Autonomous Software Agents

lab

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Lab Introduction

In the ASA lab we will see how to:

- Implement a **BDI reasoning loop**
  (we will simulate an agent and test his behaviour)
- Implement an **Automated (AI) Planning** agent
  (we will define and run planning scenarios)
- Simulate a **Multi-Agent Environment**
  (Agents and the user interact within a shared environment)

The programming language adopted in the lab is Javascript!

Lab Project

The project consists in developing your own Smart House.

1. **Scenario definition**. House structures including rooms (kitchen, living room, …), smart devices (lights, doors, washing machine, electronic appliances,), utilities (electricity, water, …), residents behaviors/schedules.
2. **Implementation**. Simulation of the status of the house, including rooms, people and devices, where agents do control devices.
3. **Autonomous Planning**. Implementation of an agent able to autonomously planning on his own (for example, an agent controlling a robot vacuum).

Assignments

Three assignments, to be delivered during the course

- 12/04/22 A1: Scenario description
- 03/05/22 A2: Implementation of smart devices and agents
- 24/05/22 A3: Implementation of a planning agent

A final submission, in which the three assignments are composed together

- 01/06/22 Final Submission

In the final submission you will have the opportunity to refine the work you have done in previous assignments.

Calendar

05/04/22	TODAY - Smart House	
06/04/22	Reasoning about goals - part 1	
12/04/22	Javascript basics: BDI reasoning loop	**A1: Scenario description**
13/04/22	Reasoning about goals - part 2	
19/04/22	Javascript advanced: Plan execution and scenario simulation	
20/04/22	Agents interaction and communication - part 1	
26/04/22	**Supporto A2**	
27/04/22	Agents interaction and communication - part 2	
03/05/22	Automated (AI) Planning	**A2: Implementation**
04/05/22	Agent-oriented methodologies	
10/05/22	Exercises on PDDL - session 1	
11/05/22	Exercises on PDDL - session 2	
17/05/22	**Supporto A3 + Encoding/parsing PDDL**	
18/05/22	Node.js advanced: Smart devices web APIs	
24/05/22	Agent-to-device and agent-to-agent interaction	**A3: Planning agent**
25/05/22	**Supporto progetto finale**	
31/05/22		
01/06/22		**Final Submission**

Smart Home Domain

A **smart home** or **smart house** is built by domotic components connected together.

A domotic system will **monitor and control** home attributes such as lighting, climate, entertainment systems, and appliances. It may also include home security such as access control and alarm systems.

The user **interface** for control of the system uses either wall-mounted terminals, tablet or computers, a mobile phone application, or a web interface that may also be accessible off-site through the Internet.

Scenario

We have a smart house structured into **rooms** communicating through doors and disposed on different floor.

Several **smart devices** (e.g. lights and electronic appliances) are available in the house. Each has its own properties, defines an internal status and can be monitored and controlled remotely.

Devices and appliances consumes **utilities**, including electricity or water and can keep track of **supplies** (food, …).

Devices can be directly controlled by the **residents** or through a **smart agent** who redirects requests, schedules tasks, and starts scripts or set-up house devices based on the context (lunch, night, party, …), while still being responsive to residents' behaviors.

Keywords

- **Residents** can be seen as NPCs controlled by the final user (possibly through a UI) who act within the house by interact with devices or with agents;
- **Devices** are passive entities (e.g. lights), where each maintain and represent its internal status, potentially with some basic automation (e.g. dishwasher), and can be monitored and controlled remotely;
- **Agents** may control specific entities (e.g. robot vacuum) to perform operations autonomously, without the need for human intervention.
- **The House Agent** (or room-specific agents) schedule and control devices, or set-up house configurations based on the context, while still being responsive to residents' behaviors!

Example - House Rooms

House floor plans - At the ground level we have the garage, and with an independent entrance we enter the living room / kitchen . Stairs lead to the upper floor and we have two separate rooms with independent doors, bedroom and bathroom.

Garage - In the garage there is an automated swinging blind, a main light, and a wall charger for the electric car.

Kitchen - Openings includes the main entrance door, the stairs to the upper floor, and two windows with curtains. In the kitchen there is a main light plus additional separated lights above the sofa and one above the table, a dishwasher, a stovetop, a oven, a fridge, and a TV.
…
Each of the room has an independent thermostat to control the heating.
Electric solar panels are installed on the roof.

Example - Devices 1

Light - Light status is either on, off, or disconnected. Actions that can be done on the lights are turn_on and turn_off. Lights consumes 20W of electricity when switched on.

Electric car - The car in the garage has a capacity of 64KWH, and can be charged at 3.6kW or 7kW, up to 100% or 80% to preserve the battery. Status of the car includes whether the car is in the garage (car_in_garage) or not (car_not_in_garage); the charging status charging_0 or charging_3.6 or charging_7. The battery level, from 0 to 100, mapped into the following discrete states: fully_charged, half_charged or need_recharge. Action are start_slow_charge, start_fast_charge and stop_charge. Prerequisites for start_slow_charge is (car_in_garage AND (half_charged OR need_recharge))

Example - Devices 2

Solar panels - produces an average of 1,5KW during day from 8.00 to 18.00 if it is sunny and 0W at night. Status… Actions…

Fridge - Fridge maintain an overall status of supplies shortage, it can be full, half or empty. Actions that can be done include set_empty, set_full, set_half. Usually, the status of the fridge is updated automatically by the house agent. Fridge consumes an average of 10W.

Dishwasher - Status are running or off. Electricity consumption is 1000WH per washing cycle. …others…

Example - People and Agents

People - Residents in the house include Anna and Bob. People can be in one room at a time, or out of home. Anna is out-of-house from 8.00 to 18.00 monday-friday, while Bob works from 6.00 to 14.00 and he takes the car. On sunday they are usually at home while they need the car fully charged only on saturday.

Robot vacuum agent - The robot is able to autonomously move among all the rooms through doors and stairs and clean them daily.

Door agent - locks the doors at night.

Example - House Agents

House agent - assist residents by taking autonomous decisions, while still being responsive to residents' behaviors.

1. Switch on the lights when people enter in a room;
2. Send notification in the case of short supplies;
3. In case of unexpected people visiting outside scheduled timetable, turns on the heating by overriding the thermostat;
4. …

Assignment 1

Assignment 1 consists in the definition of the scenario:

1. Define **house floor plans** including rooms (at least 4) (living room, garage, …) and their disposition with respect to floors and communicating doors;
2. Define smart **devices** in each room (e.g. lights, smart doors, washing machine, electronic appliances, …) and their internal status representation (e.g. on/off, started/working/end, moving/charging);
3. Define **utilities** (e.g. electricity, water) and how these are consumed by electronic appliances; and **supplies** (e.g. food), and how these may be consumed/bought on a daily or weekly schedule, or on the basis of an event;
4. Define smart agents and automation procedures, including triggering events, constraints, schedules, and house set-up configuration.

A template document will be provided for the assignment!

Submission Of Assignment 1

Here is the online form for the submission of A1:
https://forms.gle/L9ozfX1nkTPR6PgV7

- Name
- Surname
- Student code
- Attach .pdf document

Submission deadline is the 12/04/2022 at midnight!

Good Work!

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