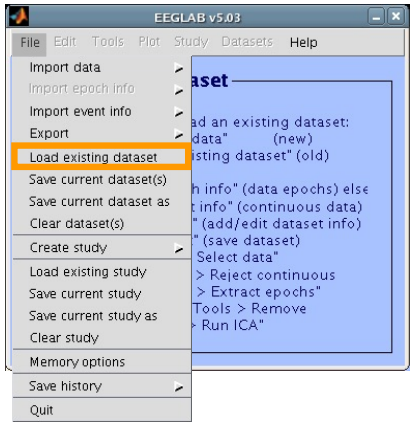
Basic scripting with EEGLAB



(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
- Export data
- Custom processing…

EEGLAB Scripting

Raw data preprocessing

```
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
```

Group level analysis

```
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
```

Using EEGLAB history for basic scripting

Task 1

Create a script from ‘eegh’ output

Task 2

Adapt your script with variables

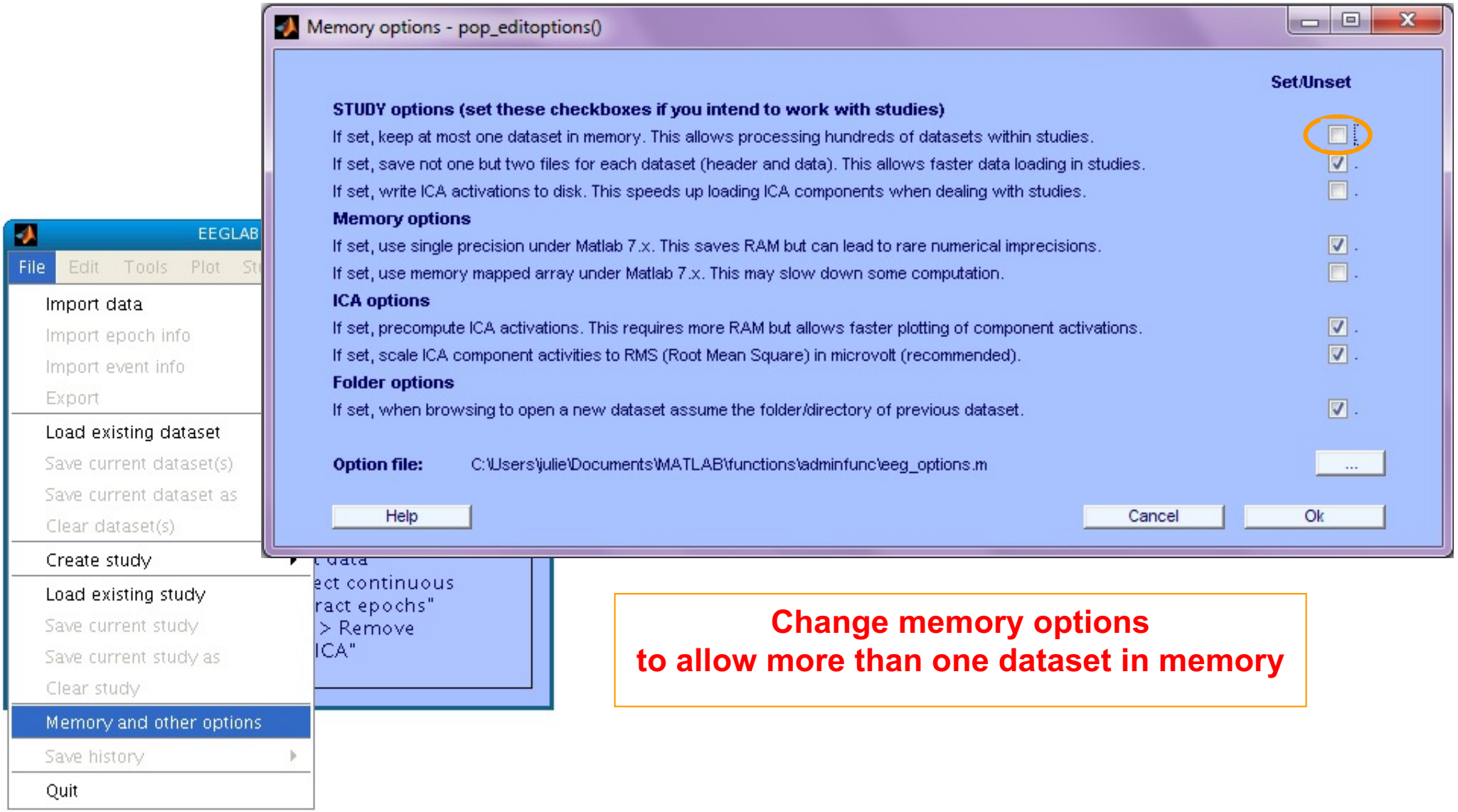
Task 3

Create a Matlab function

Task 4

Exercise...

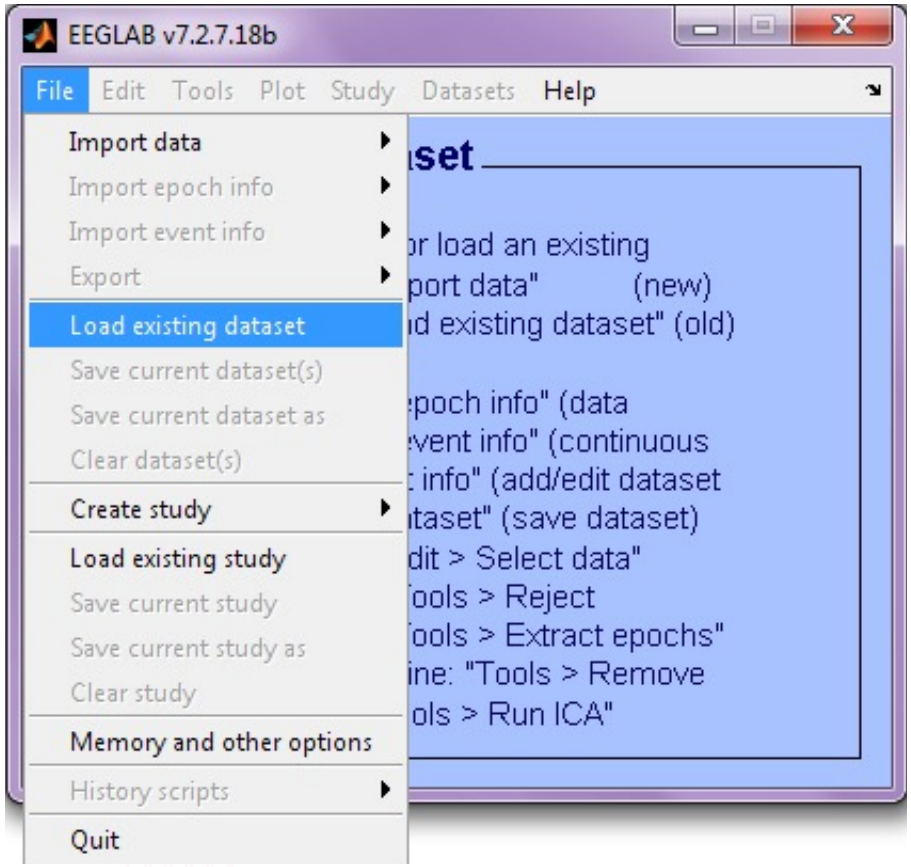
Memory options

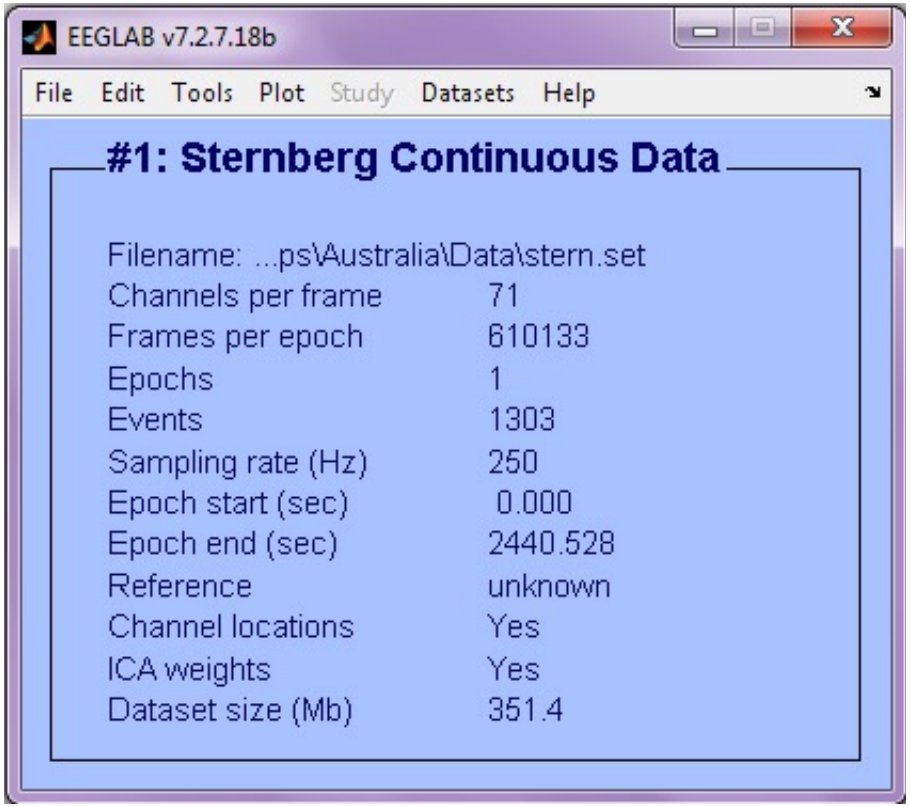


Change memory options
to allow more than one dataset in memory

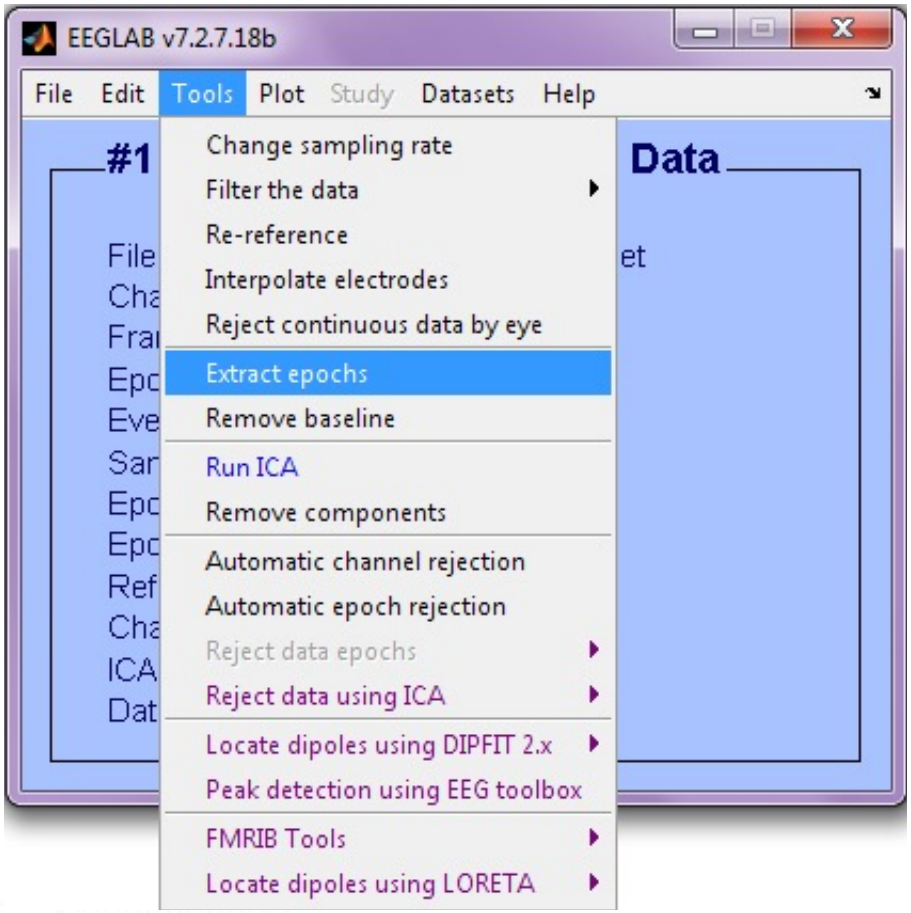
Create a script from ‘eegh’ output

Start by loading a continuous dataset

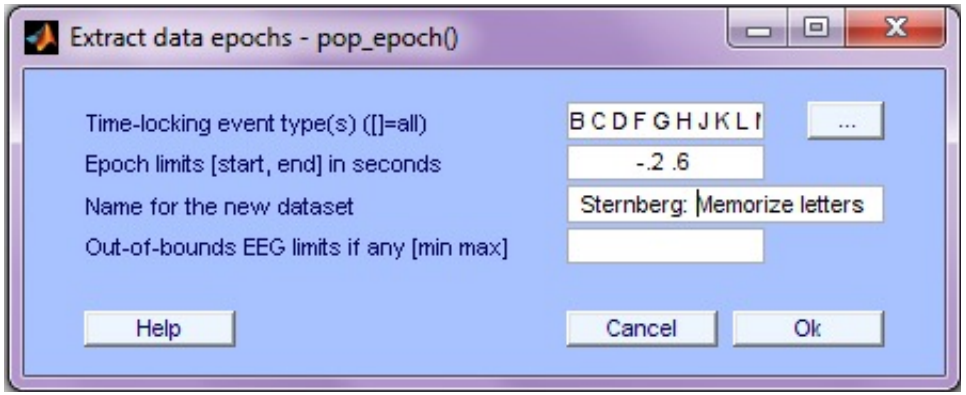




Create a script from ‘eegh’ output

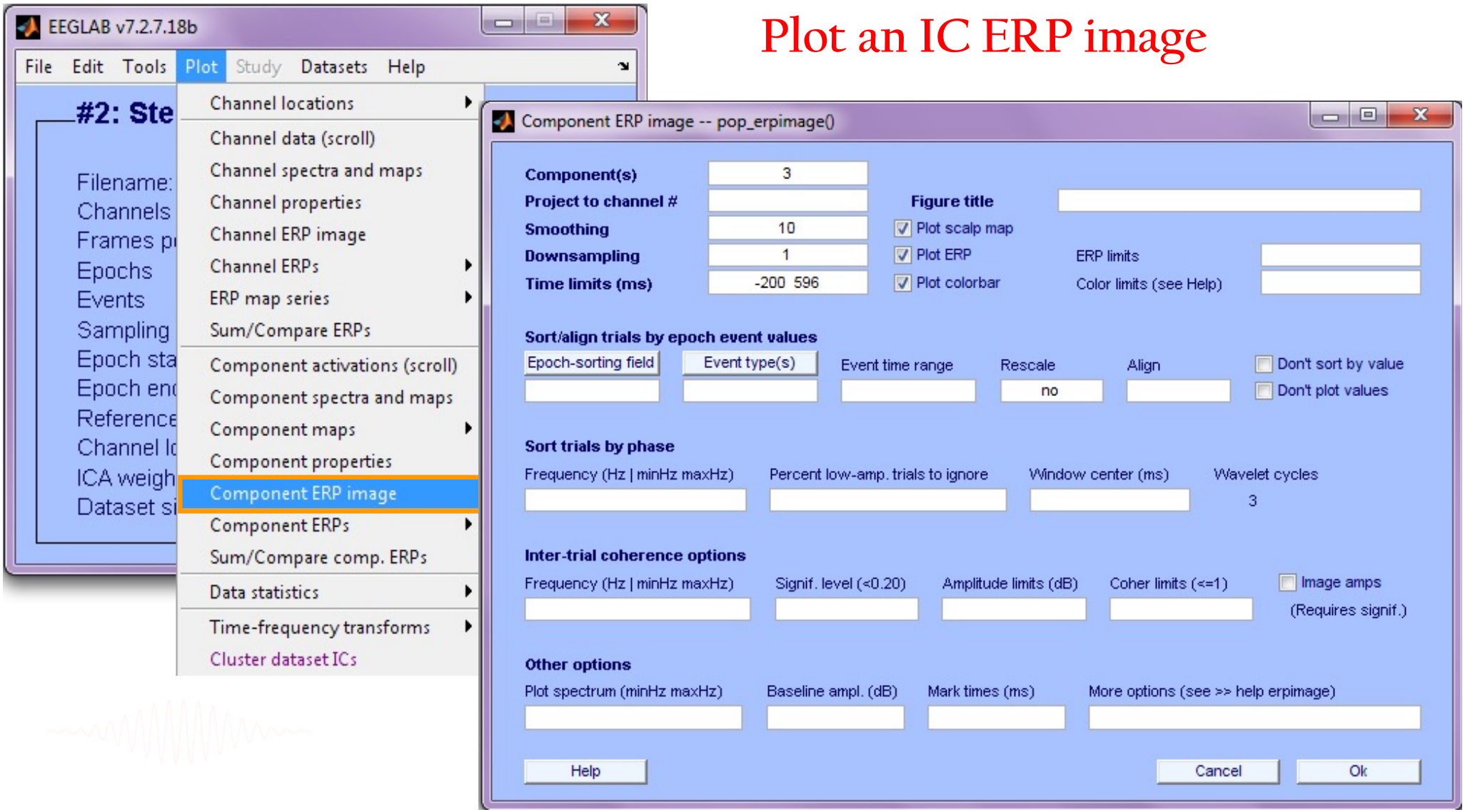


Epoch on Memorize letters

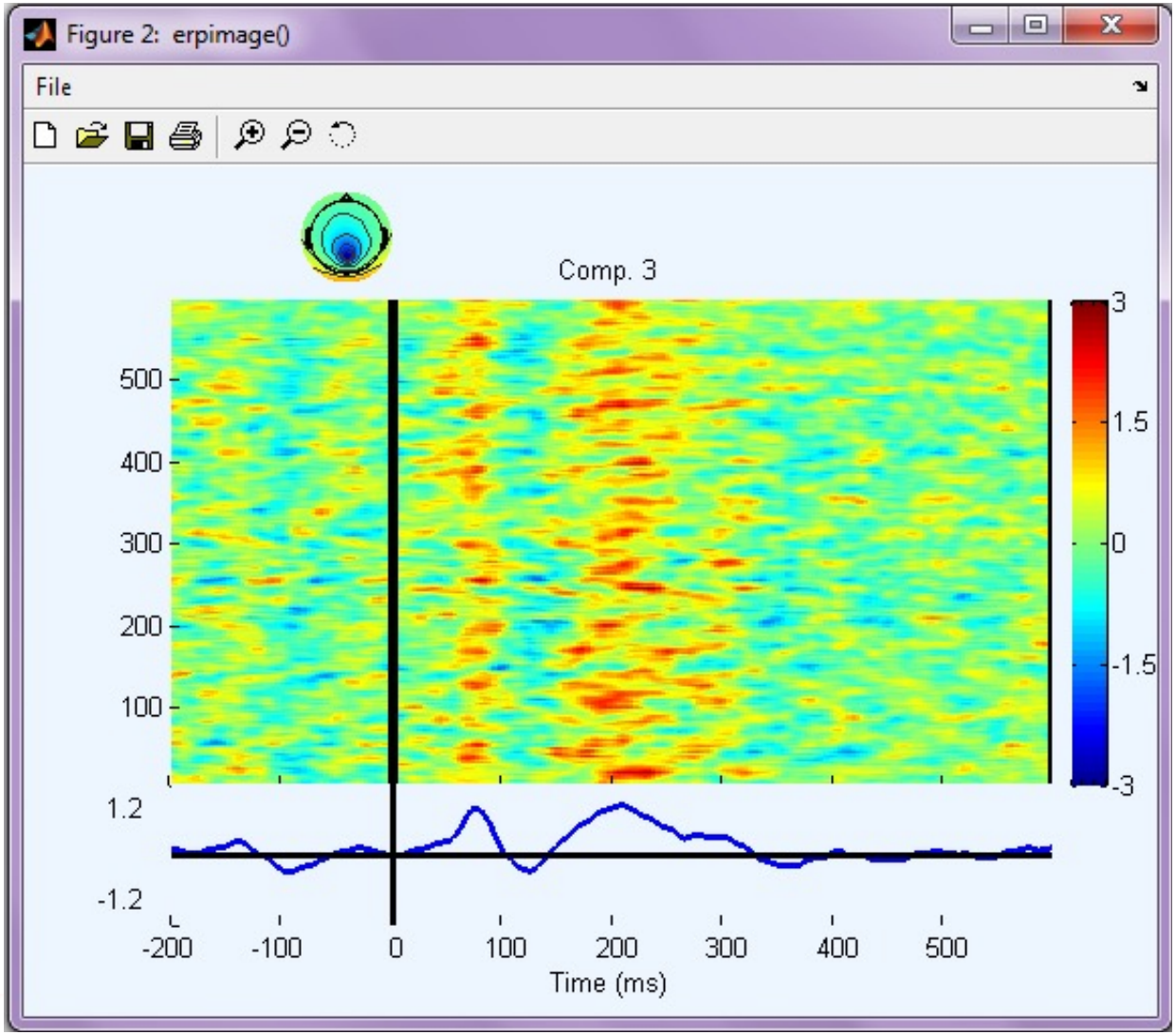


Create a script from ‘eegh’ output

Plot an IC ERP image



Create a script from ‘eegh’ output



Retrieve commands from eegh

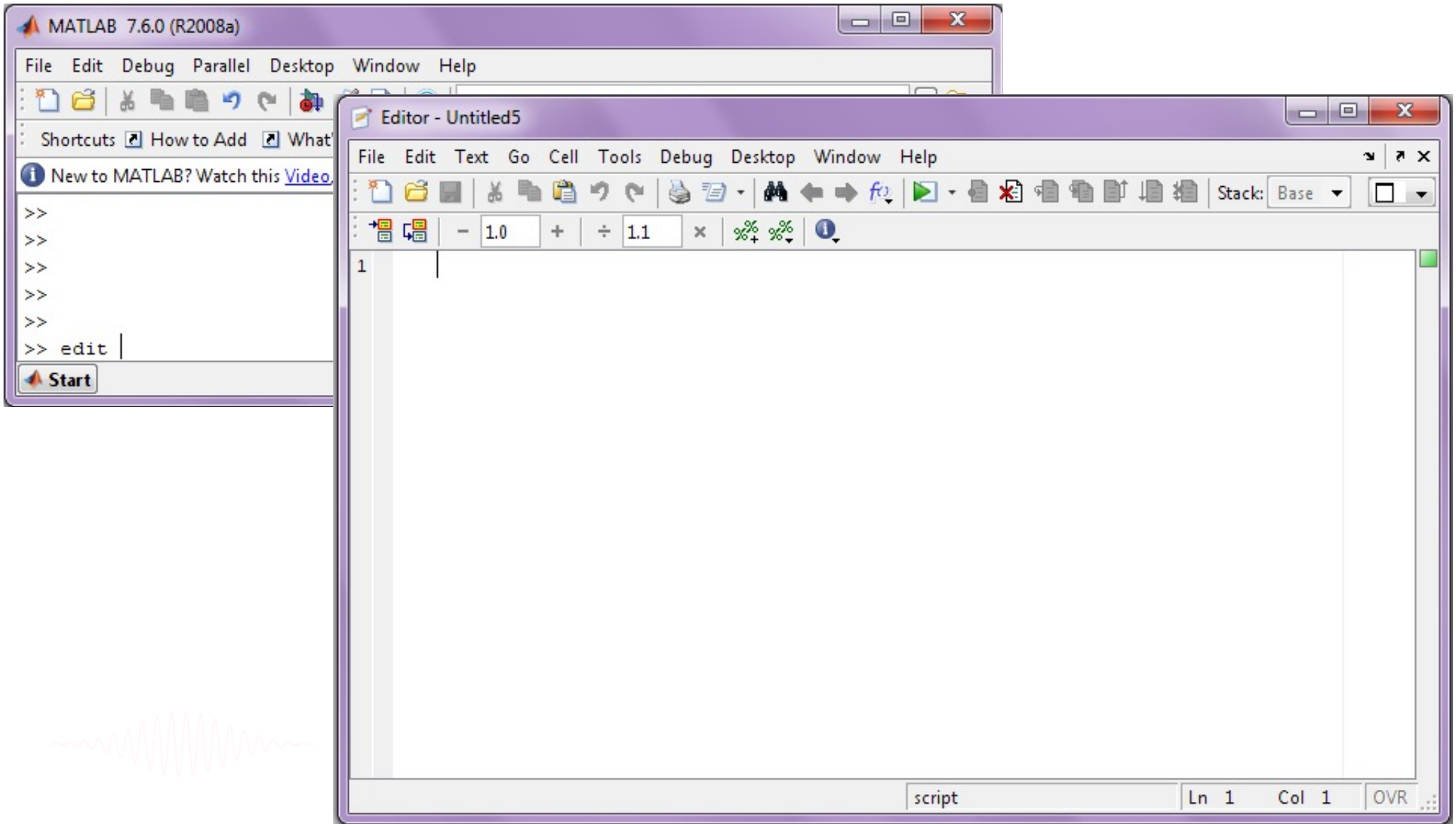
Write a script to do this:

```
>> eegh
```

Retrieve commands from eegh

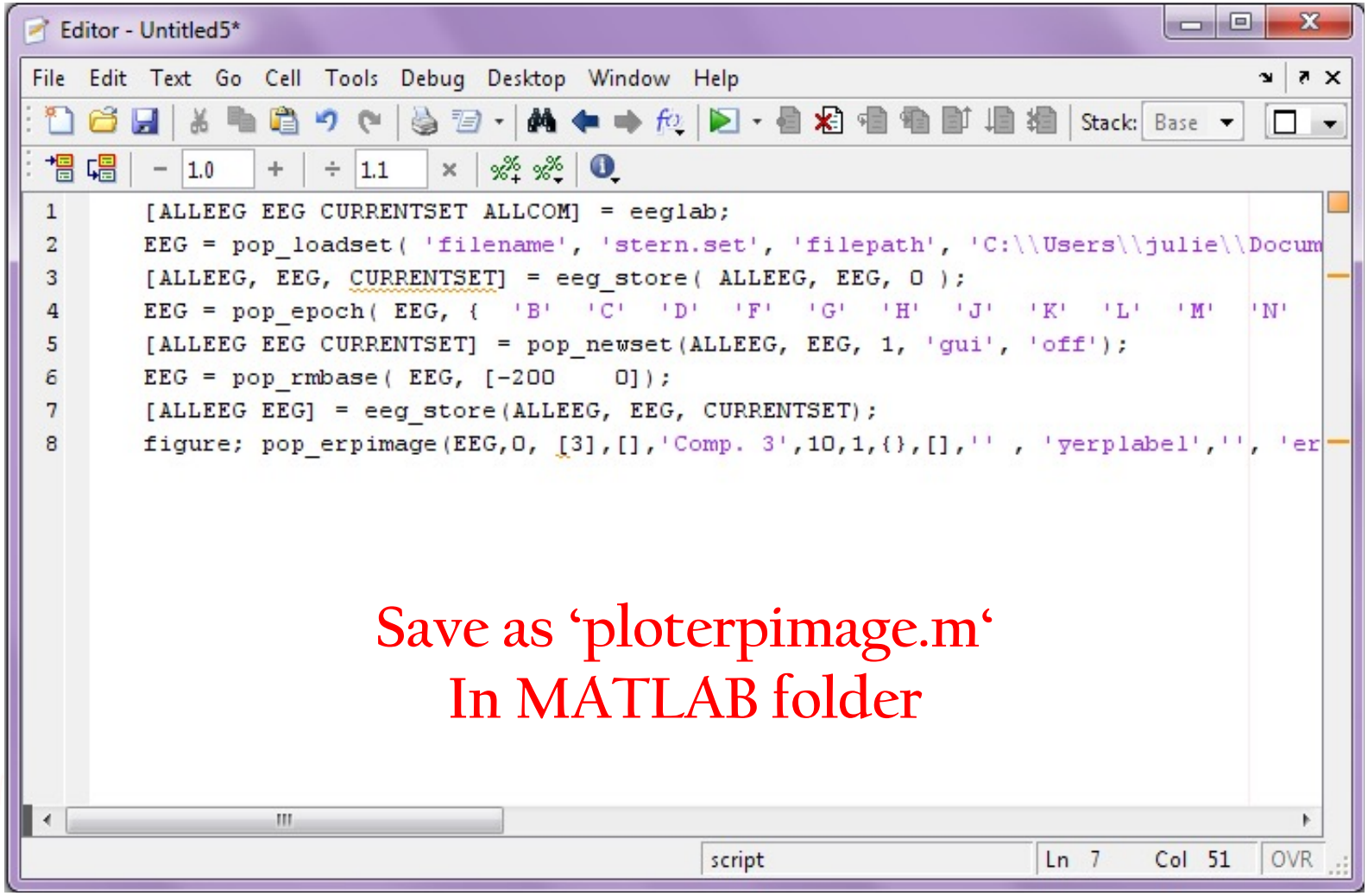
```
>> eegh
[ALLEEG EEG CURRENTSET ALLCOM] = eeglab;

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



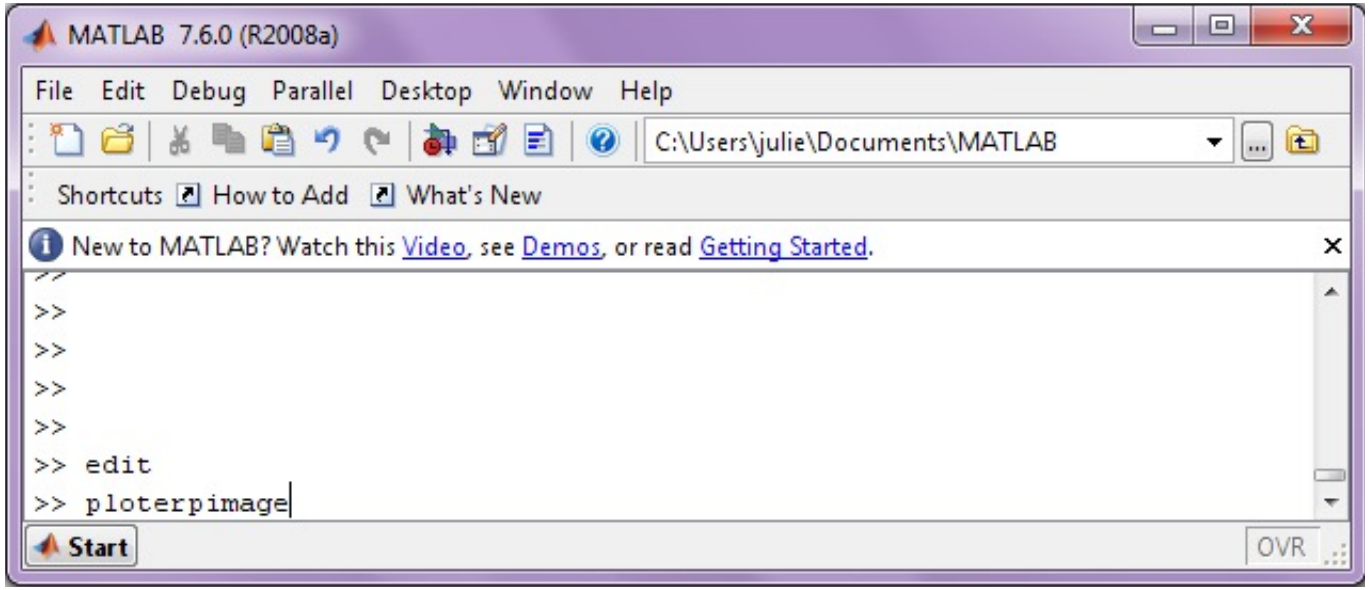
Create a Matlab script

Copy and paste from Matlab window:



Save as ‘ploterpimage.m‘
In MATLAB folder

Run your new script

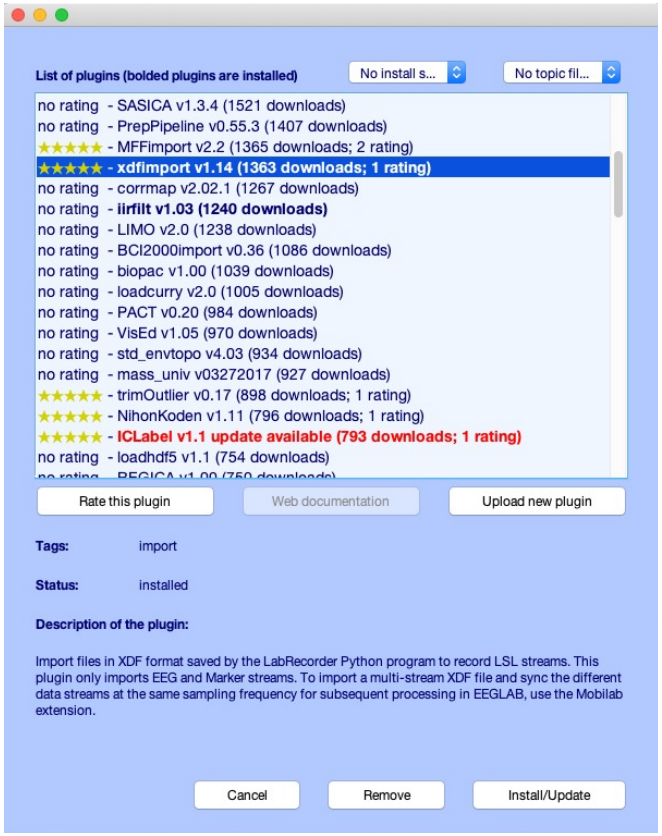


Exercise page 1

```
>> eeglab

% load dataset stern_125hz.set in data folder
% 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
```

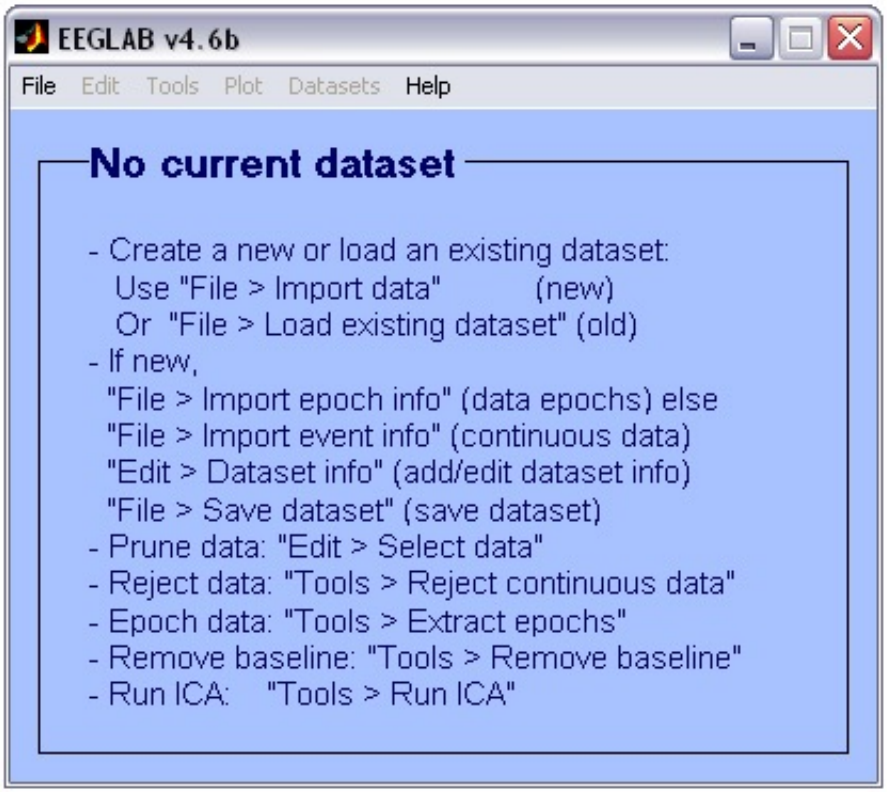
Command line tools

write a simple plugin



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)
>>
```

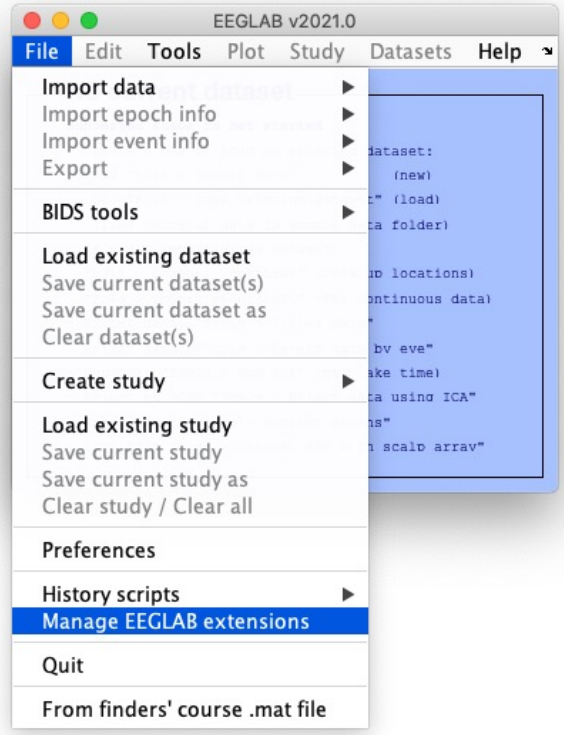


Proper EEGLAB plugins

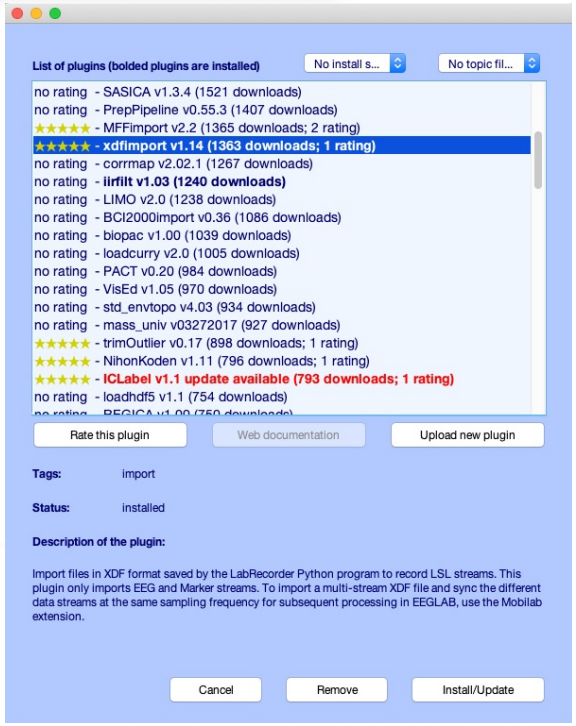
eepimport1.02	Data importing for EEprobe data (Oostenved & ANT company)
bva_io1.30	Brain vision analyzer import/export plugin (Widmann & Delorme)
ctfimport1.01	MEG CTF import plugin (Carver, Weber & Delorme)
dipfit4.0	4-shell and BEM (Oostenveld & Delorme)
fmrib1.2b	Removal of artifact from simultaneously EEG/fMRI recording (Niazi)
iirfilt1.0	Non-linear IIR filtering (Pozdin)

Matlab toolboxes interfaced as plugins

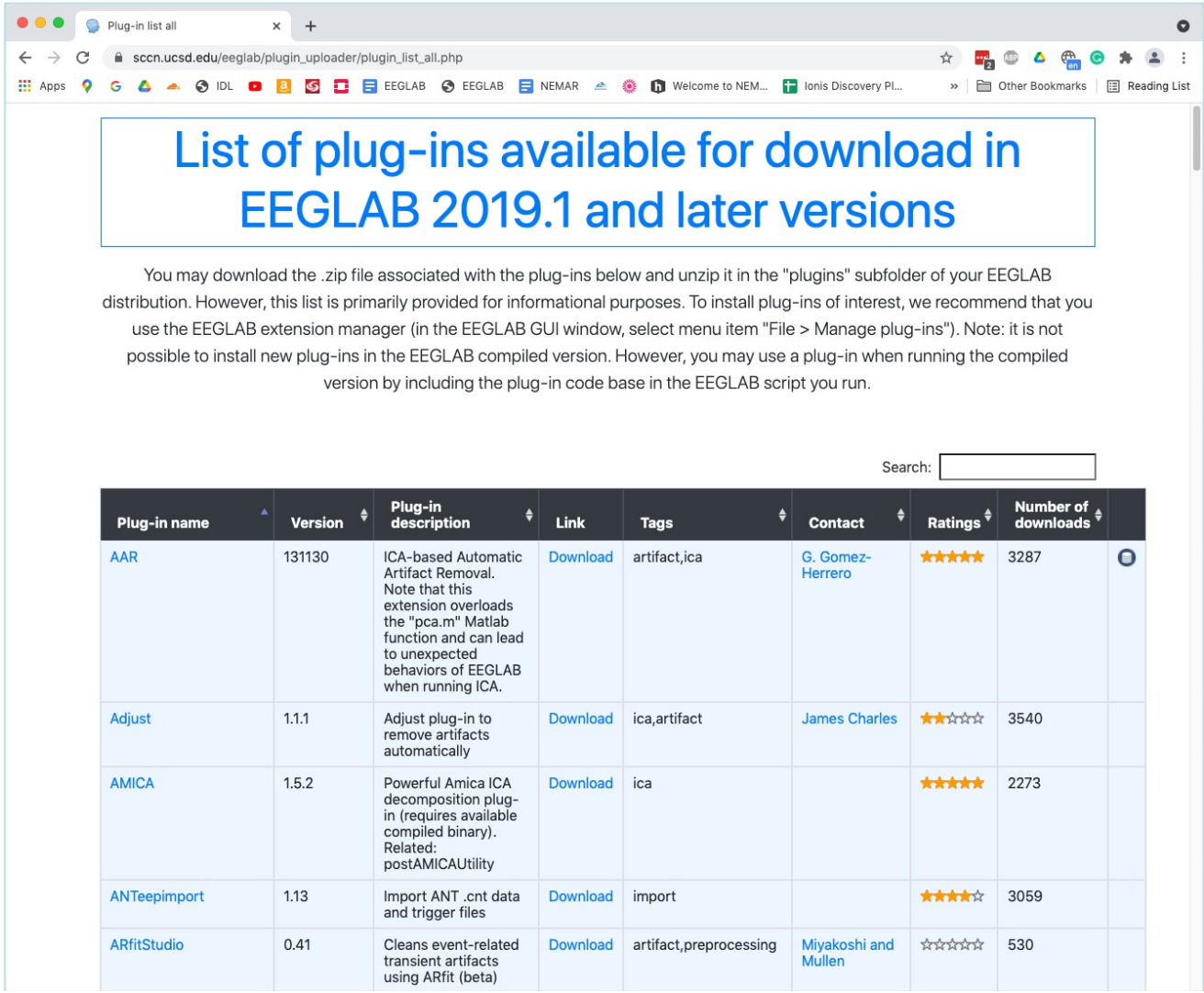
BIOSIG	Data importing for rare data binary format (Schloegl)
File-IO	Data importing (Oostenveld)
Fieldtrip	Source localization and time-freq. decompositions (Oostenveld)
LIMO-EEG	General linear model and EEG
SIFT	Source information flow toolbox



EEGLAB plugin manager



EEGLAB online plugin page



3 levels of functions

Top: Administrative functions: handle EEG/ALLEEG structures

eeglab(), eeg_checkset(), pop_delset(), …

Middle: Pop functions: interactive functions using EEG structure

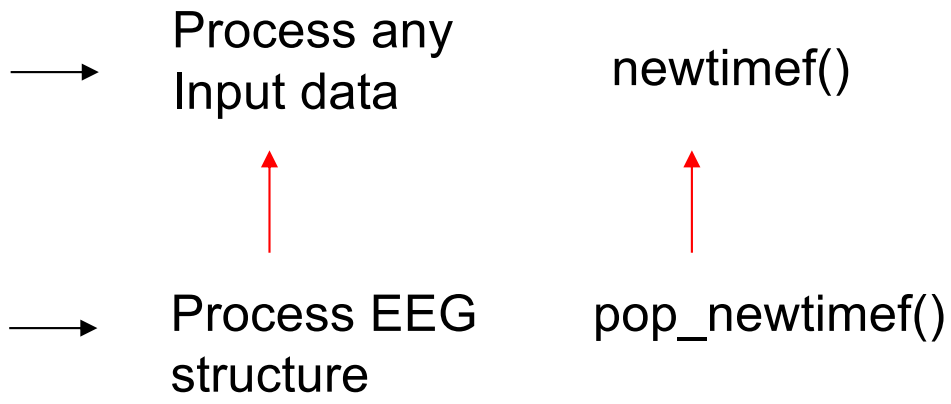
pop_erpimage(), pop_topoplot(), pop_envtopo(), …

Bottom: Signal processing functions: perform signal processing

erpimage(), topoplot(), envtopo(), …

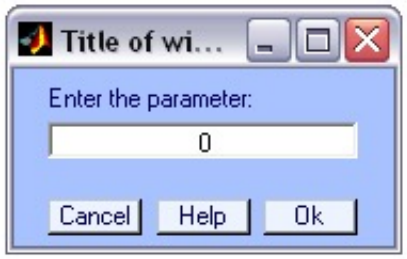
Writing EEGLAB plugins

- 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

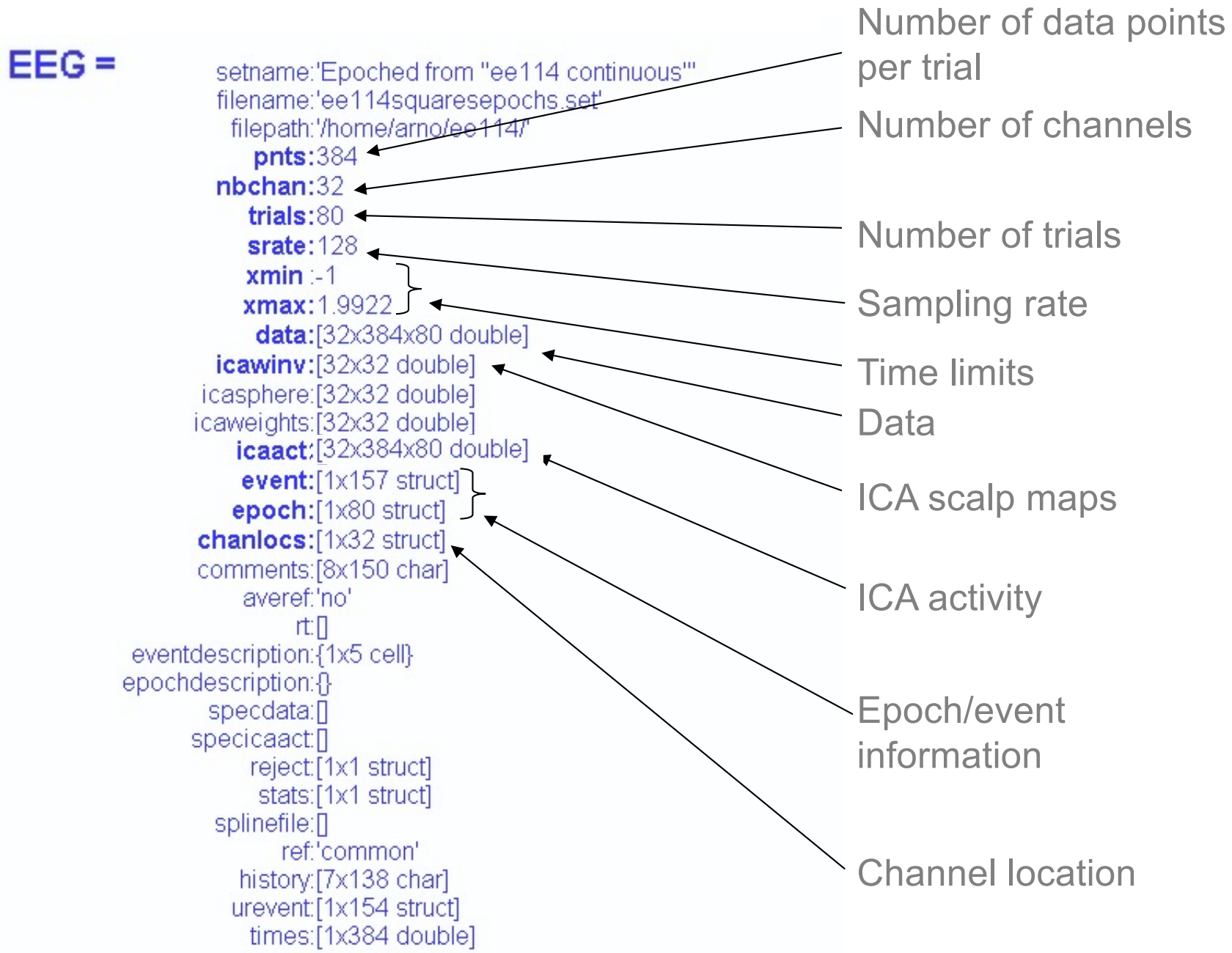



```
function [EEG, com] = pop_sample( EEG,  param1 );

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

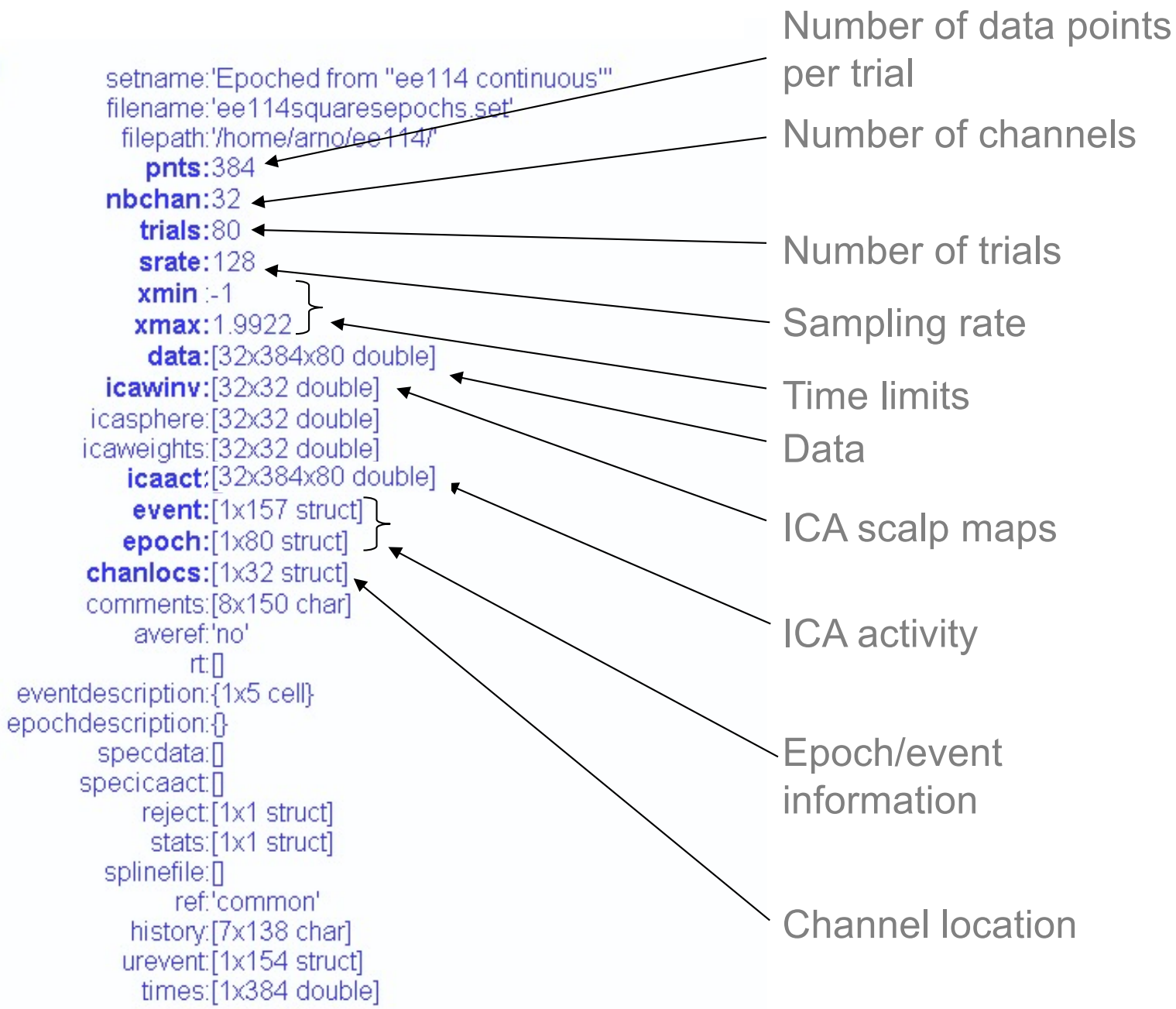
EEG structure



EEG structure

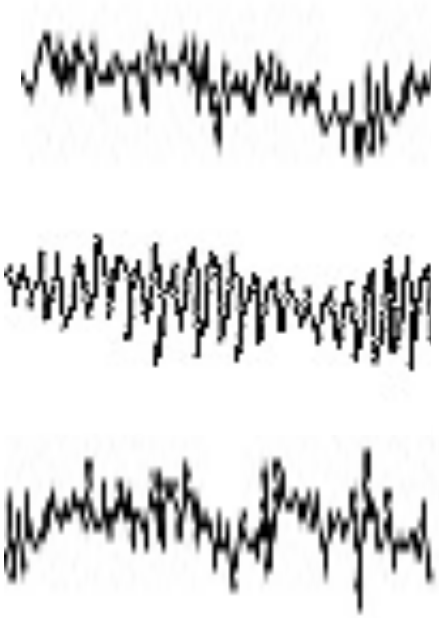
The EEG structure can be extended to include new fields

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

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

Trials 1: EEG.data(:,:,1)

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

Trials 2: EEG.data(:,:,2)

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

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

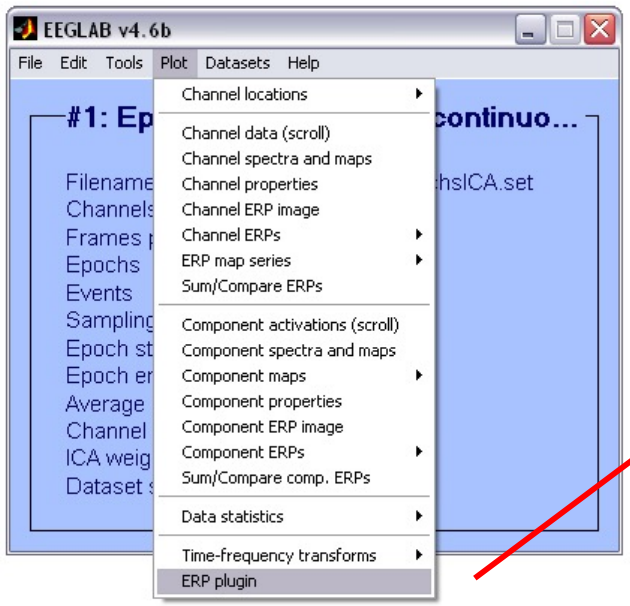
- eegplugin_erp.m function in “plugins” folder of EEGLAB

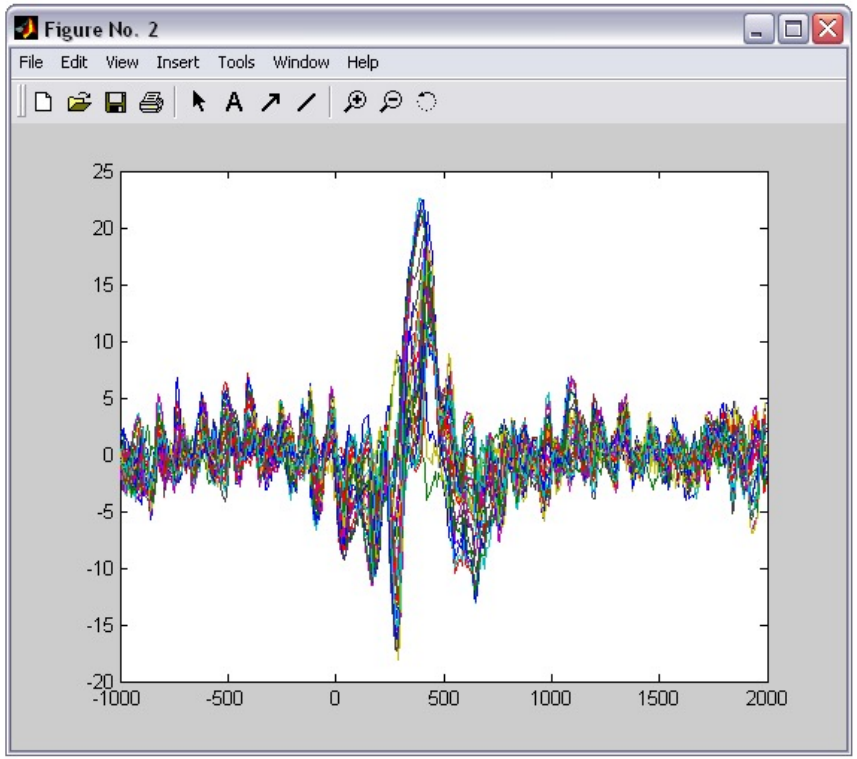
```
% eegplugin_erp() - plot ERP plugin

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));');
```


To test, load file in sample_data folder eeglab_data_epochs_ica.set

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
>>
```





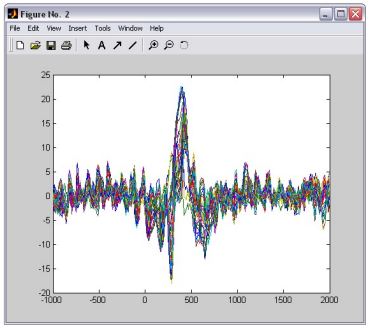
PCA plugin

```
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

Exercice

Write a plugin to plot ERPs



1. Copy and paste code from PDF
2. Save eegplugin_erp.m in the *plugins* folder of EEGLAB
3. Restart EEGLAB
4. Load epoched EEGLAB dataset (*eeglab_data_epochs_ica.set* from *sample_data* subfolder of EEGLAB)
5. Use plugin menu