Using EEGLAB history for basic scripting

1. ‘EEG’ structure
2. Scripting with EEGLAB ‘eegh’
3. Matlab functions
4. Search EEG.event structure
5. Converting from 'pop' functions

‘EEG’ structure

MATLAB 7.6.0 (R2008a)

File Edit Debug Parallel Desktop Window Help

C:\Program Files\Common Files\Adobe\Adobe Version Cue CS4\Client\

Shortcuts How to Add What's New

New to MATLAB? Watch this Video, see Demos, or read Getting Started.

```
>> EEG

EEG =

        setname: 'jo74 Sternberg Continuous epochs'
       filename: 'memorize.set'
       filepath: 'C:\Users\julie\Documents\MatlabData\EEGdata\sternberg\jo74\'
        subject: ''
          group: ''
      condition: ''
        session: []
       comments: [2x41 char]
         nbchan: 71
         trials: 464
           pnts: 750
          srate: 250
           xmin: -1
           xmax: 1.9960
          times: [1x750 double]
           data: [71x750x464 double]
         icaact: [71x750x464 double]
        icawinv: [71x71 double]
      icasphere: [71x71 double]
     icaweights: [71x71 double]
    icachansind: [1x71 double]
       chanlocs: [1x71 struct]
     urchanlocs: []
       chaninfo: [1x1 struct]
            ref: 'common'
          event: [1x928 struct]
        urevent: [1x1303 struct]
eventdescription: {[]  []  ''  ''  ''  ''  ''  ''  ''  ''  ''  ''  ''  ''  ''  ''}
          epoch: [1x464 struct]
epochdescription: {}
         reject: [1x1 struct]
          stats: [1x1 struct]
        specdata: []
     specicaact: []
     splinefile: ''
  icasplinefile: ''
         dipfit: [1x1 struct]
        history: [1x897 char]
          saved: 'yes'
            etc: []
        datfile: ''

>>
```

Start OVR

channels x times (frames) x epochs (trials)

Using EEGLAB history for basic scripting

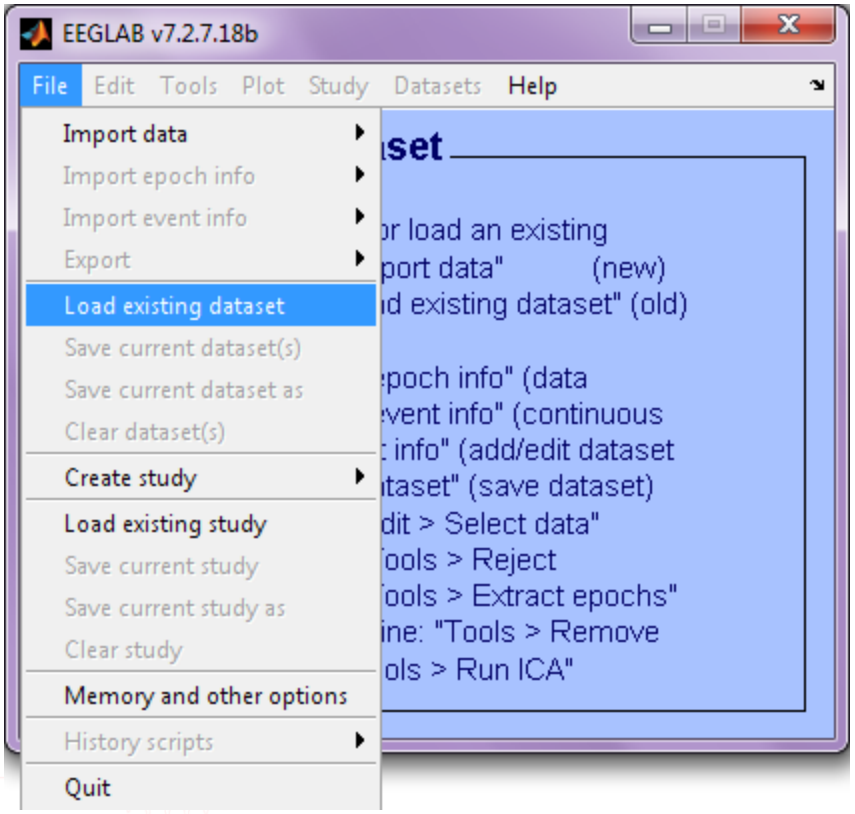
1. ‘EEG’ structure
2. Scripting with EEGLAB ‘eegh’
3. Matlab functions
4. Search EEG.event structure
5. Converting from 'pop' functions

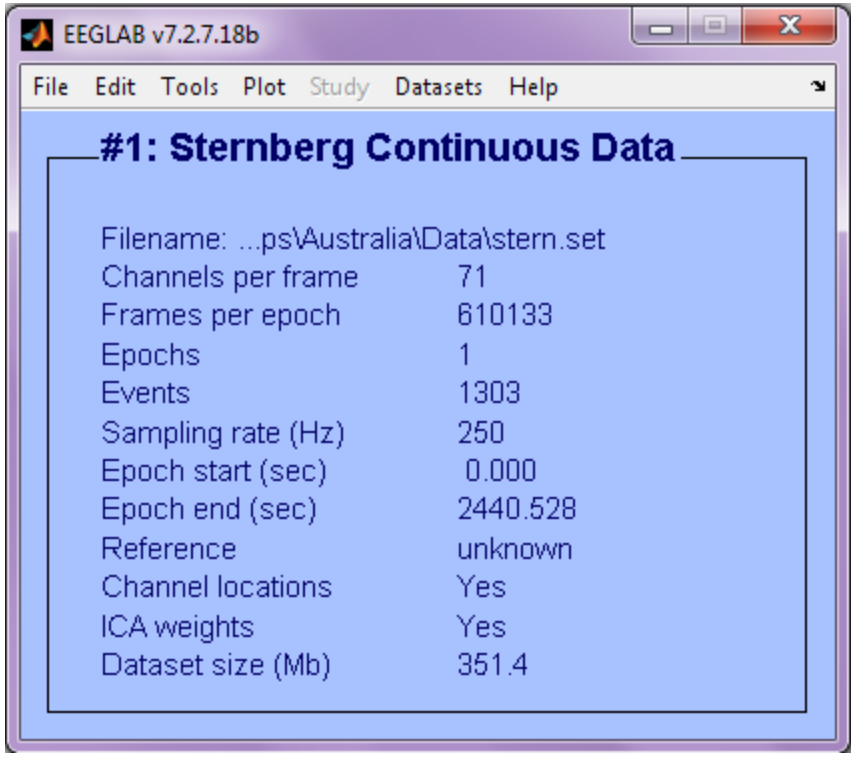
Create a script from 'eegh' output

Swartz Center for Computational Neuroscience

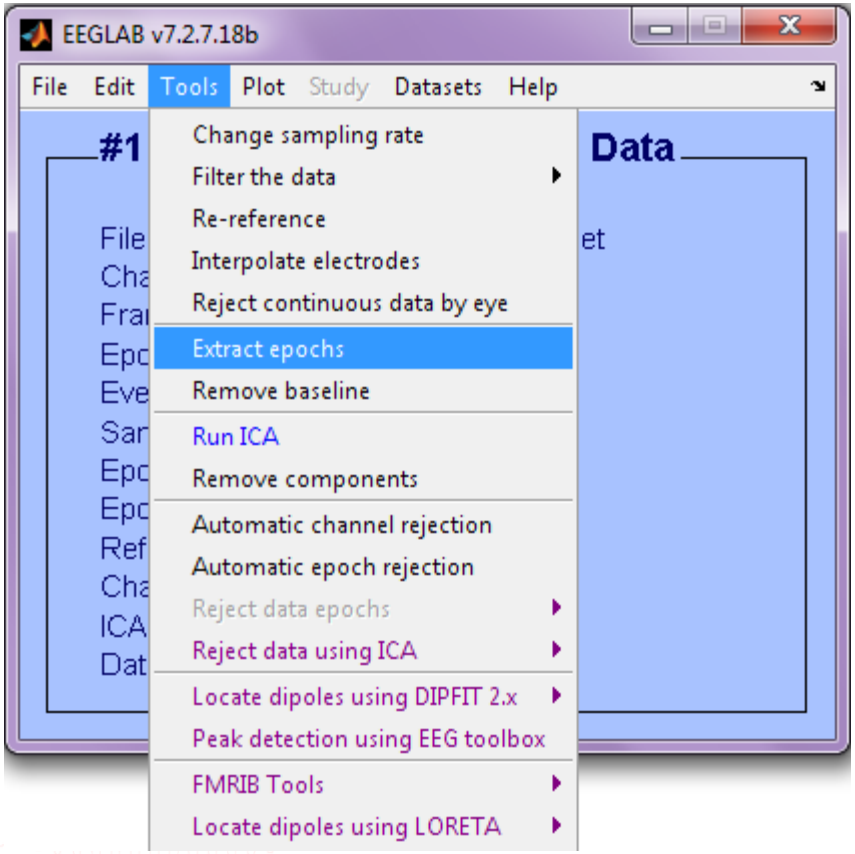
Perform a procedure through the GUI:

1) Load a continuous dataset

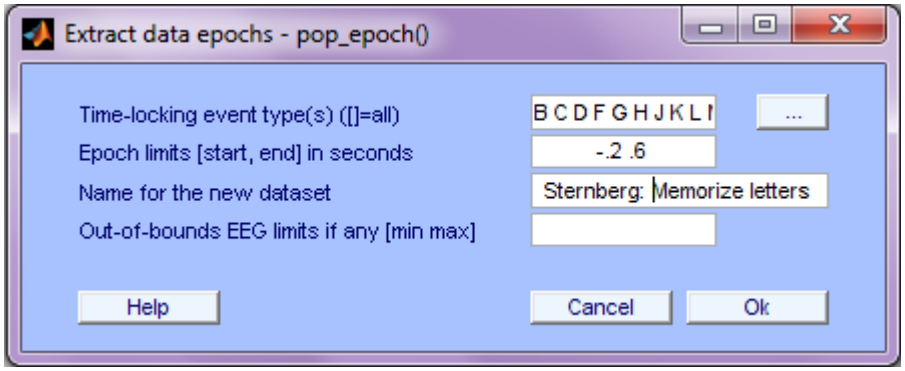




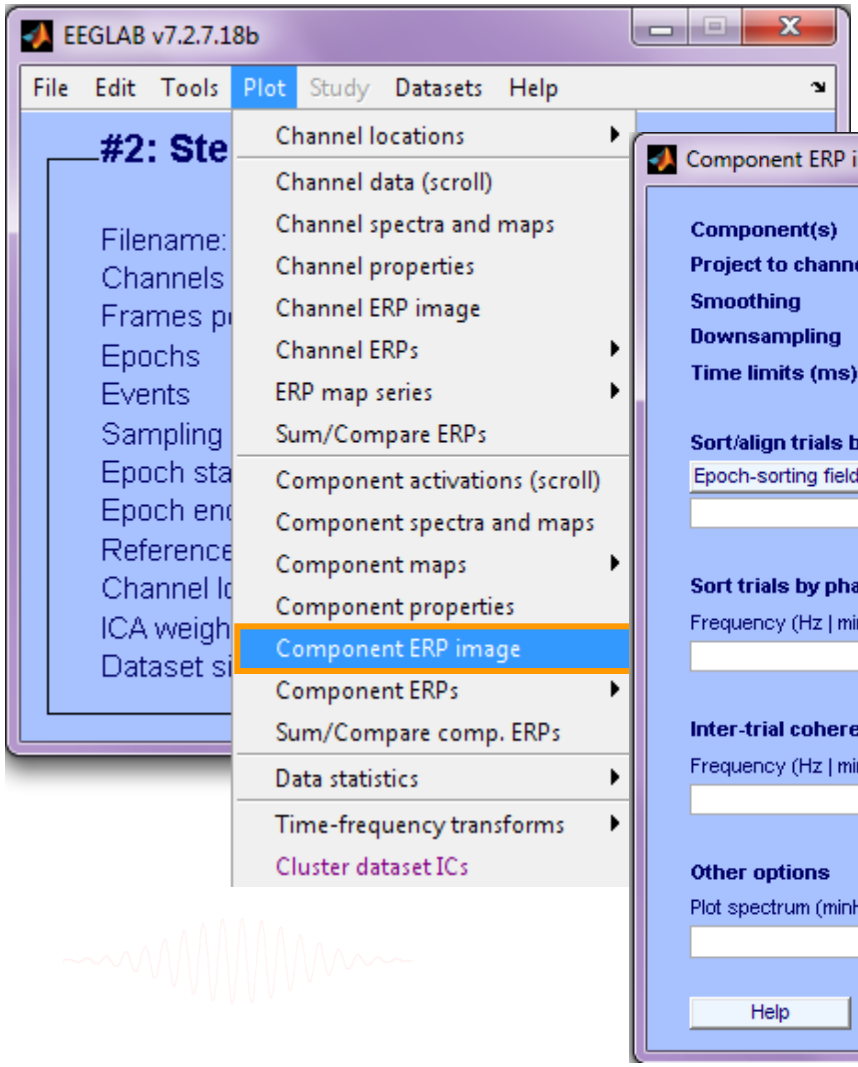
Create a script from ‘eegh’ output



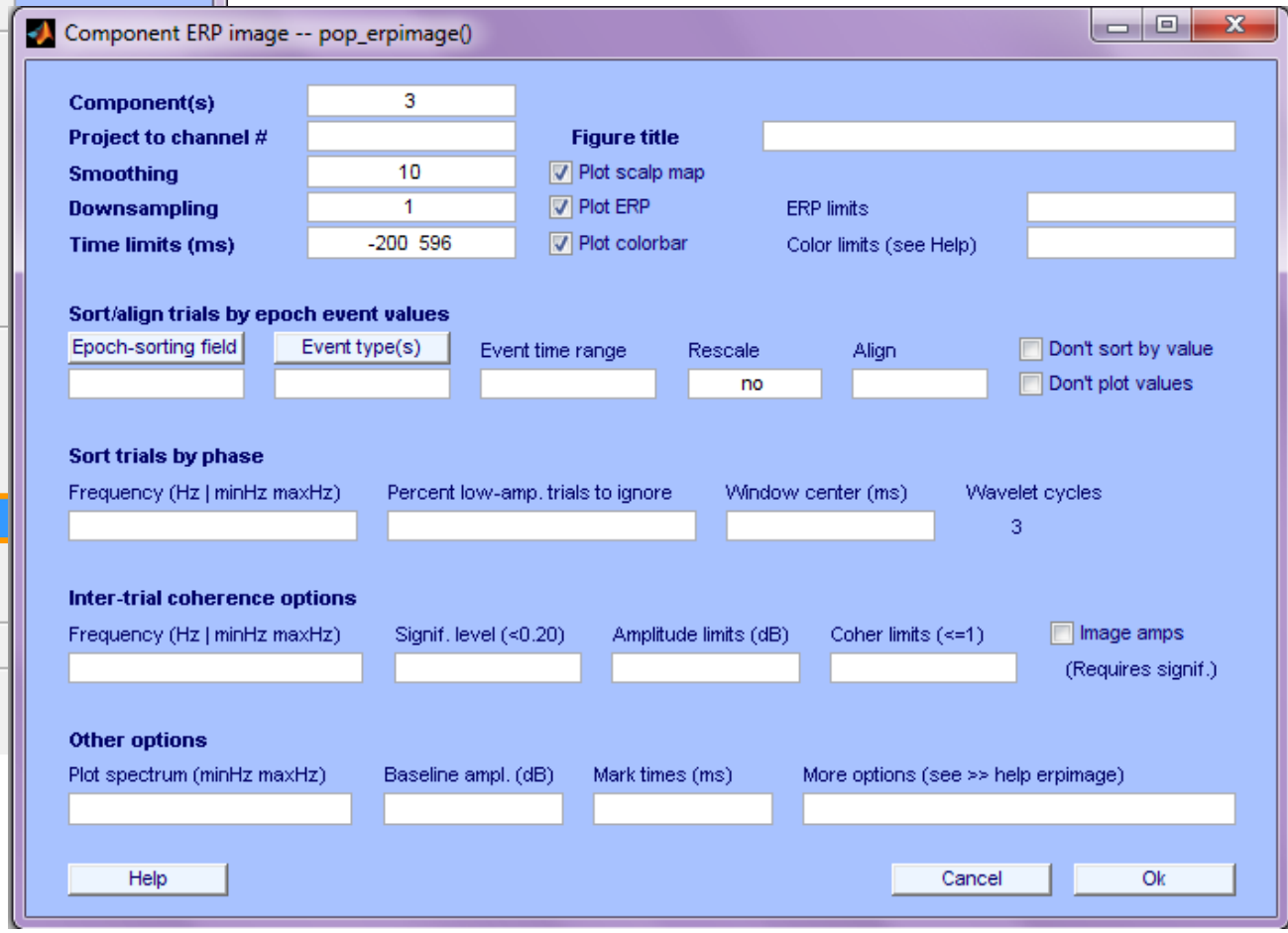
2) Epoch on Memorize letters



Create a script from ‘eegh’ output

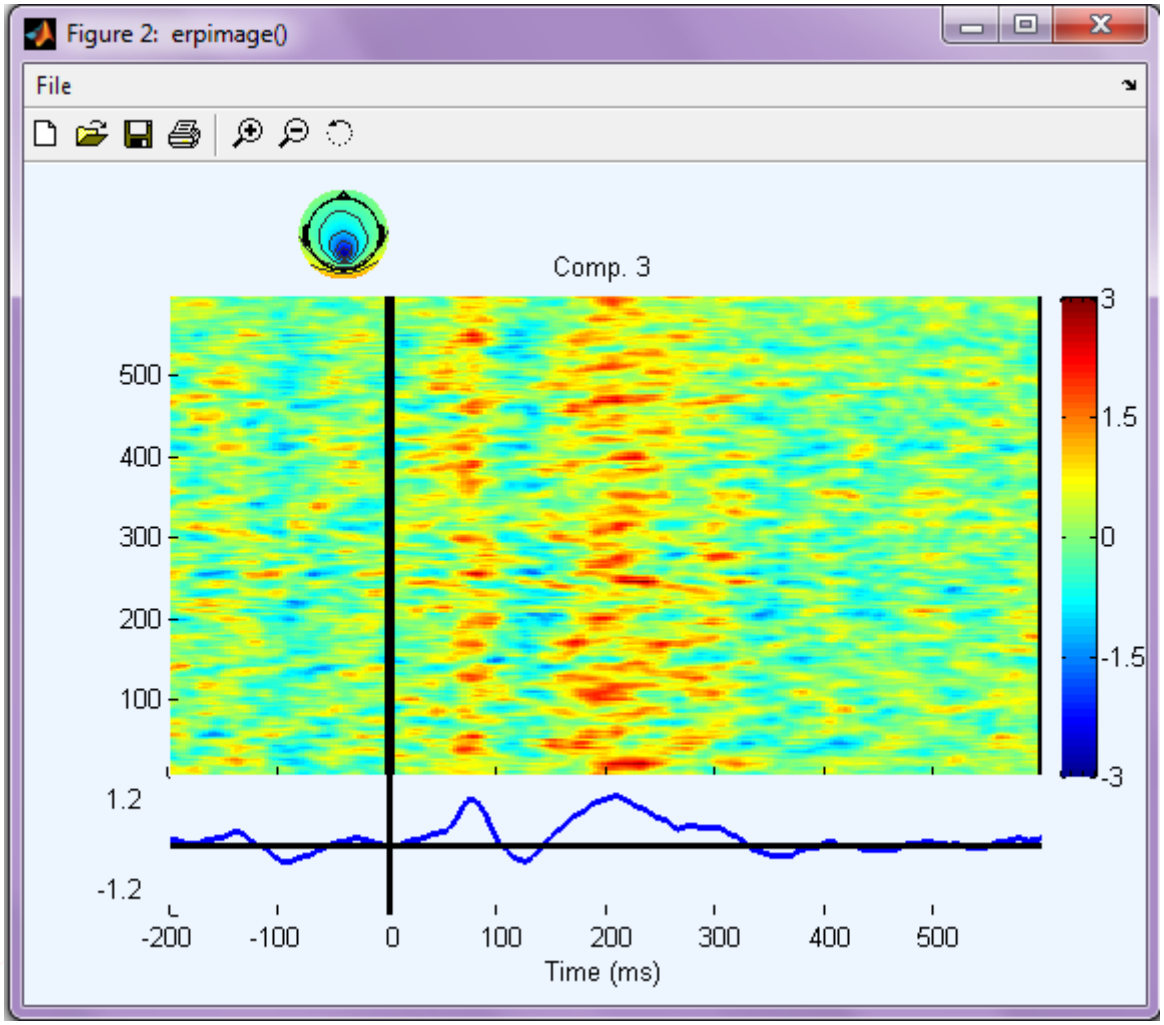


3) Plot an IC ERP image



Create a script from ‘eegh’ output

Result:



Retrieve commands from eegh

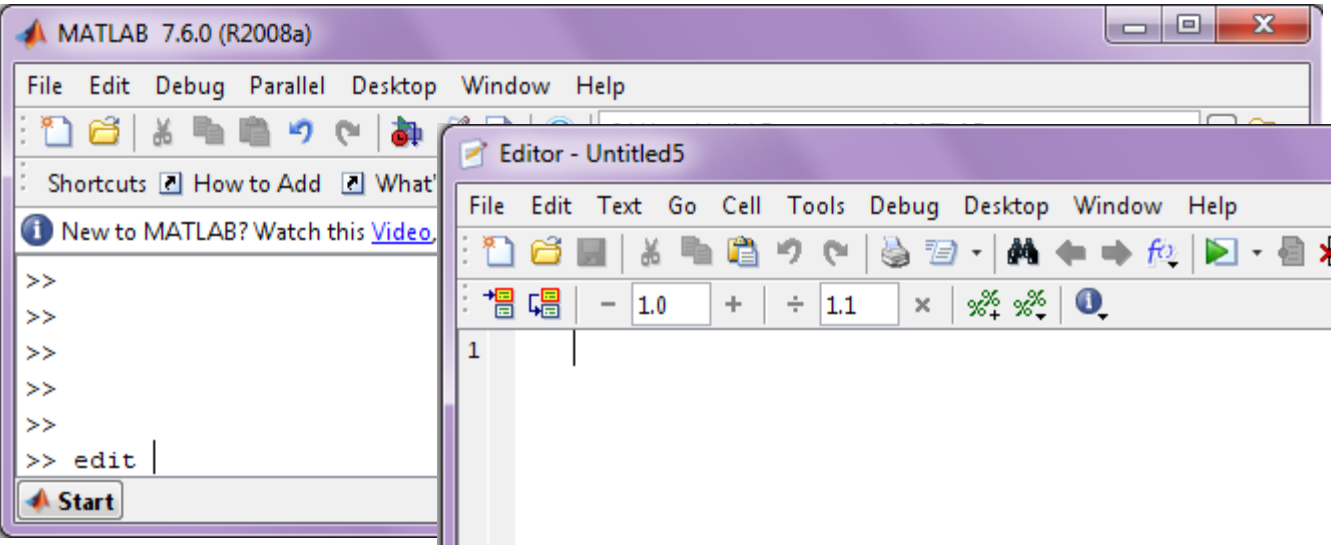
Write a script to do this:

```
>> eegh
```

Retrieve commands from eegh

```
>> eegh

[ALLEEG EEG CURRENTSET ALLCOM] = eeglab;

EEG = pop_loadset('filename', 'stern.set','filepath','...\Data\');
[ALLEEG EEG CURRENTSET] = pop_newset(ALLEEG, EEG, 0);

EEG = pop_epoch( EEG, {'B'  'C'  'D' ...}, [-0.2 0.6],...
   'newname', ,Memorize epochs', 'epochinfo', 'yes');
[ALLEEG EEG CURRENTSET] = pop_newset(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 });
```

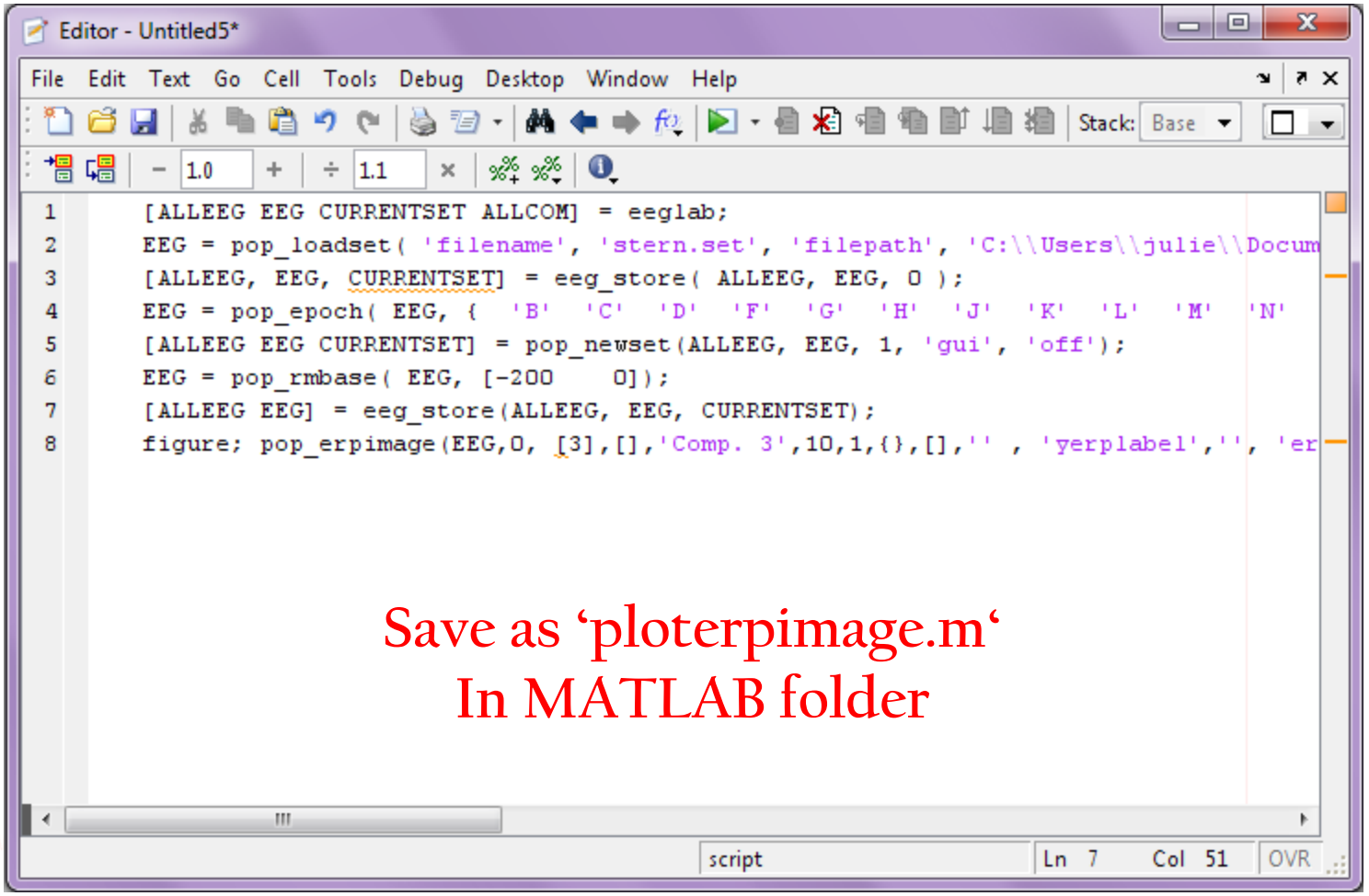
Create a Matlab script



Open Matlab editor

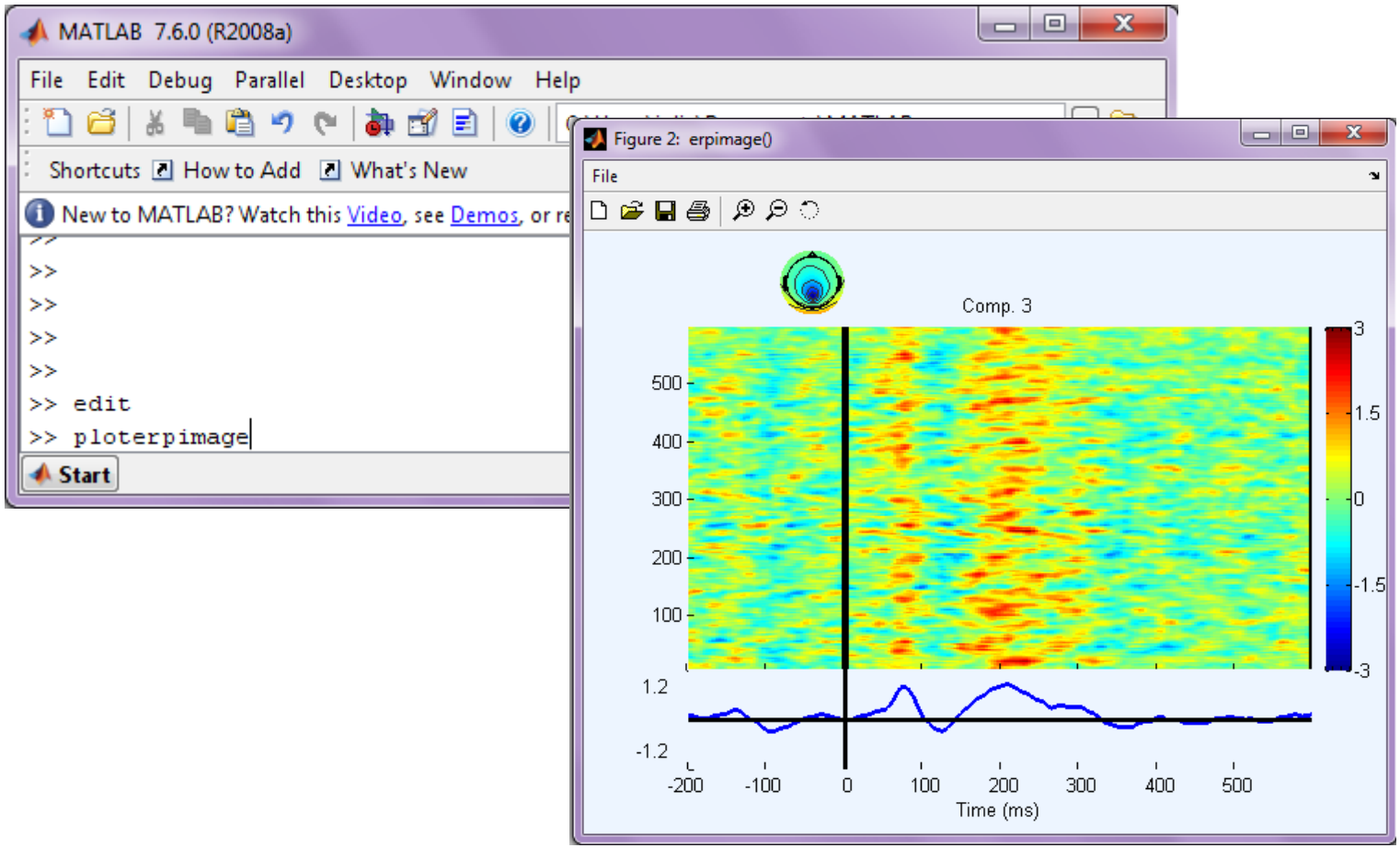
Create a Matlab script

Copy and paste from Matlab command window:



Save as ‘ploterpimage.m‘
In MATLAB folder

Run your new script



(Must add script's folder to Matlab paths)

Using EEGLAB history for basic scripting

1. ‘EEG’ structure
2. Scripting with EEGLAB ‘eegh’
3. Matlab functions
4. Search EEG.event structure
5. Converting from 'pop' functions

Write a Matlab function

Matlab functions:

1. Take arguments
2. Can return variables
3. Do not draw variables from the local workspace

   (Need all variables assigned internally or passed as arguments)

Example function

Editor - Untitled8*

File Edit Text Go Cell Tools Debug Desktop Window Help

Stack: Base

1.0 1.1

```
1   function ploterpfunc(dataset,datapath,epochletts,datsetname,comp);
2
3
4   [ALLEEG EEG CURRENTSET ALLCOM] = eeglab;
5   EEG = pop_loadset('filename', dataset,'filepath', datpath);
6   [ALLEEG EEG CURRENTSET] = pop_newset(ALLEEG, EEG, 0);
7   EEG = pop_epoch( EEG, epochletts , [-0.2 0.6],...
8   'newname', datsetname, 'epochinfo', 'yes');
9   [ALLEEG EEG CURRENTSET] = pop_newset(ALLEEG, EEG, 1);
10  EEG = pop_rmbase( EEG, [-200    0]);
11  [ALLEEG EEG] = eeg_store(ALLEEG, EEG, CURRENTSET);
12  figure; pop_erpimage(EEG,0, [comp],[],['Comp.',int2str(comp)],...
13      10,1,{},[],'','yerplabel', '', 'erp', 'on', 'cbar', 'on',...
14      'topo',{mean(EEG.icawinv(:,[comp]),2),EEG.chanlocs EEG.chaninfo });
15
16
```

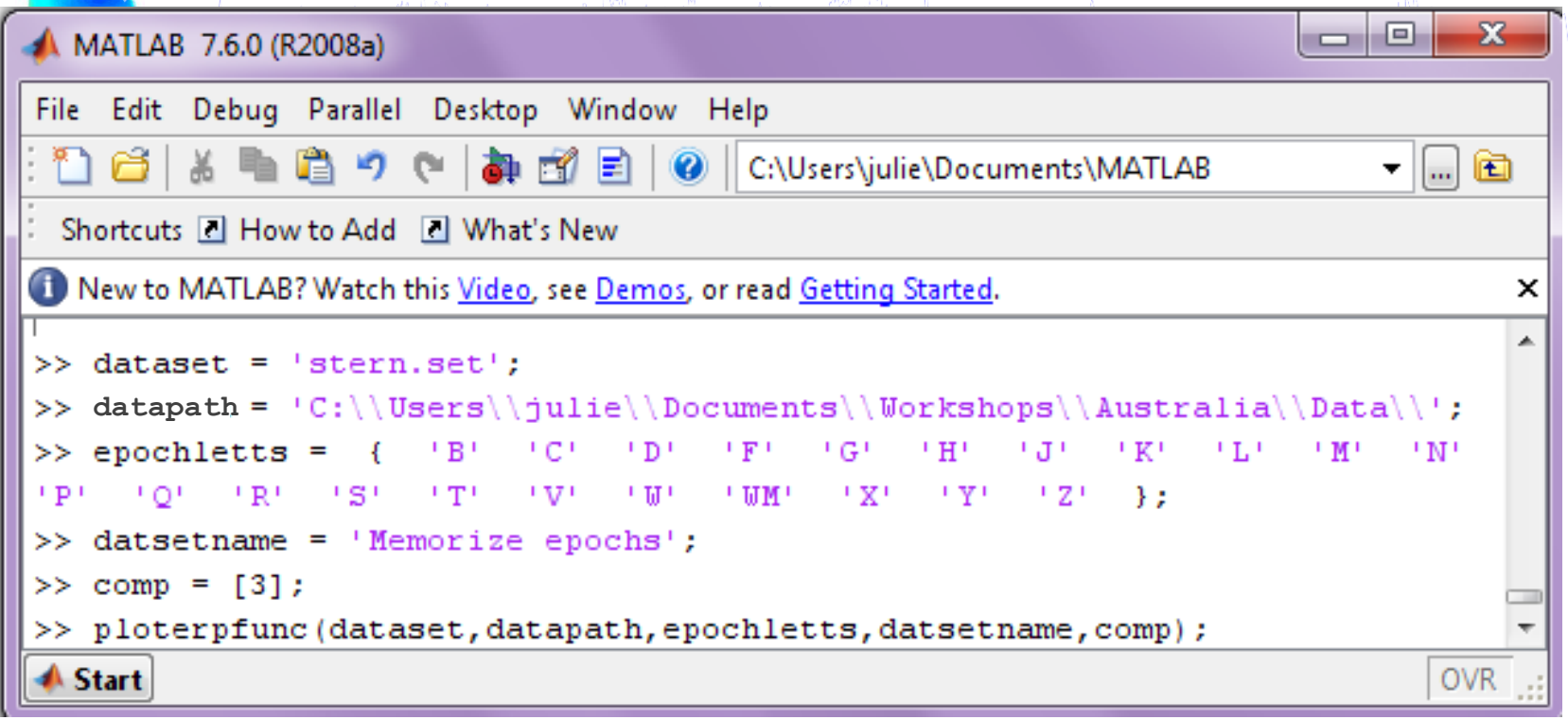
Ln 14 Col 5 OVR

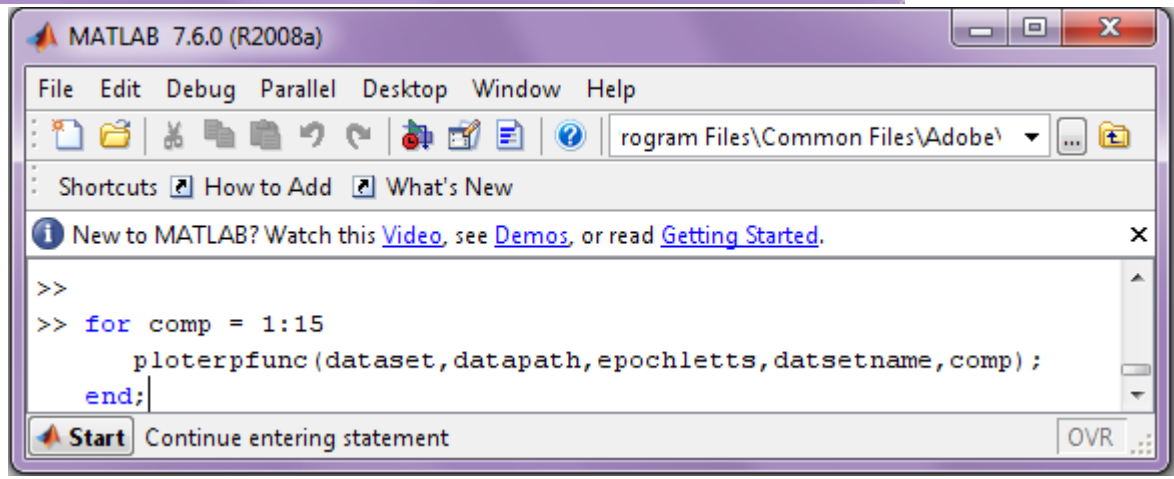
Save as ‘ploterpfunc.m‘ in MATLAB folder

Example function

```
% Variables-------------------------------
dataset = 'stern.set';
datapath = '…\EEGLAB_Workshop\Data\';
epochletts = {'B'  'C'  'D' …};
datsetname = 'Memorize epochs';
comp = 3;

ploterpfunc(dataset, datapath, epochletts, datsetname, comp);
```

Run your function in Matlab





Loop through a set of components

Using EEGLAB history for basic scripting

1. ‘EEG’ structure
2. Scripting with EEGLAB ‘eegh’
3. Matlab functions
4. Search EEG.event structure
5. Converting from 'pop' functions

Search events for specific event type

```
% OBJECTIVES:
% 1) Find all Memorize letters that were preceded by an ignore letter
% 2) Find all Memorize letters that were preceded by a memorize letter
%-------------------------------------------------------------
% hint: 'memorize' event codes are single letters
epochidxM = []; % Mem preceded by a mem letter
epochidxG = []; % Mem preceded by an ignore letter
for ev = 2:length(EEG.event)
    if length(EEG.event(ev).type)==1 & length(EEG.event(ev-1).type)==1
        epochidxM = [epochidxM, ev]; % save this event
    elseif length(EEG.event(ev).type)==1 & EEG.event(ev-1).type(1)=='g'
        epochidxG = [epochidxG, ev]; % save this event
    end;
end;
```

Epoch on selected events

```
% Epoch continuous data around selected events
%-------------------------------------------------------------
[EEG, indices] = pop_epoch( EEG, [], [-2 2],'eventindices',epochidxG);
[ALLEEG EEG CURRENTSET] = pop_newset(ALLEEG, EEG, 1,…
 'setname','Mem after Ignore letter','gui', 'off');
EEG = pop_autorej(EEG,  'nogui', 'on'); % Auto-reject noisy epochs
[ALLEEG EEG CURRENTSET]=pop_newset(ALLEEG,EEG,CURRENTSET,'retrieve',1);


[EEG, indices] = pop_epoch( EEG, [], [-2 2],'eventindices',epochidxM);
[ALLEEG EEG CURRENTSET] = pop_newset(ALLEEG, EEG, 1,…
 'overwrite','on', 'setname','Mem after Mem letter','gui', 'off');
EEG = pop_autorej(EEG,  'nogui', 'on'); % Auto-reject noisy epochs
eeglab redraw
```

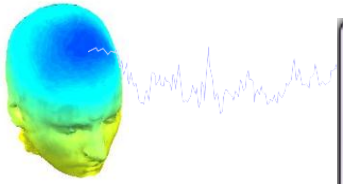
Confirm datasets contain expected epochs

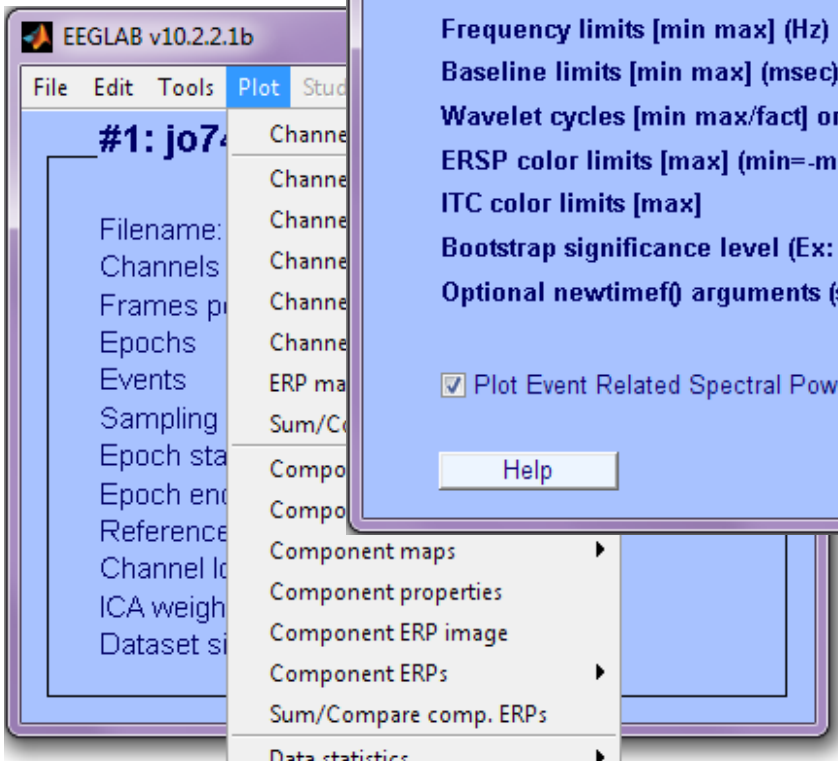
```
>> [ALLEEG EEG CURRENTSET] = pop_newset(ALLEEG, EEG, CURRENTSET, 'retrieve',1);
>> EEG.epoch(2) %--- Select several random epochs, check if correct
ans =
                event: [4 5 6]
                 eventlatency: {[-1.4400e+003]  [0]  [1.4440e+003]}
                 eventload: {[1]  [2]  [3]}
                 eventtype: {'R'  'N'  'Z'}
                 eventurevent: {[5]  [6]  [7]}
>> [ALLEEG EEG CURRENTSET] = pop_newset(ALLEEG, EEG, 2, 'retrieve',2);
>> EEG.epoch(2)
ans =            event: [4 5 6]
                 eventlatency: {[-1.4400e+003]  [0]  [1.4440e+003]}
                 eventload: {[0]  [0]  [1]}
                 eventtype: {'gC'  'Z'  'L'}
                 eventurevent: {[15]  [16]  [17]}
```

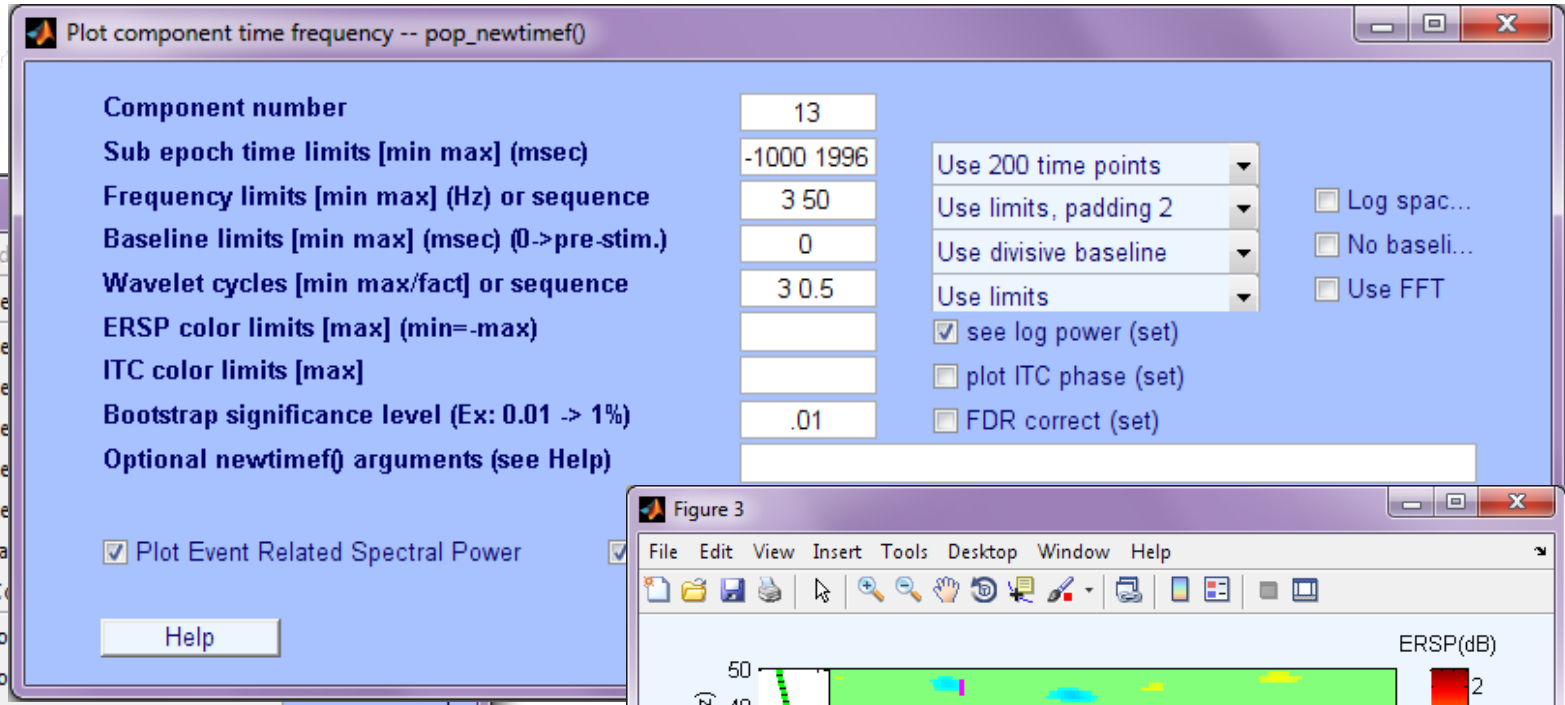
Using EEGLAB history for basic scripting

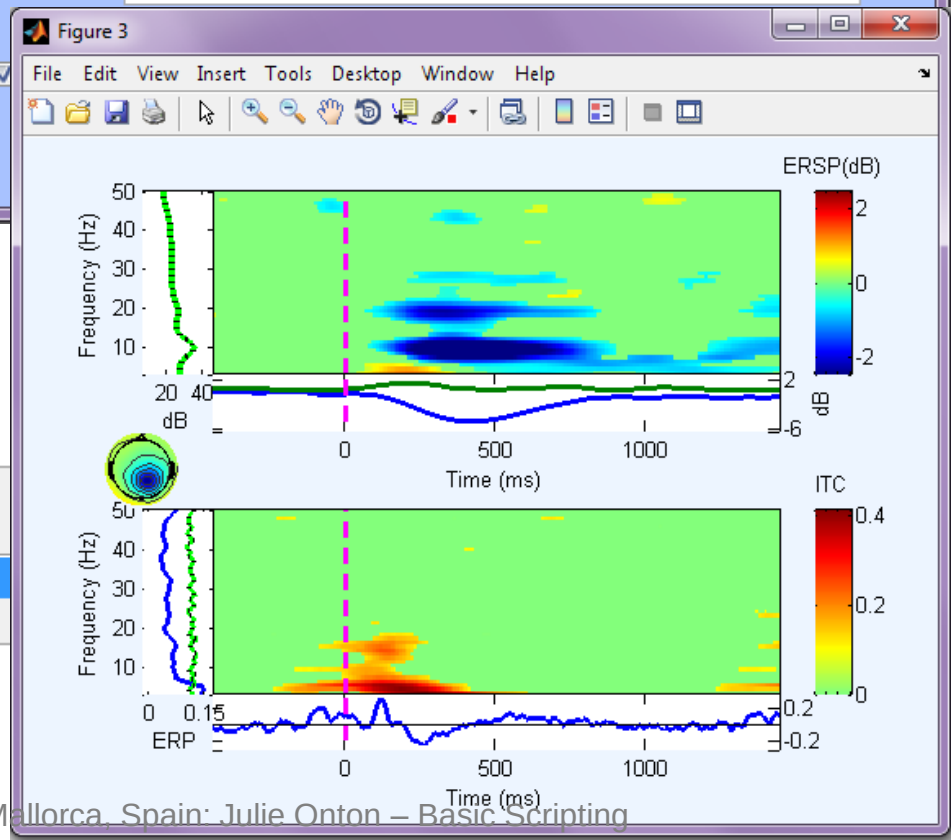
1. ‘EEG’ structure
2. Scripting with EEGLAB ‘eegh’
3. Matlab functions
4. Search EEG.event structure
5. Converting from 'pop' functions

Converting from ‘pop’ functions



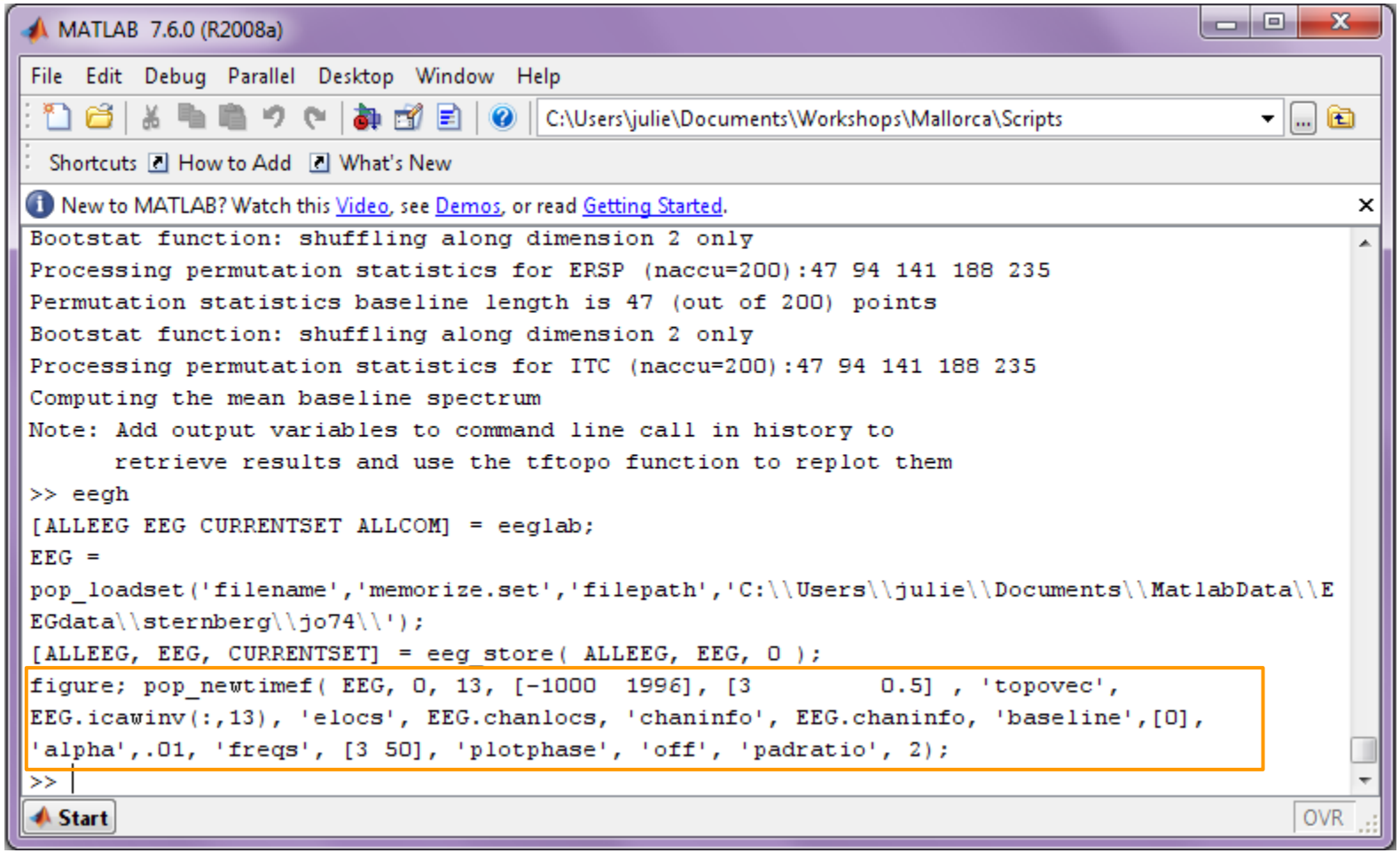






How can I get ERSP/ITC values from this plot?

Converting from 'pop' functions



Where are the outputs?...
Need to use base function: *newtimef( )*

Converting from 'pop' functions

get help for base function: remove 'pop_' from eegh function name

Example usage: lists possible output variables

MATLAB 7.6.0 (R2008a)

File Edit Debug Parallel Desktop Window Help

C:\Users\julie\Documents\Workshops\Mallorca\Scripts

Shortcuts How to Add What's New

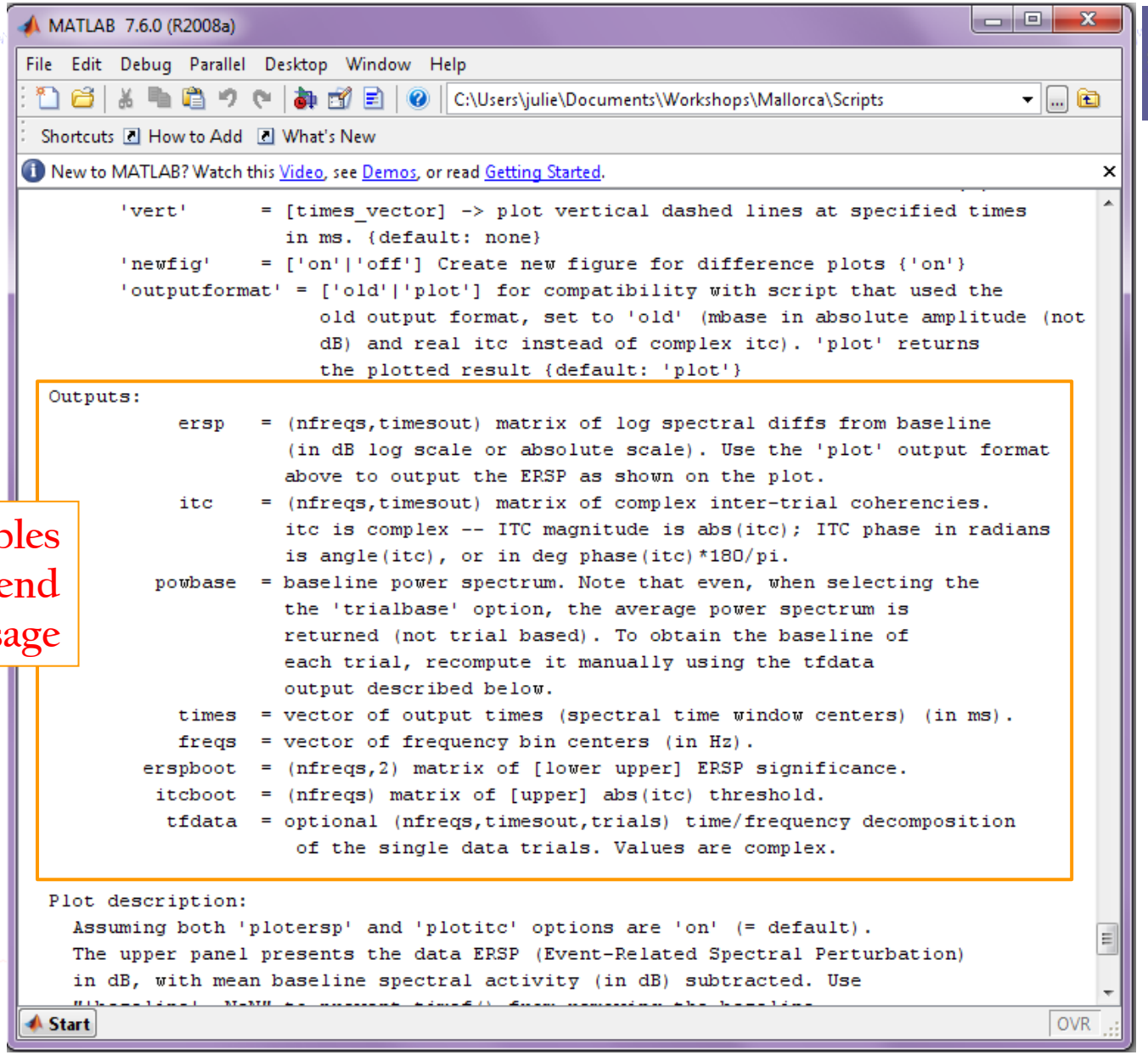
New to MATLAB? Watch this Video, see Demos, or read Getting Started.

```
>> help newtimef
  newtimef() - Return estimates and plots of mean event-related (log) spectral
               perturbation (ERSP) and inter-trial coherence (ITC) events
               across event-related trials (epochs) of a single input time series.

             * Also can compute and statistically compare transforms for two time
               series. Use to compare ERSP and ITC means in two conditions.

             * Uses either fixed-window, zero-padded FFTs (fastest), wavelet
               0-padded DFTs. FFT uses Hanning tapers; wavelets use similar Morlet
               tapers.

             * For the wavelet and FFT methods, output frequency spacing
               is the lowest frequency ('srate'/'winsize') divided by 'padratio'.
               NaN input values (such as returned by eventlock()) are ignored.

             * If 'alpha' is given (see below), permutation statistics are computed
               (from a distribution of 'naccu' surrogate data trials) and
               non-significant features of the output plots are zeroed out
               (and plotted in green).

             * Given a 'topovec' topo vector and 'elocs' electrode location file,
               the figure also shows a topoplot() view of the specified scalp map.

             * Note: Left-click on subplots to view and zoom in separate windows.

 Usage with single dataset:
        >> [ersp,itc,powbase,times,freqs,erspboot,itcboot] = ...
                  newtimef(data, frames, tlimits, srate, cycles,...
                       'key1',value1, 'key2',value2, ... );

 Example to compare two condition (channel 1 EEG versus ALLEEG(2)):
        >> [ersp,itc,powbase,times,freqs,erspboot,itcboot] = ...
                  newtimef({EEG.data(1,:,:) ALLEEG(2).data(1,:,:)}, ,,,
                       EEG.pnts, [EEG.xmin EEG.xmax]*1000, EEG.srate, cycles);
```

Start OVR

Swartz Center for Computational Neuroscience

Converting from ‘pop’ functions



Output variables described at the end of help message

Converting from 'pop' functions

Editor - Untitled*

File Edit Text Go Cell Tools Debug Desktop Window Help

```
1   figure; pop_newtimef( EEG, 0, 13, [-1000  1996], [3         0.5] ,...
2      'topovec', EEG.icawinv(:,13), 'elocs', EEG.chanlocs, 'chaninfo',...
3      EEG.chaninfo, 'baseline',[0], 'alpha',.01, 'freqs', [3 50],...
4      'plotphase', 'off', 'padratio', 2);
5
6
7   [ersp,itc,powbase,times,freqs,erspboot,itcboot] = ...
8                        newtimef(data, frames, tlimits, srate, cycles,...
9                             'key1',value1, 'key2',value2, ... );
```

Copy your eegh function call and the help message for base function into a Matlab script

(notice inputs are different)

Tutorial_4_BasicScript... | Tutorial_6_STUDY_Intr... | Tutorial_6_ICanalysis.m | DataSearchScript.m* | Untitled*

script Ln 9 Col 61 OVR

Converting from ‘pop’ functions

Editor - Untitled*

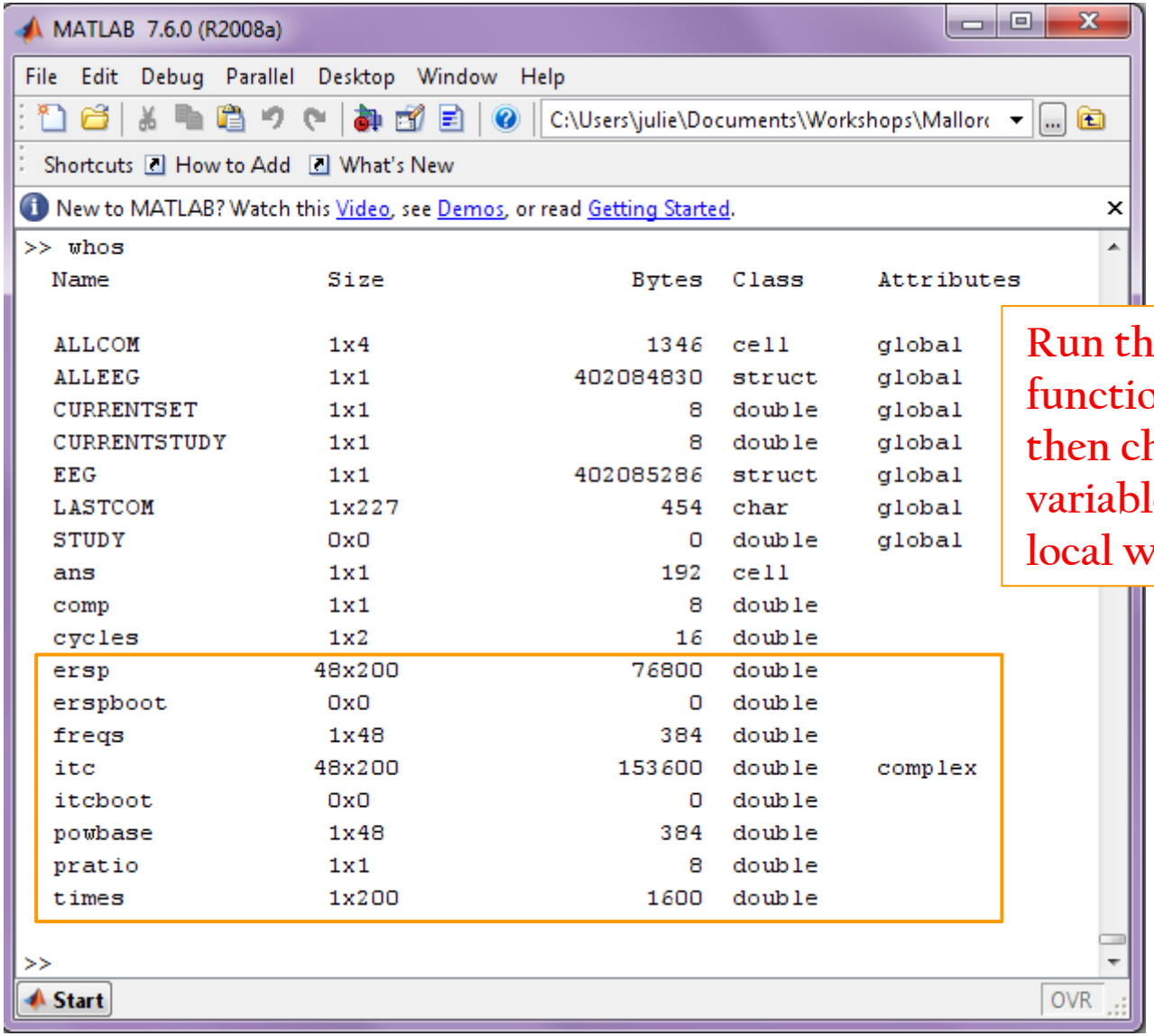
File Edit Text Go Cell Tools Debug Desktop Window Help

```
1   %figure; pop_newtimef( EEG, 0, 13, [-1000  1996], [3         0.5] ,...
2   %   'topovec', EEG.icawinv(:,13), 'elocs', EEG.chanlocs, 'chaninfo',...
3   %   EEG.chaninfo, 'baseline',[0], 'alpha',.01, 'freqs', [3 50],...
4   %   'plotphase', 'off', 'padratio', 2);
5
6   comp = 13;
7   cycles = [3 0.5];
8   freqs = [3 50];
9   pratio = 2;
10
11  [ersp,itc,powbase,times,freqs,erspboot,itcboot] = ...
12     newtimef(EEG.icaact(comp,:,:), EEG.pnts, [EEG.xmin EEG.xmax]*1000,...
13     EEG.srate, cycles, 'padratio', pratio,'freqs',freqs);
14
15
16  %[ersp,itc,powbase,times,freqs,erspboot,itcboot] = ...
17  %   newtimef({EEG.data(1,:,:) ALLEEG(2).data(1,:,:)},...
18  %   EEG.pnts, [EEG.xmin EEG.xmax]*1000, EEG.srate, cycles);
19
```

script Ln 1 Col 1 OVR

Customize the function call with your EEG data and other parameters

Converting from ‘pop’ functions



Run the new function call, then check variables saved to local workspace

Converting from ‘pop’ functions

Editor - Untitled*

File Edit Text Go Cell Tools Debug Desktop Window Help

Stack: Base

1.0 1.1

```
%figure; pop_newtimef( EEG, 0, 13, [-1000  1996], [3         0.5] ,...
%   'topovec', EEG.icawinv(:,13), 'elocs', EEG.chanlocs, 'chaninfo',...
%   EEG.chaninfo, 'baseline',[0], 'alpha',.01, 'freqs', [3 50],...
%   'plotphase', 'off', 'padratio', 2);

comps = [1:13];
cycles = [3 0.5];
freqs = [3 50];
pratio = 2;

for c = 1:length(comps)
   figure;
   [ersp(:,:,c),itc(:,:,c),powbase(c,:),times,freqs,erspboot,itcboot] = ...
   newtimef(EEG.icaact(comps(c),:,:), EEG.pnts, [EEG.xmin EEG.xmax]*1000,...
   EEG.srate, cycles, 'padratio', pratio,'freqs',freqs);
end

%[ersp,itc,powbase,times,freqs,erspboot,itcboot] = ...
%   newtimef({EEG.data(1,:,:) ALLEEG(2).data(1,:,:)},...
%   EEG.pnts, [EEG.xmin EEG.xmax]*1000, EEG.srate, cycles);
```

script Ln 1 Col 1 OVR

Make a list of components to process and collect output for all

Exercise

- **Novice**

  -Create a Matlab script by copying eegh output (for example load data, epoch, plot something)

  > Convert your script into a Matlab 'function'

- **Intermediate**

  - Write a script to load data, epoch and then loop through ICs and plot an ERSP for each

  > Try the same using *newtimef*() and collect output

- **Advanced**

  - Using stern.set (continuous data), write a script to find all Memorize letters *preceded* by another Memorize letter and create a dataset with only these epochs. Then find Memorize letters preceded by an Ignore letter and create a second dataset with only these epochs.

  > Create plots to compare these conditions

Supplementary lessons

Matlab basics -- Briefly

```
Variable = word with an assigned value (type 'whos')

Examples:
% vector of numbers:
mynumbers = [1, 2, 3, 5:10];
        (Square brackets: concatenate anything within)
% access vector elements:
>> mynumbers(2)
ans =
       2
% cell array of strings:
mylabels = {'stimulus','response'};
% access cell array elements:
>> mylabels{2}
ans =
       response
```

Parameterize a script

```
>> eegh
```

Red = values to make into variables

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

EEG = pop_loadset('filename', 'stern.set','filepath',...
   '…\EEGLAB_Workshop\Data\');
[ALLEEG EEG CURRENTSET] = pop_newset(ALLEEG, EEG, 0);

EEG = pop_epoch( EEG, {'B'  'C'  'D' ...}, [-0.2 0.6],...
   'newname', 'Memorize epochs', 'epochinfo', 'yes');
[ALLEEG EEG CURRENTSET] = pop_newset(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 });
```

Parameterize a script

```
% Variables--------------------------------
dataset = 'stern.set';
datpath = 'C:MATLAB\...\EEGLAB_Workshop\Data\';
epochletts = {'B'  'C'  'D' ...};
datsetname = 'Memorize epochs';
comp = 3; % End variables---------------
[ALLEEG EEG CURRENTSET ALLCOM] = eeglab;
EEG = pop_loadset('filename', dataset,'filepath', datpath);
[ALLEEG EEG CURRENTSET] = pop_newset(ALLEEG, EEG, 0);
EEG = pop_epoch( EEG, epochletts , [-0.2 0.6],...
'newname', datsetname, 'epochinfo', 'yes');
[ALLEEG EEG CURRENTSET] = pop_newset(ALLEEG, EEG, 1);
EEG = pop_rmbase( EEG, [-200    0]);
[ALLEEG EEG] = eeg_store(ALLEEG, EEG, CURRENTSET);
figure; pop_erpimage(EEG,0, [comp],[],['Comp.',int2str(comp)],…
10,1,{},[],'','yerplabel','','erp','on','cbar','on','topo',…
{mean(EEG.icawinv(:,[comp ]),2),EEG.chanlocs EEG.chaninfo});
```

Create a new Matlab script with variables

Editor - C:\Users\julie\Documents\Workshops\Mallorca\Scripts\ExampleMfiles\ploterpimageswithv...

File Edit Text Go Cell Tools Debug Desktop Window Help

```
1     % Variables-------------------------------
2 -   dataset = 'stern.set';
3 -   datpath = 'C:MATLAB\...\EEGLAB_Workshop\Data\';
4 -   epochletts = {'gB'  'gC'  'gD'  'gF'  'gG'  'gH'  'gJ'  'gK'...
5     'gL'  'gM'  'gN'  'gP'  'gQ'  'gR'  'gS'  'gT'  'gV'  'gW'...
6     'gX'  'gY'  'gZ'};
7 -   datsetname = 'Memorize epochs';
8 -   comp = 3; % End variables---------------
9 -   [ALLEEG EEG CURRENTSET ALLCOM] = eeglab;
10 -  EEG = pop_loadset('filename', dataset,'filepath', datpath);
11 -  [ALLEEG EEG CURRENTSET] = pop_newset(ALLEEG, EEG, 0);
12 -  EEG = pop_epoch( EEG, epochletts , [-0.2 0.6],...
13    'newname', datsetname, 'epochinfo', 'yes');
14 -  [ALLEEG EEG CURRENTSET] = pop_newset(ALLEEG, EEG, 1);
15 -  EEG = pop_rmbase( EEG, [-200    0]);
16 -  [ALLEEG EEG] = eeg_store(ALLEEG, EEG, CURRENTSET);
17 -  figure; pop_erpimage(EEG,0, comp,[],['Comp.',int2str(comp)],...
18    10,1,{},[],'','yerplabel','','erp','on','cbar','on','topo',...
19    {mean(EEG.icawinv(:,[comp ]),2),EEG.chanlocs EEG.chaninfo});
20
```

script Ln 20 Col 1 OVR

same result as ploterpimage.m but easier to change variables at the top

Save as 'ploterpimagewithvars.m'
In MATLAB folder

Run your new script

MATLAB 7.6.0 (R2008a)

File Edit Debug Parallel Desktop Window Help

rogram Files\Common Files\Adobe\Adobe Version Cue CS4\Client\4.0.1

Shortcuts How to Add What's New

New to MATLAB? Watch this Video, see Demos, or read Getting Started.

```
>>
>>
>>
>>
>>
>>
>>
>>
>>
>>
>> ploterpimagewithvars
```

Start

Figure 2: erpimage()

File