Digitalized Energy Systems

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Exercise sheet 1

Issuance: 23.10.2025 Submission: 05.11.2025, 23:59 Uhr

1 General Notes

- Within the scope of this exercise sheet, you will
  .. become familiar with the multi-agent framework *mango*.
  .. implement different types of agents
  .. design a multi-agent system
  .. repeat some of the foundations from the lecture
- As prerequisite for the exercises we expect that ...
  – you installed python >= 3.10
  – you should be familiar with python and asyncio

2 Recommendations

- If you have no previous experience with Python, please work through a tutorial (e.g.
  `https://www.programiz.com/python-programming` or
  `https://www.pythontutorial.net/` or
  `https://entwickler.de/machine-learning/python-tutorial-einfuehrung`)
  or work your way through a Python book (e.g. *Python 3 Crash Course: A Practical, Project-Based Programming Introduction; Mattest and Gronau; 2020; ISBN: 3864907357* or *Python 3; Steffan Kaminski; 2016; DOI: https://doi.org/10.1515/9783110473650*
- We recommend to use a virtual environment for your exercises.
- We strongly recommend getting familiar with Pythons *asyncio* library. *mango* is built on top of *asyncio* and a basic understanding of how coroutines are handled will save you many headaches from weird looking error messages.
  `https://docs.python.org/3/library/asyncio.html`
  `https://realpython.com/async-io-python/`
- Experience shows, that Windows is a difficult environment to use python on. We recommend using WSL on Windows Systems (`https://learn.microsoft.com/en-us/windows/wsl/install`)

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3 Exercise

Exercise 1:

1. Create a TCP container, then create a PrintingAgent (*mango.PrintingAgent*). The PrintingAgent will print every message it receives. **Do not** register or activate the container at this point. Now send a message to the agent. What is the console output? Why does that happen?
2. Register the PrintingAgent. Send a message to the PrintingAgent again. What is the output?
3. Activate the container. Send a message to the PrintingAgent again. What is the output?

Notes:

- You can call *send_message* directly on the container.
- Be sure that your code executes inside the asyncio event loop (*asyncio.run()*).
- Don't forget to await async function calls.

⇒**Answer/Code**

Exercise 2: Implement an agent using the mango Framework. The agent should ...

1. react on messages in a directly visible way (e.g. with printing on the console)
2. count how many messages it received
3. "know" one other agent to communicate with
4. send a message to the other agent on every message it receives until the counter reaches 10

Now, create two of these agents, that know each other and make them start their ping-pong message communication. ⇒**Code**

Exercise 3: What type of agent did you implement in exercise 2? (reflexive, deliberative, ...) ⇒**Answer**

Exercise 4: Extend your agent from exercise 2 such that they send each other the next Fibonacci-number (starting with $n = 1$). Terminate the agents when a chosen $n = N_{\mathrm{MAX}}$ is reached.

$$f_n = f_{n-1} + f_{n-2} \text{ with } f_1 = f_2 = 1 \tag{1}$$

⇒**Code**

Exercise 5: Explain the purpose of the separation of Agents and Containers in the mango framework. ⇒**Answer**

Exercise 6: The framework mango defines the lifecycle of an Agent (create, register, ...). Name and describe every step of this lifecycle and explain the purpose of each. Also, name the types of actions an Agent can start at every phase of its lifecycle. ⇒**Answer**

Exercise 7: In the lecture, you learned about reflexive agents and deliberative agents. Implement an example for each of these two types in mango. The differences between these types have to be visible in the implementation. ⇒**Code**

Exercise 8: Given two different problems:

1. There is a house with two solar panels and one energy storage; the owner solely wants to maximize the self-consumption (consumption of self-produced energy).
2. There are multiple houses with solar panels, and each wants to sell surplus energy to the energy market and maximize the profit.

Are agents a reasonable approach to these problems? And why (or why not)? ⇒**Answer**

Exercise 9: Implement a multi-agent system as a minimal conceptual showcase for one of the problems introduced in Exercise 5 (whichever you found more suitable). This showcase shall clearly show (for example, with simple print statements) how the communication/control flow could look like. Implement this showcase with a minimal amount of lines of code! ⇒**Code**

> **Hint:** We expect the code to be on a pure conceptual level. You have to show that you can identify the necessary agents and think of how the agents could work together to solve the problem. The solution to this should not actually solve the problem.

Exercise 10: In the lecture, you learned about the PEAS (performance metric, environment, actuators, and sensors) description of agents. Describe every agent of your solution for Exercise 6 following the PEAS categories. ⇒**Answer**