Final Project

Autonomous Software Agents - UniTn 2021/2022

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1 Introduction

The goal of this project is to simulate the behavior of a hypothetical smart home. The proposed scenario envisages the presence of two residents inside the home, who can roam the two floors of the building, using the goods and services arranged in the appropriate rooms.

There is a main house agent (*HouseAgent*) who knows everything that happens inside the dwelling. Thanks to this, it is possible to inform the agent responsible for the control of the lights (namely the *LightsAgent*).

To track the consumption of resources and carry on the automatic switching of operations, there is agent in control of the boiler (*BoilerAgent*), which manages water heating operations according to user needs.

As regards watering the plants inside the home, two supervisory agents monitor their status and take care of their due maintenance. Further details are available in section 2.4.2.

2 House description and blueprint

The house is a two story building.

The ground floor is depicted in Fig. 1, and consists of six rooms: the lobby, a spiral stairs room, an open-space composed of a living and a kitchen room, a laundry room and a bathroom. The entrance of the household is located in the bottom-right corner in the picture, and leads directly to the atrium. From this lobby room, a small door leads to the living and kitchen areas, while a double door provides access to the spiral staircase room, where there is a small workstation with a PC. The laundry or boiler room is adjacent to the kitchen and provides access to the bathroom. Moreover, the first floor contains all the conveniences, electrical and mobile utilities, including the lighting system and a general electrical panel which relays/contactors and energy usage information can be monitored by the home agent. Electrical appliances include an air-conditioner unit, a dishwasher, a fridge, an induction stove, an oven, a washing machine and a dryer.

The first floor is shown in Fig. 2 and makes accommodation for a master and a small bedroom, along with a private bathroom, a living and a drawer room right in-between, for a total of five rooms. After the spiral staircase, there is an upper-floor living area. The latter provides the transition to

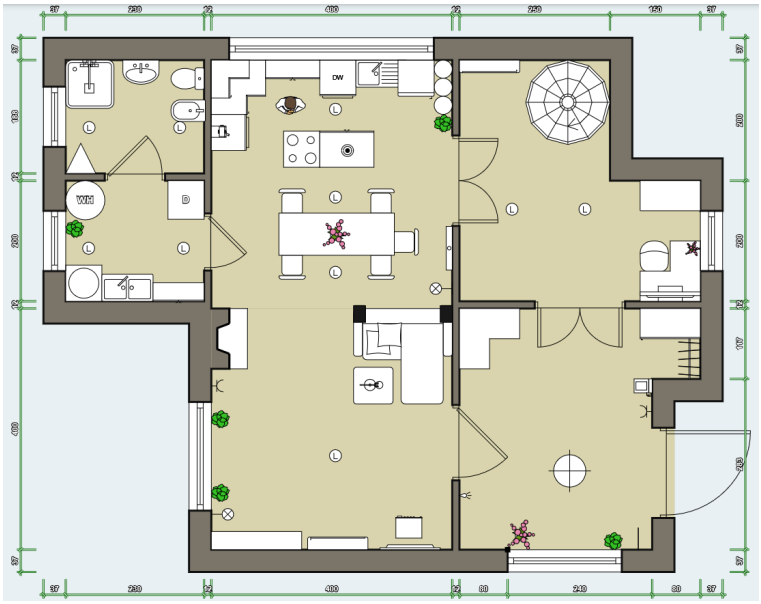

Figure 1: Ground floor layout.

a single bedroom, inside which there is a computer workstation. Then, there is a storage/wardrobe room, which interrupts the living area from the double bedroom and the private bathroom. Also on the second floor there is a lighting system for each room, and it is wired to the general electrical panel of the lower floor. Here too there is the possibility of using the air conditioning system.

2.1 Rooms

The house has a solar and photovoltaic system, with the relative energy accumulators, plus it is connected to the electricity grid. On top, it is thermally insulated by means of a resistant barrier which inhibits the exchange of thermal energy into and out of the house. This allows air conditioners installed in specific points of the house to cool, heat or simply ventilate the rooms according to the users' wishes.

In order to warm the environments, an underfloor heating system is installed.

In the bathrooms, devices are installed that allow excess humidity to escape, and are represented by the triangular symbol in fig. 1 and fig. 2.

Moreover, a presence sensor installed for each room of the house checks whether the residents are inside a given room or not, which is especially useful to toggle the lights and air-con systems all around the house.

The lighting system, shutters, temperature control and ventilation are managed on a room-by-room basis by the house agent, who is in control of the general electrical panel.

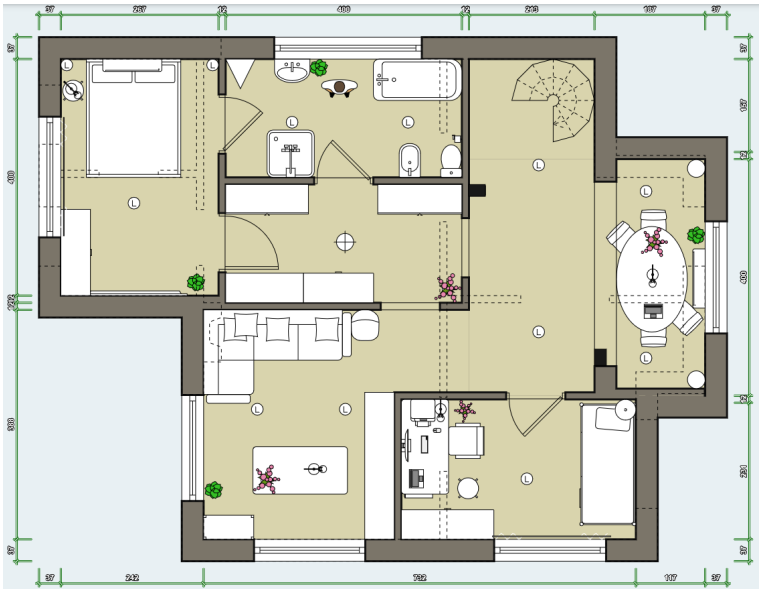

Figure 2: First floor layout.

2.1.1 Lobby

Inside the lobby there is the general electrical panel, inside which there are all the devices for monitoring the amount of energy that is consumed by each of the other rooms. In addition to this, from the panel it is possible to control all the light points in the house, as well as the electrical appliances and sockets.

2.1.2 Spiral Stairs Room

In this environment there are respectively a PC station, a chest, an air conditioner mini-split and finally obviously the spiral staircases.

2.1.3 Ground floor living

In the living area on the ground floor there is a TV which is positioned in line with the sofa with peninsula and is perpendicular to the light source. Next to the window is a plant, shelves and a fireplace. To aerate the open space room, an air conditioner is positioned on the wall parallel to the television.

2.1.4 Kitchen

The kitchen contains all the domestic equipment that may be needed, such as an electric oven, a dishwasher and a refrigerator. The induction hob is positioned as an island in the middle of the kitchen, alongside a worktop on which food can be prepared. Shelves, cupboards, bins for recycling, sink, a table and some chairs complete the furnishings.

2.1.5 Laundry Room

The boiler or laundry room is equipped with everything needed to clean and dry clothes , a double sink and a unit to heat the water and supply it throughout the housing complex.

2.1.6 Bathroom

This room houses a toilet, a bidet, a wash basin, and a shower. Air exchange and mold prevention is taken into consideration, and excess humidity is disposed of by a mechanical ventilation system (represented by the triangle symbol in that room).

2.1.7 Master Bedroom

The double room has space for a wardrobe and a wall-mounted TV. In addition, it has air conditioning. The private bathroom and the closet of the other wardrobes are accessible from this room.

2.1.8 Small Bedroom

The single bedroom is designed for geeks, so there is a PC workstation, a portable laptop, and other computer equipment available.

2.1.9 Private Bathroom

The en-suite bathroom also contains a toilet, bidet, shower and basin, but unlike the ground floor bathroom there is a bathtub available here. Here too, excess humidity is removed thanks to the ventilation system represented by the triangular symbol.

2.1.10 First floor living

From the spiral stairs it is possible to reach the living room on the upper floor. Here there are two main living areas, the first of which has an oval table with chairs welcoming the residents, and is designed for studying or working. Further on, the second living space offers the comfort of a sofa with peninsula and an armchair, all of which is illuminated by the windows placed on both perpendicular walls.

2.1.11 Drawer Room

The utility room or drawer room is located centrally with respect to the plan of the upper floor. All the shelves, furniture and anything else you want to store are housed here, and it is a room designed to store commonly used clothes, objects or documents.

2.2 Devices

The miscellaneous devices found within the home will be described below.

2.2.1 Solar and Photovoltaic Panels

The production of electricity and heat energy is entrusted to photovoltaic and solar panels. Suppose we have available a maximum solar production capacity of 2kWp, while the part of energy produced by photovoltaic is present, but is only partially taken into account for this project.

With reference to table 1, the mathematical formula that describes the behavior of the energy is given in eq. (1).

$$Heat\_Energy(t) = \left\{ \begin{array}{ll} 1000W, & \text{if } 08:00 \leqslant t \leqslant 10:00 \\ 2000W, & \text{if } 10:00 \leqslant t \leqslant 15:00 \\ 1000W, & \text{if } 15:00 \leqslant t \leqslant 20:00 \\ 0W, elsewhere & \end{array} \right\} \tag{1}$$

Statuses

Being a passive element of the system, it is always engaged.

Actions

- get_energy()

2.2.2 Light System

Each room has its own lighting system. Since the user Simone in the house is quite demanding and always wants to have as much light as possible, the lights in the house always light up when a person enters a room, regardless of whether it is day or night.

Statuses

- lights_on
- lights_off

Actions

- lightSys_on()
  - Prerequisites: lights_off AND user_in_room
- lightSys_off()
  - Prerequisites: lights_on AND not user_in_room
- compute_power()

2.2.3 Temperature regulator

The regulation of the temperature in the house can be carried out in different ways and according to the needs of the residents. The only caution required by the user is to start the regulator by setting the desired temperature.

For example, some rooms can take advantage of the possibility of having their own temperature regulated by mini-splits. In this case the user does not have to worry about anything: the system will manage the power to reach that set-point based on the amount of energy accumulated or on

solar lighting available; obviously it is cheaper to use the energy produced by panels rather than to buy from the national grid.

Another example is underfloor heating: in this case, the boiler system will be used to produce the required amount of hot water to flow through the piping system. When in use, the underfloor heating will draw hot water from the boiler and cools the water by 10°C for every hour of operation.

Statuses These states are redundant, and are inverses of each other. You could use just one state and deny it if necessary.

- regulator_on
- regulator_off

Actions

- switch_on()
  - Prerequisites: regulator_off
- switch_off()
  - Prerequisites: regulator_on
- compute_power()

2.2.4 Boiler

Hot water in the house is obtained from the boiler/laundry department and kitchen, where a couple of boilers is installed. It switches its functions based on the demand for water from the users and the presence of solar lighting of the panels. If there is no sunlight, the boiler will heat the water using methane gas as a resource.

Statuses

- warming_methane : warms up with natural resources.
- warming_energy : warms up with solar panels.
- warming_off : shutdown warming during summer.

Actions

- use_methane()
  - Prerequisites: energy_production $\simeq 0$ AND warming_off
- use_energy()
  - Prerequisites: energy_production > 0 AND warming_off
- shutdown_boiler()
  - Prerequisites: not warming_off
- compute_power()

2.2.5 Presence Sensor

For each environment, a system of presence sensor devices is installed which detects the presence or absence of users accurately within the room. They are used to send information messages to turn the lights on or off, or to start the climate.

Statuses These statuses are redundant, and are inverses of each other. You could use just one status and deny it if necessary.

- in_room: there is a user in the room.
- is_empty: no user is in the room.

2.2.6 Utilities

These are domestic appliances that can consume the water heated by the boiler: the sous vide system for cooking food, the dishwasher, the washing machine, and so on.

If the residents are at home, every day they cook a sous vide meal for the next day, which cools the water by around 5 degrees each day.

The laundry, dishwasher and showers take a constant rate of heating energy consumption, and they cool the water by 20 degrees every day.

Statuses Since these utilities are in constant use every day, and their usage is necessary every day, they are considered to be always on, hence no status is needed.

Actions

- compute_power()

2.2.7 Sprinkler Robots

Two watering robots are set up for this project, one for each floor. Their base-station is respectively in the lobby for the robot on the lower floor, and in the living area for the robot on the upper floor. A more accurate description can be found in section 2.4.2.

2.3 Metrics

2.3.1 Solar System for Water Heating

Although it is assumed that photovoltaic panels dedicated exclusively to the production of energy are installed, there are also solar panels that are responsible for converting the energy produced for water heating. Therefore, the production of the solar part is used directly in the electric water heater or boiler, that is located in the laundry room.

It is estimated that it takes around 4200 Joules to heat 1 Litre of water by 1 Degree Centigrade. Of course, a Watt is equal to 1 Joule per second. Say that the solar panels installed can produce up to 2000 Watts of energy. Let's suppose to have 1 Liter of tap water at 10°C, then to heat that amount up to 70°C then it would take 126 Seconds to reach that temperature, following eq. (2) ad eq. (3).

$$JoulesRequired = 4200 * (BoilerCapacity[L]) * (\Delta Temperature[^{\circ}C]) \tag{2}$$

Time Interval	08:00 - 10:00	10:00 - 15:00	15:00 - 20:00
Energy Production [W]	1000	2000	1000

Table 1: Solar system energy production throughout the day.

Ground Floor			
Room	Time (mins)	Water needed (L)	Amount of Charge (%)
Lobby	20	2	10
Stairs Room	10	1	5
Living	30	3	15
Kitchen	20	2	10
Laundry	10	1	5
Bathroom	0	0	0

Table 2: Resources used by the robot on the ground floor when deployed.

$$Time = \frac{JoulesRequired}{SolarEnergy[W]} \tag{3}$$

For a pair of residents, considering the fact that the house could be heated in the winter months using the solar system in part, then the capacity of the water tank could be around 300 litres. So, to kick-start the boiler from 10°C to 70°C, the system takes 10.5 Hours, as in eq. (4):

$$Time = \frac{4200 * 300[L] * 60[\Delta T]}{2000[W]} = 10.5[Hours] \tag{4}$$

The solar energy amount though is not constant during the day. To simplify the problem, it is assumed that the amount of energy produced varies according to the table table 1.

2.3.2 Sparkling Time

Each room requires special precautions in terms of irrigation, water absorption and dosage relative to the plants. Therefore, the report in terms of working time for each chamber for a robot is available in both table 2 and table 3. In some way, it could be also possible to keep track of measures of the consumed energy by the sprinklers, for example by incorporating other predicates and other ad-hoc actions which assert a predicate "quantity_X" to false in order to set a predicate "quantity_Y" to true. Though, this path is not implemented for the sake of simplicity.

2.4 People and Agents

2.4.1 People

This housing complex is designed to give space to three people. However, the house is currently inhabited by two people, namely Simone and Marianna, and the third is postponed in view of a future baby expectancy.

Both of the residents are employed in smart-working type of jobs, so it is up to them to decide whenever go to the office and when to work from home. Though, The complete sequence of actions that takes place in the simulation is right available in the beginning lines of the HouseWorld.js file.

First Floor			
Room	Time (mins)	Water needed (L)	Amount of Charge (%)
Master Bedroom	10	1	5
Small Bedroom	10	1	5
Private Bathroom	10	1	5
Living	40	4	30
Drawer	10	1	5

Table 3: Resources used by the robot on the first floor when deployed.

They both usually spend the weekend away from home, except when there is a particular race weekend involving Formula 1 or MotoGP grand prixes.

2.4.2 Agents

1. **Robot Sprinkler**

   Since there are a lot of plants scattered throughout the home, their care is entrusted to an agent who monitors their condition and waters them when the need arises. For the sake of simplicity it is assumed that each floor has an independent sprinkler robot, which moves only for its respective floor. As stated earlier in this document, their base-station is respectively in the lobby for the robot on the lower floor, and in the living area for the robot on the upper floor. Of course, before moving for performing a task, the robot should have both the batteries and the water system charged.

   Actions

   The house agent takes care of managing all the actions related to the behavior of the robots, so that the latter only have to think about the actual practice of the decision-making choices by the former. This is a matter of simplicity: what happens inside the room modifies the house agent's belief status, which in turn informs the other agents as well. In addition, in doing so the home agent becomes the central pivot on which all decision-making and practical processes rotate: he is aware of all the information, and in doing so it is easier to guarantee the correct management of the domotic home.

   - **Move**: Allows the robot to move from one room to another. When this manoeuvre is performed, it is of course assumed that the robot is not at its charging point.
     - Parameters:
       - ⋆ *room1* - Current room where the robot is.
       - ⋆ *room2* - Future room where the robot will be.
       - ⋆ *robot* - Agent to move, i.e. the Robot sprinkler.
       - ⋆ *charge_point* - The robot's own charging point.
     - Duration: 1 minute.
     - Precondition:
       - ⋆ is_in_current robot room1.
       - ⋆ is_room_adjacent room1 room2.
       - ⋆ is_room room1.

    - ⋆ is_room room2.
    - ⋆ is_robot robot.
    - ⋆ is_charge_point charge_point.
  - Effects:
    - ⋆ not is_in_current robot room1.
    - ⋆ is_in_current robot room2.
    - ⋆ not is_in_charge_point charge_point robot.
- **Sprinkle**: The robot refreshes all the plants within its current room location.
  - Parameters:
    - ⋆ *robot* - Sprinkler Robot
    - ⋆ *charge_point* - Robot's charging point.
    - ⋆ *room* - Current room where the robot is.
  - Duration: 30 minutes.
  - Precondition:
    - ⋆ is_in_current robot room1.
    - ⋆ needs_water room.
    - ⋆ is_room room.
    - ⋆ is_robot robot.
  - Effects:
    - ⋆ not needs_water room.
- **Recharge**: Calls the agent back to the charging station.
  - Parameters:
    - ⋆ *room* - Specific room where both the robot and the charging station are.
    - ⋆ *robot* - Agent to move, i.e. the Robot sprinkler.
    - ⋆ *charge_point* - The robot's own charging point.
  - Duration: 10 minutes.
  - Precondition:
    - ⋆ is_in_current robot room1.
    - ⋆ charge_point_in_room charge_point room.
    - ⋆ not is_in_charge_point charge_point robot.
    - ⋆ is_room room
    - ⋆ is_robot robot
    - ⋆ is_charge_point charge_point
  - Effects:
    - ⋆ is_in_charge_point charge_point robot.

Behavior For the sake of simplicity, it is assumed that there are two robots, each placed on each floor. Their goal is simple: when the residents aren't at home, it's up to them to take care of the plants. This basically happens when both Marianna and Simone have to go to the office for work reasons, or when there is a weekend with no races to watch.

2. **Light System**

   The house agent supplies all the information to the lighting system: the amount of light hitting the photovoltaic panels and the presence of a user in a room. All of this is what the lighting agent needs to turn the lighting systems on or off throughout the building.

   Behavior Whenever the presence of a user is perceived in an environment, the lighting system is activated.

3. **House Agent**

   As already explained, the house agent is responsible for the centralized monitoring of all inputs and outputs of the residence. It propagates all the necessary information to the other devices that are placed in the housing complex. In addition, it can establish the presence or absence of a user inside a room thanks to communication with a detection system. Besides that, it develops communication with irrigation robots, allowing them to plan their activities. Lastly, it activates or deactivates the lighting system of the respective rooms, receives information on the user's temperature setpoints to regulate the climate, ventilate the rooms, vent excess humidity, and monitor how much energy is produced by the solar system on the roof.

4. **Planning Agent**

   Domain

   The easiest way to encode the domain problem is through the use of predicates that identifies a specific task as regards for rooms, robots and charging points. Hence, for example, for the first robotic agent the following domain is produced:

```
;; domain file: domain-robot1.pddl
(define (domain robot1)
    (:requirements :strips)
    (:predicates
        (is_in_current ?robot ?room1)
        (is_adjacent ?room1 ?room2)
        (is_in_charge_point ?charge_point ?robot)
        (needs_water ?room)
        (chargePoint_in_room ?charge_point ?room)
    )

        (:action Move
            :parameters (?robot ?room1 ?room2 ?charge_point)
            :precondition (and
                (is_in_current ?robot ?room1)
                (is_adjacent ?room1 ?room2)
            )
            :effect (and
                (not (is_in_current ?robot ?room1))
                (is_in_current ?robot ?room2)
                (not (is_in_charge_point ?charge_point ?robot))
            )
```

```
        )

        (:action Sprinkle
            :parameters (?room ?robot)
            :precondition (and
                (is_in_current ?robot ?room)
                (needs_water ?room)
            )
            :effect (and
                (not (needs_water ?room))
            )
        )

        (:action Recharge
            :parameters (?robot ?charge_point ?room)
            :precondition (and
                (is_in_current ?robot ?room)
                (chargePoint_in_room ?charge_point ?room)
                (not (is_in_charge_point ?charge_point ?robot))
            )
            :effect (and
                (is_in_charge_point ?charge_point ?robot)
            )
        )
)
```

Of course, both robots have a similar domain.

Problem

Every bit of useful information about the surrounding environment is put here. Again, only the version of the problem for the first robot will be shown hereinafter (but the same goes on for the second agent). Again, goals and adjacency conditions could be modified to make the robots perform different operations in the problem.

```
;; problem file: problem-robot1.pddl
(define (problem robot1)
    (:domain robot1)
    (:objects
    lobby
    stairs
    groundLiving
    kitchen
    laundry
    groundBathroom
    masterBedroom
```

```
    privateBathroom
    drawer
    smallBedroom
    firstLiving
    charge_point2
    charge_point1
    robot2
    robot1)

(:init
    ;; Rooms adjacency information:
    (is_adjacent lobby stairs)
    (is_adjacent lobby groundLiving)
    (is_adjacent stairs lobby)
    (is_adjacent stairs kitchen)
    (is_adjacent groundLiving lobby)
    (is_adjacent groundLiving kitchen)
    (is_adjacent kitchen groundLiving)
    (is_adjacent kitchen stairs)
    (is_adjacent kitchen laundry)
    (is_adjacent laundry groundBathroom)
    (is_adjacent laundry kitchen)
    (is_adjacent groundBathroom laundry)
    (is_adjacent masterBedroom privateBathroom)
    (is_adjacent masterBedroom drawer)
    (is_adjacent smallBedroom firstLiving)
    (is_adjacent privateBathroom drawer)
    (is_adjacent privateBathroom masterBedroom)
    (is_adjacent firstLiving smallBedroom)
    (is_adjacent firstLiving drawer)
    (is_adjacent drawer masterBedroom)
    (is_adjacent drawer firstLiving)
    (is_adjacent drawer privateBathroom)

    ;; Robots' charging point spawn:
    (chargePoint_in_room charge_point2 firstLiving)
    (chargePoint_in_room charge_point1 lobby)

    ;; Robots' current information:
    (is_in_current robot2 firstLiving)
    (is_in_current robot1 lobby)
    (is_in_charge_point charge_point2 robot2)
    (is_in_charge_point charge_point1 robot1)

    ;; Robots' tasks:
    (needs_water lobby)
```

```
    (needs_water stairs)
    (needs_water groundLiving)
    (needs_water kitchen)
    (needs_water laundry)
    (needs_water groundBathroom)
    (needs_water masterBedroom)
    (needs_water smallBedroom)
    (needs_water privateBathroom)
    (needs_water firstLiving)
    (needs_water drawer))

(:goal
    (and (not (needs_water lobby))
    (not (needs_water stairs))
    (not (needs_water groundLiving))
    (not (needs_water kitchen))
    (not (needs_water laundry))
    (is_in_charge_point charge_point1 robot1)))
)
```

Plan

A solution to the problem if the robot1 spawns in the lobby room is reported below.

```
    -(sprinkle lobby robot1)
    -(move robot1 lobby stairs robot1)
    -(sprinkle stairs robot1)
    -(move robot1 stairs kitchen robot1)
    -(sprinkle kitchen robot1)
    -(move robot1 kitchen groundLiving robot1)
    -(sprinkle groundLiving robot1)
    -(move robot1 groundLiving kitchen robot1)
    -(move robot1 kitchen laundry robot1)
    -(sprinkle laundry robot1)
```

Instead, if robot1 is placed in the laundry room (and line 376 in the code is commented):

```
    -(sprinkle laundry robot1)
    -(move robot1 laundry kitchen robot1)
    -(sprinkle kitchen robot1)
    -(move robot1 kitchen groundLiving robot1)
    -(sprinkle groundLiving robot1)
    -(move robot1 groundLiving lobby robot1)
    -(sprinkle lobby robot1)
    -(recharge robot1 charge_point1 lobby)
    -(move robot1 lobby stairs robot1)
    -(sprinkle stairs robot1)
```

These plans can be confirmed by running the code and putting the domain and problem files in the online planner.

3 Implementations

3.1 Presence Sensor and Perceptions

The knowledge of the users' presence in an environment is provided by the group of sensors installed room by room.

The information propagates from the agent who takes charge of the presence acquisition system (namely the *PresenceSensorAgent*) towards the house, which will then re-propagate the information to the other agents (*LightAgent).* At first, how the various rooms are arranged with each other, what devices they have, and their states are known. When the sensors sense the presence of a user, they communicate a new belief to the home.

3.2 Agents in shared environment

Each room has a lighting system, while the kitchen and boiler room have boilers and other utilities.

Of course, The lights are triggered by the *LightAgent* by means of a change of state provided by the *PresenceSensorAgent*.

The *BoilerAgent* is activated in various ways depending on the production of energy by solar panels.

Thousands of examples could also be implemented using the combination of *PresenceSensor-Agent* and *PhotovoltaicPanel*, but to lighten the code it was left out, as it was a copy and paste matter.

The house can be navigated not only by users, whose presence is perceived, but also by robots who have the task of watering the various flowers in the rooms. The latter are the only agents defined by actions, preconditions and effects in terms of planning. The preconditions are assumed through the use of beliefs, while whenever the robot performs an action, it is then up to the house to update the environment status.

For a complete list of house actions, check out the HouseAgent.js file.

3.3 Agent interaction and coordination

The duty of each agent is independent of the other, with the exception of the house agent. All information goes through the house agent which will then take the matching actions.

3.4 Scenarios

For this project, a routine has been defined, which provides for the same actions for the first 5 consecutive days, starting from a hypothetical Monday. Then, to simulate the weekend, the remaining days are entered. In detail, the scenario foresees that users move inside or outside the house (they go away for the weekend).

Whenever a resident passes from one room to another, the sensor receives the information, passes it on to the home agent, who in turn takes the necessary actions and informs the other agents.

Each agent's intentions are assigned at the beginning of the program simulation run.

If a plan for the robot sprinklers cannot be found, more attempts will be made. Instead, the other agents will continue to function based on their state of beliefs.

To run the code, the easiest way is to open the entire VSCode folder, and write the following commands in the terminal:

- `npm install`
- `node ./src/houseworld/HouseWorld.js`

The simulation log is shown below, although it was copied in two steps as lines in terminal history were not enough:

```
node ./src/houseworld/HouseWorld.js
robot1                          Trying to use intention RetryIntention to achieve goal {RetryGoal#1:
robot1>RetryIntention#0         Intention started
robot1                          Trying to use intention OnlinePlanning to achieve goal PddlGoal#0 goa
robot1>OnlinePlanning#1         Intention started
robot2                          Trying to use intention RetryIntention to achieve goal {RetryGoal#3:
robot2>RetryIntention#2         Intention started
robot2                          Trying to use intention OnlinePlanning to achieve goal PddlGoal#2 goa
robot2>OnlinePlanning#3         Intention started
lightAgent                      Trying to use intention LightsIntention to achieve goal {LightsGoal#4
lightAgent>LightsIntention#4    Intention started
boilerAgent                     Trying to use intention BoilersIntention to achieve goal {BoilersGoal
boilerAgent>BoilersIntention#5 Intention started
house                           Trying to use intention SensorPresenceIntention to achieve goal {Sens
house>SensorPresenceIntention#6 Intention started
house                           Trying to use intention HouseIntention to achieve goal {HouseGoal#7:
house>HouseIntention#7          Intention started
house                           Belief changed: is_adjacent lobby stairs
house                           Belief changed: is_adjacent lobby groundLiving
house                           Belief changed: is_adjacent stairs lobby
house                           Belief changed: is_adjacent stairs kitchen
house                           Belief changed: is_adjacent groundLiving lobby
house                           Belief changed: is_adjacent groundLiving kitchen
house                           Belief changed: is_adjacent kitchen groundLiving
house                           Belief changed: is_adjacent kitchen stairs
house                           Belief changed: is_adjacent kitchen laundry
house                           Belief changed: is_adjacent laundry groundBathroom
house                           Belief changed: is_adjacent laundry kitchen
house                           Belief changed: is_adjacent groundBathroom laundry
house                           Belief changed: is_adjacent masterBedroom privateBathroom
house                           Belief changed: is_adjacent masterBedroom drawer
house                           Belief changed: is_adjacent smallBedroom firstLiving
house                           Belief changed: is_adjacent privateBathroom drawer
```

```
house                          Belief changed: is_adjacent privateBathroom masterBedroom
house                          Belief changed: is_adjacent firstLiving smallBedroom
house                          Belief changed: is_adjacent firstLiving drawer
house                          Belief changed: is_adjacent drawer masterBedroom
house                          Belief changed: is_adjacent drawer firstLiving
house                          Belief changed: is_adjacent drawer privateBathroom
house                          Belief changed: chargePoint_in_room charge_point2 firstLiving
house                          Belief changed: chargePoint_in_room charge_point1 lobby
house                          Belief changed: is_in_current robot2 firstLiving
house                          Belief changed: is_in_current robot1 lobby
house                          Belief changed: is_in_charge_point charge_point2 robot2
house                          Belief changed: is_in_charge_point charge_point1 robot1
house                          Belief changed: needs_water lobby
house                          Belief changed: needs_water stairs
house                          Belief changed: needs_water groundLiving
house                          Belief changed: needs_water kitchen
house                          Belief changed: needs_water laundry
house                          Belief changed: needs_water groundBathroom
house                          Belief changed: needs_water masterBedroom
house                          Belief changed: needs_water smallBedroom
house                          Belief changed: needs_water privateBathroom
house                          Belief changed: needs_water firstLiving
house                          Belief changed: needs_water drawer
house                          Belief changed: is_empty lobby
house                          Belief changed: is_empty stairs
house                          Belief changed: is_empty groundLiving
house                          Belief changed: is_empty kitchen
house                          Belief changed: is_empty laundry
house                          Belief changed: is_empty groundBathroom
house                          Belief changed: is_empty masterBedroom
house                          Belief changed: is_empty smallBedroom
house                          Belief changed: is_empty privateBathroom
house                          Belief changed: is_empty firstLiving
house                          Belief changed: is_empty drawer
robot1                         Belief changed: is_adjacent lobby stairs
robot2                         Belief changed: is_adjacent lobby stairs
robot1                         Belief changed: is_adjacent lobby groundLiving
robot2                         Belief changed: is_adjacent lobby groundLiving
robot1                         Belief changed: is_adjacent stairs lobby
robot2                         Belief changed: is_adjacent stairs lobby
robot1                         Belief changed: is_adjacent stairs kitchen
robot2                         Belief changed: is_adjacent stairs kitchen
robot1                         Belief changed: is_adjacent groundLiving lobby
robot2                         Belief changed: is_adjacent groundLiving lobby
robot1                         Belief changed: is_adjacent groundLiving kitchen
robot2                         Belief changed: is_adjacent groundLiving kitchen
```

```
robot1                          Belief changed: is_adjacent kitchen groundLiving
robot2                          Belief changed: is_adjacent kitchen groundLiving
robot1                          Belief changed: is_adjacent kitchen stairs
robot2                          Belief changed: is_adjacent kitchen stairs
robot1                          Belief changed: is_adjacent kitchen laundry
robot2                          Belief changed: is_adjacent kitchen laundry
robot1                          Belief changed: is_adjacent laundry groundBathroom
robot2                          Belief changed: is_adjacent laundry groundBathroom
robot1                          Belief changed: is_adjacent laundry kitchen
robot2                          Belief changed: is_adjacent laundry kitchen
robot1                          Belief changed: is_adjacent groundBathroom laundry
robot2                          Belief changed: is_adjacent groundBathroom laundry
robot1                          Belief changed: is_adjacent masterBedroom privateBathroom
robot2                          Belief changed: is_adjacent masterBedroom privateBathroom
robot1                          Belief changed: is_adjacent masterBedroom drawer
robot2                          Belief changed: is_adjacent masterBedroom drawer
robot1                          Belief changed: is_adjacent smallBedroom firstLiving
robot2                          Belief changed: is_adjacent smallBedroom firstLiving
robot1                          Belief changed: is_adjacent privateBathroom drawer
robot2                          Belief changed: is_adjacent privateBathroom drawer
robot1                          Belief changed: is_adjacent privateBathroom masterBedroom
robot2                          Belief changed: is_adjacent privateBathroom masterBedroom
robot1                          Belief changed: is_adjacent firstLiving smallBedroom
robot2                          Belief changed: is_adjacent firstLiving smallBedroom
robot1                          Belief changed: is_adjacent firstLiving drawer
robot2                          Belief changed: is_adjacent firstLiving drawer
robot1                          Belief changed: is_adjacent drawer masterBedroom
robot2                          Belief changed: is_adjacent drawer masterBedroom
robot1                          Belief changed: is_adjacent drawer firstLiving
robot2                          Belief changed: is_adjacent drawer firstLiving
robot1                          Belief changed: is_adjacent drawer privateBathroom
robot2                          Belief changed: is_adjacent drawer privateBathroom
robot1                          Belief changed: chargePoint_in_room charge_point2 firstLiving
robot2                          Belief changed: chargePoint_in_room charge_point2 firstLiving
robot1                          Belief changed: chargePoint_in_room charge_point1 lobby
robot2                          Belief changed: chargePoint_in_room charge_point1 lobby
robot1                          Belief changed: is_in_current robot2 firstLiving
robot2                          Belief changed: is_in_current robot2 firstLiving
robot1                          Belief changed: is_in_current robot1 lobby
robot2                          Belief changed: is_in_current robot1 lobby
robot1                          Belief changed: is_in_charge_point charge_point2 robot2
robot2                          Belief changed: is_in_charge_point charge_point2 robot2
robot1                          Belief changed: is_in_charge_point charge_point1 robot1
robot2                          Belief changed: is_in_charge_point charge_point1 robot1
robot1                          Belief changed: needs_water lobby
robot2                          Belief changed: needs_water lobby
```

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robot1                          Belief changed: needs_water stairs
robot2                          Belief changed: needs_water stairs
robot1                          Belief changed: needs_water groundLiving
robot2                          Belief changed: needs_water groundLiving
robot1                          Belief changed: needs_water kitchen
robot2                          Belief changed: needs_water kitchen
robot1                          Belief changed: needs_water laundry
robot2                          Belief changed: needs_water laundry
robot1                          Belief changed: needs_water groundBathroom
robot2                          Belief changed: needs_water groundBathroom
robot1                          Belief changed: needs_water masterBedroom
robot2                          Belief changed: needs_water masterBedroom
robot1                          Belief changed: needs_water smallBedroom
robot2                          Belief changed: needs_water smallBedroom
robot1                          Belief changed: needs_water privateBathroom
robot2                          Belief changed: needs_water privateBathroom
robot1                          Belief changed: needs_water firstLiving
robot2                          Belief changed: needs_water firstLiving
robot1                          Belief changed: needs_water drawer
robot2                          Belief changed: needs_water drawer
lightAgent                      Belief changed: is_empty lobby
boilerAgent                     Belief changed: is_empty lobby
lightAgent                      Belief changed: is_empty stairs
boilerAgent                     Belief changed: is_empty stairs
lightAgent                      Belief changed: is_empty groundLiving
boilerAgent                     Belief changed: is_empty groundLiving
lightAgent                      Belief changed: is_empty kitchen
boilerAgent                     Belief changed: is_empty kitchen
lightAgent                      Belief changed: is_empty laundry
boilerAgent                     Belief changed: is_empty laundry
lightAgent                      Belief changed: is_empty groundBathroom
boilerAgent                     Belief changed: is_empty groundBathroom
lightAgent                      Belief changed: is_empty masterBedroom
boilerAgent                     Belief changed: is_empty masterBedroom
lightAgent                      Belief changed: is_empty smallBedroom
boilerAgent                     Belief changed: is_empty smallBedroom
lightAgent                      Belief changed: is_empty privateBathroom
boilerAgent                     Belief changed: is_empty privateBathroom
lightAgent                      Belief changed: is_empty firstLiving
boilerAgent                     Belief changed: is_empty firstLiving
lightAgent                      Belief changed: is_empty drawer
boilerAgent                     Belief changed: is_empty drawer
Watts consumed today: 0 W
house                           Belief changed: warming_on
house                           Belief changed: not warming_off
0:01:45 robot2>OnlinePlanning#3        Plan found:
```

```
robot2>OnlinePlanning#3        - (sprinkle firstliving robot2)
robot2>OnlinePlanning#3        - (move robot2 firstliving smallbedroom robot1)
robot2>OnlinePlanning#3        - (sprinkle smallbedroom robot2)
robot2>OnlinePlanning#3        - (move robot2 smallbedroom firstliving robot1)
robot2>OnlinePlanning#3        - (move robot2 firstliving drawer robot1)
robot2>OnlinePlanning#3        - (sprinkle drawer robot2)
robot2>OnlinePlanning#3        - (move robot2 drawer masterbedroom robot1)
robot2>OnlinePlanning#3        - (sprinkle masterbedroom robot2)
robot2>OnlinePlanning#3        - (move robot2 masterbedroom privatebathroom robot1)
robot2>OnlinePlanning#3        - (sprinkle privatebathroom robot2)
robot1>OnlinePlanning#1        Plan found:
robot1>OnlinePlanning#1        - (sprinkle lobby robot1)
robot1>OnlinePlanning#1        - (move robot1 lobby stairs robot1)
robot1>OnlinePlanning#1        - (sprinkle stairs robot1)
robot1>OnlinePlanning#1        - (move robot1 stairs kitchen robot1)
robot1>OnlinePlanning#1        - (sprinkle kitchen robot1)
robot1>OnlinePlanning#1        - (move robot1 kitchen groundliving robot1)
robot1>OnlinePlanning#1        - (sprinkle groundliving robot1)
robot1>OnlinePlanning#1        - (move robot1 groundliving kitchen robot1)
robot1>OnlinePlanning#1        - (move robot1 kitchen laundry robot1)
robot1>OnlinePlanning#1        - (sprinkle laundry robot1)
robot2>OnlinePlanning#3        Starting sequential step (Sprinkle firstliving robot2) Effect: not ne
robot2>Sprinkle#8              Intention started
house                          sprinkle robot2 firstliving
house                          Belief changed: not needs_water firstliving
house                          Belief changed: is_clean firstliving
robot1                         Belief changed: not needs_water firstliving
robot2                         Belief changed: not needs_water firstliving
robot1>OnlinePlanning#1        Starting sequential step (Sprinkle lobby robot1) Effect: not needs_wa
robot1>Sprinkle#18             Intention started
house                          sprinkle robot1 lobby
house                          Belief changed: not needs_water lobby
house                          Belief changed: is_clean lobby
robot1                         Belief changed: not needs_water lobby
robot2                         Belief changed: not needs_water lobby
robot2>Sprinkle#8              Intention success
robot1>Sprinkle#18             Intention success
0:02:00 robot2>OnlinePlanning#3        Starting sequential step (Move robot2 firstliving smallbedroo
robot2>Move#9                  Intention started
house                          move firstliving smallbedroom robot2
house                          Belief changed: not is_in_current robot2 firstliving
house                          Belief changed: is_in_current robot2 smallbedroom
house                          Belief changed: not is_in_charge_point undefined robot2
robot1                         Belief changed: not is_in_current robot2 firstliving
robot2                         Belief changed: not is_in_current robot2 firstliving
robot1                         Belief changed: is_in_current robot2 smallbedroom
```

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robot2                          Belief changed: is_in_current robot2 smallbedroom
robot1                          Belief changed: not is_in_charge_point undefined robot2
robot2                          Belief changed: not is_in_charge_point undefined robot2
robot1>OnlinePlanning#1         Starting sequential step (Move robot1 lobby stairs robot1) Effect: no
robot1>Move#19                  Intention started
house                           move lobby stairs robot1
house                           Belief changed: not is_in_current robot1 lobby
house                           Belief changed: is_in_current robot1 stairs
house                           Belief changed: not is_in_charge_point undefined robot1
robot1                          Belief changed: not is_in_current robot1 lobby
robot2                          Belief changed: not is_in_current robot1 lobby
robot1                          Belief changed: is_in_current robot1 stairs
robot2                          Belief changed: is_in_current robot1 stairs
robot1                          Belief changed: not is_in_charge_point undefined robot1
robot2                          Belief changed: not is_in_charge_point undefined robot1
robot2>Move#9                   Intention success
robot1>Move#19                  Intention success
robot2>OnlinePlanning#3         Starting sequential step (Sprinkle smallbedroom robot2) Effect: not n
robot2>Sprinkle#10              Intention started
house                           sprinkle robot2 smallbedroom
house                           Belief changed: not needs_water smallbedroom
house                           Belief changed: is_clean smallbedroom
robot1                          Belief changed: not needs_water smallbedroom
robot2                          Belief changed: not needs_water smallbedroom
robot1>OnlinePlanning#1         Starting sequential step (Sprinkle stairs robot1) Effect: not needs_w
robot1>Sprinkle#20              Intention started
house                           sprinkle robot1 stairs
house                           Belief changed: not needs_water stairs
house                           Belief changed: is_clean stairs
robot1                          Belief changed: not needs_water stairs
robot2                          Belief changed: not needs_water stairs
0:02:15 robot2>Sprinkle#10              Intention success
```

The log was copied in two steps as lines in terminal history were not enough!

```
robot1>Sprinkle#12              Intention started
house                           sprinkle robot1 kitchen
house                           Belief changed: not needs_water kitchen
house                           Belief changed: is_clean kitchen
robot1                          Belief changed: not needs_water kitchen
robot2                          Belief changed: not needs_water kitchen
0:02:15 robot2>Move#21                  Intention success
robot2>OnlinePlanning#3         Starting sequential step (Move robot2 firstliving drawer robot1) Effe
robot2>Move#22                  Intention started
house                           move firstliving drawer robot2
```

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house                          Belief changed: not is_in_current robot2 firstliving
house                          Belief changed: is_in_current robot2 drawer
robot1                         Belief changed: not is_in_current robot2 firstliving
robot2                         Belief changed: not is_in_current robot2 firstliving
robot1                         Belief changed: is_in_current robot2 drawer
robot2                         Belief changed: is_in_current robot2 drawer
robot1>Sprinkle#12             Intention success
robot1>OnlinePlanning#1        Starting sequential step (Move robot1 kitchen groundliving robot1) Ef
robot1>Move#13                 Intention started
house                          move kitchen groundliving robot1
house                          Belief changed: not is_in_current robot1 kitchen
house                          Belief changed: is_in_current robot1 groundliving
robot1                         Belief changed: not is_in_current robot1 kitchen
robot2                         Belief changed: not is_in_current robot1 kitchen
robot1                         Belief changed: is_in_current robot1 groundliving
robot2                         Belief changed: is_in_current robot1 groundliving
robot2>Move#22                 Intention success
robot2>OnlinePlanning#3        Starting sequential step (Sprinkle drawer robot2) Effect: not needs_w
robot2>Sprinkle#23             Intention started
house                          sprinkle robot2 drawer
house                          Belief changed: not needs_water drawer
house                          Belief changed: is_clean drawer
robot1                         Belief changed: not needs_water drawer
robot2                         Belief changed: not needs_water drawer
0:02:30 robot1>Move#13                 Intention success
robot1>OnlinePlanning#1        Starting sequential step (Sprinkle groundliving robot1) Effect: not n
robot1>Sprinkle#14             Intention started
house                          sprinkle robot1 groundliving
house                          Belief changed: not needs_water groundliving
house                          Belief changed: is_clean groundliving
robot1                         Belief changed: not needs_water groundliving
robot2                         Belief changed: not needs_water groundliving
robot2>Sprinkle#23             Intention success
robot2>OnlinePlanning#3        Starting sequential step (Move robot2 drawer masterbedroom robot1) Ef
robot2>Move#24                 Intention started
house                          move drawer masterbedroom robot2
house                          Belief changed: not is_in_current robot2 drawer
house                          Belief changed: is_in_current robot2 masterbedroom
robot1                         Belief changed: not is_in_current robot2 drawer
robot2                         Belief changed: not is_in_current robot2 drawer
robot1                         Belief changed: is_in_current robot2 masterbedroom
robot2                         Belief changed: is_in_current robot2 masterbedroom
robot1>Sprinkle#14             Intention success
0:02:45 robot1>OnlinePlanning#1        Starting sequential step (Move robot1 groundliving kitchen ro
robot1>Move#15                 Intention started
house                          move groundliving kitchen robot1
```

```
house                          Belief changed: not is_in_current robot1 groundliving
house                          Belief changed: is_in_current robot1 kitchen
robot1                         Belief changed: not is_in_current robot1 groundliving
robot2                         Belief changed: not is_in_current robot1 groundliving
robot1                         Belief changed: is_in_current robot1 kitchen
robot2                         Belief changed: is_in_current robot1 kitchen
robot2>Move#24                 Intention success
robot2>OnlinePlanning#3        Starting sequential step (Sprinkle masterbedroom robot2) Effect: not
robot2>Sprinkle#25             Intention started
house                          sprinkle robot2 masterbedroom
house                          Belief changed: not needs_water masterbedroom
house                          Belief changed: is_clean masterbedroom
robot1                         Belief changed: not needs_water masterbedroom
robot2                         Belief changed: not needs_water masterbedroom
robot1>Move#15                 Intention success
robot1>OnlinePlanning#1        Starting sequential step (Move robot1 kitchen laundry robot1) Effect:
robot1>Move#16                 Intention started
house                          move kitchen laundry robot1
house                          Belief changed: not is_in_current robot1 kitchen
house                          Belief changed: is_in_current robot1 laundry
robot1                         Belief changed: not is_in_current robot1 kitchen
robot2                         Belief changed: not is_in_current robot1 kitchen
robot1                         Belief changed: is_in_current robot1 laundry
robot2                         Belief changed: is_in_current robot1 laundry
robot2>Sprinkle#25             Intention success
0:03:00 robot2>OnlinePlanning#3        Starting sequential step (Move robot2 masterbedroom privateba
robot2>Move#26                 Intention started
house                          move masterbedroom privatebathroom robot2
house                          Belief changed: not is_in_current robot2 masterbedroom
house                          Belief changed: is_in_current robot2 privatebathroom
robot1                         Belief changed: not is_in_current robot2 masterbedroom
robot2                         Belief changed: not is_in_current robot2 masterbedroom
robot1                         Belief changed: is_in_current robot2 privatebathroom
robot2                         Belief changed: is_in_current robot2 privatebathroom
robot1>Move#16                 Intention success
robot1>OnlinePlanning#1        Starting sequential step (Sprinkle laundry robot1) Effect: not needs_
robot1>Sprinkle#17             Intention started
house                          sprinkle robot1 laundry
house                          Belief changed: not needs_water laundry
house                          Belief changed: is_clean laundry
robot1                         Belief changed: not needs_water laundry
robot2                         Belief changed: not needs_water laundry
robot2>Move#26                 Intention success
robot2>OnlinePlanning#3        Starting sequential step (Sprinkle privatebathroom robot2) Effect: no
robot2>Sprinkle#27             Intention started
house                          sprinkle robot2 privatebathroom
```

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house                          Belief changed: not needs_water privatebathroom
house                          Belief changed: is_clean privatebathroom
robot1                         Belief changed: not needs_water privatebathroom
robot2                         Belief changed: not needs_water privatebathroom
0:03:15 robot1>Sprinkle#17             Intention success
robot2>Sprinkle#27             Intention success
robot1>OnlinePlanning#1        Intention success
robot1                         Succesfully used intention OnlinePlanning to achieve goal PddlGoal#0
robot2>OnlinePlanning#3        Intention success
robot2                         Succesfully used intention OnlinePlanning to achieve goal PddlGoal#2
0:03:30 robot1>RetryIntention#0        Intention success
robot1                         Succesfully used intention RetryIntention to achieve goal {RetryGoal#
robot2>RetryIntention#2        Intention success
robot2                         Succesfully used intention RetryIntention to achieve goal {RetryGoal#
0:07:00 house                          Belief changed: not is_empty kitchen
house                          Belief changed: not is_empty masterBedroom
lightAgent                     Belief changed: not is_empty kitchen
boilerAgent                    Belief changed: not is_empty kitchen
lightAgent                     Belief changed: not is_empty masterBedroom
boilerAgent                    Belief changed: not is_empty masterBedroom
7:0 - LightSystem turned on in kitchen
7:0 - LightSystem turned on in masterBedroom
0:07:30 house                          Belief changed: not is_empty groundLiving
house                          Belief changed: is_empty kitchen
house                          Belief changed: is_empty masterBedroom
house                          Belief changed: not is_empty privateBathroom
lightAgent                     Belief changed: not is_empty groundLiving
boilerAgent                    Belief changed: not is_empty groundLiving
lightAgent                     Belief changed: is_empty kitchen
boilerAgent                    Belief changed: is_empty kitchen
lightAgent                     Belief changed: is_empty masterBedroom
boilerAgent                    Belief changed: is_empty masterBedroom
lightAgent                     Belief changed: not is_empty privateBathroom
boilerAgent                    Belief changed: not is_empty privateBathroom
7:30 - LightSystem turned on in groundLiving
7:30 - LightSystem turned off in kitchen
7:30 - LightSystem turned off in masterBedroom
7:30 - LightSystem turned on in privateBathroom
0:08:00 house                          Belief changed: not is_empty away
house                          Belief changed: is_empty groundLiving
house                          Belief changed: is_empty privateBathroom
house                          Belief changed: not is_empty drawer
lightAgent                     Belief changed: not is_empty away
boilerAgent                    Belief changed: not is_empty away
lightAgent                     Belief changed: is_empty groundLiving
boilerAgent                    Belief changed: is_empty groundLiving
```

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lightAgent                    Belief changed: is_empty privateBathroom
boilerAgent                   Belief changed: is_empty privateBathroom
lightAgent                    Belief changed: not is_empty drawer
boilerAgent                   Belief changed: not is_empty drawer
8:0 - LightSystem turned off in groundLiving
8:0 - LightSystem turned off in privateBathroom
8:0 - LightSystem turned on in drawer
0:09:00 house                         Belief changed: is_empty drawer
house                         Belief changed: not is_empty firstLiving
lightAgent                    Belief changed: is_empty drawer
boilerAgent                   Belief changed: is_empty drawer
lightAgent                    Belief changed: not is_empty firstLiving
boilerAgent                   Belief changed: not is_empty firstLiving
9:0 - LightSystem turned off in drawer
9:0 - LightSystem turned on in firstLiving
0:10:00 house                         Belief changed: is_empty firstLiving
house                         Belief changed: not is_empty stairs
lightAgent                    Belief changed: is_empty firstLiving
boilerAgent                   Belief changed: is_empty firstLiving
lightAgent                    Belief changed: not is_empty stairs
boilerAgent                   Belief changed: not is_empty stairs
10:0 - LightSystem turned off in firstLiving
10:0 - LightSystem turned on in stairs
0:11:00 house                         Belief changed: is_empty stairs
house                         Belief changed: not is_empty kitchen
lightAgent                    Belief changed: is_empty stairs
boilerAgent                   Belief changed: is_empty stairs
lightAgent                    Belief changed: not is_empty kitchen
boilerAgent                   Belief changed: not is_empty kitchen
11:0 - LightSystem turned off in stairs
11:0 - LightSystem turned on in kitchen
0:12:00 house                         Belief changed: is_empty kitchen
house                         Belief changed: not is_empty groundLiving
lightAgent                    Belief changed: is_empty kitchen
boilerAgent                   Belief changed: is_empty kitchen
lightAgent                    Belief changed: not is_empty groundLiving
boilerAgent                   Belief changed: not is_empty groundLiving
12:0 - LightSystem turned off in kitchen
12:0 - LightSystem turned on in groundLiving
0:13:00 house                         Belief changed: is_empty groundLiving
house                         Belief changed: not is_empty kitchen
lightAgent                    Belief changed: is_empty groundLiving
boilerAgent                   Belief changed: is_empty groundLiving
lightAgent                    Belief changed: not is_empty kitchen
boilerAgent                   Belief changed: not is_empty kitchen
13:0 - LightSystem turned off in groundLiving
```

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13:0 - LightSystem turned on in kitchen
0:14:00 house                          Belief changed: is_empty kitchen
house                          Belief changed: not is_empty stairs
lightAgent                     Belief changed: is_empty kitchen
boilerAgent                    Belief changed: is_empty kitchen
lightAgent                     Belief changed: not is_empty stairs
boilerAgent                    Belief changed: not is_empty stairs
14:0 - LightSystem turned off in kitchen
14:0 - LightSystem turned on in stairs
0:15:30 house                          Belief changed: not is_empty lobby
house                          Belief changed: is_empty stairs
house                          Belief changed: not is_empty firstLiving
lightAgent                     Belief changed: not is_empty lobby
boilerAgent                    Belief changed: not is_empty lobby
lightAgent                     Belief changed: is_empty stairs
boilerAgent                    Belief changed: is_empty stairs
lightAgent                     Belief changed: not is_empty firstLiving
boilerAgent                    Belief changed: not is_empty firstLiving
15:30 - LightSystem turned on in lobby
15:30 - LightSystem turned off in stairs
15:30 - LightSystem turned on in firstLiving
0:16:30 house                          Belief changed: not is_empty stairs
house                          Belief changed: is_empty lobby
lightAgent                     Belief changed: not is_empty stairs
boilerAgent                    Belief changed: not is_empty stairs
lightAgent                     Belief changed: is_empty lobby
boilerAgent                    Belief changed: is_empty lobby
16:30 - LightSystem turned on in stairs
16:30 - LightSystem turned off in lobby
0:18:30 house                          Belief changed: not is_empty kitchen
house                          Belief changed: is_empty firstLiving
lightAgent                     Belief changed: not is_empty kitchen
boilerAgent                    Belief changed: not is_empty kitchen
lightAgent                     Belief changed: is_empty firstLiving
boilerAgent                    Belief changed: is_empty firstLiving
18:30 - LightSystem turned on in kitchen
18:30 - LightSystem turned off in firstLiving
0:19:00 house                          Belief changed: is_empty stairs
lightAgent                     Belief changed: is_empty stairs
boilerAgent                    Belief changed: is_empty stairs
19:0 - LightSystem turned off in stairs
0:21:00 house                          Belief changed: not is_empty stairs
house                          Belief changed: is_empty kitchen
lightAgent                     Belief changed: not is_empty stairs
boilerAgent                    Belief changed: not is_empty stairs
lightAgent                     Belief changed: is_empty kitchen
```

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boilerAgent                    Belief changed: is_empty kitchen
21:0 - LightSystem turned on in stairs
21:0 - LightSystem turned off in kitchen
0:22:00 house                          Belief changed: not is_empty firstLiving
house                          Belief changed: is_empty stairs
lightAgent                     Belief changed: not is_empty firstLiving
boilerAgent                    Belief changed: not is_empty firstLiving
lightAgent                     Belief changed: is_empty stairs
boilerAgent                    Belief changed: is_empty stairs
22:0 - LightSystem turned on in firstLiving
22:0 - LightSystem turned off in stairs
0:22:30 house                          Belief changed: not is_empty privateBathroom
house                          Belief changed: is_empty privateBathroom
house                          Belief changed: is_empty firstLiving
house                          Belief changed: not is_empty privateBathroom
house                          Belief changed: is_empty privateBathroom
lightAgent                     Belief changed: not is_empty privateBathroom
boilerAgent                    Belief changed: not is_empty privateBathroom
lightAgent                     Belief changed: is_empty privateBathroom
boilerAgent                    Belief changed: is_empty privateBathroom
lightAgent                     Belief changed: is_empty firstLiving
boilerAgent                    Belief changed: is_empty firstLiving
lightAgent                     Belief changed: not is_empty privateBathroom
boilerAgent                    Belief changed: not is_empty privateBathroom
lightAgent                     Belief changed: is_empty privateBathroom
boilerAgent                    Belief changed: is_empty privateBathroom
22:30 - LightSystem turned on in privateBathroom
22:30 - LightSystem turned off in firstLiving
1:00:00 Watts consumed today: 235 W
1:07:00 house                          Belief changed: not is_empty kitchen
house                          Belief changed: not is_empty masterBedroom
lightAgent                     Belief changed: not is_empty kitchen
boilerAgent                    Belief changed: not is_empty kitchen
lightAgent                     Belief changed: not is_empty masterBedroom
boilerAgent                    Belief changed: not is_empty masterBedroom
7:0 - LightSystem turned on in kitchen
7:0 - LightSystem turned on in masterBedroom
1:07:30 house                          Belief changed: not is_empty groundLiving
house                          Belief changed: is_empty kitchen
house                          Belief changed: is_empty masterBedroom
house                          Belief changed: not is_empty privateBathroom
lightAgent                     Belief changed: not is_empty groundLiving
boilerAgent                    Belief changed: not is_empty groundLiving
lightAgent                     Belief changed: is_empty kitchen
boilerAgent                    Belief changed: is_empty kitchen
lightAgent                     Belief changed: is_empty masterBedroom
```

```
boilerAgent                    Belief changed: is_empty masterBedroom
lightAgent                     Belief changed: not is_empty privateBathroom
boilerAgent                    Belief changed: not is_empty privateBathroom
7:30 - LightSystem turned on in groundLiving
7:30 - LightSystem turned off in kitchen
7:30 - LightSystem turned off in masterBedroom
1:08:00 house                          Belief changed: is_empty groundLiving
house                          Belief changed: is_empty privateBathroom
house                          Belief changed: not is_empty drawer
lightAgent                     Belief changed: is_empty groundLiving
boilerAgent                    Belief changed: is_empty groundLiving
lightAgent                     Belief changed: is_empty privateBathroom
boilerAgent                    Belief changed: is_empty privateBathroom
lightAgent                     Belief changed: not is_empty drawer
boilerAgent                    Belief changed: not is_empty drawer
8:0 - LightSystem turned off in groundLiving
8:0 - LightSystem turned off in privateBathroom
8:0 - LightSystem turned on in drawer
1:09:00 house                          Belief changed: is_empty drawer
house                          Belief changed: not is_empty firstLiving
lightAgent                     Belief changed: is_empty drawer
boilerAgent                    Belief changed: is_empty drawer
lightAgent                     Belief changed: not is_empty firstLiving
boilerAgent                    Belief changed: not is_empty firstLiving
9:0 - LightSystem turned off in drawer
9:0 - LightSystem turned on in firstLiving
1:10:00 house                          Belief changed: is_empty firstLiving
house                          Belief changed: not is_empty stairs
lightAgent                     Belief changed: is_empty firstLiving
boilerAgent                    Belief changed: is_empty firstLiving
lightAgent                     Belief changed: not is_empty stairs
boilerAgent                    Belief changed: not is_empty stairs
10:0 - LightSystem turned off in firstLiving
10:0 - LightSystem turned on in stairs
1:11:00 house                          Belief changed: is_empty stairs
house                          Belief changed: not is_empty kitchen
lightAgent                     Belief changed: is_empty stairs
boilerAgent                    Belief changed: is_empty stairs
lightAgent                     Belief changed: not is_empty kitchen
boilerAgent                    Belief changed: not is_empty kitchen
11:0 - LightSystem turned off in stairs
11:0 - LightSystem turned on in kitchen
1:12:00 house                          Belief changed: is_empty kitchen
house                          Belief changed: not is_empty groundLiving
lightAgent                     Belief changed: is_empty kitchen
boilerAgent                    Belief changed: is_empty kitchen
```

```
lightAgent                    Belief changed: not is_empty groundLiving
boilerAgent                   Belief changed: not is_empty groundLiving
12:0 - LightSystem turned off in kitchen
12:0 - LightSystem turned on in groundLiving
1:13:00 house                         Belief changed: is_empty groundLiving
house                         Belief changed: not is_empty kitchen
lightAgent                    Belief changed: is_empty groundLiving
boilerAgent                   Belief changed: is_empty groundLiving
lightAgent                    Belief changed: not is_empty kitchen
boilerAgent                   Belief changed: not is_empty kitchen
13:0 - LightSystem turned off in groundLiving
13:0 - LightSystem turned on in kitchen
1:14:00 house                         Belief changed: is_empty kitchen
house                         Belief changed: not is_empty stairs
lightAgent                    Belief changed: is_empty kitchen
boilerAgent                   Belief changed: is_empty kitchen
lightAgent                    Belief changed: not is_empty stairs
boilerAgent                   Belief changed: not is_empty stairs
14:0 - LightSystem turned off in kitchen
14:0 - LightSystem turned on in stairs
1:15:30 house                         Belief changed: not is_empty lobby
house                         Belief changed: is_empty stairs
house                         Belief changed: not is_empty firstLiving
lightAgent                    Belief changed: not is_empty lobby
boilerAgent                   Belief changed: not is_empty lobby
lightAgent                    Belief changed: is_empty stairs
boilerAgent                   Belief changed: is_empty stairs
lightAgent                    Belief changed: not is_empty firstLiving
boilerAgent                   Belief changed: not is_empty firstLiving
15:30 - LightSystem turned on in lobby
15:30 - LightSystem turned off in stairs
15:30 - LightSystem turned on in firstLiving
1:16:30 house                         Belief changed: not is_empty stairs
house                         Belief changed: is_empty lobby
lightAgent                    Belief changed: not is_empty stairs
boilerAgent                   Belief changed: not is_empty stairs
lightAgent                    Belief changed: is_empty lobby
boilerAgent                   Belief changed: is_empty lobby
16:30 - LightSystem turned on in stairs
16:30 - LightSystem turned off in lobby
1:18:30 house                         Belief changed: not is_empty kitchen
house                         Belief changed: is_empty firstLiving
lightAgent                    Belief changed: not is_empty kitchen
boilerAgent                   Belief changed: not is_empty kitchen
lightAgent                    Belief changed: is_empty firstLiving
boilerAgent                   Belief changed: is_empty firstLiving
```

```
18:30 - LightSystem turned on in kitchen
18:30 - LightSystem turned off in firstLiving
1:19:00 house                          Belief changed: is_empty stairs
lightAgent                     Belief changed: is_empty stairs
boilerAgent                    Belief changed: is_empty stairs
19:0 - LightSystem turned off in stairs
1:21:00 house                          Belief changed: not is_empty stairs
house                          Belief changed: is_empty kitchen
lightAgent                     Belief changed: not is_empty stairs
boilerAgent                    Belief changed: not is_empty stairs
lightAgent                     Belief changed: is_empty kitchen
boilerAgent                    Belief changed: is_empty kitchen
21:0 - LightSystem turned on in stairs
21:0 - LightSystem turned off in kitchen
1:22:00 house                          Belief changed: not is_empty firstLiving
house                          Belief changed: is_empty stairs
lightAgent                     Belief changed: not is_empty firstLiving
boilerAgent                    Belief changed: not is_empty firstLiving
lightAgent                     Belief changed: is_empty stairs
boilerAgent                    Belief changed: is_empty stairs
22:0 - LightSystem turned on in firstLiving
22:0 - LightSystem turned off in stairs
1:22:30 house                          Belief changed: not is_empty privateBathroom
house                          Belief changed: is_empty privateBathroom
house                          Belief changed: is_empty firstLiving
house                          Belief changed: not is_empty privateBathroom
house                          Belief changed: is_empty privateBathroom
lightAgent                     Belief changed: not is_empty privateBathroom
boilerAgent                    Belief changed: not is_empty privateBathroom
lightAgent                     Belief changed: is_empty privateBathroom
boilerAgent                    Belief changed: is_empty privateBathroom
lightAgent                     Belief changed: is_empty firstLiving
boilerAgent                    Belief changed: is_empty firstLiving
lightAgent                     Belief changed: not is_empty privateBathroom
boilerAgent                    Belief changed: not is_empty privateBathroom
lightAgent                     Belief changed: is_empty privateBathroom
boilerAgent                    Belief changed: is_empty privateBathroom
22:30 - LightSystem turned on in privateBathroom
22:30 - LightSystem turned off in firstLiving
2:00:00 Watts consumed today: 375 W
2:07:00 house                          Belief changed: not is_empty kitchen
house                          Belief changed: not is_empty masterBedroom
lightAgent                     Belief changed: not is_empty kitchen
boilerAgent                    Belief changed: not is_empty kitchen
lightAgent                     Belief changed: not is_empty masterBedroom
boilerAgent                    Belief changed: not is_empty masterBedroom
```

```
7:0 - LightSystem turned on in kitchen
7:0 - LightSystem turned on in masterBedroom
2:07:30 house                          Belief changed: not is_empty groundLiving
house                          Belief changed: is_empty kitchen
house                          Belief changed: is_empty masterBedroom
house                          Belief changed: not is_empty privateBathroom
lightAgent                     Belief changed: not is_empty groundLiving
boilerAgent                    Belief changed: not is_empty groundLiving
lightAgent                     Belief changed: is_empty kitchen
boilerAgent                    Belief changed: is_empty kitchen
lightAgent                     Belief changed: is_empty masterBedroom
boilerAgent                    Belief changed: is_empty masterBedroom
lightAgent                     Belief changed: not is_empty privateBathroom
boilerAgent                    Belief changed: not is_empty privateBathroom
7:30 - LightSystem turned on in groundLiving
7:30 - LightSystem turned off in kitchen
7:30 - LightSystem turned off in masterBedroom
2:08:00 house                          Belief changed: is_empty groundLiving
house                          Belief changed: is_empty privateBathroom
house                          Belief changed: not is_empty drawer
lightAgent                     Belief changed: is_empty groundLiving
boilerAgent                    Belief changed: is_empty groundLiving
lightAgent                     Belief changed: is_empty privateBathroom
boilerAgent                    Belief changed: is_empty privateBathroom
lightAgent                     Belief changed: not is_empty drawer
boilerAgent                    Belief changed: not is_empty drawer
8:0 - LightSystem turned off in groundLiving
8:0 - LightSystem turned off in privateBathroom
8:0 - LightSystem turned on in drawer
2:09:00 house                          Belief changed: is_empty drawer
house                          Belief changed: not is_empty firstLiving
lightAgent                     Belief changed: is_empty drawer
boilerAgent                    Belief changed: is_empty drawer
lightAgent                     Belief changed: not is_empty firstLiving
boilerAgent                    Belief changed: not is_empty firstLiving
9:0 - LightSystem turned off in drawer
9:0 - LightSystem turned on in firstLiving
2:10:00 house                          Belief changed: is_empty firstLiving
house                          Belief changed: not is_empty stairs
lightAgent                     Belief changed: is_empty firstLiving
boilerAgent                    Belief changed: is_empty firstLiving
lightAgent                     Belief changed: not is_empty stairs
boilerAgent                    Belief changed: not is_empty stairs
10:0 - LightSystem turned off in firstLiving
10:0 - LightSystem turned on in stairs
2:11:00 house                          Belief changed: is_empty stairs
```

```
house                          Belief changed: not is_empty kitchen
lightAgent                     Belief changed: is_empty stairs
boilerAgent                    Belief changed: is_empty stairs
lightAgent                     Belief changed: not is_empty kitchen
boilerAgent                    Belief changed: not is_empty kitchen
11:0 - LightSystem turned off in stairs
11:0 - LightSystem turned on in kitchen
2:12:00 house                          Belief changed: is_empty kitchen
house                          Belief changed: not is_empty groundLiving
lightAgent                     Belief changed: is_empty kitchen
boilerAgent                    Belief changed: is_empty kitchen
lightAgent                     Belief changed: not is_empty groundLiving
boilerAgent                    Belief changed: not is_empty groundLiving
12:0 - LightSystem turned off in kitchen
12:0 - LightSystem turned on in groundLiving
2:13:00 house                          Belief changed: is_empty groundLiving
house                          Belief changed: not is_empty kitchen
lightAgent                     Belief changed: is_empty groundLiving
boilerAgent                    Belief changed: is_empty groundLiving
lightAgent                     Belief changed: not is_empty kitchen
boilerAgent                    Belief changed: not is_empty kitchen
13:0 - LightSystem turned off in groundLiving
13:0 - LightSystem turned on in kitchen
2:14:00 house                          Belief changed: is_empty kitchen
house                          Belief changed: not is_empty stairs
lightAgent                     Belief changed: is_empty kitchen
boilerAgent                    Belief changed: is_empty kitchen
lightAgent                     Belief changed: not is_empty stairs
boilerAgent                    Belief changed: not is_empty stairs
14:0 - LightSystem turned off in kitchen
14:0 - LightSystem turned on in stairs
2:15:30 house                          Belief changed: not is_empty lobby
house                          Belief changed: is_empty stairs
house                          Belief changed: not is_empty firstLiving
lightAgent                     Belief changed: not is_empty lobby
boilerAgent                    Belief changed: not is_empty lobby
lightAgent                     Belief changed: is_empty stairs
boilerAgent                    Belief changed: is_empty stairs
lightAgent                     Belief changed: not is_empty firstLiving
boilerAgent                    Belief changed: not is_empty firstLiving
15:30 - LightSystem turned on in lobby
15:30 - LightSystem turned off in stairs
15:30 - LightSystem turned on in firstLiving
2:16:30 house                          Belief changed: not is_empty stairs
house                          Belief changed: is_empty lobby
lightAgent                     Belief changed: not is_empty stairs
```

```
boilerAgent                    Belief changed: not is_empty stairs
lightAgent                     Belief changed: is_empty lobby
boilerAgent                    Belief changed: is_empty lobby
16:30 - LightSystem turned on in stairs
16:30 - LightSystem turned off in lobby
2:18:30 house                          Belief changed: not is_empty kitchen
house                          Belief changed: is_empty firstLiving
lightAgent                     Belief changed: not is_empty kitchen
boilerAgent                    Belief changed: not is_empty kitchen
lightAgent                     Belief changed: is_empty firstLiving
boilerAgent                    Belief changed: is_empty firstLiving
18:30 - LightSystem turned on in kitchen
18:30 - LightSystem turned off in firstLiving
2:19:00 house                          Belief changed: is_empty stairs
lightAgent                     Belief changed: is_empty stairs
boilerAgent                    Belief changed: is_empty stairs
19:0 - LightSystem turned off in stairs
2:21:00 house                          Belief changed: not is_empty stairs
house                          Belief changed: is_empty kitchen
lightAgent                     Belief changed: not is_empty stairs
boilerAgent                    Belief changed: not is_empty stairs
lightAgent                     Belief changed: is_empty kitchen
boilerAgent                    Belief changed: is_empty kitchen
21:0 - LightSystem turned on in stairs
21:0 - LightSystem turned off in kitchen
2:22:00 house                          Belief changed: not is_empty firstLiving
house                          Belief changed: is_empty stairs
lightAgent                     Belief changed: not is_empty firstLiving
boilerAgent                    Belief changed: not is_empty firstLiving
lightAgent                     Belief changed: is_empty stairs
boilerAgent                    Belief changed: is_empty stairs
22:0 - LightSystem turned on in firstLiving
22:0 - LightSystem turned off in stairs
2:22:30 house                          Belief changed: not is_empty privateBathroom
house                          Belief changed: is_empty privateBathroom
house                          Belief changed: is_empty firstLiving
house                          Belief changed: not is_empty privateBathroom
house                          Belief changed: is_empty privateBathroom
lightAgent                     Belief changed: not is_empty privateBathroom
boilerAgent                    Belief changed: not is_empty privateBathroom
lightAgent                     Belief changed: is_empty privateBathroom
boilerAgent                    Belief changed: is_empty privateBathroom
lightAgent                     Belief changed: is_empty firstLiving
boilerAgent                    Belief changed: is_empty firstLiving
lightAgent                     Belief changed: not is_empty privateBathroom
boilerAgent                    Belief changed: not is_empty privateBathroom
```

```
lightAgent                    Belief changed: is_empty privateBathroom
boilerAgent                   Belief changed: is_empty privateBathroom
22:30 - LightSystem turned on in privateBathroom
22:30 - LightSystem turned off in firstLiving
3:00:00 Watts consumed today: 375 W
3:07:00 house                          Belief changed: not is_empty kitchen
house                         Belief changed: not is_empty masterBedroom
lightAgent                    Belief changed: not is_empty kitchen
boilerAgent                   Belief changed: not is_empty kitchen
lightAgent                    Belief changed: not is_empty masterBedroom
boilerAgent                   Belief changed: not is_empty masterBedroom
7:0 - LightSystem turned on in kitchen
7:0 - LightSystem turned on in masterBedroom
3:07:30 house                          Belief changed: not is_empty groundLiving
house                         Belief changed: is_empty kitchen
house                         Belief changed: is_empty masterBedroom
house                         Belief changed: not is_empty privateBathroom
lightAgent                    Belief changed: not is_empty groundLiving
boilerAgent                   Belief changed: not is_empty groundLiving
lightAgent                    Belief changed: is_empty kitchen
boilerAgent                   Belief changed: is_empty kitchen
lightAgent                    Belief changed: is_empty masterBedroom
boilerAgent                   Belief changed: is_empty masterBedroom
lightAgent                    Belief changed: not is_empty privateBathroom
boilerAgent                   Belief changed: not is_empty privateBathroom
7:30 - LightSystem turned on in groundLiving
7:30 - LightSystem turned off in kitchen
7:30 - LightSystem turned off in masterBedroom
3:08:00 house                          Belief changed: is_empty groundLiving
house                         Belief changed: is_empty privateBathroom
house                         Belief changed: not is_empty drawer
lightAgent                    Belief changed: is_empty groundLiving
boilerAgent                   Belief changed: is_empty groundLiving
lightAgent                    Belief changed: is_empty privateBathroom
boilerAgent                   Belief changed: is_empty privateBathroom
lightAgent                    Belief changed: not is_empty drawer
boilerAgent                   Belief changed: not is_empty drawer
8:0 - LightSystem turned off in groundLiving
8:0 - LightSystem turned off in privateBathroom
8:0 - LightSystem turned on in drawer
3:09:00 house                          Belief changed: is_empty drawer
house                         Belief changed: not is_empty firstLiving
lightAgent                    Belief changed: is_empty drawer
boilerAgent                   Belief changed: is_empty drawer
lightAgent                    Belief changed: not is_empty firstLiving
boilerAgent                   Belief changed: not is_empty firstLiving
```

```
9:0 - LightSystem turned off in drawer
9:0 - LightSystem turned on in firstLiving
3:10:00 house                          Belief changed: is_empty firstLiving
house                          Belief changed: not is_empty stairs
lightAgent                     Belief changed: is_empty firstLiving
boilerAgent                    Belief changed: is_empty firstLiving
lightAgent                     Belief changed: not is_empty stairs
boilerAgent                    Belief changed: not is_empty stairs
10:0 - LightSystem turned off in firstLiving
10:0 - LightSystem turned on in stairs
3:11:00 house                          Belief changed: is_empty stairs
house                          Belief changed: not is_empty kitchen
lightAgent                     Belief changed: is_empty stairs
boilerAgent                    Belief changed: is_empty stairs
lightAgent                     Belief changed: not is_empty kitchen
boilerAgent                    Belief changed: not is_empty kitchen
11:0 - LightSystem turned off in stairs
11:0 - LightSystem turned on in kitchen
3:12:00 house                          Belief changed: is_empty kitchen
house                          Belief changed: not is_empty groundLiving
lightAgent                     Belief changed: is_empty kitchen
boilerAgent                    Belief changed: is_empty kitchen
lightAgent                     Belief changed: not is_empty groundLiving
boilerAgent                    Belief changed: not is_empty groundLiving
12:0 - LightSystem turned off in kitchen
12:0 - LightSystem turned on in groundLiving
3:13:00 house                          Belief changed: is_empty groundLiving
house                          Belief changed: not is_empty kitchen
lightAgent                     Belief changed: is_empty groundLiving
boilerAgent                    Belief changed: is_empty groundLiving
lightAgent                     Belief changed: not is_empty kitchen
boilerAgent                    Belief changed: not is_empty kitchen
13:0 - LightSystem turned off in groundLiving
13:0 - LightSystem turned on in kitchen
3:14:00 house                          Belief changed: is_empty kitchen
house                          Belief changed: not is_empty stairs
lightAgent                     Belief changed: is_empty kitchen
boilerAgent                    Belief changed: is_empty kitchen
lightAgent                     Belief changed: not is_empty stairs
boilerAgent                    Belief changed: not is_empty stairs
14:0 - LightSystem turned off in kitchen
14:0 - LightSystem turned on in stairs
3:15:30 house                          Belief changed: not is_empty lobby
house                          Belief changed: is_empty stairs
house                          Belief changed: not is_empty firstLiving
lightAgent                     Belief changed: not is_empty lobby
```

```
boilerAgent                    Belief changed: not is_empty lobby
lightAgent                     Belief changed: is_empty stairs
boilerAgent                    Belief changed: is_empty stairs
lightAgent                     Belief changed: not is_empty firstLiving
boilerAgent                    Belief changed: not is_empty firstLiving
15:30 - LightSystem turned on in lobby
15:30 - LightSystem turned off in stairs
15:30 - LightSystem turned on in firstLiving
3:16:30 house                          Belief changed: not is_empty stairs
house                          Belief changed: is_empty lobby
lightAgent                     Belief changed: not is_empty stairs
boilerAgent                    Belief changed: not is_empty stairs
lightAgent                     Belief changed: is_empty lobby
boilerAgent                    Belief changed: is_empty lobby
16:30 - LightSystem turned on in stairs
16:30 - LightSystem turned off in lobby
3:18:30 house                          Belief changed: not is_empty kitchen
house                          Belief changed: is_empty firstLiving
lightAgent                     Belief changed: not is_empty kitchen
boilerAgent                    Belief changed: not is_empty kitchen
lightAgent                     Belief changed: is_empty firstLiving
boilerAgent                    Belief changed: is_empty firstLiving
18:30 - LightSystem turned on in kitchen
18:30 - LightSystem turned off in firstLiving
3:19:00 house                          Belief changed: is_empty stairs
lightAgent                     Belief changed: is_empty stairs
boilerAgent                    Belief changed: is_empty stairs
19:0 - LightSystem turned off in stairs
3:21:00 house                          Belief changed: not is_empty stairs
house                          Belief changed: is_empty kitchen
lightAgent                     Belief changed: not is_empty stairs
boilerAgent                    Belief changed: not is_empty stairs
lightAgent                     Belief changed: is_empty kitchen
boilerAgent                    Belief changed: is_empty kitchen
21:0 - LightSystem turned on in stairs
21:0 - LightSystem turned off in kitchen
3:22:00 house                          Belief changed: not is_empty firstLiving
house                          Belief changed: is_empty stairs
lightAgent                     Belief changed: not is_empty firstLiving
boilerAgent                    Belief changed: not is_empty firstLiving
lightAgent                     Belief changed: is_empty stairs
boilerAgent                    Belief changed: is_empty stairs
22:0 - LightSystem turned on in firstLiving
22:0 - LightSystem turned off in stairs
3:22:30 house                          Belief changed: not is_empty privateBathroom
house                          Belief changed: is_empty privateBathroom
```

```
house                          Belief changed: is_empty firstLiving
house                          Belief changed: not is_empty privateBathroom
house                          Belief changed: is_empty privateBathroom
lightAgent                     Belief changed: not is_empty privateBathroom
boilerAgent                    Belief changed: not is_empty privateBathroom
lightAgent                     Belief changed: is_empty privateBathroom
boilerAgent                    Belief changed: is_empty privateBathroom
lightAgent                     Belief changed: is_empty firstLiving
boilerAgent                    Belief changed: is_empty firstLiving
lightAgent                     Belief changed: not is_empty privateBathroom
boilerAgent                    Belief changed: not is_empty privateBathroom
lightAgent                     Belief changed: is_empty privateBathroom
boilerAgent                    Belief changed: is_empty privateBathroom
22:30 - LightSystem turned on in privateBathroom
22:30 - LightSystem turned off in firstLiving
4:00:00 Watts consumed today: 375 W
4:07:00 house                          Belief changed: not is_empty kitchen
house                          Belief changed: not is_empty masterBedroom
lightAgent                     Belief changed: not is_empty kitchen
boilerAgent                    Belief changed: not is_empty kitchen
lightAgent                     Belief changed: not is_empty masterBedroom
boilerAgent                    Belief changed: not is_empty masterBedroom
7:0 - LightSystem turned on in kitchen
7:0 - LightSystem turned on in masterBedroom
4:07:30 house                          Belief changed: not is_empty groundLiving
house                          Belief changed: is_empty kitchen
house                          Belief changed: is_empty masterBedroom
house                          Belief changed: not is_empty privateBathroom
lightAgent                     Belief changed: not is_empty groundLiving
boilerAgent                    Belief changed: not is_empty groundLiving
lightAgent                     Belief changed: is_empty kitchen
boilerAgent                    Belief changed: is_empty kitchen
lightAgent                     Belief changed: is_empty masterBedroom
boilerAgent                    Belief changed: is_empty masterBedroom
lightAgent                     Belief changed: not is_empty privateBathroom
boilerAgent                    Belief changed: not is_empty privateBathroom
7:30 - LightSystem turned on in groundLiving
7:30 - LightSystem turned off in kitchen
7:30 - LightSystem turned off in masterBedroom
4:08:00 house                          Belief changed: is_empty groundLiving
house                          Belief changed: is_empty privateBathroom
house                          Belief changed: not is_empty drawer
lightAgent                     Belief changed: is_empty groundLiving
boilerAgent                    Belief changed: is_empty groundLiving
lightAgent                     Belief changed: is_empty privateBathroom
boilerAgent                    Belief changed: is_empty privateBathroom
```

```
lightAgent                    Belief changed: not is_empty drawer
boilerAgent                   Belief changed: not is_empty drawer
8:0 - LightSystem turned off in groundLiving
8:0 - LightSystem turned off in privateBathroom
8:0 - LightSystem turned on in drawer
4:09:00 house                         Belief changed: is_empty drawer
house                         Belief changed: not is_empty firstLiving
lightAgent                    Belief changed: is_empty drawer
boilerAgent                   Belief changed: is_empty drawer
lightAgent                    Belief changed: not is_empty firstLiving
boilerAgent                   Belief changed: not is_empty firstLiving
9:0 - LightSystem turned off in drawer
9:0 - LightSystem turned on in firstLiving
4:10:00 house                         Belief changed: is_empty firstLiving
house                         Belief changed: not is_empty stairs
lightAgent                    Belief changed: is_empty firstLiving
boilerAgent                   Belief changed: is_empty firstLiving
lightAgent                    Belief changed: not is_empty stairs
boilerAgent                   Belief changed: not is_empty stairs
10:0 - LightSystem turned off in firstLiving
10:0 - LightSystem turned on in stairs
4:11:00 house                         Belief changed: is_empty stairs
house                         Belief changed: not is_empty kitchen
lightAgent                    Belief changed: is_empty stairs
boilerAgent                   Belief changed: is_empty stairs
lightAgent                    Belief changed: not is_empty kitchen
boilerAgent                   Belief changed: not is_empty kitchen
11:0 - LightSystem turned off in stairs
11:0 - LightSystem turned on in kitchen
4:12:00 house                         Belief changed: is_empty kitchen
house                         Belief changed: not is_empty groundLiving
lightAgent                    Belief changed: is_empty kitchen
boilerAgent                   Belief changed: is_empty kitchen
lightAgent                    Belief changed: not is_empty groundLiving
boilerAgent                   Belief changed: not is_empty groundLiving
12:0 - LightSystem turned off in kitchen
12:0 - LightSystem turned on in groundLiving
4:13:00 house                         Belief changed: is_empty groundLiving
house                         Belief changed: not is_empty kitchen
lightAgent                    Belief changed: is_empty groundLiving
boilerAgent                   Belief changed: is_empty groundLiving
lightAgent                    Belief changed: not is_empty kitchen
boilerAgent                   Belief changed: not is_empty kitchen
13:0 - LightSystem turned off in groundLiving
13:0 - LightSystem turned on in kitchen
4:14:00 house                         Belief changed: is_empty kitchen
```

```
house                          Belief changed: not is_empty stairs
lightAgent                     Belief changed: is_empty kitchen
boilerAgent                    Belief changed: is_empty kitchen
lightAgent                     Belief changed: not is_empty stairs
boilerAgent                    Belief changed: not is_empty stairs
14:0 - LightSystem turned off in kitchen
14:0 - LightSystem turned on in stairs
4:15:30 house                          Belief changed: not is_empty lobby
house                          Belief changed: is_empty stairs
house                          Belief changed: not is_empty firstLiving
lightAgent                     Belief changed: not is_empty lobby
boilerAgent                    Belief changed: not is_empty lobby
lightAgent                     Belief changed: is_empty stairs
boilerAgent                    Belief changed: is_empty stairs
lightAgent                     Belief changed: not is_empty firstLiving
boilerAgent                    Belief changed: not is_empty firstLiving
15:30 - LightSystem turned on in lobby
15:30 - LightSystem turned off in stairs
15:30 - LightSystem turned on in firstLiving
4:16:30 house                          Belief changed: not is_empty stairs
house                          Belief changed: is_empty lobby
lightAgent                     Belief changed: not is_empty stairs
boilerAgent                    Belief changed: not is_empty stairs
lightAgent                     Belief changed: is_empty lobby
boilerAgent                    Belief changed: is_empty lobby
16:30 - LightSystem turned on in stairs
16:30 - LightSystem turned off in lobby
4:18:30 house                          Belief changed: not is_empty kitchen
house                          Belief changed: is_empty firstLiving
lightAgent                     Belief changed: not is_empty kitchen
boilerAgent                    Belief changed: not is_empty kitchen
lightAgent                     Belief changed: is_empty firstLiving
boilerAgent                    Belief changed: is_empty firstLiving
18:30 - LightSystem turned on in kitchen
18:30 - LightSystem turned off in firstLiving
4:19:00 house                          Belief changed: is_empty stairs
lightAgent                     Belief changed: is_empty stairs
boilerAgent                    Belief changed: is_empty stairs
19:0 - LightSystem turned off in stairs
4:21:00 house                          Belief changed: not is_empty stairs
house                          Belief changed: is_empty kitchen
lightAgent                     Belief changed: not is_empty stairs
boilerAgent                    Belief changed: not is_empty stairs
lightAgent                     Belief changed: is_empty kitchen
boilerAgent                    Belief changed: is_empty kitchen
21:0 - LightSystem turned on in stairs
```

```
21:0 - LightSystem turned off in kitchen
4:22:00 house                          Belief changed: not is_empty firstLiving
house                          Belief changed: is_empty stairs
lightAgent                     Belief changed: not is_empty firstLiving
boilerAgent                    Belief changed: not is_empty firstLiving
lightAgent                     Belief changed: is_empty stairs
boilerAgent                    Belief changed: is_empty stairs
22:0 - LightSystem turned on in firstLiving
22:0 - LightSystem turned off in stairs
4:22:30 house                          Belief changed: not is_empty privateBathroom
house                          Belief changed: is_empty privateBathroom
house                          Belief changed: is_empty firstLiving
house                          Belief changed: not is_empty privateBathroom
house                          Belief changed: is_empty privateBathroom
lightAgent                     Belief changed: not is_empty privateBathroom
boilerAgent                    Belief changed: not is_empty privateBathroom
lightAgent                     Belief changed: is_empty privateBathroom
boilerAgent                    Belief changed: is_empty privateBathroom
lightAgent                     Belief changed: is_empty firstLiving
boilerAgent                    Belief changed: is_empty firstLiving
lightAgent                     Belief changed: not is_empty privateBathroom
boilerAgent                    Belief changed: not is_empty privateBathroom
lightAgent                     Belief changed: is_empty privateBathroom
boilerAgent                    Belief changed: is_empty privateBathroom
22:30 - LightSystem turned on in privateBathroom
22:30 - LightSystem turned off in firstLiving
5:00:00 Watts consumed today: 375 W
5:09:30 house                          Belief changed: not is_empty masterBedroom
house                          Belief changed: is_empty masterBedroom
house                          Belief changed: not is_empty masterBedroom
house                          Belief changed: is_empty masterBedroom
lightAgent                     Belief changed: not is_empty masterBedroom
boilerAgent                    Belief changed: not is_empty masterBedroom
lightAgent                     Belief changed: is_empty masterBedroom
boilerAgent                    Belief changed: is_empty masterBedroom
lightAgent                     Belief changed: not is_empty masterBedroom
boilerAgent                    Belief changed: not is_empty masterBedroom
lightAgent                     Belief changed: is_empty masterBedroom
boilerAgent                    Belief changed: is_empty masterBedroom
9:30 - LightSystem turned on in masterBedroom
5:10:00 house                          Belief changed: not is_empty drawer
lightAgent                     Belief changed: not is_empty drawer
boilerAgent                    Belief changed: not is_empty drawer
10:0 - LightSystem turned on in drawer
5:10:30 house                          Belief changed: not is_empty lobby
house                          Belief changed: is_empty drawer
```

```
house                          Belief changed: not is_empty stairs
lightAgent                     Belief changed: not is_empty lobby
boilerAgent                    Belief changed: not is_empty lobby
lightAgent                     Belief changed: is_empty drawer
boilerAgent                    Belief changed: is_empty drawer
lightAgent                     Belief changed: not is_empty stairs
boilerAgent                    Belief changed: not is_empty stairs
10:30 - LightSystem turned on in lobby
10:30 - LightSystem turned off in drawer
10:30 - LightSystem turned on in stairs
5:11:00 house                          Belief changed: is_empty lobby
house                          Belief changed: is_empty stairs
lightAgent                     Belief changed: is_empty lobby
boilerAgent                    Belief changed: is_empty lobby
lightAgent                     Belief changed: is_empty stairs
boilerAgent                    Belief changed: is_empty stairs
11:0 - LightSystem turned off in lobby
11:0 - LightSystem turned off in stairs
5:22:00 house                          Belief changed: not is_empty lobby
lightAgent                     Belief changed: not is_empty lobby
boilerAgent                    Belief changed: not is_empty lobby
22:0 - LightSystem turned on in lobby
5:22:30 house                          Belief changed: not is_empty firstLiving
house                          Belief changed: is_empty lobby
lightAgent                     Belief changed: not is_empty firstLiving
boilerAgent                    Belief changed: not is_empty firstLiving
lightAgent                     Belief changed: is_empty lobby
boilerAgent                    Belief changed: is_empty lobby
22:30 - LightSystem turned on in firstLiving
22:30 - LightSystem turned off in lobby
6:00:00 Watts consumed today: -755 W
6:09:30 house                          Belief changed: not is_empty masterBedroom
house                          Belief changed: is_empty masterBedroom
house                          Belief changed: is_empty firstLiving
house                          Belief changed: not is_empty masterBedroom
house                          Belief changed: is_empty masterBedroom
lightAgent                     Belief changed: not is_empty masterBedroom
boilerAgent                    Belief changed: not is_empty masterBedroom
lightAgent                     Belief changed: is_empty masterBedroom
boilerAgent                    Belief changed: is_empty masterBedroom
lightAgent                     Belief changed: is_empty firstLiving
boilerAgent                    Belief changed: is_empty firstLiving
lightAgent                     Belief changed: not is_empty masterBedroom
boilerAgent                    Belief changed: not is_empty masterBedroom
lightAgent                     Belief changed: is_empty masterBedroom
boilerAgent                    Belief changed: is_empty masterBedroom
```

```
9:30 - LightSystem turned off in firstLiving
6:10:00 house                          Belief changed: not is_empty drawer
lightAgent                     Belief changed: not is_empty drawer
boilerAgent                    Belief changed: not is_empty drawer
10:0 - LightSystem turned on in drawer
6:10:30 house                          Belief changed: not is_empty lobby
house                          Belief changed: is_empty drawer
house                          Belief changed: not is_empty stairs
lightAgent                     Belief changed: not is_empty lobby
boilerAgent                    Belief changed: not is_empty lobby
lightAgent                     Belief changed: is_empty drawer
boilerAgent                    Belief changed: is_empty drawer
lightAgent                     Belief changed: not is_empty stairs
boilerAgent                    Belief changed: not is_empty stairs
10:30 - LightSystem turned on in lobby
10:30 - LightSystem turned off in drawer
10:30 - LightSystem turned on in stairs
6:11:00 house                          Belief changed: is_empty lobby
house                          Belief changed: is_empty stairs
lightAgent                     Belief changed: is_empty lobby
boilerAgent                    Belief changed: is_empty lobby
lightAgent                     Belief changed: is_empty stairs
boilerAgent                    Belief changed: is_empty stairs
11:0 - LightSystem turned off in lobby
11:0 - LightSystem turned off in stairs
6:22:00 house                          Belief changed: not is_empty lobby
lightAgent                     Belief changed: not is_empty lobby
boilerAgent                    Belief changed: not is_empty lobby
22:0 - LightSystem turned on in lobby
6:22:30 house                          Belief changed: not is_empty firstLiving
house                          Belief changed: is_empty lobby
lightAgent                     Belief changed: not is_empty firstLiving
boilerAgent                    Belief changed: not is_empty firstLiving
lightAgent                     Belief changed: is_empty lobby
boilerAgent                    Belief changed: is_empty lobby
22:30 - LightSystem turned on in firstLiving
22:30 - LightSystem turned off in lobby
7:00:00 Watts consumed today: 515 W
7:09:30 house                          Belief changed: not is_empty masterBedroom
house                          Belief changed: is_empty masterBedroom
house                          Belief changed: is_empty firstLiving
house                          Belief changed: not is_empty masterBedroom
house                          Belief changed: is_empty masterBedroom
lightAgent                     Belief changed: not is_empty masterBedroom
boilerAgent                    Belief changed: not is_empty masterBedroom
lightAgent                     Belief changed: is_empty masterBedroom
```

```
boilerAgent                    Belief changed: is_empty masterBedroom
lightAgent                     Belief changed: is_empty firstLiving
boilerAgent                    Belief changed: is_empty firstLiving
lightAgent                     Belief changed: not is_empty masterBedroom
boilerAgent                    Belief changed: not is_empty masterBedroom
lightAgent                     Belief changed: is_empty masterBedroom
boilerAgent                    Belief changed: is_empty masterBedroom
9:30 - LightSystem turned off in firstLiving
7:10:00 house                          Belief changed: not is_empty drawer
lightAgent                     Belief changed: not is_empty drawer
boilerAgent                    Belief changed: not is_empty drawer
10:0 - LightSystem turned on in drawer
7:10:30 house                          Belief changed: not is_empty lobby
house                          Belief changed: is_empty drawer
house                          Belief changed: not is_empty stairs
lightAgent                     Belief changed: not is_empty lobby
boilerAgent                    Belief changed: not is_empty lobby
lightAgent                     Belief changed: is_empty drawer
boilerAgent                    Belief changed: is_empty drawer
lightAgent                     Belief changed: not is_empty stairs
boilerAgent                    Belief changed: not is_empty stairs
10:30 - LightSystem turned on in lobby
10:30 - LightSystem turned off in drawer
10:30 - LightSystem turned on in stairs
7:11:00 house                          Belief changed: is_empty lobby
house                          Belief changed: is_empty stairs
lightAgent                     Belief changed: is_empty lobby
boilerAgent                    Belief changed: is_empty lobby
lightAgent                     Belief changed: is_empty stairs
boilerAgent                    Belief changed: is_empty stairs
11:0 - LightSystem turned off in lobby
11:0 - LightSystem turned off in stairs
7:22:00 house                          Belief changed: not is_empty lobby
lightAgent                     Belief changed: not is_empty lobby
boilerAgent                    Belief changed: not is_empty lobby
22:0 - LightSystem turned on in lobby
7:22:30 house                          Belief changed: not is_empty firstLiving
house                          Belief changed: is_empty lobby
lightAgent                     Belief changed: not is_empty firstLiving
boilerAgent                    Belief changed: not is_empty firstLiving
lightAgent                     Belief changed: is_empty lobby
boilerAgent                    Belief changed: is_empty lobby
22:30 - LightSystem turned on in firstLiving
22:30 - LightSystem turned off in lobby
8:00:00 Watts consumed today: 515 W
```

4 Source Code Organization

- 223716_Luchetta_Simone_Report_ASA.pdf: Report in PDF format.
- TFD: folder with the Temporal Fast Downward planner.
- src/: main code.
  - houseworld: main scenario, entities, agents and the executable HouseWorld.js file.
    - agents: folder containing all agents.
    - entities: folder containing all entities.

All is available at the following Github repository: Click Me.