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This is the documentation of **Blockchain** a simple implementation in Python to get familiar with Python and the basic concepts of Blockchains.

**Short Disclaimer:** It is just a private **Python 3.7.2** project. Its purposes is to get a little bit familiar with the Python projects and the concepts of Blockchains. Therefore it is not intended for production usage, and any warranties are excluded.
The easiest way to get up a single miner or a whole blockchain network is to use Docker. This repository offers the needed Dockerfile and docker-compose.yaml in the directory docker. Do the following steps:

1. Change to docker directory
2. Run `docker build --no-cache -t blockchain .`
3. Run `docker-compose up`

This starts a Blockchain network with 3 miners and forwards their ports (12345, 12346, 12347) to your host system. It uses the directory `~/.blockchain/` on your host system to save the created files for each miner.

### 1.1 Install the CLI Locally

1. Clone this repository: `git clone git@github.com:se-jaeger/blockchain.git`
2. Open the clone directory: `cd blockchain`
3. Create a virtual env: `python -m venv venv`
4. Activate the virtual env: `source venv/bin/activate`
5. Install all dependencies: `pip install -r requirements.txt`
6. Install the `blockchain` CLI, run the following in the root directory of this project: `pip install -e .`
7. Check available commands: `blockchain --help`
This implementation produces a simple CLI, Miner and UI. It is necessary to get up and running a local Miner. The CLI, as well as the UI, uses the Miners REST interface to interact with it. Created messages get synchronized with all other known Miners (neighbours) in the Blockchain network. A Miner asks all its neighbours periodically (if not max amount of neighbours is reached) to send unknown Miner and connects to them. Also in a periodical manner, Miner synchronizes their local Blockchain with the chains of there neighbours and use the longest valid chain in the network.

2.1 Miner Implementation

This Miner implementation offers a REST API with the following endpoints:

- `/add` (PUT): needs the URL parameter `message`. Adds the message to the local cache of unprocessed data.
  - response (200): JSON with message: ‘Message added!’
  - response (400): JSON with message: ‘No Message added!’
- `/chain` (GET): Returns the miners local chain.
  - response (200): JSON with the actual chain and its length.
- `/neighbours` (GET): Returns the miners neighbours.
  - response (200): JSON with the actual neighbours and its length.
- `/data` (GET): Returns the miners local cache of unprocessed data.
  - response (200): JSON with the actual list of unprocessed data.

The miner uses a set of files for normal operation:
• `<filename>.chain`: Representation of the actual file.
• `<filename>.hash`: SHA-256 of the actual chain file. Is used to check if the local chain differs from its on disc representation.
• `<filename>_<date>_<time>`: Older versions of the chain file. Created at `<date>_<time>`.
• `miner.log`: Log file and up to three backup files named `miner.log.x` where `x` is a number.

The Miner runs several Threads and a Process to run parallel and periodical tasks:

• **Gossip Job (Thread):** Implementation of a simple Gossip Protocol. Fetches periodical all neighbours of its neighbours.
• **Sync Chain Job (Thread):** To get the actual longest global chain. Fetches periodical the chain of all neighbours.
• **Sync Unprocessed Data Job (Thread):** To propagate unprocessed data through the network. Fetches periodical the set of unprocessed data of all neighbours.
• **Backup Local Chain Job (Thread):** To backup the local chain to disc. Backups periodical the local chain to disc if they differ from each other.
• **Server Process (Process):** Servers the Miners REST API in a separate process.
• **Communication Job (Thread):** Communication thread to exchange message with the server process.

### 2.2 Web-based User Interface

The CLI offers a subcommand `ui`, this allows to start an webserver for convenient interaction with the blockchain system.

### 2.3 Proof of Work

A very simple implementation of a **Proof of Work** algorithm. The SHA-256 hash value of the concatenation of the previous proof and the proof of the new Block has to start with difficulty trailing 0s.
CHAPTER 3

Improvements

• Miner endpoint (health) to check availability and provide opportunity to delete a neighbour
• More Error handling -> chain probably gets corrupt when killing miner
• Use locking for (chain, neighbours, data)
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4.2 Contributors

• Sebastian Jäger <se.jaeger@web.de>

4.3 Changelog

4.3.1 Version 0.1

• Implement core functionality

4.3.2 Version 0.2

• Implement Web-based user interface

4.4 src

4.4.1 blockchain package

Subpackages

blockchain.blockchain package

Submodules

blockchain.blockchain.block module

class blockchain.blockchain.block.Block (index: int, data: blockchain.blockchain.data.Data, proof: int, previous_hash: str)

Bases: object

__bytes__ () → bytes

Uses the encoded string representation of this Block object as bytes representation.

Returns byte representation of Block object.

Return type bytes

__eq__ (other: object) → bool

Method for comparing two Block objects.

Parameters other (Block) – Block object to compare with self.

Returns True if blocks are equal. False otherwise.

Return type bool
__repr__() → str
String representation of Block object.

Returns String representation of Block object.

Return type str
data
index
previous_hash
proof
timestamp

blockchain.blockchain.blockchain module

class blockchain.blockchain.blockchain.Blockchain(path_to_chain: str, json_format: bool, force_new_chain: bool)
Bases: object

_load_chain() → None
Helper method to load chain from disk. Raises an error if no chain is found.

Raises ChainNotFoundError – Will be raised if no local chain could be found.

add_new_block(data: blockchain.blockchain.data.Data, proof: int, previous_hash: str) → blockchain.blockchain.blockchain.Block
Adds a new Block to the existing chain.

Parameters

• data (Data) – Data that is attached to this block.
• proof (int) – The proof value for this block.
• previous_hash (str) – Hash value of previous block in chain.

chain

 genesis_block = |
|===================================================================================================================================|
|index: 0 |
|===================================================================================================================================|
|previous_hash: 'beac2e974625627e92f58831a56fd005570fb08a740cf114deb358dfa6b9525' |

 json_format

 last_block

 path_to_chain

 save_chain() → None
Helper method to save chain to disk. Creates intermediate directories and backups an existing chain file if necessary.

blockchain.blockchain.data module

class blockchain.blockchain.data.Data(message: str)
Bases: object

__hash__()
Needed to use Set's of 'Data objects.
id
message

Module contents

blockchain.cli package

Submodules

blockchain.cli.cli module

Module contents

blockchain.client package

Submodules

blockchain.client.miner module


Bases: object

_backup_local_chain() → None
Periodical thread to backup the local chain to disc.

__check_for_longest_chain() → None
Consensus Algorithm:

Ask each neighbour for that neighbours. Add all unknown miner to neighbours set until maximum amount of neighbours is reached.

__communicate() → None
Periodical thread to communicate with server process.

_fetch_unprocessed_data() → None
Periodical thread to get unprocessed data form neighbours. => Broadcasts unprocessed data around the network.

static _hash(block: blockchain.blockchain.block.Block) → str
Hash a Block object with SHA-256.

Parameters block (Block) – Object of class Block to hash.

Returns Hex representation of block hash.

Return type str

Raises ValueError – Will be raised if no Block object is passed.

_is_chain_valid(chain: list = None) → bool

Checks if the given chain satisfies the following rules:

1. The first (genesis) block:
   - index = 0
• previous_hash = None
• proof = None

2. each and every following block:
   • index: step size 1 and monotonically increasing (1, 2, 3, 4, …)
   • previous_hash: SHA-256 of the string representation of the preceding block
   • proof: has to be valid -> see: is_proof_of_work_valid()
   • timestamp: higher than the timestamp of the preceding block

Parameters chain (list) – Optional chain if None internal representation is used.
Returns True if chain is valid, False otherwise.
Return type bool

_is_data_processed (data: blockchain.blockchain.data.Data) → bool
Checks if data is already in local chain.
Parameters data (Data) – Data object to check if it exists in the actual chain.
Returns True if unprocessed.
Return type bool

static _is_proof_of_work_valid (last_proof: int, proof: int, difficulty: int) → bool
Checks if the proof of work was correct. The hash value of last_proof concatenated with proof has to be difficulty trailing 0s.
Parameters
• last_proof (int) – Value of the proof of the preceding block.
• proof (int) – proof of the actual block.
• difficulty (int) – Amount of trailing 0s.
Returns True if proof of work is correct, False otherwise.
Return type bool

Raises ValueError – Will be raised if difficulty is not a positive integer value.

_mine () → None
Blocking Mining loop.

If not_processed_messages are available it uses a random message an mines a new block.

_new_message (message: str) → None
Adds the new message to its local cache.

Parameters message (str) –

_proof_of_work (last_proof: int, difficulty: int) → int
Simple proof of work:
Find a number p that when hashed with the previous block’s solution a hash with difficulty trailing 0s is produced.
Parameters
• **last_proof**(int) – Solution of the last blocks’ proof of work

• **difficulty**(int) – Amount of trailing 0s for a valid proof of work.

    Returns Solution for this proof of work quiz.
    Return type int

    Raises ValueError – Will be raised if difficulty is not a positive integer value.

    _update_neighbours() → None
        Periodical thread to update neighbours if limit is not exceeded.

    blockchain
difficulty
jobs
neighbours
port
queue
server_process
start() → None
    Starts some background Jobs for the Gossip Protocol, Chain syncing, Data syncing, communication thread as well as the server functionalities as process. Starts the blocking function mine().

stop() → None
    Function that gets called when Python was killed. Takes care to shutting down all threads/process and saves the chain to disc.

unprocessed_data

**blockchain.client.server module**

**blockchain.client.server.start_server**(queue: multiprocessing.context.BaseContext.Queue, port: int)

**Module contents**

**blockchain.ui package**

**Submodules**

**blockchain.ui.forms module**

**blockchain.ui.routes module**

**Module contents**

**blockchain.utils package**
Submodules

**blockchain.utils.constants module**

**blockchain.utils.errors module**

```python
exception blockchain.utils.errors.ChainNotFoundError
    Bases: Exception
    Error if no local chain could be found.
```

```python
exception blockchain.utils.errors.ChainNotValidError
    Bases: Exception
    Error if loaded chain is not valid.
```

```python
exception blockchain.utils.errors.PortValueError
    Bases: ValueError
    Error if given port is out of valid range (1 - 65535).
```

```python
exception blockchain.utils.errors.ProgramKilledError
    Bases: Exception
    Error if process get killed.
```

**blockchain.utils.utils module**

```python
class blockchain.utils.utils.Job(interval: datetime.timedelta, execute, *args, **kwargs)
    Bases: threading.Thread
    run() → None
        Runs the background Job
    stop() → None
        Stops the background Job.
```

```python
blockchain.utils.utils.colorize(text: str, color: str) → str
```

```python
blockchain.utils.utils.create_proper_url_string(host_port: (<class 'str'>, <class 'int'>), path: str) → str
```

Takes the internal representation of neighbours and a endpoint path to create a proper URL string for requests.

**Parameters**

- **host_port** *(str, int)* – Internal representation of IP address/hostname and port combination.
- **path** *(str)* – The endpoint of the API.

**Returns** Correct URL string for `address` and `path`.

**Return type** `str`

```python
blockchain.utils.utils.encode_file_path_properly(file_path: str) → str
```

Encode each and every input filepath as absolute paths.

**Parameters** `file_path` *(str)* – Path to encode properly

**Returns** Absolute and properly encoded `file_path`

**Return type** `str`
blockchain.utils.utils.signal_handler(signum, frame)

Signal handler used to raise special ProgramKilledError.

Raises ProgramKilledError – To intercept for graceful shutdown.

blockchain.utils.utils.split_url_string(host_port: str) -> (class 'str'), (class 'int')

Parses the given URL string and returns the IP address/hostname and the port/default port.

Parameters host_port (str) – Representation of the miner as URL string, e.g.: 127.0.0.1:12345, miner:8888, miner, http://localhost,...

Returns Tuple of IPv4 Address or hostname string and port number.

Return type (str, int)

Raises

• PortValueError – Will be raised if given port is out of range.

• AddressValueError – Will be raised if given address is not a valid IPv4 address or “localhost”.

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