

Developer's Guide

February 7, 2025

Version 7.0

by the PsPM team¹:

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1 Introduction

Contributed by Teddy Zhao in April 2023

PsychoPhysiological Modelling, abbreviated as PsPM, is a software package for model-based analysis of psychophysiological signals. PsPM can be accessed through either graphical user interface (GUI) or command lines. PsPM is written in MATLAB language, thus it supports cross platform usages, either Windows, macOS or Linux, and can be easily utilised in customised shell scripts. PsPM is actively updated and maintained by bringing new features and fixing bugs, thus the latest version of PsPM is always encouraged for users. The recommended version of MATLAB for running PsPM is MATLAB 2023a (version 9.14), and the earliest version of MATLAB that could be used for running PsPM is MATLAB 2006a (version 7.2).

2 General

Contributed by Dominik R Bach and Teddy Zhao

Reviewed and revised by Teddy Zhao in March 2023

2.1 Data files

In PsPM, data and information is stored as `struct` variables and saved as `mat` files. A data `struct` may contain multiple cells, and each cell contains a `struct` with channel specific fields, `infos` and `data`. Specifically, `infos` is a `struct` variable with general information, and `data` is a `cell` array with the data for each channel. Both `infos` and `data` have the following mandatory subfields, whilst `infos` may have some optional subfields that can be defined if necessary, as is shown in **Table 1**.

Table 1 Description of data fields in PsPM

	Field	Subfield	Description
Mandatory	infos	duration	The duration of the acquired data, normally defined in seconds
		data	header.channeltype
		header.sr	The type of the corresponding channel, as defined in the settings.
		header.units	the sample rate (or frequency) in 1/second (or Hz), or timestamp units in seconds
		data	the unit of data, or the 'events'
Optional	infos	sourcefile	the actual data
		importfile	
		importdate	
		sourcetype	
		recdate	
		rectime	

In most cases, only the subfield data in the field data will be modified since new results have been generated and are expected to replace the old data. All the other fields, for both data and infos, the content will be kept unchanged. However, some data manipulation functions, for example `pspm_trim`, will update infos to record some file history. Please check the specific descriptions of each function for understanding how data and infos will be updated.

2.2 Types of functions in PsPM

2.2.1 Interactive functions

- `pspm_data_editor`
- `pspm_display`
- `pspm_ecg_editor`
- `pspm_guide`
- `pspm_review`

2.2.2 Functions that create data files

- `pspm_import`
- `pspm_trim`
- `pspm_split_sessions`
- `pspm_merge`
- `pspm_ren`

- `pspm_interpolate` (only if run on all channels)

2.2.3 Functions that change channels

- `pspm_combine_markerchannels`
- `pspm_convert_area2diameter`
- `pspm_convert_au2unit`
- `pspm_convert_ecg2hb`
- `pspm_convert_ecg2hb_amri`
- `pspm_convert_gaze`
- `pspm_convert_hb2hp`
- `pspm_convert_ppg2hb`
- `pspm_emg_pp`
- `pspm_find_sounds`
- `pspm_find_valid_fixations`
- `pspm_gaze_pp`
- `pspm_interpolate`
- `pspm_pp`
- `pspm_pupil_correct_eyelink`
- `pspm_pupil_pp`
- `pspm_remove_epochs`
- `pspm_resp_pp`
- `pspm_scr_pp`
- `pspm_remove_epochs` (not available in GUI)
- `pspm_expand_epochs` (not available in GUI)

2.2.4 First level models

- `pspm_dcm`
- `pspm_glm`
- `pspm_process_illuminance`
- `pspm_sf`
- `pspm_tam` (not available in GUI)

2.2.5 User-accessible I/O functions

- `pspm_exp`
- `pspm_extract_segments`
- `pspm_get_markerinfo`

2.2.6 Internal and helper functions

- `pspm_align_channels`
- `pspm_blink_saccade_filt`
- `pspm_butter`

- `pspm_check_model`
- `pspm_convert_pixel2unit_core`
- `pspm_convert_unit`
- `pspm_convert_visangle2sps_core`
- `pspm_convert_visual_angle_core`
- `pspm_denoise_spike`
- `pspm_downsample`
- `pspm_epochs2logical`
- `pspm_extract_segments_core`
- `pspm_eye` `pspm_filtfilt`
- `pspm_find_channel`
- `pspm_find_eye`
- `pspm_get_timing`
- `pspm_interp1`
- `pspm_leaky_integrator`
- `pspm_load1`
- `pspm_load_channel`
- `pspm_load_data`
- `pspm_load_gaze`
- `pspm_logical2epochs`
- `pspm_multi2index`
- `pspm_prepdata`
- `pspm_pulse_convert`
- `pspm_pupil_correct`
- `pspm_select_channels`
- `pspm_sf_auc`
- `pspm_sf_dcm`
- `pspm_sf_mp`
- `pspm_sf_scl`
- `pspm_sf_theta`
- `pspm_show_arms`
- `pspm_struct2vec`
- `pspm_time2index`
- `pspm_transfer_function`
- `pspm_update_channeltype`
- `pspm_version` `pspm_write_channel`
- `pspm_dcm_inv`
- `pspm_get_rf`
- `pspm_glm_recon`

2.2.7 Basis functions

- `pspm_bf_data`
- `pspm_bf_FIR`

- pspm_bf_hprf
- pspm_bf_hprf_e
- pspm_bf_hprf_fc
- pspm_bf_hprf_fc_f
- pspm_bf_lcrf_gm
- pspm_bf_ldrf_gm
- pspm_bf_ldrf_gu
- pspm_bf_psr_f_erl
- pspm_bf_psr_f_fc
- pspm_bf_rarf_e
- pspm_bf_rarf_fc
- pspm_bf_rfrf_e
- pspm_bf_rprf_e
- pspm_bf_scrf
- pspm_bf_scrf_f
- pspm_bf_sebrf
- pspm_bf_spsrf_box
- pspm_bf_spsrf_gamma
- f_SCR
- f_SF
- g_SCR

2.2.8 Housekeeping functions

- pspm_check_model
- pspm_check_python
- pspm_check_python_modules
- pspm_init
- pspm_options
- pspm_overwrite
- pspm_path
- pspm_quit
- pspm_pupil_pp_options

2.2.9 Convenience functions

- pspm_multi_channel
- pspm_pull_zenodo

2.2.10 Not accessible to users

- pspm_jobman
- pspm_format_history
- pspm_format_history_from_file

2.3 How to add a new import data type

2.3.1 Add function

Function name pspm_get_xxx (where xxx is the data type name).

Format [sts, import, sourceinfo] = pspm_get_xxx(datafile, import).
The function needs to take an import job and add, for each job.

Fields

- Mandatory
 - .data** - the actual data for this channel (column vector)
 - .sr** - the sample rate for this channel (only if .autosr enabled in pspm_init)
- Optional
 - .marker** For marker channels (timestamps or continuous, see pspm_get_marker)
 - .markerinfo** See pspm_get_marker
 - .minfreq** Minimum frequency for pulse channels
 - .units** If data units are defined by the recording software
 - sts** Set as -1 if import is unsuccessful
 - sourceinfo** Contains information on the source file, with field
 - .chan** A cell of string descriptions of the imported source channels, e. g. names, or numbers any optional fields that will be added to infos.source (e. g. recording date & time, and others)

Notes for multiple blocks File formats that support multiple block storage within one file can return cell arrays import{1:blkno} and sourceinfo{1:blkno}. PsPM will save individual files for each block, with a filename pspm_fn_blk0x.mat.

2.3.2 Add information to settings

The file pspm_init contains a block that defines possible import data types. Add a new field here

```
% Description of data type
% -----
defaults.import.datatypes(1) = ...
struct('short', 'xxx', ... % short name for internal purposes
'long', 'Datatype description', ... % long name for GUI
'ext', '*', ... % data file extension
'funct', @pspm_get_xxx, ... % import function
'chantypes', {{defaults.chantypes.type}}, ... % allowed channel types
'chandescription', 'channel', ... % description of channels for GUI
'multioption', 1, ... % import of multiple channels for GUI
'searchoption', 1, ... % allow channel name search for GUI
```

```
'automarker', 0, ... % marker not stored in separate channel
'autosr', 1); % sample rate automatically assigned
```

Good to know

- The “long” definition is used in the GUI – make sure it’s readable.
- If no event channels can be imported, change .chantypes.
- If channels have searchable names in the import file, set .searchoption = 1.
- If no channel number needs to be assigned for the marker channel, set .automarker = 1.
- If sample rate is contained in import file and determined during import, set .autosr = 1.
- If you need external functions – put them into a folder in the ‘import’ subdirectory and add/remove this path within the pspm_get_xxx function.

2.4 How to add a new channel type

2.4.1 Add function

Function pspm_get_xxx (where xxx is the channel type)

Format [sts, data] = pspm_get_channeltype(import)

Arguments

data Data cell of structure readable by pspm_load_data.

Good to know For event channels, use the function pspm_get_events to convert various event formats into time stamps (see pspm_get_marker or pspm_get_hb as an example)

2.4.2 Add information to settings

Add information on the new channel type and import function to

```
defaults.chantypes(k).type = 'xxx'; % channel type name
defaults.chantypes(k).import = @pspm_get_xxx; % conversion function
defaults.chantypes(k).data = 'xxx'; % 'wave' or 'events'
```

2.5 How to add a new GLM type

2.5.1 Add information to settings (Example SCR)

```
defaults.glm(1) = ...
struct('modality', 'scr', ... % modality name
'cbf', struct('fhandle', @pspm_bf_scrf, 'args', 1), ...
% default basis function/set
'filter', struct('lpfreq', 5, 'lporder', 1, ...
'hpfreq', 0.05, 'hporder', 1, 'down', 10, 'direction', 'uni'));
% default filter settings
```

2.5.2 Add default basis function

Function `pspm_bf_XXX`

Arguments vector of arguments, first element is time resolution, further arguments as defined in `defaults.glm(n).cbf.args`.

2.6 Warning IDs in PsPM

2.6.1 General

- `invalid_input`
- `invalid_channeltype`
- `nonexistent_file`
- `channel_not_contained_in_file`
- `obsolete_function`
- `not_allowed_channeltype`
- `invalid_data_structure`
- `no_matching_channels`
- `unknown_action`
- `missing_data`
- `out_of_range`

2.6.2 Function specific

- `pspm_load1`
 - `not_saving_data`
- `pspm_interpolate`
 - `option_disabled`
- `pspm_trim`
 - `marker_out_of_range`
- `pspm_find_channel`
 - `multiple_matching_channels`
- `pspm_find_sounds`
 - `no_marker_chan`
 - `no_sound_chan`
- `pspm_get_scr`
 - `no_conversion_constant`
- `pspm_pp`
 - `invalid_freq`
- `pspm_prepdata`

- no_low_pass_filtering
 - downsampling_failed
 - nonint_sr
- pspm_get_timing
 - invalid_vector_size
 - event_names_dont_match
 - no_numeric_vector
 - no_integers
- pspm_down
 - rate_below_minimum

3 List of data formats

3.1 Supported Channel types

Data format	SCR	ECG	Heart Rate	Heart Beat	Heart Period	Respiration	Pupil Size	Marker	Custom	Sound channel	Pulse oxymeter	Gaze x/y, l/r
CED Spike	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
MATLAB	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
Text	✓	✓	✓		✓	✓	✓	✓	✓	✓	✓	✓
Biopach AcqKnowledge (≤ v3.9.0)	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
Biopac AcqKnowledge (exported)	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
Labchart (any Version, Windows only)	✓	✓	✓		✓	✓	✓	✓	✓	✓	✓	✓
Labchart exported (≤ v7.1)	✓	✓	✓		✓	✓	✓	✓	✓	✓	✓	✓
Labchart exported (≥ v7.2)	✓	✓	✓		✓	✓	✓	✓	✓	✓	✓	✓
VarioPort	✓	✓	✓		✓	✓	✓	✓	✓	✓	✓	✓
Biograph Infiniti (exported)	✓			✓		✓						
Mindmedia Biotrace (exported)	✓	✓	✓		✓	✓	✓	✓	✓	✓	✓	✓
Brain Vision	✓	✓	✓		✓	✓	✓	✓	✓	✓	✓	✓
Windaq (wdq)	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓		✓
Observer XT compatible	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
NeuroScan	✓	✓	✓		✓	✓	✓	✓	✓	✓	✓	✓
BioSemi	✓	✓	✓		✓	✓	✓	✓	✓	✓	✓	✓
Eyelink							✓	✓	✓			✓
European Data Format	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
Philips Scanphyslog		✓				✓		✓	✓		✓	
SMI							✓	✓	✓			✓
ViewPoint							✓	✓	✓			✓

3.2 Further settings

Data format	Datatype	File extension	Manufacturer	Import multiple channels	Search channel names	Automarker	Ask for sampling rate
CED Spike	spike	.smr	CED	✓	✓		
CED Spike	spike	.smrx	CED	✓	✓		
MATLAB	mat	.mat		✓			✓
Text	txt	.txt		✓	✓		
Biopach AcqKnowledge (\leq v3.9.0)	acq	.acq	Biopac	✓	✓		
Biopac AcqKnowledge (exported)	acqmat	.mat	Biopac	✓	✓		
Labchart (any Version, Windows only)	labchart	.adicht	ADInstruments	✓	✓	✓	
Labchart exported (\leq v7.1)	labchartmat_ext	.mat	ADInstruments	✓	✓	✓	✓
Labchart exported (\geq v7.2)	labchartmat_in	.mat	ADInstruments	✓		✓	
VarioPort	vario	.vpd	Becker MediTec	✓	✓	✓	
Biograph Infiniti (exported)	biograph	.txt	Thought Technology				
Mindmedia Biotrace (exported)	biotrace	.txt	MindMedia			✓	
Brain Vision	brainvision	.eeg	BrainProducts	✓	✓	✓	
Windaq (wdq)	windaq	.wdq	Dataq	✓			
Observer XT compatible	observer	.any	Noldus	✓	✓		
NeuroScan	cnt	.cnt		✓	✓	✓	
BioSemi	biosemi	.bdf		✓	✓	✓	
Eyelink	txt	.asc		✓		✓	
European Data Format	edf	.edf	European Data Format	✓	✓	✓	
Philips Scanphyslog	txt	.log	Philips	✓			
SMI	txt	20 .txt	SensoMotoric Instruments	✓	✓	✓	
ViewPoint	txt	.txt	Arrington Research	✓	✓	✓	

Note: Automarkers means no channel number has to be specified because markers are always at the same place.

4 GUI

Contributed by Gabriel Gräni and Teddy Zhao.

Revised by Teddy Zhao in February 2022.

4.1 MATLABbatch: Getting started

1. Add the trunk folder to the MATLAB path.
2. Type `pspm_init` into the command window (after the execution of the command the folders `pspm_cfg` and `MATLABbatch` should be added to the MATLAB path)
3. Start MATLABbatch by the typing `cfg_ui` into the command window
4. If the item `PsPM` exists in the menu bar of MATLABbatch you can skip steps 5 to 7 and continue at step 8
5. Select `→ File → Add Application`
6. Navigate to the folder `pspm_cfg` on the left hand side of the window and select the file `pspm_cfg.m` on the right hand side `→ Press the button Done`
7. A new item, called `PsPM`, will appear in the upper menu bar.
8. By selecting `PsPM` the desired action can be selected (at the moment, there is only `Data Preparation` `→ {Import, Trim}` available)

4.1.1 Example Function: Trim

This example demonstrates how MATLABbatch can be used to execute a function. For all other functions MATLABbatch behaves in the same manner.

- Select a file by pressing the `Select Files Button` (under `Datafile`)
- Select `Reference` and choose an item in the lower part of the window
- Fill in the desired values in the fields which are marked with `"<-X"`
- After you have chosen a file and filled in all values correctly, you will see a green arrow on the upper left part of the window
- By pressing on the green arrow the selected file will be trimmed according to the filled in values

4.2 MATLABbatch: How to

4.2.1 Preliminaries

- Add folder of `MATLABbatch` to the MATLAB path
- Add first application and then load the batch in order to execute a function

4.2.2 Some notes for creating a new application

- Leafs (items) are specified first
- Assigning child items to `.val` or `.values` fields of their parent items
- Root node of a tree is specified last
- Some examples of items:

– `cfg_item`

```
item1= cfg_item; % Defines generic configuration item
item1.name= 'Def 1'; % The display name
item1.tag = 'def1'; % The name appearing in the harvested job
% structure. This name must be unique
% among all items in the val field of the
% superior node
item1.val = {true}; % Value of item (optional)
item1.help = {'Help...'}; % Help text
```

– `cfg_entry`

```
entry1 = cfg_entry; % Defines entry configuration item
entry1.name = 'Input';
entry1.tag = 'input';
entry1.strtye = 'r'; % Type of values which can be entered
entry1.num = [1 1]; % Expected dimension of the input
entry1.help = {'Help...'};
```

– `cfg_choice`

```
choice = cfg_item; % Defines choice configuration item
choice.name = 'Choice';
choice.tag = 'choice';
choice.values = {item1, entry1}; % Defines which items will be
% selectable in the choice menu.
choice.help = {'Help...'};
```

– `cfg_exbranch`

```
fct = cfg_exbranch; % Defines the branch that has information
% about how to run this module fct.name = 'Trim';
fct.tag = 'trim';
fct.val = {choice}; % The items that belong to this branch.
% All items must be filled before this
% branch can run or produce virtual
% outputs
```

```
fct.prog = @cfg_run_fct; % A function handle that will be called
% with the harvested job to run the
% computation
```

```
trim.vout = @cfg_vout_fct; % A function handle that will be
% called with the harvested job to
% determine virtual outputs
trim.help = {Help...'};
```

- There exists a number of other item classes. Here is a list of the most important classes: `cfg_item`, `cfg_entry`, `cfg_choice`, `cfg_menu`, `cfg_exbranch`, `cfg_files`, `cfg_branch`, `cfg_repeat`.
For more information call the help function in MATLAB (e.g. `help cfg_item`)

Note The inputs to each module have to be described in a tree-like structure.

During data entry, there is no way to change the tree structure based on input data. Add application to the configuration tree by default

4.2.3 Add application to the configuration tree by default

In the following it is shown how an application can be added to the menu bar of MATLABbatch by default (without adding it every time MATLABbatch is started)

- Start MATLABbatch and add the application `cfg_configui` in the folder `MATLABbatch/cfg_configui`.
- Put Generate code into the Module list by selecting `ConfigUI` → `Generate code` in the menu bar
- Fill out all the input fields on the right side:
 - Output filename: This file will contain the whole menu structure, validity constraints and links to run time code of the application.
 - Output directory: All files which are created by the ConfigUI will be stored into this directory (choose a directory which is added to the MATLAB path)
 - Root node of config: Name of the root node of the application's configuration tree
 - Options:
 1. Create Defaults File: Yes
 2. Create `mlbatch_appcfg` File: Yes
 3. Create Code for `addpath()`: No
- Finally press the green arrow on the upper left side of the batch editor
- As no error occurred 3 new files (`{Output filename}.m`, `{Output filename}_def.m`, `cfg_mlbatch_appcfg.m`) should be created and added into the folder `{Output directory}`.
- Each time MATLABbatch is started, it will search for any `cfg_mlbatch_appcfg.m` file (this file contains the names of the configuration files) and will add the corresponding application to the batch editor.

4.2.4 Add modules to module list

Example Module Import and Trim will be added to the module list


```

arg1 = 'scr.prep.import_data';
arg2 = 'scr.prep.trim';
mod_cfg_id1 = cfg_util('tag2mod_cfg_id',arg1);
mod_cfg_id2 = cfg_util('tag2mod_cfg_id',arg2);
cjob = cfg_util('initjob');
mod_job_id1 = cfg_util('addtojob', cjob, mod_cfg_id1);
mod_job_id2 = cfg_util('addtojob', cjob, mod_cfg_id2);
cfg_util('harvest', cjob, mod_job_id1);
cfg_util('harvest', cjob, mod_job_id2);
cfg_ui('local_showjob', cfg_ui, cjob);

```

4.2.5 Changes

- In the function `private/cfg_onscreen` at line 36 `figure(fg);` is commented out in order to prevent the appearance of the GUI for a short time if the function `cfg_ui('Visible', 'off')` is called.

4.3 MATLABbatch: changing help texts and fieldnames

4.3.1 File structure of MATLABbatch GUI

There exist two files per function: 1 configuration file and 1 run file. The configuration file defines the structure of the corresponding function in the MATLABbatch GUI whereas the run file firstly gathers all entered values and secondly calls the corresponding SCR function. Both types of files are located in the subfolder `pspm_cfg`. The name of a configuration or a run file consists of two parts. The prefix of a configuration filename is called `pspm_cfg_` whereas the filename of a run file begins with `pspm_cfg_run_`. The second part of the filename is named after the function name (eg. for the function `pspm_import.m` → `pspm_cfg_import.m`, `pspm_cfg_run_import.m`).

4.3.2 Edit help texts and fieldname

In order to change any help text or fieldname in a MATLABbatch GUI function the corresponding configuration file has to be opened. For each item in a MATLABbatch GUI function a struct variable which contains several struct fields is defined in the configuration file.

- **Help text** The field `.help` defines the help text of the item which can be edited in order to change the help text. As soon as MATLABbatch has been closed and opened again, the changes in the help text will be visible in MATLABbatch GUI.
- **Fieldname** The fieldname of an MATLABbatch GUI item is defined by the struct field `.tag`. In case a fieldname of an item should be changed be careful to verify if no other item, which has the same root node, hold the same fieldname. Otherwise MATLABbatch will not work properly. After the fieldname of an item has been changed the run file (`pspm_cfg_run_functionname.m`) of the corresponding function has to be adapted as well in order to ensure that the function call in the run file is done properly.

4.4 Python Support

PsPM provides some features that are enabled by using Python packages, namely HeartPy and Bioread, and descriptions in the GUI. This is controlled through `pspm_cfg_python`. Any PsPM functions or features that require Python-enabled features need to call `pspm_cfg_python` to show Python path specification in the GUI, so that users can select appropriate Python location for calling the packages.

4.4.1 Python packages

The Python packages that are used by PsPM are Bioread and HeartPy, until PsPM version 7.0. This is to support the features of importing .acq data for Bioread and process PPG data for HeartPy. The tested compatible version of these packages are Python 3.11, Bioread 3.0.1, and HeartPy 1.2.7. Because some packages may have dependence on other packages such as numpy, here is a list of Python packages that work on both Windows and macOS

```
Pillow==10.1.0
aigpy==2022.7.8.1
bioread==3.0.1
certifi==2023.11.17
charset-normalizer==3.3.2
colorama==0.4.6
contourpy==1.2.0
cycler==0.12.1
docopt==0.6.2
fonttools==4.45.1
heartpy==1.2.7
idna==3.4
kiwisolver==1.4.5
matplotlib==3.8.2
mutagen==1.47.0
numpy==1.26.2
packaging==23.2
pip==24.0
prettytable==3.9.0
pycryptodome==3.19.0
pydub==0.25.1
pyparsing==3.1.1
python-dateutil==2.8.2
requests==2.31.0
scipy==1.11.4
setuptools==68.2.2
six==1.16.0
urllib3==2.1.0
wcwidth==0.2.12
wheel==0.41.3
```

4.4.2 HeartPy for processing PPG data

The package HeartPy (stylised to be in line with its official website) (<https://pypi.org/project/heartpy/>) is designed for analysing PPG signals and used for processing PPG data in PsPM.

The process of using HeartPy to process PPG data is described as following. Initially, PsPM will check if python has been installed in the computer, and this is done by using the function `pspm_check_python`. In this process, `pspm_check_python` requires a path of python that is provided by the user so that it can determine if python has been installed there. Secondly, PsPM checks if HeartPy package has been installed in the defined python path, and this is handled with `pspm_check_python_modules`. If both python and HeartPy have been installed, it is then safe to use function family `py.heartpy` to do analysis. The details of available functions that are provided by HeartPy can be found at <https://python-heart-rate-analysis-toolkit.readthedocs.io/en/latest/heartpy.heartpy.html>. The details about how PPG data are processed can be found at `pspm_convert_ppg2hb`.

4.4.3 Bioread for importing biopac data

The package Bioread (<https://pypi.org/project/bioread/>) supports reading biopac files in any version, and it has been included in PsPM for importing biopac files since version 7.0. Bioread-based importing is set as an alternative method in parallel to previous methods, and it is managed in `acqread_python`. Users have to specify the functionality of importing biopac data with python to use this method, but they can also call the function `acqread_python` in command line or scripts to directly use this feature. The method of checking python and Bioread is identical to what has been checked for HeartPy. The generic flowchart of `acqread_python` is to get the main content and other metadata from original files and then save such information to the corresponding places for meeting PsPM's data storage requirements. Further information is available in `acqread_python` that is under the path `src/Import/acq`.

4.5 GUI Development Progress

MATLAB GUIDE <https://uk.mathworks.com/help/matlab/migrate-guide-apps.html> was originally used as the framework for designing the GUI of PsPM. However, the framework suffers from the risk that plots may be unexpectedly displayed on such figures since they need to be called by users' command lines. At the same time, GUIDE based GUI will lose support from Mathworks in a future release of MATLAB. Consequently, PsPM is currently slowly being migrated to the new UI designing framework, MATLAB AppDesigner. Instead of creating `.fig` files, the new AppDesigner frameworks will create `.mlapp` files. The `.mlapp` file can be created natively through the new MATLAB GUI guide. Alternatively, it can be generated by converting the classic GUIDE based `.fig` file through the feature *migration*.

The main GUI has been recreated by using AppDesigner in PsPM version 6.1, where the function lists inherited from the legacy of GUIDE-based GUI. The code has been re-sorted out in MATLAB by following the coding style of AppDesigner. A typical button corresponds to the function shown below

```
function
button_Callback(app, event)
switch event.Value
case 'A'
action;
end
```

| end

The new GUI is currently using the colour #7f2534 for styling. The main typeface for UI design is Segoe UI, San Francisco (or Helvetica Neue for Yosemite, Lucida Grande for pre-Yosemite) and DejaVu Sans for Windows, macOS, and Linux, respectively.

4.6 Help Text

4.6.1 Introduction

Help text refers to the descriptive text that is included in the initial couple of lines of source code. Such help text can be sorted by calling the function `pspm_help` into a struct. Typically, the help text shall be written into sections as

Description	The general introduction of a function. This is normally describing the use of the function and how it works, such as importing a specific type of data and how information is read and managed.
Format	The format of a function as how it can be called. If the function has some variable arguments, then the details can be listed as multiple lines.
Arguments	The list of input variables of a function with their descriptions. Every individual input variable shall be lead by a star mark. Structs and their subfields shall be managed with table symbols. An example of how this is managed is given below.
Outputs	The list of output variables of a function with their descriptions, similar to Arguments.
Developer's notes	This section can be used as a paragraph of technical notes for the function. Such information is typically useful for developing the function, and it is relatively more useful for developers than for users.
History	The section includes some notes about who has contributed to a function, which may be useful for future checking.

4.6.2 Typical example

- Description

General introduction of the function.

- Format

```
[output1, output2, output3] = pspm_xxx(varargin);  
[output1, output2, output3] = pspm_xxx(input1, input2);
```

- Arguments

* input1 : description of input1.

* input2 : description of input2.

```
└─input3  
└─.subfield1 : description of subfield1.  
└─.subfield2 : description of subfield2.
```

- Outputs

* output1 : description of output1.

* output2 : description of output2.

[output3
└subfield1 : description of subfield1.
└subfield2 : description of subfield2.

● Developer's notes

A few sentences of technical information for this function.

● History

Introduced in PsPM version a.

Written in 2024 by developer a.

5 Test Environment

Contributed by Linus Rüttimann, Tobias Moser and Teddy Zhao.

Revised and updated by Teddy Zhao in February 2022.

5.0.1 Unittest: General implementation

In PsPM the MATLAB Unit Testing Framework is used for testing of functions. For each tested function there is a MATLAB class with the name `functionname_test`, which contains the unittests for that specific function. Additionally there is a documentation page for each of the test classes, where information about the unittests can be found.

To run the unittests of a test class, an object of the class has to be created

```
| testCase = functionname_test.
```

where `testCase` is an arbitrary object name and `functionname_test` is the name of a test class. Then all the unittest that are contained in the test class can be run with

```
| testCase.run.
```

A specific unittest can be run with

```
| testCase.run(unittest_name').
```

Remember that a new test class object must be generated each time the test class has been changed.

5.0.2 parameterised test classes

Parameterised test classes is a feature provided by the MATLAB test case class. A test class is parameterised when it has

- Test parameters defined (within the property section)
- Test methods implementing the defined test parameters

Each function implementing test parameters will be called multiple times with each possible parameter combination (which is determined by MATLAB). Thus parameterised classes allow to write single tests for different parameter combinations. If one of the following test cases is a parameterised test class, it will be mentioned accordingly.

5.1 Align Channels

5.1.1 Overview

Testclass `pspm_align_channels_test`

Format `[sts, data, duration] = pspm_align_channels(data, induration)`

5.1.2 Setup

This test uses data stored in `ImportTestData/ecg2hb/tpspm_s102_s1.mat`

5.1.3 Testcases

Invalid input

Function name `invalid_input(this)`

Description Checks for warnings given invalid inputs.

Lower optional duration

Function name `lower_optional_duration(this)`

Description Passes an optional duration that is less than the maximum duration of all channels in the input to `pspm_align_channels`.

Tests

1. Assert that lower optional duration has no effect on the output.
2. Check if all of the returned channels have the same duration.

Same optional duration

Function name `same_optional_duration(this)`

Description Passes an optional duration that is equal to the maximum duration of all channels in the input to `pspm_align_channels` and does the exact same checks as in lower duration case.

Higher optional duration

Function name `higher_optional_duration(this)`

Description Passes an optional duration that is higher than the maximum duration of all channels.

Tests

1. Assert that durations of all returned channels is the same as the passed optional duration.

Max duration is passed in marker channel

Function name `max_duration_is_given_in_events(this)`

Description Passes the maximum duration in marker channel to `pspm_align_channels`.

Tests

1. Assert that all returned channels are aligned to the maximum duration passed in marker channel.

Various case checks

Function names

`only_one_channel_longer_others_same(this)`

`only_one_channel_shorter_others_same(this)`

`increasing_channel_lengths(this)`

`two_same_others_shorter(this)`

Description In each of these cases check if the returned channels have the same duration that is equal to the maximum duration of all input channels.

5.2 Butter

5.2.1 Overview

Testclass `pspm_butter_test`

Function `[sts, b, a] = pspm_butter(order, freqratio, pass)`

5.2.2 Testcases

Invalid input

Function name `invalid_input(this)`

Description Checks for warnings, if the input arguments are invalid and if the signal processing toolbox is installed.

Tests

Input	Expected warning
pspm_butter() [no input]	ID:invalid_input
pspm_butter(1,1,'abc') [pass not equal to 'high' or 'low']	ID:invalid_input
pspm_butter(2,1) ['Signal processing toolbox is missing' #1]	ID:toolbox_missing
pspm_butter(1,1) ['Signal processing toolbox is missing' #2]	ID:toolbox_missing

5.3 pspm_bf

5.3.1 Overview

Testclass pspm_bf_test

Format [bs, x] = pspm_bf_<specific function name>

5.3.2 Setup

This test class is parameterised.

Method setup parameters These parameters define which function should be tested.

Basis function Specifies the basis functions to test (without the pspm_bf_ prefix). The current basis function to test is then called via `this.bf()`;

Test parameters These are parameters which define what kind of data or option should be passed to each basis function.

Time res log	Specifies for the basic test different time resolutions (argument 'td') which a basis function should be able to handle (as long as $td \leq \text{duration}$). The values are logarithmic and have to be translated before passed to the basis function.
---------------------	--

5.3.3 Testcases

Invalid input

Function name invalid_input(this)

Description Checks for warnings, if the input arguments are invalid.

Tests

Input	Expected warning
this.bf() [no parameters]	ID:invalid_input
this.bf(dur+1) [pass 'td' > duration of function]	ID:invalid_input
this.bf(0) [invalid time resolution]	ID:invalid_input

Basic

Function name test_basic(this, time_res_log)

Description Test for different requirements to verify whether the current basis function is valid or not.

Tests

1. Test with $td = 0.1$, verify that no warning is issued and determine the duration
2. Test with $td = 0.01$ and check if the new duration is equal to the duration calculated before.
3. Test if function runs through without warning and that the time vector begins at ≤ 0 .
4. Test if the function runs through without warning with $td = 10^{\text{time_res_log}}$ (as long as $td < \text{duration}$)

5.4 pspmm_convert_unit

5.4.1 Overview

Testclass pspmm_convert_unit_test

Function [sts, converted] = pspmm_convert_unit(data, from, to)

5.4.2 Setup

Constants inch_to_cm = 2.54

5.4.3 Testcases

Invalid input

Function name invalid_input(testCase)

Description Pass invalid from or to metrics and check if warnings are issued.

Valid input

Function name `valid_input(this)`

Description Pass various valid inputs and compare results to manually calculated ones.

Tests

1. If empty input data is passed, result is also empty.
2. Convert single cm value to m.
3. Various unit conversion checks:
 - (a) Conversion between same units (cm to cm)
 - (b) mm to km and km to mm conversions
 - (c) inch to cm conversions
4. Negative value conversions
5. Convert single dimensional array with multiple elements.
6. Convert each element in 3D array.

5.5 pspm_ecg2hb

5.5.1 Overview

Testclass `pspm_ecg2hb_test`

Format `[sts,pt_debug] = pspm_ecg2hb(fn, chan, options)`

5.5.2 Setup

Constants

- `testdata{0}.chan_struct = struct('nr', 1, 'name', 'ecg');`
- `testdata{0}.filename = 'ImportTestData\ecg2hb\test_ecg77.mat';`
- `testdata{0}.num_channels = 1`
- `testdata{1}.chan_struct = struct('nr', 3, 'name', 'ecg');`
- `testdata{1}.filename = 'ImportTestData\ecg2hb\tpspm_s102_s1.mat';`
- `testdata{1}.num_channels = 5`
- `backup_suffix = '_backup';`
- `options = struct('semi', 0);`

5.5.3 Testcases

Invalid input arguments

Function name `invalid_input(this)`

Description Pass invalid input arguments and check if the warnings are as expected.

Tests	Input	Expected warning
	<code>pspm_ecg2hb()</code> [no arguments]	ID:invalid_input
	<code>pspm_ecg2hb(1)</code> [invalid file name]	ID:invalid_input
	<code>pspm_ecg2hb(this.fn, 'bla')</code> [invalid channel (text)]	ID:invalid_input
	<code>pspm_ecg2hb(this.fn, 1)</code> [invalid channel type]	ID:not_allowed_channeltype
	<code>o.twthresh = 'bla'; pspm_ecg2hb(this.fn, this.chan.nr, o)</code> [invalid twthresh (text)]	ID:invalid_input
	<code>o.minHR = 202; pspm_ecg2hb(this.fn, this.chan.nr, o)</code> [invalid minHR (> default_maxHR)]	ID:invalid_input
	<code>o.minHR = 202; o.maxHR = 19; pspm_ecg2hb(this.fn, this.chan.nr, o)</code> [invalid minHR > maxHR]	ID:invalid_input
	<code>o.maxHR = 19; pspm_ecg2hb(this.fn, this.chan.nr, o)</code> [invalid maxHR (< default_minHR)]	ID:invalid_input
	<code>o.debugmode = 5; pspm_ecg2hb(this.fn, this.chan.nr, o)</code> [invalid debugmode (not in [0,1])]	ID:invalid_input
	<code>o.semi = 5; pspm_ecg2hb(this.fn, this.chan.nr, o)</code> [invalid semi (not in [0,1])]	ID:invalid_input

Valid input arguments

Function name `valid_input(this)`

Description Pass valid input arguments and check if there are no warnings.

Tests	Input	Expected warning
	<code>pspm_ecg2hb(this.fn, this.chan.nr, this.options)</code>	-
	<code>pspm_ecg2hb(this.fn, this.chan.name, this.options)</code>	-
	<code>this.test_added_data()</code>	-

5.5.4 Other Methods

Test for added data

Function name test_added_data()

Description Check if added hb channels show an expected behaviour.

Tests	(for	each	channel)
	Tested Value	Expected Value	
	Sampling rate	1	
	Unit	'events'	
	Channel type	'hb'	
	Amount of data points in data	> 1	
	Heartbeat indices are monotonically increasing	True	
	Maximum number of heartbeats per second	< 5	
	Data is distributed equally (standard deviation)	< 2s	
	Time between end of recording and last data point	< 60s	

5.6 pspm_filtfilt

5.6.1 Overview

Testclass pspm_filtfilt_test

Format y = pspm_filtfilt(b,a,x)

5.6.2 Testcases

Invalid input

Function name invalid_input(this)

Description Checks for warnings, if the input arguments are invalid.

Tests	Input	Expected warning
	pspm_filtfilt() [no input]	ID:invalid_inpu
	pspm_filtfilt([1:10],[1:20],[1:10]) [data length less than 3 times filter order]	ID:invalid_inpu

5.7 pspm_find_channel

5.7.1 Overview

Testclass pspm_find_channel_test

Format chan = pspm_find_channel(headercell, chantype)

5.7.2 Testcases

Invalid input arguments

Function name `invalid_inputargs(this)`

Description Checks for warnings, if the input arguments are invalid.

Setup `headercell = {'heart', 'scr', 'pupil'};`

Tests

Input	Expected warning
<code>pspm_find_channel('str','scr') [no headercell]</code>	ID:invalid_input
<code>pspm_find_channel(headercell, 'str')</code>	ID:not_allowed_channeltype
<code>pspm_find_channel(headercell, 4) [no string chantype]</code>	ID:invalid_input

Valid Input Arguments

Function name `valid_inputargs(this)`

Description Checks for correct return value if the input arguments are valid

Setup `headercell = {'heart', 'scr', 'pupil', 'mark', 'gsr', 'eda'};`

Tests

Input	Exp. Output	Expected warning
<code>pspm_find_channel(headercell, 'pupil')</code>	3	
<code>pspm_find_channel(headercell, 'resp')</code>	0	ID:no_matching_channels
<code>pspm_find_channel(headercell, 'scr')</code>	-1	ID:multiple_matching_channels
<code>pspm_find_channel(headercell, {'mark', 'str', 'bla'})</code>	4	
<code>pspm_find_channel(headercell, {'call', 'str', 'me'})</code>	0	no matching channel, but no warning
<code>pspm_find_channel(headercell, {'scr', 'gsr', 'eda'})</code>	-1	multiple matching channels, but no warning

5.8 pspm_extract_segments

5.8.1 Overview

Testclass `pspm_extract_segments_test`

Description Checks for equality of produced segments by `pspm_extract_segments` with manually computed segments.

Tests

1. Generate segments from test data.
2. Test if function call worked WarningFree
3. Test if variable `segments` exists in output
4. Test if correct number of segments were produced
5. Test each segment holds correct data

Test manual mode with durations

Function name `test_manual_duration(this,nr_trial,nan_ratio)`

Description Checks for equality of produced segments by `pspm_extract_segments` with manually computed segments.

Tests

1. Generate segments from test data.
2. Test if function call worked WarningFree
3. Test if variable `'segments'` exists in output
4. Test if correct number of segments were produced
5. Test each segment holds correct data

Test auto mode with GLM using marker onsets

Function name `test_auto_mode_glm_with_markers(this)`

Description Runs `pspm_extract_segments` with a particular GLM model stored in `ImportTestData/fitted_model` and compares the results to manually calculated results.

Tests

1. Test if length of the returned cell array (from now on called `segments`) is the same as the number of conditions
2. Test if shape of data arrays in each element of `segments` agrees with the passed durations and number of onsets.
3. Test if `segments.trial_idx` agrees with input data.
4. Test if statistics calculated manually from `segments.data` is the same as `segments.mean` and `segments.std`.
5. Compute each statistic field in each element of `segments` manually using the input data and compare the results to `segments`.

Test auto mode with GLM using second onsets

Function name `test_auto_mode_glm_with_seconds(this)`

Description Do the exact same tests as in `test_auto_mode_glm_with_markers` but this time using seconds to specify onsets.

Test auto mode with DCM

Function name `test_auto_mode_dcm(this)`

Description Runs `pspm_extract_segments` with a particular DCM model stored in `ImportTestData/fitted_model` and compares the results to manually calculated results. In order to get meaningful condition statistic information this test function assigns the same trial name to certain groups of trials.

Note Since in DCM case onsets are calculated using trial start and end seconds of DCM trials, there is no second/marker distinction in DCM test.

Tests Do the exact same tests as in `test_auto_mode_glm_with_markers` by adapting the computation steps to DCM case.

5.9 pspm_find_sounds

5.9.1 Overview

Testclass `pspm_find_sounds_test`

Format `[sts, infos] = pspm_find_sounds(file, options)`

5.9.2 Setup

This test class is parameterised. The test data is generated by the function itself and when needed, files will be written to `testdatafile<variable_nr>.mat`.

Test parameters These are parameters which define what kind of data should be passed to `pspm_find_sounds` and which options should be set.

Channel output	Specifies whether 'all' found markers or only 'corrected' markers should be returned.
Max delay	Varies the max delay option and defines how far away a marker at most can be.
Min delay	Varies the min delay option and defines how far away a marker at least should be.
Threshold	Defines the minimum size of a marker to be recognized as a marker event. Passed in percent of the maximum amplitude of the recorded data.
Resample	Defines whether the function should resample (and interpolate) the data to a higher sample rate in order to get more exact marker findings.
Channel action	Defines whether a newly created marker channel should replace the existing marker channel or should be added as a new marker channel.

5.9.3 Testcases

Invalid input

Function name `invalid_input(this)`

Description Checks for warnings, if the input arguments are invalid.

Tests

Input	Expected warning
<code>pspm_find_sounds('')</code>	ID:file_not_found
<code>pspm_find_sounds(fn)</code> [invalid pspm file]	ID:invalid_input
<code>pspm_find_sounds(fn)</code> [pspm file without a 'snd' channel]	ID:no_sound_chan
<code>pspm_find_sounds(fn, o)</code> [invalid values for positive integer fields]	ID:invalid_input
<code>pspm_find_sounds(fn, o)</code> [invalid values for positive numeric fields]	ID:invalid_input
<code>pspm_find_sounds(fn, o)</code> [invalid values for logic fields]	ID:invalid_input
<code>pspm_find_sounds(fn, o)</code> [invalid channel ids for channel fields]	ID:out_of_range
<code>pspm_find_sounds(fn, o)</code> [enabled diagnostics without a marker channel]	ID:no_marker_chan
<code>pspm_find_sounds(fn, o)</code> [invalid values for channelaction]	ID:invalid_input
<code>pspm_find_sounds(fn, o)</code> [invalid values for roi]	ID:invalid_input
<code>pspm_find_sounds(fn, o)</code> [maxdelay < mindelay]	ID:invalid_input

Test add channel

Function name `test_add_channel(this, channeloutput, max_delay, resample, channelaction)`

Description Test add channel with different options. Diagnostics is always enabled, Channel output, Max delay, Resample and Channel action are varied. Once `pspm_find_sounds` is complete, the function tests if the returned data has the expected format.

Tests

1. Generate data with channel snd and marker; and count amount of reference markers
2. Set

- (a) options according to test parameters
- (b) diagnostics to 1
- 3. Test if function runs through without warning
- 4. Test if returned data has the correct format
- 5. Test if channels has been added or replaced
- 6. Test if added channel has correct amount of data

Test region count

Function name test_region_count(this)

Description Test region of interest in combination with expected sound count.

Tests

- 1. Generate data with channel 'snd' and 'marker'
- 2. Test if function finds the function finds all markers in the whole file
- 3. Test if function finds all the markers in the whole file with initial threshold 1
- 4. Test if function finds half of the markers in half of the file

Test threshold

Function name test_threshold(this, threshold)

Description Vary the threshold option and test whether the functions returns the expected data.

Tests

- 1. Generate data with channel 'snd' and 'marker'
- 2. Set
 - (a) threshold according to test parameter
 - (b) diagnostics to 1
- 3. Test if function runs through without warning
- 4. Test if returned data has the correct format

Test plot

Function name `test_plot(this, threshold)`

Description Test if the plot functions return the expected data and runs through without warning.

Tests

1. Generate data with channel snd and marker
2. Set
 - (a) plot to 1
 - (b) diagnostics to 1
3. Test if function runs through without warning
4. Test if returned data has the correct format

5.10 pspm_find_valid_fixations

5.10.1 Overview

Testclass `pspm_find_valid_fixations_test`

Format `[sts, out_file] = pspm_find_valid_fixations(fn, options)`

5.10.2 Setup

This test class is parameterised. The test data is generated by the function itself and when needed, files will be written to `testdatafile<variable_nr>.mat`.

Test parameters These are parameters which define what kind of data should be passed to `pspm_find_valid_fixations` and which options should be set.

Distance	Used for gaze validation; defines the distance between eyes and screen.
Aspect used	Used for gaze validation; defines the aspect ratio set in the software.
Aspect actual	Used for gaze validation; defines the aspect ratio of the hardware.
Screen size	Used for gaze validation; defines the size of the screen in inches.
Eyes	Is used for data generation and tells the function for which eyes data should be generated.
Channel action	Defines whether to 'add' or 'replace' existing channels.
Newfile	Defines whether to create a new file or extend the existing file.
Overwrite	Defines whether to overwrite the existing file or not.
Interpolate	Defines whether to interpolate NaN values in validated channels or not.
Missing	Defines whether to create a channel which holds information about which positions have been set to NaN (and may have been interpolated afterwards).
Work eye	Defines which eyes should be used for fixation validation.
Work chans	Defines which channels should be set to NaN during invalid fixations.

5.10.3 Testcases

Invalid input

Function name `invalid_input(this)`

Description Checks for warnings, if the input arguments are invalid.

Tests

Input	Expected warning
<code>pspm_find_valid_fixations()</code>	ID:invalid_input
<code>pspm_find_valid_fixations('a')</code>	ID:invalid_input
<code>pspm_find_valid_fixations(fn, options) [invalid options.validate_fixations]</code>	ID:invalid_input
<code>pspm_find_valid_fixations(fn, options) [invalid options.box_degree]</code>	ID:invalid_input
<code>pspm_find_valid_fixations(fn, options) [invalid options.screen_settings]</code>	ID:invalid_input
<code>pspm_find_valid_fixations(fn, options) [missing fields for options.screen_settings]</code>	ID:invalid_input
<code>pspm_find_valid_fixations(fn, options) [invalid options.aspect_actual]</code>	ID:invalid_input
<code>pspm_find_valid_fixations(fn, options) [invalid options.aspect_used]</code>	ID:invalid_input
<code>pspm_find_valid_fixations(fn, options) [invalid options.bitmap]</code>	ID:invalid_input
<code>pspm_find_valid_fixations(fn, options) [invalid options.display_size]</code>	ID:invalid_input
<code>pspm_find_valid_fixations(fn, options) [invalid options.display_size]</code>	ID:invalid_input
<code>pspm_find_valid_fixations(fn, options) [invalid options.fixation_point]</code>	ID:invalid_input
<code>pspm_find_valid_fixations(fn, options) [invalid options.channel_action]</code>	ID:invalid_input
<code>pspm_find_valid_fixations(fn, options) [invalid options.newfile]</code>	ID:invalid_input
<code>pspm_find_valid_fixations(fn, options) [invalid options.overwrite]</code>	ID:invalid_input
<code>pspm_find_valid_fixations(fn, options) [invalid options.interpolate]</code>	ID:invalid_input
<code>pspm_find_valid_fixations(fn, options) [invalid options.missing]</code>	ID:invalid_input
<code>pspm_find_valid_fixations(fn, options) [invalid eyes]</code>	ID:invalid_input
<code>pspm_find_valid_fixations(fn, options) [invalid options.channels]</code>	ID:invalid_input

Test work chans

Function name test_work_chans(this, work_chans)

Description Tests whether the option 'channels' actually works on the specified channels or not.

Tests

1. Generate data with
 - distance** 500
 - aspect_used** 16:9
 - aspect_actual** 4:3
 - screen_size** 20
 - eyes** 'lr'
2. Set options with
 - overwrite** 1
 - channels** work_chans
 - channel_action** 'add'
3. Test if function runs through without warning
4. Test if sts==1
5. Test if specified work_chans are added as new processed channels

Test work eye

Function name test_work_eye(this, work_eye)

Description Test whether the option 'eyes' actually works on the specified eyes or not.

Tests

1. Generate data with
 - distance** 500
 - aspect_used** 16:9
 - aspect_actual** 4:3
 - screen_size** 20

eyes 'lr'

2. Set options with

overwrite 1

eyes work_eye

channel_action 'add'

3. Test if function runs through without warning
4. Test if sts==1
5. Test if specified eyes have been processed accordingly and test if not specified eyes have ignored.

Test missing

Function name test_missing(this, missing)

Description Test whether for each a a new missing channel is created if missing is specified as true.

Tests

1. Generate data with

distance 500

aspect_used 16:9

aspect_actual 4:3

screen_size 20

eyes 'lr'

2. Set options with

overwrite 1

missing missing

channel_action 'add'

3. Test if function runs through without warning
4. Test if sts==1
5. Depending on the status of 'missing', test if there are any missing channels or if there is no missing channel

Test interpolate

Function name test_interpolate(this, interpolate)

Description Test whether data is interpolated during periods which are set to NaN by the function.

Tests

1. Generate data with

distance 500
aspect_used 16:9
aspect_actual 4:3
screen_size 20
eyes 'lr'

2. Set options with

overwrite 1
interpolate interpolate
channel_action 'add'

3. Test if function runs through without warning
4. Test if sts==1
5. Depending on the status of 'interpolate' test whether there are some NaN values or if NaN periods have been interpolated accordingly.

Test overwrite

Function name test_overwrite(this, overwrite)

Description Test if files are overwritten, if specified with 'overwrite' option.

Tests

1. Generate data with

distance 500
aspect_used 16:9
aspect_actual 4:3
screen_size 20

eyes 'lr'

2. Set options with

overwrite 1
interpolate interpolate
channel_action 'add'

3. Test if function runs through without warning
4. Test if sts==1
5. Test if file has been overwritten or not (tests, if there are any new channels).

Test channel action

Function name test_channel_action(this, channel_action)

Description Test if channels are added or replaced (according to channel_action).

Tests

1. Generate data with

distance 500
aspect_used 16:9
aspect_actual 4:3
screen_size 20
eyes 'lr'

2. Set options with

overwrite 1
channel_action channel_action

3. Test if function runs through without warning
4. Test if sts==1
5. Test if channels have been added or replaced (tests, if there are any new channels).

Test newfile

Function name test_newfile(this, newfile)

Description Test whether the output is written to a newfile or to the input file.

Tests

1. Generate data with

```
distance 500
aspect_used 16:9
aspect_actual 4:3
screen_size 20
eyes 'lr'
```

2. Set options with

- (a) overwrite = 1
- (b) if newfile enabled
 - i. search for new file name
 - ii. set options.newfile to new file name
- (c) if newfile is disabled, set options.newfile to ''

3. Test if function runs through without warning

4. Test if sts==1

5. Test if returned outputfile equals the specified newfile or not (depending on the value of 'newfile')

Test gaze validation

Function name test_gaze_validation(this, distance, screen_size, aspect_actual, aspect_used, eyes)

Description Test whether gaze validation is done correctly.

Tests

1. Generate data with the according function parameters

2. Iterate to returned degree values generated by the generation function

- (a) set function options
 - i. overrewrite = 1
 - ii. validate_fixation =1
 - iii. screen_settings and distance to function call settings

- iv. missing = 1
- (b) depending on the specified degree, test whether function runs through without warnings or not
- (c) load outputfile and test if (according to degree expectation) gaze validation has been done or not

Test bitmap validation

Function name test_bitmap_validation(this, distance, resolution, eyes)

Description Test whether bitmap validation is done correctly.

Tests

1. Generate data with the according function parameters
2. Iterate to returned bitmaps generated by the generation function
 - (a) Set function options

missing 1
 - (b) Depending on the specified number of valid fixations in the bitmap, test whether function runs through without warnings or not.
 - (c) Load outputfile and test if (according to bitmap expectation) bitmap validation has been done or not.

5.11 pspm_gaze_pp

5.11.1 Overview

Testclass pspm_gaze_pp_test

Function pspm_gaze_pp preprocesses gaze signals, gaze x and gaze y channels at % the same time.

5.11.2 Testcases

Invalid input

Function name invalid_input(this).

Description Check if the input is valid.

Tests

1. Test if input as a number is invalid.
2. Test if input as a string is invalid.
3. Test if combining two identical channels is invalid.
4. Test if combining an invalid channel is invalid.

Preprocessed channel

Function name `preprocessed_channel(this).`

Description Check if preprocessing a single channel is successful.

Tests

1. Test if gaze_x_r can be pre-processed successfully.
2. Test if gaze_x_l can be pre-processed successfully.
3. Test if gaze_y_r can be pre-processed successfully.
4. Test if gaze_y_l can be pre-processed successfully.

Check upsampling rate

Function name `upsampling_rate(this)`

Description Check the upsampling rate after gaze_pp.

Check channel combining

Function name `channel_combining(this).`

Description Test if combining two appropriate channels is successful.

Tests

1. Test if combining gaze_x_r and gaze_x_l is successful.
2. Test if combining gaze_y_r and gaze_y_l is successful.

5.12 pspm_get_ecg

5.12.1 Overview

Testclass pspm_get_ecg_test

Function [sts, data] = pspm_get_ecg(import)

5.12.2 Testcases

Test

Function name test(this).

Description Test if all fields are returned correctly.

Tests

1. Test if sts==1.
2. Test if data.data is equal to import.data.
3. Test if data.header.chantype is 'ecg'.
4. Test if data.header.units is equal to import.units.
5. Test if data.header.sr is equal to import.sr.

5.13 pspm_get_events

5.13.1 Overview

Testclass pspm_get_events_test

Function [sts, import] = pspm_get_events(import)

5.13.2 Testcases

Check warnings

Function name check_warnings(this)

Description Checks for warnings, if the field '.markers' is missing or contains invalid content.

	Input	Expected warning
Tests	Missing marker field	ID:nonexistent_field
	import.marker = 'foo'	ID:invalid_field_content

Timestamps

Function name timestamps(this)

Description Checks for correct output if the input is timestamp data.

Tests

1. Test if sts==1.
2. Test if the length of the output data is equal to the length of the input data.

Continuous

Function name continuous(this)

Description Checks for correct output if the input is continuous data.

Tests

1. Perform three tests with different settings

Tests:

- (a) Test if sts==1.
- (b) Test if the length of the field 'markerinfo' is equal to the length of the output data.
- (c) Test if the length of the output data is equal to the expected number of pulses in the input data.

Settings

- (a) flank='both' (default)
- (b) flank='both' & data_offset=50
- (c) flank='ascending'
- (d) flank='descending'
- (e) inverted input signal
- (f) signal with angular flanks
- (g) check with

2. Additional test for setting (b): Test if data offset has been removed in the output data.
3. Additional test for setting (c) and (d): Test if positions returned by output data correspond to flank changes in the input data.
4. Test if markerinfo is not set if it has been set before.

5.14 pspm_get_eyelink

5.14.1 Overview

Testclass pspm_get_eyelink_test

Function [sts, data] = pspm_get_eyelink(import)

5.14.2 Methods

Set import values

Function [import_struct, channel_types] = set_import_values(this)

Description Helperfunction, which creates an import data set and the expected channel data set

Verify basic data structure

Function name verify_basic_data_structure(this, data, sourceinfo, channel_types)

Description Tests if the returned data structure is valid and match a given expected pattern.

Tests

1. Test if all channels are numeric
2. Test if recorded time and date have a valid format
3. Test if blink channels have correct unit
4. Test if pupil channels have either 'diameter' or 'area' as unit
5. Test if channels labeled with 'position' have unit 'pixel'
6. Test if channels labeled with 'blink' have unit 'blink'

5.14.3 Testcases

test_multi_session

Function name test_multi_session(this)

Description Test if the returned data structure fits into the pattern of a multi session data set.

Tests

1. Calls 'set_import_values(this)' to get import data set and expected channel data set.
2. passes returned sets to 'verify_basic_data_structure()'.

test_two_eyes

Function name test_two_eyes(this)

Description Test if the returned data structure fits into the pattern of a two eyes data set.

Tests

1. Calls 'set_import_values(this)' to get import data set and expected channel data set.
2. Passes returned sets to 'verify_basic_data_structure()'.

test_one_eye

Function name test_one_eye(this)

Description Test if the returned data structure fits into the pattern of a one eye data set.

Tests

1. Create an import data set and the expected channel data set and pass it to 'verify_basic_data_structure()'.

test_track_dist

Function name test_track_dist(this)

Description Test if the returned data structure fits into the pattern of a two eyes data with eyelink_trackdist set.

Tests

1. Call 'set_import_values(this)' to get import data set and expected channel data set.
2. Overwrite some import data and channel data.
3. Pass returned sets to 'verify_basic_data_structure()'.

5.15 pspm_get_hb

5.15.1 Overview

Testclass pspm_get_hb_test

Format [sts, data] = pspm_get_hb(import)

5.15.2 Testcases

Test

Function name test(this)

Description Test if all fields are returned correctly.

Tests

1. Test if sts==1.
2. Test if data.data is equal import.data
3. Test if data.header.chantype is 'hb'
4. Test if data.header.units is 'events'
5. Test if data.header.sr==1

5.16 pspm_get_hr

5.16.1 Overview

Testclass pspm_get_hr_test

Function [sts, data] = pspm_get_hr(import)

5.16.2 Testcases

Test

Function name test(this)

Description Test if all fields are returned correctly.

Tests

1. Test if sts==1.
2. Test if data.data is equal import.data
3. Test if data.header.chantype is 'hr'
4. Test if data.header.units is equal import.units
5. Test if data.header.sr is equal import.sr

5.17 pspm_get_marker

5.17.1 Overview

Testclass pspm_get_marker_test

Function [sts, data] = pspm_get_marker(import)

5.17.2 Testcases

Test

Function name test(this)

Description Test if all fields are returned correctly.

Tests

1. Test if sts==1.
2. Test if data.data is equal to import.data.
3. Test if data.header.chantype is 'marker'.
4. Test if data.header.units is 'events'.
5. Test if data.header.sr==1.

5.18 pspm_get_pupil

5.18.1 Overview

Testclass pspm_get_pupil_test

Function [sts, data] = pspm_get_pupil(import)

5.18.2 Testcases

Test

Function name test(this)

Description Test if all fields are returned correctly

Tests

1. Test if sts==1.
2. Test if data.data is equal import.data
3. Test if data.header.chantype is 'pupil'
4. Test if data.header.units is equal to import.units
5. Test if data.header.sr is equal import.sr

5.19 pspm_get_resp

5.19.1 Overview

Testclass pspm_get_resp_test

Function [sts, data] = pspm_get_resp(import)

5.19.2 Testcases

Test

Function name test(this)

Description Test if all fields are returned correctly

Tests

1. Test if sts==1
2. Test if data.data is equal import.data
3. Test if data.header.chantype is 'resp'
4. Test if data.header.units is equal import.units
5. Test if data.header.sr is equal import.sr

5.20 pspm_get_scr

5.20.1 Overview

Testclass pspm_get_scr_test

Function [sts, data] = pspm_get_scr(import)

5.20.2 Testcases

There are three test functions. One for the case that no transfer parameters are defined, one for the case that the transfer parameters are defined in a struct and one for the case that they are defined in a .mat file. They are all performing the following tests, plus eventually some individual tests.

Tests

1. Test if sts==1
2. Test if the field data.data exists
3. Test if the field data.data is not empty
4. Test if the field data.header.units exists
5. Test if the field data.header.sr exists
6. Test if the field data.header.chantype exists
7. Test if data.header.sr is equal to import.sr
8. Test if data.header.chantype is 'scr'

No transfer parameters

Function name no_transferparams(testCase)

Description Test if all fields are returned correctly, if no transfer parameters are defined.

Additional Tests No additional tests

Struct transfer parameters

Function name stuct_transferparams(testCase)

Description Test if all fields are returned correctly, if the transfer parameters are defined in a struct.

Additional Tests

1. Check for warning if the conversion constant (`import.transfer.c`) is not defined
2. Checks that there are no warnings if `import.transfer.Rs` or `import.transfer.offset` is not defined.

File transfer parameters

Function name `file_transferparams(testCase)`

Description Test if all fields are returned correctly, if the transfer parameters are defined in a `.mat` file.

Additional Tests

1. Check for warning if the transfer parameter file doesn't exist.

5.21 pspm_get_timing

5.21.1 Overview

Testclass `pspm_get_timing_test`

Functions

- `[sts, multi] = pspm_get_timing('onsets', intiming, timeunits)`
- `[sts, events] = pspm_get_timing('markervalues', markerinfo, names)`
- `[sts, epochs] = pspm_get_timing('epochs', epochs)`
- `[sts, events] = pspm_get_timing('events', events)`

5.21.2 Testcases

Invalid input arguments

Function name `invalid_inputargs(this)`

Description Checks for warnings, if the input arguments are invalid.

Tests	
Input	Expected warning
<code>pspm_get_timing('epochs')</code> [missing input var]	ID:invalid_input
<code>pspm_get_timing('onsets', 'str')</code> [no timeunits var]	ID:invalid_input
<code>pspm_get_timing('foo')</code> [unknown format]	ID:invalid_input
<code>pspm_get_timing('onsets', intiming, 'samples')</code> [two sessions with nonmatching number of conditions]	ID:number_of_elements_dont_match
<code>pspm_get_timing('onsets', intiming, 'samples')</code> [two sessions with nonmatching condition names]	ID:event_names_dont_match
<code>pspm_get_timing('onsets', intiming, 'samples')</code> [intiming.onsets{1} is no numeric vector]	ID:no_numeric_vector
<code>pspm_get_timing('epochs', fn_mat, 'samples')</code> [epochs is not an integer array]	ID:no_integers
<code>pspm_get_timing('markervalues', markerinfo)</code> [no markervalue and no name]	ID:invalid_input
<code>pspm_get_timing('markervalues', markerinfo, markervalue, names)</code> [markervalue is not of numeric type nor a cell array]	ID:invalid_input
<code>pspm_get_timing('markervalues', markerinfo, markervalue, names)</code> [markervalue and names are not of the same length]	ID:invalid_input

Case Epochs

Function name case_epochs(this)

Description Checks the function in 'epochs' mode.

Function [sts, epochs] = pspm_get_timing('epochs', epochs)

Test 1 (matfile input)

Input mat file with variable: epochs = [1 4; 2 5; 3 6]
Check if sts==1 and if the return value is equal the input array.

Test 2 (spm input)

Input mat file with variable: onsets{1} = [1 2 3]'; onsets{2} = [4 5 6]';
Check if sts==1 and if the return value is equal [onsets{1}, onsets{2}].

Test 3 (textfile input)

Input textfile with variable: epochs = [1 4; 2 5; 3 6]
Check if sts==1 and if the return value is equal the input array.

Test 4 (matrix input)

Input matrix: epochs = [1 4; 2 5; 3 6]
Check if sts==1 and if the return value is equal the input array.

Case onsets

Function name case_onsets(this)

Description Checks the function in 'onsets' mode.

Function [sts, multi] = pspm_get_timing('onsets', intiming, timeunits)

Test 1

Input A .mat file with the following variables

- names = {'name1', 'name2'};
- onsets = {[1 2], [3 4]};
- pmod.name = {'name3', 'name4'};
- pmod.param = {[2 3], [4 5]};
- pmod.poly = {2, 2};
- save(fn_mat, 'names', 'onsets', 'pmod');

Function call [sts, outtiming] = pspm_get_timing('onsets', fn_mat, 'samples');

Tests Check if sts==1, if onsets and names are unchanged and if outtiming.pmod.param == {[2 3], [4 9], [4 5], [16 25]}

Test 2

Input A .mat file with the variables

- names = {'name1', 'name2'};
- onsets = {[1 2 3], [3 4 5]}; durations = {[3 4 5]', [5 6 7]'};
- pmod.name = {'name3', 'name4'};
- pmod.param = {[2 3 4], [4 5 6]};
- pmod.poly = {2, 1};

Function call [sts, outtiming] = pspm_get_timing('onsets', fn_mat, 'samples');

Tests Check if sts==1, if onsets, names and durations are unchanged and if outtiming.pmod.param == {[2 3 4], [4 9 16], [4 5 6]}.

Case events

Function name case_events(this)

Description Checks the function in 'events' mode.

Function [sts, epochs] = pspm_get_timing('events', events)

Check the function if input is a one element cell array and a multiple element cell array.

Check for warnings (ID:invalid_vector_size) if elements have more than two columns and if not all elements have the same number of rows.

5.22 pspm_get_<datatype>

5.22.1 Overview

The datatype import functions are all tested in a similar way. The individual testclasses must inherit the class 'pspm_get_superclass', from which they inherit the main test function 'valid_datafile'. They also have to implement the property 'fhandle', which is a function handle to the specific import function.

The tests are performed with the sampledata files that are listed in the SampleDataMasterList.docx file (as at 18.11.2013).

Superclass pspm_get_superclass

Testclasses

- `pspm_get_acq_test`
- `pspm_get_acqmat_test`
- `pspm_get_biograph_test`
- `pspm_get_biosemi_test`
- `pspm_get_biotrace_test`
- `pspm_get_brainvis_test`
- `pspm_get_edf`
- `pspm_get_labchartmat_ext_test`
- `pspm_get_labchartmat_in_test`
- `pspm_get_mat_test`
- `pspm_get_obs_test`
- `pspm_get_smr_test`
- `pspm_get_smr_x_test`
- `pspm_get_superclass`
- `pspm_get_txt_test`
- `pspm_get_vario_test`
- `pspm_get_eyelink_test`

Function `[sts, import, sourceinfo] = pspm_get_<datatype>(datafile, import)`

5.22.2 Notes

5.22.3 Setup

Define testcases In this method the testcases are defined and the testdata is generated (if needed). Each testcase is a cell in the cellarray 'testcases'. Each testcase has the following fields:

- `.pth`: the path to the samplefile
- `.import`: the input variable

For datatypes which support blocks there has to be an additional field:

- `.numofblocks`

5.22.4 Testcases

Valid datafile

Function name `valid_datafile(this)`

Description The main test function, for tests with valid inputdata. It tests all testcases equally.

Tests

1. Test if `sts==1`.
2. If the datatype supports blocks, test if the number of blocks is correct.
3. Test if number of elements of the returned 'import' variable is correct.
4. Test if each importjob has a field 'data', that is a numeric vector.
5. Test if each importjob has a field 'sr', that is a number.
6. Test if each importjob has a field 'type'.
7. Test if all event importjobs have a field 'marker'.
8. Test if all importjobs have duration below 1h.
9. Test if all importjobs have a samplerate between 1 and 10000 for continuous channels or between 10^{-6} and 1 for timestamp channels.

Invalid datafile

Function name `invalid_datafile(this)`

Description The main test function, for tests with invalid inputdata.

Tests If the datatype supports multiple channels: Check for warning when trying to import a channel, that is not contained in the file ('ID:channel_not_contained_in_file').

5.23 pspm_get_acq

In this section we describe the testcases specific to `pspm_get_acq` apart from generic `pspm_get` tests.

5.23.1 Overview

Testclass `pspm_get_acq_test`

Function `[tss, import, sourceinfo] = pspm_get_acq(datafile, import)`

5.23.2 Testcases

get_acq should return the exact same data as Acqknowledge exported mat file

Function `get_acq_returns_same_data_as_acqknowledge_exported_mat(this)`

Description The data obtained by using `pspm_get_acq` should be identical with the data obtained by using `export .mat` file functionality in Acqknowledge software.

Steps

1. Load data stored in `ImportTestData/acq/impedance_acq.acq` and `ImportTestData/acq/impedance_mat.mat` separately.
2. Compare the first channel of `impedance_mat` with the first channel of data obtained by calling `pspm_get_acq` on `impedance_acq`.

5.24 pspm_glm

5.24.1 Overview

Testclass `pspm_glm_test`

Function `glm = pspm_glm(model, options)`

There are seven testcase functions. One invalid input arguments test and test 1 to 6. Tests 1 to 5 are of the same kind. There are one or multiple testcases per test function, have a look at the testcase description for more information. In these tests only Kronecker delta functions are used as basis functions, furthermore all conditions, pmods and nuisance regressors are pairwise orthogonal. The data is also not down sampled and not filtered. With these limitations it's easy to calculate the data vectors and the expected stats. For each testcase it is then tested:

- If `numel(glm.names)` has the expected value.
- If `numel(glm.stats)` has the expected value.
- If `glm.stats` has the expected value (with a tolerance of 1%).

In test 6 the default basis functions are used, and not all conditions and pmods are orthogonal. The data is down sampled and low and high pass filtered. In exchange the stats are not tested for correct values, just for the correct number of elements. The properties `'shiftbf'` and `'norm'` are `TestParameters`, which means that this testclass is parameterised. All functions implementing these parameters (Test 1 to Test 5) are called several times with all the different values and combinations of the mentioned parameters.

5.24.2 Testcases

Invalid input arguments

Function name `invalid_input (this)`

Description Checks for warnings, if the input arguments are invalid.

Tests

Input	Expected warning
<code>pspm_glm(model)</code> [no timeunits field]	ID:invalid_input
<code>pspm_glm(model)</code> [no timeunits var]	ID:invalid_input
<code>pspm_glm(model)</code> with <code>model.timeunits = 'foo'</code> [no valid timeunits field]	ID:invalid_input
<code>pspm_glm(model)</code> with <code>model.timing = zeros(10,2)</code> [no valid timing field]	ID:invalid_input
<code>pspm_glm(model)</code> with <code>model.modality = 'foo'</code> [no valid modality field]	ID:invalid_input
<code>pspm_glm(model)</code> with <code>model.channel = 'scr'</code> [no valid channel field]	ID:invalid_input
<code>pspm_glm(model)</code> with <code>model.norm = 'no'</code> [no valid norm field]	ID:invalid_input
<code>pspm_glm(model)</code> with <code>model.filt.down = 'none'</code> [filt.down is not numeric]	ID:invalid_input
<code>pspm_glm(model)</code> with <code>model.bf.fhandle = 'foohandle'</code> [non existing bf]	ID:invalid_fhandle
<code>pspm_glm(model)</code> with <code>numel(model.datafile) != numel(model.timing)</code>	ID:number_of_elements_dont_match
<code>pspm_glm(model)</code> with <code>model.missing</code> is struct [non valid missing field]	ID:invalid_input
<code>pspm_glm(model)</code> with <code>numel(model.datafile) != numel(model.missing)</code>	ID:number_of_elements_dont_match
<code>pspm_glm(model)</code> with <code>model.nuisance</code> is struct [non valid nuisance field]	ID:invalid_input
<code>pspm_glm(model)</code> with <code>numel(model.datafile) != numel(model.nuisance)</code>	ID:number_of_elements_dont_match
<code>pspm_glm(model)</code> with no R variable in the nuisance file	ID:invalid_input
<code>pspm_glm(model)</code> with R variable in the nuisance file that has not the same length as the datafile	ID:number_of_elements_dont_match

Test 1

Format `test1(this, shiftbf)`

Description Basic test with one basis function, one session, no nuisance regressors, no missings and one condition. Timeunits are seconds.

Testcases

1. no pmods

2. one pmod
3. two pmods

Test 2

Format test2(this, shiftbf)

Description Test with one basis function, one session, no nuisance regressors, no missings and two conditions. Timeunits are seconds.

Testcases

1. no pmods
2. first condition: no pmods; second condition: one pmod
3. first condition: one pmod; second condition: two pmods

Test 3

Format test3(this, shiftbf)

Description Test with one basis function, one session, two nuisance regressors (1Hz cosinus, 1Hz sinus), no missings, one condition and no pmods. Timeunits are seconds.

Testcases Only one testcase.

Test 4

Format test4(this, shiftbf)

Description Test with one basis function, two sessions, no nuisance regressors, no missings and one condition.

Testcases

1. timeunits are seconds
2. timeunits are samples
3. timeunits are markers

Test 5

Format test5(this, shiftbf)

Description Test with two basis functions, one session, no nuisance regressors and one condition. Timeunits are seconds.

Testcases

1. no missings
2. with missings

Test 6

Format test6(this)

Description Test with default basis function and non-orthogonal conditions and pmods.

Testcase Default basis functions, no nuisance regressors, no missings, two sessions and two conditions. Timeunits are seconds.

- first condition: two pmods (with $\text{pmod}(1).\text{poly}\{1\} = 2$ and $\text{pmod}(1).\text{poly}\{2\} = 3$)
- second condition: no pmods

Test 7

Format test_extract_missing(this, cutoff, nan_percent)

Description Test with one basis function, one session, no nuisance regressors, no missings and three conditions. Timeunits are seconds.

Testcases for all combinations of the test parameters cutoff and nan_percent.

- glm vector stats_missing has the appropriate length according to the number of conditions.
- percentages in glm vector stats_missing contains the expected value.
- glm vector stats_exclude has the appropriate length according to the number of conditions.
- glm vector stats_exclude contains the expected condition which should be excluded.

5.25 pspm_hb2hp

5.25.1 Overview

Testclass pspm_hb2hp_test

Function [sts, infos] = pspm_hb2hp(fn, sr, chan, options)

5.25.2 Testcases

Invalid input

Function name `invalid_input(this)`

Description Checks for warnings, if the input arguments are invalid.

Tests

Input	Expected warning
<code>pspm_hb2hp()</code> [no input]	ID:invalid_input
<code>pspm_hb2hp(2)</code> [not a string filename]	ID:invalid_input
<code>pspm_hb2hp('abc')</code> [no sample rate]	ID:invalid_input
<code>pspm_hb2hp('abc','abc')</code> [not a string sample rate]	ID:invalid_input
<code>pspm_hb2hp('abc',2,'abc')</code> [not a numeric channel]	ID:invalid_input
<code>pspm_hb2hp(files{1},100)</code> [call of <code>pspm_load_data</code> fails]	ID:invalid_input
<code>pspm_hb2hp(files{2}, 100)</code> [not enough points for <code>interp1</code>]	ID:too_strict_limits
<code>pspm_hb2hp(files{3},100,[],options)</code> [<code>pspm_write_channel</code> fails]	ID:invalid_input

5.26 pspm_import

5.26.1 Overview

Testclass `pspm_import_test`

Function `outfile = pspm_import(datafile, datatype, import, options)`

5.26.2 Testcases

Invalid input arguments

Function name `invalid_inputargs(this)`

Description Checks for warnings, if the input arguments are invalid.

Tests

Test No.	Input	Expected warning
1	pspm_import(datafile, datatype) [no import variable]	ID:invalid_input
2	pspm_import(datafile, datatype, 'foo') [no cell/struct import var.]	ID:invalid_input
3	pspm_import(datafile, 'foo', import) [invalid channeltype]	ID:invalid_channeltype
4	pspm_import(5, datatype, import) [no char filename]	ID:invalid_input

Invalid import variable structure

Function name invalid_import_struct(this)

Description Checks for warnings, if the structure of the import variable is invalid.
Tests

Test No.	Input	Expected warning
1	Multiple channel, though not supported	ID:invalid_import_struct
2	Not allowed channeltype	ID:invalid_import_struct
3	No sr given, though autosr is not supported	ID:invalid_import_struct
4	Nonexistent file	ID:nonexistent_file

One datafile

Function name one_datafile(this)

Description Checks the function, if datafile is a string (import of one datafile) and all inputs are correct. The outfile is checked with the pspm_load_data function. The tests are performed with a spike samplefile and a labchartmat_in samplefile (to check the handling of blocks).

Multiple datafiles

Function name multiple_datafiles(this)

Description Checks the function, if datafile is a cell array of strings (import of multiple datafiles) and all inputs are correct. The outfiles are tested with the pspm_load_data function.

5.27 pspm_interpolate

5.27.1 Overview

Testclass pspm_interpolate_test

Function [sts, outdata] = pspm_interpolate(indata, options)

5.27.2 Setup

This test class is parameterised. The test data is generated by the function itself and when needed, files will be written to datafile<variable_nr>.mat.

Test parameters These are parameters which define what kind of data should be passed to pspm_interpolate and which options should be set.

Amount	Specifies how many elements in data (for <code>pspm_interpolate</code>) should have.
Datatype	Specifies what type of data should be generated. struct a valid data struct will be generated inline a numeric vector will be generated file a valid scr file will be generated all all types will sequentially be generated until amount is reached
Chans	If datatype is not inline this specifies how many and which type of data channels the generated data should have. In a second field it also defines which of these channels should be interpolated (this will be passed later in <code>options.channels</code>).
Nan method	Specifies how NaN values will be put into the data. start range is 1+offset:<random number before the center> center range is <radnom number before the center>:<random number after the center> end range is <random number after the center>:end-offset The offset is 1 if 'extrap' is not defined. This is needed because if there is no data at the end or beginning of the data, the function is unable to interpolate (unless extrapolation is activated).
Extrap	Is either true or false and activates or deactivates the extrapolation.
Interp method	Specifies the interpolation method.
Newfile	True or false and tells the function to either create a file or add the data as new channel.
Overwrite	True or false and tells the function to either overwrite an existing file or not.
Replace channel	True or false and tells the function to either replace the given channels with the interpolated data or to add the interpolated data as new channel.

5.27.3 Testcases

Invalid input

Function name `invalid_input(this)`

Description Checks for warnings, if the input arguments are invalid.

Tests

Test No.	Input	Expected warning
1	pspm_interpolate() [no arguments]	ID:missing_data
2	pspm_interpolate({{}}) [data is not char, struct, numeric]	ID:invalid_input
3	pspm_interpolate({}) [data empty]	ID:missing_data
4	pspm_interpolate(struct()) [invalid struct]	ID:invalid_data_structure
5	pspm_interpolate(invalid_data) [file which does not exist]	ID:nonexistent_file
6	pspm_interpolate(valid_data, options) [options.channels is larger than valid_data]	ID:invalid_input
7	pspm_interpolate(valid_data, options) [options.channels is not numeric]	ID:invalid_input
8	pspm_interpolate(valid_data, options) [options.method is invalid]	ID:invalid_input
9	pspm_interpolate(valid_data, options) [options.newfile is invalid]	ID:invalid_input
10	pspm_interpolate(valid_data, options) [options.extrapolate is invalid]	ID:invalid_input
11	pspm_interpolate(valid_data, options) [options.overwrite is invalid]	ID:invalid_input
12	pspm_interpolate(valid_data, options) [options.replace_channels is invalid]	ID:invalid_input
13	pspm_interpolate(invalid_data, options) [try to interpolate an events channel]	ID:invalid_channeltype
14	pspm_interpolate(invalid_data) [try to interpolate with nan from beginning and without extrapolation]	ID:option_disabled
15	pspm_interpolate(invalid_data, options) [try to interpolate with nan from beginning and with extrapolation]	ID:out_of_range
16	pspm_interpolate(invalid_data) [try to interpolate with nan from end and without extrapolation]	ID:option_disabled
17	pspm_interpolate(invalid_data, options) [try to interpolate with nan from end and with extrapolation]	ID:out_of_range

Test datatypes

Function name `test_datatypes(this, datatype, amount, chans)`

Description Tries to interpolate with different datatypes, amount of data, channels.

Steps

1. Generate data with datatype, amount, 'center', chans, false
2. Test if function issues no warnings
3. Test if `sts==1`
4. Test if size of outdata equals the size of the data
5. Test if channels to be interpolated have no more NaNs
6. Test if channels not to be interpolated still contain NaNs

Test interpolation variations

Function name `test_interpolation_variations(this, interp_method, extrapol, nan_method)`

Description Tries to interpolate with different interpolation methods while varying options.`extrapolate` and the `nan_method`.

Tests

1. Generate data with 'inline', 1, nan_method, {{'scr'}, []}, extrapol
2. Test if function issues no warnings
3. Test if `sts==1`
4. Test if size of outdata equals the size of the data
5. Test if data has no more NaNs

Special case When extrapolation is on and `nan_method` is 'start' and `interp_method` is 'previous' or `nan_method` is 'end' and `interp_method` is 'next'. This should issue a warning because this is not possible (e.g. interpolate with previous value when first NaN is at the beginning of the data set).

1. Generate data as above
2. Test if function issues a warning.

Test no nan

Function name test_no_nan(this)

Description Test whether function works even if there is nothing to interpolate.

Tests

1. Generate data struct() with pspm_test_data_gen()
2. Test if function issues no warnings
3. Test if sts==1
4. Test if size of outdata equals the size of data
5. Test if outdata equals data
6. Test if data has no NaNs

Test write

Function name test_write(this, newfile)

Description Vary the option newfile and test whether new file is created correctly or data is correctly added to a new channel.

Tests

1. Generate data with 'file', 2, 'center', {'scr', 'scr', 'scr'}, [1,3], false
2. Test if function issues no warnings
3. Test if sts==1
4. Test if size of outdata equals the size of data
5. Test if outdata does not equal data

New files only

1. Test if new file exists
2. Load old and new file and test if size of data is equal
3. Verify that interpolated channels in the new file are NaN free

Added to existing file only

1. Test if all returned values are numeric (new channel ids)
2. Verify that the added channels are NaN free
3. Test if added channels match the size of the original data channels

Test overwrite

Function name `test_overwrite(this, overwrite)`

Description Vary overwrite and test whether files are overwritten or not.

Tests

1. Generate data with 'file', 2, 'center', {{'scr', 'scr', 'scr'}, [1,2,3]}, false
2. Create files with expected filenames
3. Test if function issues no warning
4. Test if sts==1
5. According to overwrite test if file has been overwritten or not

Test replace channel

Function name `test_replace_channel(this, replace_channels)`

Description Vary replace_channel and test whether channels are overwritten or not.

Tests

1. Generate data with 'file', 2, 'center', {{'scr', 'scr', 'scr'}, [1,2,3]}, false
2. Test if function issues no warnings
3. Test if sts==1
4. Test if size of outdata equals the size of data
5. Test if outdata does not equal data
6. According to replace_channel test whether returned channel ids correspond to replaced channels or correspond to added channels.

5.27.4 Other methods

Generate data

Has all of the Test parameters as parameter implemented and accordingly generates the data. It calls put nan to insert NaN values into the data. The generated data is returned as data to the calling function. Also all return values are stored in the property testdata (for cleanup data).

Cleanup data

Sits in MethodTeardown and is called once the test class has finished all tests. It then removes all the datafiles which can be found in the property 'testdata'.

Verify NaN free

Helper function to verify whether the data is NaN free or not. It copes with two states. Either a channel should have been interpolated, then it shouldn't contain any NaN values or a channel should not have been interpolated, then the channel should still contain NaN values.

5.28 pspm_load1

5.28.1 Overview

Testclass pspm_load1_test

Function [sts, data, mdltype] = pspm_load1(fn, action, savedata, options)

5.28.2 Setup

The datafile fn is referring to a datafile which was generated with pspm_load1_test.generate_testdata(this). The function is part of the test object and generates models for all of the available model types (defined in settings.first). The models are created with data generated with pspm_testdata_gen. Two files belong to each model: model_<modeltype><variable_nr>.mat (fn) and dummy_<modeltype><variable_nr> (dfn). The model file on the one hand is the actual model file while on the other hand, the dummy file is a copy of the model file, used by the test to manipulate the test data.

Generated aquisition data (pspm_testdata_gen) data{1}.chantype = 'scr';
data{2}.chantype = 'hb';
The duration of the channels is 100s.

Generated GLM model model.timing{1}.names = {'a';'b';'c'};
model.timing{1}.onsets = {[10, 20, 30], [15, 25, 35], [18, 28, 38]};

Generated DCM & SF model model.timing{1} = [10,20; 23,38; 40,70];
model.condition{1}.name = {'a';'b'};
model.condition{1}.index = [1;2];

5.28.3 Testcases

Invalid model structure (general)

Function `invalid_model_tructure_general(this)`

Description Tries to pass invalid data structures, and tests for certain warnings. Applys to all available modeltypes.

Tests

Input	Expected warning
empty model file	ID:invalid_data_structure
missing field 'modelfile'	ID:invalid_data_structure
missing field 'modeltype'	ID:invalid_data_structure
missing field 'modality'	ID:invalid_data_structure
missing field 'stats'	ID:invalid_data_structure
missing field 'names'	ID:invalid_data_structure

Invalid model structure (specific)

Function `invalid_model_structure_general(this)`

Description Tries to pass invalid data structures, and tests for certain warnings. Model specific.

Tests	for	GLM
Input	Expected warning	
field 'stats' is not an n x 1 vector	ID:invalid_data_structure	
unequal amount of numbers and parameters in field 'stats'	ID:invalid_data_structure	
options.zscored = 1 & action = 'cond'	ID:invalid_input	

Tests	for	DCM	&	SF
Input	Expected warning			
unequal size for fields in 'trlnames' and rows in 'stats'	ID:invalid_data_structure			
missing field 'trlnames'	ID:invalid_data_structure			
unequal size for fields in 'names' and columns in 'stats'	ID:invalid_data_structure			
action = 'recon'	ID:invalid_input			

Tests	for	DCM
Input		Expected warning
options.zscored = 1 & pspm_load1(dfn, 'none', {}, options)		ID:invalid_input
options.zscored = 1 & pspm_load1(dfn, 'cond', {}, options)		-
options.zscored = 1 & pspm_load1(dfn, 'stats', {}, options)		-

Tests	for	GLM	&	SF
Input				Expected warning
options.zscored = 1 & pspm_load1(dfn, 'cond', {}, options)				ID:invalid_input

Action 'none'

Function test_action_none(this)

Description Test for all modeltypes if action 'none' matches the expected behaviour.

Tests

1. Basic function test
2. Test if returned data is empty.

Action 'stats'

Function test_action_stats(this)

Description Test for all modeltypes if action 'stats' matches the expected behaviour.

Tests for all

1. Basic function test
2. Returned data contains field 'stats'
3. Returned data contains field 'names'

Tests for DCM & SF

1. Returned data contains field 'trlnames'
2. Returned data contains field 'condnames'

Action 'cond'

Function test_action_cond(this)

Description Test for all modeltypes if action 'cond' matches the expected behaviour.

Tests for all

1. Basic function test
2. Returned data contains field 'stats'
3. Returned data contains field 'names'

Tests for DCM & SF

1. Returned data contains field 'trlnames'
2. Returned data contains field 'condnames'

Action 'recon'

Function test_action_recon(this)

Description Test for all modeltypes if action 'recon' matches the expected behaviour.

Tests for GLM

1. Basic function test
2. Returned data contains field 'stats'
3. Returned data contains field 'names'

Tests for DCM & SF already done in specific structure test.

Action 'savecon'

Function test_action_savecon(this)

Description Test for all modeltypes if action 'savecon' matches the expected behaviour. Generates a number, passes it within the 'savecon' struct and tests if the number is returned correctly.

Tests

1. Basic function test
2. Returned data contains field 'con'
3. Field 'con' contains field 'test'
4. Field 'con.test' is equal to the randomly generated number

Action 'con'

Function test_action_con(this)

Description Test for all modeltypes if action 'con' matches the expected behaviour. Tests if the in 'savecon' generated field test is still returned.

Tests

1. Basic function test
2. Returned data contains field 'con'
3. Field 'con' contains field 'test'.

Action 'all'

Function test_action_all(this)

Description Test for all modeltypes if action 'all' matches the expected behaviour.

Tests

1. Basic function test
2. Returned data is not empty.

Action 'save'

Function test_action_save(this)

Description Test for all modeltypes if action 'save' matches the expected behaviour. Test with options.overwrite = 1. Generates random number and writes it into field 'test' in model structure.

Tests

1. Basic function test
2. Model structure contains field 'test'
3. Field 'test' in model structure equals to the randomly generated number.

Options

Function test_options(this)

Description Test for all modeltypes if options passed with options structure cause the expected behaviour. Does also work with a randomly generated number in <model struct>.test to test whether the data is written or not.

Tests for all

1. overwrite = 0 returns warning ID:not_saving_data and field 'test' in model struct does not match generated number
2. overwrite = 1 field 'test' in returned model struct does match generated number

Tests for DCM with overwrite = 1

1. zscored = 0 & action = 'stats'
 - (a) Basic function test
 - (b) Returned data.stats is not zscored
2. zscored = 1 & action = 'stats'
 - (a) Basic function test
 - (b) Returned data.stats is zscored
3. zscored = 0 & action = 'cond'
 - (a) Basic function test
 - (b) Returned data is different when calling with zscored = 1 & action = 'cond' (should not zscore, when not specified)

5.28.4 Other methods

Remove testdata Removes all the test data generated by the test class. It is called once the class is finished with testing.

Basic function test Is called in each test after the tested function has been called. It does two checks:

- Returned modeltype matches the modeltype stored in the returned model structure
- Returned status sts==1

5.29 pspm_load_data

Reviewed and updated by Teddy on 19 April 2022

5.29.1 Overview

Testclass pspm_load_data_test

Function [sts, infos, data, filestruct] = pspm_load_data(fn, chan)

5.29.2 Setup

If not otherwise declared, the input variable fn is referring to a datafile which was generated with pspm_testdata_gen and consists out of the following channels:

```
data{1}.chantype 'scr';  
data{2}.chantype 'marker';  
data{3}.chantype 'hr';  
data{4}.chantype 'hb';  
data{5}.chantype 'marker';  
data{6}.chantype 'resp';  
data{7}.chantype 'scr';
```

The duration of the channels is 10s.

5.29.3 Testcases

Invalid input arguments

Function name invalid_inputargs(testCase)

Description Checks for warnings, if the input arguments are invalid.

Tests

#	Issue	Input	Expected warning
1	No filename	/	ID:invalid_input
2	No char filename	1	ID:invalid_input
3	Negative channel number	fn, -1	ID:invalid_input
4	No allowed ch type	fn, 'foobar'	ID:invalid_input
5	Missing field in foo struct	fn, foo	ID:invalid_input
6	Invalid channel option	fn, {1}	ID:invalid_input
7	Struct has no infos field	struct	ID:invalid_input
8	Nonexisting channel	fn, 250	ID:invalid_input

Invalid datafile

Format invalid_datafile(testCase)

Description Checks for warnings, if the datafile is invalid.

Tests

#	Issue	Input	Expected warning
1	non-existent datafile		ID:nonexistent_file
2	missing 'infos' variable		ID:invalid_data_structure
3	missing 'data' variable		ID:invalid_data_structure
4	missing 'data' field in 'data{2}'		ID:invalid_data_structure
5	missing 'header' field 'data{3}'		ID:invalid_data_structure
6	missing 'sr' field in 'data{7}.header'		ID:invalid_data_structure
7	data{4} is a nx2 vector (instead of a nx1 vector)		ID:invalid_data_structure
8	the length of data{1}.data is incompatible with the duration		ID:invalid_data_structure
9	An entry of data{2}.data is larger than 'duration'		ID:invalid_data_structure
10	data{5} has an non-existent chantype ('scanner')		ID:invalid_data_structure
11	duplicates (9) with struct chan input		ID:invalid_data_structure

Return all channels

Function name valid_datafile_0(testCase)

Description Checks the function, if all channels shall be returned (chan = 0).

Return all channels (struct input)

Function name valid_datafile_1(testCase)

Description Checks the function, if all channels shall be returned (chan = 0) and the input is a struct.

Return one channel

Function name valid_datafile_2(testCase)

Description Checks the function, if only one channel shall be returned (chan = 2).

Return multiple channels

Function name valid_datafile_3(testCase)

Description Checks the function, if multiple channels shall be returned (chan = [3 5]).

Return scr channels

Function name valid_datafile_4(testCase)

Description Checks the function, if only the scr channels shall be returned.

Return event channels

Function name valid_datafile_5(testCase)

Description Checks the function, if only the event channels shall be returned.

Save data

Function name valid_datafile_6(testCase)

Description Checks the function, if data is to be saved (chan struct).

5.30 pspm_pp

5.30.1 Overview

Testclass pspm_pp_test

Format newfile = pspm_pp('median', datafile, n, channelnumber) or newfile = pspm_pp('butter', datafile, freq, channelnumber)

5.30.2 Testcases

Invalid input

Format invalid_input(this)

Description Checks for warnings, if the input arguments are invalid.

Tests

#	Issue	Parameters of the function	Expected warning
1	No frequency	'butter', 'file'	ID:invalid_input
2	No valid first argument	'foo', 'file', 100	ID:invalid_input
3	Freq below 20	'butter', 'file', 19	ID:invalid_input

Median test

Function name median_test(this)

Description Checks medianfilter functionality

Setup Testfile with 3 channels (scr, hb, scr).

Tests

1. Filter one channel [Input: newfile = pspm_pp('median', testfile, 50, 3)]
 - i. Check if sts == 1, when data is loaded with pspm_load_data.
 - ii. Check if newfile has the same number of channels as testfile
2. Filter multiple channel [Input: newfile = pspm_pp('median', testfile, 50)]
 - i. Check if sts == 1, when data is loaded with pspm_load_data.
 - ii. Check if newfile has the same number of channels as testfile

Butterworth filter test

Function name butter_test(this)

Description Checks Butterworth filter functionality

Setup Testfile with 3 channels (scr, hb, scr).

Tests

1. Filter one channel [Input: newfile = pspm_pp('butter', testfile, 40, 3)]
 - i. Check if sts == 1, when data is loaded with pspm_load_data.
 - ii. Check if newfile has the same number of channels as testfile
2. Filter multiple channel [Input: newfile = pspm_pp('butter', testfile, 40)]
 - i. Check if sts == 1, when data is loaded with pspm_load_data.
 - ii. Check if newfile has the same number of channels as testfile

5.31 pspm_prepdata

5.31.1 Overview

Testclass pspm_prepdata_test

Function [sts, outdata, newsr] = pspm_prepdata(data, filt)

5.31.2 Testcases

Invalid input

Function name invalid_input(this)

Description

Checks for warnings, if the input arguments are invalid.

Input	Expected warning
pspm_prepdata([1 NaN 3], filt) [NaN values in data]	ID:invalid_input
pspm_prepdata([1 2 3]) [no filt variable]	ID:invalid_input
pspm_prepdata(data, filt) [filt has no horder field]	ID:invalid_input
pspm_prepdata('foo', filt) [no numeric data]	ID:invalid_input
pspm_prepdata(data, filt) [with lpfreq = 'foo' (not valid)]	ID:invalid_input

Tests

Hipassfilter test

Function name hipassfilter_test(this)

Description Checks hipassfilter functionality (without downsampling)

Setup

```
data rand(1000,1)
filt.sr 100
filt.lpfreq 'none'
filt.lporder 1
filt.hpfreq 20
filt.hporder 1
filt.down 'none'
```

Tests

1. Unidirectional tests [**filt.direction** = 'uni']
 - i. Check if **sts** == 1
 - ii. Check if **newsr** == **filt.sr**
 - iii. Check if **outdata** is empty
 - iv. Check if **length(outdata)** == **length(data)**
2. Unidirectional tests [**filt.direction** = 'bi']
 - i. Check if **sts** == 1
 - ii. Check if **newsr** == **filt.sr**
 - iii. Check if **outdata** is empty
 - iv. Check if **length(outdata)** == **length(data)**

Lowpassfilter test

Function name lowpassfilter_test(this)

Description Checks hipassfilter functionality (without downsampling)

Setup

```
data rand(1000,1)
filt.sr 100
filt.lpfreq 40
filt.lporder 1
```

filt.hpfreq 'none'

filt.hporder 1

filt.down 'none'

Tests Same tests as in `hipassfilter_test`. Additionally there is a check for a warning if `filt.lpfreq` is higher (or equal) than the nyquist frequency

Input	Expected warning
<code>pspm_prepdata(data, filt) [filt.sr = 100; filt.lpfreq = 60]</code>	ID:no_low_pass_filtering

Bandpassfilter test

Function name `bandpassfilter_test(this)`

Description Checks bandpassfilter functionality (without downsampling).

Setup

data `rand(1000,1)`

filt.sr 200

filt.lpfreq 99

filt.lporder 1

filt.hpfreq 20

filt.hporder 1

filt.down 'none'

Tests Same tests as in `hipassfilter_test`.

Integer samplerate ratio downsampling test

Function name `int_sr_ratio_downsample_test(this)`

Description Checks downsampling functionality, if the ratio between `filt.sr` and `filt.down` is an integer.

Setup

```
ratio 2 % ratio between filt.sr and filt.down
filt.down 100
filt.sr ratio*filt.down
filt.lpfreq 40
filt.lporder 1
filt.hpfreq 'none'
filt.hporder 1
filt.direction 'uni'
and data = rand(filt.sr * 10,1).
```

Tests

1. Check if sts == 1
2. Check if newsr == filt.down
3. Check if outdata is empty
4. Check if ratio*length(outdata) == length(data)

5.32 pspm_process_illuminance

5.32.1 Overview

Testclass pspm_process_illuminance_test

Function [sts, out] = pspm_process_illuminance(ldata, sr, options)

5.32.2 Setup

This test class is parameterised. The test data is generated by the function itself and when needed, files will be written to datafile<variable_nr>.mat.

Test parameters These are parameters which define what kind of data should be passed to `pspm_process_illuminance` and which options should be set.

`bf_dur` Defines the duration of the basis function.

`bf_offset` Defines the offset of the basis function.

`dur` Defines the duration of the generated dataset.

`sr` Defines the samplerate of the generated dataset.

`n_times` Defines how many datasets should be generated.

`mode` Defines the whether the dataset should be written to a file, kept as inline variable or should be a mix of both. Can be either 'file', 'inline' or 'mixed'.

`overwrite` Defines whether existing files should be overwritten or not.

5.32.3 Testcases

Invalid input

Function name `invalid_input(this)`

Description Checks for warnings, if the input arguments are invalid.

Tests

Test No.	Input	Expected warning
1	pspm_process_illuminance() [no arguments]	ID:invalid_input
2	pspm_process_illuminance([]) [empty data]	ID:missing_data
3	pspm_process_illuminance(1:10) [missing samplerate]	ID:invalid_input
4	pspm_process_illuminance(1:10, 'a') [invalid ssamplerate]	ID:invalid_input
5	pspm_process_illuminance({1:10}, 1) [cell, no cell]	ID:invalid_input
6	pspm_process_illuminance(1:10, {1}) [no cell, cell]	ID:invalid_input
7	pspm_process_illuminance({1:10, 10:10}, {1}) [different sized cells]	ID:invalid_input
8	pspm_process_illuminance({1:10, 'a'}, {1,2}) [invalid file]	ID:non_existent_file
9	pspm_process_illuminance({1:10, 1:10}, {1, 'a'}) [invalid samplerate]	ID:invalid_input
10	pspm_process_illuminance({1:10}, {1}, 'o') [wrong options]	ID:invalid_input
11	pspm_process_illuminance({1:10}, {1}, opt)[wrong transfer settings]	ID:invalid_input
12	pspm_process_illuminance({1:10}, {1}, opt)[wrong duration]	ID:invalid_input
13	pspm_process_illuminance({1:10}, {1}, opt)[wrong offset]	ID:invalid_input
14	pspm_process_illuminance({1:10}, {1}, opt)[wrong outputfile]	ID:invalid_input
15	pspm_process_illuminance({1:10}, {1}, opt)[format of ldata and opt.fn differs]	ID:invalid_input
16	pspm_process_illuminance({1:10}, {1}, opt)[opt.overwrite is not boolean]	ID:invalid_input

Test options

Function name test_options(this, sr, dur, bf_dur, bf_offset)

Description Tries out different combination options to process the generated illuminance data.

Tests

1. Generate data with `sr` and `dur`
2. Set options according to `bf_dur` and `bf_offset`
3. Set expected warning according to `sr*dur` and `sr*bf_dur`
 - (a) expect empty data if `sr*dur < 1`
 - (b) expect `invalid_input` if `sr*bf_dur < 1`
 - (c) otherwise expect no warning
4. Test if issued warning equals expected warning
5. Test if `sts` equals expected value
6. Test if amount of data elements of input and output data is equal

Test multi

Function name `test_multi(this, n_times, mode)`

Description Generates `n` sets of illuminance data and passes it to `pspm_process_illuminance`.

Steps

1. Generate data with 10 (`sr`), 100 (`dur`), `n_times` (amount), `mode`
2. Test if `pspm_process_illuminance` issues no warning
3. Test if `sts==1`
4. For `n_times == 1`, test if out has 10×100 data points
5. For `n_times ~= 1`, test if output has same size as input

Test overwrite

Function name `test_overwrite(this, overwrite)`

Description Generate illuminance file and test overwrite behaviour.

Tests

1. Generate data with 10 (`sr`), 100 (`dur`), 1 (amount), 'file'
2. Test if `pspm_process_illuminance` issues no warning
3. Test if `sts==1`
4. Test if existing file was overwritten or not

5.32.4 Other methods

Generate lx Has some of the Test parameters as parameter implemented and accordingly generates the lx data. According to the calling arguments the output is a cell of files and data vectors. All generated files will be stored in the property 'datafiles'. They will be removed once all tests have finished.

Cleanup Located in MethodTeardown and is called once the test class has finished all tests. It then removes all the datafiles which can be found in the property 'datafiles'.

5.33 pspm_pulse_convert

5.33.1 Overview

Testclass pspm_pulse_convert_test

Function [sts, wavedata] = pspm_pulse_convert(pulsedata, resamplingrate, samplingrate)

5.33.2 Testcases

Invalid input

Function name invalid_input(testCase)

Description Pass invalid input arguments and test if the error message is correct.

Tests

Input	Expected warning
pspm_pulse_convert()	ID:invalid_input
pspm_pulse_convert(10^-3 * (1:10000)')	ID:invalid_input
pspm_pulse_convert(10^-3 * (1:10000)', 10000)	ID:invalid_input

Valid input

Function name valid_input(testCase)

Description Pass generated, valid data and test if function issues no warning.

Steps

1. Test function without downsampling the data
2. Test function with downsampling the data

5.34 pspm_ren

5.34.1 Overview

Testclass pspm_ren_test

Function out_newfilename = pspm_ren(filename, newfilename)

5.34.2 Testcases

Invalid input

Function name invalid_input (this)

Description Checks for warnings, if the input arguments are invalid.

Tests

Input	Expected warning
pspm_ren('fn') [no newfilename]	ID:invalid_input
pspm_ren({'fn1', 'fn2'}, {'rfn1', 'rfn2', 'rfn3'}) [non same size cell arrays]	ID:invalid_input

Char Valid Input

Function name char_valid_input (this)

Description Checks the function if the input variables are of type char. It uses pspm_load_data to check the files.

Steps

1. Check if `out_newfilename = newfilename`
2. Check if `sts==1` (of `pspm_load_data` output)
3. Check if the field '`infos.rendata`' exists
4. Check if the field '`infos.newname`' exists
5. Check if the original file has been deleted

Cell Valid Input

Function name `cell_valid_input (this)`

Description Checks the function if the input variables are of type cell. It uses `pspm_load_data` to check the files.

Tests The inputs are two-element cell arrays. For both elements the same tests as in the `char_valid_input` function are performed individually.

5.35 pspm_resp_pp

5.35.1 Overview

Testclass `pspm_resp_pp_test`

Function `sts = pspm_resp_pp(fn, sr, chan, options)`

5.35.2 Testcases

Regression Test against Revision r660

Function name `compare_results_to_results_obtained_from_r660_version(this)`

Description In r660, there was a bug found in `pspm_resp_pp` that caused it to crash with index out of bounds error on inputs containing some edgecase. This test specifically checks whether the fixed version returns the same results as the version before the bugfix on data that didn't cause a crash.

Tests

1. Check if the returned channel types have the same name and ordering
2. Check if the returned data is the same

5.36 pspm_scr_pp

5.36.1 Overview

Testclass pspm_scr_pp_test

Properties ...

Format ...

5.37 pspm_split_sessions

5.37.1 Overview

Testclass pspm_split_sessions_test

Properties expected_number_of_files = 3

Format newdatafile = pspm_split_sessions(datafile, markerchannel, options)

5.37.2 Setup

For the tests a testdatafile with three channels is used (duration is 100s). The markerchannel data is

```
data = [1 4 9 12 30 31 34 41 43 59 65 72 74 80 89 96]'
```

Hence if MAXSN==10 and BRK2NORM==3 (default values), the datafiles should be split into 3 files. If different values are being used, update the property 'expected_number_of_files' of the testclass object accordingly.

5.37.3 Testcases

Invalid input

Function name invalid_input (this)

Description Checks for warnings, if the input arguments are invalid.

Tests

Input	Expected warning
<code>pspm_split_sessions()</code> [no filename]	ID:invalid_input
<code>pspm_split_sessions (2)</code> [no string filename]	ID:invalid_input
<code>pspm_split_sessions ('fn', 'foo')</code> [no numeric marker channel no.]	ID:invalid_input

One datafile

Function name `one_datafile(this)`

Description Checks the function if the variable 'datafile' is of type char (one datafile). The markerchannel number is not assigned explicitly.

Steps

1. Check if the file has been split into 'expected_number_of_files' files For each output file the following tests are performed:
2. Check if `sts == 1`, when data is loaded with `pspm_load_data`.
3. Check if number of channels is correct.
4. Check if the field `infos.slitdate` exists
5. Check if the field `infos.splitsn` exists
6. Check if the field `infos.splitfile` exists.

Multiple datafiles

Function name `multiple_datafiles(this)`

Description Checks the function if the variable 'datafile' is of type cell (two datafiles). The markerchannel number is assigned explicitly.

Tests For both datafiles the same tests as in the `one_datafile` function are performed individually. Additionally it is tested if the number of input files does match the number of output files.

5.38 pspm_trim

Reviewed and updated by Teddy on 19 April 2022

5.38.1 Overview

Testclass pspm_trim_test

Function newdatafile = pspm_trim(datafile, from, to, reference, options)

5.38.2 Setup

If not otherwise declared, the input variable fn is referring to a datafile which was generated with pspm_testdata_gen and consists of the following channels

data{1}.chantype 'scr'

data{2}.chantype 'marker'

data{3}.chantype 'hr'

data{4}.chantype 'hb'

data{5}.chantype 'marker'

data{6}.chantype 'resp'

data{7}.chantype 'scr'

The duration of the data recording is 10s.

5.38.3 Testcases

Invalid input arguments

Function name invalid_inputargs(testCase)

Description Checks for warnings, if the input arguments are invalid.

Tests

Input	Expected warning
<code>pspm_trim(testCase.fn, [1 2], 5, 'marker')</code> [invalid from parameter]	ID:invalid_input
<code>pspm_trim(testCase.fn, 0, 'bla', 'marker')</code> [invalid to parameter]	ID:invalid_input
<code>pspm_trim(testCase.fn, 0, '[]', 'marker')</code> [invalid to parameter]	ID:invalid_input
<code>pspm_trim(fn, 0, 5)</code> [no reference]	ID:invalid_input
<code>pspm_trim(fn, 0, 5, 6)</code> [no char or 2-element numeric reference]	ID:invalid_input
<code>pspm_trim(fn, 0, 5, 'bla')</code> [invalid char reference]	ID:invalid_input
<code>pspm_trim(fn, 0, 5, [-1 5])</code> [invalid numeric start reference]	ID:invalid_input
<code>pspm_trim(fn, 0, 5, [5 4])</code> [invalid numeric start/end reference]	ID:invalid_input

Testing 'marker' as reference

- **Function name**
 - `marker_tests(testCase)`
- **Description**
 - A wrapper function for tests with reference = 'marker'. It executes the methods `markertest_k`, where the testcases are defined.

markertest_1

- **Description**
 - from and to are set so that the trimming points are out of the range [0,duration]. Hence the data should not be trimmed.
- **Expected warning**
 - ID: marker_out_of_range
- **Input**
 - `pspm_trim(fn, -20, 20, 'marker')`

markertest_2

- **Description**
 - from and to are set so that the trimming points are exactly (0, duration). Hence the data should not be trimmed.

- **Input**

- from -1 * marker(1)
- to duration - marker(end)
- then `pspm_trim(fn, from, to, 'marker')`

markertest_3

- **Description**

- from and to are set so that the trimming points in the range [0,duration].

- **Input**

- `pspm_trim(fn, 1, -2, 'marker')`

Testing 'file' as reference

- **Function name**

- `file_tests(testCase)`

- **Description**

- A wrapper function for tests with reference = 'file'. It executes the methods `filetest_k`, where the testcases are defined.

filetest_1

- **Description**

- from and to are set so that the trimming points are out of the range [0,duration]. Hence the data should not be trimmed.

- **Expected warning**

- ID: `marker_out_of_range`

- **Input**

- `pspm_trim(fn, -12.5, 50, 'marker')`

filetest_2

- **Description**

- from and to are set so that the trimming points are exactly (0, duration). Hence the data should not be trimmed.

- **Input**

- `pspm_trim(fn, 0, duration, 'marker')`

filetest_3

- **Description**

- from and to are set so that the trimming points in the range [0, duration].

- **Input**

- `pspm_trim(fn, 2.1, duration - 2.5, 'marker')`

Numeric reference tests

- **Function name**

- `num_tests(testCase)`

- **Description**

- A wrapper function for tests with reference = [a b] (a, b are two integers with a<b). It executes the methods `markertest_k`, where the testcases are defined.

numtest_1

- **Description**

- from and to are set so that the trimming points are out of the range [0,duration]. Hence the data should not be trimmed.

- **Expected warning**

- ID: `marker_out_of_range`

- **Input**

- `pspm_trim(fn, -20, 20, [2 14])`

numtest_2

- **Description**

- from and to are set so that the trimming points are exactly (0, duration). Hence the data should not be trimmed.

- **Input**

- `from = -1 * marker(3)`
- `to = duration - marker(8)`
- then `pspm_trim(fn, from, to, [3 8])`

numtest_3

- **Description**

- from and to are set so that the trimming points in the range [0, duration].

- **Input**

- `pspm_trim(fn, -1.5, 2, [2 7])`

numtest_4

- **Description**

- Second reference point is out of the marker range; from is set to 'none'. Hence the data should not be trimmed.

- **Expected warning**

- ID: marker_out_of_range

- **Input**

- `pspm_trim(fn, 'none', 0, [1 (numel(marker) + 1)])`

Multiple file reference tests

- **Function name**

- `multiple_files(testCase)`

- **Description**

- The input variable datafile is either a cell array of two filenames or a cell array of two structs. In both cases it is tested whether the return value is also a cell array of two filenames and whether both files are trimmed correctly.

Option tests (marker channel number option)

- **Function name**

- `marker_chan_num_option_test(testCase)`

- **Description**

- Tests if the option marker_chan_num is working correctly. There are two tests:
 1. Checks for a warning if the selected channel is no marker channel.
 2. Checks if the selected channel is actually used.

5.39 pspm_write_channel

5.39.1 Overview

Testclass `pspm_write_channel_test`

Format `[sts] = pspm_write_channel(fn, newdata, action, options)`

5.39.2 Setup

Testdatafile The testdatafile is a class property. It is generated by the function `generate_testdatafile()` once the test class is setup. Changes made by a test to the testdatafile won't be reverted. Thus some test functions rely on the changes made by another test function. Therefore the functions may not work properly if called individually.

Structure Created with `generate_testdatafile()`.

`data{1}.chantype 'scr';`

`data{2}.chantype 'marker';`

`data{3}.chantype 'scr';`

The sampling rate is 100Hz and the duration is 500s.

5.39.3 Testcases

Invalid input

Function name `invalid_input(this)`

Description Checks for warnings, if the input arguments are invalid.

Tests

Input	Expected warning
<code>pspm_write_channel()</code> [no parameter]	ID:invalid_input
<code>pspm_write_channel(1)</code> [fn is a number]	ID:invalid_input
<code>pspm_write_channel('some_file', [])</code> [no action passed]	ID:unknown_action
<code>pspm_write_channel('some_file', [], '')</code> [empty action passed]	ID:unknown_action
<code>options.channel = 'some invalid channel'</code> <code>pspm_write_channel('some_file', [], 'add', options)</code> [invalid channel]	ID:invalid_input
<code>options.channel = -1</code> <code>pspm_write_channel('some_file', [], 'add', options)</code> [negative channel]	ID:invalid_input
<code>options.channel = 0</code> <code>pspm_write_channel('some_file', [], 'delete', options)</code> [no channel and no data given]	ID:invalid_input
<code>options.channel = 0</code> <code>pspm_write_channel('some_file', [], 'add', options)</code> [empty newdata]	ID:invalid_input
<code>options.channel = 0</code> <code>pspm_write_channel('some_file', 1:3, 'add', options)</code> [newdata is not cell and not struct]	ID:invalid_input
<code>options.channel = 1:5</code> <code>pspm_write_channel(this.testdatafile, [], 'delete', options)</code> [more given channels than in file exist]	ID:invalid_input
<code>options.channel = 'ecg';</code> <code>pspm_write_channel(this.testdatafile, [], 'delete', options)</code>	ID:no_matching_channels
<code>pspm_write_channel(this.testdatafile, gen_data.data{1}, 'add')</code> [generated data has the wrong format (two rows in one channel)]	ID:invalid_data_structure

Action 'add'

Function name `test_add(this)`

Description Checks if action 'add' behaves as expected. A new channel with chantype = 'hb', sr = 200 and duration = 500 is generated.

Tests

1. Load condition before and after and pass it to 'Verify write'

Action 'add transposed'

Function name test_add_transposed(this)

Description Checks if action 'add' behaves as expected, when data has the wrong dimensions. A new channel with chantype = 'rs', sr = 200 and duration = 500 is generated.

Tests

1. Transpose generated data
2. Load condition before and after and pass it to 'Verify write'

Action 'replace'/'add'

Function name test_replace_add(this)

Description Checks if action 'replace' behaves as expected. A new channel with chantype = 'hr', sr = 10 and duration = 500 is generated.

Tests

1. Running pspm_write_channel with action = 'replace' should issue 'ID:no_matching_channels' (channeltype should not exist before) and then instead add the channel
2. Load condition before and after and pass it to 'Verify write'

Action 'replace'

Function name test_replace(this)

Description Checks if action 'replace' behaves as expected. A new channel with chantype = 'hr', sr = 20 and duration = 500 is generated.

Tests

1. Load condition before and after and pass it to 'Verify write'
2. Test if 'hr' channel has sample rate 20

Action 'delete' (one channel)

Function name test_delete_single(this)

Description Checks if action 'delete' behaves as expected. In this test only one channel will be deleted. To test the delete algorithm there will be 7 channels added which are then also used for `test_delete_multi(this)`. The particular channels are then identified by the sample rate which corresponds to the channel id * 10.

Tests

1. Delete channel with `chantype = 'hr'` in `newdata.header.chantype`
 - (a) Verify write
 - (b) Ensure only one channel has been deleted
 - (c) Test if there is no more channel with `chantype = 'hr'`
2. Delete channel with channel number in `options.channel`
 - (a) Verify Write
 - (b) Ensure only one channel has been deleted
3. Test the delete algorithm
 - (a) Remove 'resp' channel with `options.delete = 'last'`
 - i. Verify write
 - ii. Ensure only one channel has been deleted
 - iii. Test if last channel was deleted
 - (b) Remove 'resp' channel with `options.delete = 'first'`
 - i. Verify write
 - ii. Ensure only one channel has been deleted
 - iii. Test if last entry was not deleted

Action 'delete' (multiple channels)

Function name `test_delete_multi(this)`

Description Checks if action 'delete' behaves as expected. In this test only multiple channels will be deleted. This test relies on the changes made to the testdatafile by other test functions in this class.

Tests

1. Delete channel 1 and 2 from testdatafile
 - (a) Verify write
 - (b) Ensure two channels have been deleted

2. Delete all 'resp' channels from testdatafile
 - (a) Verify write
 - (b) Test if datafile contains no more 'resp' channels

5.39.4 Other methods

Verify write Is called after `pspm_write_channel` has been called (action = 'add' or action = 'replace') and tests if data was written and a new history entry was made.

Tests

1. if action == 'add', test if there is a new channel
2. if action == 'replace', test if there is still the same amount of channels
3. if action == 'delete', test if there have been as many channels deleted as given in `outinfos.channel`
4. test if history has a new entry
5. search for channels with same chantype as added channel (should be only one channel)
6. test if number of data elements in new channel and added channel is equal
7. test if new channel and added channel have same 'sr'.

5.40 Python

5.40.1 Overview

Testclass `pspm_check_python_test`
`pspm_check_python_module_test`

Format `out = pspm_cfg_python(package_name)`
`sts = pspm_check_python(valid_python_path)`
`sts = pspm_check_python_modules(package_name)`

Note `pspm_cfg_python` is a UI controller function that handles python path. The function can be called by other UI functions if Python is required for performing relevant processing. The function will ask users to define the path for python that has been installed in the system.

5.40.2 Test for python

Function name `pspm_check_python`

Description `pspm_check_python_test` is a test function that checks the installation of python in the system by using `pspm_check_python`, and the path of the python package that has been installed is detected by `pspm_py_find_location.py`.

Tests

1. `test_current_python_environment`
 - (a) ensure a Python environment is already configured
2. `test_set_new_python_environment`
 - (a) Automatically detect the python installed in the system and test if it can be checked successfully by `pspm_check_python`.
3. `test_set_invalid_python_environment`
 - (a) Use an invalid python path to check if `pspm_check_python` returns invalid results.
4. `test_python_environment_already_set`
 - (a) Test when the specified Python environment is already set as the current.

5.40.3 Test for python modules

Function name `pspm_check_python_module_test`

Description `pspm_check_python_module_test` manages to check the modules that is installed in the system by using `pspm_check_python_modules`. Currently, it only tests the module “math”.

Tests

1. `test_python_environment_with_modules`
 - (a) To test the package “math” that has been installed can be checked successfully by using `pspm_check_python_modules`.

6 External Functions and Tools

6.1 VB (Variational Bayes) inversion algorithm by Jean Daunizeau

Updated October 2014

VBA_ReDisplay.m Fixed try-catch syntax in various places by adding a comma after “try” to avoid warning in MATLAB > 2007

VBA_inv.m In line 42, added warning off/on to suppress the warning `Matrix is singular, close to singular or badly scaled. Results may be inaccurate. RCOND = NaN.`

Updated October 2016

VBA_ReDisplay.m Fixed try-catch syntax in various places by adding a comma after “try” to avoid warning in MATLAB > 2007

VBA_inv.m In line 48: added warning off/on to suppress the warning `“Matrix is singular, close to singular or badly scaled. Results may be inaccurate. RCOND = NaN.”`

VBA_NLStateSpaceModel.m Added resetting warning to preceeding state.

7 GitHub Actions

Contributed by Teddy Zhao

Updated in March 2022

GitHub Actions is a Continuous Integration (CI) environment for testing GitHub repository, which is now used for testing and maintaining PsPM. GitHub Actions is deeply implemented in GitHub, thus there is no further website or facility needed for running GitHub Actions for PsPM.

7.1 Repositories

Until March 2022, code and test data are separately stored in GitHub, in *PsPM* and *PsPM-data*, respectively. Both of *PsPM* and *PsPM-data* are under the *bachlab* account. *PsPM* is a public repository allowing group members and public visitors to check the code and propose issues. *PsPM-data* is a private repository allowing only group members to check the data and propose issues. This is because *PsPM-data* has some research data that may not be appropriate for public visitors. It could be a good idea to find another cloud storage service with University's approval to store research data. *PsPM-data* has all the required test data for running testsuit of *PsPM*. To run testsuit of *PsPM*, it must be guaranteed that *PsPM-data* is accessible.

7.2 Workflow

To guide the actions of GitHub Actions, a workflow script as a `.yaml` file is required, which should be stored at `~/bachlab/PsPM/.github/workflow`. The workflow has been prepared and tested to be running well for maintaining *PsPM*. The explanations of key scripts are show below.

Step 1 Import PsPM

```
- name: Check out repository code
  uses: actions/checkout@v2
```

This step imports the source code of *PsPM* to the server, in our case, a Ubuntu server.

Step 2 Import PsPM-data

```
- name: Add test data
  uses: actions/checkout@v2
  with:
    repository: bachlab/PsPM-data
    token: ${ secrets.PSPM_PAT }
    path: ImportTestData
```

This step imports the test data in *PsPM-data* to the server. The details of the token is introduced in the next section.

Step 3 Setup MATLAB

```
- name: Setup MATLAB
  uses: matlab-actions/setup-matlab@v1.0.1
```

Step 4 Setup testing script

```
- name: Run script
  id: pspm_test_main
  uses: matlab-actions/run-command@v1
  with:
    command: addpath('test'), addpath('src'), pspm_test_github_actions
```

The script of testing *PsPM* has been optimised for GitHub Actions, which is saved as `pspm_test_github_actions`. Further modifications should be done here.

Step 5 Save records

```
- name: Check status
  id: check_status
  uses: andstor/file-existence-action@v1
  with:
    files: "success.txt"
```

This step return a document `success.txt` if the script does not return any error, indicating the code has passed the test suit.

Step 6 Return success

```
- name: Return running success
  if: ${ steps.check_status.outputs.files_exists == 'true' }
  run: exit 0
```

Step 7 Return failure

```
- name: Return running failure
  if: ${ steps.check_status.outputs.files_exists != 'true' }
  run: exit 1
```

7.3 Token

Tokens are required to perform GitHub Actions for *PsPM* as the data repository is stored as private. The steps for generating and implementing tokens are described as below.

Step 1 Generate a Personal Access Token (PAT) at <https://github.com/settings/tokens>, name it as `PSPM_PAT` with required privileges.

Step 2 In the YAML file, the script for running GitHub Actions, make sure the PAT file has been mentioned appropriately, like

```
token: ${ secrets.PSPM_PAT }
```

Step 3 In the settings of *PsPM* repository, which can be found at <https://github.com/bachlab/PsPM/settings/secrets>, make sure *Repository Secrets*, which is under *Actions Secrets*, has contained `PSPM_PAT`. This operation requires your privilege to access the setting profiles of the corresponding repository.

Step 4 Similar to Step 3, in the settings of *PsPM-data* repository, which can be found at <https://github.com/bachlab/PsPM-data/settings/secrets/actions>, make sure *Repository Secrets*, which is under *Actions Secrets*, has contained `PSPM_PAT`. This operation requires your privilege to access the setting profiles of the corresponding repository.

Now the script should be running ok. Please note the PAT must be updated regularly due to security concerns.

8 Website and function descriptions

Contributed by Teddy Zhao in January 2025

This chapter describes how to contribute to the PsPM website and generate documents of function description.

8.1 Website

The official website of PsPM is located at bachlab.github.io/pspm, and it is hosted on GitHub at the branch “gh-pages” under the PsPM repository at github.com/bachlab/PsPM. Any update to the website will need to be made by updating this branch. The website is built up based on the website template Jekyll Gitbook: <https://sighingnow.github.io/jekyll-gitbook/>. Therefore, further website behaviour and action changes to the PsPM website may need to refer to the original jekyll-gitbook manual. Instead of writing fixed-content websites, the jekyll-gitbook website template uses markdown files for generating HTML files automatically. In early 2025, the jekyll-gitbook template was adopted for PsPM website and live for users. The content of the website repository includes three folders and a few individual files, which are introduced as following.

8.2 General structure

The PsPM website includes a main page and a few subpages. The main page is stored at README.md, which means the updates to the main page should be addressed by modifying README.md. This file is located in the root folder. Please follow the previously updated formats, such as hyperlinks and images, for future content updates. The subpages are stored in _posts, whose main description can be found in the next section.

8.3 Folders

8.3.1 _includes

This folder contains the required module and behaviour control files in html or json.tpl format. Most of the files are not expected to be modified, such as “mathjax.html”, as they are just required for rendering the webpage components. However, a few files should be noticed when updating the webpage content in the future.

To update the table of content for the website, please go to the file “toc-date.html”, at around line 69 or 70, there is a if-else clause explaining how the table of content will be generated. Only the listed pages in this line of code will be displayed in the table of content.

8.3.2 _layouts

This folder stores the html-based webpage templates. There are two kinds of webpage templates, which are “home” and “post”. In PsPM website, only the home page use “home” as the template, and all other webpages should use “post”. A markdown file is required for adding the corresponding content, which is introduced as below.

8.3.3 `_posts`

This folder stores the content for all the webpages on PsPM website except for the main page that is stored in README.md. All the files in this folder need to be markdown files, and the format of markdown file content can follow the currently available files. Each file has its file name as “date-filename.md”. The date needs to be written in the format of “YYYY-MM-DD” (American date style). If every file has the same date, they will be ranked alphabetically in the table of content, otherwise it will be based on the date. The table of content will not be automatically updated after adding new markdown files. To update the table of content, please check the `_includes` section.

8.3.4 `asset`

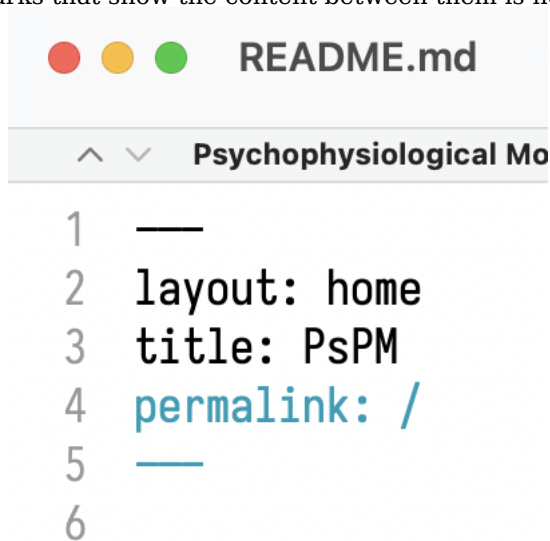
This folder stores the required resources, such as images, for the website. Images should be put at the location `/assets/images`, and they need to be properly referred when being added to the webpages.

8.4 Basic File formats

This section introduces how to write the markdown files for webpage contents. This is given by using the README.md as an example.

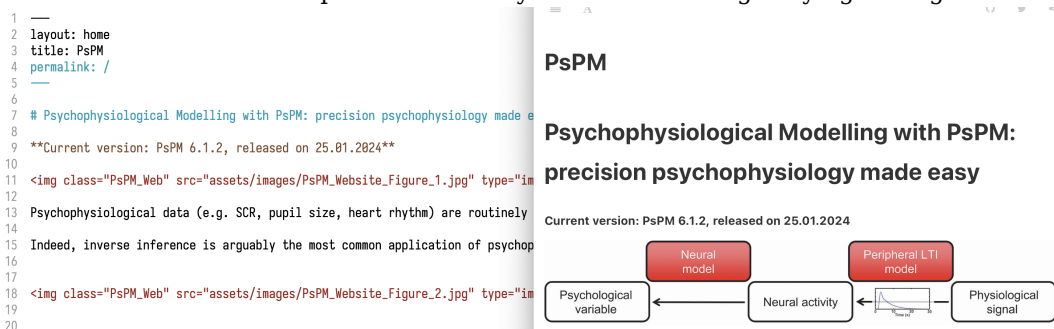
8.4.1 Header

In the line 1-5 of a markdown file, the line 1 and line 5 should be “---” (three dashes). This is the marks that show the content between them is header and can be read.



The first line is the layout that will be used for displaying this webpage. It can be either “home” or “post”. “Home” is used for the homepage, and “post” is used for any other webpage, such as “Course” or a descriptive page for a PsPM function.

The second line is the title of this webpage. This is the displayed title of this webpage that can be used for referring to by other functions, such as table of content generation content. Please make sure this title is not shared by two different webpages for avoiding potential risks. This head will be displayed as the header on the webpage, as shown below. For visual comfortableness, please leave the title to be simple and relatively short for avoiding busy feeling unless required.



The third line is the permanent link of this webpage. If it is left as just a "/", it means this page is the default home page. For PsPM, a "/" means the link to this page is "bachlab.github.com/pspm". If it is a "/ref", then the page would be "bachlab.github.com/pspm/ref".

8.4.2 Captions and links

To insert images for webpages, please use the following sentence. In this sentence, the src should be the link of the image that is normally stored within the "assets" folder. The "alt" is the caption of the image.

```

```

To insert a hyperlink to a website, please use the following sentence.

```
[retrodictive validity](https://doi.org/10.1038/s41562-020-00976-8)
```

8.4.3 Table of content generation

Please use the file "toc-date.html" to control the generation of table of content. Currently, please go to line 69–70, where the list of items shown in the table of content is listed here. Items will not be displayed unless they are specified here, thus please always keep this file updated.

```

62
63
64
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78
79
80
81

```

```

    {% for post in reversed_posts %}
    {% if page.url == post.url %}
    <li class="chapter active" data-level="1.2" data-path="{{site.baseurl}}{{post.url}}">
    {% else %}
    <li class="chapter" data-level="1.1" data-path="{{site.baseurl}}{{post.url}}">
    {% endif %}
    {% if post.url == "/learn/" or post.url == "/documentation/" or post.url == "/"
    news/" or post.url == "/opendata/" or post.url == "/ref/" or post.url == "/"
    download/" %}
    <a href="{{site.baseurl}}{{post.url}}" onclick="pageScrollToTop(this)">
    {{ post.title | escape }}
    </a>
    {% if site.toc.enabled %}
    {% if page.url == post.url %}
    {% include toc.html html=content h_min=site.toc.h_min
    h_max=site.toc.h_max %}
    {% endif %}
    {% endif %}
    {% endif %}
    </li>
    {% endfor %}

```

9 List of Functions

Function Name	Main Author(s)	Test Function	Test Document
f_SCR	DB & JD	-	-
f_SF	DB	-	-
g_SCR	DB	-	-
pspm	DB	x	x
scr	DB	x	x
pspm_align_channels	DB	x	x
pspm_axpos	DB	-	-
pspm_bf_brf	SK & DB	-	-
pspm_bf_FIR	DB	-	-
pspm_bf_Fourier	DB	-	-
pspm_bf_hprf	DB	-	-
pspm_bf_hprf_e	TM	-	-
pspm_bf_hprf_fc	TM	-	-
pspm_bf_hprf_fc_f	TM	-	-
pspm_bf_lcrf_gm	TM	-	-
pspm_bf_ldrf_gm	TM	-	-
pspm_bf_ldrf_gu	TM	-	-

pspm_bf_psrff_fc	TM	-	-
pspm_rarf_e	TM	-	-
pspm_rarf_fc	TM	-	-
pspm_rfrrf_e	TM	-	-
pspm_rprf_e	TM	-	-
pspm_bf_scrf_f	DB	-	-
pspm_bf_scrf	DB	-	-
pspm_bf_spsrf_box	LC	-	-
pspm_bf_spsrf_gamma	LC	-	-
pspm_butter	DB	X	X
pspm_con1	DB	-	-
pspm_con2	DB	-	-
pspm_contrast	DB	-	-
pspm_convert_area2diameter	TM	-	-
pspm_convert_au2mm	TM	-	-
pspm_convert_illum2lum	TM	-	-
pspm_convert_lux2cdm2	TM	-	-
pspm_convert_mm2visdeg	TM	-	-
pspm_convert_pixel2unit_core	LC	-	-
pspm_convert_unit	TM	x	x
pspm_convert_visangle2sps	LC	-	-
pspm_convert_visual_angle_core	DB	-	-
pspm_data_editor	TM	-	-
pspm_dcm_inv	DB	-	-
pspm_dcm	DB	-	-
pspm_denoise_spike	DB	-	-
pspm_display	PCP	-	-
pspm_down	DB	x	-
pspm_downsample	DB	-	-
pspm_ecg2hb	PCP	x	x
pspm_ecg2hb_amri	EY	x	-

pspm_ecg_editor	TM	-	-
pspm_exp	DB	x	-
pspm_extract_segments	TM	x	x
pspm_filtfilt	DB	x	x
pspm_find_channel	DB	x	x
pspm_find_data_epochs	TM	-	-
pspm_find_sounds	SG	x	x
pspm_find_valid_fixations	TM	x	x
pspm_get_acq_bioread	TM	x	x
pspm_get_acq	DB	x	x
pspm_get_acqmat	DB	x	x
pspm_get_biograph	DB	x	x
pspm_get_biosemi	DB	x	x
pspm_get_biotrace	DB	x	x
pspm_get_blink_l	TM	-	-
pspm_get_blink_r	TM	-	-
pspm_get_brainvis	DB	x	x
pspm_get_cell	DB	-	-
pspm_get_cnt	DB	-	-
pspm_get_custom	TM	-	-
pspm_get_ecg	DB	x	x
pspm_get_edf	TM	x	x
pspm_get_events	DB	x	x
pspm_get_eyelink	CK & TM	x	x
pspm_get_gaze_x_l	TM	-	-
pspm_get_gaze_y_l	TM	-	-
pspm_get_gaze_x_r	TM	-	-
pspm_get_gaze_y_r	TM	-	-
pspm_get_hb	DB	x	x
pspm_get_hp	DB	-	-
pspm_get_hr	DB	x	x

pspm_get_labchartmat_ext	DB	x	x
pspm_get_labchartmat_in	DB	x	x
pspm_get_marker	DB	x	x
pspm_get_markerinfo	DB	-	-
pspm_get_mat	DB	x	x
pspm_get_obs	LR	x	x
pspm_get_physlog	TM	-	-
pspm_get_pupil	DB	x	x
pspm_get_pupil_l	TM	-	-
pspm_get_pupil_r	TM	-	-
pspm_get_resp	DB	x	x
pspm_get_rf	DB	-	-
pspm_get_saccade_l	LC	-	-
pspm_get_saccade_r	LC	-	-
pspm_get_scr	DB	x	x
pspm_get_smi	EY	-	-
pspm_get_sps	LC	-	-
pspm_get_smr	DB	x	x
pspm_get_smr_x	TZ	-	-
pspm_get_sound	TM	-	-
pspm_get_timing	DB	x	x
pspm_get_txt	DB	x	x
pspm_get_vario	DB	x	x
pspm_get_viewpoint	EY	-	-
pspm_get_wdq	DB	-	-
pspm_get_wdq_n	TM	x	x
pspm_glm_recon	DB	-	-
pspm_glm	DB	x	x
pspm_hb2hp	DB	x	x
pspm_hb2hr	DB	-	-
pspm_import	DB	x	x

pspm_init	DB	-	-
pspm_interpolate	TM	x	x
pspm_jobman	GG	-	-
pspm_job_create	DB	-	-
pspm_load_data	DB	x	x
pspm_load1	DB	x	x
pspm_load_single_chan	EY	-	-
pspm_merge	DB	-	-
pspm_overwrite	TZ	-	-
pspm_path	EY	x	-
pspm_peakscore	DB	-	-
pspm_pp	DB	x	x
pspm_ppg2hb	SG	-	-
pspm_predval	DB	-	-
pspm_prepdata	DB	x	x
pspm_process_illuminance	TM	x	-
pspm_pulse_convert	DB	x	-
pspm_pupil_correct_eyelink	EY	x	-
pspm_pupil_correct	EY	x	-
pspm_pupil_pp	EY	x	-
pspm_pupil_pp_options	EY	-	-
pspm_quit	DB	-	-
pspm_ren	DB	x	x
pspm_resp_pp	DB	-	-
pspm_rev_con	DB	-	-
pspm_rev_dcm	DB	-	-
pspm_rev_glm	DB	-	-
pspm_rev2	DB	-	-
pspm_review	GG	-	-
pspm_segment_mean	TM	-	-
pspm_scr_pp	TZ	x	x

pspm_sf_auc	DB	-	-
pspm_sf_dcm	DB	-	-
pspm_sf_mp	DB	-	-
pspm_sf_scl	DB	-	-
pspm_sf_theta	DB	-	-
pspm_sf	DB	-	-
pspm_sf_get_theta	DB	-	-
pspm_show_arms	DB	-	-
pspm_spike_convert	DB	-	-
pspm_split_sessions	LR	x	x
pspm_transfer_function	DB	-	-
pspm_time2index	TZ	x	x
pspm_trim	DB	x	x
pspm_version	TM	-	-
pspm_write_channel	TM	x	x
set_blinks_saccades_to_nan	EY	x	-

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