From Ontology to Action: Streamlining Multiagent System Development with SPADE

AI2Future

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Contents

Introduction

Introduction

Assistant Professor at the University of Zagreb Faculty of Organization and Informatics, and a member of the Artificial Intelligence Laboratory at UNIZG FOI. Main scientific interests can be found in:

- multiagent systems,
- semantic modelling,
- gamification,
- artificial intelligence,
- computer games.

Introduction

One of the teachers of the following courses in Croatian or English:

- Multiagent Systems,
- Database Theory,
- Declarative Programming,
- Introduction to Artificial Intelligence,
- Introduction to Computer Games,
- Internet Security,
- Computer Game Development Platforms.

Introduction

Engaged in international activities and promoting international relations:

- Erasmus student at Karl-Franzens University of Graz (AT),
- Erasmus intern at Jožef Stefan Institute in Ljubljana (SI),
- Erasmus+ intern at Elettra Sincrotrone in Trieste (IT),
- 3-month research stay at Universitat Politècnica de València in Valencia (ES),
- ITEC student at Centre for Development of Advanced Computing in NOIDA (IN),
- 16-month research visit at Universitat Politècnica de València in Valencia (ES),

Introduction

Publications

Project activity

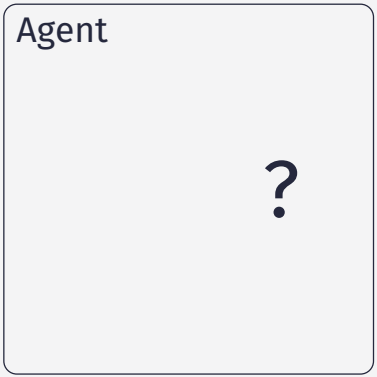
BSc and MA Mentees

Artificial Agents

Agent

Figure 1: Visual definition of an artificial agent, based on [1, p. 55]

Artificial Agents



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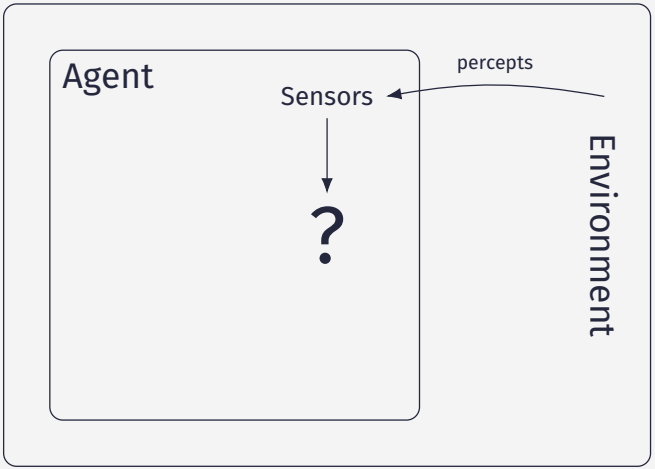

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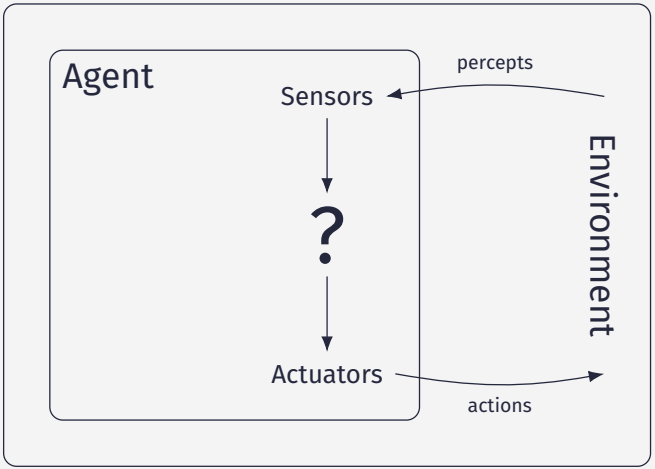

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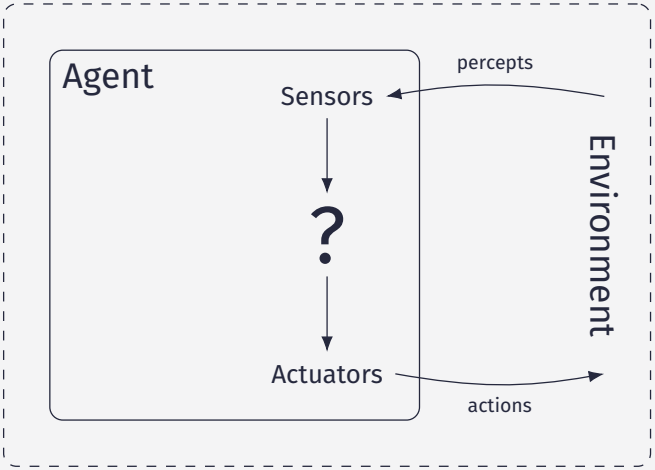

Figure 1: Visual definition of an artificial agent, based on [1, p. 55]

SPADE

Smart Python Agent Development Environment (SPADE)

```python
import spade

class DummyAgent(spade.agent.Agent):
    async def setup(self):
        print("Hello World! I'm agent {}".format(str(self.jid)))

async def main():
    dummy = DummyAgent("your_jid@your_xmpp_server", "your_password")
    await dummy.start()

if __name__ == "__main__":
    spade.run(main())
```

Listing 1: A simple SPADE agent

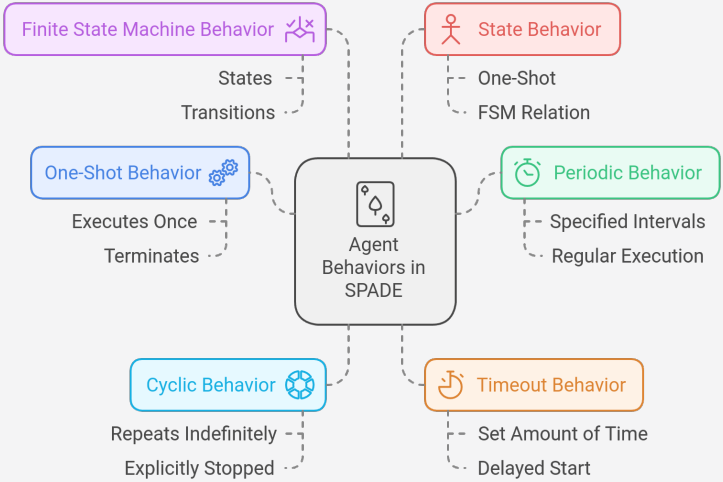

Figure 2: Types of agent behaviour in SPADE

Smart Python Agent Development Environment (SPADE)

```python
class DummyAgent(Agent):
    class MyBehav(CyclicBehaviour):
        async def on_start(self):
            print("Starting behaviour . . .")

        async def run(self):
            print("Running the behaviour . . .")

    async def setup(self):
        print("Agent starting . . .")
        b = self.MyBehav()
        self.add_behaviour(b)

async def main():
    dummy = DummyAgent("your_jid@your_xmpp_server", "your_password")
    await dummy.start()

    await wait_until_finished(dummy)
```

Listing 2: A simple SPADE agent with a simple cyclic behaviour

Smart Python Agent Development Environment (SPADE)

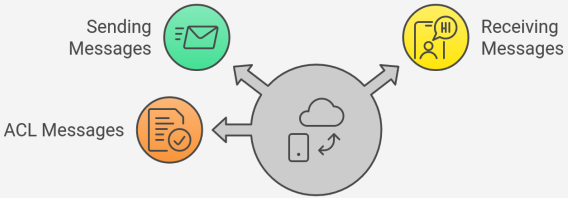

Figure 3: Features of agent communication in SPADE

Smart Python Agent Development Environment (SPADE)

```
class ReceiverAgent(Agent):
    class ReceiveBehav(OneShotBehavior):
        async def run(self):
            msg = await self.receive(timeout=10)
            if msg:
                print(f"Message received: {msg.body}")
            else:
                print("No message received.")

async def setup(self):
    print("Receiver Agent is starting...")
    self.add_behaviour(self.ReceiveBehav())
```

Listing 3: Implementing an agent that can receive messages.

Smart Python Agent Development Environment (SPADE)

```python
class SenderAgent(Agent):
    class SendBehav(OneShotBehavior):
        async def run(self):
            msg = Message(to="receiver@your_xmpp_server")
            msg.set_metadata("performative", "inform")
            msg.body = "Hello, Agent B!"
            await self.send(msg)
            print("Message sent!")

    async def setup(self):
        print("Sender Agent is starting...")
        self.add_behaviour(self.SendBehav())
```

Listing 4: Implementing an agent that can send messages.

MAGO

Developing a Framework for Agent Gamification Based on Ontologies (MAGO)

The result of a cooperation between:

- University of Zagreb Faculty of Organization and Informatics (UNIZG FOI) and
- Universitat Politècnica de València (UPV), Valencian Research Institute for Artificial Intelligence (VRAIN).

This cooperation is funded by the European Union and the Croatian Science Foundation.

Developing a Framework for Agent Gamification Based on Ontologies (MAGO)

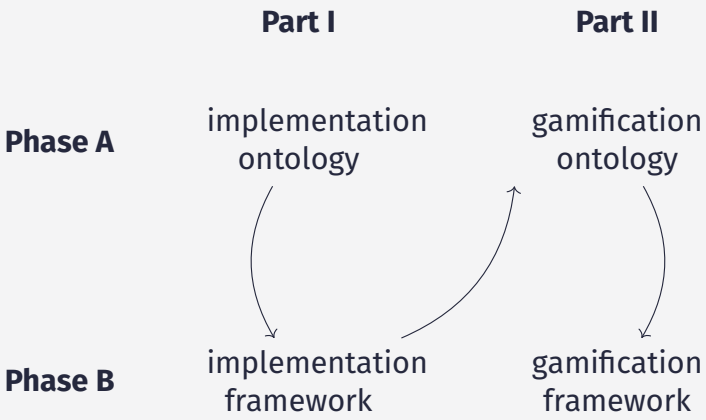

Figure 4: The flow between the parts and the phases

MAGO

MAGO-Ag Ontology

MAGO-Ag Ontology

- An ontology comprising concepts applicable to implementing multiagent systems (MASs) as intelligent virtual environments (IVEs).
- The main goal of the ontology is to enable the modelling of a multiagent system in terms of implementation possibilities.
- The ontology contains a selection of modified and enriched concepts of the MAMbO5 ontology, a result of earlier cooperation [2].
  - e.g. Agent, Behaviour, Action, Process, Objective, Artefact

MAGO-Ag Ontology

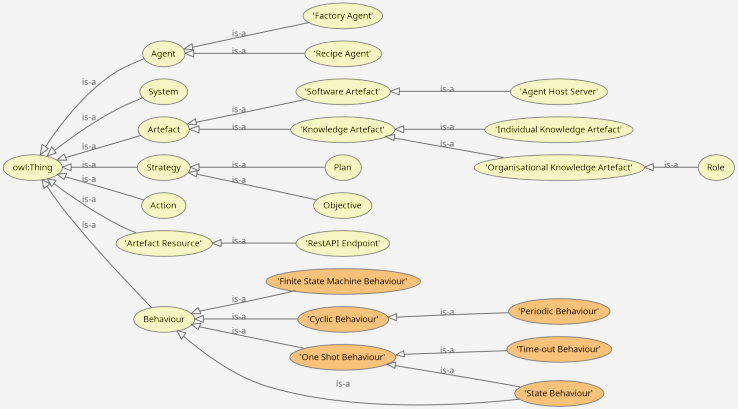

Figure 5: Visual relationship of the concepts of the MAGO-Ag ontology

MAGO

MAGO-Ag Framework

MAGO-Ag Framework

- The main objective of the MAGO-Ag framework is to translate a MAS modelled using the MAGO-Ag ontology into an implementation template for a MAS comprising SPADE agents.

MAGO-Ag Framework

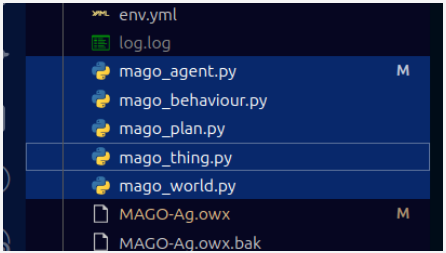

Figure 6: Essential files of the translation process

MAGO-Ag Framework

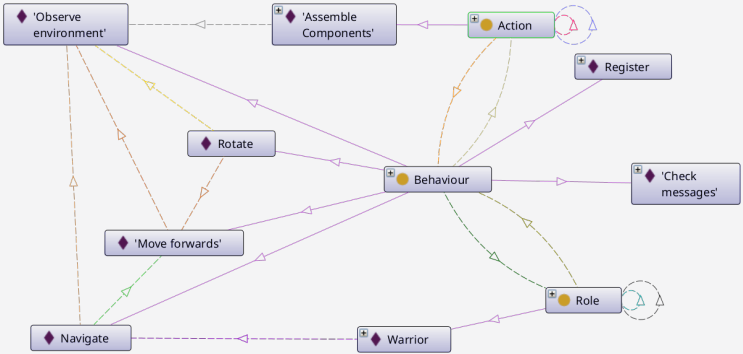

Figure 7: A selection of individuals modelling agent behaviour instance

MAGO-Ag Framework

```python
class Navigate(FSMBehaviour):

    async def on_start(self) -> None:
        print("Starting behaviour.")

    async def on_end(self) -> None:
        print("Ending behaviour.")

    async def state_setup(self):
        self.add_state(name='Observe_environment', state=Observe_environment(), initial=True)
        self.add_state(name='Move_forwards', state=Move_forwards())
        self.add_state(name='Rotate', state=Rotate())
        self.add_transition(source='Observe_environment', dest='Rotate')
        self.add_transition(source='Rotate', dest='Move_forwards')
        self.add_transition(source='Move_forwards', dest='Observe_environment')
```

Listing 5: Finite state machine behaviour implementation template with three state behaviours

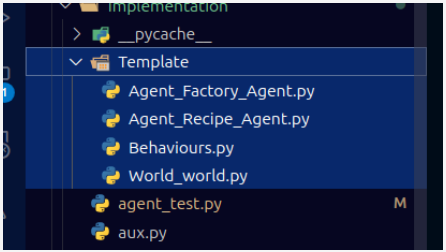

Figure 8: Generated template files for the modelled system

MAGO-Ag Framework

```
:~/$ python translate.py
. . .
:~/$ python Template/World_world.py
AgentAlice: New agent running.
AgentBravo: New agent running.
AgentClive: New agent running.
```

Listing 6: Running the translation script and the modelled system's generated implementation template

MAGO-Ag Framework

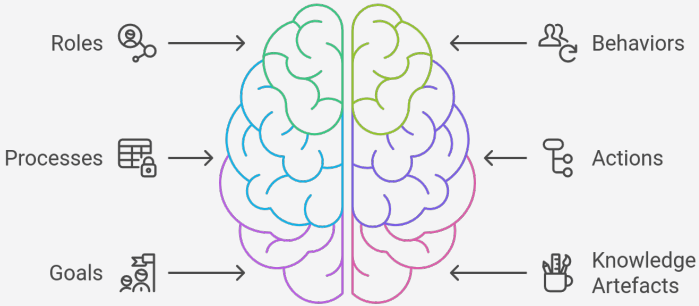

Figure 9: Pieces of knowledge available to agents after template generation

Conclusion

Conclusion

The framework, in its presented state, is a work-in-progress package.
Further improvements are seen in:

- rendering strategy-related concepts using languages that allow for reasoning;
- implementing the framework as a distributed system that would focus on deploying agent implementation templates over several workspaces;
- further testing the framework using different scenarios;
- adapting the implementation templates to different agent development frameworks.

Bibliography

Bibliography i

[1] S. J. Russell and P. Norvig, Eds., *Artificial Intelligence: A Modern Approach* (Pearson Series in Artificial Intelligence), 4th ed., in collab. with M.-w. Chang, J. Devlin, A. Dragan *et al.* Harlow, UK: Pearson Education Limited, 2022, 1166 pp., ISBN: 978-1-292-40113-3.

[2] B. Okreša Đurić, J. Rincon, C. Carrascosa, M. Schatten and V. Julian, 'MAMbO5: A new Ontology Approach for Modelling and Managing Intelligent Virtual Environments Based on Multi-Agent Systems,' *Journal of Ambient Intelligence and Humanized Computing*, vol. 10, no. 9, pp. 3629–3641, 2019, ISSN: 1868-5145. DOI: 10.1007/s12652-018-1089-4.

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