Welcome to Deci

A fluid pipeline to analyze EEG Data with ease

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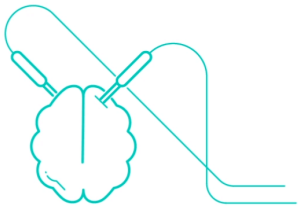

Deci uses Fieldtrip (Robert Oostenveld) as the backbone of its analysis with a few codes modified so it may not be compatible with other versions of Fieldtrip.

Getting Started

In order to have a good experience, I suggest turn on 'Sections' in Code Folding in Preferences (under Home Tab)

You'll then be able press [Ctrl and =] to Collapse all Sections to a easier-to-read format

To start, Save a new copy of this file. Each type of experiment will require specific parameter so it's good save their parameters in seperate files.

Deci has 6 Stages, each segmented by it's own section with it's own list of parameters. I suggest using the "Run Section" to work through each section step by step.

0. MainMenu

General Information used to find Raw Files director and Output Directory

Input Information

To start, You'll need to specify a Raw Data Folder with your Data within *.Folder.Raw*

Types of Raw formats compatible are [.dat, .eeg, .bdf, .cnt]

.SubjectList specifies which subjects in *.Folder.Raw* you'll like to analyze. [Cell Array of Strings], ['all' to specify all] or ['gui' to manually choose].

```
Deci = [];
Deci.File = mfilename;
Deci.Folder.Raw         = ['C:\Users\User\Desktop\John\Data_new'];
Deci.SubjectList        = 'gui';
```

If using "Run to End", the following gives you flexibility in where to start and how to proceed. Use 1 if using "Run Section".

```
Deci.Step               =1; % Define Trial;
Deci.Proceed            =1;                          % If 0 or 1, Do you want Deci to automati
```

The following are smaller parameters

```
Deci.Layout.Noeye       = 'Collab_noeye.mat';         % Layout without Ocular Channels, Defaul
Deci.Layout.eye         = 'Collab_eye.mat';           % Layout with Ocular Channels
Deci.PCom               = 0;        % Activates Parallel Computing (if availible)
Deci.Debug              = 0;        % Activates dbstop if error
```

Output Information

Specify your output folder as *Folder.Version.* This is where all Processed Data will be sent to. This Folder will be automatically created if it does not exist.

At any step, you can define a new *Folder.Version* if you wish to for those analysis files to be stored seperately, i.e. "Data_noica","Data_ica"

When MainMenu runs, a snapshot of this file's parameters will be saved as "Parameter.txt" in your *Folder.Version* Directory

```
Deci.Folder.Version     = ['C:\Users\User\Desktop\John\ProcessedData'];
```

```
Deci = Checkor(Deci);
```

1. Trial Definitions

Terminology:

Experimental Trials (ETs) - specific to the psychological experiment.

Trial Definition - Information on how to sorts ET into specific Conditions.

Collected Trials (CTs) - The output of Trial Definition.

Conditions (Conds) - Each type of CT belongs to one type of Condition.

When EEG is first collected, you will end up with a Marker File and a Raw File. The Raw File is all but a matrix is of voltage that contains no important information on its own. The Marker File contains a list of events logged in the psychological experiment. Together, you'll use both files to segment your data into ETs and then sort them into CTs and Conds.

Auto Trial Definition

Deci comes with a rudimentary Auto Trial Definition, however this comes with a few assumptions.

1. There are unique markers signifying the start and end of your ETs that are not used anywhere else in .
2. Any one of your *.DT.Starts* Codes will appear first in the Marker file before any *.DT.End* Codes appears.
3. There are equal total amounts of *.DT.Starts* Markers and *.DT.End* Codes found in your Marker File.
4. There is a specific marker you will timelock to and set your time axis as 0.

If you find that the above assumptions conflict with your needs [for example, you need CTs within a certain type of block but not others], you'll have to refer to Fieldtrip's ft_definetrial tutorial to create your cfg data.

Once you've created that File, save it to "..\Deci\Xtra_Fun" and set *.DT.Type* as that file's name and your CT will become Deci-compatible.

No other fields will be relevant for this case.

```
Deci.DT.Type = 'Manual';
Deci.DT.Starts     = {300};         %Cell Array of Markers for ETs Start.
Deci.DT.Ends       = {400};         %Cell Array of Markers for ETs End.
```

The following fields works respectively, Each index corresponds to a single Condition. i.e. the first index of the *.DT.Conditions* corresponds to the first index of *.DT.Markers*.

- *.DT.Markers* - 1xConds Cell Array. Specfies which makers MUST be found in a ET for it be a CT. Use negatives to specify MUST NOT be found.
- *.DT.Locks* - 1xConds Char Vector. Specfies which of *.DT.Markers* is set as 0 in time.
- *.DT.Conditions* - 1xConds Char Vector. If two Conds share the same numerical value, they will collapse into one Cond.

```
Deci.DT.Markers    = {[10] [11]};
Deci.DT.Locks      = [10 11];
Deci.DT.Conditions = [1 2];
```

CTs Time of Interest

- *.DT.Toi* - [Beg End in Secs], Times around *.DT.Locks* for each CT. ETs may have different trial lengths but all CTs within a Trial Definition will always be the same length.

If you get a "cannot read data after the end of the file" error, this is because the time length requested from *.DT.Toi* for the last trial is further than file's end.

The only good solution to prevent this is to leave on-line data recording for a few seconds more after last trial finishes.

```
    Deci.DT.Toi        = [-2 2];
```

```
if Deci.Step <= 1
    DefineTrialor(Deci);
    if ~Deci.Proceed; return; end
end
```

2. PreProcessing Steps

While Trial Definition finds CTs, it does not go through your *Raw File* and cut out the relevant data to use.

This is done in this current step, along with steps to get the data ready to be analyzed.

Leave any option empty ,[], if the processing step is not desired.

Rereference channel to average of Implicit Electrode and Offline Reference

```
   Deci.PP.Imp                = 'RM:LM'; % 'Impicit Reference?[Implicit:RefChannels without Imp
   Deci.PP.Ocu                = '';    % 'Ocular Reref?[Ref-Channels without Ref]'
```

Other Processing Steps

```
    Deci.PP.ScalingFactor       = [];               % Scalar, If the data needs to scale
    Deci.PP.HBP                 = [];               % Scalar,High-bandpass filter, in Hz.
    Deci.PP.Demean              = [-.5 -.2];        % [Beg End], Secs Relative to .DT.Locks, Ba

    Deci.PP.Repair              = [];                           % Structure, View and Repair (v
%     Deci.PP.Repair.Type         = 'Manual';                   % String,'Manual' or 'Auto'
%     Deci.PP.Repair.Auto         = {};                         % Nx1 Subject cell array of Mx1

    Deci.PP.CleanLabels = 0; % Binary, normalize electrode names to be compatiable with Reinhar
```

```
if Deci.Step <= 2
    PreProcessor(Deci)
    if ~Deci.Proceed; return; end
end
```

3. Artifact Rejection

Individual Component Analysis

Will Reject Components and Alter Data for Analysis.

```
    Deci.Art.ICA.Reject                     = 1; % Whether or Not to do ICA
    Deci.Art.ICA.Eye.Chans           = {'BVEOG','RHEOG','AF7','AF8'};
```

Trial Artifacts

Auto-identification of Artifacts.

Does not rejection artifacts unless specified in Step 4, *.Analysis.ArtifactReject*

```
     Deci.Art.TR.Toi              = [-.5 -.2];          % Time Range of Interest to look for Ar
     Deci.Art.TR.rToi           = [-.5 1];              % Only available for Shifts.

     Deci.Art.TR.Eye                  = [];               % Comment the rest of .Eye to not do
%      Deci.Art.TR.Eye.Interactive      =  0;                % Enable Interactive Trial Artifac
%      Deci.Art.TR.Eye.Chans            = {'BVEOG','RHEOG','AF7','AF8'};    % 1xChan Cell Array

    Deci.Art.TR.Muscle               = [];               % Comment the rest of .Muscle to not c
%     Deci.Art.TR.Muscle.Interactive   = 0;                % Enable Interactive Trial Artifact
```

Manual Visual Artifact Rejection

Artification identification via inspection by Summary.

Does not rejection artifacts unless specified in Step 4, *.Analysis.ArtifactReject*

```
    Deci.Art.Manual = [];
%     Deci.Art.Manual.Toi              = [-.5 -.2];
%     Deci.Art.Manual.rToi              =[-.5 1];  % Only available for Shifts.
```

```
   if Deci.Step <= 3
    Artifactor(Deci);
    if ~Deci.Proceed; return; end
end
```

4. Analysis

Currently functionalites

Time-Frequency

TotalPower	[only through wavelet decomposition]
ITPC	[only through wavelet decomposition]

Event-Related Data

Power-Related Potential

Cross-Frequency Coupling

- Phase-Locking Value
- Phase-Amplitude Coupling

General Set-Up

```
    Deci.Analysis.ArtifactReject     =0;                    % Specify whether or not to Apply T
    Deci.Analysis.Channels           = {'Fz','Cz','C3','O1'};                % Cell array of ch
    Deci.Analysis.Laplace            =0;                   % Leave .Laplace as 0 to not do a La

    Deci.Analysis.Redefine = [];                             % Only available for Shifts.
%     Deci.Analysis.Redefine.Bsl = [-.5 -.2];
%     Deci.Analysis.Redefine.ERPToi = -.5;
```

Time-Frequency Analysis

This *.Freq* Structure follows exactly ft_freqanalysis but may need to modify due to the *.Freq.Toi* parameter (instead of lowercase *.Freq.toi*)

```
    Deci.Analysis.Freq               = [];           % Comment the rest of .Freq to not do Four
    Deci.Analysis.Freq.method        = 'wavelet';    % Currently only uses Wavelet Decomp
    Deci.Analysis.Freq.foi           = exp(linspace(log(2),log(40),40));       % Frequency of I
    Deci.Analysis.Freq.width         = 7 ;           % Width
    Deci.Analysis.Freq.gwidth        = 4;            % Gwidth
    Deci.Analysis.Freq.Toi           = [-.5 1];       % Time Range

    Deci.Analysis.Freq.Redefine = 0;   % 1 for Both BSL and Freq, or 2 just BSL % Only availabl
```

Event Related Potential Analysis

Note that entire Time Range will be analyzed.

```
    Deci.Analysis.ERP                =  0;
```

Cross-Frequency Coupling

Requires *.Freq* to have been done.

```
    Deci.Analysis.Freq.CFC = [];
    Deci.Analysis.Freq.CFC.chanlow = {'Fz' 'Cz'};
    Deci.Analysis.Freq.CFC.chanhigh = {'C3' 'O1'}; %Try not to do all to all if you have more t

    Deci.Analysis.Freq.CFC.latencyhigh = [-.5 .5]; %no implementation yet to check for edge art
    Deci.Analysis.Freq.CFC.latencylow = [-.5 .5];

    Deci.Analysis.Freq.CFC.Freqhigh = 'beta';
    Deci.Analysis.Freq.CFC.Freqlow = 'theta';

    Deci.Analysis.Freq.CFC.timebin = 5;
    Deci.Analysis.Freq.CFC.methods = {'mi','plv'};  % can only currently handle 'plv' or 'mi'(p
    Deci.Analysis.Freq.CFC.keeptrials =  'no';

    %     cfg.method     = string, can be
    %                      'coh' - coherence [Fourier-Fourier]
    %                      'plv' - phase locking value [phase-phase of amp]
    %                      'mvl' - mean vector length [phase-amp]
    %                      'mi'  - modulation index  [phase-amp]
    %                      'cs_cc'  - circstats circular-circular [phase-phase]
    %                      'cs_cl'  - circstats circular-linear [phase-amp]
```

Not Available

```
    Deci.Analysis.EvokedPower        = 0; %Not Available
```

```
if Deci.Step <= 4
    Analyzor(Deci)
    if ~Deci.Proceed; return; end
end
```

5. Plotting

General Set-Up

```
    Deci.Plot.GA =  0;                          % 0 for Individual Plots, 1 for GrandAverage
    Deci.Plot.Scale = 'linear';
    Deci.Plot.Save = [];
    Deci.Plot.Save.Format =  'fig';
```

Math

Allows plotting of new Conds that computed by mathically operations done on current Conds. Those new Conds can also contribute to creation of more new Conds

Examples: 4 Conds created

.Plot.Math.Form = {'[x1+x3]','[x2+x4]','x6-x5'};

in this example sum Cond 1+3 creates Cond 5, Cond 2+4 creates Cond 6 and together Cond 5+6 creates Cond 7

```
    Deci.Plot.Math = [];
%   Deci.Plot.Math.Form = {'[x1+x3]','[x2+x4]','x6-x5'};    % in this example sum of Cond1 and
    Deci.Plot.Math.Type = 0;                    % 0 = no math plots, 1 = only math plots, 2 = b
```

Time-Frequency

```
    Deci.Plot.Freq = [];


    Deci.Plot.Freq.Plot = 0;                % 1 or 0 to do Freq Plots
    Deci.Plot.Freq.Foi = [3 4.5];
    Deci.Plot.Toi = [0 .8];
    Deci.Plot.Freq.Channel = [{'VEM'  'HEM'  'F3'  'F4'  'C3'  'C4'  'P3'  'P4'  'PO3'  'PO4'
    Deci.Plot.Freq.Type = 'TotalPower';     % Use 'TotalPower','ITPC' or 'EvokedPower'

    Deci.Plot.Freq.Bsl = [-.5 -.2];           % Baseline Correction Time
    Deci.Plot.Freq.Roi = [];          % use 'maxmin','maxabs or [min max] to set.
    Deci.Plot.Freq.BslType ='db';    % Use 'absolute','relative','relchange','db','normchange'

    Deci.Plot.Freq.Topo = 1;
    Deci.Plot.Freq.Square = 1;
```

Time-Frequency Wires

```
    Deci.Plot.Freq.Wires = [];
%         Deci.Plot.Freq.Wires.Collapse = 'Time';        %Which Dim to Collapse 'Time' or 'Freq
%         Deci.Plot.Freq.Wires.avgoverfreq = 'no';
%         Deci.Plot.Freq.Wires.avgovertime= 'yes';
%         Deci.Plot.Freq.Wires.frequency = [4 8];
%         Deci.Plot.Freq.Wires.latency = [.1  .5];
%         Deci.Plot.Freq.Wires.nanmean = 'no';
```

ERP

```
    Deci.Plot.ERP = []; %Not Available to plot
    %     Deci.Plot.ERP.Channel = 'all';             % Cell array of channels or 'all'
```

PRP

```
    Deci.Plot.PRP = [];                     %Requires .Freq/.ERP to be filled out
    %Power related Potential
    %Plot 1 = Collapsed-Frequency/Channel Freq.Type Data
    %plot 2 = Collapsed-Channel           ERP Data
    %plot 3 = Condition-Specific Timepoint by Timepoint Freq-ERP coorelation across subjects
    %plot 4 = Collapsed-Time/Freq/Channel Condition-Specific Subject by Subject plotted along
    %Changes .GA into 0
    %     Deci.Plot.PRP.label = 1;                %Whether or Not to add subject info on plot
    %     Deci.Plot.PRP.ScatterToi = [.3 .7];     %Time range for plot 4
```

Cross-Frequency Coupling

```
    Deci.Plot.CFC = [];
    Deci.Plot.CFC.method = 'plv';
    Deci.Plot.CFC.Topo = 1;
    Deci.Plot.CFC.Square = 1;
    Deci.Plot.CFC.Roi = 'maxmin';          % Power Range of Interest
```

```
if Deci.Step <= 5
    Plottor(Deci);
    if ~Deci.Proceed; return; end
end
```