
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 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.

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 and install **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](#).

1.3 Python Prerequisites

The following Python packages will be automatically installed by **lab-utils**:

-

1.4 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. Clone the repository into the directory \$DIR:

```
git clone git@gitlab.ethz.ch:exotic-matter/cw-beam/lab-utils $DIR
cd $DIR
```

2. Install the package and its dependencies

```
python -m pip install .
```

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

```
python -m pip install . --only-binary psycopg2
```

3. Run some examples to test that everything works

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

4. If you want to build the documentation

```
cd $PATH_TO_SOURCE
python -m pip install .[docs]
cd docs
make clean
make html
```

1.5 Import into your own app

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

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

1.6 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.

1.6.1 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

1.6.2 socket_comm

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

1.7 Authors

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

1.8 Contributing

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

1.9 Versioning

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

1.10 License

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

1.11 Built With

- [PyCharm Community Edition](#) - The IDE used
- [Sphinx](#) - Documentation

1.12 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 <i>PostgreSQL</i> database.
<i>socket_comm</i>	Server/client communication via TCP sockets.

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 <i>PostgreSQL</i> database.

2.1.1 Constraint

Description

class `lab_utils.database.Constraint`

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

Attributes

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

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

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

2.1.3 Database

Description

class `lab_utils.database.Database` (*config_file*: *str* = *None*)

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

Methods

<code>Database.__init__</code>	Initializes the <code>Database</code> object.
<code>Database.check_column</code>	Checks if a column exists in a given table.
<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_timescale_db</code>	Creates a <code>TimescaleDB</code> 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.

`Database.__init__`

`Database.__init__` (*config_file*: *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

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*)

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_table

Database.**check_table** (*table_name*)

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* = '/home/docs/checkouts/readthedocs.org/user_builds/lab-utils/envs/v0.1.0/lib/python3.7/site-packages/lab_utils/conf/database.ini')

Loads the configuration.

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

Parameters **config_file** (*str*, *optional*) – *Configuration file name*, default is 'conf/database.ini'

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

Database.new_column

Database.**new_column** (*table_name: str, column_name: str, data_type: lab_utils.database.DataType, constraints: list = None*)

Creates a new column in a given table.

If the column already exists, it just returns True. If the table does not exist, returns False.

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

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`, 1024

Classes

<i>ArgumentParser</i>	Modifies error management 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,      descrip-
                                             tion=None,      epilog=None,      par-
                                             ents=[],      formatter_class=<class      'arg-
                                             parse.HelpFormatter'>,      prefix_chars='-
                                             ',      fromfile_prefix_chars=None,      argu-
                                             ment_default=None, conflict_handler='error',
                                             add_help=True, allow_abbrev=True)
```

Modifies error management of the `argparse` library.

Methods

<code>ArgumentParser.error</code>	Prints a usage message incorporating the message to stderr and exits.
-----------------------------------	---

ArgumentParser.error

`ArgumentParser.error` (*message: string*)

Prints a usage message incorporating the message to stderr and exits.

If you override this in a subclass, it should not return – it should either exit or raise an exception.

2.2.2 Client

Description

class `lab_utils.socket_comm.Client` (*config_file: str = None, host: str = None, port: 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 <i>Client</i> object.
<code>Client.config</code>	Loads the configuration from a file.
<code>Client.send_message</code>	Complete communication process.

Client.__init__

`Client.__init__(config_file: str = None, host: str = None, port: 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 = '/home/docs/checkouts/readthedocs.org/user_builds/lab-utils/envs/v0.1.0/lib/python3.7/site-packages/lab_utils/conf/server.ini')`

Loads the configuration from a file.

The method reads the `config_file` using the library `configparser`. The structure of the file is shown in the [examples section](#).

Parameters `config_file` (*str*, optional) – TODO

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(msg: str) → str`

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

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: str = None`, `pid_file_name: str = None`)

Daemon-like TCP Server. The user should override the `create_parser()` method, which defines the server behaviour upon reception of a message from a `Client`.

Attributes

<i>Server.address</i>	TCP binding address.
<i>Server.host</i>	Host address.
<i>Server.lock</i>	LockFile object.
<i>Server.logger</i>	Single logger for the whole class.
<i>Server.max_backlog</i>	TCP connection queue.
<i>Server.message</i>	Message from the client.
<i>Server.namespace</i>	Attribute container
<i>Server.parser</i>	Argument parser.
<i>Server.pid_file_name</i>	The PID file name
<i>Server.port</i>	Connection port.
<i>Server.quit_flag</i>	Internal flag to stop the daemon.
<i>Server.reply</i>	Reply to the client.
<i>Server.sock</i>	Connection socket.
<i>Server.sp</i>	Argument subparser

Server.address

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

Server.host

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

Server.lock

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

Server.logger

`Server.logger: logging.Logger = None`
Single logger 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`
Attribute container

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.reply

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

Server.sock

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

Server.sp

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

Methods

<code>Server.__init__</code>	Initializes and runs the <code>Server</code> object.
<code>Server.config</code>	Loads the server configuration from a file.
<code>Server.create_parser</code>	Configures the message <code>parser</code> .
<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.run</code>	Starts the server.

Server.__init__

`Server.__init__(config_file: str = None, pid_file_name: str = 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`.

The method `daemonize()` tries to lock the PID file, and finally `run()` is called, which starts an endless loop listening on the specified TCP `port`.

Parameters

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

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.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*. Upon reception of a message, *create_parser()* will call the appropriate function. Other arguments given to the parser will be available in the *namespace* attribute.

As an example, the subparser for the message ‘quit’ is implemented. The user should override the method *quit()*, 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. 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.run

`Server.run()`

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 text string. The message will be parsed by the *parser*, which will call the respective function. If the message is invalid, a help string will be sent to the client.

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

Exceptions

MessageError

Invalid message.

2.2.4 MessageError

exception `lab_utils.socket_comm.MessageError`

Invalid message.

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 0.1.0 - 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>

GNU GENERAL PUBLIC LICENSE

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6.1 Preamble

The GNU General Public License is a free, copyleft license for software and other kinds of works.

The licenses for most software and other practical works are designed to take away your freedom to share and change the works. By contrast, the GNU General Public License is intended to guarantee your freedom to share and change all versions of a program—to make sure it remains free software for all its users. We, the Free Software Foundation, use the GNU General Public License for most of our software; it applies also to any other work released this way by its authors. You can apply it to your programs, too.

When we speak of free software, we are referring to freedom, not price. Our General Public Licenses are designed to make sure that you have the freedom to distribute copies of free software (and charge for them if you wish), that you receive source code or can get it if you want it, that you can change the software or use pieces of it in new free programs, and that you know you can do these things.

To protect your rights, we need to prevent others from denying you these rights or asking you to surrender the rights. Therefore, you have certain responsibilities if you distribute copies of the software, or if you modify it: responsibilities to respect the freedom of others.

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```
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```

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```
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```

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