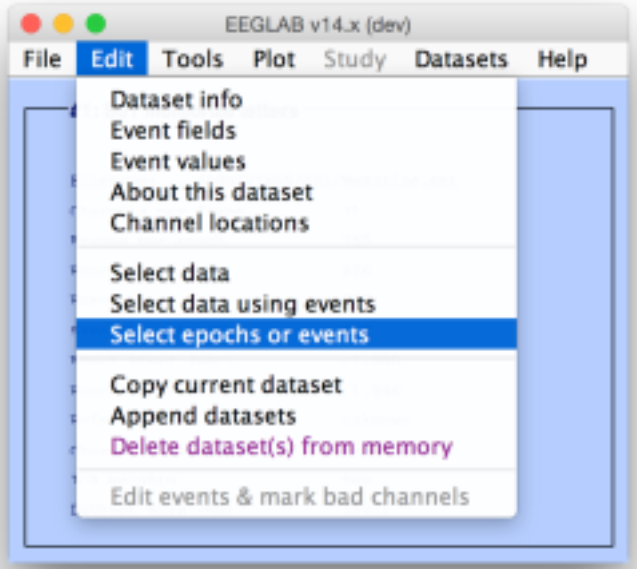
5- Modify the script to import subject 1 to 4

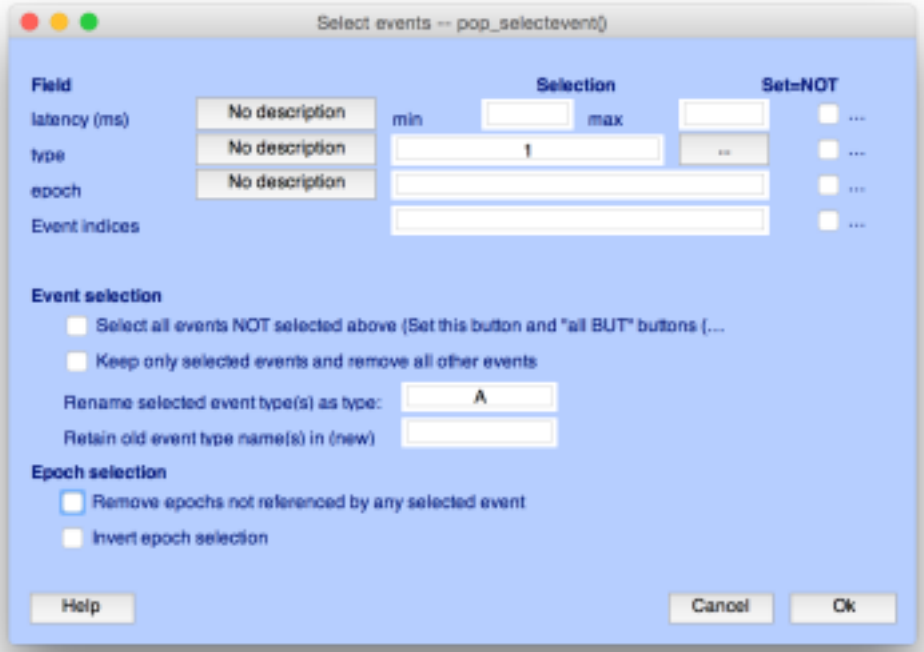
6- Restart Matlab, execute the script, look at your STUDY info and design

Redefining events

Adjusting latencies

```
for iEvent = 1:length(EEG.event)
    % shift by 16 samples (or 53.3ms at 200Hz) due to filter delay
    EEG.event(iEvent).latency = EEG.event(iEvent).latency + 16;
end;
EEG.saved = 'no';
[ALLEEG EEG CURRENTSET] = eeg_store(ALLEEG, EEG);
eeglab redraw
```





Renaming events

```
for iDat = 1:length(ALLEEG)
    EEG = ALLEEG(iDat);
    % rename events
    EEG = pop_selectevent( EEG, 'type',1,'renametype','A','deleteevents','off');
    EEG = pop_selectevent( EEG, 'type',2,'renametype','B','deleteevents','off');
    EEG = pop_selectevent( EEG, 'type',3,'renametype','C','deleteevents','off');
    EEG = pop_selectevent( EEG, 'type',4,'renametype','D','deleteevents','off');
    EEG = pop_selectevent( EEG, 'type',8,'renametype','rt','deleteevents','off');
    EEG.saved = 'no';
    [ALLEEG EEG CURRENTSET] = eeg_store(ALLEEG, EEG, iDat);
end;
eeglab redraw
```


```
EEG.event(4)
        type: 'square'
    position: 2
     latency: 424
     urevent: 1
       epoch: 2

EEG.event(1)
        type: 'square'
    position: 2
     latency: 129
     urevent: 1
       epoch: 1

EEG.urevent(1)
        type: 'square'
    position: 2
     latency: 129
```

Redefining events

```
for iDat = 1:length(ALLEEG)
    TMPEEG = eeg_checkset(ALLEEG(iDat), 'loaddata'); % load data

    % 'B'  'C'  'D'  'F'  'G'  'H'  'J'  'K'  'L' ... -> Memorize
    % 'gB' 'gC' 'gD' 'gF' 'gG' 'gH' 'gJ' 'gK' 'gL' ... -> Ignore
    for iEvent = 1:length(TMPEEG.event)
          prevEvent = TMPEEG.event(iEvent).urevent-2;
          if prevEvent > 2 && TMPEEG.urevent(prevEvent).type(1) == 'g'
             TMPEEG.event(iEvent).prevEvent = 'ignore';
          else TMPEEG.event(iEvent).prevEvent = 'memorize';
          end;
    end;

    TMPEEG.saved = 'no'; % tag as not saved
    ALLEEG(iDat) = pop_saveset(TMPEEG, 'savemode', 'resave'); % resave data
end;

STUDY = std_maketrialinfo(STUDY, ALLEEG); % update STUDY
STUDY.saved = 'no';
[STUDY EEG] = pop_savestudy( STUDY, EEG, 'savemode', 'resave'); % resave STUDY
```

Precomputed files need to be recomputed after changing events.


Edit STUDY design -- pop_studydesign()
Select STUDY design
New
Rename
Delete
Design Matrix
memorize vs ignore
Design 2
Design 3
Design 4
Resave STUDY
Edit selected design
Independent variables
New
Import
Edit
Delete
Categorical variable: condition - Values (probe - ignore
Categorical variable: prevEvent - Values (ignore - memo
Subjects
S07
S08
S09
S10
S11
S12
S13
Delete all pre-computed datafiles for this STUDY design
Web help
Cancel
Ok
Add variable
Select independent variable
prevEvent
reqtime
rt
stimulus
ttime
type
uncertainty1
Categorical variable
Select variable values
ignore
memorize
Combine selected values
Cancel
Ok
Design Matrix: Design 4
SD1
Design Matrix
condition-probe
condition-ignore&memorize
prevEvent-ignore
prevEvent-memorize
constant
Trials
100
200
300
400
500
600
700
1
2
3
4
5

Load dataset info from commandline

```
% Create Stern STUDY
[ALLEEG EEG CURRENTSET ALLCOM] = eeglab;
pop_editoptions( 'option_storedisk', 1);
subjects = {'S01' 'S02' 'S03' 'S04' 'S05' 'S06' 'S07' 'S08' 'S09' 'S10' 'S11' 'S12'};
filepath = '/Users/arno/temp/STUDY'; % XXXXX Change path here XXXXX
if ~exist(filepath), error('You need to change the path to the STUDY'); end;
commands = {}; % initialize STUDY dataset list

% Loop through all of the subjects in the study to create the dataset
for loopnum = 1:length(subjects) %for each subject
    IgnoreFile   = fullfile(filepath, subjects{loopnum}, 'Ignore.set');
    MemorizeFile = fullfile(filepath, subjects{loopnum}, 'Memorize.set');
    ProbeFile    = fullfile(filepath, subjects{loopnum}, 'Probe.set');
    commands = {commands{:} ...
        {'index' 3*loopnum-2 'load' IgnoreFile   'subject' subjects{loopnum} 'condition' 'Ignore'} ...
        {'index' 3*loopnum-1 'load' MemorizeFile 'subject' subjects{loopnum} 'condition' 'Memorize'} ...
        {'index' 3*loopnum   'load' ProbeFile    'subject' subjects{loopnum} 'condition' 'Probe'}};
end;
% Uncomment the line below to select ICA components with less than 15% residual variance
% commands = {commands{:} {'dipselect', 0.15}};
[STUDY, ALLEEG] = std_editset(STUDY, ALLEEG, 'name','Sternberg','commands',commands,'updatedat','on');

% Update workspace variables and redraw EEGLAB
CURRENTSTUDY = 1; EEG = ALLEEG; CURRENTSET = [1:length(EEG)];
[STUDY, ALLEEG] = std_checkset(STUDY, ALLEEG);
eeglab redraw
```

STUDY structure

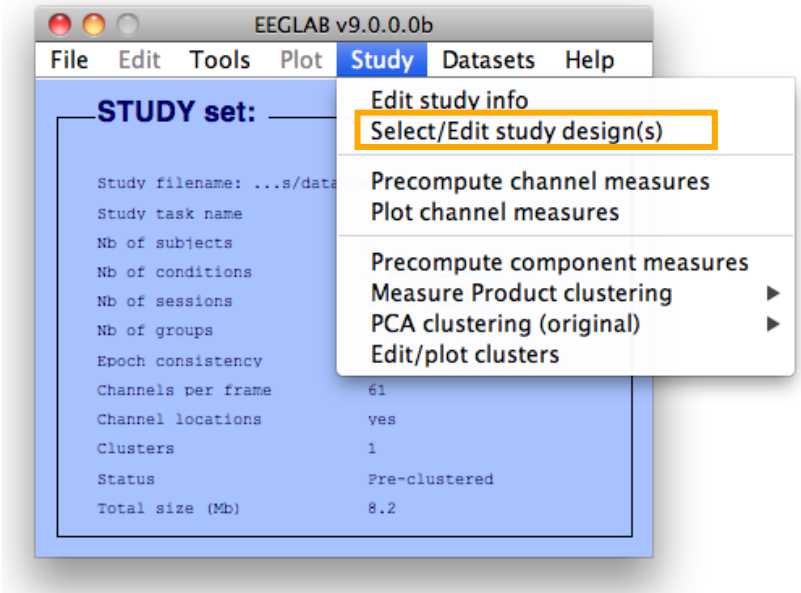
```
STUDY =
            name: 'Sternberg'
            task: 'Sternberg'
     datasetinfo: [1x39 struct]
           notes: ''
        filename: 'stern.study'
        filepath: 'C:\Users\julie\Documents\Workshops\Finland\STUDY'
         history: [1x7332 char]
         subject: {1x13 cell}
           group: {''}
         session: []
       condition: {'ignore'  'memorize'  'probe'}
          design: [1x1 struct]
             etc: [1x1 struct]
        preclust: [1x1 struct]
         cluster: [1x1 struct]
         changrp: [1x71 struct]
           saved: 'yes`
```

Understanding STUDY structure

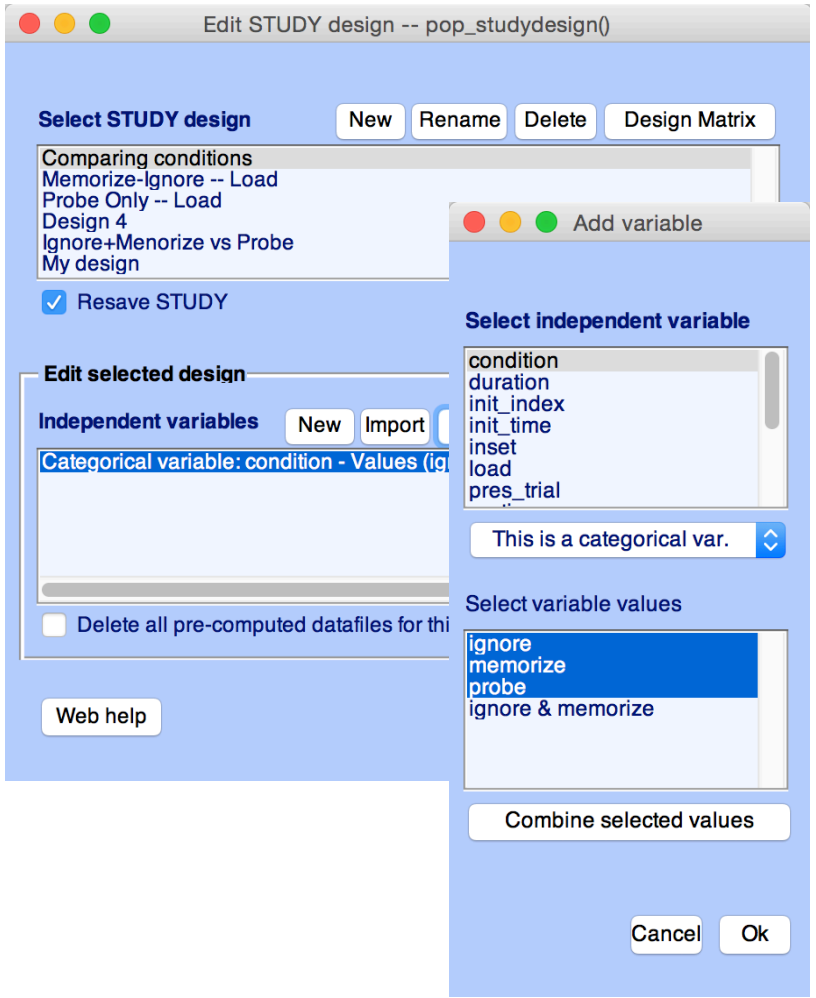
```
>> STUDY.datasetinfo(11) % access dataset 11
ans =
      filepath: [1x61 char]
      filename: 'S04.set'
       subject: 'S04'
       session: []
     condition: ''
         group: ''
    trialinfo: 1x350 struct
         index: 11
         comps: [1x24 double]
```

Subject 4!

```
>> trialinfo(163) % access trial 163
ans =
      stimtype: 'Memorize'
       latency: 13201
      duration: 0
      ...
```



Select subjects




```
STUDY = std_makedesign(STUDY, ALLEEG, 3,
'variable1','condition',
'variable2','',
'name','Design 3',
'values1',{'ignore' 'memorize' 'probe'},
'subjselect',{'S02' 'S03'},
'dataselect',{'condition' {'probe'}});
```

STUDY design structure

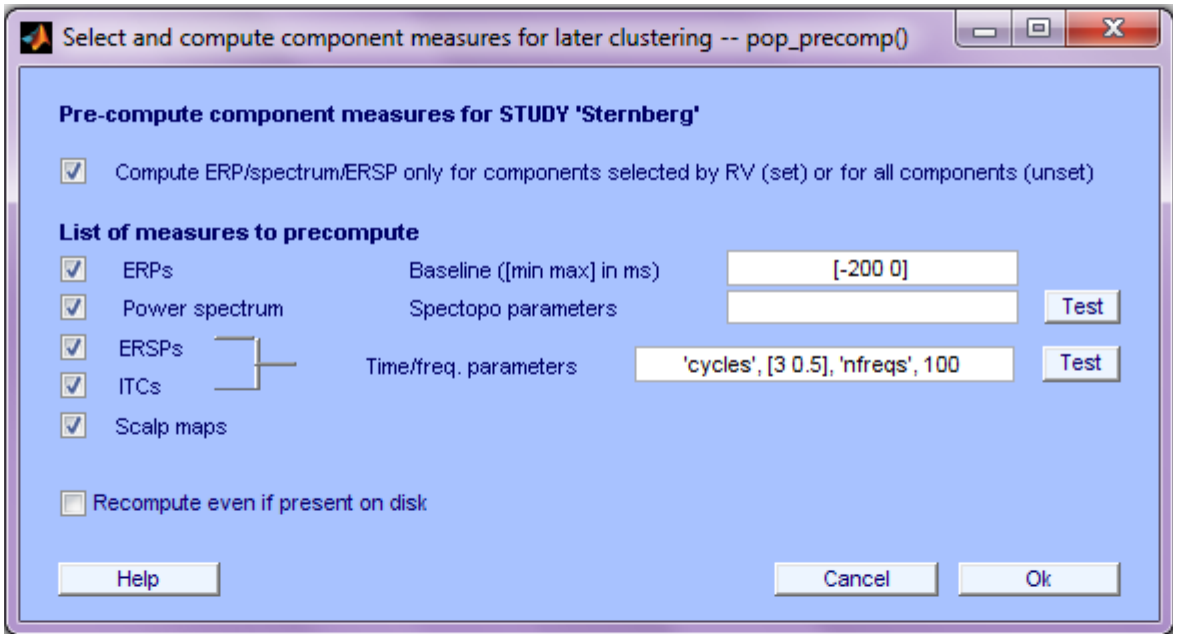
```
STUDY.design(1)

ans =

           name: 'Design 1 - compare letter types'
       variable: [1x2 struct]
          cases: [1x1 struct]
        include: {}
          cells: [1x39 struct]
```

Exploding the contents of each of these sub-structures, we obtain

```
           name: 'Design 1 - light and audio all subjects'

       variable: [1x2 struct]
            (1).label   : 'condition'
            (1).pairing: 'on'
            (1).value   : {'ignore'  'memorize'  'probe'}
            (2).label   : ''
            (2).pairing: 'off'
            (2).value   : {}

         cases: [1x1 struct]
            label: 'subject'
            value: {'S01'  'S02'  'S03'  'S04'  'S05'  'S06' }
```

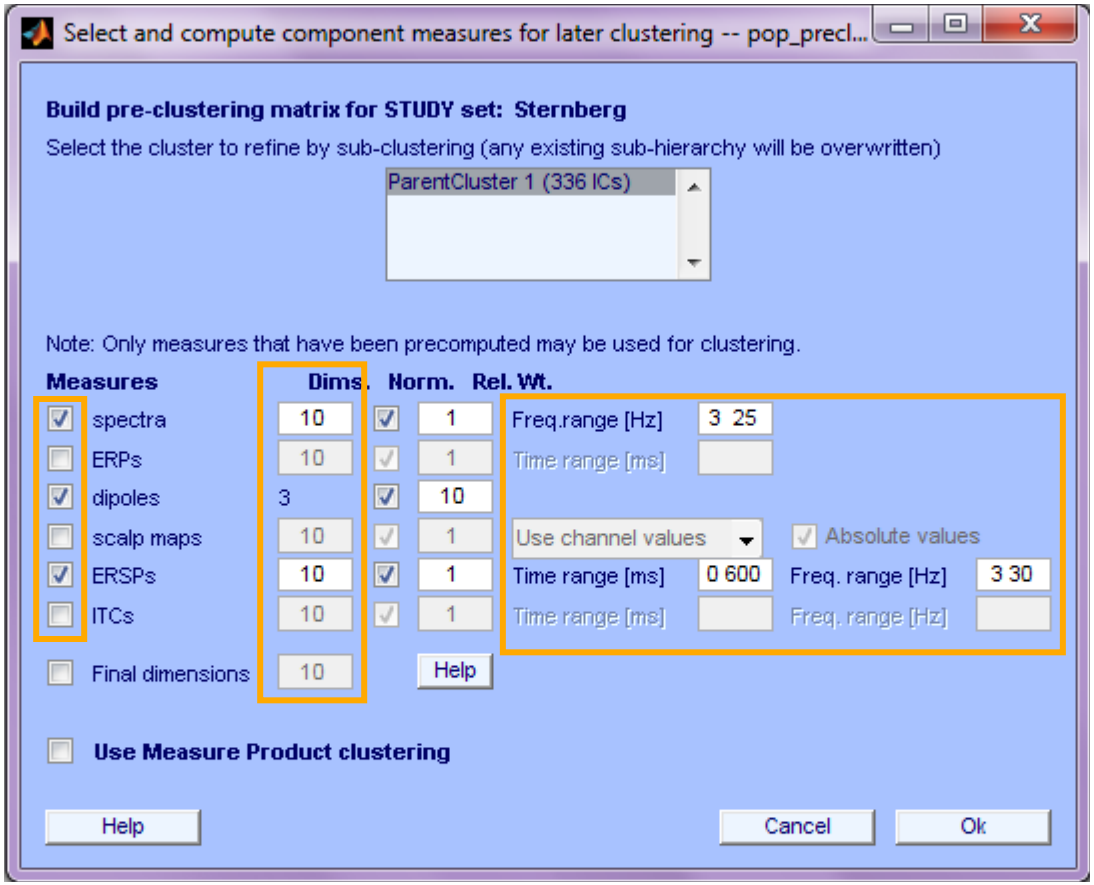
Precompute data measures

TIP: Compute all measures so you can test different combinations for clustering



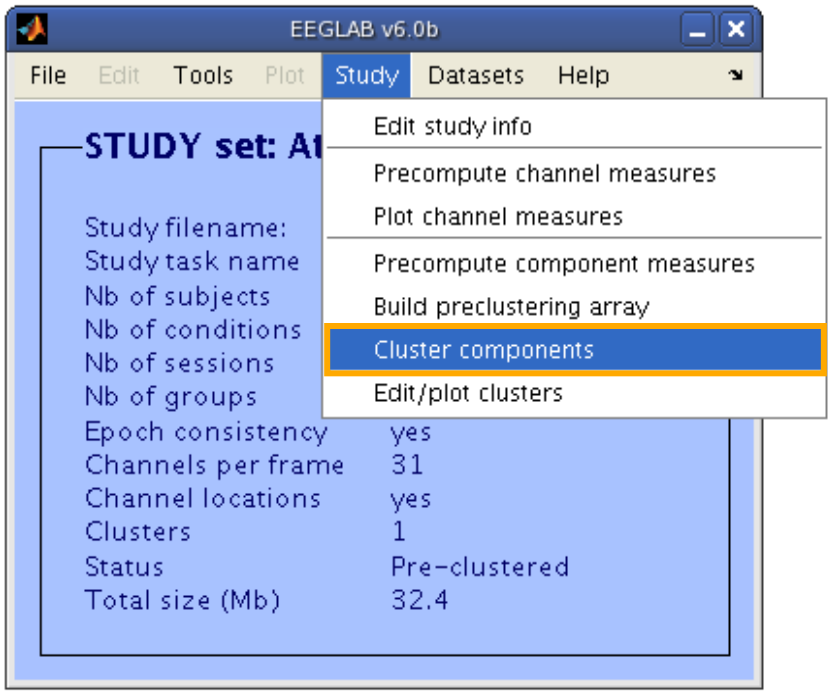

```
[STUDY ALLEEG] = std_precomp(STUDY, ALLEEG, 'components', 'erp', ...
'on', 'rmbase',[-200 0] , 'scalp', 'on', 'spec', 'on', ...
'specparams',{}, 'ersp', 'on', 'erspparams', {'cycles' [3 0.5] ...
'nfreqs',100, 'freqs',[3 70] }, 'itc', 'on');
```

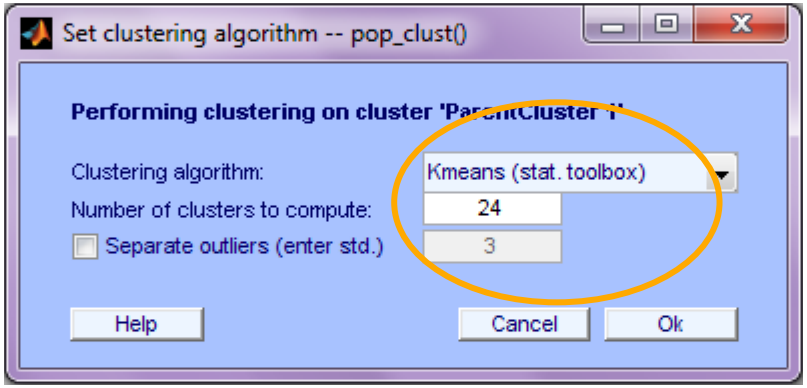
Precluster the data




```
[STUDY ALLEEG] = std_preclust(STUDY, ALLEEG, 1,{'spec','npca',5,…
   'norm',1,'weight',1,'freqrange',[3 25]},{'erp','npca',6,'norm',1,…
   'weight',1, 'timewindow',[0 400]},{'scalp','npca',10,'norm',1,'weight',1,…
   'abso',1},{'dipoles','norm',1,'weight',10},{'ersp','npca',20,…
   'freqrange',[3 30] ,'timewindow',[0 600],'norm',1,'weight',1},{'itc',…
   'npca',6,'freqrange',[3 30],'timewindow',[0 400] , 'norm',1, 'weight',1});
```

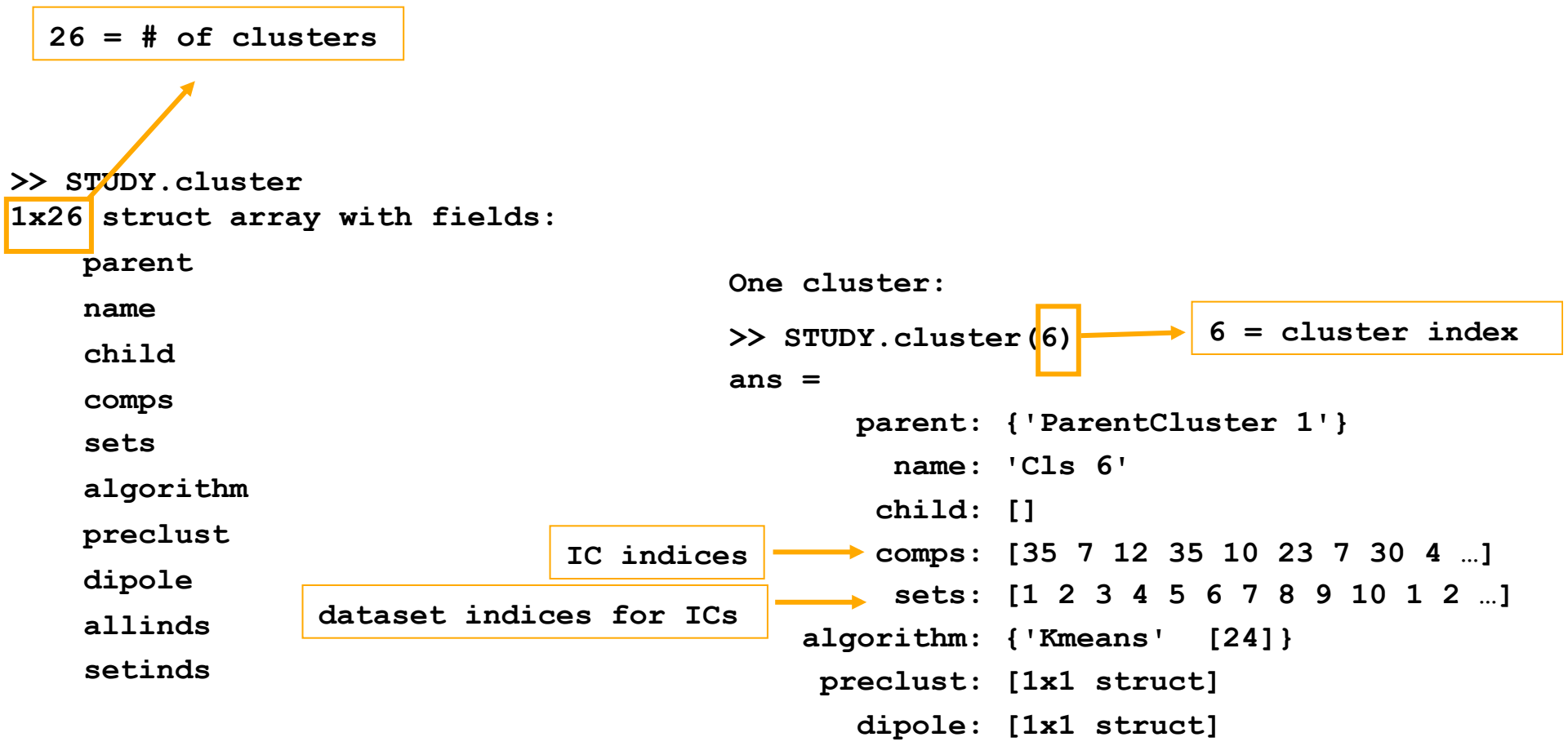
Cluster components

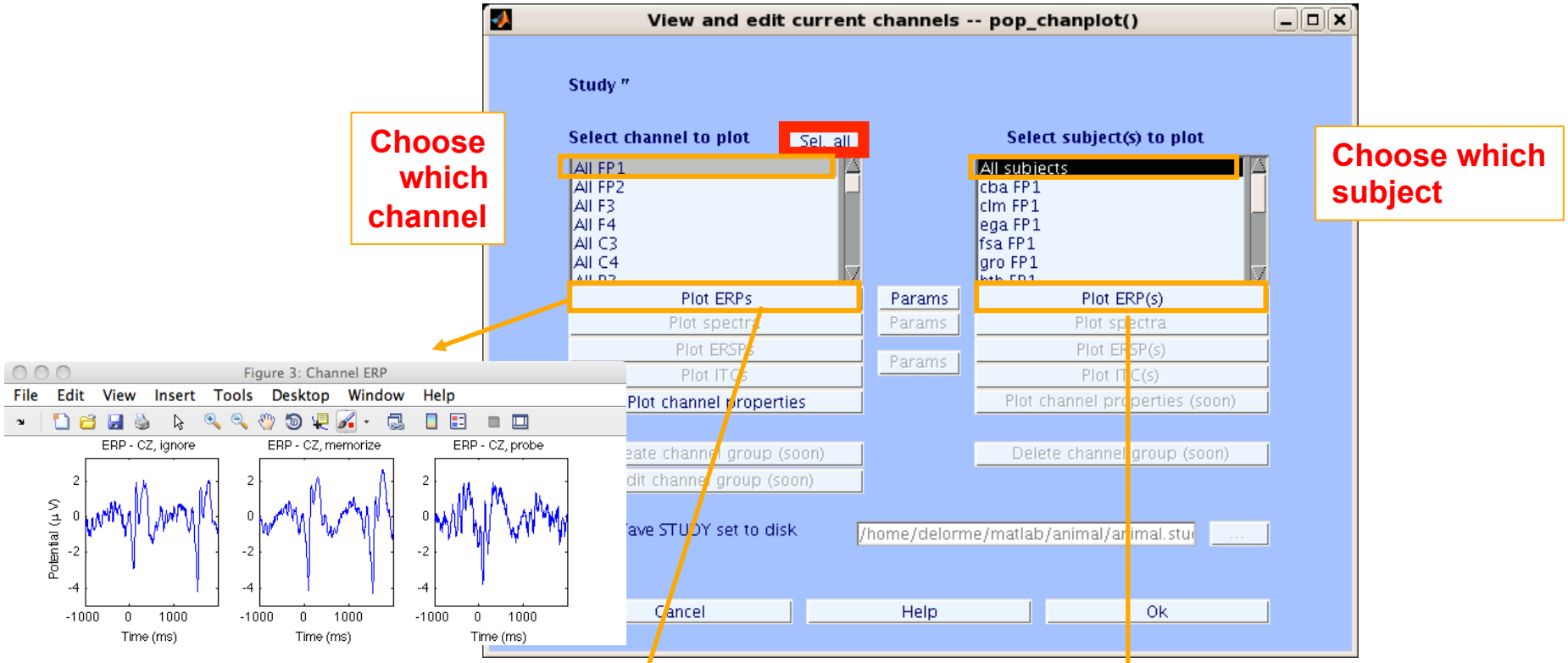





```
[STUDY] = pop_clust(STUDY, ALLEEG,'algorithm','kmeans','clus_num',24);
```

Understanding STUDY structure

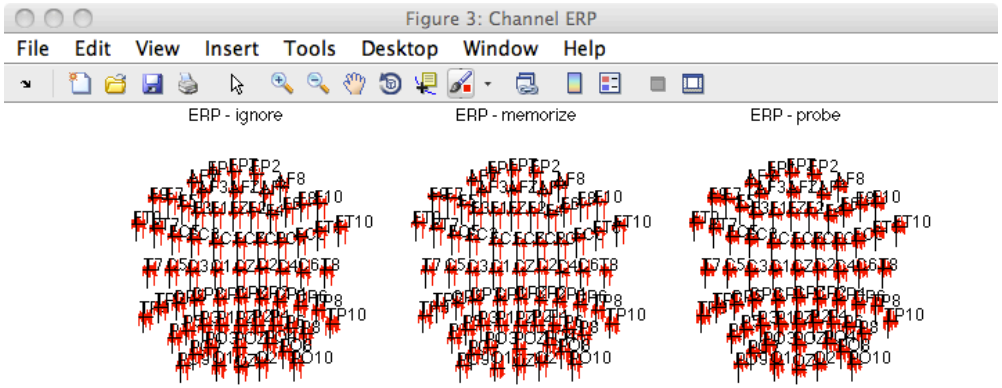


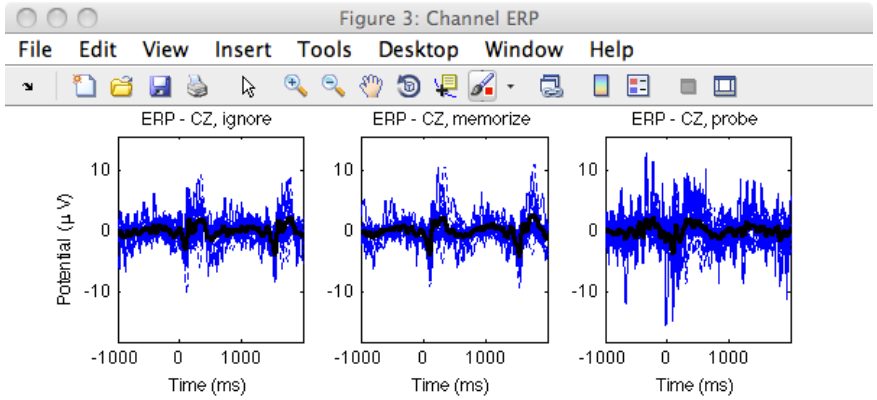


Choose which channel

Choose which subject

STUDY = std_erpplot(STUDY,ALLEEG,'channels',{'FP1'});



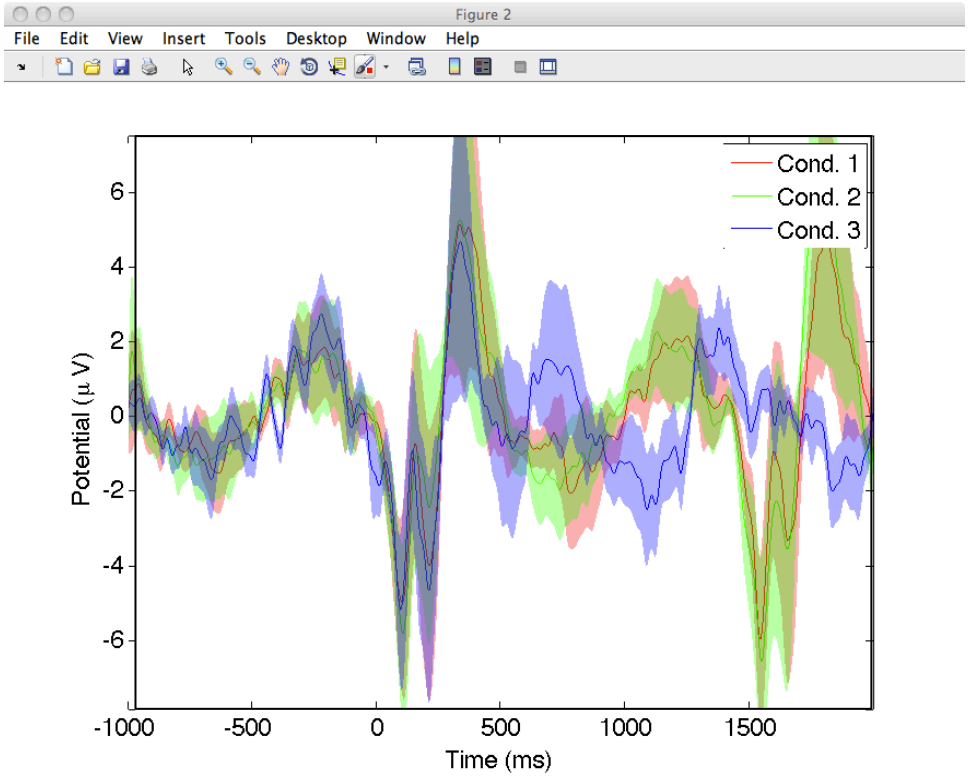


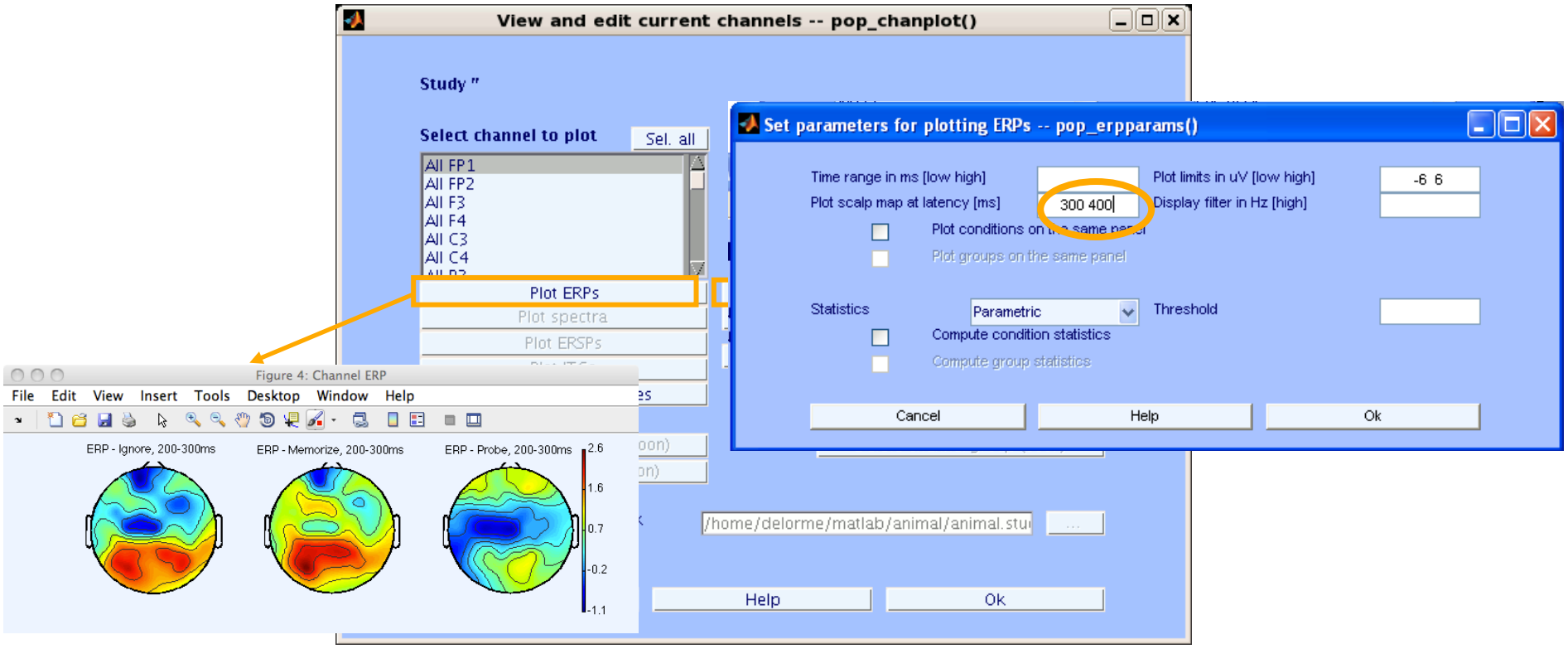
STUDY = std_erpplot(STUDY,ALLEEG,'channels',{'FP1' … });

STUDY = std_erpplot(STUDY,ALLEEG,'channels',{'FP1'}, 'plotsubjects', 'on');

Advanced plotting features

```
STUDY = std_erpplot(STUDY,ALLEEG,'channels',{'CZ'});
std_plotcurve(STUDY.changrp(39).erptimes,
   STUDY.changrp(39).erpdata,  'plotconditions',
   'together', 'plotstderr', 'on', 'filter', 30);
```





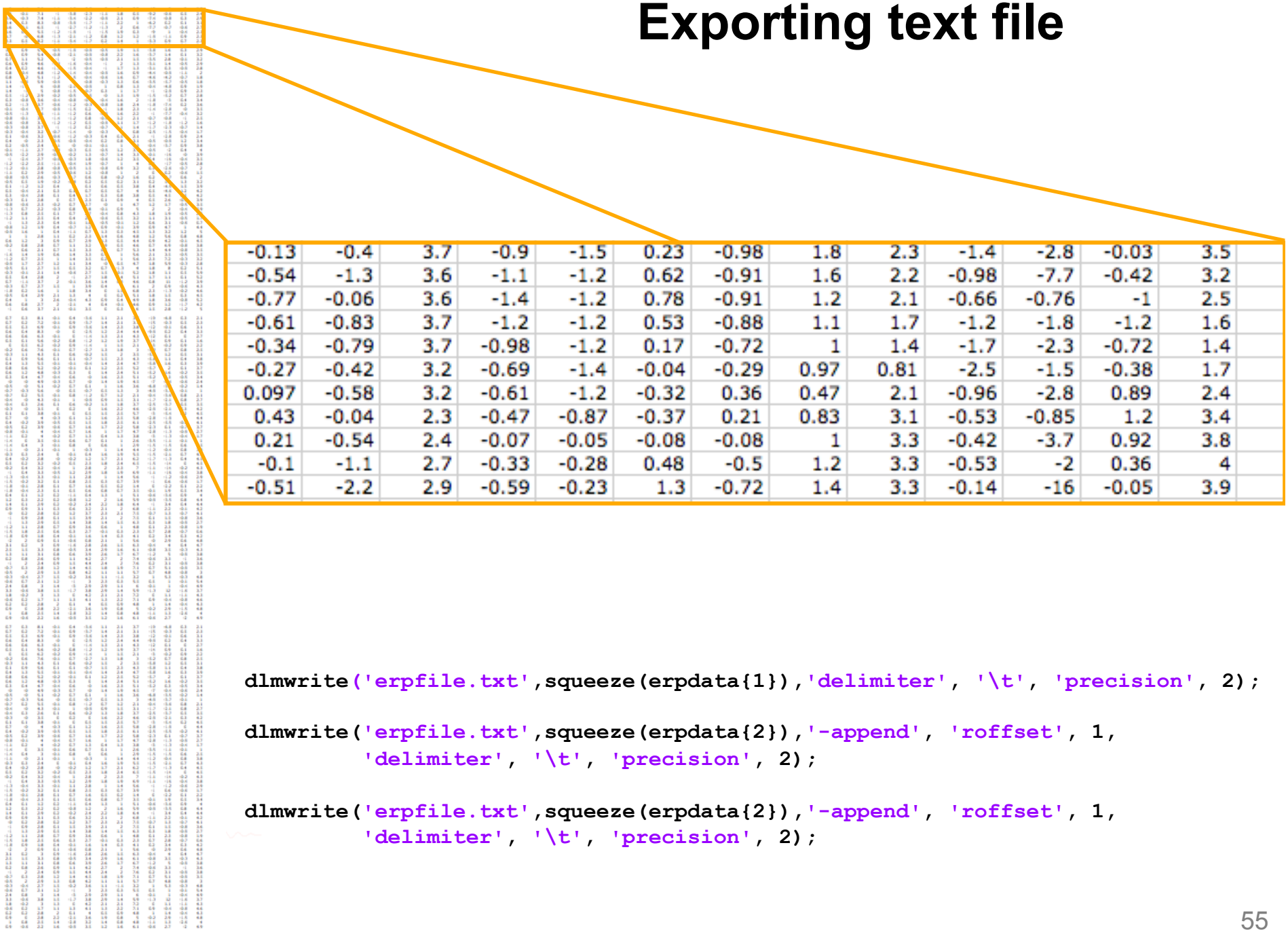

```
STUDY = std_erpplot(STUDY,ALLEEG, 'topotime',[200 300] , 'channels',{'OZ' 'O2' 'FP1' 'FPZ' 'FP2'});
[STUDY erpdata ] = std_erpplot(STUDY,ALLEEG, , 'topotime',[200 300] , 'channels',{'OZ' 'O2'});
```

Exporting to excell file

```
[1x67x13 double]
[1x67x13 double]
[1x67x13 double]
```

```
xlswrite('myxlsfile',squeeze(erpdata{1}),1);
xlswrite('myxlsfile',squeeze(erpdata{2}),2);
xlswrite('myxlsfile',squeeze(erpdata{3}),3);
```

Exporting text file



-0.13	-0.4	3.7	-0.9	-1.5	0.23	-0.98	1.8	2.3	-1.4	-2.8	-0.03	3.5
-0.54	-1.3	3.6	-1.1	-1.2	0.62	-0.91	1.6	2.2	-0.98	-7.7	-0.42	3.2
-0.77	-0.06	3.6	-1.4	-1.2	0.78	-0.91	1.2	2.1	-0.66	-0.76	-1	2.5
-0.61	-0.83	3.7	-1.2	-1.2	0.53	-0.88	1.1	1.7	-1.2	-1.8	-1.2	1.6
-0.34	-0.79	3.7	-0.98	-1.2	0.17	-0.72	1	1.4	-1.7	-2.3	-0.72	1.4
-0.27	-0.42	3.2	-0.69	-1.4	-0.04	-0.29	0.97	0.81	-2.5	-1.5	-0.38	1.7
0.097	-0.58	3.2	-0.61	-1.2	-0.32	0.36	0.47	2.1	-0.96	-2.8	0.89	2.4
0.43	-0.04	2.3	-0.47	-0.87	-0.37	0.21	0.83	3.1	-0.53	-0.85	1.2	3.4
0.21	-0.54	2.4	-0.07	-0.05	-0.08	-0.08	1	3.3	-0.42	-3.7	0.92	3.8
-0.1	-1.1	2.7	-0.33	-0.28	0.48	-0.5	1.2	3.3	-0.53	-2	0.36	4
-0.51	-2.2	2.9	-0.59	-0.23	1.3	-0.72	1.4	3.3	-0.14	-16	-0.05	3.9

```
dlmwrite('erpfile.txt',squeeze(erpdata{1}),'delimiter', '\t', 'precision', 2);

dlmwrite('erpfile.txt',squeeze(erpdata{2}),'-append', 'roffset', 1,
         'delimiter', '\t', 'precision', 2);

dlmwrite('erpfile.txt',squeeze(erpdata{2}),'-append', 'roffset', 1,
         'delimiter', '\t', 'precision', 2);
```

Exercice: run STUDY Script

```
% Create Stern STUDY
[ALLEEG EEG CURRENTSET ALLCOM] = eeglab;
pop_editoptions( 'option_storedisk', 1);
subjects = {'S01' 'S02' 'S03' 'S04' 'S05' 'S06' 'S07' 'S08' 'S09' 'S10' 'S11' 'S12'};
filepath = '/Users/arno/temp/STUDY'; % XXXXX Change path here XXXXX
if ~exist(filepath), error('You need to change the path to the STUDY'); end;
commands = {}; % initialize STUDY dataset list

% Loop through all of the subjects in the study to create the dataset
for loopnum = 1:length(subjects) %for each subject
    IgnoreFile   = fullfile(filepath, subjects{loopnum}, 'Ignore.set');
    MemorizeFile = fullfile(filepath, subjects{loopnum}, 'Memorize.set');
    ProbeFile    = fullfile(filepath, subjects{loopnum}, 'Probe.set');
    commands = {commands{:} ...
        {'index' 3*loopnum-2 'load' IgnoreFile   'subject' subjects{loopnum} 'condition' 'Ignore'} ...
        {'index' 3*loopnum-1 'load' MemorizeFile 'subject' subjects{loopnum} 'condition' 'Memorize'} ...
        {'index' 3*loopnum   'load' ProbeFile    'subject' subjects{loopnum} 'condition' 'Probe'}};
end;
% Uncomment the line below to select ICA components with less than 15% residual variance
% commands = {commands{:} {'dipselect', 0.15}};
[STUDY, ALLEEG] = std_editset(STUDY, ALLEEG, 'name','Sternberg','commands',commands,'updatedat','on');

% Update workspace variables and redraw EEGLAB
CURRENTSTUDY = 1; EEG = ALLEEG; CURRENTSET = [1:length(EEG)];
[STUDY, ALLEEG] = std_checkset(STUDY, ALLEEG);
eeglab redraw

[STUDY ALLEEG] = std_precomp(STUDY, ALLEEG, {},'rmicacomps','on','interp','on','recompute','on','erp','on');
STUDY = pop_erpparams(STUDY, 'topotime',[200 300] );
[STUDY erpdata] = std_erpplot(STUDY,ALLEEG,'channels',{'LEYE' 'REYE' 'OZ' 'O2' 'FP1' 'FPZ' 'FP2' 'AF7' ...
            'AF3' 'AFZ' 'AF4' 'AF8' 'F9' 'F7' 'F5' 'F3' 'F1' 'FZ' 'F2' 'F4' 'F6' 'F8' 'F10' 'FT9' ...
            'FT7' 'FC5' 'FC3' 'FC1' 'FCZ' 'FC2' 'FC4' 'FC6' 'FT8' 'FT10' 'T7' 'C5' 'C3' 'C1' 'CZ' ...
            'C2' 'C4' 'C6' 'T8' 'TP9' 'TP7' 'CP5' 'CP3' 'CP1' 'CPZ' 'CP2' 'CP4' 'CP6' 'TP8' 'TP10' ...
            'P7' 'P5' 'P3' 'P1' 'PZ' 'P2' 'P4' 'P6' 'P8' 'PO9' 'PO7' 'PO3' 'POZ' 'PO4' 'PO8' 'PO10' 'O1'});

dlmwrite('erpfile.txt',squeeze(erpdata{1}),'delimiter', '\t', 'precision', 2);
dlmwrite('erpfile.txt',squeeze(erpdata{2}),'-append', 'roffset', 1, 'delimiter', '\t', 'precision', 2);
dlmwrite('erpfile.txt',squeeze(erpdata{2}),'-append', 'roffset', 1, 'delimiter', '\t', 'precision', 2);
```

Advanced scripting: EEG pipeline

```
sInfo = [];
sInfo(end+1).file = 'rawdata/S01.raw';
sInfo(end).name = 'S01';
sInfo(end).bad_channels = { 'E1' };
```

Raw data file

Subject name

Subject name

Advanced scripting: EEG pipeline

```
sInfo = [];
sInfo(end+1).file = 'rawdata/S01.raw';
sInfo(end).name = 'S01';
sInfo(end).bad_channels = { 'E1' };
sInfo(end).bad_data  = [726 1495;6098 6831;13245 14057;15715 16399;22756 2445
```

Raw data file

Subject name

Subject name

Copy the output from the eeg_eegrej function in the history

Advanced scripting: EEG pipeline

```
sInfo = [];
sInfo(end+1).file = 'rawdata/S01.raw';
sInfo(end).name = 'S01';
sInfo(end).bad_channels = { 'E1' };
sInfo(end).bad_data  = [726 1495;6098 6831;13245 14057;15715 16399;22756];
sInfo(end).bad_comps = [1.6681  1.9870 0.3979 0.4444 -0.2274 -0.1433 -0.2626 ·
                        1.1917 -1.4838 0.7469 -1.1599 0.4773 -0.3257  0.3074 ·
```

Raw data file

Subject name

Subject name

Copy transposed columns of the inverse weight matrix EEG.icawinv for your selected artifact components

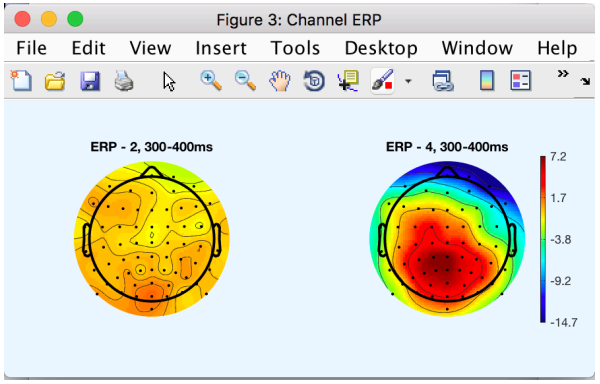
Advanced scripting: EEG pipeline

datainfo.m file

```
sInfo = [];
sInfo(end+1).file = 'S01.raw';
sInfo(end).name = 'S01';
sInfo(end).bad_channels = { 'E1' };
sInfo(end).bad_data  = [726 1495;6098 6831;13245 14057;15715 16399;22756 24457;3074
sInfo(end).bad_comps = [1.6681  1.9870 0.3979 0.4444 -0.2274 -0.1433 -0.2626 -0.108
                        1.1917 -1.4838 0.7469 -1.1599 0.4773 -0.3257  0.3074 -0.163

sInfo(end+1).file = 'S02.raw';
sInfo(end).name = 'S02';
sInfo(end).bad_channels = { };
sInfo(end).bad_data  = [41661 43713;24000 24833;44878 46501;48706 49210;51190 52353
sInfo(end).bad_comps = [0.6960 -0.8637  0.9087 -0.8028  0.4873 -0.2142  0.2737 -0.2
                       -0.0875 -0.4056 -0.0287 -0.3870  0.0600 -0.3716  0.3425 -0.4
                        2.1928  1.5712  0.8622  0.3215 -0.0357 -0.3125 -0.2268 -0.3

sInfo(end+1).file = 'S03.raw';
sInfo(end).name = 'S03';
sInfo(end).bad_channels = { 'E10' 'E19' 'E20' 'E29' };
sInfo(end).bad_data  = [1 10449;19808 21815;25678 27254;29257 30010;34023 36016;367
sInfo(end).bad_comps = [ 1.8583  2.0468 -0.0516  0.3159 -0.4256 -0.2770 -0.3643 -0.
                         1.2189 -0.7385  1.2464 -0.8913  0.5475 -0.3971  0.2987 -0.
                        -0.1248 -0.1358 -0.1954 -0.2533 -0.1555 -0.2313 -0.0351 -0.
```

```
datainfo;
pop_editoptions( 'option_storedisk', 1);
outputEEGFolder = 'preprocessed_data';
if ~exist(outputEEGFolder), mkdir(outputEEGFolder); end;

for iSubj = 1:length(sInfo)

    % load dataset
    EEG = pop_biosig(sInfo(iSubj).file);
    EEG.setname = sInfo(iSubj).name;

    % proprocess data
    chanFile= 'plugins/dipfit2.3/standard_BEM/elec/standard_1005.elc';
    EEG = pop_chanedit(EEG, 'lookup', fullfile(fileparts(which('eeglab.m')), chanFile));
    EEG = pop_iirfilt( EEG, 0.5, 0, [], 0, 0); % high pass filtering
    EEG = pop_iirfilt( EEG, 0, 55, [], 0, 0); % low pass filtering
    EEG = pop_select(EEG, 'nochannel', sInfo(iSubj).bad_channels); % remove bad channels
    EEG = pop_reref( EEG, []); % average reference (optional)
    EEG = eeg_eegrej( EEG, sInfo(iSubj).bad_data); % remove bad portions of data

    % run ICA
    EEG = pop_runica(EEG, 'icatype', 'sobi');

    % tag bad components
    EEG = pop_findmatchingrejcomps(EEG,'matchcomps',sInfo(iSubj).bad_comps,'corrthresh',0.92);

    % extract data epochs
    EEG = pop_epoch(EEG, { 2 4 } , [-1 2]);

    % save dataset
    EEG.saved = 'no';
    EEG = pop_saveset( EEG, 'filepath', outputEEGFolder, 'filename', [ sInfo(iSubj).name '.set' ])
end
```

Create STUDY




```
datainfo;
pop_editoptions( 'option_storedisk', 1);
outputEEGFolder = 'preprocessed_data';
studyCommand    = {};

% generate STUDY commands
for iSubject = 1:length(sInfo)
    fileName  = fullfile(outputEEGFolder, [ sInfo(iSubject).name '.set' ]);
    studyCommand = [ studyCommand { 'index' iSubject 'load' fileName 'subject' ...
           sInfo(iSubject).name } ];
end;

% create data
[STUDY ALLEEG] = std_editset( [], [], 'name', 'test', 'commands', studyCommand, ...
        'updatedat','off', 'filename', 'test.study', 'resave', 'on');
STUDY = std_makedesign(STUDY, ALLEEG, 1, 'name','STUDY.design 1','delfiles','off', ...
'defaultdesign','off','variable1','type','values1',{'2' '4' });


% update workspace variables and redraw EEGLAB
CURRENTSTUDY = 1; EEG = ALLEEG; CURRENTSET = [1:length(EEG)];
[STUDY, ALLEEG] = std_checkset(STUDY, ALLEEG);
eeglab redraw

% precompute and plot data
allchanlocs = eeg_mergelocs(ALLEEG.chanlocs);
[STUDY ALLEEG] = std_precomp(STUDY, ALLEEG, {},'interp','on','recompute','on','erp', 'on');
STUDY = pop_statparams(STUDY, 'condstats','on','singletrials','on','mode','fieldtrip', ...
'fieldtripmethod','montecarlo','fieldtripmcorrect','cluster');
[STUDY erp] = std_erpplot(STUDY,ALLEEG, 'channels',{allchanlocs.labels}, 'topotime',[300 400]);
print results.eps -depsc
```

Exercice: build your own pipeline

Suggestion for exercise

1. Load oddball_file.bdf dataset (in Data folder or on the wiki)
2. High pass filter at 0.5Hz (menu Tools > Filter)
3. Reject bad channels by hand (plot spectrum)
4. Re-reference to average ref. (optional) (menu Tools > Re-reference)
5. Reject bad portion of data by hand (menu Tools > Reject continuous…)
6. Build your *datainfo.m* file using EEGLAB history (see scripting lecture)
7. Run ICA; select bad ICA components
8. Epoch data on Oddball (type 4) and Standard (type 2) – save dataset
9. Add components to you *datainfo.m* file
10. Create a STUDY with this single file
11. Compare the ERP for Oddball (type 4) and Standard (type 2) and use single-trial statistics with cluster correction for multiple comparisons
12. Build a script that creates the STUDY and perform the same analysis
13. Save the figure at the end of the script in eps or jpg format (“print –depsc file” command or “print –djpg file” command).
14. Run the full pipeline (dataset processing and STUDY processing)
15. Change the filtering in the pipeline (step 2) and observe effects