

# Codeine - Computing over Decentralized Network, with P2P

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## 1 Glossary

- Agent - single application instance, is able to compute one subproblem at a time
- Computational problem - problem solvable with Codeine. It should be divisible into a finite amount of subproblems which can be solved independent of each other
- Computational network (usually referred to as "network") - a network of agents communicating with each other, who together solve one computational problem
- Subproblem - a single subproblem of the computational problem

## 2 Requirements

- Project should implement peer-to-peer networking on LAN
- We should assume that about 5 agents at once can work on our computational problem
- Every agent should have exactly the same application
- After application launch, agent should automatically attempt to discover other agents in the network
- The computational problem itself doesn't matter, it should only allow for long enough computing time to let us see the network working as intended
- Subproblem assignment should be decentralized
- Agents should be immune to other agents disconnecting from the network, there should be no side effects
- Results should be visualized, accessible (in the best case in real time)

## 3 Assumptions & Constraints

- Packet type - a string consisting of only upper case letters (e.g. IMALIVE, NETTOPOLOGY)
- The solution of a single subproblem should be able to fit in a single UDP packet (<64kB)
- Every subproblem has it's ID and immutable State, common for all subproblems
- Every subproblem can be solved

## 4 Networking

### 4.1 Packets

- Topology discovery, registering agents
  - IMALIVE - send empty packet informing that agent is in the network <>
  - NETTOPOLOGY - send network topology <agent[]>
- Subproblem assignment
  - REGSUBPROB - register new subproblem <subproblem\_id>
  - DROPSUBPROB - stop working on this subproblem <subproblem\_id>
- Result distribution
  - SUBPROBRES - send subproblem result <subproblem\_id, subproblem\_result>
- Confirmation
  - ACKNOWL - acknowledge <previous\_package\_control\_sum>

### 4.2 Rules

# - broadcast

- #IMALIVE → NETTOPOLOGY (optional)
- #REGSUBPROB → DROPSUBPROB | SUBPROBRES
- #SUBPROBRES → ACKNOWL

### 4.3 Network scenarios

#### 4.3.1 Scenario 1

**Story:**

Agent tries to join the network right after launching Codeine.

**Prerequisites:**

- None

**Scenario:**

1. Agent broadcasts IMALIVE packet.
2. Agent waits for ??? seconds for replies from every other agent already in the network.
3. Every other agent already in the network replies with NETTOPOLOGY packet.
4. Agent registers the network. End of Scenario 1.

**Scenario extensions:**

- 3a. There is no response from the network (proceed to calculations). End of Scenario 1.

#### 4.3.2 Scenario 2

**Story:**

Agent periodically informs the network that he's still alive.

**Prerequisites:**

- Agent is already in the network

**Scenario:**

1. Agent broadcasts IMALIVE packet. End of Scenario 2.

#### 4.3.3 Scenario 3

**Story:**

Agent wants to register a subproblem

**Prerequisites:**

- Agent is already in the network

**Scenario:**

1. Agent broadcasts REGSUBPROB packet.
2. Agent starts calculations.
3. No response from network. End of Scenario 3

**Scenario extensions:**

- 3a. An agent replies with DROPSUBPROB.
  - 3a.1. Agent stops calculations.
  - 3a.2. Agent sets that subproblem's state to WIP.
  - 3a.3. Agent chooses another subproblem. Repeat from point 1. End of Scenario 3.
- 3b. An agent replies with SUBPROBRES.
  - 3b.1. Agent stops calculations.
  - 3b.2. Agent registers received subproblem result.
  - 3b.3. Agent chooses another subproblem. Repeat from point 1. End of Scenario 3.

#### 4.3.4 Scenario 4

**Story:**

Agent wants to broadcast subproblem results.

**Prerequisites:**

- Agent is already in the network
- Agent has calculated a subproblem and received a concrete result

**Scenario:**

1. Agent broadcast SUBPROBRES packet.
2. Agent waits for ??? seconds for replies.
3. Every other agent registered in his net topology base replies with ACKNOWL. End of Scenario 4.

**Scenario extensions:**

- 3a. If any agent hasn't replied with ACKNOWL, send packet SUBPROBRES again to him. Repeat ??? times.
  - 3a.1. An agent hasn't replied after ??? sent SUBPROBRES packets. Remove him from net topology base.

**4.3.5 Scenario 5****Story:**

Agent has received a SUBPROBRES packet with subproblem ID of a subproblem he already has a result of.

**Prerequisites:**

- Agent is already in the network
- Agent already has results of at least one subproblem

**Scenario:**

1. Agent received a SUBPROBRES packet.
2. Agent tries to register the subproblem result. Subproblem with that ID already has a registered result.
3. Subproblem result of received packet is ignored.
4. Reply with ACKNOWL packet. End of Scenario 5.

**4.3.6 Scenario 6****Story:**

Agent A tries to register a subproblem with ID == X. Agent B replies with STOPWIP packet. Agent A sets subproblem X's state to WIP. Agent B then disconnects.

**Prerequisites:**

- Agent is already in the network

**Scenario:**

1. Agent A broadcasts REGSUBPROB packet with subproblem ID == X.
2. Agent B replies with STOPWIP.
3. Agent A sets subproblem X's state to WIP.
4. Agent B disconnects.
5. Agent A doesn't receive IMALIVE packets from agent B for ??? minutes.
6. Agent A sets subproblem X's state to unregistered. End of Scenario 6.

**5 Computational problem**

The chosen problem is finding a hash created with SHA1 cipher corresponding to a hardcoded hash of a 6 letter password. The goal is to find hashes for all possible 6 character combinations of lower case letters and digits and compare them to the hardcoded password until the correct one is found. In the worst case scenario,  $36^6$  hashes have to be calculated.

To solve it with a decentralized computing network, it has been split into  $36^2$  subproblems, each consisting of  $36^4$  hashes to calculate. They are divided based on the first two characters, e.g. one subproblem is to find hashes of all 6 character long strings that start with "bg". Each agent can compute only one subproblem at a time.

## 6 Design Patterns

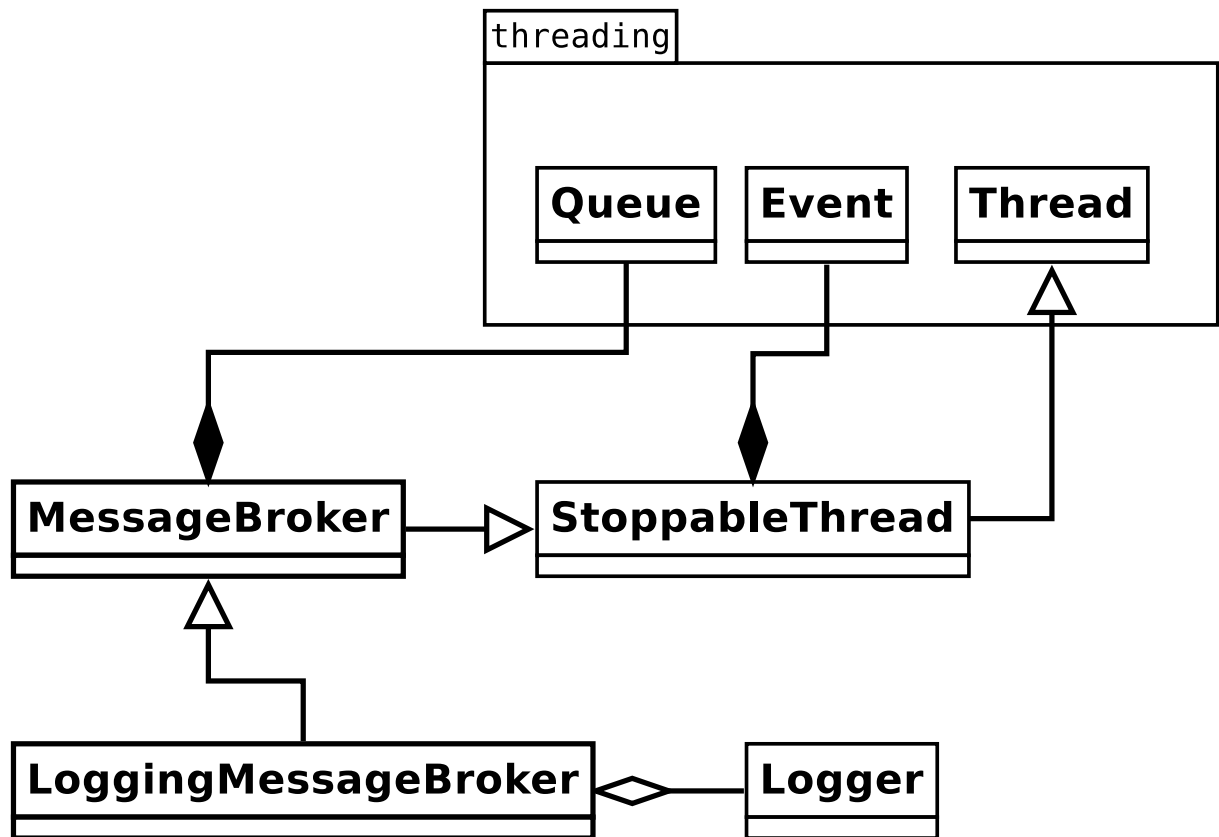


Figure 1: MessageBroker Class Diagram

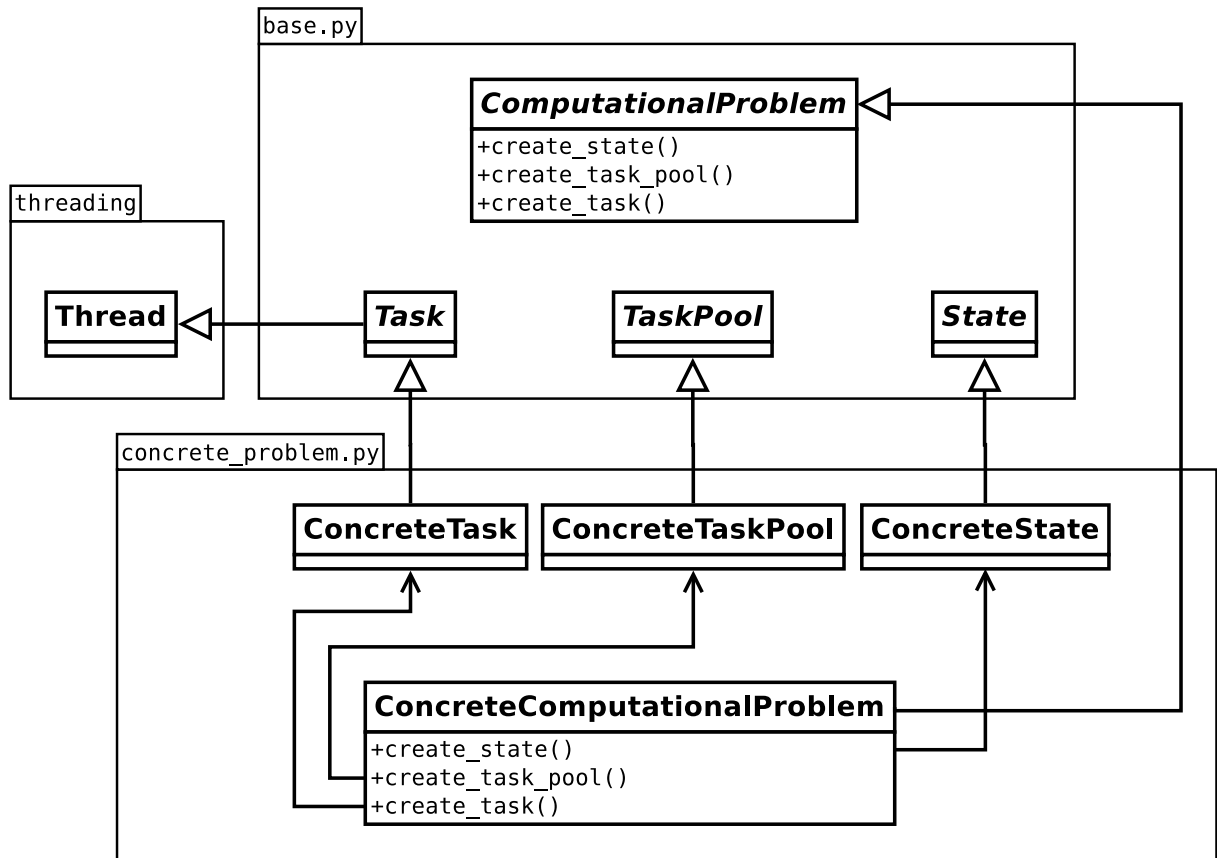


Figure 2: Computational Problem Factory Diagram

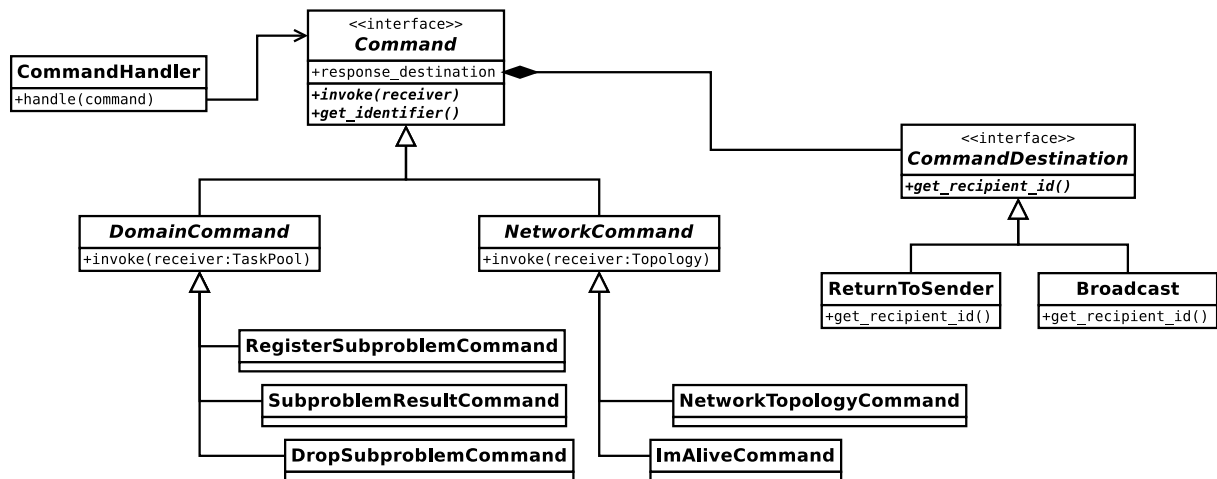


Figure 3: Command Diagram

## 7 Technology

- **Python 3.7:** Python version 3.7. introduced @dataclass, which makes it easier to work with data structures. It allows creating immutable data structures.
- **Network Communication:** transmission of data in JSON format, using UDP protocol.
- **Tkinter:** Python library Tkinter will be used to create GUI.