perceptivo

Release 0.0.1

Jonny L Saunders, Avinash Singh Bala

Nov 10, 2022

HARDWARE

1 Organization 3

2 Narrative Docs 5

3 Meta 17

4 API Docs 21

Bibliography 105

Python Module Index 107

Index 109

A hardware/software package to perform audiology exams by measuring pupil dilation.

CHAPTER

ONE

ORGANIZATION

This documentation is split into three sections:

- Narrative documentation: descriptions of how the component systems work and why
- Meta: high-level docs for developers & coordinating development
- API-level documentation: class, method, and function level documentation

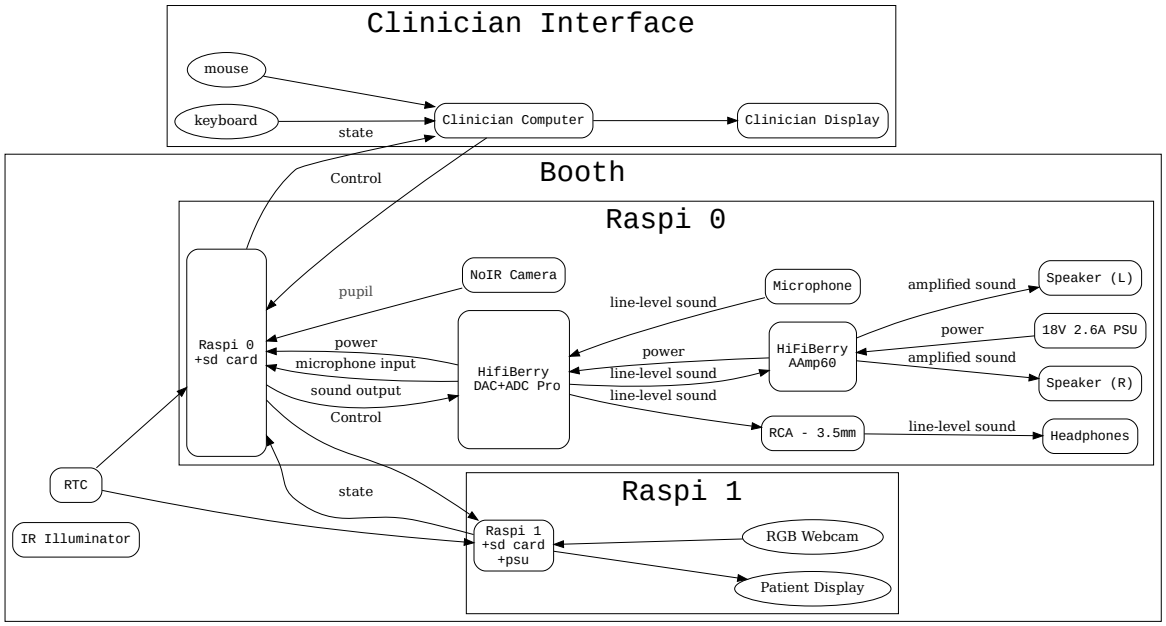
CHAPTER

TWO

NARRATIVE DOCS

2.1 Overview

2.1.1 Hardware Block Diagram



2.1.2 Parts List

Clinician Interface

Name	Distributor	Number	Link	Datasheet
Raspberry Pi 400	Adafruit	1		
Touchscreen		1		
Mouse	Newegg	1		

Raspis

Name	Distributor	Number	Link	Datasheet
Raspberry Pi 4B - 8GB	Adafruit	2		- brief - mechanical - circuits - bcm2711
USB-C 5.1V 3A PSU	Adafruit	2		
18V 2.6A PSU	Digikey	1		
Samsung 64GB Pro Endurance microSD	Newegg	2		
Enclosures?		2		
RTC?		1		

Audio

Name	Distributor	Number	Link	Datasheet
AAmp60	HiFiBerry	1		
DAC+ADC Pro	HiFiBerry	1		
Tang Band W3-1878	Parts Express	2		
Condenser Microphone		1		
Phantom Power Supply		1		
Sennheiser HDA 300		1		
RCA -> 3.5mm Adapter		1		

Video

Name	Distributor	Number	Link	Datasheet
NoIR Camera	Adafruit	1		
Raspberry Pi Camera V2	Adafruit	1		
Touchscreen				
Light source?				

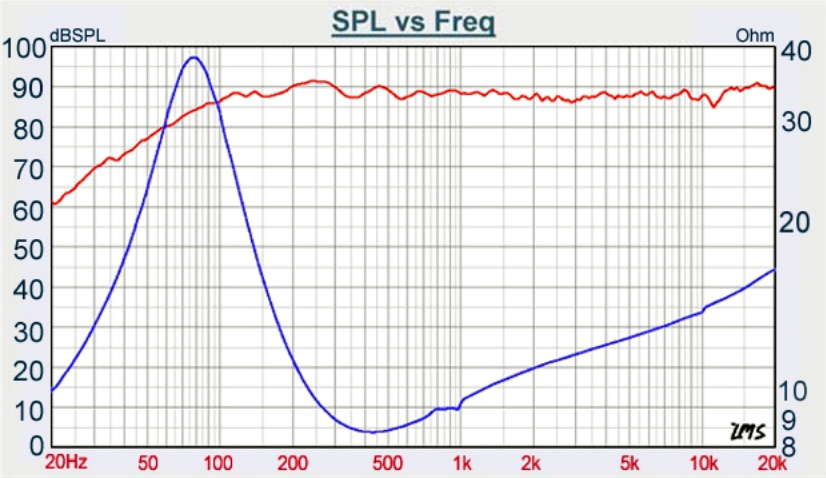
Etc

Name	Distributor	Number	Link	Datasheet
Netgear 5-Port Switch (GS105NA)	Newegg	1		
Ethernet Cables (10ft)	Newegg	3		
Perixx Periboard-706plus with trackball	Newegg	1		
Speaker Wire				

2.2 Speaker Candidates

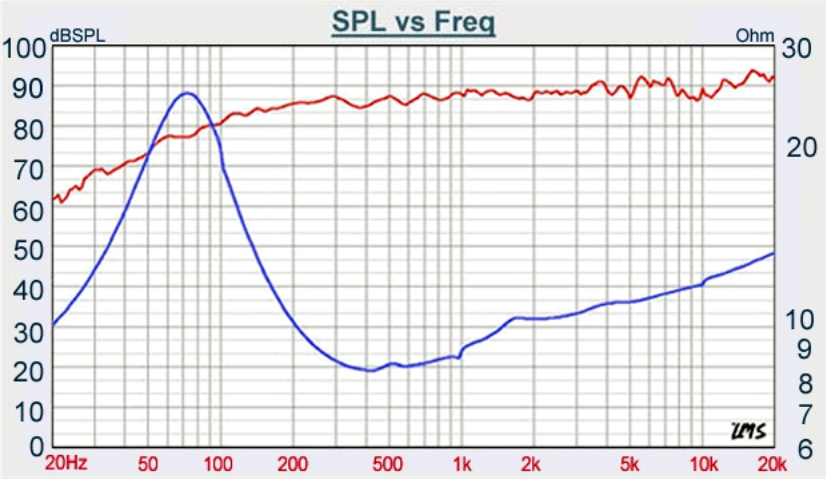
2.2.1 Tang Band W3-1878

$87.49, 3”



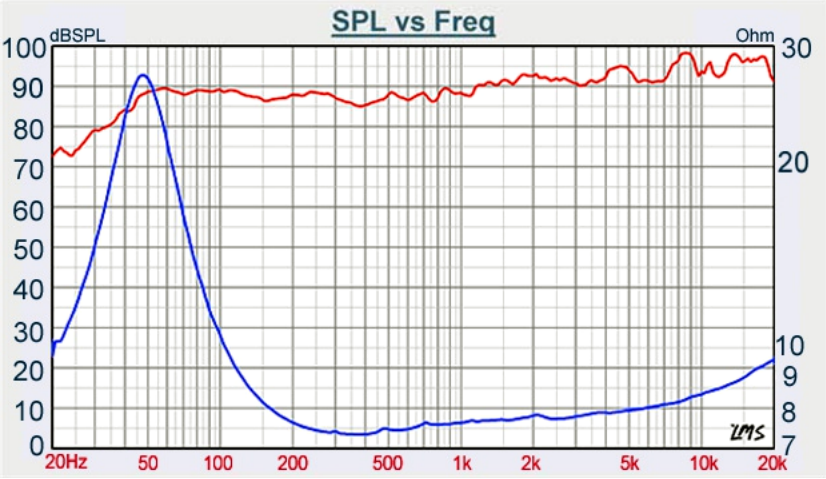
2.2.2 Tang Band W4-1320SJ

$69.40, 4”



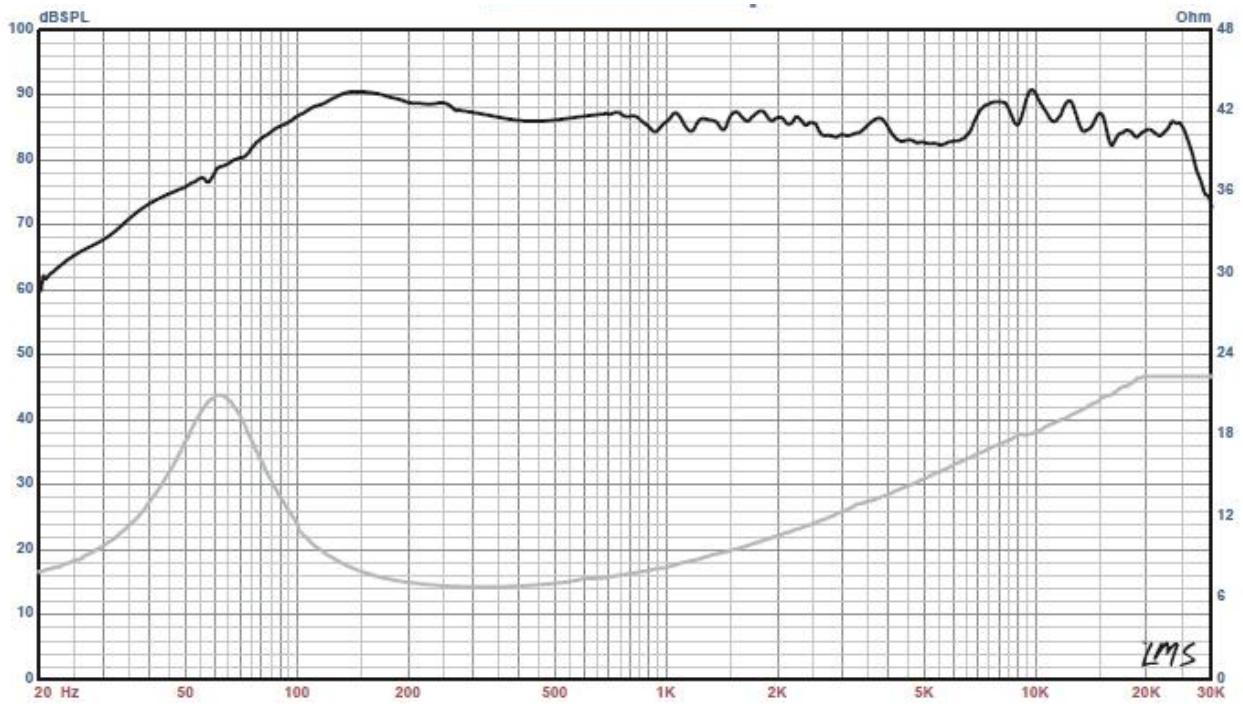
2.2.3 Tang Band W6-2144

$91.10, 6.5”



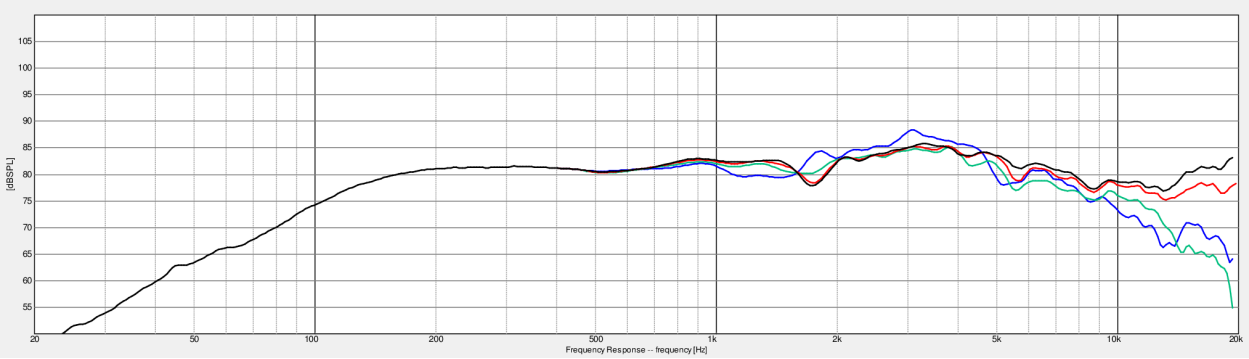
2.2.4 Fountek FR135EX

$99.98, 5.5”



2.2.5 Dayton RS75T-8

$25.98, 3”



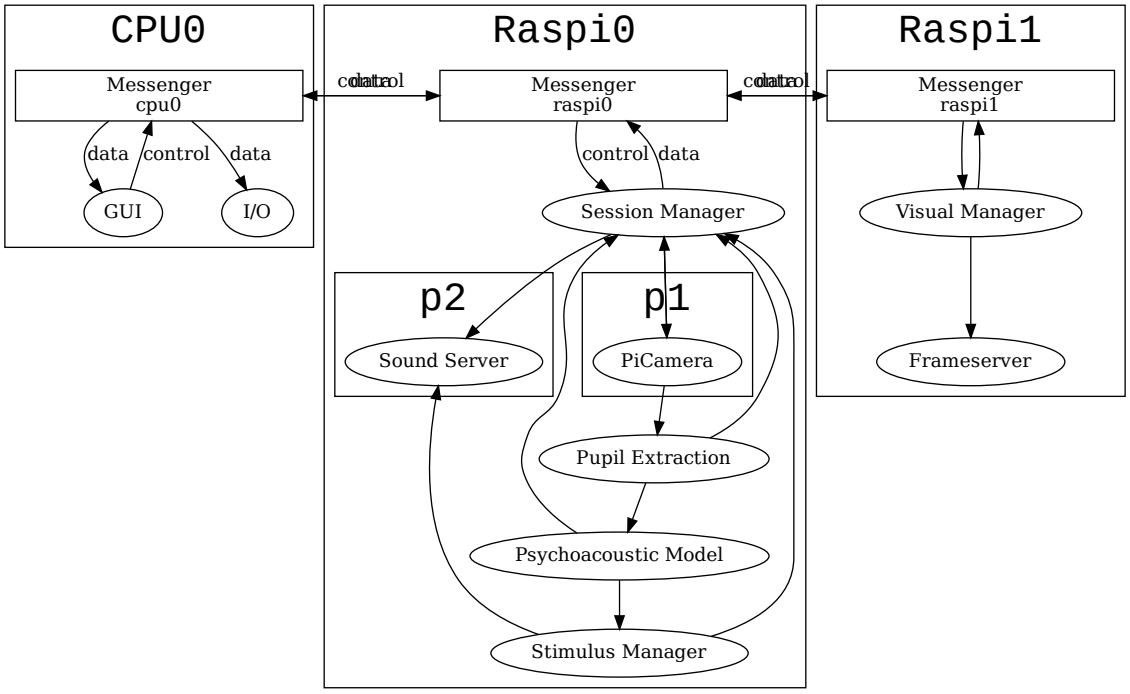
2.2.6 Additional References

- http://feleppa.com.au/speakermeasmid.html

.. _SoftwareOverview:

2.3 Software Overview

2.3.1 Block Diagram



2.3.2 Draft Description

Message-based architecture

- The system will consist of separable modules that communicate with a globally-defined enum of message types.
- The system will consist of independent computers networked with an [ad-hoc or hosted? wireless network].
- Messages will be serialized and sent as tcp packets between computers, and as inter-and intra-process packets within a computer.

Distribution of Labor

- One computer will serve as the clinician-facing interface that controls the operation of the examination
- One computer will serve as the primary examination device, delivering auditory stimuli, measuring pupil dilation, and controlling the stepping algorithm
- One computer will serve as the patient-facing interface, presenting visual stimuli (as well as physical enclosure for cameras and speakers)

Synchronization

- The two computers operating the examination will be tightly synchronized with a shared real-time clock
- The examination computers will communicate asynchronously with the clinician-facing computer

GUI

- The GUI will be made with Qt6, written in PySide6
- [*control requirements*]
- [*display requirements*]
- [*utility requirements*]

Image Capture

- Pupil images will be captured with a PiCam NoIR camera as single-channel luminance images from a YUV-encoded frame
- Raw images will only be saved if explicitly requested, otherwise they will be shown in the GUI as a diagnostic

Pupil Processing

- Pupil diameter will be extracted as the shorter diameter of an ellipse fit on the edges of a tracked pupil to account for eccentricity/occlusion
- [*filtering and signal conditioning*]
- [*preservation of provenance*]

Psychoacoustic Model

this'll be a bit of work, ya!?

Sound

Generation

talk to avinash about stimuli

Presentation

- Sound will be presented with jack audio
- Sound will be prebuffered in the presenting process, prioritizing continuity over low-latency

Recording & Calibration

Video

Generation

Presentation

Patient Data

Maintenance, Logging, Debugging

2.4 Installation

2.4.1 Imaging RaspiOS

- Download the RaspiOS image from the Download Page
  - For Patient, download Raspi OS Lite - HTTP, .torrent
  - For Clinician, download Raspi OS with Desktop - HTTP, .torrent

Mac

- Find the name of the SD card using `sudo diskutil list`, will be something like `/dev/disk2`
- Unmount disk with `sudo diskutil unmountDisk /dev/disk2` (but replacing the name/number of your disk)
- Use `dd` to copy the image, note the use of `rdisk` (with same number) rather than `disk`. You can check the status of the transfer with `ctrl+t`:

```
sudo dd if=/path/to/raspios-image.img of=/dev/rdisk2 bs=1m
```

Imager

You can also use the raspberry pi imager, available for windows, mac, and ubuntu:

https://www.raspberrypi.org/downloads. . . /

2.4.2 Shared

On all raspberry pis, after installing the operating system you should. . .

Basic Configuration

- Change the password using `passwd`
- Update and upgrade system packages with `sudo apt update && sudo apt upgrade -y`
- Use `sudo raspi-config` to configure
  - localization settings and timezone
  - enable SSH access
  - enable WiFi access (if needed)
- If enabling SSH, install an RSA key and disable password access - see https://wiki.auto-pi-lot.com/index.php/SSH

Install system packages

Install the following system packages from apt:

```
sudo apt install -y \
  git \
  python3-pip \
  openssl \
  build-essential \
  libssl-dev \
  libffi-dev \
  libjpeg-dev \
  zlib1g-dev \
  libatlas-base-dev \
  gfortran \
  libhdf5-dev \
  cmake \
  ninja-build \
  libopenjp2-7 \
  libtiff5
```

Upgrade pip:

```
pip install --upgrade pip
```

Install perceptivo

Clone the repository and enter the directory

```
git clone https://github.com/perceptivo/perceptivo
cd perceptivo
```

Depending on which raspi this is, you need to specify some additional, optional packages:

patient

```
poetry install -E patient
```

Clinician

```
poetry install -E clinician
```

2.4.3 Patient

Install additional post-install dependencies using perceptivo & autopilot scripts

- Install jackd audio from source using `jackd_source` script
- Do performance-enhancing tweaks using `performance`
- Enable hifiberry DAC / ADC Pro

Call

```
python -m perceptivo.setup --patient
```

and then restart.

Audio

Depending on the raspberry pi, you might need some additional configuration to tell alsa which sound card to use. By default, autopilot creates an alsa configuration file that points to the 0th card.

To tell which card to use…

```
>>> aplay -l

**** List of PLAYBACK Hardware Devices ****
card 0: vc4hdmi0 [vc4-hdmi-0], device 0: MAI PCM i2s-hifi-0 [MAI PCM i2s-hifi-0]
  Subdevices: 1/1
  Subdevice #0: subdevice #0
card 1: vc4hdmi1 [vc4-hdmi-1], device 0: MAI PCM i2s-hifi-0 [MAI PCM i2s-hifi-0]
  Subdevices: 1/1
  Subdevice #0: subdevice #0
card 2: sndrpihifiberry [snd_rpi_hifiberry_dacplusadcpro], device 0: HiFiBerry DAC+ADC␣
↪Pro HiFi multicodec-0 [HiFiBerry DAC+ADC Pro HiFi multicodec-0]
  Subdevices: 0/1
  Subdevice #0: subdevice #0
```

in this case we want to use card 2, so we replace that number in `/etc/asound.conf`

2.5 Configuration

Each runtime has its own class of prefs that define their operation. By default, the runtimes will attempt to load them from the default location specified in the *Directories* object:

class perceptivo.**Directories**(*user_dir: pathlib.Path = PosixPath('/home/docs/.perceptivo')*, *prefs_file: pathlib.Path = PosixPath('/home/docs/.perceptivo/prefs.json')*, *log_dir: pathlib.Path = PosixPath('/home/docs/.perceptivo/logs')*)

Bases: object

user_dir: pathlib.Path = PosixPath('/home/docs/.perceptivo')

prefs_file: pathlib.Path = PosixPath('/home/docs/.perceptivo/prefs.json')

log_dir: pathlib.Path = PosixPath('/home/docs/.perceptivo/logs')

CHAPTER

THREE

META

3.1 Project Status

High-level overview of Perceptivo's status.

Last Updated

November 2022

See also:

- *Roadmap* for high-level development plan and milestones
- *TODO* for more specific lower-level requirements.

3.1.1 Roadmap

High-level overview of phases of development. Specific code-level TODO items should be put in *TODO*

Completed

- `2021-06-30` - **Design Draft** - Initial system diagrams for hardware and software
- `2021-08-09` - **Software Scaffold** - Structure of package
- `2021-08-23` - **GUI Draft** - Initial visual draft of GUI
- `2021-08-27` - **Networking Architecture** - Draft of socket types and distribution among patient and clinicial classes
- `2021-10-20` - **Gammatone Synthesis**
- `2021-11-08` - **Audiogram Estimation** - Algorithm to estimate audiogram from minimal number of samples
- `2021-12-15` - **Patient Loop Structure** - A full draft of the structure of the patient processing loop
- `2022-01-05` - **Audio Output** - using Soundcard library
- `2022-02-16` - **Pupil Extraction** - Implementation of a simplistic pupil extraction system using traditional image processing
- `2022-02-28` - **Patient Loop Integration** - Integration of components into a running patient loop

Remaining

- **Refine Pupil Extraction** - The existing pupil extraction is very basic, this will need to get refined and made customizable by the clinician
- **Perf in Patient Loop** - The patient loop has been written and has a modular structure, but none of its components have been optimized for performance.
- **Networking** - A shell structure for networking components using sockets and message types has been written, but the communication between runtimes needs to be written and hooked up to the relevant actions
- **Visual Stimuli** - The stimuli used to keep the patient's attention are unimplemented
- **Hardware Design** - The hardware design has been drafted and parts picked, but much of the work on the hardware remains: testing, calibrating, and packaging
- **UX/UI** - The GUI is, at the moment, an extremely gestural shell, and so the UX/UI will need to be completed and user tested
- **Validation** - Everything needs to be validated with a patient! Including audiogram estimation, sound output, etc.

3.1.2 TODO

Sound

- Calibrate sound output to relate amplitudes 0-1 to dbSPL
- Translation back and forth between Bark and Hz

GUI

- Connect rest of exam params to gui elements

Code Cleanup

- So much.
- Relate *perceptivo.types.gui.GUI_Params* to *perceptivo.types.exam.Exam_Params* so that GUI elements can be derived from control parameters

Documentation

- Preferences and how they interact with the different runtimes.
- How to use logging
- Directory structure within the repository

3.1.3 Software

See the *Software Overview* for a description of how the package is designed.

The structure of the software has been largely completed such that all the remaining pieces should have some relatively clear place to go and defined way of interacting with the existing components. The remaining work can be roughly put in three groups:

Patient Runtime

The patient loop is in a runnable state, and has baseline implementations of all its major components: sound synthesis & output, video capture, pupil extraction, and audiogram estimation. This is where most of the development time has been spent to-date. All could use some optimization, particularly the video capture and pupil extraction systems, which need probably significant performance optimization. The visual stimuli to keep attention are also not implemented yet, but that should be relatively straightforward to do in psychopy or similar. That might need to be written as a third runtime, depending on the perf that can be squeezed out of the pi. If all else fails, effectively all of this code except the specific usage of the picamera can be trivially ported to more powerful hardware.

Clinician Runtime

The clinician runtime is the means by which the clinician administers the exam and manages patient data. Currently it has a *very* rough GUI in place, with points of extension for future work, but beyond that needs to have most of its functionality implemented. This should be done keeping Qt's signal/slot architecture in mind, as its pretty compatible with the message-passing style intended to be used in the rest of the system. So signals/slots need to be be made that match the configuration and use of the patient runtime, and then hooked up with the networking modules.

Integration

The last bit of work before user testing and finishing the industrial design will be on system integration: getting the two (potentially three) runtimes to work together. The only really synchronization-critical part of the system is between the sound output and the image acquisition, but even that can be somewhat asynchronous as long as the time of acquisition is known and comparable to the time of audio presentation. The rest of the system can be asynchronous up to the allowance of UX - eg. depending on streaming latencies that are tolerable in the clinician GUI. The package is written in python as a prototype, so performance optimization might require some of those components be rewritten in a compiled language to make smooth.

The actual work of integration will consist of hooking up the methods of the various runtimes to networking objects, operationalized by sockets, each of the runtimes having several depending on the independent components. Within a runtime (ie. on the same computer) IPC can be used so that the components can be made to run independently (eg. as different processes), and between runtimes TCP is good for commands and UDP is good for streaming. That should all be configurable in the `Socket` class, which is consumed by `Node`.

Afterwards, in order to make the product marketable, more work will be needed to polish it, finish the industrial design, branding, etc. but the above steps should make it at least functional.

> **Warning:** Special care will need to be taken to make sure that the open source licenses of the projects used within are respected - specifically any projects that use strong copyleft licenses like GPL-3.0 - if the end-product will be distributed in a proprietary way. Please note that python is very difficult to distribute in a way that's hard to reverse engineer, and so it would be trivial for someone to dump the contents of the raspi flash drive to see the source.
>
> Rather than distribute it in a proprietary way, I would consider keeping the source open and patenting it for commercial use (eg. other people can use and inspect the source, just not for commercial purposes).

3.1.4 Hardware

The hardware has been specified on a draft level, and some initial usability testing was done with the picamera to make sure it worked with a raspiOS update (buster) that happened during primary development, but much of the rest of the hardware remains to be designed and built.

3.2 Developer Docs

3.2.1 Packaging

3.3 References

CHAPTER

FOUR

API DOCS

Modules are described in the *Software Overview*

4.1 runtimes

class perceptivo.runtimes.runtime.**Runtime**(***kwargs*)

Bases: *perceptivo.root.Perceptivo_Object*

Root object for the various perceptivo runtime objects, *Patient*, and *clinician.Clinician*.

(at the moment empty, but kept as a scaffold for shared functionality)

property procs: List[subprocess.Popen]

List of processes opened by this runtime agent!

Returns typing.List[subprocess.Popen]

abstract property prefs_class: Type[*perceptivo.prefs.Prefs*]

load_prefs(*prefs_file: Optional[pathlib.Path] = None*) → Union[*perceptivo.prefs.Prefs*, *perceptivo.prefs.Patient_Prefs*, *perceptivo.prefs.Clinician_Prefs*]

Load prefs file. If defaults haven't already been dumped to a `prefs.json` file, do so.

Parameters **prefs_file** (*Path*) – *prefs.json* file to load. if None, use `Runtime.prefs_file`

Returns *perceptivo.prefs.Prefs* a subtype of prefs, specified by *Runtime.prefs_class*

classmethod make_default_prefs(*path: Optional[pathlib.Path] = None*)

perceptivo.runtimes.runtime.**base_args**(*parser: argparse.ArgumentParser*) → argparse.ArgumentParser

4.1.1 clinician

entrypoint for clinician interface

perceptivo.runtimes.clinician.**clinician_parser**(*manual_args: Optional[List[str]] = None*) → argparse.Namespace

class perceptivo.runtimes.clinician.**Clinician**(*networking: Optional[*perceptivo.types.networking.Clinician_Networking*] = None*, *prefs_file: pathlib.Path = PosixPath('/home/docs/.perceptivo/prefs.json')*, ***kwargs*)

Bases: *perceptivo.runtimes.runtime.Runtime*

prefs_class

alias of *perceptivo.prefs.Clinician_Prefs*

init_gui()

perceptivo.runtimes.clinician.**main**()

4.1.2 patient

entrypoint for patient interface

class perceptivo.runtimes.patient.**Patient**(*audio_config:* perceptivo.types.sound.Audio_Config = *Audio_Config(fs=44100)*, *audiogram_model: Optional[*perceptivo.types.psychophys.Psychoacoustic_Model*]* = *None*, *picamera_params: Optional[*perceptivo.types.video.Picamera_Params*]* = *None*, *oracle: Optional[callable]* = *None*, *pupil_extractor: Optional[*perceptivo.video.pupil.Pupil_Extractors*]* = *None*, *pupil_extractor_params: Optional[*perceptivo.video.pupil.EllipseExtractor_Params*]* = *None*, *networking: Optional[*perceptivo.types.networking.Patient_Networking*]* = *None*, *prefs_file: pathlib.Path* = *PosixPath('/home/docs/.perceptivo/prefs.json')*, ***kwargs*)

Bases: *perceptivo.runtimes.runtime.Runtime*

Runtime agent for the patient-facing Pi (see SoftwareOverview).

Runs the

- Sound Server
- PiCamera
- Processing stages including pupil extraction, psychoacoustic model, and stimulus manager

On intialization, boot the sound server and rehydrate the psychoacoustic model from the parameterization passed in `audiogram_model`. The patient runtime is parameterized by the *perceptivo.prefs.Patient_Prefs* object, which creates and reads from a `prefs.json` file (located at `perceptivo.prefs.Directories.prefs_file`).

The basic operation of the Patient runtime is encapsulated in the *trial()* method, see that for further documentation.

Parameters

- **audio_config** (*Jackd_Config*) – Configuration used to boot the jackd server
- **audiogram_model** (*Psychoacoustic_Model*) – Model parameterization used to model the audiogram as well as generate optimal stimuli to sample
- **oracle** (*callable*) – Optional, if present use an oracle to generate responses to stimuli rather than getting them from the pupil extraction method. Mostly for testing, takes a function that accepts a *Sound* object and returns a boolean response, typically generated by functions in *oracle* like *reference_audiogram()*

prefs_class

alias of *perceptivo.prefs.Patient_Prefs*

trial() → *perceptivo.types.psychophys.Sample*

One complete loop through a probe cycle. In order:

- check if a previous trial is still running using the `_trial_active` event, if so, return, logging an exception
- clear the lists that collect pupil samples: `_frames` and `_pupils`
- *next_sound()* to parameterize the next sound, returning a *types.sound.Sound* object, based on the output of the *Audiogram_Model.next()* method
- *probe()* to deliver the sound and collect the response. Within the probe method:
  - the *Picamera_Process.collecting* flag is set to indicate that it should dump frames into its queue
  - the sound is played with *play_sound()*
  - the *await_response()* method spawns a `_collecting_thread`, which calls *_collect_frames()* to pull frames from *Picamera_Process.q* and process them with `pupil_extractor` until the queue is empty. *types.video.Frame* s and *types.pupil.Pupil* s are appended to the `_frames` and `_pupils` collectors
  - once the thread finishes, the picamera's collection event is cleared, and the *types.pupil.Pupil_Params*, which set the threshold of dilation that constitutes a positive response to the sound is updated with *_update_pupil_params()*
  - The *Pupil_Params*, *Sound*, and list of *Pupil* objects are collected into a *Dilation* object and returned
- the *probe()* method then combines the *Sound* and *Dilation* objects into a *Sample* object, which is then appended to the *samples* attr
- Finally, the `model` is updated with the `update_model()`

Stores the *Samples* in *samples*, which also include the parameterizations and timestamps of the presented sounds

next_sound() → *perceptivo.types.sound.Sound*

Generate the next sound using the psychoacoustic `model`

Returns *Sound* to play

probe(*sound:* perceptivo.types.sound.Sound) → Optional[*perceptivo.types.psychophys.Sample*]

One loop of

- Presenting a sound stimulus
- Signaling to the other Pi to present a visual stimulus
- Estimating the Pupil Response

Returns *perceptivo.types.psychophys.Sample*

play_sound(*sound:* perceptivo.types.sound.Sound) → *perceptivo.types.sound.Sound*

Play a parameterized sound

Parameters **sound** ()

Returns *Sound*

await_response(*sound:* perceptivo.types.sound.Sound) → Optional[*perceptivo.types.pupil.Dilation*]

Wait until we are given a pupil from the picamera process

Returns bool

_collect_frames(*start_time: datetime.datetime*)

Collect frames from the picamera for one sample

handle_message(*message*)

Handle a message by calling some method according to its `key` attribute

Parameters **message** (*bytes*) – a serialized `networking.messages.Message` object

cb_control(*control: Union[*perceptivo.types.gui.GUI_Control*, Dict[str,* perceptivo.types.gui.GUI_Control*]]*)

Handle GUI Control messages.

Parameters **control** ()

Returns:

cb_start(*params: Union[*perceptivo.types.exam.Exam_Params*, Dict[str,* perceptivo.types.exam.Exam_Params*]]*)

Start the exam!

Parameters **params** (`types.exam.Exam_Params`) – Parameters to run the exam!

cb_stop(*value=None*)

Stop the exam :Parameters: **value** ()

Returns:

_update_pupil_params(*pupils: List[*perceptivo.types.pupil.Pupil*]*) → *perceptivo.types.pupil.Pupil_Params*

Parameters **pupils** ()

Returns:

_init_audio() → Union[autopilot.stim.sound.jackclient.JackClient, soundcard.pulseaudio._Speaker]

Start the jackd process, connect a client to it!

Returns `autopilot.stim.sound.jackclient.JackClient` - A booted jack client!

perceptivo.runtimes.patient.**patient_parser**(*manual_args: Optional[List[str]] = None*) → argparse.Namespace

perceptivo.runtimes.patient.**main**()

4.2 data

Data

4.2.1 logging

Logging and debugging tools

perceptivo.data.logging._LOGGERS: list = []

List of instantiated loggers, used in *init_logger()* to return existing loggers without modification

perceptivo.data.logging.**init_logger**(*instance=None*, *module_name=None*, *class_name=None*, *object_name=None*, *loglevel: Optional[str] = None*) → logging.Logger

Initialize a logger

Loggers are created such that…

- There is one logger per module (eg. all gpio objects will log to hardware.gpio)
- If the passed object has a `name` attribute, that name will be prefixed to its log messages in the file
- The loglevel for the file handler and the stdout is determined by `prefs.get('LOGLEVEL')`, and if none is provided `WARNING` is used by default
- logs are rotated according to `prefs.get('LOGSIZE')` (in bytes) and `prefs.get('LOGNUM')` (number of backups of `prefs.get('LOGSIZE')` to cycle through)

Logs are stored in `prefs.get('LOGDIR')`, and are formatted like:

```
"%(asctime)s - %(name)s - %(levelname)s : %(message)s"
```

Loggers can be initialized either by passing an object to the first `instance` argument, or by specifying any of `module_name` , `class_name` , or `object_name` (at least one must be specified) which are combined with periods like `module.class_name.object_name`

Parameters

- **instance** – The object that we are creating a logger for! if None, at least one of `module, class_name, or object_name` must be passed
- **module_name** (*None, str*) – If no `instance` passed, the module name to create a logger for
- **class_name** (*None, str*) – If no `instance` passed, the class name to create a logger for
- **object_name** (*None, str*) – If no `instance` passed, the object name/id to create a logger for

Returns `logging.logger`

4.2.2 patient

class perceptivo.data.patient.**Patient_Data**(*name: str*, *dob: datetime.date*)

Bases: `object`

Container for patient-specific data

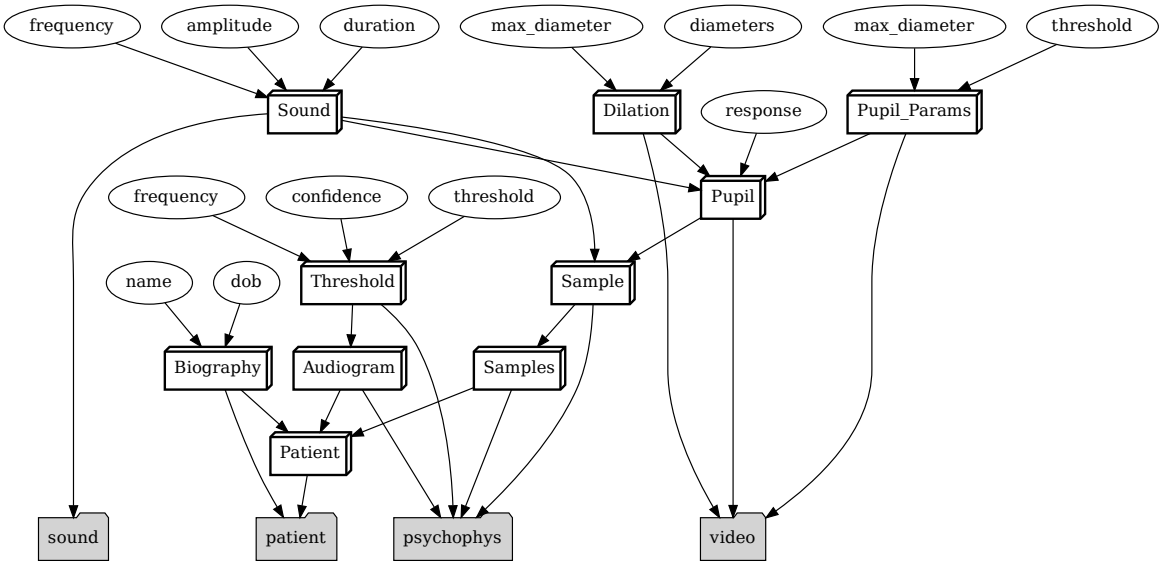
name: `str`

dob: `datetime.date`

4.3 types

Representations of data and parameters used throughout the system.

Here are some of the basic relationships between the basic types mapped to show how they relate in order to derive a patient's audiogram



Data types to keep inter-module communication consistent

4.3.1 exam

Types for controlling the administration of the examination

pydantic model perceptivo.types.exam.**Completion_Metric**

Bases: perceptivo.types.root.PerceptivoType

A means of deciding whether the exam is completed or not

Create a new model by parsing and validating input data from keyword arguments.

Raises ValidationError if the input data cannot be parsed to form a valid model.


```
{
   "title": "Completion_Metric",
   "description": "A means of deciding whether the exam is completed or not",
   "type": "object",
   "properties": {
      "log_likelihood": {
         "title": "Log Likelihood",
         "default": -70,
         "type": "number"
      },
      "n_trials": {
         "title": "N Trials",
```


(continues on next page)

(continued from previous page)


```
            "type": "integer"
        },
        "duration": {
            "title": "Duration",
            "type": "number"
        },
        "use": {
            "title": "Use",
            "default": "any",
            "type": "string"
        }
    }
}
```


Config

- **json_encoders**: *dict = {<class 'numpy.ndarray'>: <function pack_array at 0x7f07dd6cfdc0>, <class 'datetime.datetime'>: <function PerceptivoType.Config.<lambda> at 0x7f07dd6c91f0>}*
- **underscore_attrs_are_private**: *bool = True*

Fields

- *duration (Optional[float])*
- *log_likelihood (Optional[float])*
- *n_trials (Optional[int])*
- *use (str)*

field log_likelihood: Optional[float] = -70

End exam when log likelihood of model is below this value

field n_trials: Optional[int] = None

End exam after n trials

field duration: Optional[float] = None

End exam after n minutes

field use: str = 'any'

Name of which (non-None) metric to use. Default `any` for ending exam if any of the criteria are met

pydantic model perceptivo.types.exam.**Exam_Params**

Bases: `perceptivo.types.root.PerceptivoType`

Create a new model by parsing and validating input data from keyword arguments.

Raises ValidationError if the input data cannot be parsed to form a valid model.


```
{
   "title": "Exam_Params",
   "type": "object",
   "properties": {
      "frequencies": {
         "title": "Frequencies",
```


(continues on next page)

(continued from previous page)


```
            "type": "array",
            "minItems": 1,
            "maxItems": 1,
            "items": [
               {
                  "type": "number"
               }
            ]
         },
         "amplitudes": {
            "title": "Amplitudes",
            "type": "array",
            "minItems": 1,
            "maxItems": 1,
            "items": [
               {
                  "type": "number"
               }
            ]
         },
         "iti": {
            "title": "Iti",
            "type": "number"
         },
         "iti_jitter": {
            "title": "Iti Jitter",
            "default": 0.1,
            "type": "number"
         },
         "completion_metric": {
            "title": "Completion Metric",
            "default": {
               "log_likelihood": -70,
               "n_trials": null,
               "duration": null,
               "use": "any"
            },
            "allOf": [
               {
                  "$ref": "#/definitions/Completion_Metric"
               }
            ]
         },
         "allow_repeats": {
            "title": "Allow Repeats",
            "default": false,
            "type": "boolean"
         }
      },
      "required": [
         "frequencies",
         "amplitudes",
```


(continues on next page)

(continued from previous page)


```
      "iti"
   ],
   "definitions": {
      "Completion_Metric": {
         "title": "Completion_Metric",
         "description": "A means of deciding whether the exam is completed or not",
         "type": "object",
         "properties": {
            "log_likelihood": {
               "title": "Log Likelihood",
               "default": -70,
               "type": "number"
            },
            "n_trials": {
               "title": "N Trials",
               "type": "integer"
            },
            "duration": {
               "title": "Duration",
               "type": "number"
            },
            "use": {
               "title": "Use",
               "default": "any",
               "type": "string"
            }
         }
      }
   }
}
```


Config

- **json_encoders**: *dict = {<class 'numpy.ndarray'>: <function pack_array at 0x7f07dd6cfdc0>, <class 'datetime.datetime'>: <function PerceptivoType.Config.<lambda> at 0x7f07dd6c91f0>}*
- **underscore_attrs_are_private**: *bool = True*

Fields

- *allow_repeats (bool)*
- *amplitudes (Tuple[float])*
- *completion_metric (perceptivo.types.exam.Completion_Metric)*
- *frequencies (Tuple[float])*
- *iti (float)*
- *iti_jitter (float)*

field frequencies: Tuple[float] [Required]

Frequencies (Hz) to test in exam

field amplitudes: Tuple[float] [Required]

Amplitudes (dbSPL) to test in exam

field iti: float [Required]

Seconds between each trial

field iti_jitter: float = 0.1

Amount to jitter trials as a proportion of the ITI (eg. 0.1 for an iti of 5s would be maximum 0.5s of jitter)

field completion_metric: *perceptivo.types.exam.Completion_Metric* = Completion_Metric(log_likelihood=-70, n_trials=None, duration=None, use='any')

Metric that decides when the exam is over.

field allow_repeats: bool = False

Allow repeated sounds

4.3.2 gui

perceptivo.types.gui.**GUI_PARAM_KEY**

Possible keys for GUI parameters.

- `frequencies` - a tuple of frequencies to test
- `amplitudes` - a tuple of amplitudes to test
- `log_x` - boolean indicating whether an x-axis should be log scaled (True) or linearly scaled
- `log_y` - boolean indicating whether a y-axis should be log scaled (True) or linearly scaled
- `extra_amplitude` - boolean indicating whether an additional, suprathreshold amplitude should be tested as a confirmation
- `amplitude_step` - Step size of amplitudes to test in dB

alias of `Literal`['frequencies', 'amplitudes', 'log_x', 'log_y', 'extra_amplitude', 'amplitude_step', 'amplitude_range', 'max_amplitude', 'frequency_step', 'frequency_range', 'iti', 'iti_jitter']

perceptivo.types.gui.**GUI_WIDGET_TYPE**

Widget types that correspond to particular Qt Widgets

- `int`, `float` - `PySide.QtWidgets.QSpinBox` and `PySide.QtWidgets.QDoubleSpinBox`
- `range` - *widgets.components.Range_Setter*
- `tuple` - `PySide.QtWidgets.QLineEdit` evaluated by `ast.literal_eval`
- `bool` - `PySide.QtWidgets.QCheckBox`

alias of `Literal`['int', 'float', 'range', 'tuple', 'bool']

pydantic model perceptivo.types.gui.**GUI_Control**

Bases: `perceptivo.types.root.PerceptivoType`

Container for GUI_Params in transit

Create a new model by parsing and validating input data from keyword arguments.

Raises ValidationError if the input data cannot be parsed to form a valid model.

```
{
   "title": "GUI_Control",
   "description": "Container for GUI_Params in transit",
   "type": "object",
   "properties": {
      "key": {
         "title": "Key",
         "enum": [
            "frequencies",
            "amplitudes",
            "log_x",
            "log_y",
            "extra_amplitude",
            "amplitude_step",
            "amplitude_range",
            "max_amplitude",
            "frequency_step",
            "frequency_range",
            "iti",
            "iti_jitter"
         ],
         "type": "string"
      },
      "value": {
         "title": "Value",
         "anyOf": [
            {
               "type": "string"
            },
            {
               "type": "number"
            },
            {
               "type": "array",
               "items": {}
            }
         ]
      }
   },
   "required": [
      "key",
      "value"
   ]
}
```


Config

- **json_encoders**: *dict = {<class 'numpy.ndarray'>: <function pack_array at 0x7f07dd6cfdc0>, <class 'datetime.datetime'>: <function PerceptivoType.Config.<lambda> at 0x7f07dd6c91f0>}*
- **underscore_attrs_are_private**: *bool = True*

Fields

- *key (Literal['frequencies', 'amplitudes', 'log_x', 'log_y', 'extra_amplitude', 'amplitude_step', 'amplitude_range', 'max_amplitude', 'frequency_step', 'frequency_range', 'iti', 'iti_jitter'])*
- *value (Union[str, float, tuple])*

field key: Literal['frequencies', 'amplitudes', 'log_x', 'log_y', 'extra_amplitude', 'amplitude_step', 'amplitude_range', 'max_amplitude', 'frequency_step', 'frequency_range', 'iti', 'iti_jitter'] [Required]

field value: Union[str, float, tuple] [Required]

pydantic model perceptivo.types.gui.**GUI_Range**

Bases: perceptivo.types.root.PerceptivoType

Range for *widgets.components.Range_Setter*

Create a new model by parsing and validating input data from keyword arguments.

Raises ValidationError if the input data cannot be parsed to form a valid model.


```
{
   "title": "GUI_Range",
   "description": "Range for :class:`.widgets.components.Range_Setter`",
   "type": "object",
   "properties": {
      "min": {
         "title": "Min",
         "type": "number"
      },
      "max": {
         "title": "Max",
         "type": "number"
      },
      "n": {
         "title": "N",
         "type": "integer"
      }
   },
   "required": [
      "min",
      "max",
      "n"
   ]
}
```


Config

- **json_encoders**: *dict = {<class 'numpy.ndarray'>: <function pack_array at 0x7f07dd6cfdc0>, <class 'datetime.datetime'>: <function PerceptivoType.Config.<lambda> at 0x7f07dd6c91f0>}*
- **underscore_attrs_are_private**: *bool = True*

Fields

- *max (float)*

- *min (float)*
- *n (int)*

field min: float **[Required]**

field max: float **[Required]**

field n: int **[Required]**

pydantic model perceptivo.types.gui.**GUI_Param**

Bases: perceptivo.types.root.PerceptivoType

Parameterization for a GUI Parameter itself. ie. How a particular parameter should be represented.

Params: key (GUI_PARAMS): the key used for the parameter name (str): A human readable name for the parameter widget_type (GUI_WIDGETS): A string that indicates the type of widget that should be used.

Different `widget_type` s may use different widgets, combinations of widgets, and validators, and are thus not strictly isomorphic to a single widget type.

default (any): the default value to be set, must correspond to widget type args (list): args to pass to the widget kwargs (dict): kwargs to pass to the widget

Create a new model by parsing and validating input data from keyword arguments.

Raises ValidationError if the input data cannot be parsed to form a valid model.


```
{
   "title": "GUI_Param",
   "description": "Parameterization for a GUI Parameter itself. ie. How a␣
↪particular parameter should be represented.\n\nParams:\n    key (GUI_PARAMS): the␣
↪key used for the parameter\n    name (str): A human readable name for the␣
↪parameter\n    widget_type (GUI_WIDGETS): A string that indicates the type of␣
↪widget that should be used.\n        Different ``widget_type`` s may use␣
↪different widgets, combinations of widgets, and\n        validators, and are thus␣
↪not strictly isomorphic to a single widget type.\n    default (any): the default␣
↪value to be set, must correspond to widget type\n    args (list): args to pass to␣
↪the widget\n    kwargs (dict): kwargs to pass to the widget",
   "type": "object",
   "properties": {
      "key": {
         "title": "Key",
         "enum": [
            "frequencies",
            "amplitudes",
            "log_x",
            "log_y",
            "extra_amplitude",
            "amplitude_step",
            "amplitude_range",
            "max_amplitude",
            "frequency_step",
            "frequency_range",
            "iti",
            "iti_jitter"
         ],
```


(continues on next page)

(continued from previous page)


```
            "type": "string"
        },
        "name": {
            "title": "Name",
            "type": "string"
        },
        "widget_type": {
            "title": "Widget Type",
            "enum": [
                "int",
                "float",
                "range",
                "tuple",
                "bool"
            ],
            "type": "string"
        },
        "default": {
            "title": "Default",
            "anyOf": [
                {
                    "type": "number"
                },
                {
                    "type": "integer"
                },
                {
                    "$ref": "#/definitions/GUI_Range"
                },
                {
                    "type": "array",
                    "items": {}
                }
            ]
        },
        "args": {
            "title": "Args",
            "type": "array",
            "items": {}
        },
        "kwargs": {
            "title": "Kwargs",
            "type": "object"
        }
    },
    "required": [
        "key",
        "name",
        "widget_type"
    ],
    "definitions": {
        "GUI_Range": {
```


(continues on next page)

(continued from previous page)


```
        "title": "GUI_Range",
        "description": "Range for :class:`.widgets.components.Range_Setter`",
        "type": "object",
        "properties": {
           "min": {
              "title": "Min",
              "type": "number"
           },
           "max": {
              "title": "Max",
              "type": "number"
           },
           "n": {
              "title": "N",
              "type": "integer"
           }
        },
        "required": [
           "min",
           "max",
           "n"
        ]
     }
  }
}
```


Config

- **json_encoders**: *dict = {<class 'numpy.ndarray'>: <function pack_array at 0x7f07dd6cfdc0>, <class 'datetime.datetime'>: <function PerceptivoType.Config.<lambda> at 0x7f07dd6c91f0>}*
- **underscore_attrs_are_private**: *bool = True*

Fields

- *args (list)*
- *default (Optional[Union[float, int, perceptivo.types.gui.GUI_Range, tuple]])*
- *key (Literal['frequencies', 'amplitudes', 'log_x', 'log_y', 'extra_amplitude', 'amplitude_step', 'amplitude_range', 'max_amplitude', 'frequency_step', 'frequency_range', 'iti', 'iti_jitter'])*
- *kwargs (dict)*
- *name (str)*
- *widget_type (Literal['int', 'float', 'range', 'tuple', 'bool'])*

field key: Literal['frequencies', 'amplitudes', 'log_x', 'log_y', 'extra_amplitude', 'amplitude_step', 'amplitude_range', 'max_amplitude', 'frequency_step', 'frequency_range', 'iti', 'iti_jitter'] [Required]

field name: str [Required]

field widget_type: Literal['int', 'float', 'range', 'tuple', 'bool'] [Required]

field default: Optional[Union[float, int, *perceptivo.types.gui.GUI_Range*, tuple]] = None

field args: list [Optional]

field kwargs: dict [Optional]

pydantic model perceptivo.types.gui.**Control_Panel_Params**

Bases: perceptivo.types.root.PerceptivoType

Defaults and parameters for perceptivo.gui.widgets.Control_Panel

Create a new model by parsing and validating input data from keyword arguments.

Raises ValidationError if the input data cannot be parsed to form a valid model.


```
{
   "title": "Control_Panel_Params",
   "description": "Defaults and parameters for :class:`perceptivo.gui.widgets.
↪Control_Panel`",
   "type": "object",
   "properties": {
      "amplitude_range": {
         "title": "Amplitude Range",
         "default": {
            "key": "amplitude_range",
            "name": "Amplitude Range (dBSPL)",
            "widget_type": "range",
            "default": {
               "min": 0.0,
               "max": 80.0,
               "n": 8
            },
            "args": [],
            "kwargs": {
               "limits": [
                  0,
                  100
               ]
            }
         },
         "allOf": [
            {
               "$ref": "#/definitions/GUI_Param"
            }
         ]
      },
      "frequency_range": {
         "title": "Frequency Range",
         "default": {
            "key": "frequency_range",
            "name": "Frequency Range (Hz)",
            "widget_type": "range",
            "default": {
```


(continues on next page)

(continued from previous page)


```
                "min": 0.0,
                "max": 8000.0,
                "n": 17
            },
            "args": [],
            "kwargs": {
               "limits": [
                  0,
                  20000
               ]
            }
         },
         "allOf": [
            {
               "$ref": "#/definitions/GUI_Param"
            }
         ]
      },
      "iti": {
         "title": "Iti",
         "default": {
            "key": "iti",
            "name": "Inter-Trial Interval (s)",
            "widget_type": "float",
            "default": 5.0,
            "args": [],
            "kwargs": {}
         },
         "allOf": [
            {
               "$ref": "#/definitions/GUI_Param"
            }
         ]
      },
      "iti_jitter": {
         "title": "Iti Jitter",
         "default": {
            "key": "iti_jitter",
            "name": "Inter-Trial Jitter (proportion of ITI)",
            "widget_type": "float",
            "default": 0.1,
            "args": [],
            "kwargs": {}
         },
         "allOf": [
            {
               "$ref": "#/definitions/GUI_Param"
            }
         ]
      }
   },
   "definitions": {
```


(continues on next page)

(continued from previous page)


```
      "GUI_Range": {
         "title": "GUI_Range",
         "description": "Range for :class:`.widgets.components.Range_Setter`",
         "type": "object",
         "properties": {
            "min": {
               "title": "Min",
               "type": "number"
            },
            "max": {
               "title": "Max",
               "type": "number"
            },
            "n": {
               "title": "N",
               "type": "integer"
            }
         },
         "required": [
            "min",
            "max",
            "n"
         ]
      },
      "GUI_Param": {
         "title": "GUI_Param",
         "description": "Parameterization for a GUI Parameter itself. ie. How a␣
↪particular parameter should be represented.\n\nParams:\n    key (GUI_PARAMS): the␣
↪key used for the parameter\n    name (str): A human readable name for the␣
↪parameter\n    widget_type (GUI_WIDGETS): A string that indicates the type of␣
↪widget that should be used.\n        Different ``widget_type`` s may use␣
↪different widgets, combinations of widgets, and\n        validators, and are thus␣
↪not strictly isomorphic to a single widget type.\n    default (any): the default␣
↪value to be set, must correspond to widget type\n    args (list): args to pass to␣
↪the widget\n    kwargs (dict): kwargs to pass to the widget",
         "type": "object",
         "properties": {
            "key": {
               "title": "Key",
               "enum": [
                  "frequencies",
                  "amplitudes",
                  "log_x",
                  "log_y",
                  "extra_amplitude",
                  "amplitude_step",
                  "amplitude_range",
                  "max_amplitude",
                  "frequency_step",
                  "frequency_range",
                  "iti",
                  "iti_jitter"
```


(continues on next page)

(continued from previous page)

```
            ],
            "type": "string"
         },
         "name": {
            "title": "Name",
            "type": "string"
         },
         "widget_type": {
            "title": "Widget Type",
            "enum": [
               "int",
               "float",
               "range",
               "tuple",
               "bool"
            ],
            "type": "string"
         },
         "default": {
            "title": "Default",
            "anyOf": [
               {
                  "type": "number"
               },
               {
                  "type": "integer"
               },
               {
                  "$ref": "#/definitions/GUI_Range"
               },
               {
                  "type": "array",
                  "items": {}
               }
            ]
         },
         "args": {
            "title": "Args",
            "type": "array",
            "items": {}
         },
         "kwargs": {
            "title": "Kwargs",
            "type": "object"
         }
      },
      "required": [
         "key",
         "name",
         "widget_type"
      ]
   }
```

(continues on next page)

(continued from previous page)

```
    }
}
```

Config

- **json_encoders**: *dict = {<class 'numpy.ndarray'>: <function pack_array at 0x7f07dd6cfdc0>, <class 'datetime.datetime'>: <function PerceptivoType.Config.<lambda> at 0x7f07dd6c91f0>}*
- **underscore_attrs_are_private**: *bool = True*

Fields

pydantic model perceptivo.types.gui.**GUI_Params**

Bases: perceptivo.types.root.PerceptivoType

Container for all parameters to be given to the GUI on init

Create a new model by parsing and validating input data from keyword arguments.

Raises ValidationError if the input data cannot be parsed to form a valid model.


```
{
   "title": "GUI_Params",
   "description": "Container for all parameters to be given to the GUI on init",
   "type": "object",
   "properties": {
      "control_panel": {
         "title": "Control Panel",
         "default": {
            "amplitude_range": {
               "key": "amplitude_range",
               "name": "Amplitude Range (dBSPL)",
               "widget_type": "range",
               "default": {
                  "min": 0.0,
                  "max": 80.0,
                  "n": 8
               },
               "args": [],
               "kwargs": {
                  "limits": [
                     0,
                     100
                  ]
               }
            },
            "frequency_range": {
               "key": "frequency_range",
               "name": "Frequency Range (Hz)",
               "widget_type": "range",
               "default": {
                  "min": 0.0,
                  "max": 8000.0,
```


(continues on next page)

(continued from previous page)


```
                "n": 17
            },
            "args": [],
            "kwargs": {
               "limits": [
                  0,
                  20000
               ]
            }
         },
         "iti": {
            "key": "iti",
            "name": "Inter-Trial Interval (s)",
            "widget_type": "float",
            "default": 5.0,
            "args": [],
            "kwargs": {}
         },
         "iti_jitter": {
            "key": "iti_jitter",
            "name": "Inter-Trial Jitter (proportion of ITI)",
            "widget_type": "float",
            "default": 0.1,
            "args": [],
            "kwargs": {}
         }
      },
      "allOf": [
         {
            "$ref": "#/definitions/Control_Panel_Params"
         }
      ]
   }
},
"definitions": {
   "GUI_Range": {
      "title": "GUI_Range",
      "description": "Range for :class:`.widgets.components.Range_Setter`",
      "type": "object",
      "properties": {
         "min": {
            "title": "Min",
            "type": "number"
         },
         "max": {
            "title": "Max",
            "type": "number"
         },
         "n": {
            "title": "N",
            "type": "integer"
         }
```


(continues on next page)

(continued from previous page)


```
        },
        "required": [
           "min",
           "max",
           "n"
        ]
     },
     "GUI_Param": {
        "title": "GUI_Param",
        "description": "Parameterization for a GUI Parameter itself. ie. How a␣
↪particular parameter should be represented.\n\nParams:\n    key (GUI_PARAMS): the␣
↪key used for the parameter\n    name (str): A human readable name for the␣
↪parameter\n    widget_type (GUI_WIDGETS): A string that indicates the type of␣
↪widget that should be used.\n        Different ``widget_type`` s may use␣
↪different widgets, combinations of widgets, and\n        validators, and are thus␣
↪not strictly isomorphic to a single widget type.\n    default (any): the default␣
↪value to be set, must correspond to widget type\n    args (list): args to pass to␣
↪the widget\n    kwargs (dict): kwargs to pass to the widget",
        "type": "object",
        "properties": {
           "key": {
              "title": "Key",
              "enum": [
                 "frequencies",
                 "amplitudes",
                 "log_x",
                 "log_y",
                 "extra_amplitude",
                 "amplitude_step",
                 "amplitude_range",
                 "max_amplitude",
                 "frequency_step",
                 "frequency_range",
                 "iti",
                 "iti_jitter"
              ],
              "type": "string"
           },
           "name": {
              "title": "Name",
              "type": "string"
           },
           "widget_type": {
              "title": "Widget Type",
              "enum": [
                 "int",
                 "float",
                 "range",
                 "tuple",
                 "bool"
              ],
              "type": "string"
```


(continues on next page)

(continued from previous page)


```
            },
            "default": {
               "title": "Default",
               "anyOf": [
                  {
                     "type": "number"
                  },
                  {
                     "type": "integer"
                  },
                  {
                     "$ref": "#/definitions/GUI_Range"
                  },
                  {
                     "type": "array",
                     "items": {}
                  }
               ]
            },
            "args": {
               "title": "Args",
               "type": "array",
               "items": {}
            },
            "kwargs": {
               "title": "Kwargs",
               "type": "object"
            }
         },
         "required": [
            "key",
            "name",
            "widget_type"
         ]
      },
      "Control_Panel_Params": {
         "title": "Control_Panel_Params",
         "description": "Defaults and parameters for :class:`perceptivo.gui.widgets.
↪Control_Panel`",
         "type": "object",
         "properties": {
            "amplitude_range": {
               "title": "Amplitude Range",
               "default": {
                  "key": "amplitude_range",
                  "name": "Amplitude Range (dBSPL)",
                  "widget_type": "range",
                  "default": {
                     "min": 0.0,
                     "max": 80.0,
                     "n": 8
                  },
```


(continues on next page)

(continued from previous page)


```
                "args": [],
                "kwargs": {
                    "limits": [
                        0,
                        100
                    ]
                }
            },
            "allOf": [
                {
                    "$ref": "#/definitions/GUI_Param"
                }
            ]
        },
        "frequency_range": {
            "title": "Frequency Range",
            "default": {
                "key": "frequency_range",
                "name": "Frequency Range (Hz)",
                "widget_type": "range",
                "default": {
                    "min": 0.0,
                    "max": 8000.0,
                    "n": 17
                },
                "args": [],
                "kwargs": {
                    "limits": [
                        0,
                        20000
                    ]
                }
            },
            "allOf": [
                {
                    "$ref": "#/definitions/GUI_Param"
                }
            ]
        },
        "iti": {
            "title": "Iti",
            "default": {
                "key": "iti",
                "name": "Inter-Trial Interval (s)",
                "widget_type": "float",
                "default": 5.0,
                "args": [],
                "kwargs": {}
            },
            "allOf": [
                {
                    "$ref": "#/definitions/GUI_Param"
```


(continues on next page)

(continued from previous page)


```
                }
            ]
        },
        "iti_jitter": {
            "title": "Iti Jitter",
            "default": {
                "key": "iti_jitter",
                "name": "Inter-Trial Jitter (proportion of ITI)",
                "widget_type": "float",
                "default": 0.1,
                "args": [],
                "kwargs": {}
            },
            "allOf": [
                {
                    "$ref": "#/definitions/GUI_Param"
                }
            ]
        }
    }
  }
}
```


Config

- **json_encoders**: *dict = {<class 'numpy.ndarray'>: <function pack_array at 0x7f07dd6cfdc0>, <class 'datetime.datetime'>: <function PerceptivoType.Config.<lambda> at 0x7f07dd6c91f0>}*
- **underscore_attrs_are_private**: *bool = True*

Fields

- *control_panel (perceptivo.types.gui.Control_Panel_Params)*

field control_panel: *perceptivo.types.gui.Control_Panel_Params* = Control_Panel_Params(amplitude_range=GUI_Param(key='amplitude_range', name='Amplitude Range (dBSPL)', widget_type='range', default=GUI_Range(min=0.0, max=80.0, n=8), args=[], kwargs={'limits': (0, 100)}), frequency_range=GUI_Param(key='frequency_range', name='Frequency Range (Hz)', widget_type='range', default=GUI_Range(min=0.0, max=8000.0, n=17), args=[], kwargs={'limits': (0, 20000)}), iti=GUI_Param(key='iti', name='Inter-Trial Interval (s)', widget_type='float', default=5.0, args=[], kwargs={}), iti_jitter=GUI_Param(key='iti_jitter', name='Inter-Trial Jitter (proportion of ITI)', widget_type='float', default=0.1, args=[], kwargs={}))

4.3.3 networking

class perceptivo.types.networking.**Socket**(*id: str*, *socket_type: Literal['REQ', 'REP', 'PUB', 'SUB', 'PAIR', 'DEALER', 'ROUTER', 'PULL', 'PUSH']*, *protocol: Literal['tcp', 'ipc', 'inproc']*, *mode: Literal['connect', 'bind']*, *port: int*, *ip: str = '*'*, *to: Optional[str] = None*)

Bases: object

id: str

socket_type: Literal['REQ', 'REP', 'PUB', 'SUB', 'PAIR', 'DEALER', 'ROUTER', 'PULL', 'PUSH']

protocol: Literal['tcp', 'ipc', 'inproc']

mode: Literal['connect', 'bind']

port: int

ip: str = '*'

to: Optional[str] = None

pydantic model perceptivo.types.networking.**Clinician_Networking**

Bases: pydantic.main.BaseModel

Default networking properties for the Clinician computer

Create a new model by parsing and validating input data from keyword arguments.

Raises ValidationError if the input data cannot be parsed to form a valid model.


```
{
   "title": "Clinician_Networking",
   "description": "Default networking properties for the Clinician computer",
   "type": "object",
   "properties": {
      "ip": {
         "title": "Ip",
         "default": "",
         "type": "string"
      },
      "patient_ip": {
         "title": "Patient Ip",
         "default": "",
         "type": "string"
      },
      "eyecam": {
         "title": "Eyecam",
         "default": {
            "id": "clinician:eyecam",
            "socket_type": "PULL",
            "protocol": "tcp",
            "mode": "bind",
            "port": 5500,
            "ip": "*",
```


(continues on next page)

(continued from previous page)


```
            "to": null
         },
         "allOf": [
            {
               "$ref": "#/definitions/Socket"
            }
         ]
      },
      "control": {
         "title": "Control",
         "default": {
            "id": "clinician:control",
            "socket_type": "ROUTER",
            "protocol": "tcp",
            "mode": "bind",
            "port": 5600,
            "ip": "*",
            "to": null
         },
         "allOf": [
            {
               "$ref": "#/definitions/Socket"
            }
         ]
      }
   },
   "definitions": {
      "Socket": {
         "title": "Socket",
         "type": "object",
         "properties": {
            "id": {
               "title": "Id",
               "type": "string"
            },
            "socket_type": {
               "title": "Socket Type",
               "enum": [
                  "REQ",
                  "REP",
                  "PUB",
                  "SUB",
                  "PAIR",
                  "DEALER",
                  "ROUTER",
                  "PULL",
                  "PUSH"
               ],
               "type": "string"
            },
            "protocol": {
               "title": "Protocol",
```


(continues on next page)

(continued from previous page)

```
                "enum": [
                    "tcp",
                    "ipc",
                    "inproc"
                ],
                "type": "string"
            },
            "mode": {
                "title": "Mode",
                "enum": [
                    "connect",
                    "bind"
                ],
                "type": "string"
            },
            "port": {
                "title": "Port",
                "type": "integer"
            },
            "ip": {
                "title": "Ip",
                "default": "*",
                "type": "string"
            },
            "to": {
                "title": "To",
                "type": "string"
            }
        },
        "required": [
            "id",
            "socket_type",
            "protocol",
            "mode",
            "port"
        ]
    }
}
}
```

Fields

- *control (perceptivo.types.networking.Socket)*
- *eyecam (perceptivo.types.networking.Socket)*
- *ip (str)*
- *patient_ip (str)*

field ip: `str = ''`

field patient_ip: `str = ''`

field eyecam: *perceptivo.types.networking.Socket* **= Socket(id='clinician:eyecam', socket_type='PULL', protocol='tcp', mode='bind', port=5500, ip='*', to=None)**

field control: *perceptivo.types.networking.Socket* **= Socket(id='clinician:control', socket_type='ROUTER', protocol='tcp', mode='bind', port=5600, ip='*', to=None)**

pydantic model perceptivo.types.networking.**Patient_Networking**

Bases: pydantic.main.BaseModel

Create a new model by parsing and validating input data from keyword arguments.

Raises ValidationError if the input data cannot be parsed to form a valid model.


```
{
   "title": "Patient_Networking",
   "type": "object",
   "properties": {
      "ip": {
         "title": "Ip",
         "default": "",
         "type": "string"
      },
      "clinician_ip": {
         "title": "Clinician Ip",
         "default": "",
         "type": "string"
      },
      "eyecam": {
         "title": "Eyecam",
         "default": {
            "id": "patient:eyecam",
            "socket_type": "PUSH",
            "protocol": "tcp",
            "mode": "connect",
            "port": 5500,
            "ip": "",
            "to": null
         },
         "allOf": [
            {
               "$ref": "#/definitions/Socket"
            }
         ]
      },
      "control": {
         "title": "Control",
         "default": {
            "id": "patient:control",
            "socket_type": "DEALER",
            "protocol": "tcp",
            "mode": "connect",
            "port": 5600,
            "ip": "",
            "to": "clinician:control"
         },
```


(continues on next page)

(continued from previous page)

```
        "allOf": [
           {
              "$ref": "#/definitions/Socket"
           }
        ]
     }
  },
  "definitions": {
     "Socket": {
        "title": "Socket",
        "type": "object",
        "properties": {
           "id": {
              "title": "Id",
              "type": "string"
           },
           "socket_type": {
              "title": "Socket Type",
              "enum": [
                 "REQ",
                 "REP",
                 "PUB",
                 "SUB",
                 "PAIR",
                 "DEALER",
                 "ROUTER",
                 "PULL",
                 "PUSH"
              ],
              "type": "string"
           },
           "protocol": {
              "title": "Protocol",
              "enum": [
                 "tcp",
                 "ipc",
                 "inproc"
              ],
              "type": "string"
           },
           "mode": {
              "title": "Mode",
              "enum": [
                 "connect",
                 "bind"
              ],
              "type": "string"
           },
           "port": {
              "title": "Port",
              "type": "integer"
           },
```

(continues on next page)

(continued from previous page)

```
            "ip": {
               "title": "Ip",
               "default": "*",
               "type": "string"
            },
            "to": {
               "title": "To",
               "type": "string"
            }
         },
         "required": [
            "id",
            "socket_type",
            "protocol",
            "mode",
            "port"
         ]
      }
   }
}
```

Fields

- *clinician_ip (str)*
- *control (perceptivo.types.networking.Socket)*
- *eyecam (perceptivo.types.networking.Socket)*
- *ip (str)*

field ip: `str = ''`

field clinician_ip: `str = ''`

field eyecam: *perceptivo.types.networking.Socket* `= Socket(id='patient:eyecam', socket_type='PUSH', protocol='tcp', mode='connect', port=5500, ip='', to=None)`

field control: *perceptivo.types.networking.Socket* `= Socket(id='patient:control', socket_type='DEALER', protocol='tcp', mode='connect', port=5600, ip='', to='clinician:control')`

4.3.4 patient

class perceptivo.types.patient.**Biography**(*name: str*, *dob: datetime.date*)

Bases: `object`

Biographical details for a patient

name: `str`

dob: `datetime.date`

class perceptivo.types.patient.**Patient**(*biography:* perceptivo.types.patient.Biography, *samples:* perceptivo.types.psychophys.Samples, *audiogram:* perceptivo.types.psychophys.Audiogram)

Bases: object

Data for a given patient

biography: *perceptivo.types.patient.Biography*

samples: *perceptivo.types.psychophys.Samples*

audiogram: *perceptivo.types.psychophys.Audiogram*

pydantic model perceptivo.types.patient.**Collection_Params**

Bases: pydantic.main.BaseModel

Create a new model by parsing and validating input data from keyword arguments.

Raises ValidationError if the input data cannot be parsed to form a valid model.


```
{
   "title": "Collection_Params",
   "type": "object",
   "properties": {
      "collection_wait": {
         "title": "Collection Wait",
         "default": 5,
         "type": "number"
      }
   }
}
```


Fields

- *collection_wait (float)*

field **collection_wait:** float = 5

Total duration to wait to collect pupil frames, starting when the sound does.

4.3.5 psychophys

class perceptivo.types.psychophys.**Sample**(*sound: perceptivo.types.sound.Sound*, *dilation: typing.Optional[perceptivo.types.pupil.Dilation] = None*, *timestamp: datetime.datetime = <factory>*, *response: dataclasses.InitVar[bool] = <property object>*)

Bases: object

A single sample of a psychophysical response to a sound

Variables

- **dilation** (*types.pupil.Dilation*) – Pupil object storing dilation for a given sample
- **sound** (*types.sound.Sound*) – Sound presented to elicit Pupil response
- **timestamp** (datetime.datetime) – Timestamp at which the response was elicited

Properties: response (bool): Sub/Subtrathreshold response from `Pupil.response`

sound: *perceptivo.types.sound.Sound*

dilation: Optional[*perceptivo.types.pupil.Dilation*] = None

timestamp: datetime.datetime

property response: bool

class perceptivo.types.psychophys.**Samples**(*samples: Optional[List[perceptivo.types.psychophys.Sample]] = None, dilations: Optional[List[perceptivo.types.pupil.Dilation]] = None, frequencies: Optional[List[float]] = None, amplitudes: Optional[List[float]] = None, responses: Optional[List[bool]] = None*)

Bases: object

Multiple Samples!

Convenience class to init samples from numpy arrays and convert to pandas dataframe

samples: List[*perceptivo.types.psychophys.Sample*]

responses: List[bool]

frequencies: List[float]

amplitudes: List[float]

append(*sample:* perceptivo.types.psychophys.Sample)

Add a sample to the collection

Parameters **sample** (*Sample*) – A New Sample!

to_df() → pandas.core.frame.DataFrame

Make a dataframe with sound parameterization flattened out

plot(*show=True*)

Plot a collection of samples as points, with blue meaning the sample was audible and red meaning inaudible

Examples

```
from perceptivo.psychophys.oracle import generate_samples

samples = generate_samples(n_samples=1000, scale=10)
samples.plot()
```

Parameters **show** (*bool*) – If `True` (default), call plt.show()

class perceptivo.types.psychophys.**Threshold**(*frequency: float, threshold: float, confidence: float = 0*)

Bases: object

The audible threshold for a particular frequency

Parameters

- **frequency** (*float*) – Frequency of threshold in Hz

- **threshold** (*float*) – Audible threshold in dbSPL
- **confidence** (*float*) – Confidence of threshold, units vary depending on estimation type

frequency: float

threshold: float

confidence: float = 0

class perceptivo.types.psychophys.**Audiogram**(*thresholds: List[perceptivo.types.psychophys.Threshold]*)

Bases: object

A collection of :class:`.Threshold`s that represent a patient's audiogram.

Thresholds can be accessed like a dictionary, using frequencies as keys, eg:

```
>>> agram = Audiogram([Threshold(1000, 10), Threshold(2000, 20)])
>>> agram[1000]
Threshold(frequency=1000, threshold=10, confidence=0)
>>> agram[3000] = Threshold(3000, 30)
>>> agram[3000]
Threshold(frequency=1000, threshold=10, confidence=0)
```

thresholds: List[*perceptivo.types.psychophys.Threshold*]

property frequencies: List[float]

List of frequencies in *thresholds*

to_dict() → Dict[float, float]

Return audiogram thresholds as a {frequency:threshold} dictionary, eg.:

```
>>> agram = Audiogram([Threshold(1000, 10), Threshold(2000, 20)])
>>> agram.to_dict()
{1000: 10, 2000: 20}
```

pydantic model perceptivo.types.psychophys.**Kernel**

Bases: pydantic.main.BaseModel

Default kernel to use with *psychophys.model.Gaussian_Process*

Uses a kernel with a short length scale for frequency, but a longer length scale for amplitude, which should be smoother/monotonic where frequency can have an unpredictable shape

Create a new model by parsing and validating input data from keyword arguments.

Raises ValidationError if the input data cannot be parsed to form a valid model.

```
{
   "title": "Kernel",
   "description": "Default kernel to use with :class:`.psychophys.model.Gaussian_
↪Process`\n\nUses a kernel with a short length scale for frequency, but a longer␣
↪length scale for amplitude,\nwhich should be smoother/monotonic where frequency␣
↪can have an unpredictable shape",
   "type": "object",
   "properties": {
      "length_scale": {
         "title": "Length Scale",
```

(continues on next page)

(continued from previous page)


```
            "default": [
               100.0,
               200.0
            ],
            "type": "array",
            "minItems": 2,
            "maxItems": 2,
            "items": [
               {
                  "type": "number"
               },
               {
                  "type": "number"
               }
            ]
         },
         "length_scale_bounds": {
            "title": "Length Scale Bounds",
            "default": [
               1,
               100000.0
            ],
            "type": "array",
            "minItems": 2,
            "maxItems": 2,
            "items": [
               {
                  "type": "number"
               },
               {
                  "type": "number"
               }
            ]
         }
      }
}
```


Config

- **arbitrary_types_allowed**: *bool* = *True*

Fields

- *length_scale (Tuple[float, float])*
- *length_scale_bounds (Tuple[float, float])*

field length_scale: Tuple[float, float] = (100.0, 200.0)

field length_scale_bounds: Tuple[float, float] = (1, 100000.0)

property kernel: sklearn.gaussian_process.kernels.RBF

class perceptivo.types.psychophys.**Psychoacoustic_Model**(*model_type: typing.Literal['Gaussian_Process'] = 'Gaussian_Process'*, *args: typing.Optional[list] = <factory>*, *kwargs: typing.Optional[typing.Dict[str, perceptivo.types.psychophys.Kernel]] = <factory>*)

Bases: object

Parameterization of a psychoacoustic model to use to estimate audiograms and control the presentation of stimuli

model_type: Literal['Gaussian_Process'] = 'Gaussian_Process'

args: Optional[list]

kwargs: Optional[Dict[str, *perceptivo.types.psychophys.Kernel*]]

4.3.6 pupil

Types specifically for carrying and manipulating pupil measurements

class perceptivo.types.pupil.**Pupil**(*ellipse:* perceptivo.types.units.Ellipse, *frame:* perceptivo.types.video.Frame)

Bases: object

A single-frame measurement of a pupil

Variables

- **ellipse** (*Ellipse*) – Fit ellipse given frame
- **params** (*Pupil_Params*) – Pupil parameterization!

ellipse: *perceptivo.types.units.Ellipse*

frame: *perceptivo.types.video.Frame*

class perceptivo.types.pupil.**Pupil_Params**(*threshold: float*, *max_diameter: float*)

Bases: object

Parameters to use with *video.pupil.PupilExtractor* classes to parameterize

Variables

- **threshold** (*float*) – Diameter threshold as a fraction of maximum diameter to consider a positive response to a stimulus
- **max_diameter** (*float*) – Maximum diameter of pupil in pixels

threshold: float

max_diameter: float

class perceptivo.types.pupil.**Dilation**(*params:* perceptivo.types.pupil.Pupil_Params, *pupils: List[*perceptivo.types.pupil.Pupil*]*, *timestamps: List[datetime.datetime]*)

Bases: object

A timeseries of pupil diameters and timestamps corresponding to a pupil dilation event

Variables

- **ellipses** (*List[Pupil]*) – List of ellipses from a pupil measurement
- **timestamps** (*List[datetime.datetime]*) – List of timestamps of equal length to `ellipses`
- **sound** (*types.sound.Sound*) – Sound that was presented for this pupil response

Properties: max_diameter (float): maximum diameter reached during a given sample diameters (typing.List[float]): List of diameters in pixels of equal length to `timestamps` response (bool): True/False whether the sound was heard, calculated by dividing

the maximum measured pupil dilation in pixels / maximum possible dilation in pixels and comparing to the detection threshold. Aka (*Dilation.max_diameter* / *Pupil_Params.max_diameter*) > *Pupil_Params.threshold*

params: *perceptivo.types.pupil.Pupil_Params*

pupils: List[*perceptivo.types.pupil.Pupil*]

timestamps: List[datetime.datetime]

property diameters: List[float]

Extract major axes from ellipses

Returns List of major axes in pixels

Return type *List*[float]

property max_diameter: float

property response: bool

4.3.7 sound

class perceptivo.types.sound.**Audio_Config**(*fs: int = 44100*)

Bases: object

Base class for audio configuration

Params: fs (int): Sampling rate in Hz, default 44100

fs: int = 44100

class perceptivo.types.sound.**Jackd_Config**(*fs: int = 44100*, *bin: pathlib.Path = <factory>*, *priority: int = 75*, *driver: str = 'alsa'*, *device_name: typing.Union[str, int] = 'hw:sndrpihifiberry'*, *nperiods: int = 3*, *period: int = 1024*, *playback_only: bool = True*, *outchannels: list = <factory>*)

Bases: *perceptivo.types.sound.Audio_Config*

Configure the jackd daemon used by the sound server, see https://linux.die.net/man/1/jackd

Params: bin (pathlib.Path): Path to the jackd binary priority (int): Priority to run the process (higher is better), default 75 driver (str): Driver to use, default 'alsa' device_name (str, int): Device to use in alsa's parlance, default 'hw:sndrpihifiberry'.

Also accepts ints for use with coreaudio

nperiods (int): Number of periods per buffer cycle, default 3 period (int): size of period, default 1024 samples. launch_str (str): launch string with arguments compiled from the other arguments

bin: pathlib.Path

priority: int = 75

driver: str = 'alsa'

device_name: Union[str, int] = 'hw:sndrpihifiberry'

nperiods: int = 3

period: int = 1024

playback_only: bool = True

outchannels: list

property launch_str: str

pydantic model perceptivo.types.sound.**Sound**

Bases: pydantic.main.BaseModel

Parameterization of an abstract probe sound

Parameters

- **frequency** (*float*) – Frequency in Hz
- **amplitude** (*float*) – Amplitude in dbSPL
- **duration** (*float*) – Duration of sound in seconds

Variables **uuid** (*str*) – Unique UUID to identify sounds

Create a new model by parsing and validating input data from keyword arguments.

Raises ValidationError if the input data cannot be parsed to form a valid model.


```
{
   "title": "Sound",
   "description": "Parameterization of an abstract probe sound\n\nArgs:\n    
↪frequency (float): Frequency in Hz\n    amplitude (float): Amplitude in dbSPL\n 
↪ duration (float): Duration of sound in seconds\n\nAttributes:\n    uuid (str): 
↪Unique UUID to identify sounds",
   "type": "object",
   "properties": {
      "frequency": {
         "title": "Frequency",
         "type": "number"
      },
      "amplitude": {
         "title": "Amplitude",
         "type": "number"
      },
      "duration": {
         "title": "Duration",
         "default": 0.5,
         "type": "number"
```


(continues on next page)

(continued from previous page)


```
      },
      "sound_type": {
         "title": "Sound Type",
         "default": "Gammatone",
         "enum": [
            "Gammatone"
         ],
         "type": "string"
      },
      "timestamp": {
         "title": "Timestamp",
         "type": "string",
         "format": "date-time"
      },
      "jack_client": {
         "title": "Jack Client"
      },
      "uuid": {
         "title": "Uuid",
         "type": "string"
      }
   },
   "required": [
      "frequency",
      "amplitude"
   ]
}
```


Config

- **arbitrary_types_allowed**: *bool* = *True*

Fields

- *amplitude (float)*
- *duration (float)*
- *frequency (float)*
- *jack_client (Optional[JackClient])*
- *sound_type (Literal['Gammatone'])*
- *timestamp (Optional[datetime.datetime])*
- *uuid (str)*

field frequency: float [Required]

field amplitude: float [Required]

field duration: float = 0.5

field sound_type: Literal['Gammatone'] = 'Gammatone'

field timestamp: Optional[datetime.datetime] = None

field jack_client: Optional[JackClient] = None

field uuid: str [Optional]

stamp_time()

Record the time that the sound is played in `Sound.timestamp`

property sound_kwargs: dict

Sound kwargs that the sound class accepts

(ie. filtering out `sound_type` and others the sound class doesn't take)

Returns dict of arguments

property sound_class: autopilot.stim.sound.base.Sound

The sound class that corresponds to the `sound_type` retrieved from the *perceptivo.sound.sounds* module.

Returns `autopilot.stim.sound.sounds.Jack_Sound` - The sound class!

4.3.8 units

Very basic units or unit-like things

class perceptivo.types.units.**Ellipse**(*x: int*, *y: int*, *a: float*, *b: float*, *t: float*)

Bases: object

Parameterization of an ellipse corresponding to a Pupil

Attrs: x (int): Ellipse center in pixels y (int): Ellipse center in pixels a (float): Major axis in pixels b (float): Minor axis in pixels t (float): Orientation in radians, clockwise from vertical

x: int

y: int

a: float

b: float

t: float

mask(*scale: float = 1*) → Tuple[numpy.ndarray, numpy.ndarray]

Coordinates for a boolean mask, created with `skimage.draw.ellipse()`

Note: When calling ellipse, *y* is used as the 0th dimension and *x* as the 1st, since rows in a frame (y) are typically the 0th dimension.

Parameters **scale** (*float*) – Scale the major and minor axes by this much!

Returns tuple of two ndarrays, coordinates in the 0th and 1st axis of the mask points

4.3.9 video

pydantic model perceptivo.types.video.**Frame**

Bases: perceptivo.types.root.PerceptivoType

Single video frame container

Variables

- **frame** (numpy.ndarray) – Frame!
- **timestamp** (datetime.datetime) – Time of acquisition
- **color** (*bool*) – If `False` , grayscale (frame should be 2 dimensional or 3rd axis should be len == 1). if `True`, RGB Color.

Create a new model by parsing and validating input data from keyword arguments.

Raises ValidationError if the input data cannot be parsed to form a valid model.


```
{
   "title": "Frame",
   "description": "Single video frame container\n\nAttributes:\n    frame␣
↪(:class:`numpy.ndarray`): Frame!\n    timestamp (:class:`datetime.datetime`):␣
↪Time of acquisition\n    color (bool): If ``False`` , grayscale (frame should be␣
↪2 dimensional or 3rd axis should be len  == 1 ).\n        if ``True``, RGB Color.
↪",
   "type": "object",
   "properties": {
      "frame": {
         "title": "Frame"
      },
      "timestamp": {
         "title": "Timestamp",
         "type": "string",
         "format": "date-time"
      },
      "color": {
         "title": "Color",
         "type": "boolean"
      },
      "cropped": {
         "title": "Cropped"
      },
      "dtype": {
         "title": "Dtype"
      }
   }
}
```


Config

- **arbitrary_types_allowed**: *bool* = *True*

Fields

- *color (Optional[bool])*
- *cropped (Optional[perceptivo.types.video.Frame])*

- *dtype (Optional[numpy.dtype])*
- *frame (numpy.ndarray)*
- *timestamp (datetime.datetime)*

field frame: numpy.ndarray [Required]

field timestamp: datetime.datetime [Optional]

field cropped: Optional[*perceptivo.types.video.Frame*] = None

field dtype: Optional[numpy.dtype] = None

field color: Optional[bool] = None

set_color(*color*)

norm()

make frame 0-1

property gray: numpy.ndarray

Grayscale version of the frame, if color

crop(*bbox: List[int]*)

Crop with a bounding box (top, bottom, left, right), assign to self.cropped

Parameters **bbox** ()

Returns new Frame image with cropped image as its frame

pydantic model perceptivo.types.video.**Picamera_Params**

Bases: pydantic.main.BaseModel

Configuration for a perceptivo.video.cameras.PiCamera

Create a new model by parsing and validating input data from keyword arguments.

Raises ValidationError if the input data cannot be parsed to form a valid model.


```
{
   "title": "Picamera_Params",
   "description": "Configuration for a :class:`perceptivo.video.cameras.PiCamera`",
   "type": "object",
   "properties": {
      "sensor_mode": {
         "title": "Sensor Mode",
         "default": 0,
         "type": "integer"
      },
      "resolution": {
         "title": "Resolution",
         "default": [
            1280,
            720
         ],
         "type": "array",
         "minItems": 2,
         "maxItems": 2,
```


(continues on next page)

(continued from previous page)

```
            "items": [
               {
                  "type": "integer"
               },
               {
                  "type": "integer"
               }
            ]
         },
         "fps": {
            "title": "Fps",
            "default": 30,
            "type": "integer"
         },
         "format": {
            "title": "Format",
            "default": "grayscale",
            "enum": [
               "rgb",
               "grayscale"
            ],
            "type": "string"
         },
         "output_file": {
            "title": "Output File",
            "type": "string",
            "format": "path"
         }
      }
}
```

Fields

- *format (Literal['rgb', 'grayscale'])*
- *fps (int)*
- *output_file (Optional[pathlib.Path])*
- *resolution (Tuple[int, int])*
- *sensor_mode (int)*

field sensor_mode: int = 0

field resolution: Tuple[int, int] = (1280, 720)

field fps: int = 30

field format: Literal['rgb', 'grayscale'] = 'grayscale'

field output_file: Optional[pathlib.Path] = None

class perceptivo.types.video.**Camera_Calibration**(*picam:* perceptivo.types.video.Picamera_Params, *distance: float*, *mm_per_px: float*)

Bases: object

Parameters that define the conditions of use for a camera

Parameters

- **picam** (*Picamera_Params*) – Parameterization of the PiCamera
- **distance** (*float*) – distance from camera to subject in mm
- **mm_per_px** (*float*) – approximate number of mm per pixel at a given distance

picam: *perceptivo.types.video.Picamera_Params*

distance: float

mm_per_px: float

4.4 gui

4.4.1 main

Main Gui container for Perceptivo Clinician interface

class perceptivo.gui.main.**Perceptivo_Clinician**(**args: Any*, ***kwargs: Any*)

Bases: PySide6.QtWidgets.QMainWindow

GUI container for the Perceptivo clinician interface

controlChanged

alias of *perceptivo.types.gui.GUI_Control*

changeControl(*value:* perceptivo.types.gui.GUI_Control)

Receive changed control settings from widgets, etc. and emit them to the patient.

Also emits from the *controlChanged* signal

Parameters **value** (*types.gui.GUI_Control*) – Control value that changed

setStarted(*value: bool*)

property exam_params: *perceptivo.types.exam.Exam_Params*

property settings

Load and return PySide6.QtCore.QSettings

drawFrame(*frame*)

receive_messages()

cb_connect(*msg:* perceptivo.networking.messages.Message)

Parameters **msg** ()

Returns:

cb_data(*msg:* perceptivo.networking.messages.Message)

Receive data from the patient during an exam

Message that contains a *types.psychophys.Sample*

closeEvent(*event*)

class Frame_Receiver(**args: Any*, ***kwargs: Any*)

Bases: PySide6.QtCore.QThread

Thread to launch a networking node, receive threads, and emit new frames

frame

alias of *perceptivo.types.video.Frame*

run()

quitting()

4.4.2 params

4.4.3 styles

Styles

Values and stylesheets that control the appearance of the GUI

4.4.4 widgets

audiogram

Plot displaying audiogram options, current estimate of audiogram

class perceptivo.gui.widgets.audiogram.**Audiogram**(**args: Any*, ***kwargs: Any*)

Bases: PySide6.QtWidgets.QGroupBox

gridChanged(*value:* perceptivo.types.gui.GUI_Control)

scaleChanged(*value:* perceptivo.types.gui.GUI_Control)

components

Subcomponents for larger GUI widgets

class perceptivo.gui.widgets.components.**Range_Setter**(**args: Any*, ***kwargs: Any*)

Bases: PySide6.QtWidgets.QWidget

Buttons and text fields to parameterize a linearly or logarithmically spaced array of values

Parameters

- **key** (*str*) – key of value that is set by this widget, likely one of `types.GUI_PARAM_KEY`
- **name** (*str*) – human-readable name of parameter
- **round** (*int*) – Digits to round generated values to (default `0`)
- **limits** (*tuple*) – Absolute allowable maximum and minimum
- **step** (*float*) – Step size of the spinboxes
- ***args, **kwargs** – passed to `PySide6.QtWidgets.QWidget`

valueChanged

alias of *perceptivo.types.gui.GUI_Control*

buttonClicked

alias of *perceptivo.types.gui.GUI_Control*

scaleChanged

alias of `str`

__init__(*key: Literal['frequencies', 'amplitudes', 'log_x', 'log_y', 'extra_amplitude', 'amplitude_step', 'amplitude_range', 'max_amplitude', 'frequency_step', 'frequency_range', 'iti', 'iti_jitter']*, *name: str*, *round: int = 0*, *limits: Tuple[int, int] = (0, 100)*, *default:* perceptivo.types.gui.GUI_Range = *GUI_Range(min=0.0, max=100.0, n=10)*, **args*, ***kwargs*)

Parameters

- **key** (*str*) – key of value that is set by this widget, likely one of `types.GUI_PARAM_KEY`
- **name** (*str*) – human-readable name of parameter
- **round** (*int*) – Digits to round generated values to (default `0`)
- **limits** (*tuple*) – Absolute allowable maximum and minimum
- **step** (*float*) – Step size of the spinboxes
- ***args, **kwargs** – passed to `PySide6.QtWidgets.QWidget`

value() → Tuple[float]

setMaximum(*value: float*)

setMinimum(*value: float*)

control_panel

Control operation of perceptivo, set audiogram params

class perceptivo.gui.widgets.control_panel.**Control_Panel**(**args: Any*, ***kwargs: Any*)

Bases: `PySide6.QtWidgets.QGroupBox`

valueChanged

alias of *perceptivo.types.gui.GUI_Control*

scaleChanged

alias of *perceptivo.types.gui.GUI_Control*

startToggled

alias of *perceptivo.types.gui.GUI_Control*

setValue(*value:* perceptivo.types.gui.GUI_Control)

patient

Dialog popup to set patient params

pupil

Timeseries of pupil diameter, audio/stimulus presentation info

class perceptivo.gui.widgets.pupil.**Pupil**(**args: Any*, ***kwargs: Any*)

Bases: PySide6.QtWidgets.QGroupBox

video

https://stackoverflow.com/a/35316662/13113166

class perceptivo.gui.widgets.video.**Video**(**args: Any*, ***kwargs: Any*)

Bases: pyqtgraph.ImageView

4.5 networking

Networking between objects and computers

4.5.1 messages

Message classes for explicit typing and the sanity of clear expectations

class perceptivo.networking.messages.**Message**(*message_number: Optional[int] = None*, *timestamp: Optional[datetime.datetime] = None*, *key: str = ''*, ***kwargs*)

Bases: *perceptivo.root.Perceptivo_Object*

Message container implementing msgpack-based numpy array de/serialization.

Subclass this to make specific message types!

Parameters ****kwargs** (*dict*) – key/value pairs stored in `Message.value`

Attrs: value (dict): (deserialized) dictionary of values passed from **kwargs

counter = count(0)

__init__(*message_number: Optional[int] = None*, *timestamp: Optional[datetime.datetime] = None*, *key: str = ''*, ***kwargs*)

Parameters ****kwargs** (*dict*) – key/value pairs stored in `Message.value`

Attrs: value (dict): (deserialized) dictionary of values passed from **kwargs

serialize(*msg: Optional[dict] = None*) → bytes

classmethod from_serialized(*msg: bytes*) → *perceptivo.networking.messages.Message*

Create an instance of Message from a msgpack serialized bytestring

4.5.2 node

Messenger objects for communication intra, interprocess and intercomputer

class perceptivo.networking.node.**Node**(*socket:* perceptivo.types.networking.Socket, *poll_mode:* perceptivo.networking.node.Node.Poll_Mode = *Poll_Mode.IOLOOP*, *callback:* *Optional[Callable]* = *None*, *to:* *Optional[str]* = *None*, *deque_size:* *int* = *256*)

Bases: *perceptivo.root.Perceptivo_Object*

Wrapper around zmq sockets to send and receive messages

Parameters

- **socket** (types.Socket) – Socket descriptor (see Socket)
- **poll_mode** (*Poll_Mode*) – Strategy for polling messages.
  - **IOLOOP - uses tornado's IOloop and ZMQStreams to poll for messages.** Needs to be given callback as well, which will be called with the received message as the only argument
  - DEQUE - a thread is spawned to poll the socket and add any message to deque
  - NONE - interact with the socket manually
- **callback** (*typing.Callable*) – A callable object that will be called with a received message as its only argument if poll_mode == IOLOOP

class Poll_Mode(*value*)

Bases: enum.Enum

An enumeration.

IOLOOP = 1

DEQUE = 2

NONE = 3

__init__(*socket:* perceptivo.types.networking.Socket, *poll_mode:* perceptivo.networking.node.Node.Poll_Mode = *Poll_Mode.IOLOOP*, *callback:* *Optional[Callable]* = *None*, *to:* *Optional[str]* = *None*, *deque_size:* *int* = *256*)

Wrapper around zmq sockets to send and receive messages

Parameters

- **socket** (types.Socket) – Socket descriptor (see Socket)
- **poll_mode** (*Poll_Mode*) – Strategy for polling messages.
  - **IOLOOP - uses tornado's IOloop and ZMQStreams to poll for messages.** Needs to be given callback as well, which will be called with the received message as the only argument
  - DEQUE - a thread is spawned to poll the socket and add any message to deque
  - NONE - interact with the socket manually
- **callback** (*typing.Callable*) – A callable object that will be called with a received message as its only argument if poll_mode == IOLOOP

property address: *str*

The full address, including protocol, ip, port, or endpoint, depending on the protocol

Returns str

send(*msg: Optional[perceptivo.networking.messages.Message] = None*, *to: Optional[str] = None*, ***kwargs*)

for now just wrapping the socket

_start_ioloop(*loop: tornado.ioloop.IOLoop*)

spawn a tornado ioloop

_start_polling()

spawn a thread to poll the socket and add incoming messages to the queue

release()

4.5.3 sockets

Abstract description of socket topology.

Each entry in each dict is a set of sockets to be run in an independent process.

perceptivo.networking.sockets.**CLINICIAN = {'gui': (Socket(id='clinician.command', socket_type='PUB', protocol='tcp', mode='bind', port=5000, ip='*', to=None), Socket(id='clinician.data', socket_type='ROUTER', protocol='tcp', mode='bind', port=5001, ip='*', to=None))}**

Sockets used by the clinician object

- `clinician.command` - `PUB` socket for dispersing control commands to subordinate computers
- `clincian.data` - `ROUTER` for receiving data from subordinate computers

perceptivo.networking.sockets.**EXAMINER = {'data': (Socket(id='examiner.data_in', socket_type='ROUTER', protocol='ipc', mode='bind', port=5003, ip='*', to=None), Socket(id='examiner.data_out', socket_type='DEALER', protocol='tcp', mode='connect', port=5001, ip='192.168.0.100', to=None)), 'manager': (Socket(id='examiner.manager.command', socket_type='SUB', protocol='tcp', mode='connect', port=5000, ip='192.168.0.100', to=None), Socket(id='examiner.manager.process', socket_type='ROUTER', protocol='ipc', mode='bind', port=5002, ip='*', to=None), Socket(id='examiner.manager.data_out', socket_type='DEALER', protocol='ipc', mode='connect', port=5003, ip='localhost', to=None)), 'picamera': (Socket(id='examiner.picamera.data_out', socket_type='DEALER', protocol='ipc', mode='connect', port=5002, ip='*', to=None),)}**

Sockets used by the 'examiner' machine responsible for managing the exam - measuring the pupil, presenting sounds, and maintaining the psychoacoustic model

Processes:

manager

- `examiner.manager.command` - `SUB` - subscriber to clinician commands
- `examiner.manager.process` - `ROUTER` - receives data from picamera
- `examiner.manager.data_out` - `DEALER` - sends data to the `data` process to forward to clinician

picamera

- `examiner.picamera.data_out` - `DEALER` - sends frames to the `process` socket

data

- `examiner.data.data_in` - `ROUTER` - receives data from `process`
- `examiner.data.data_out` - `DEALER` - sends data to clinician

`perceptivo.networking.sockets.STIM = {'stim': (Socket(id='stim.command', socket_type='SUB', protocol='tcp', mode='connect', port=5000, ip='192.168.0.100', to=None), Socket(id='stim.manager', socket_type='DEALER', protocol='tcp', mode='connect', port=5002, ip='192.168.0.101', to=None))}`

Sockets used by the stimulus delivery machine

- `stim.command` - `SUB` - subscriber to clinician commands
- `stim.manager` - `DEALER` - subscriber to the `process` socket of the examiner, receives commands to present stimuli, etc.

4.6 psychophys

4.6.1 gaussian

Refactoring of `sklearn.gaussian_process.GaussianProcessClassifier` to allow for iterative training

`class perceptivo.psychophys.gaussian._IterativeBinaryGPCLaplace(`*kernel=None*, ***, *optimizer='fmin_l_bfgs_b'*, *n_restarts_optimizer=0*, *max_iter_predict=100*, *warm_start=False*, *copy_X_train=True*, *random_state=None*`)`

Bases: `sklearn.gaussian_process._gpc._BinaryGaussianProcessClassifierLaplace`

Reclassing to allow for fitting without needing a sample with >=2 categories

`fit(`*X*, *y*`)`

Fit Gaussian process classification model.

Parameters

- **X** – array-like of shape (n_samples, n_features) or list of object Feature vectors or other representations of training data.
- **y** – array-like of shape (n_samples,) Target values, must be binary.

Returns **self**

Return type returns an instance of self.

`class perceptivo.psychophys.gaussian.IterativeGPC(`*kernel=None*, ***, *optimizer='fmin_l_bfgs_b'*, *n_restarts_optimizer=0*, *max_iter_predict=100*, *warm_start=False*, *copy_X_train=True*, *random_state=None*, *multi_class='one_vs_rest'*, *n_jobs=None*`)`

Bases: `sklearn.gaussian_process._gpc.GaussianProcessClassifier`

Reclassed to use patched *`_IterativeBinaryGPCLaplace`* instead of original model

fit(*X*, *y*)

Fit Gaussian process classification model.

Parameters

- **X** – array-like of shape (n_samples, n_features) or list of object Feature vectors or other representations of training data.
- **y** – array-like of shape (n_samples,) Target values, must be binary.

Returns self

clone_kernel() → sklearn.gaussian_process.kernels.Kernel

4.6.2 models

perceptivo.psychophys.model.**f_to_bark**(*frequency: float*) → float

Convert frequency to Bark using [WSG91]

Parameters **frequency** (*float*) – Frequency to convert

Returns (float) Bark

perceptivo.psychophys.model.**bark_to_f**(*bark: float*) → float

Convert bark to frequency using inverted [WSG91]

Parameters **bark** (*float*) – bark to convert

Returns (float) frequency

class perceptivo.psychophys.model.**Audiogram_Model**(*freq_range: Tuple[float, float] = (125, 8500)*, *amplitude_range: Tuple[float, float] = (5, 60)*, *exam_params: Optional[*perceptivo.types.exam.Exam_Params*] = None*, **args*, ***kwargs*)

Bases: *perceptivo.root.Perceptivo_Object*

Metaclass for Audiogram models and estimators.

These classes are used to estimate the audiogram, as well as control the order of the presentation of probe sounds.

Note: This class may be split into an experimental runner class and an audiogram model, but since the choice of the next stimulus should ideally be based on the current audiogram model, they are built together for now.

Parameters

- **freq_range** (*tuple*) – Tuple of two floats indicating min/max frequency (default: (125, 8500))
- **amplitude_range** (*tuple*) – Tuple of two floats indicating min/max amplitude in dbSPL (default: (5,60))

Variables

- **audiogram** (*types.psychophys.Audiogram*) – Audiogram of model
- **samples** (*types.psychophys.Samples*) – Individual samples of frequency/amplitude and whether a sound was detected.

abstract update(*sample:* perceptivo.types.psychophys.Sample)

Update the model with a new :class:`~.types.psychophys.Sample

abstract next() → *perceptivo.types.sound.Sound*

Generate parameters for the next *Sound* to be presented

Next should generate samples that respect the frequencies and amplitudes set in *exam_params*, if present. As well as `allow_repeats`

class perceptivo.psychophys.model.**Gaussian_Process**(*kernel: Optional[Union[sklearn.gaussian_process.kernels.Kernel, perceptivo.types.psychophys.Kernel]] = None*, **args*, ***kwargs*)

Bases: *perceptivo.psychophys.model.Audiogram_Model*

Gaussian process model based on [CdeVries16]

Model: * Bayesian Process Classifier, predicting binary audibility as a function of frequency and amplitude * Kernel: * Covariance Function: Squared Exponent (RBF)

Process: * Convert sampled frequency to bark with *f_to_bark()* * Update model * Generate next stimulus * Convert back to freq

Examples

```
from perceptivo.psychophys.oracle import reference_audiogram
from perceptivo.psychophys.model import Gaussian_Process
from perceptivo.types.psychophys import Sample

oracle = reference_audiogram(scale=3)
model = Gaussian_Process(amplitude_range=(5,35))

for i in range(100):
    sound = model.next()
    sample = Sample(response=oracle(sound), sound=sound)
    model.update(sample)

model.plot()
```

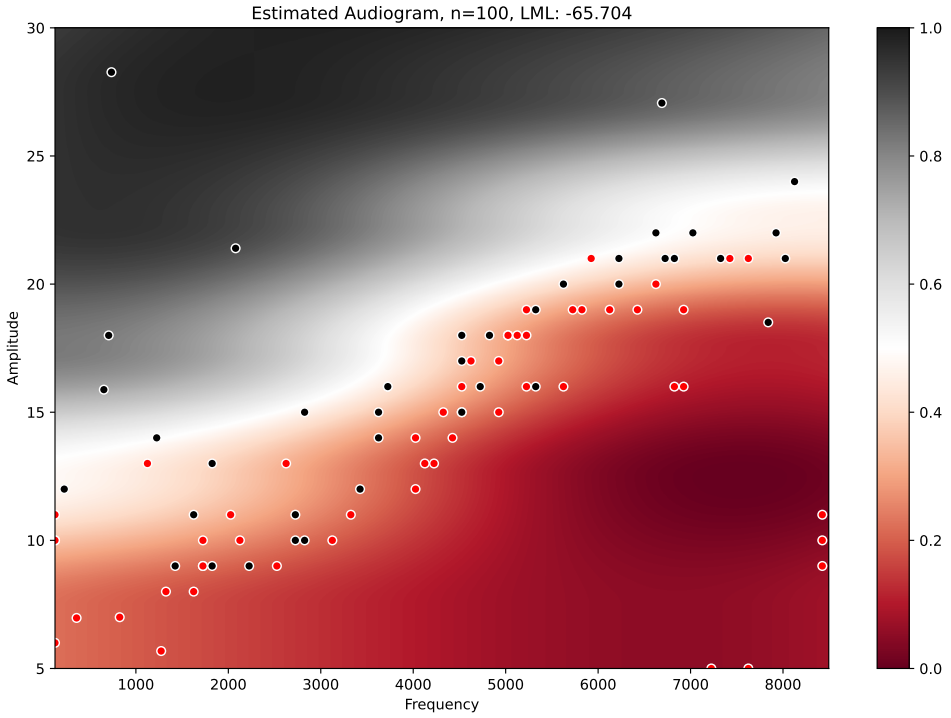
References

- [CdeVries16]
- [GMG+15]
- [MSG16]
- []

property kernel: sklearn.gaussian_process.kernels.Kernel

Kernel used in the gaussian process model. If `None` is given on init, use the *types.psychophys.Kernel*

Returns `sklearn.gaussian_process.kernels.Kernel`



property samples: *perceptivo.types.psychophys.Samples*

Stored samples from updates

Returns *Samples*

update(*sample:* perceptivo.types.psychophys.Sample)

Update the model with a new sample!

Parameters **sample** ()

_get_params() → Tuple[float, float]

Generate sound params

Returns a tuple of freq, amp

next() → *perceptivo.types.sound.Sound*

Generate parameters for the next sound to present

Returns *Sound*

plot(*mesh_resolution: int = 5*)

References

https://scikit-learn.org/stable/auto_examples/gaussian_process/plot_gpc_iris.html#sphx-glr-auto-examples-gaussian-process-plot-gpc-iris-py

Returns:

4.6.3 oracle

Oracle functions for testing model

perceptivo.psychophys.oracle.**piecewise_probabilistic**(*points: numpy.ndarray*, *scale: float = 5*) → callable

Make a piecewise function along a series of (frequency, amplitude) points with some gaussian error

Parameters

- **points** (*np.ndarray*) – n x 2 array of x/y (frequency, amplitude) coordinates that make up an audiogram
- **scale** (*float*) – Scale parameter of noise in amplitude domain to get answers "wrong"

Returns:

perceptivo.psychophys.oracle.**reference_audiogram**(*scale: float = 2*) → callable

Generate fake audiometry samples using median threshold values obtained from the NHANES dataset: https://wwwn.cdc.gov/Nchs/Nhanes/2015-2016/AUX_I.htm

The median rates make a piecewise linear function:

Frequency	Threshold
500	10
1000	10
2000	10
3000	10
4000	15
6000	20
8000	20

Parameters **scale** (*float*) – amount of randomness to multiply the noise of the pseudo-response threshold by

Returns callable made by `piecewise_probabilistic()` that works as an oracle function

Parameters **scale** ()

Returns A numpy piecewise function that returns Sample objects for a given input frequency and amplitude

perceptivo.psychophys.oracle.**generate_samples**(*n_samples: int*, *scale: float = 2*, *freqs=None*, *amplitudes=None*, *randomize=False*, *freq_range=(500, 8000)*, *amplitude_range=(0, 50)*, *oracle: Optional[callable] = None*) → *perceptivo.types.psychophys.Samples*

Generate fake audiometry samples using median threshold values obtained from the NHANES dataset: https://wwwn.cdc.gov/Nchs/Nhanes/2015-2016/AUX_I.htm

The median rates make a piecewise linear function:

Frequency	Threshold
500	10
1000	10
2000	10
3000	10
4000	15
6000	20
8000	20

Examples

```
from perceptivo.psychophys.oracle import generate_samples

samples = generate_samples(n_samples=1000, scale=10)
samples.plot()
```

Parameters

- **n_samples** (*int*) – number of samples to generate
- **scale** (*float*) – amount of randomness to multiply the noise of the pseudo-response threshold by
- **freqs** (*arraylike*) – (Optional) - predetermined array of frequencies (of length n_samples) to test
- **amplitudes** (*arraylike*) – (Optional) - predetermined array of amplitudes (of length n_samples) to test
- **randomize** (*bool*) – Randomize order of samples before returning, (default `False`)

Returns *types.psychophys.Samples*

4.7 sound

4.7.1 server

Wrapper around autopilot's `JackClient`

- boot and kill the jackd daemon
- references to jackclient module

`perceptivo.sound.server.`**`boot_jackd`**(*config:* perceptivo.types.sound.Jackd_Config) → subprocess.Popen

Boot the jacked server given the configuration given by `types.Jackd_Config`

Launches with `shell = True` and `preexec_fn=os.setsid` so that the process can be killed later.

Registers the jackd sound server to be killed at exit.

Thanks to https://stackoverflow.com/a/4791612/13113166 for information about how to kill a process with `shell = True`

Returns `subprocess.Popen` - opened subprocess

perceptivo.sound.server.**kill_jackd**(*proc: Optional[subprocess.Popen] = None*)

4.7.2 sounds

Sound synthesis

4.8 stim

4.9 video

4.9.1 cameras

Picamera capture. Easy enough with Autopilot

class perceptivo.video.cameras.**Picamera_Process**(*params:* perceptivo.types.video.Picamera_Params = *Picamera_Params(sensor_mode=0, resolution=(1280, 720), fps=30, format='grayscale', output_file=None)*, *networking:* *Optional*[perceptivo.types.networking.Socket] = *None*, *queue_size: int = 1024*, ***kwargs*)

Bases: multiprocessing.context.Process, *perceptivo.root.Perceptivo_Object*

Separate process for the picamera

q

Queue for the parent runtime to grab frames from the picamera.

collecting

Event set when collecting a sample. when set, dump frames into *Picamera_Process.q*

run()

Method to be run in sub-process; can be overridden in sub-class

release()

Stop running and release picamera resources

4.9.2 pupil

Process and extract pupil

Sketch of default strategy:

- Track to find approximate position of eyes with *processors.Haar_Tracker*
- Mask image around both eyes, split processing in parallel L/R (if present)
- Use white of eyes to mask cornea and pupil
- Sigmoid filter images to separate cornea and pupil
- Blob detection to find center mass of pupil
- Compare blob vs. edge detection of pupil.
- Use Kalman filter on *perceptivo.types.units.Ellipse* properties to avoid jumps and all that

class perceptivo.video.pupil.**PupilExtractor**(*preprocessor:* *Optional*[perceptivo.video.pupil.Preprocessor] = *None*, *filter:* *Optional*[perceptivo.video.pupil.PupilFilter] = *None*, ***kwargs*)

Bases: *perceptivo.root.Perceptivo_Object*

Base class for pupil extraction strategies.

process(*frame:* perceptivo.types.video.Frame) → Optional[*perceptivo.types.pupil.Pupil*]

Call *preprocess()* and then *_process()*, returning a Pupil estimate

Parameters **frame** (*types.video.Frame*) – Frame to process

Returns *types.pupil.Pupil* Pupil Estimate

abstract _process(*frame:* perceptivo.types.video.Frame) → *perceptivo.types.pupil.Pupil*

Given a frame, extract a pupil estimate

Parameters **frame** (*types.video.Frame*) – Frame to process!

Returns Estimated Pupil!

Return type *types.pupil.Pupil*

class perceptivo.video.pupil.**PupilFilter**(***kwargs*)

Bases: *perceptivo.root.Perceptivo_Object*

Base class for filtering pupil tracks – for example by using a Kalman filter to filter erroneous pupil detections from a *PupilExtractor* .

PupilFilters should be given to the *PupilExtractor* as its *filter* argument, and should be called last in the *PupilExtractor.process()* method.

Each subclass should implement a `_process` method that takes and returns a *Pupil* object.

process(*pupil:* perceptivo.types.pupil.Pupil) → *perceptivo.types.pupil.Pupil*

class perceptivo.video.pupil.**Preprocessor**(***kwargs*)

Bases: *perceptivo.root.Perceptivo_Object*

Base class for preprocessing images before they reach the main *PupilExtractor.process()* method.

Each subclass should implement a `process` method that takes and returns a *Frame* object.

abstract process(*frame:* perceptivo.types.video.Frame) → *perceptivo.types.video.Frame*

pydantic model perceptivo.video.pupil.**EllipseExtractor_Params**

Bases: `pydantic.main.BaseModel`

Create a new model by parsing and validating input data from keyword arguments.

Raises ValidationError if the input data cannot be parsed to form a valid model.


```
{
   "title": "EllipseExtractor_Params",
   "type": "object",
   "properties": {
      "footprint_size": {
         "title": "Footprint Size",
         "default": 5,
         "type": "integer"
```


(continues on next page)

(continued from previous page)

```
        },
        "search_scale": {
            "title": "Search Scale",
            "default": 1.5,
            "type": "number"
        }
    }
}
```

Fields

- *footprint_size (int)*
- *search_scale (float)*

field footprint_size: int = 5

field search_scale: float = 1.5

class perceptivo.video.pupil.**EllipseExtractor**(*footprint_size: int = 5*, *search_scale: float = 1.5*, ***kwargs*)

Bases: *perceptivo.video.pupil.PupilExtractor*

Very simple extractor that estimates an ellipse from the edges of a pupil. This extractor assumes that the *Frame* given to it has very high contrast, ie. that the rest of the face is essentially white and the pupil and cornea are the only colored things in the image.

In order

- Median Filter to smooth image - `skimage.filters.rank.median()`
- Scharr Filter to detect edges - `skimage.filters.scharr()`
- Get the otsu threshold on the scharr filtered image - `skimage.filters.threshold_otsu()`
- Skeletonize the pixels above the threshold - `skimage.morphology.skeletonize()`
- Label the independent edges - `skimage.measure.label()`
- If present, use the *types.units.Ellipse* from `PupilExtractor.filter.last_pupil` to select only those edges within the ellipse (scaled by `search_scale`)
- Estimate ellipses from remaining edges - `skimage.measure.EllipseModel`
- Keep the ellipses with the lowest median pixel value (presumably the pupil is dark)
- Return a *Pupil* object.

References

- Read a few years ago, might be worth revisiting: https://cdn.intechopen.com/pdfs/33559/InTech-Methods_for_ellipse_detection_from_edge_maps_of_real_images.pdf

Parameters

- **footprint_size** (*int*) – Diameter of footprint (a `skimage.morphology.disk()`) used in the median filter `skimage.filters.rank.median()` . This should be roughly the size of the pupil.

- **search_scale** (*float*) – If present, how much to scale the `PupilExtractor.filter.last_pupil` to select edges before fitting ellipses. Eg. `1.5` enlarges the last ellipse by 1.5 and rejects all edges outside of that radius.
- ****kwargs** ()

`__init__`(*footprint_size: int = 5*, *search_scale: float = 1.5*, ***kwargs*)

Parameters

- **footprint_size** (*int*) – Diameter of footprint (a `skimage.morphology.disk()`) used in the median filter `skimage.filters.rank.median()` . This should be roughly the size of the pupil.
- **search_scale** (*float*) – If present, how much to scale the `PupilExtractor.filter.last_pupil` to select edges before fitting ellipses. Eg. `1.5` enlarges the last ellipse by 1.5 and rejects all edges outside of that radius.
- ****kwargs** ()

property footprint_size: int

As described in the `attr` docstring. When setting a footprint size, remake the `footprint`

Returns int

`filter_edges`(*edges: numpy.ndarray*) → numpy.ndarray

Set all edges outside of a search radius, given our previous ellipse, to zero

`choose_ellipse`(*edges: numpy.ndarray*, *frame: numpy.ndarray*) → Optional[skimage.measure.fit.EllipseModel]

Given an array of edge labels (from `skimage.morphology.label()`), usually from *`_process()`*, return an `skimage.measure.EllipseModel` , choose the one that is the pupil

Parameters

- **edges** () – An array of image labels, ie. an array of ints where background == 0, edge 1 == 1, and so on.
- **frame** () – The original or filtered image frame (the array, not the *`Frame`* object)

Returns the most pupil-like ellipse

Return type `skimage.measure.EllipseModel`

class perceptivo.video.pupil.**EnsembleExtractor_NonIR**(*sigmoid=(0.5, 5)*, *canny_kwargs: Optional[dict] = None*, *hough_kwargs: Optional[dict] = None*, **args*, ***kwargs*)

Bases: *`perceptivo.video.pupil.PupilExtractor`*

Extractor that uses an ensemble of techniques to track a pupil.

Written before realizing the trakcing problem was much easier using IR! Kept to mine parts from before discontinuing

- Track to find approximate position of eyes with *`processors.Haar_Tracker`*
- Mask image around both eyes, split processing in parallel L/R (if present)
- Use white of eyes to mask cornea and pupil
- Sigmoid filter images to separate cornea and pupil
- Blob detection to find center mass of pupil

- Compare blob vs. edge detection of pupil.
- Use Kalman filter on *perceptivo.types.units.Ellipse* properties to avoid jumps and all that

preprocess(*frame:* perceptivo.types.video.Frame) → *perceptivo.types.video.Frame*

_bbox_from_circle(*circle: List[int]*)

convert opencv's circles to a bounding box (top, bottom, left, right)

class perceptivo.video.pupil.**Pupil_Extractors**(*value*)

Bases: enum.Enum

An enumeration.

simple = <class 'perceptivo.video.pupil.EllipseExtractor'>

perceptivo.video.pupil.**get_extractor**(*extractor=<enum 'Pupil_Extractors'>*) → Type[*perceptivo.video.pupil.EllipseExtractor*]

Parameters extractor (str, *Pupil_Extractors*) – str corresponding to one of the entries in *Pupil_Extractors*, eg 'simple'

Returns:

4.9.3 processors

Individual transformation operations for video frames.

To be used with the *perceptivo.video.pupil.PupilExtractor* subclasses

class perceptivo.video.processors.**Processor**(***kwargs*)

Bases: *perceptivo.root.Perceptivo_Object*

Individual processing stage, can be added together to make a processing chain

__add__ method based on autopilot.transform.transforms.Transform

property parent: Optional[*perceptivo.video.processors.Processor*]

If this Transform is in a chain of transforms, the transform that precedes it

Returns Transform, None if no parent.

abstract process(*input: Union[*perceptivo.types.video.Frame, perceptivo.types.units.Ellipse*]*) → Union[*perceptivo.types.video.Frame*, *perceptivo.types.units.Ellipse*]

Process a frame!

Typically you want a chain of processors to end up outputting an Ellipse, but this is not enforced

Returns:

__add__(*other*)

Add another Transformation in the chain to make a processing pipeline :Parameters: **other** (Transformation) – The transformation to be chained

class perceptivo.video.processors.**Canny**(*blur_sigma: float = 1*, *low_thresh: float = 0.2*, *high_thresh: float = 0.5*)

Bases: *perceptivo.video.processors.Processor*

Canny edge detection.

Slight modification of `skimage.feature.canny()`, but using opencv and Scharr kernel rather than sobel for better orientation invariance, and also using the eigenvectors of the structure tensor rather than the simple hypotenuse

The source for this class is really blippy because it is optimized for speed!

Variables

- **blur_sigma** (*float*) – Amount of blurring to use in the initial smoothing step
- **low_thresh** (*float*) – Low threshold for canny edge detection
- **high_thresh** (*float*) – High threshold for canny edge detection

References

- [WS02]
- [BY15]
- [ZFD+16]

process(*frame:* perceptivo.types.video.Frame) → *perceptivo.types.video.Frame*

Process a frame!

Typically you want a chain of processors to end up outputting an Ellipse, but this is not enforced

Returns:

class perceptivo.video.processors.**Haar_Tracker**(*tracker_type: str = 'eye'*, *min_neighbors: int = 20*, *adaptive_neighbors: bool = True*, ***kwargs*)

Bases: *perceptivo.video.processors.Processor*

Download and use a haar cascade to track.

Many trained cascade .xml files are available at https://github.com/opencv/opencv/tree/master/data/haarcascades

References

- OpenCV Cascade Classifier Tutorial

XML_URLS = {'eye': 'https://raw.githubusercontent.com/opencv/opencv/415a42f327104653604fc99314eb215cd938d6d7/data/haarcascades/haarcascade_eye.xml', 'face_default': 'https://raw.githubusercontent.com/opencv/opencv/415a42f327104653604fc99314eb215cd938d6d7/data/haarcascades/haarcascade_frontalface_default.xml'}

property url: *str*

property filename: *pathlib.Path*

process(*frame:* perceptivo.types.video.Frame) → Tuple[List[tuple], List[int]]

Parameters **frame** (*Frame*)

Returns list of tuples corresponding to (x,y,width,height)

class perceptivo.video.processors.**Filtered_Hough**(*radii=(15, 30, 100)*, *max_considered=3*, *peaks_kwargs: Optional[dict] = None*)

Bases: *perceptivo.video.processors.Processor*

A hough transform to detect circles, returning the one that bounds the darkest area in the image

process(*edges: numpy.ndarray*)

Frame to process, along with edges from canny edge detection

class perceptivo.video.processors.**Filter_Circles**(*prior_bias=0.5*)

Bases: *perceptivo.video.processors.Processor*

Filter Circles!

Parameters **prior_bias** (*float*) – how strongly to weight the similarity to the prior circle, if given

__init__(*prior_bias=0.5*)

Parameters **prior_bias** (*float*) – how strongly to weight the similarity to the prior circle, if given

process(*frame:* perceptivo.types.video.Frame, *circles*, *prev_eye=None*)

Process a frame!

Typically you want a chain of processors to end up outputting an Ellipse, but this is not enforced

Returns:

perceptivo.video.processors.**circle_to_mask**(*frame*, *ix*, *iy*, *rad*)

4.10 util

Utility functions! everyone's favorite!

perceptivo.util.**download**(*url: str*, *file_name: Union[pathlib.Path, str]*) → bool

Download a file with a progress bar

Returns `True` if nothing happened and its probs good, `False` otherwise

Return type bool

References

https://gist.github.com/yanqd0/c13ed29e29432e3cf3e7c38467f42f51

perceptivo.util.**pack_array**(*array*) → dict

perceptivo.util.**unpack_array**(*shape: tuple*, *dtype: numpy.dtype*, *array: bytes*) → numpy.ndarray

perceptivo.util.**serialize**(*array: Union[numpy.ndarray, Any]*) → Union[dict, Any]

Serialization for use with `msgpack.packb` as `default`

Returns

dict like:

```
{
    '__numpy__': True,
    'shape': array.shape,
    'dtype': str(array.dtype),
    'array': array.data
}
```

perceptivo.util.**deserialize**(*obj*)

perceptivo.util.**msgpack_loads**(*msg*)

Wrapper of the msgpack

perceptivo.util.**msgpack_dumps**(*msg*, *, *default=None*)

4.11 prefs

Preferences and configuration shared throughout the program.

Saves and loads to a prefs file (default is *~/.perceptivo/prefs.json*)

Each runtime has its own set of preferences. When first run, if there is not prefs file detected it populates with defaults (though defaults can be populated at any time by instantiating the object with no arguments and using save, eg.:

```
prefs = Patient_Prefs()
prefs.save()
```

class perceptivo.prefs.**Runtimes**(*value*)

Bases: enum.Enum

An enumeration.

patient = 'patient'

clinician = 'clinician'

stimuli = 'stimuli'

perceptivo.prefs.**json_dumps_pretty**(*v*, *, *default*)

pydantic model perceptivo.prefs.**Prefs**

Bases: pydantic.main.BaseModel

Create a new model by parsing and validating input data from keyword arguments.

Raises ValidationError if the input data cannot be parsed to form a valid model.

```
{
   "title": "Prefs",
   "type": "object",
   "properties": {
      "loglevel": {
         "title": "Loglevel",
         "default": "DEBUG",
         "enum": [
            "DEBUG",
```

(continues on next page)

(continued from previous page)


```
            "INFO",
            "WARNING",
            "ERROR"
         ],
         "type": "string"
      }
   }
}
```


Config

- **json_dumps**: *function* = <*function json_dumps_pretty at 0x7f07dd545700*>

Fields

- *loglevel (Literal['DEBUG', 'INFO', 'WARNING', 'ERROR'])*

field loglevel: Literal['DEBUG', 'INFO', 'WARNING', 'ERROR'] = 'DEBUG'

save(*file: pathlib.Path = PosixPath('/home/docs/.perceptivo/prefs.json')*)

classmethod load(*file: pathlib.Path = PosixPath('/home/docs/.perceptivo/prefs.json')*) → *perceptivo.prefs.Prefs*

classmethod get_runtime_prefs(*runtime:* perceptivo.prefs.Runtimes) → *perceptivo.prefs.Patient_Prefs*

pydantic model perceptivo.prefs.**Patient_Prefs**

Bases: *perceptivo.prefs.Prefs*

Create a new model by parsing and validating input data from keyword arguments.

Raises ValidationError if the input data cannot be parsed to form a valid model.


```
{
   "title": "Patient_Prefs",
   "type": "object",
   "properties": {
      "loglevel": {
         "title": "Loglevel",
         "default": "DEBUG",
         "enum": [
            "DEBUG",
            "INFO",
            "WARNING",
            "ERROR"
         ],
         "type": "string"
      },
      "runtime": {
         "default": "patient",
         "allOf": [
            {
               "$ref": "#/definitions/Runtimes"
            }
         ]
```


(continues on next page)

(continued from previous page)


```
    },
    "Audio_Config": {
       "title": "Audio Config",
       "default": {
          "fs": 44100
       },
       "allOf": [
          {
             "$ref": "#/definitions/Audio_Config"
          }
       ]
    },
    "Audiogram_Model": {
       "title": "Audiogram Model",
       "default": {
          "model_type": "Gaussian_Process",
          "args": [],
          "kwargs": {
             "kernel": "length_scale=(100.0, 200.0) length_scale_bounds=(1,␣
↪100000.0)"
          }
       },
       "allOf": [
          {
             "$ref": "#/definitions/Psychoacoustic_Model"
          }
       ]
    },
    "Picamera_Params": {
       "title": "Picamera Params",
       "default": {
          "sensor_mode": 0,
          "resolution": [
             1280,
             720
          ],
          "fps": 30,
          "format": "grayscale",
          "output_file": null
       },
       "allOf": [
          {
             "$ref": "#/definitions/Picamera_Params"
          }
       ]
    },
    "picamera_process": {
       "title": "Picamera Process",
       "default": true,
       "type": "boolean"
    },
    "picam_queue_size": {
```


(continues on next page)

(continued from previous page)


```
            "title": "Picam Queue Size",
            "default": 1024,
            "type": "integer"
        },
        "pupil_extractor": {
            "title": "Pupil Extractor",
            "default": "simple",
            "type": "string"
        },
        "pupil_extractor_params": {
            "title": "Pupil Extractor Params",
            "default": {
                "footprint_size": 5,
                "search_scale": 1.5
            },
            "allOf": [
                {
                    "$ref": "#/definitions/EllipseExtractor_Params"
                }
            ]
        },
        "collection_params": {
            "title": "Collection Params",
            "default": {
                "collection_wait": 5
            },
            "allOf": [
                {
                    "$ref": "#/definitions/Collection_Params"
                }
            ]
        },
        "networking": {
            "title": "Networking",
            "default": {
                "ip": "",
                "clinician_ip": "",
                "eyecam": "Socket(id='patient:eyecam', socket_type='PUSH', protocol='tcp
↪', mode='connect', port=5500, ip='', to=None)",
                "control": "Socket(id='patient:control', socket_type='DEALER', protocol=
↪'tcp', mode='connect', port=5600, ip='', to='clinician:control')"
            },
            "allOf": [
                {
                    "$ref": "#/definitions/Patient_Networking"
                }
            ]
        }
    },
    "definitions": {
        "Runtimes": {
            "title": "Runtimes",
```


(continues on next page)

(continued from previous page)


```
         "description": "An enumeration.",
         "enum": [
            "patient",
            "clinician",
            "stimuli"
         ]
      },
      "Audio_Config": {
         "title": "Audio_Config",
         "description": "Base class for audio configuration\n\nParams:\n    fs
↪(int): Sampling rate in Hz, default 44100",
         "type": "object",
         "properties": {
            "fs": {
               "title": "Fs",
               "default": 44100,
               "type": "integer"
            }
         }
      },
      "Kernel": {
         "title": "Kernel",
         "description": "Default kernel to use with :class:`.psychophys.model.
↪Gaussian_Process`\n\nUses a kernel with a short length scale for frequency, but a
↪longer length scale for amplitude,\nwhich should be smoother/monotonic where
↪frequency can have an unpredictable shape",
         "type": "object",
         "properties": {
            "length_scale": {
               "title": "Length Scale",
               "default": [
                  100.0,
                  200.0
               ],
               "type": "array",
               "minItems": 2,
               "maxItems": 2,
               "items": [
                  {
                     "type": "number"
                  },
                  {
                     "type": "number"
                  }
               ]
            },
            "length_scale_bounds": {
               "title": "Length Scale Bounds",
               "default": [
                  1,
                  100000.0
               ],
```


(continues on next page)

(continued from previous page)


```
                "type": "array",
                "minItems": 2,
                "maxItems": 2,
                "items": [
                   {
                      "type": "number"
                   },
                   {
                      "type": "number"
                   }
                ]
             }
          }
       },
       "Psychoacoustic_Model": {
          "title": "Psychoacoustic_Model",
          "description": "Parameterization of a psychoacoustic model to use to␣
↪estimate audiograms and\ncontrol the presentation of stimuli",
          "type": "object",
          "properties": {
             "model_type": {
                "title": "Model Type",
                "default": "Gaussian_Process",
                "enum": [
                   "Gaussian_Process"
                ],
                "type": "string"
             },
             "args": {
                "title": "Args",
                "type": "array",
                "items": {}
             },
             "kwargs": {
                "title": "Kwargs",
                "type": "object",
                "additionalProperties": {
                   "$ref": "#/definitions/Kernel"
                }
             }
          }
       },
       "Picamera_Params": {
          "title": "Picamera_Params",
          "description": "Configuration for a :class:`perceptivo.video.cameras.
↪PiCamera`",
          "type": "object",
          "properties": {
             "sensor_mode": {
                "title": "Sensor Mode",
                "default": 0,
                "type": "integer"
```


(continues on next page)

(continued from previous page)


```
            },
            "resolution": {
               "title": "Resolution",
               "default": [
                  1280,
                  720
               ],
               "type": "array",
               "minItems": 2,
               "maxItems": 2,
               "items": [
                  {
                     "type": "integer"
                  },
                  {
                     "type": "integer"
                  }
               ]
            },
            "fps": {
               "title": "Fps",
               "default": 30,
               "type": "integer"
            },
            "format": {
               "title": "Format",
               "default": "grayscale",
               "enum": [
                  "rgb",
                  "grayscale"
               ],
               "type": "string"
            },
            "output_file": {
               "title": "Output File",
               "type": "string",
               "format": "path"
            }
         }
      },
      "EllipseExtractor_Params": {
         "title": "EllipseExtractor_Params",
         "type": "object",
         "properties": {
            "footprint_size": {
               "title": "Footprint Size",
               "default": 5,
               "type": "integer"
            },
            "search_scale": {
               "title": "Search Scale",
               "default": 1.5,
```


(continues on next page)

(continued from previous page)

```
            "type": "number"
         }
      }
   },
   "Collection_Params": {
      "title": "Collection_Params",
      "type": "object",
      "properties": {
         "collection_wait": {
            "title": "Collection Wait",
            "default": 5,
            "type": "number"
         }
      }
   },
   "Socket": {
      "title": "Socket",
      "type": "object",
      "properties": {
         "id": {
            "title": "Id",
            "type": "string"
         },
         "socket_type": {
            "title": "Socket Type",
            "enum": [
               "REQ",
               "REP",
               "PUB",
               "SUB",
               "PAIR",
               "DEALER",
               "ROUTER",
               "PULL",
               "PUSH"
            ],
            "type": "string"
         },
         "protocol": {
            "title": "Protocol",
            "enum": [
               "tcp",
               "ipc",
               "inproc"
            ],
            "type": "string"
         },
         "mode": {
            "title": "Mode",
            "enum": [
               "connect",
               "bind"
```

(continues on next page)

(continued from previous page)

```
            ],
            "type": "string"
         },
         "port": {
            "title": "Port",
            "type": "integer"
         },
         "ip": {
            "title": "Ip",
            "default": "*",
            "type": "string"
         },
         "to": {
            "title": "To",
            "type": "string"
         }
      },
      "required": [
         "id",
         "socket_type",
         "protocol",
         "mode",
         "port"
      ]
   },
   "Patient_Networking": {
      "title": "Patient_Networking",
      "type": "object",
      "properties": {
         "ip": {
            "title": "Ip",
            "default": "",
            "type": "string"
         },
         "clinician_ip": {
            "title": "Clinician Ip",
            "default": "",
            "type": "string"
         },
         "eyecam": {
            "title": "Eyecam",
            "default": {
               "id": "patient:eyecam",
               "socket_type": "PUSH",
               "protocol": "tcp",
               "mode": "connect",
               "port": 5500,
               "ip": "",
               "to": null
            },
            "allOf": [
               {
```

(continues on next page)

(continued from previous page)

```
                    "$ref": "#/definitions/Socket"
                }
            ]
        },
        "control": {
            "title": "Control",
            "default": {
                "id": "patient:control",
                "socket_type": "DEALER",
                "protocol": "tcp",
                "mode": "connect",
                "port": 5600,
                "ip": "",
                "to": "clinician:control"
            },
            "allOf": [
                {
                    "$ref": "#/definitions/Socket"
                }
            ]
        }
    }
  }
}
```

Config

- **use_enum_values**: *bool* = *True*

Fields

- *Audio_Config (perceptivo.types.sound.Audio_Config)*
- *Audiogram_Model (perceptivo.types.psychophys.Psychoacoustic_Model)*
- *Picamera_Params (perceptivo.types.video.Picamera_Params)*
- *collection_params (perceptivo.types.patient.Collection_Params)*
- *networking (perceptivo.types.networking.Patient_Networking)*
- *picam_queue_size (int)*
- *picamera_process (bool)*
- *pupil_extractor (str)*
- *pupil_extractor_params (perceptivo.video.pupil.EllipseExtractor_Params)*
- *runtime (perceptivo.prefs.Runtimes)*

field runtime: *perceptivo.prefs.Runtimes* = 'patient'

field Audio_Config: *perceptivo.types.sound.Audio_Config* = Audio_Config(fs=44100)

field Audiogram_Model: *perceptivo.types.psychophys.Psychoacoustic_Model* = Psychoacoustic_Model(model_type='Gaussian_Process', args=[], kwargs={'kernel': Kernel(length_scale=(100.0, 200.0), length_scale_bounds=(1, 100000.0))})

field Picamera_Params: *perceptivo.types.video.Picamera_Params* = Picamera_Params(sensor_mode=0, resolution=(1280, 720), fps=30, format='grayscale', output_file=None)

field picamera_process: bool = True

Run the picamera in a separate Process (using *cameras.Picamera_Process* . Only True supported for now!

field picam_queue_size: int = 1024

field pupil_extractor: str = 'simple'

field pupil_extractor_params: *perceptivo.video.pupil.EllipseExtractor_Params* = EllipseExtractor_Params(footprint_size=5, search_scale=1.5)

field collection_params: *perceptivo.types.patient.Collection_Params* = Collection_Params(collection_wait=5)

field networking: *perceptivo.types.networking.Patient_Networking* = Patient_Networking(ip='', clinician_ip='', eyecam=Socket(id='patient:eyecam', socket_type='PUSH', protocol='tcp', mode='connect', port=5500, ip='', to=None), control=Socket(id='patient:control', socket_type='DEALER', protocol='tcp', mode='connect', port=5600, ip='', to='clinician:control'))

pydantic model perceptivo.prefs.Clinician_Prefs

Bases: *perceptivo.prefs.Prefs*

Create a new model by parsing and validating input data from keyword arguments.

Raises ValidationError if the input data cannot be parsed to form a valid model.


```
{
   "title": "Clinician_Prefs",
   "type": "object",
   "properties": {
      "loglevel": {
         "title": "Loglevel",
         "default": "DEBUG",
         "enum": [
            "DEBUG",
            "INFO",
            "WARNING",
            "ERROR"
         ],
         "type": "string"
      },
      "networking": {
         "title": "Networking",
         "default": {
            "ip": "",
            "patient_ip": "",
            "eyecam": "Socket(id='clinician:eyecam', socket_type='PULL', protocol=
↪'tcp', mode='bind', port=5500, ip='*', to=None)",
```


(continues on next page)

(continued from previous page)

```
            "control": "Socket(id='clinician:control', socket_type='ROUTER',␣
↪protocol='tcp', mode='bind', port=5600, ip='*', to=None)"
         },
         "allOf": [
            {
               "$ref": "#/definitions/Clinician_Networking"
            }
         ]
      },
      "gui": {
         "title": "Gui",
         "default": {
            "control_panel": {
               "amplitude_range": {
                  "key": "amplitude_range",
                  "name": "Amplitude Range (dBSPL)",
                  "widget_type": "range",
                  "default": {
                     "min": 0.0,
                     "max": 80.0,
                     "n": 8
                  },
                  "args": [],
                  "kwargs": {
                     "limits": [
                        0,
                        100
                     ]
                  }
               },
               "frequency_range": {
                  "key": "frequency_range",
                  "name": "Frequency Range (Hz)",
                  "widget_type": "range",
                  "default": {
                     "min": 0.0,
                     "max": 8000.0,
                     "n": 17
                  },
                  "args": [],
                  "kwargs": {
                     "limits": [
                        0,
                        20000
                     ]
                  }
               },
               "iti": {
                  "key": "iti",
                  "name": "Inter-Trial Interval (s)",
                  "widget_type": "float",
                  "default": 5.0,
```

(continues on next page)

(continued from previous page)

```
                "args": [],
                "kwargs": {}
            },
            "iti_jitter": {
                "key": "iti_jitter",
                "name": "Inter-Trial Jitter (proportion of ITI)",
                "widget_type": "float",
                "default": 0.1,
                "args": [],
                "kwargs": {}
            }
        }
    },
    "allOf": [
        {
            "$ref": "#/definitions/GUI_Params"
        }
    ]
},
"update_period": {
    "title": "Update Period",
    "default": 0.05,
    "type": "number"
}
},
"definitions": {
"Socket": {
    "title": "Socket",
    "type": "object",
    "properties": {
        "id": {
            "title": "Id",
            "type": "string"
        },
        "socket_type": {
            "title": "Socket Type",
            "enum": [
                "REQ",
                "REP",
                "PUB",
                "SUB",
                "PAIR",
                "DEALER",
                "ROUTER",
                "PULL",
                "PUSH"
            ],
            "type": "string"
        },
        "protocol": {
            "title": "Protocol",
            "enum": [
```

(continues on next page)

(continued from previous page)

```
                "tcp",
                "ipc",
                "inproc"
            ],
            "type": "string"
        },
        "mode": {
            "title": "Mode",
            "enum": [
                "connect",
                "bind"
            ],
            "type": "string"
        },
        "port": {
            "title": "Port",
            "type": "integer"
        },
        "ip": {
            "title": "Ip",
            "default": "*",
            "type": "string"
        },
        "to": {
            "title": "To",
            "type": "string"
        }
    },
    "required": [
        "id",
        "socket_type",
        "protocol",
        "mode",
        "port"
    ]
},
"Clinician_Networking": {
    "title": "Clinician_Networking",
    "description": "Default networking properties for the Clinician computer",
    "type": "object",
    "properties": {
        "ip": {
            "title": "Ip",
            "default": "",
            "type": "string"
        },
        "patient_ip": {
            "title": "Patient Ip",
            "default": "",
            "type": "string"
        },
        "eyecam": {
```

(continues on next page)

(continued from previous page)


```
            "title": "Eyecam",
            "default": {
               "id": "clinician:eyecam",
               "socket_type": "PULL",
               "protocol": "tcp",
               "mode": "bind",
               "port": 5500,
               "ip": "*",
               "to": null
            },
            "allOf": [
               {
                  "$ref": "#/definitions/Socket"
               }
            ]
         },
         "control": {
            "title": "Control",
            "default": {
               "id": "clinician:control",
               "socket_type": "ROUTER",
               "protocol": "tcp",
               "mode": "bind",
               "port": 5600,
               "ip": "*",
               "to": null
            },
            "allOf": [
               {
                  "$ref": "#/definitions/Socket"
               }
            ]
         }
      }
   },
   "GUI_Range": {
      "title": "GUI_Range",
      "description": "Range for :class:`.widgets.components.Range_Setter`",
      "type": "object",
      "properties": {
         "min": {
            "title": "Min",
            "type": "number"
         },
         "max": {
            "title": "Max",
            "type": "number"
         },
         "n": {
            "title": "N",
            "type": "integer"
         }
```


(continues on next page)

(continued from previous page)


```
        },
        "required": [
           "min",
           "max",
           "n"
        ]
     },
     "GUI_Param": {
        "title": "GUI_Param",
        "description": "Parameterization for a GUI Parameter itself. ie. How a␣
↪particular parameter should be represented.\n\nParams:\n    key (GUI_PARAMS): the␣
↪key used for the parameter\n    name (str): A human readable name for the␣
↪parameter\n    widget_type (GUI_WIDGETS): A string that indicates the type of␣
↪widget that should be used.\n        Different ``widget_type`` s may use␣
↪different widgets, combinations of widgets, and\n        validators, and are thus␣
↪not strictly isomorphic to a single widget type.\n    default (any): the default␣
↪value to be set, must correspond to widget type\n    args (list): args to pass to␣
↪the widget\n    kwargs (dict): kwargs to pass to the widget",
        "type": "object",
        "properties": {
           "key": {
              "title": "Key",
              "enum": [
                 "frequencies",
                 "amplitudes",
                 "log_x",
                 "log_y",
                 "extra_amplitude",
                 "amplitude_step",
                 "amplitude_range",
                 "max_amplitude",
                 "frequency_step",
                 "frequency_range",
                 "iti",
                 "iti_jitter"
              ],
              "type": "string"
           },
           "name": {
              "title": "Name",
              "type": "string"
           },
           "widget_type": {
              "title": "Widget Type",
              "enum": [
                 "int",
                 "float",
                 "range",
                 "tuple",
                 "bool"
              ],
              "type": "string"
```


(continues on next page)

(continued from previous page)


```
            },
            "default": {
               "title": "Default",
               "anyOf": [
                  {
                     "type": "number"
                  },
                  {
                     "type": "integer"
                  },
                  {
                     "$ref": "#/definitions/GUI_Range"
                  },
                  {
                     "type": "array",
                     "items": {}
                  }
               ]
            },
            "args": {
               "title": "Args",
               "type": "array",
               "items": {}
            },
            "kwargs": {
               "title": "Kwargs",
               "type": "object"
            }
         },
         "required": [
            "key",
            "name",
            "widget_type"
         ]
      },
      "Control_Panel_Params": {
         "title": "Control_Panel_Params",
         "description": "Defaults and parameters for :class:`perceptivo.gui.widgets.
↪Control_Panel`",
         "type": "object",
         "properties": {
            "amplitude_range": {
               "title": "Amplitude Range",
               "default": {
                  "key": "amplitude_range",
                  "name": "Amplitude Range (dBSPL)",
                  "widget_type": "range",
                  "default": {
                     "min": 0.0,
                     "max": 80.0,
                     "n": 8
                  },
```


(continues on next page)

(continued from previous page)


```
                "args": [],
                "kwargs": {
                    "limits": [
                        0,
                        100
                    ]
                }
            },
            "allOf": [
                {
                    "$ref": "#/definitions/GUI_Param"
                }
            ]
        },
        "frequency_range": {
            "title": "Frequency Range",
            "default": {
                "key": "frequency_range",
                "name": "Frequency Range (Hz)",
                "widget_type": "range",
                "default": {
                    "min": 0.0,
                    "max": 8000.0,
                    "n": 17
                },
                "args": [],
                "kwargs": {
                    "limits": [
                        0,
                        20000
                    ]
                }
            },
            "allOf": [
                {
                    "$ref": "#/definitions/GUI_Param"
                }
            ]
        },
        "iti": {
            "title": "Iti",
            "default": {
                "key": "iti",
                "name": "Inter-Trial Interval (s)",
                "widget_type": "float",
                "default": 5.0,
                "args": [],
                "kwargs": {}
            },
            "allOf": [
                {
                    "$ref": "#/definitions/GUI_Param"
```


(continues on next page)

(continued from previous page)


```
                    }
                ]
            },
            "iti_jitter": {
                "title": "Iti Jitter",
                "default": {
                    "key": "iti_jitter",
                    "name": "Inter-Trial Jitter (proportion of ITI)",
                    "widget_type": "float",
                    "default": 0.1,
                    "args": [],
                    "kwargs": {}
                },
                "allOf": [
                    {
                        "$ref": "#/definitions/GUI_Param"
                    }
                ]
            }
        }
    },
    "GUI_Params": {
        "title": "GUI_Params",
        "description": "Container for all parameters to be given to the GUI on init
↪",
        "type": "object",
        "properties": {
            "control_panel": {
                "title": "Control Panel",
                "default": {
                    "amplitude_range": {
                        "key": "amplitude_range",
                        "name": "Amplitude Range (dBSPL)",
                        "widget_type": "range",
                        "default": {
                            "min": 0.0,
                            "max": 80.0,
                            "n": 8
                        },
                        "args": [],
                        "kwargs": {
                            "limits": [
                                0,
                                100
                            ]
                        }
                    },
                    "frequency_range": {
                        "key": "frequency_range",
                        "name": "Frequency Range (Hz)",
                        "widget_type": "range",
                        "default": {
```


(continues on next page)

(continued from previous page)


```
                        "min": 0.0,
                        "max": 8000.0,
                        "n": 17
                     },
                     "args": [],
                     "kwargs": {
                        "limits": [
                           0,
                           20000
                        ]
                     }
                  },
                  "iti": {
                     "key": "iti",
                     "name": "Inter-Trial Interval (s)",
                     "widget_type": "float",
                     "default": 5.0,
                     "args": [],
                     "kwargs": {}
                  },
                  "iti_jitter": {
                     "key": "iti_jitter",
                     "name": "Inter-Trial Jitter (proportion of ITI)",
                     "widget_type": "float",
                     "default": 0.1,
                     "args": [],
                     "kwargs": {}
                  }
               },
               "allOf": [
                  {
                     "$ref": "#/definitions/Control_Panel_Params"
                  }
               ]
            }
         }
      }
   }
}
```


Config

- **json_dumps**: *function* = <*function json_dumps_pretty at 0x7f07dd545700*>

Fields

- *gui (perceptivo.types.gui.GUI_Params)*
- *networking (perceptivo.types.networking.Clinician_Networking)*
- *update_period (float)*

field networking: *perceptivo.types.networking.Clinician_Networking* = Clinician_Networking(ip='', patient_ip='', eyecam=Socket(id='clinician:eyecam', socket_type='PULL', protocol='tcp', mode='bind', port=5500, ip='*', to=None), control=Socket(id='clinician:control', socket_type='ROUTER', protocol='tcp', mode='bind', port=5600, ip='*', to=None))

field gui: *perceptivo.types.gui.GUI_Params* = GUI_Params(control_panel=Control_Panel_Params(amplitude_range=GUI_Param(key='amplitude_range', name='Amplitude Range (dBSPL)', widget_type='range', default=GUI_Range(min=0.0, max=80.0, n=8), args=[], kwargs={'limits': (0, 100)}), frequency_range=GUI_Param(key='frequency_range', name='Frequency Range (Hz)', widget_type='range', default=GUI_Range(min=0.0, max=8000.0, n=17), args=[], kwargs={'limits': (0, 20000)}), iti=GUI_Param(key='iti', name='Inter-Trial Interval (s)', widget_type='float', default=5.0, args=[], kwargs={}), iti_jitter=GUI_Param(key='iti_jitter', name='Inter-Trial Jitter (proportion of ITI)', widget_type='float', default=0.1, args=[], kwargs={})))

field update_period: float = 0.05

perceptivo.prefs.**get**(*field: str*, *file: pathlib.Path = PosixPath('/home/docs/.perceptivo/prefs.json')*)

perceptivo.prefs.**set_global**(*prefs:* perceptivo.prefs.Prefs)

perceptivo.prefs.**get_global**() → *perceptivo.prefs.Prefs*

4.12 root

Root Perceptivo Object from which others inherit

class perceptivo.root.**Perceptivo_Object**

Bases: abc.ABC

property logger: logging.Logger

BIBLIOGRAPHY

[BY15] Ahmadreza Baghaie and Zeyun Yu. Structure Tensor Based Image Interpolation Method. *AEU - International Journal of Electronics and Communications*, 69(2):515–522, February 2015. arXiv:1402.5564, doi:10.1016/j.aeue.2014.10.022.

[CdeVries16] Marco Cox and Bert de Vries. A Bayesian binary classification approach to pure tone audiometry. *arXiv:1511.08670 [stat]*, March 2016. arXiv:1511.08670.

[GMG+15] Jacob Gardner, Gustavo Malkomes, Roman Garnett, Kilian Q Weinberger, Dennis Barbour, and John P Cunningham. Bayesian Active Model Selection with an Application to Automated Audiometry. In *Advances in Neural Information Processing Systems*, volume 28. Curran Associates, Inc., 2015.

[MSG16] Gustavo Malkomes, Charles Schaff, and Roman Garnett. Bayesian optimization for automated model selection. In *Advances in Neural Information Processing Systems*, volume 29. Curran Associates, Inc., 2016.

[WSG91] S. Wang, A. Sekey, and A. Gersho. Auditory distortion measure for speech coding. In *Acoustics, Speech, and Signal Processing, IEEE International Conference On*, 493–496. IEEE Computer Society, April 1991. doi:10.1109/ICASSP.1991.150384.

[WS02] Joachim Weickert and Hanno Scharr. A Scheme for Coherence-Enhancing Diffusion Filtering with Optimized Rotation Invariance. *Journal of Visual Communication and Image Representation*, 13(1):103–118, March 2002. doi:10.1006/jvci.2001.0495.

[ZFD+16] Wenxing Zhang, Jérôme Fehrenbach, Annaïck Desmaison, Valérie Lobjois, Bernard Ducommun, and Pierre Weiss. Structure Tensor Based Analysis of Cells and Nuclei Organization in Tissues. *IEEE transactions on medical imaging*, 35(1):294–306, January 2016. doi:10.1109/TMI.2015.2470093.

PYTHON MODULE INDEX

p

perceptivo.data, 24
perceptivo.data.logging, 25
perceptivo.data.patient, 25
perceptivo.gui, 64
perceptivo.gui.main, 64
perceptivo.gui.styles, 65
perceptivo.gui.widgets, 65
perceptivo.gui.widgets.audiogram, 65
perceptivo.gui.widgets.components, 65
perceptivo.gui.widgets.control_panel, 66
perceptivo.gui.widgets.patient, 67
perceptivo.gui.widgets.pupil, 67
perceptivo.gui.widgets.video, 67
perceptivo.networking, 67
perceptivo.networking.messages, 67
perceptivo.networking.node, 68
perceptivo.networking.sockets, 69
perceptivo.prefs, 83
perceptivo.psychophys, 70
perceptivo.psychophys.gaussian, 70
perceptivo.psychophys.model, 71
perceptivo.psychophys.oracle, 74
perceptivo.root, 103
perceptivo.runtimes.clinician, 21
perceptivo.runtimes.patient, 22
perceptivo.runtimes.runtime, 21
perceptivo.sound, 75
perceptivo.sound.server, 75
perceptivo.sound.sounds, 76
perceptivo.stim, 76
perceptivo.types, 26
perceptivo.types.exam, 26
perceptivo.types.gui, 30
perceptivo.types.networking, 46
perceptivo.types.patient, 51
perceptivo.types.psychophys, 52
perceptivo.types.pupil, 56
perceptivo.types.sound, 57
perceptivo.types.units, 60
perceptivo.types.video, 61
perceptivo.util, 82
perceptivo.video, 76
perceptivo.video.cameras, 76
perceptivo.video.processors, 80
perceptivo.video.pupil, 76

INDEX

Symbols

_IterativeBinaryGPCLaplace (*class in perceptivo.psychophys.gaussian*), 70
_LOGGERS (*in module perceptivo.data.logging*), 25
__add__() (*perceptivo.video.processors.Processor method*), 80
__init__() (*perceptivo.gui.widgets.components.Range_Setter method*), 66
__init__() (*perceptivo.networking.messages.Message method*), 67
__init__() (*perceptivo.networking.node.Node method*), 68
__init__() (*perceptivo.video.processors.Filter_Circles method*), 82
__init__() (*perceptivo.video.pupil.EllipseExtractor method*), 79
_bbox_from_circle() (*perceptivo.video.pupil.EnsembleExtractor_NonIR method*), 80
_collect_frames() (*perceptivo.runtimes.patient.Patient method*), 24
_get_params() (*perceptivo.psychophys.model.Gaussian_Process method*), 73
_init_audio() (*perceptivo.runtimes.patient.Patient method*), 24
_process() (*perceptivo.video.pupil.PupilExtractor method*), 77
_start_ioloop() (*perceptivo.networking.node.Node method*), 69
_start_polling() (*perceptivo.networking.node.Node method*), 69
_update_pupil_params() (*perceptivo.runtimes.patient.Patient method*), 24

A

a (*perceptivo.types.units.Ellipse attribute*), 60
address (*perceptivo.networking.node.Node property*), 68
allow_repeats (*perceptivo.types.exam.Exam_Params attribute*), 30
amplitude (*perceptivo.types.sound.Sound attribute*), 59
amplitudes (*perceptivo.types.exam.Exam_Params attribute*), 29
amplitudes (*perceptivo.types.psychophys.Samples attribute*), 53
append() (*perceptivo.types.psychophys.Samples method*), 53
args (*perceptivo.types.gui.GUI_Param attribute*), 36
args (*perceptivo.types.psychophys.Psychoacoustic_Model attribute*), 56
Audio_Config (*class in perceptivo.types.sound*), 57
Audio_Config (*perceptivo.prefs.Patient_Prefs attribute*), 92
Audiogram (*class in perceptivo.gui.widgets.audiogram*), 65
Audiogram (*class in perceptivo.types.psychophys*), 54
audiogram (*perceptivo.types.patient.Patient attribute*), 52
Audiogram_Model (*class in perceptivo.psychophys.model*), 71
Audiogram_Model (*perceptivo.prefs.Patient_Prefs attribute*), 92
await_response() (*perceptivo.runtimes.patient.Patient method*), 23

B

b (*perceptivo.types.units.Ellipse attribute*), 60
bark_to_f() (*in module perceptivo.psychophys.model*), 71
base_args() (*in module perceptivo.runtimes.runtime*), 21
bin (*perceptivo.types.sound.Jackd_Config attribute*), 58
Biography (*class in perceptivo.types.patient*), 51
biography (*perceptivo.types.patient.Patient attribute*), 52
boot_jackd() (*in module perceptivo.sound.server*), 75
buttonClicked (*perceptivo.gui.widgets.components.Range_Setter attribute*), 66

C

Camera_Calibration (*class in perceptivo.types.video*), 63

Canny (*class in perceptivo.video.processors*), 80
cb_connect() (*perceptivo.gui.main.Perceptivo_Clinician method*), 64
cb_control() (*perceptivo.runtimes.patient.Patient method*), 24
cb_data() (*perceptivo.gui.main.Perceptivo_Clinician method*), 64
cb_start() (*perceptivo.runtimes.patient.Patient method*), 24
cb_stop() (*perceptivo.runtimes.patient.Patient method*), 24
changeControl() (*perceptivo.gui.main.Perceptivo_Clinician method*), 64
choose_ellipse() (*perceptivo.video.pupil.EllipseExtractor method*), 79
circle_to_mask() (*in module perceptivo.video.processors*), 82
Clinician (*class in perceptivo.runtimes.clinician*), 21
CLINICIAN (*in module perceptivo.networking.sockets*), 69
clinician (*perceptivo.prefs.Runtimes attribute*), 83
clinician_ip (*perceptivo.types.networking.Patient_Networking attribute*), 51
clinician_parser() (*in module perceptivo.runtimes.clinician*), 21
clone_kernel() (*perceptivo.psychophys.gaussian.IterativeGPC method*), 71
closeEvent() (*perceptivo.gui.main.Perceptivo_Clinician method*), 64
collecting (*perceptivo.video.cameras.Picamera_Process attribute*), 76
collection_params (*perceptivo.prefs.Patient_Prefs attribute*), 93
collection_wait (*perceptivo.types.patient.Collection_Params attribute*), 52
color (*perceptivo.types.video.Frame attribute*), 62
completion_metric (*perceptivo.types.exam.Exam_Params attribute*), 30
confidence (*perceptivo.types.psychophys.Threshold attribute*), 54
control (*perceptivo.types.networking.Clinician_Networking attribute*), 49
control (*perceptivo.types.networking.Patient_Networking attribute*), 51
Control_Panel (*class in perceptivo.gui.widgets.control_panel*), 66
control_panel (*perceptivo.types.gui.GUI_Params attribute*), 45
controlChanged (*perceptivo.gui.main.Perceptivo_Clinician attribute*), 64
counter (*perceptivo.networking.messages.Message attribute*), 67
crop() (*perceptivo.types.video.Frame method*), 62
cropped (*perceptivo.types.video.Frame attribute*), 62

D

default (*perceptivo.types.gui.GUI_Param attribute*), 36
DEQUE (*perceptivo.networking.node.Node.Poll_Mode attribute*), 68
deserialize() (*in module perceptivo.util*), 83
device_name (*perceptivo.types.sound.Jackd_Config attribute*), 58
diameters (*perceptivo.types.pupil.Dilation property*), 57
Dilation (*class in perceptivo.types.pupil*), 56
dilation (*perceptivo.types.psychophys.Sample attribute*), 53
Directories (*class in perceptivo*), 15
distance (*perceptivo.types.video.Camera_Calibration attribute*), 64
dob (*perceptivo.data.patient.Patient_Data attribute*), 25
dob (*perceptivo.types.patient.Biography attribute*), 51
download() (*in module perceptivo.util*), 82
drawFrame() (*perceptivo.gui.main.Perceptivo_Clinician method*), 64
driver (*perceptivo.types.sound.Jackd_Config attribute*), 58
dtype (*perceptivo.types.video.Frame attribute*), 62
duration (*perceptivo.types.exam.Completion_Metric attribute*), 27
duration (*perceptivo.types.sound.Sound attribute*), 59

E

Ellipse (*class in perceptivo.types.units*), 60
ellipse (*perceptivo.types.pupil.Pupil attribute*), 56
EllipseExtractor (*class in perceptivo.video.pupil*), 78
EnsembleExtractor_NonIR (*class in perceptivo.video.pupil*), 79
exam_params (*perceptivo.gui.main.Perceptivo_Clinician property*), 64
EXAMINER (*in module perceptivo.networking.sockets*), 69
eyecam (*perceptivo.types.networking.Clinician_Networking attribute*), 48
eyecam (*perceptivo.types.networking.Patient_Networking attribute*), 51

F

f_to_bark() (*in module perceptivo.psychophys.model*), 71

filename (*perceptivo.video.processors.Haar_Tracker property*), 81
Filter_Circles (*class in perceptivo.video.processors*), 82
filter_edges() (*perceptivo.video.pupil.EllipseExtractor method*), 79
Filtered_Hough (*class in perceptivo.video.processors*), 81
fit() (*perceptivo.psychophys.gaussian._IterativeBinaryGPClaplace method*), 70
fit() (*perceptivo.psychophys.gaussian.IterativeGPC method*), 70
footprint_size (*perceptivo.video.pupil.EllipseExtractor property*), 79
footprint_size (*perceptivo.video.pupil.EllipseExtractor_Params attribute*), 78
format (*perceptivo.types.video.Picamera_Params attribute*), 63
fps (*perceptivo.types.video.Picamera_Params attribute*), 63
frame (*perceptivo.gui.main.Perceptivo_Clinician.Frame_Receiver attribute*), 65
frame (*perceptivo.types.pupil.Pupil attribute*), 56
frame (*perceptivo.types.video.Frame attribute*), 62
frequencies (*perceptivo.types.exam.Exam_Params attribute*), 29
frequencies (*perceptivo.types.psychophys.Audiogram property*), 54
frequencies (*perceptivo.types.psychophys.Samples attribute*), 53
frequency (*perceptivo.types.psychophys.Threshold attribute*), 54
frequency (*perceptivo.types.sound.Sound attribute*), 59
from_serialized() (*perceptivo.networking.messages.Message class method*), 67
fs (*perceptivo.types.sound.Audio_Config attribute*), 57

G

Gaussian_Process (*class in perceptivo.psychophys.model*), 72
generate_samples() (*in module perceptivo.psychophys.oracle*), 74
get() (*in module perceptivo.prefs*), 103
get_extractor() (*in module perceptivo.video.pupil*), 80
get_global() (*in module perceptivo.prefs*), 103
get_runtime_prefs() (*perceptivo.prefs.Prefs class method*), 84
gray (*perceptivo.types.video.Frame property*), 62
gridChanged() (*perceptivo.gui.widgets.audiogram.Audiogram method*), 65
gui (*perceptivo.prefs.Clinician_Prefs attribute*), 103
GUI_PARAM_KEY (*in module perceptivo.types.gui*), 30
GUI_WIDGET_TYPE (*in module perceptivo.types.gui*), 30

H

Haar_Tracker (*class in perceptivo.video.processors*), 81
handle_message() (*perceptivo.runtimes.patient.Patient method*), 24

I

id (*perceptivo.types.networking.Socket attribute*), 46
init_gui() (*perceptivo.runtimes.clinician.Clinician method*), 22
init_logger() (*in module perceptivo.data.logging*), 25
IOLOOP (*perceptivo.networking.node.Node.Poll_Mode attribute*), 68
ip (*perceptivo.types.networking.Clinician_Networking attribute*), 48
ip (*perceptivo.types.networking.Patient_Networking attribute*), 51
ip (*perceptivo.types.networking.Socket attribute*), 46
IterativeGPC (*class in perceptivo.psychophys.gaussian*), 70
iti (*perceptivo.types.exam.Exam_Params attribute*), 30
iti_jitter (*perceptivo.types.exam.Exam_Params attribute*), 30

J

jack_client (*perceptivo.types.sound.Sound attribute*), 59
Jackd_Config (*class in perceptivo.types.sound*), 57
json_dumps_pretty() (*in module perceptivo.prefs*), 83

K

kernel (*perceptivo.psychophys.model.Gaussian_Process property*), 72
kernel (*perceptivo.types.psychophys.Kernel property*), 55
key (*perceptivo.types.gui.GUI_Control attribute*), 32
key (*perceptivo.types.gui.GUI_Param attribute*), 35
kill_jackd() (*in module perceptivo.sound.server*), 75
kwargs (*perceptivo.types.gui.GUI_Param attribute*), 36
kwargs (*perceptivo.types.psychophys.Psychoacoustic_Model attribute*), 56

L

launch_str (*perceptivo.types.sound.Jackd_Config property*), 58
length_scale (*perceptivo.types.psychophys.Kernel attribute*), 55

length_scale_bounds (*perceptivo.types.psychophys.Kernel attribute*), 55
load() (*perceptivo.prefs.Prefs class method*), 84
load_prefs() (*perceptivo.runtimes.runtime.Runtime method*), 21
log_dir (*perceptivo.Directories attribute*), 15
log_likelihood (*perceptivo.types.exam.Completion_Metric attribute*), 27
logger (*perceptivo.root.Perceptivo_Object property*), 103
loglevel (*perceptivo.prefs.Prefs attribute*), 84

M

main() (*in module perceptivo.runtimes.clinician*), 22
main() (*in module perceptivo.runtimes.patient*), 24
make_default_prefs() (*perceptivo.runtimes.runtime.Runtime class method*), 21
mask() (*perceptivo.types.units.Ellipse method*), 60
max (*perceptivo.types.gui.GUI_Range attribute*), 33
max_diameter (*perceptivo.types.pupil.Dilation property*), 57
max_diameter (*perceptivo.types.pupil.Pupil_Params attribute*), 56
Message (*class in perceptivo.networking.messages*), 67
min (*perceptivo.types.gui.GUI_Range attribute*), 33
mm_per_px (*perceptivo.types.video.Camera_Calibration attribute*), 64
mode (*perceptivo.types.networking.Socket attribute*), 46
model_type (*perceptivo.types.psychophys.Psychoacoustic_Model attribute*), 56
module
    perceptivo.data, 24
    perceptivo.data.logging, 25
    perceptivo.data.patient, 25
    perceptivo.gui, 64
    perceptivo.gui.main, 64
    perceptivo.gui.styles, 65
    perceptivo.gui.widgets, 65
    perceptivo.gui.widgets.audiogram, 65
    perceptivo.gui.widgets.components, 65
    perceptivo.gui.widgets.control_panel, 66
    perceptivo.gui.widgets.patient, 67
    perceptivo.gui.widgets.pupil, 67
    perceptivo.gui.widgets.video, 67
    perceptivo.networking, 67
    perceptivo.networking.messages, 67
    perceptivo.networking.node, 68
    perceptivo.networking.sockets, 69
    perceptivo.prefs, 83
    perceptivo.psychophys, 70
    perceptivo.psychophys.gaussian, 70
    perceptivo.psychophys.model, 71
    perceptivo.psychophys.oracle, 74
    perceptivo.root, 103
    perceptivo.runtimes.clinician, 21
    perceptivo.runtimes.patient, 22
    perceptivo.runtimes.runtime, 21
    perceptivo.sound, 75
    perceptivo.sound.server, 75
    perceptivo.sound.sounds, 76
    perceptivo.stim, 76
    perceptivo.types, 26
    perceptivo.types.exam, 26
    perceptivo.types.gui, 30
    perceptivo.types.networking, 46
    perceptivo.types.patient, 51
    perceptivo.types.psychophys, 52
    perceptivo.types.pupil, 56
    perceptivo.types.sound, 57
    perceptivo.types.units, 60
    perceptivo.types.video, 61
    perceptivo.util, 82
    perceptivo.video, 76
    perceptivo.video.cameras, 76
    perceptivo.video.processors, 80
    perceptivo.video.pupil, 76
msgpack_dumps() (*in module perceptivo.util*), 83
msgpack_loads() (*in module perceptivo.util*), 83

N

n (*perceptivo.types.gui.GUI_Range attribute*), 33
n_trials (*perceptivo.types.exam.Completion_Metric attribute*), 27
name (*perceptivo.data.patient.Patient_Data attribute*), 25
name (*perceptivo.types.gui.GUI_Param attribute*), 35
name (*perceptivo.types.patient.Biography attribute*), 51
networking (*perceptivo.prefs.Clinician_Prefs attribute*), 102
networking (*perceptivo.prefs.Patient_Prefs attribute*), 93
next() (*perceptivo.psychophys.model.Audiogram_Model method*), 72
next() (*perceptivo.psychophys.model.Gaussian_Process method*), 73
next_sound() (*perceptivo.runtimes.patient.Patient method*), 23
Node (*class in perceptivo.networking.node*), 68
Node.Poll_Mode (*class in perceptivo.networking.node*), 68
NONE (*perceptivo.networking.node.Node.Poll_Mode attribute*), 68
norm() (*perceptivo.types.video.Frame method*), 62
nperiods (*perceptivo.types.sound.Jackd_Config attribute*), 58

O

outchannels (*perceptivo.types.sound.Jackd_Config attribute*), 58
output_file (*perceptivo.types.video.Picamera_Params attribute*), 63

P

pack_array() (*in module perceptivo.util*), 82
params (*perceptivo.types.pupil.Dilation attribute*), 57
parent (*perceptivo.video.processors.Processor property*), 80
Patient (*class in perceptivo.runtimes.patient*), 22
Patient (*class in perceptivo.types.patient*), 51
patient (*perceptivo.prefs.Runtimes attribute*), 83
Patient_Data (*class in perceptivo.data.patient*), 25
patient_ip (*perceptivo.types.networking.Clinician_Networking attribute*), 48
patient_parser() (*in module perceptivo.runtimes.patient*), 24
perceptivo.data
    module, 24
perceptivo.data.logging
    module, 25
perceptivo.data.patient
    module, 25
perceptivo.gui
    module, 64
perceptivo.gui.main
    module, 64
perceptivo.gui.styles
    module, 65
perceptivo.gui.widgets
    module, 65
perceptivo.gui.widgets.audiogram
    module, 65
perceptivo.gui.widgets.components
    module, 65
perceptivo.gui.widgets.control_panel
    module, 66
perceptivo.gui.widgets.patient
    module, 67
perceptivo.gui.widgets.pupil
    module, 67
perceptivo.gui.widgets.video
    module, 67
perceptivo.networking
    module, 67
perceptivo.networking.messages
    module, 67
perceptivo.networking.node
    module, 68
perceptivo.networking.sockets
    module, 69
perceptivo.prefs
    module, 83
perceptivo.psychophys
    module, 70
perceptivo.psychophys.gaussian
    module, 70
perceptivo.psychophys.model
    module, 71
perceptivo.psychophys.oracle
    module, 74
perceptivo.root
    module, 103
perceptivo.runtimes.clinician
    module, 21
perceptivo.runtimes.patient
    module, 22
perceptivo.runtimes.runtime
    module, 21
perceptivo.sound
    module, 75
perceptivo.sound.server
    module, 75
perceptivo.sound.sounds
    module, 76
perceptivo.stim
    module, 76
perceptivo.types
    module, 26
perceptivo.types.exam
    module, 26
perceptivo.types.gui
    module, 30
perceptivo.types.networking
    module, 46
perceptivo.types.patient
    module, 51
perceptivo.types.psychophys
    module, 52
perceptivo.types.pupil
    module, 56
perceptivo.types.sound
    module, 57
perceptivo.types.units
    module, 60
perceptivo.types.video
    module, 61
perceptivo.util
    module, 82
perceptivo.video
    module, 76
perceptivo.video.cameras
    module, 76
perceptivo.video.processors
    module, 80
perceptivo.video.pupil

module, 76
Perceptivo_Clinician (*class in perceptivo.gui.main*), 64
Perceptivo_Clinician.Frame_Receiver (*class in perceptivo.gui.main*), 65
Perceptivo_Object (*class in perceptivo.root*), 103
period (*perceptivo.types.sound.Jackd_Config attribute*), 58
picam (*perceptivo.types.video.Camera_Calibration attribute*), 64
picam_queue_size (*perceptivo.prefs.Patient_Prefs attribute*), 93
Picamera_Params (*perceptivo.prefs.Patient_Prefs attribute*), 93
Picamera_Process (*class in perceptivo.video.cameras*), 76
picamera_process (*perceptivo.prefs.Patient_Prefs attribute*), 93
piecewise_probabilistic() (*in module perceptivo.psychophys.oracle*), 74
play_sound() (*perceptivo.runtimes.patient.Patient method*), 23
playback_only (*perceptivo.types.sound.Jackd_Config attribute*), 58
plot() (*perceptivo.psychophys.model.Gaussian_Process method*), 73
plot() (*perceptivo.types.psychophys.Samples method*), 53
port (*perceptivo.types.networking.Socket attribute*), 46
prefs_class (*perceptivo.runtimes.clinician.Clinician attribute*), 22
prefs_class (*perceptivo.runtimes.patient.Patient attribute*), 22
prefs_class (*perceptivo.runtimes.runtime.Runtime property*), 21
prefs_file (*perceptivo.Directories attribute*), 15
preprocess() (*perceptivo.video.pupil.EnsembleExtractor_NonIR method*), 80
Preprocessor (*class in perceptivo.video.pupil*), 77
priority (*perceptivo.types.sound.Jackd_Config attribute*), 58
probe() (*perceptivo.runtimes.patient.Patient method*), 23
process() (*perceptivo.video.processors.Canny method*), 81
process() (*perceptivo.video.processors.Filter_Circles method*), 82
process() (*perceptivo.video.processors.Filtered_Hough method*), 82
process() (*perceptivo.video.processors.Haar_Tracker method*), 81
process() (*perceptivo.video.processors.Processor method*), 80
process() (*perceptivo.video.pupil.Preprocessor method*), 77
process() (*perceptivo.video.pupil.PupilExtractor method*), 77
process() (*perceptivo.video.pupil.PupilFilter method*), 77
Processor (*class in perceptivo.video.processors*), 80
procs (*perceptivo.runtimes.runtime.Runtime property*), 21
protocol (*perceptivo.types.networking.Socket attribute*), 46
Psychoacoustic_Model (*class in perceptivo.types.psychophys*), 55
Pupil (*class in perceptivo.gui.widgets.pupil*), 67
Pupil (*class in perceptivo.types.pupil*), 56
pupil_extractor (*perceptivo.prefs.Patient_Prefs attribute*), 93
pupil_extractor_params (*perceptivo.prefs.Patient_Prefs attribute*), 93
Pupil_Extractors (*class in perceptivo.video.pupil*), 80
Pupil_Params (*class in perceptivo.types.pupil*), 56
PupilExtractor (*class in perceptivo.video.pupil*), 76
PupilFilter (*class in perceptivo.video.pupil*), 77
pupils (*perceptivo.types.pupil.Dilation attribute*), 57

Q

q (*perceptivo.video.cameras.Picamera_Process attribute*), 76
quitting() (*perceptivo.gui.main.Perceptivo_Clinician.Frame_Receiver method*), 65

R

Range_Setter (*class in perceptivo.gui.widgets.components*), 65
receive_messages() (*perceptivo.gui.main.Perceptivo_Clinician method*), 64
reference_audiogram() (*in module perceptivo.psychophys.oracle*), 74
release() (*perceptivo.networking.node.Node method*), 69
release() (*perceptivo.video.cameras.Picamera_Process method*), 76
resolution (*perceptivo.types.video.Picamera_Params attribute*), 63
response (*perceptivo.types.psychophys.Sample property*), 53
response (*perceptivo.types.pupil.Dilation property*), 57
responses (*perceptivo.types.psychophys.Samples attribute*), 53
run() (*perceptivo.gui.main.Perceptivo_Clinician.Frame_Receiver method*), 65
run() (*perceptivo.video.cameras.Picamera_Process method*), 76

Runtime (*class in perceptivo.runtimes.runtime*), 21
runtime (*perceptivo.prefs.Patient_Prefs attribute*), 92
Runtimes (*class in perceptivo.prefs*), 83

S

Sample (*class in perceptivo.types.psychophys*), 52
Samples (*class in perceptivo.types.psychophys*), 53
samples (*perceptivo.psychophys.model.Gaussian_Process property*), 72
samples (*perceptivo.types.patient.Patient attribute*), 52
samples (*perceptivo.types.psychophys.Samples attribute*), 53
save() (*perceptivo.prefs.Prefs method*), 84
scaleChanged (*perceptivo.gui.widgets.components.Range_Setter attribute*), 66
scaleChanged (*perceptivo.gui.widgets.control_panel.Control_Panel attribute*), 66
scaleChanged() (*perceptivo.gui.widgets.audiogram.Audiogram method*), 65
search_scale (*perceptivo.video.pupil.EllipseExtractor_Params attribute*), 78
send() (*perceptivo.networking.node.Node method*), 69
sensor_mode (*perceptivo.types.video.Picamera_Params attribute*), 63
serialize() (*in module perceptivo.util*), 82
serialize() (*perceptivo.networking.messages.Message method*), 67
set_color() (*perceptivo.types.video.Frame method*), 62
set_global() (*in module perceptivo.prefs*), 103
setMaximum() (*perceptivo.gui.widgets.components.Range_Setter method*), 66
setMinimum() (*perceptivo.gui.widgets.components.Range_Setter method*), 66
setStarted() (*perceptivo.gui.main.Perceptivo_Clinician method*), 64
settings (*perceptivo.gui.main.Perceptivo_Clinician property*), 64
setValue() (*perceptivo.gui.widgets.control_panel.Control_Panel method*), 66
simple (*perceptivo.video.pupil.Pupil_Extractors attribute*), 80
Socket (*class in perceptivo.types.networking*), 46
socket_type (*perceptivo.types.networking.Socket attribute*), 46
sound (*perceptivo.types.psychophys.Sample attribute*), 53
sound_class (*perceptivo.types.sound.Sound property*), 60
sound_kwargs (*perceptivo.types.sound.Sound property*), 60
sound_type (*perceptivo.types.sound.Sound attribute*), 59
stamp_time() (*perceptivo.types.sound.Sound method*), 60
startToggled (*perceptivo.gui.widgets.control_panel.Control_Panel attribute*), 66
STIM (*in module perceptivo.networking.sockets*), 70
stimuli (*perceptivo.prefs.Runtimes attribute*), 83

T

t (*perceptivo.types.units.Ellipse attribute*), 60
Threshold (*class in perceptivo.types.psychophys*), 53
threshold (*perceptivo.types.psychophys.Threshold attribute*), 54
threshold (*perceptivo.types.pupil.Pupil_Params attribute*), 56
thresholds (*perceptivo.types.psychophys.Audiogram attribute*), 54
timestamp (*perceptivo.types.psychophys.Sample attribute*), 53
timestamp (*perceptivo.types.sound.Sound attribute*), 59
timestamp (*perceptivo.types.video.Frame attribute*), 62
timestamps (*perceptivo.types.pupil.Dilation attribute*), 57
to (*perceptivo.types.networking.Socket attribute*), 46
to_df() (*perceptivo.types.psychophys.Samples method*), 53
to_dict() (*perceptivo.types.psychophys.Audiogram method*), 54
trial() (*perceptivo.runtimes.patient.Patient method*), 23

U

unpack_array() (*in module perceptivo.util*), 82
update() (*perceptivo.psychophys.model.Audiogram_Model method*), 71
update() (*perceptivo.psychophys.model.Gaussian_Process method*), 73
update_period (*perceptivo.prefs.Clinician_Prefs attribute*), 103
url (*perceptivo.video.processors.Haar_Tracker property*), 81
use (*perceptivo.types.exam.Completion_Metric attribute*), 27
user_dir (*perceptivo.Directories attribute*), 15
uuid (*perceptivo.types.sound.Sound attribute*), 60

V

value (*perceptivo.types.gui.GUI_Control attribute*), 32
value() (*perceptivo.gui.widgets.components.Range_Setter method*), 66

valueChanged (*perceptivo.gui.widgets.components.Range_Setter attribute*), 65
valueChanged (*perceptivo.gui.widgets.control_panel.Control_Panel attribute*), 66
Video (*class in perceptivo.gui.widgets.video*), 67

W

widget_type (*perceptivo.types.gui.GUI_Param attribute*), 35

X

x (*perceptivo.types.units.Ellipse attribute*), 60
XML_URLS (*perceptivo.video.processors.Haar_Tracker attribute*), 81

Y

y (*perceptivo.types.units.Ellipse attribute*), 60