
perceptivo

Release 0.0.1

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HARDWARE

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

ORGANIZATION

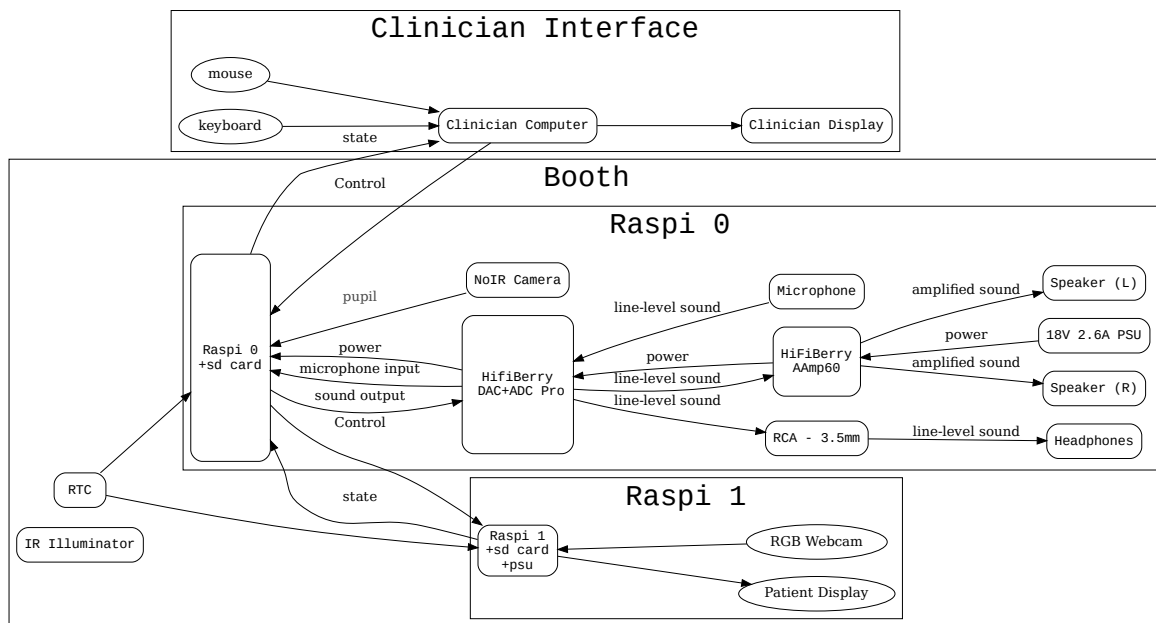
This documentation is split into three sections:

- 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

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 Touchscreen	Adafruit	1		
Mouse	Newegg	1		

Raspis

Name	Distribu- tor	Num- ber	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 mi- croSD	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?				

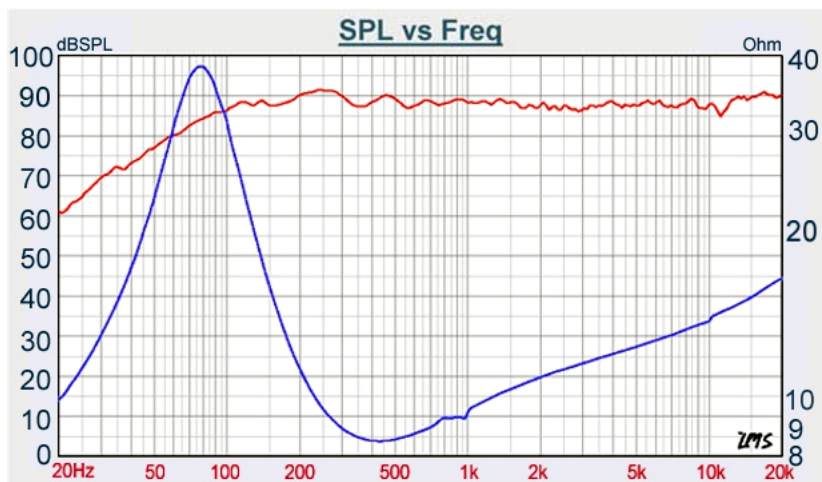
Etc

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

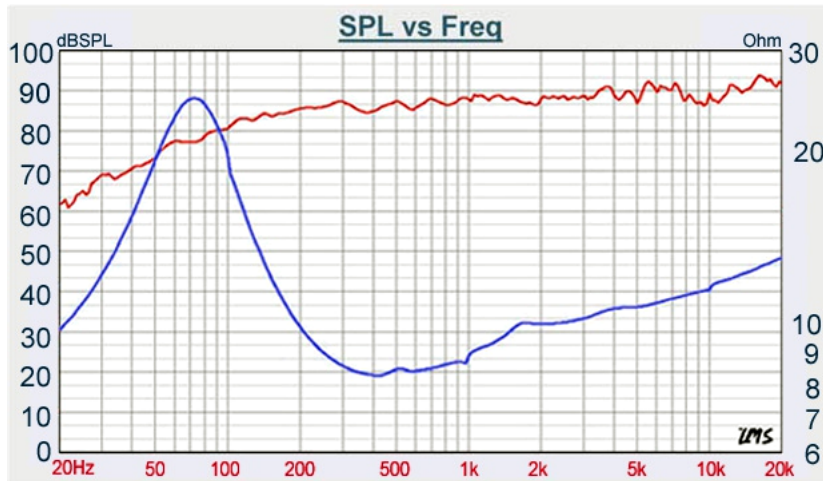
2.2.1 Tang Band W3-1878

\$87.49, 3"



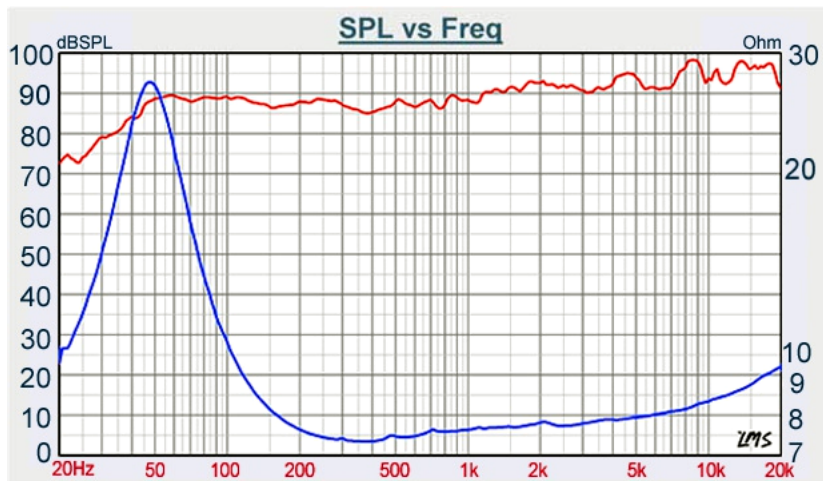
2.2.2 Tang Band W4-1320SJ

\$69.40, 4"



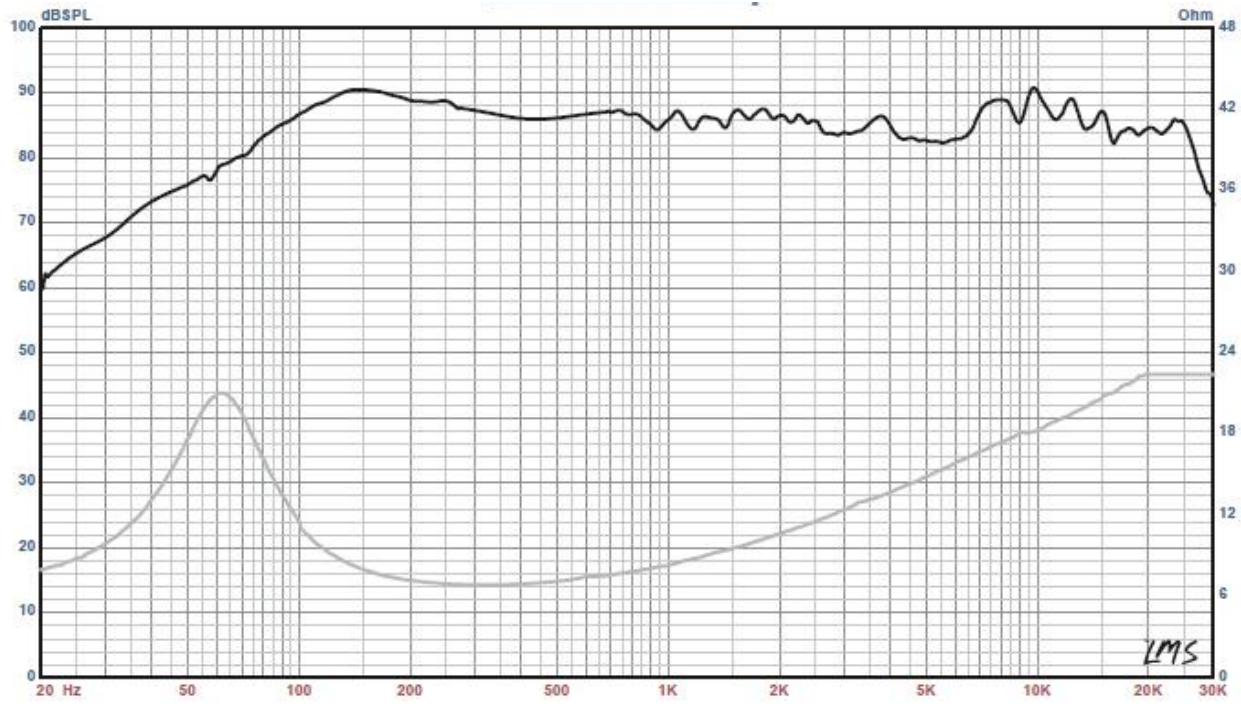
2.2.3 Tang Band W6-2144

\$91.10, 6.5"



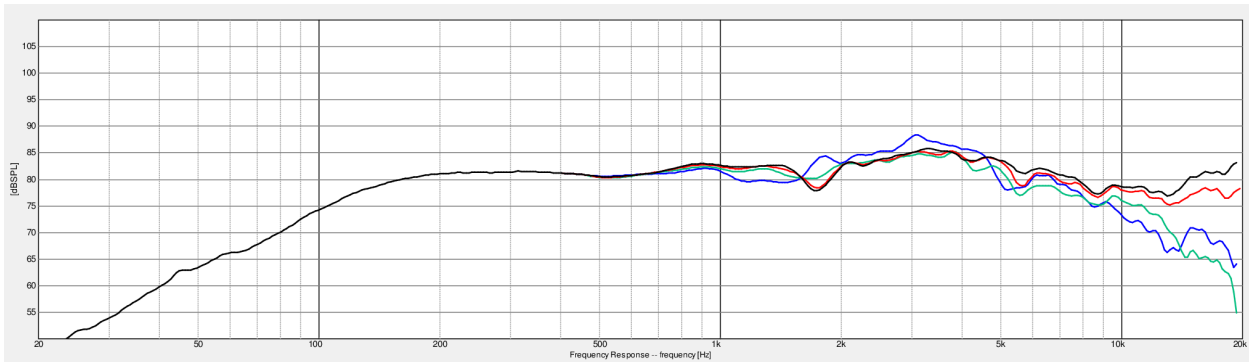
2.2.4 Fountek FR135EX

\$99.98, 5.5"



2.2.5 Dayton RS75T-8

\$25.98, 3"



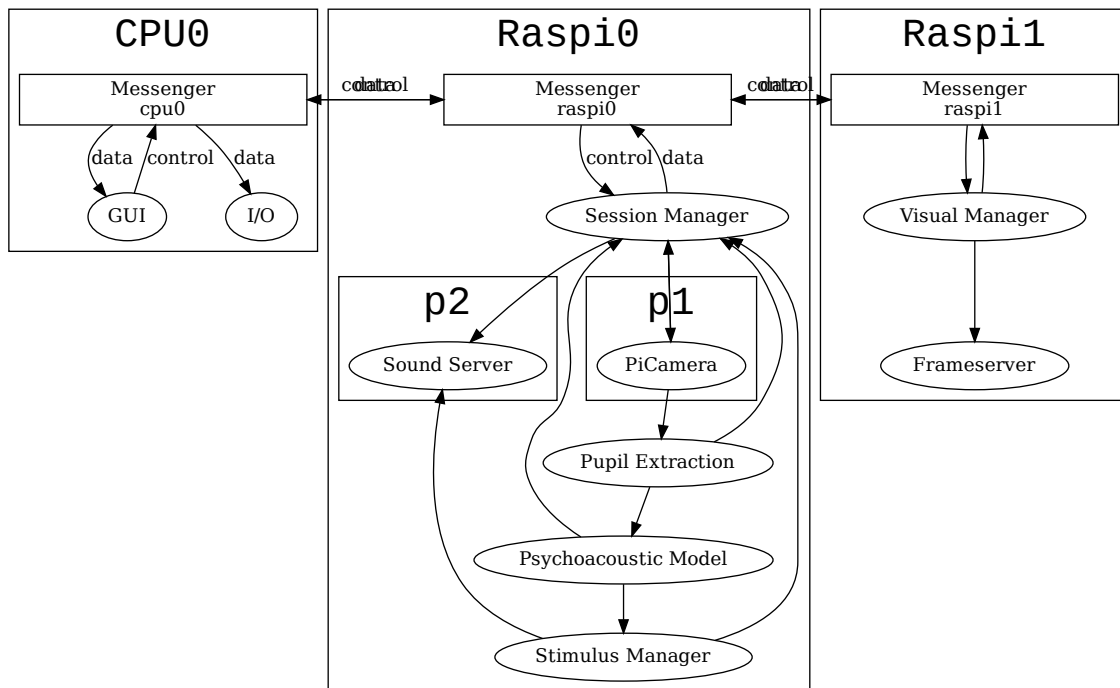
2.2.6 Additional References

- <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')`

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 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

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: Op-  
    tional[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 initialization, 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

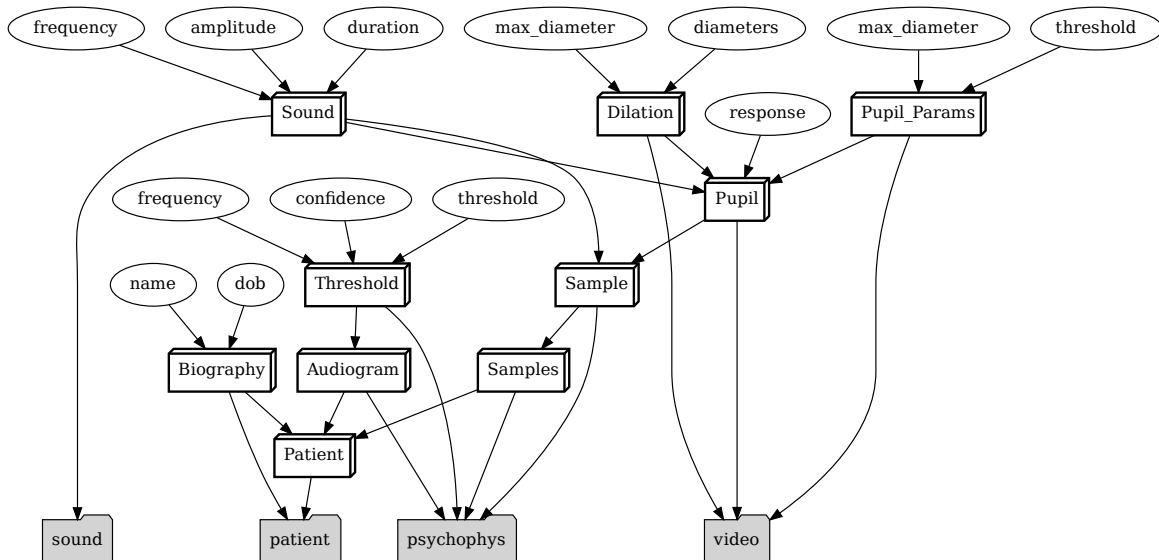
name: `str`

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",

```

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```

        "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 0x7f8d44ac8c10>, <class 'datetime.datetime'>: <function PerceptivoType.Config.<lambda> at 0x7f8d44ac2040>}
- **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",

```

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```

    "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",

```

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```

    "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 0x7f8d44ac8c10>, <class 'datetime.datetime'>: <function Perceptivo-Type.Config.<lambda> at 0x7f8d44ac2040>}`
- **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 0x7f8d44ac8c10>, <class 'datetime.datetime'>: <function Perceptivo-Type.Config.<lambda> at 0x7f8d44ac2040>}
- **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 0x7f8d44ac8c10>, <class 'datetime.datetime'>: <function PerceptivoType.Config.<lambda> at 0x7f8d44ac2040>}`
- `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"
      ]
    },
  },
}
```

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```

    "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": {

```

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```

    "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 0x7f8d44ac8c10>, <class 'datetime.datetime'>: <function Perceptivo-
Type.Config.<lambda> at 0x7f8d44ac2040>}`
- **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 (dB SPL)",
        "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": {
```

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```

        "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": {

```

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```

"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"
      ]
    }
  }
}

```

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```

    ],
    "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"
]
}

```

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```
}
}
```

Config

- **json_encoders:** *dict* = {<class 'numpy.ndarray'>: <function *pack_array* at 0x7f8d44ac8c10>, <class 'datetime.datetime'>: <function *PerceptivoType.Config.<lambda>* at 0x7f8d44ac2040>}
- **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,
```

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```

        "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"
            }
        }
    }
}

```

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```

    },
    "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"
        }
    }
}

```

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```

    },
    "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 (dB SPL)",
        "widget_type": "range",
        "default": {
          "min": 0.0,
          "max": 80.0,
          "n": 8
        }
      },

```

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```

        "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"
        }
    ]
}

```

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```

    }
  ]
},
"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 0x7f8d44ac8c10>, <class 'datetime.datetime'>: <function Perceptivo.Type.Config.<lambda> at 0x7f8d44ac2040>}`
- **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": "*"
      }
    }
  }
}
```

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```

        "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",

```

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```

        "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"
      },

```

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```

    "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"
        }
      }
    }
  }
}

```

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```

        "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/Subthreshold 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",
```

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```

    "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"
    }
  }
}
```

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```

    },
    "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
- `clinician.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()
```

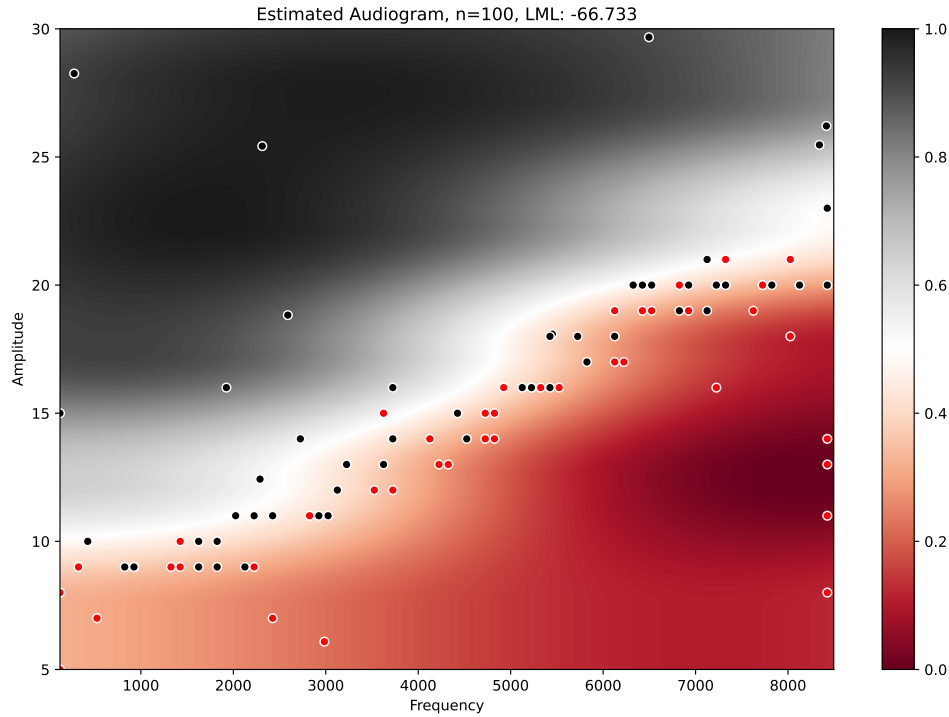
References

- [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 jackd 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"
        }
    }
}
```

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```
    },
    "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 tracking 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",
```

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```

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

```

Config

- `json_dumps: function = <function json_dumps_pretty at 0x7f8d11cdce50>`

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"
        }
      ]
    }
  }
}

```

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```

    },
    "Audio_Config": {
      "title": "Audio Config",
      "default": {
        "fs": 44100
      },
      "allOf": [
        {
          "$ref": "#/definitions/Audio_Config"
        }
      ]
    },
    "Audiogram_Model": {
      "title": "Audiogram Model",
      "default": {
        "model_type": "Gaussian_Process",
        "args": [],
        "kwargs": {
          "kernel": "length_scale=(100.0, 200.0) length_scale_bounds=(1, ↵
↵1000000.0)"
        }
      },
      "allOf": [
        {
          "$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": {

```

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```

        "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",

```

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```

    "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,
        1000000.0
    ],

```

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```

        "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"
        }
      }
    }
  }
}

```

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```

    },
    "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,

```

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```

        "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"
            ]
        }
    }
}

```

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```

        ],
        "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": [
                {

```

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```

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

```

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```

        "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 (dB SPL)",
                "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,

```

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```

        "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"
            }
        },
        "type": "string"
    },
    "protocol": {
        "title": "Protocol",
        "enum": [

```

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```

        "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": {

```

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```

        "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"
        }
    }
}

```

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```

    },
    "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"
        }
    }
}

```

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```

    },
    "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
        }
      },

```

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```

        "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"
        }
    ]
}

```

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```

    }
  ]
},
"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 (dB SPL)",
          "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": {

```

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```

        "min": 0.0,
        "max": 80000.0,
        "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 0x7f8d11cdce50>

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 (dB SPL)', 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*

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