
Lab Utils Documentation

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lab_utils is a collection of useful modules for Python development in the context of scientific laboratory work. It was created to standardize common tasks and features used by many different apps and users. The package aims to provide simple, efficient and robust protocols in the following areas:

- **PostgreSQL Database Interface.** The *database* module provides a simple interface to manage connections to a PostgreSQL database. It uses the package *psycopg2* (a Python wrapper of the C library *libpq*) to provide simple database functionality.
- **Daemon-like TCP Server.** The *socket_comm* module provides a daemon-like TCP server base class. The *lab_utils.socket_comm.Server* is supposed to start and run indefinitely in the background, while listening for incoming communications over a TCP port. When a message is received, a string parser calls the appropriate method. Users should develop their own child class inheriting from *lab_utils.socket_comm.Server* and implementing the necessary methods for their particular needs.

The module also provides a simple *lab_utils.socket_comm.Client* to send messages to a running *lab_utils.socket_comm.Server* and receive the reply.

If this is your first time using *lab_utils*, have a look at our *Readme* for a more detailed summary and installation instructions. If you're already familiar with this package, or you want to dive straight in, you can jump to the *API reference*. There are also some *examples* which demonstrate specific applications of the modules.

README

1.1 Lab Utils, a collection of useful Python modules

This package contains several useful *modules* to help build Python applications. All modules provide support for a configuration file using *configparser* and standard *logging*.

Available modules:

- *database*: simple interface to manage connections to a PostgreSQL database
- *socket_comm*: TCP server/client communication for daemon-like apps.

1.2 Dependencies

The package **lab-utils** has the following pre-requisites:

- *libpq*, a C library that implements connections to the PostgreSQL backend server. The python package *psycopg2* needed by the module *database* is built around this library, and it is strongly recommended to have it installed. If for some reason you can't install it or don't have access to it, a *precompiled binary package* is also available. Please notice that using precompiled binaries can lead to *other problems*.
- *Python 3.6* and *pip 10.0* are the minimum required versions to build **lab-utils** and its dependencies. It is recommended to install and run **lab-utils** (and any other package, for that matter) under a *virtual environment*.
- *Pandas*

1.3 Getting Started

These instructions will install the package **lab-utils** and let you import its modules in your own apps. It is assumed that you have successfully installed the *prerequisites* and are running inside a virtual environment.

1. Install the package and its dependencies

```
python -m pip install lab-utils
```

If you don't have PostgreSQL and libpq installed, you can use

```
python -m pip install lab-utils --only-binary psycopg2
```

2. Run some examples to test that everything works

```
cd examples
python database/create_column.py
```

1.4 Import into your own app

To use a <module> from the **lab_utils** collection in your own Python app, simply add

```
from lab_utils import <module>
```

1.5 Modules

All the modules provided by the package provide support for:

- Usage of a configuration file via the <module>.config(*filename*) method
- [Standard Python logging](#).

1.5.1 database

This module is a simple interface to manage connections to a PostgreSQL database based on the [psycopg2](#) library. The main features are:

- Database connection and closing
- Create a new [TimescaleDB](#) table
- Check if column and/or table exist in a given database
- Create a new column in a table, with optional constraints

1.5.2 socket_comm

This module implements a simple TCP server/client structure to develop daemon-like application.

1.6 Authors

- [Carlos Vigo](#) - *Initial work* - [GitLab](#)

1.7 Contributing

Please read our [contributing policy](#) for details on our code of conduct, and the process for submitting pull requests to us.

1.8 Versioning

We use [Git](#) for versioning. For the versions available, see the [tags on this repository](#).

1.9 License

This project is licensed under the [GNU GPLv3 License](#)

1.10 Built With

- [PyCharm Professional 2020](#) - The IDE used
- [Sphinx](#) - Documentation

1.11 Acknowledgments

- Nobody so far

API REFERENCE

Description

Collection of useful modules to build consistent Python apps. All modules share some basic principles to increase app compatibility and facilitate development:

- **Settings.** The modules have a `config()` method based in the standard library `configparser`. Documentation about the different configuration files can be found in the *examples section*.
- **Logging.** The modules use the standard `logging` library to manage logs at all *levels*. Each method will produce logs using a logger named like the method itself, so an app importing the module can easily modify the logging behaviour on a per-method basis. This is shown in the example TODO.

Modules

<i>database</i>	Basic interface to a <code>PostgreSQL</code> database.
<i>socket_comm</i>	Server/client communication via TCP sockets.
<i>custom_logging</i>	Implements a custom logging service.

2.1 database

Description

Basic interface to a `PostgreSQL` database.

The module consists of a main class `Database` which implements methods for connection and disconnection, table verification and data insertion.

The database settings are set with a *config file* and the standard library `configparser`.

Classes

<i>Constraint</i>	List of accepted constraints for new columns.
<i>DataType</i>	List of accepted data types for new columns.
<i>Database</i>	Manages connections and operations with a PostgreSQL database.

2.1.1 Constraint

Description

class `lab_utils.database.Constraint(value)`

List of accepted constraints for new columns. The constraints are hard-coded for safety reasons: SQL insertions are potentially dangerous.

Attributes

<i>Constraint.positive</i>	The variable must be greater or equal to 0
<i>Constraint.positive_strict</i>	The variable must be strictly positive

Constraint.positive

`Constraint.positive = ' CHECK({column_name} >= 0) '`

The variable must be greater or equal to 0

Constraint.positive_strict

`Constraint.positive_strict = ' CHECK({column_name} > 0) '`

The variable must be strictly positive

2.1.2 DataType

Description

class `lab_utils.database.DataType(value)`

List of accepted data types for new columns. The types are hard-coded for safety reasons: SQL insertions are potentially dangerous. See [here](#) for more information.

Attributes

<i>DataType.bool</i>	Boolean
<i>DataType.double</i>	Floating-point number, 8 bytes
<i>DataType.float</i>	Floating-point number, 4 bytes
<i>DataType.int</i>	Integer (4 bytes, range is -2,147,483,648 to +2,147,483,647)
<i>DataType.long</i>	Integer (8 bytes, range is -9,223,372,036,854,775,808 to +9,223,372,036,854,775,807)
<i>DataType.short</i>	Integer (2 bytes, range is -32,768 to +32,767)
<i>DataType.string</i>	String, unlimited length
<i>DataType.time</i>	Time stamp, with time zone information

DataType.bool

`DataType.bool = 'BOOLEAN'`
Boolean

DataType.double

`DataType.double = 'FLOAT(53)'`
Floating-point number, 8 bytes

DataType.float

`DataType.float = 'FLOAT(24)'`
Floating-point number, 4 bytes

DataType.int

`DataType.int = 'INTEGER'`
Integer (4 bytes, range is -2,147,483,648 to +2,147,483,647)

DataType.long

`DataType.long = 'BIGINT'`
Integer (8 bytes, range is -9,223,372,036,854,775,808 to +9,223,372,036,854,775,807)

DataType.short

`DataType.short = 'SMALLINT'`
Integer (2 bytes, range is -32,768 to +32,767)

DataType.string

`DataType.string = 'TEXT'`
String, unlimited length

DataType.time

`DataType.time = 'TIMESTAMPZ'`
Time stamp, with time zone information

2.1.3 Database

Description

class `lab_utils.database.Database`(*config_file: Optional[str] = None, host: Optional[str] = None, port: Optional[int] = None, database: Optional[str] = None, user: Optional[str] = None, passfile: Optional[str] = None*)

Manages connections and operations with a PostgreSQL database. The class is based on the [psycopg2](#) library and on this [tutorial](#).

Attributes

<code>Database.connection</code>	Connection object returned by <code>psycopg2.connect()</code>
<code>Database.cursor</code>	Cursor provided by <code>connection.cursor()</code> to execute an SQL query
<code>Database.database</code>	The database name to connect to
<code>Database.db_version</code>	Database version
<code>Database.host</code>	The host name where the database is located
<code>Database.passfile</code>	Location of the pgpass file with the credentials
<code>Database.port</code>	Connection port
<code>Database.user</code>	User name

Database.connection

`Database.connection = None`
Connection object returned by `psycopg2.connect()`

Database.cursor

Database.cursor = None

Cursor provided by connection.cursor() to execute an SQL query

Database.database

Database.database: str = 'beam'

The database name to connect to

Database.db_version

Database.db_version: str = ''

Database version

Database.host

Database.host: str = 'localhost'

The host name where the database is located

Database.passfile

Database.passfile: str = '~/.pgpass'

Location of the pgpass file with the credentials

Database.port

Database.port: int = 5432

Connection port

Database.user

Database.user: str = 'cw-beam'

User name

Methods

<code>Database.__init__</code>	Initializes the <i>Database</i> object.
<code>Database.check_column</code>	Checks if a column exists in a given table.
<code>Database.check_empty_table</code>	Checks whether a table is empty or not
<code>Database.check_table</code>	Checks if a table exists.
<code>Database.close</code>	Closes the connection to the database.
<code>Database.config</code>	Loads the configuration.
<code>Database.connect</code>	Connects to the database.
<code>Database.create_aggregate_view</code>	Creates a set of <i>aggregate views</i> in a given table.
<code>Database.create_database</code>	Creates a database named <i>db_name</i> .
<code>Database.create_timescale_db</code>	Creates a <i>TimescaleDB</i> table.

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<code>Database.fetch_latest_value</code>	Retrieves the latest values of a time-ordered table.
<code>Database.fetch_next_serial_id</code>	Checks the latest ID of a serialized table and returns the next available one.
<code>Database.get_list_columns</code>	Fetches the list of columns in a given table.
<code>Database.new_column</code>	Creates a new column in a given table.
<code>Database.new_entry</code>	Inserts data into a given table.
<code>Database.retrieve_entries</code>	Retrieves entries from a table with given conditions.
<code>Database.update_measurement</code>	Updates the entry of a measurement.

Database.__init__

`Database.__init__(config_file: Optional[str] = None, host: Optional[str] = None, port: Optional[int] = None, database: Optional[str] = None, user: Optional[str] = None, passfile: Optional[str] = None)`

Initializes the `Database` object. If a *configuration file name* is given, the constructor calls the method `config()` and overrides the default attributes

Parameters

- `config_file` (str, optional) – Configuration file name, default is *None*. See [here](#) for a configuration file example.
- `host` (str, optional) – Database host.
- `port` (int, optional) – Database port.
- `database` (str, optional) – Database name.
- `user` (str, optional) – Database user.
- `passfile` (str, optional) – Local file with PostgreSQL password.

Raises `configparser.Error` – If a configuration file name was given, the method `config()` can fail raising this exception.

Database.check_column

`Database.check_column(table_name, column_name) → bool`

Checks if a column exists in a given table.

Parameters

- `table_name` (str) – The table where the column has to be checked
- `column_name` (str) – The column to be checked

Returns *True* if the column exists, *False* otherwise.

Return type bool

Raises `psycopg2.Error` – Base exception for all kind of database errors

Database.check_empty_table

Database.**check_empty_table**(*table_name: str*) → bool

Checks whether a table is empty or not

Parameters *table_name* (str) – Name of the table where the column has to be retrieved from.

Returns True if the table is empty, False if it is not empty.

Return type bool

Raises `psycopg2.Error` – Base exception for all kind of database errors.

Database.check_table

Database.**check_table**(*table_name*) → bool

Checks if a table exists.

Parameters *table_name* (str) – The name of the table to be checked

Returns True if the table exists, False otherwise.

Return type bool

Raises `psycopg2.Error` – Base exception for all kind of database errors

Database.close

Database.**close**()

Closes the connection to the database.

Raises `psycopg2.Error` – Base exception for all kind of database errors

Database.config

Database.**config**(*config_file: str*)

Loads the configuration.

Reads the *config_file* using the `configparser` library. The structure of the file is shown in the *examples section*.

Parameters *config_file* (str) – Configuration file name.

Raises `configparser.Error` – Error while parsing the file, e.g. no file was found, a parameter is missing or it has an invalid value.

Database.connect

Database.**connect**(*print_version: bool = False*)

Connects to the database.

If the connection was successful and the flag *print* was set, it also prints the database version as a connection check.

Parameters *print_version* (bool, optional) – Print the database version, default is 'False'.

Raises `psycopg2.Error` – Base exception for all kind of database errors

Database.create_aggregate_view

`Database.create_aggregate_view(table_name: str, index_name: str = 'time', recreate: bool = True)`
Creates a set of `aggregate views` in a given table.

Parameters `table_name` (str) – Name of the table where the column has to be created.

index_name [str, optional] Column to be used as index for the aggregate view, default is 'time'.

recreate [bool, optional] Recreate the aggregate view if it exists, default is 'True'.

Raises `psycpg2.Error` – Base exception for all kind of database errors. In particular, it is raised if the table does not exist or the aggregate view could not be created.

Database.create_database

`Database.create_database(db_name: str, owner: str = 'postgres')`
Creates a database named `db_name`. If `timescaledb_extension` is set (default is 'True'), the TimescaleDB extension is installed in the database to allow TimescaleDB hypertables.

Parameters

- `db_name` (str) – The name of the database to be created
- `owner` (str, optional) – Database owner, default is 'postgres'.

Raises `psycpg2.Error` – Base exception for all kind of database errors

Database.create_timescale_db

`Database.create_timescale_db(table_name: str, default_now: bool = True)`
Creates a `TimescaleDB` table.

The table has a single column named 'time' with type 'TIMESTAMPTZ'. If the flag `default_now` is set (default is 'True'), the column 'time' will default to 'NOW()'

Parameters

- `table_name` (str) – The name of the table to be checked
- `default_now` (bool, optional) – Set the 'time' column default to 'NOW()', default is `True`.

Raises `psycpg2.Error` – Base exception for all kind of database errors

Database.fetch_latest_value

`Database.fetch_latest_value(table_name: str, column_name: Optional[List[str]] = None) → tuple`
Retrieves the latest values of a time-ordered table. If paramref:'column_name' is not given, all values of the table are retrieved.

Parameters

- `table_name` (str) – Name of the table where the column has to be retrieved from.
- `column_name` (str) – Column[s] to be retrieved, default is all columns.

Returns Latest data. First element is the time of the latest entry. Consecutive elements are the value of each column.

Return type `tuple`

Raises `psycopg2.Error` – Base exception for all kind of database errors.

Database.fetch_next_serial_id

`Database.fetch_next_serial_id(table_name: str) → int`

Checks the latest ID of a serialized table and returns the next available one.

Parameters `table_name` (`str`) – Name of the table to check.

Returns Next available serial ID.

Return type `int`

Raises `psycopg2.Error` – Base exception for all kind of database errors.

Database.get_list_columns

`Database.get_list_columns(table_name: str) → List[List[str]]`

Fetches the list of columns in a given table.

Returns Column data: list of pairs <name, type>.

Return type `List[List[str]]`

Raises `psycopg2.Error` – Base exception for all kind of database errors. In particular, it is raised if the table does not exist or the aggregate view could not be created.

Database.new_column

`Database.new_column(table_name: str, column_name: str, data_type: lab_utils.database.DataType, constraints: Optional[list] = None)`

Creates a new column in a given table.

If the column already exists, it just returns. If the table does not exist or the column could not be created, it raises a `psycopg2.Error`.

Parameters

- `table_name` (`str`) – Name of the table where the column has to be created
- `column_name` (`str`) – Name of the column to be created
- `data_type` (`DataType`) – Data type of the new column
- `constraints` (`list`, `optional`) – List of `Constraints`, default is 'None'

Raises

- `TypeError` – Invalid constraint or data type
- `ValueError` – Invalid constraint or data type
- `psycopg2.Error` – Base exception for all kind of database errors

Database.new_entry

`Database.new_entry(table_name: str, columns: list, data: list, check_columns: bool = False)`

Inserts data into a given table.

See [this example](#) for usage examples

Parameters

- `table_name` (str) – Name of the table where the data has to be inserted
- `columns` (list[str]) – List of columns names corresponding to the data
- `data` (list) – Values of the new data entry
- `check_columns` (bool, optional) – Check that columns exist before insertion, default is False

Raises

- `TypeError` – Invalid data
- `ValueError` – Invalid data
- `psycopg2.Error` – Base exception for all kind of database errors

Database.retrieve_entries

`Database.retrieve_entries(table_name: str, conditions: Union[str, List[str]]) →`

`pandas.core.frame.DataFrame`

Retrieves entries from a table with given conditions.

Parameters

- `table_name` (str) – Name of the table to query
- `conditions` (str, List[str]) – Condition (or list of conditions) for data selection

Returns Pandas Dataframe with retrieved data, and column names as indexes

Return type DataFrame

Raises `psycopg2.Error` – Base exception for all kind of database errors.

Database.update_measurement

`Database.update_measurement(table_name: str, measurement_id: int, columns: Optional[List[str]] = None, values: Optional[List] = None, pairs: Optional[List[Union[Tuple, List]]] = None)`

Updates the entry of a measurement.

Parameters

- `table_name` (str) – Measurement type.
- `measurement_id` (int) – Measurement ID.
- `columns` (List[str]) – List of columns names corresponding to the data
- `values` (List) – Values of the new data entry
- `pairs` (List[tuple]) – List of pairs (variable, value)

Returns True if the table is empty, False if it is not empty.

Return type `bool`

Raises `psycpg2.Error` – Base exception for all kind of database errors.

2.2 socket_comm

Description

Server/client communication via TCP sockets. The module implements TCP communication between a daemon-like *Server* and a simple *Client*.

The *Server* class is meant to be run as a daemon-like app. The user should override the `create_parser()` method to define the daemon behaviour upon reception of a message from a *Client*. The base class provides support for the message 'quit', which will terminate the daemon. Any other message will be met with a help-like reply.

The *Client* class communicates with the *Server* sending a text string.

The *ArgumentParser* class and *MessageError* exception are necessary to override some unwanted default behaviour of the `argparse` library.

The module is based upon [this tutorial](#).

`lab_utils.socket_comm.buffer_size`

Maximum length of a transmitted messages

Type `int`, 4096

Classes

<i>ArgumentParser</i>	Modifies some annoying behaviours of the <code>argparse</code> library.
<i>Client</i>	Simple TCP client to communicate with a running <i>Server</i> .
<i>Server</i>	Daemon-like TCP server.

2.2.1 ArgumentParser

Description

```
class lab_utils.socket_comm.ArgumentParser(prog=None, usage=None, description=None, epilog=None,
                                           parents=None, formatter_class=<class
                                           'argparse.HelpFormatter'>, prefix_chars='-',
                                           fromfile_prefix_chars=None, argument_default=None,
                                           conflict_handler='error', add_help=False,
                                           allow_abbrev=True)
```

Modifies some annoying behaviours of the `argparse` library.

Methods

<code>ArgumentParser.__init__</code>	Overrides the default initialization of <code>add_help</code> to <code>False</code> .
<code>ArgumentParser.error</code>	Avoids the call to <code>sys.exit()</code> when an error is encountered.
<code>ArgumentParser.full_help</code>	Creates a complete help message for the daemon usage.

`ArgumentParser.__init__`

`ArgumentParser.__init__(prog=None, usage=None, description=None, epilog=None, parents=None, formatter_class=<class 'argparse.HelpFormatter'>, prefix_chars='-', fromfile_prefix_chars=None, argument_default=None, conflict_handler='error', add_help=False, allow_abbrev=True)`

Overrides the default initialization of `add_help` to `False`. It also fixes the ‘default value is mutable’ warning.

`ArgumentParser.error`

`ArgumentParser.error(message: str)`

Avoids the call to `sys.exit()` when an error is encountered.

Raises `MessageError` – Custom exception just for this purpose.

`ArgumentParser.full_help`

`ArgumentParser.full_help() → str`

Creates a complete help message for the daemon usage. The `–help` option of `argparse` does not provide the possibility to print a monolithic help message including the subparsers.

Returns Full help message.

Return type `str`

2.2.2 Client

Description

`class lab_utils.socket_comm.Client(config_file: Optional[str] = None, host: Optional[str] = None, port: Optional[int] = None)`

Simple TCP client to communicate with a running `Server`. It sends a message and receives the reply from the server.

Attributes

<code>Client.host</code>	Host address.
<code>Client.port</code>	Connection port.

Client.host

`Client.host: str = 'localhost'`
Host address.

Client.port

`Client.port: int = 1507`
Connection port.

Methods

<code>Client.__init__</code>	Initializes the <code>Client</code> object.
<code>Client.config</code>	Loads the TCP configuration from the file <code>config_file</code> .
<code>Client.send_message</code>	Complete communication process.

Client.__init__

`Client.__init__(config_file: Optional[str] = None, host: Optional[str] = None, port: Optional[int] = None)`

Initializes the `Client` object. If a `config_file` is given, the constructor calls the `config()` method and overrides the default attributes. If the parameters `host` and `port` are given, they will override the configuration file.

Parameters

- `config_file` (str, optional) – Configuration file name, default is `None`. Same as See the example TODO.
- `host` (str, optional) – Host address, default is `None`.
- `port` (int, optional) – Connection port, default is `None`.

Raises `configparser.Error` – If a configuration file name was given, the method `config()` can fail raising this exception.

Client.config

`Client.config(config_file: str)`

Loads the TCP configuration from the file `config_file`.

The method reads the file using the library `configparser`.

Parameters `config_file` (*str*) – TCP configuration file, full path.

Raises `configparser.Error` – Error while parsing the file, e.g. no file was found, a parameter is missing or it has an invalid value.

Client.send_message

`Client.send_message(message: str) → str`

Complete communication process. Connects to the `Server`, sends a `message`, gets the reply and closes the connection.

Parameters `message` (*str*) – Message for the `Server`.

Raises `OSError` – Various socket errors, e.g. address or timeout

Returns Reply from the server

Return type *str*

2.2.3 Server

Description

`class lab_utils.socket_comm.Server(config_file: Optional[str] = None, pid_file_name: Optional[str] = None, host: Optional[str] = None, port: Optional[int] = None)`

Daemon-like TCP server. The server connects to the specified `host` and `port` and locks a `PID file` to ensure it is the only instance running.

If successful, the server will then listen indefinitely, waiting for a client to connect. Upon connection, a `message` is received and passed to the `parser`. If the message is valid, the parser will call the respective method. The base class provides only the `quit()` method; users should create new methods suitable for their needs. These methods should always set an appropriate `reply`, which will be then sent back to the client.

If a message is not valid (i.e. the parser does not support it), an error message and a complete help string is sent back to the client. The help string by the `argparse` library is not complete and hence is overridden by the `ArgumentParser.full_help()` method.

Attributes

<code>Server.address</code>	TCP binding address.
<code>Server.delimiter_left</code>	Left delimiter
<code>Server.delimiter_right</code>	Left delimiter
<code>Server.host</code>	Host address.
<code>Server.lock</code>	LockFile object.
<code>Server.logger</code>	Single <code>CustomLogger</code> for the whole class.
<code>Server.max_backlog</code>	TCP connection queue.
<code>Server.message</code>	Message from the client.

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<code>Server.namespace</code>	Container to hold message options.
<code>Server.parser</code>	Argument parser.
<code>Server.pid_file_name</code>	The PID file name
<code>Server.port</code>	Connection port.
<code>Server.quit_flag</code>	Internal flag to stop the daemon.
<code>Server.regex</code>	Parsing pattern.
<code>Server.reply</code>	Reply to the client.
<code>Server.sock</code>	Connection socket.
<code>Server.socket_timeout</code>	Socket time-out, used for Ctrl+C handling
<code>Server.sp</code>	Argument subparser

Server.address

`Server.address:` `str = None`
TCP binding address.

Server.delimiter_left

`Server.delimiter_left:` `chr = None`
Left delimiter

Server.delimiter_right

`Server.delimiter_right:` `chr = None`
Left delimiter

Server.host

`Server.host:` `str = 'localhost'`
Host address.

Server.lock

`Server.lock:` `zc.lockfile.LockFile = None`
LockFile object.

Server.logger

`Server.logger:` `lab_utils.custom_logging.CustomLogger = None`
Single *CustomLogger* for the whole class.

Server.max_backlog

Server.max_backlog: `int = 1`
TCP connection queue.

Server.message

Server.message: `str = ''`
Message from the client.

Server.namespace

Server.namespace: `argparse.Namespace = None`
Container to hold message options.

Server.parser

Server.parser: `lab_utils.socket_comm.ArgumentParser = None`
Argument parser.

Server.pid_file_name

Server.pid_file_name: `str = '/tmp/socket_comm.pid'`
The PID file name

Server.port

Server.port: `int = 1507`
Connection port.

Server.quit_flag

Server.quit_flag: `bool = False`
Internal flag to stop the daemon.

Server.regex

Server.regex: `Pattern = None`
Parsing pattern.

Server.reply

Server.reply: `str = ''`
 Reply to the client.

Server.sock

Server.sock: `_socket.socket = None`
 Connection socket.

Server.socket_timeout

Server.socket_timeout: `float = 1.0`
 Socket time-out, used for Ctrl+C handling

Server.sp

Server.sp: `argparse._SubParsersAction = None`
 Argument subparser

Methods

<code>Server.__init__</code>	Initializes and runs the <code>Server</code> object.
<code>Server.close</code>	Releases the PID lock file and the TCP socket.
<code>Server.config</code>	Loads the server configuration from a file.
<code>Server.create_parser</code>	Configures the message <code>parser</code> , which will call the appropriate method upon reception of a message.
<code>Server.daemonize</code>	Locks a PID file to ensure that a single instance of the server is running.
<code>Server.quit</code>	User-defined task example.
<code>Server.signal_handler</code>	
<code>Server.start_daemon</code>	Starts the server.

Server.__init__

Server.__init__(*config_file: Optional[str] = None, pid_file_name: Optional[str] = None, host: Optional[str] = None, port: Optional[int] = None*)

Initializes and runs the `Server` object. The constructor calls the `config()` method to read out the server attributes, and initializes the `logger` and the message `parser`. Finally, the method `daemonize()` tries to lock the PID file `pid_file_name`.

Parameters

- **config_file** (*str, optional*) – Configuration file, default is `None`.
- **pid_file_name** (*str, optional*) – If given, overrides the default `PID file name`.
- **host** (*int, optional*) – If given, overrides the server `host`.
- **port** (*int, optional*) – If given, overrides the server `port`.

Raises

- **configparser.Error** – Configuration file error
- **LockError** – The PID file could not be locked (see [here](#)).
- **OSError** – Various socket errors, e.g. address or timeout

Server.close

Server.close()

Releases the PID lock file and the TCP socket.

Server.config

Server.config(filename: str)

Loads the server configuration from a file.

Parameters **filename** *(str)* – The file name to be read.

Raises **configparser.Error** – If an error happened while parsing the file, e.g. no file was found

Server.create_parser

Server.create_parser()

Configures the message *parser*, which will call the appropriate method upon reception of a message. Other arguments given to the parser will be available in the *namespace*.

As an example, the subparser for the message ‘quit’ is implemented. The user should override the *quit()* method, as well as implement other methods for the particular daemon tasks.

Server.daemonize

Server.daemonize()

Locks a PID file to ensure that a single instance of the server is running. It is based on the (poorly documented) *zc.lockfile* package.

Raises **LockError** – The PID file could not be locked.

Server.quit

Server.quit()

User-defined task example. The method is called by the *parser* when the message ‘quit’ is received. For the base class, it just says goodbye to the client. Users should override it to do proper clean-up of their daemon.

Server.signal_handler

Server.signal_handler(,)

Server.start_daemon

Server.start_daemon()

Starts the server. The server will run in an endless loop until the message 'quit' is received. Clients can connect to the TCP port and send a text string. The message will be parsed by the *parser*, which will call the respective function. If the message is invalid, a help string is sent to the client.

The binding to the TCP port might fail for several reasons (e.g. the port is already in use by another process or requires admin rights), in which an *OSError* exception is raised. If the binding is successful, the server should be able to manage all exceptions, log them, and continue normal operations.

Raises *OSError* – Various socket errors, e.g. address or timeout

Exceptions

<i>MessageError</i>	Invalid message.
---------------------	------------------

2.2.4 MessageError

exception lab_utils.socket_comm.MessageError

Invalid message.

2.3 custom_logging

Description

Implements a custom logging service. The logging setup is based upon the standard Python *logging* library and offers some advantages:

- Standard logging across multiple apps using this module.
- Ease of use and configuration, with only necessary options.
- Extra functionality:
 - E-mail notification over TLS.
 - Coloured output to a terminal
 - Improved file rotation naming.
 - Logging over TCP socket compatible with the *socket_comm* module.

lab_utils.custom_logging.SUCCESS

New log level (25) intended to report successful events to Slack, between INFO (20) and WARNING (30).

Type *int*

Classes

<i>ColoredFormatter</i>	Console <i>formatter</i> that prepends the coloured severity level of the message.
<i>CustomLogger</i>	Custom logging class based on the default Python <i>Logger</i> .
<i>CustomTimedRotatingFileHandler</i>	Variation of <i>TimedRotatingFileHandler</i> .
<i>NonPickledSocketHandler</i>	Socket handler that sends non-pickled strings.
<i>TlsSMTPHandler</i>	<i>SMTPHandler</i> with TLS support.

2.3.1 ColoredFormatter

Description

class `lab_utils.custom_logging.ColoredFormatter`(*fmt=None, datefmt=None, style='%'*)
Console *formatter* that prepends the coloured severity level of the message. Based upon this [gist](#).

Attributes

<i>ColoredFormatter.colour_map</i>	Colour mapping.
<i>ColoredFormatter.colours</i>	Terminal colour codes.
<i>ColoredFormatter.prefix</i>	Prefix to modify terminal output colour.
<i>ColoredFormatter.suffix</i>	Suffix to modify terminal output colour.

ColoredFormatter.colour_map

```
ColoredFormatter.colour_map = {'CRITICAL': 'bgred', 'DEBUG': 'bggrey', 'ERROR':  
'red', 'EXCEPTION': 'bgred', 'INFO': 'cyan', 'SUCCESS': 'green', 'WARNING':  
'yellow'}  
    Colour mapping.
```

ColoredFormatter.colours

```
ColoredFormatter.colours = {'bggrey': 100, 'bgred': 41, 'black': 30, 'blue': 34,  
'cyan': 36, 'green': 32, 'magenta': 35, 'red': 31, 'white': 37, 'yellow': 33}  
    Terminal colour codes.
```

ColoredFormatter.prefix

```
ColoredFormatter.prefix = '\x1b['  
    Prefix to modify terminal output colour.
```

ColoredFormatter.suffix

`ColoredFormatter.suffix = '\x1b[0m'`
 Suffix to modify terminal output colour.

Methods

<code>ColoredFormatter.format</code>	Prepends a fixed-length, coloured trailer with the log level.
--------------------------------------	---

ColoredFormatter.format

`ColoredFormatter.format(record: logging.LogRecord) → str`
 Prepends a fixed-length, coloured trailer with the log level.

Parameters `record` (*LogRecord*) – The record to be logged.

Returns The formatted message

Return type `str`

2.3.2 CustomLogger

Description

class `lab_utils.custom_logging.CustomLogger(name, level=0)`
 Custom logging class based on the default Python `Logger`. It introduces the new logging level `SUCCESS = 25`, meant to be used to notify Slack about important, non-error events.

Attributes

—

Methods

<code>CustomLogger.__init__</code>	Calls the parent constructor and adds the <code>SUCCESS = 25</code> logging level.
<code>CustomLogger.success</code>	Creates a log entry with level <code>SUCCESS</code> , similar to the standard <code>error()</code> and <code>info()</code> .

CustomLogger.__init__

`CustomLogger.__init__(name, level=0)`

Calls the parent constructor and adds the `SUCCESS = 25` logging level.

CustomLogger.success

`CustomLogger.success(message, *args, **kws)`

Creates a log entry with level `SUCCESS`, similar to the standard `error()` and `info()`.

2.3.3 CustomTimedRotatingFileHandler

Description

`class lab_utils.custom_logging.CustomTimedRotatingFileHandler(path: str, basename: str, extension: str = '.log')`

Variation of `TimedRotatingFileHandler`. The handler will produce daily log files to a given directory, appending the date to a given base name.

Attributes

<code>CustomTimedRotatingFileHandler.basename</code>	Complete file base name where date will be appended, without extension.
<code>CustomTimedRotatingFileHandler.extension</code>	Log file extension.
<code>CustomTimedRotatingFileHandler.path</code>	Parent directory to save all logs.
<code>CustomTimedRotatingFileHandler.rolloverAt</code>	Next rollover time
<code>CustomTimedRotatingFileHandler.stream</code>	File stream

CustomTimedRotatingFileHandler.basename

`CustomTimedRotatingFileHandler.basename: str = None`

Complete file base name where date will be appended, without extension.

CustomTimedRotatingFileHandler.extension

CustomTimedRotatingFileHandler.**extension**: **str** = **None**
 Log file extension.

CustomTimedRotatingFileHandler.path

CustomTimedRotatingFileHandler.**path**: **str** = **None**
 Parent directory to save all logs.

CustomTimedRotatingFileHandler.rolloverAt

CustomTimedRotatingFileHandler.**rolloverAt** = **None**
 Next rollover time

CustomTimedRotatingFileHandler.stream

CustomTimedRotatingFileHandler.**stream**: **TextIO** = **None**
 File stream

Methods

<i>CustomTimedRotatingFileHandler.__init__</i>	Calls the parent constructor and creates the logging directory, if it does not exist.
<i>CustomTimedRotatingFileHandler.doRollover</i>	Rotates log files on daily basis.

CustomTimedRotatingFileHandler.__init__

CustomTimedRotatingFileHandler.**__init__**(*path*: *str*, *basename*: *str*, *extension*: *str* = '.log')

Calls the parent constructor and creates the logging directory, if it does not exist.

Parameters

- **path** (str) – Parent directory to save all logs.
- **basename** (str) – File base name where date will be appended, without extension.
- **extension** (str, optional) – Log file extension, default is 'log'.

Raises **OSError** – The logging directory could not be created. The handler should not be used if this exception is raised.

CustomTimedRotatingFileHandler.doRollover

CustomTimedRotatingFileHandler.doRollover()

Rotates log files on daily basis. The file name of the current logfile is *basename* + `strftime()` + *extension*, with time format ‘%Y-%m-%d’.

2.3.4 NonPickledSocketHandler

Description

class lab_utils.custom_logging.NonPickledSocketHandler(*host, port*)

Socket handler that sends non-pickled strings. Such strings are compatible with a [Server](#) listening on the appropriate TCP port.

Attributes

—

Methods

<i>NonPickledSocketHandler.emit</i>	Encodes a <i>record</i> and writes it to the socket.
-------------------------------------	--

NonPickledSocketHandler.emit

NonPickledSocketHandler.emit(*record: logging.LogRecord*)

Encodes a *record* and writes it to the socket. If there is an error with the socket, silently drops the packet. If there was a problem with the socket, re-establishes the socket.

Parameters *record* (LogRecord) – The record to be emitted.

2.3.5 TlsSMTPHandler

Description

class lab_utils.custom_logging.TlsSMTPHandler(*mailhost, fromaddr, toaddrs, subject, credentials=None, secure=None, timeout=5.0*)

SMTPHandler with TLS support. Based upon this [gist](#).

Attributes

<i>TlsSMTPHandler.fromaddr</i>	Sender address (inherited).
<i>TlsSMTPHandler.mailhost</i>	Mail provider (inherited).
<i>TlsSMTPHandler.mailport</i>	Mail port (inherited).
<i>TlsSMTPHandler.password</i>	Login password (inherited).
<i>TlsSMTPHandler.toaddrs</i>	Recipients addresses (inherited).
<i>TlsSMTPHandler.username</i>	Login username (inherited).

TlsSMTPHandler.fromaddr

TlsSMTPHandler.fromaddr: `str = None`
Sender address (inherited).

TlsSMTPHandler.mailhost

TlsSMTPHandler.mailhost: `str = None`
Mail provider (inherited).

TlsSMTPHandler.mailport

TlsSMTPHandler.mailport: `int = None`
Mail port (inherited).

TlsSMTPHandler.password

TlsSMTPHandler.password: `str = None`
Login password (inherited).

TlsSMTPHandler.toaddrs

TlsSMTPHandler.toaddrs: `List[str] = None`
Recipients addresses (inherited).

TlsSMTPHandler.username

TlsSMTPHandler.username: `str = None`
Login username (inherited).

Methods

<i>TlsSMTPHandler.emit</i>	Emits a record.
----------------------------	-----------------

TlsSMTPHandler.emit

TlsSMTPHandler.emit(*record*)
Emits a record. Opens a TLS SMTP connection using the `smtplib` library and sends an `EmailMessage`.

Functions

<code>configure_logging</code>	Sets up the custom logger.
<code>getLogger</code>	Overrides the Python standard <code>logging.getLogger()</code> to fix type completion hints, referring them to <code>CustomLogger</code> instead of <code>Logger</code> .
<code>string_to_bool</code>	Parses a variety of strings (e.g.

2.3.6 configure_logging

`lab_utils.custom_logging.configure_logging(config_file: Optional[str] = None, fallback: bool = False, logger_name: str = 'root', log_level: Optional[int] = None)`

Sets up the custom logger. Loads the configuration from `config_file` using the `configparser` library.

Parameters

- **config_file** *(str)* – Configuration file name.
- **fallback** *(bool, optional)* – If ‘True’ and the logger setup fails, fall back to the default `Logger`.
- **logger_name** *(str, optional)* – Logger name.
- **log_level** *(int, optional)* – Initial logging level, overrides the configuration file.

Raises `configparser.Error` – Error while parsing the file, e.g. no file was found, a parameter is missing or it has an invalid value.

2.3.7 getLogger

`lab_utils.custom_logging.getLogger(name: Optional[str] = None) → lab_utils.custom_logging.CustomLogger`

Overrides the Python standard `logging.getLogger()` to fix type completion hints, referring them to `CustomLogger` instead of `Logger`. Taken from a StackOverflow [question](#).

Parameters **name** *(str, optional)* – The logger name

Returns A named instance of the logger.

Return type `CustomLogger`

2.3.8 string_to_bool

`lab_utils.custom_logging.string_to_bool(s: str) → bool`

Parses a variety of strings (e.g. ‘true’ or ‘1’) to a boolean.

Parameters **s** *(str)* – The string to parse

Returns

True if s is one of:

- ‘true’
- ‘1’
- ‘t’

- 'y'
- 'yes'
- 'on'

Return type `bool`

EXAMPLES

This documentation is intended to show practical usage examples of the different modules included in the *lab_utils* package.

3.1 Configuration files

The `config` method of each module expects a configuration file with a specific pattern. In addition, a sample file accepted by the standard `logging.config` method is also provided.

3.1.1 Logging Configuration File

The logging configuration file

3.1.2 Database Configuration File

The database configuration file

3.2 Database

3.2.1 Installing

lab_utils can be obtained from pip via

```
pip install lab_utils
```

You can also get *lab_utils* from its current source on GitHub, to get all the latest and greatest features. *lab_utils* is under active development, and many new features are being added. However, note that the API is currently unstable at this time.

```
git clone https://github.com/mrocklin/sparse.git
cd ./sparse/
pip install .
```


CHANGELOG

All notable changes to this project will be documented in this file.

The format is based on [Keep a Changelog](#), and this project adheres to [Semantic Versioning](#).

4.1 [0.5.12] - 2021-05-25

- **database:** add method to retrieve entries
- pandas is now a project requirement

4.2 [0.5.11] - 2021-05-12

- **custom_logging:** fix bug in midnight file rotation

4.3 [0.5.10] - 2021-04-28

- **custom_logging:** minor bug fixes

4.4 [0.5.9] - 2021-04-22

- **database:** add method to update an existing measurement entry

4.5 [0.5.8] - 2021-04-22

- **database:** add methods to check whether a table is empty and to retrieve the next serial ID

4.6 [0.5.7] - 2021-04-16

- **custom_logging**: add parameter to *configure_logging* for initial logging level setup

4.7 [0.5.6] - 2021-04-16

- **database**: add method *get_list_columns* to retrieve all columns in a table

4.8 [0.5.5] - 2021-04-16

- **database**: add method *fetch_latest_value* to retrieve latest data from a time-ordered table

4.9 [0.5.4] - 2021-04-14

- **database**: remove aggregate views for 10 s and 10 min, only 1 min is left

4.10 [0.5.2] - 2020-10-26

- Changes to **socket_comm** module:
 - Fix bug when the argparse option **choices** is used for an argument
 - Increase TCP buffer size to 4096

4.11 0.5.1 - 2020-06-22

- Changes to **database** module:
 - Fix method *create_aggregate_view*

4.12 0.5.0 - 2020-06-09

- Changes to **database** module:
 - Add methods *create_database* and *create_aggregate_view*
 - Minor improvements and typos fixed

4.13 0.4.0 - 2020-05-25

- Improve log formatting
- Implement new logging system in the database and socket_comm modules
- Minor changes to documentation

4.14 0.3.0 - 2020-05-20

- Fix Server class destructor.
- Add module **custom_logging** for homogeneous logging setup across apps with the following handlers:
 - Console (with coloured code).
 - File (with daily rotation).
 - TCP socket, to notify a central alarm management app.
 - Email (SMTP over TLS).
 - Slack notification.
- Implement new logging schema in the examples.
- Improve documentation and other minor fixes.

4.15 0.2.0 - 2020-05-08

- Implement CI with `__gitlab-ci.yml`.
- Improve documentation
- Module socket_comm:
- Implement `method` to send a complete help message to the client.
- Implement signal handler to deal with Ctrl+C nicely
- Expand `examples`

4.16 0.1.0 - 2020-05-05

- First release of the **lab-utils** package
- Installation instructions and setup
- Modules available: **database** and **socket_comm**

CONTRIBUTING

When contributing to this repository, please first discuss the change you wish to make via issue, email, or any other method with the owners of this repository before making a change.

Please note we have a code of conduct, please follow it in all your interactions with the project.

5.1 Pull Request Process

1. Ensure any install or build dependencies are removed before the end of the layer when doing a build.
2. Update the README.md with details of changes to the interface, this includes new environment variables, exposed ports, useful file locations and container parameters.
3. Increase the version numbers in any examples files and the README.md to the new version that this Pull Request would represent. The versioning scheme we use is [SemVer](#).
4. You may merge the Pull Request in once you have the sign-off of two other developers, or if you do not have permission to do that, you may request the second reviewer to merge it for you.

5.2 Code of Conduct

5.2.1 Our Pledge

In the interest of fostering an open and welcoming environment, we as contributors and maintainers pledge to making participation in our project and our community a harassment-free experience for everyone, regardless of age, body size, disability, ethnicity, gender identity and expression, level of experience, nationality, personal appearance, race, religion, or sexual identity and orientation.

5.2.2 Our Standards

Examples of behavior that contributes to creating a positive environment include:

- Using welcoming and inclusive language
- Being respectful of differing viewpoints and experiences
- Gracefully accepting constructive criticism
- Focusing on what is best for the community
- Showing empathy towards other community members

Examples of unacceptable behavior by participants include:

- The use of sexualized language or imagery and unwelcome sexual attention or advances
- Trolling, insulting/derogatory comments, and personal or political attacks
- Public or private harassment
- Publishing others' private information, such as a physical or electronic address, without explicit permission
- Other conduct which could reasonably be considered inappropriate in a professional setting

5.2.3 Our Responsibilities

Project maintainers are responsible for clarifying the standards of acceptable behavior and are expected to take appropriate and fair corrective action in response to any instances of unacceptable behavior.

Project maintainers have the right and responsibility to remove, edit, or reject comments, commits, code, wiki edits, issues, and other contributions that are not aligned to this Code of Conduct, or to ban temporarily or permanently any contributor for other behaviors that they deem inappropriate, threatening, offensive, or harmful.

5.2.4 Scope

This Code of Conduct applies both within project spaces and in public spaces when an individual is representing the project or its community. Examples of representing a project or community include using an official project e-mail address, posting via an official social media account, or acting as an appointed representative at an online or offline event. Representation of a project may be further defined and clarified by project maintainers.

5.2.5 Enforcement

Instances of abusive, harassing, or otherwise unacceptable behavior may be reported by contacting the project team at [INSERT EMAIL ADDRESS]. All complaints will be reviewed and investigated and will result in a response that is deemed necessary and appropriate to the circumstances. The project team is obligated to maintain confidentiality with regard to the reporter of an incident. Further details of specific enforcement policies may be posted separately.

Project maintainers who do not follow or enforce the Code of Conduct in good faith may face temporary or permanent repercussions as determined by other members of the project's leadership.

5.2.6 Attribution

This Code of Conduct is adapted from the [Contributor Covenant](http://contributor-covenant.org/version/1/4), version 1.4, available at <http://contributor-covenant.org/version/1/4>

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The precise terms and conditions for copying, distribution and modification follow.

6.2 TERMS AND CONDITIONS

6.2.1 0. Definitions

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6.2.2 1. Source Code

The “source code” for a work means the preferred form of the work for making modifications to it. “Object code” means any non-source form of a work.

A “Standard Interface” means an interface that either is an official standard defined by a recognized standards body, or, in the case of interfaces specified for a particular programming language, one that is widely used among developers working in that language.

The “System Libraries” of an executable work include anything, other than the work as a whole, that (a) is included in the normal form of packaging a Major Component, but which is not part of that Major Component, and (b) serves only to enable use of the work with that Major Component, or to implement a Standard Interface for which an implementation is available to the public in source code form. A “Major Component”, in this context, means a major essential component (kernel, window system, and so on) of the specific operating system (if any) on which the executable work runs, or a compiler used to produce the work, or an object code interpreter used to run it.

The “Corresponding Source” for a work in object code form means all the source code needed to generate, install, and (for an executable work) run the object code and to modify the work, including scripts to control those activities. However, it does not include the work’s System Libraries, or general-purpose tools or generally available free programs

which are used unmodified in performing those activities but which are not part of the work. For example, Corresponding Source includes interface definition files associated with source files for the work, and the source code for shared libraries and dynamically linked subprograms that the work is specifically designed to require, such as by intimate data communication or control flow between those subprograms and other parts of the work.

The Corresponding Source need not include anything that users can regenerate automatically from other parts of the Corresponding Source.

The Corresponding Source for a work in source code form is that same work.

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```
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