Final Project

Autonomous Software Agents - UniTn 2021/2022

Emiliano Tolotti

Introduction

The project consists in a multi agent implementation of a smart house environment. The smart home contains connected smart devices that help people accomplish some tasks in order to increase comfort. The domotic components can be controlled by agents to achieve automation and increase utility.
The smart house has a number of connected and remotely controllable smart devices that can be activated both manually and also by a main house agent system that manages their behavior, considering the context and being responsive to residents intentions.
The agent has the ability to manage the devices in order to minimize utilities costs along with scheduling and optimizing tasks with automated behavior. Agents have the ability to reason and plan. They can coordinate and negotiate with other agents or house residents to fulfill the goals.

House description and blueprint

House blueprint

The smart home is a little house with a single floor, a garage and a garden. There is an open space including living room, kitchen and corridor, a big bedroom, a little studio room, a bathroom and a tiny hall. Rooms can have sliding or standard opening doors.

Rooms

Every room has an independent thermostat with temperature probe, a light sensor, and an occupancy detection sensor, for the control of independent heating and light.

Kitchen

The kitchen shares the space with the living room, and has a single dedicated window. It is accessible by the living room only. In the kitchen there are many lights, and curtains. It is a heated environment and it is cleaned by the vacuum bot.

Living room

The living room is in the same open space as the kitchen and it is the main room of the house, where residents spent most time in. It is accessible from the main house entrance after the hall as well as from the corridor. It has many lights and curtains. It is heated and gets cleaned by the bot.

Bedroom

The bedroom is used at night, it has a main smart light and a TV. It is accessible from the corridor with a sliding door. It is a heated and ventilated environment and is cleaned by the bot.

Studio

The studio room has a main smart light and it is accessible from the corridor with a sliding door. It is heated and cleaned.

Bathroom

The bathroom is accessible via the corridor, through a standard opening door. It has some lights and a washing machine. It is heated, but it is not cleaned by the vacuum bot.

Entrance

The tiny foyer is the main entrance of the house and accesses the living room through a sliding door. It has a single light, it is not heated, but it is cleaned by the bot.

Garage
The garage is used to store the cars, it is not heated nor cleaned by the vacuum robot. It has a door that opens to the corridor for accessing the house. It has a main smart light.

Garden
The garden is used by the residents to relax outside and sometimes it is used to host parties. It is irrigated automatically.

Devices

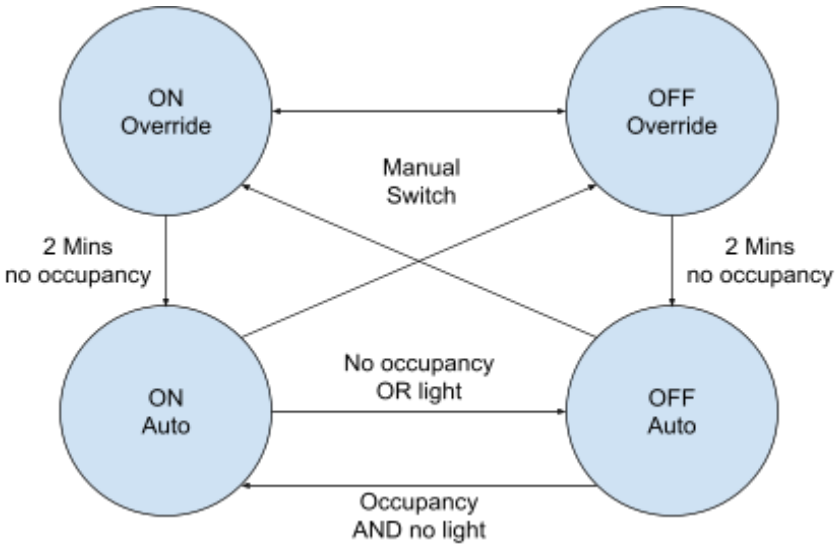
Lights
Lights provide illuminations to rooms which might have no light, for example at night time.

Statuses:
status:

on: light is on
off: light is off
on_override: light is on by switch action
off_override: light is off by switch action

intensity:

number: intensity value from 0 to 100



Lights FSM

Actions:
switch_on_light: turn on the light
switch_off_light: turn off the light
switch_on_light_override: turn on the light manually
switch_off_light_override: turn off the light manually

Lights are automatically turned on and off for a room depending on the occupancy and available light. The illumination intensity is operated with a dimmer based on the light sensor reading before the illumination is turned on. The light can be turned on with maximum brightness with manual action on the switch. The lights in the rooms are dimmable, and can consume from 10W up to 50W, when turned on.

Irrigation
The irrigation system is used to water the garden.

Statuses:
status:
- on: watering is active
- off: watering is inactive

Actions:
open_valve: start irrigating
close_valve: stop irrigating

Irrigation has scheduled times, but operation is based on the reading of a soil hygrometer sensor and the occupation detection, combined with the rain probability by weather forecasts. If the system detects a persistent occupation of the garden then the needed irrigation is delayed.

Curtains
Curtains are opened when residents are at home, by monitoring the occupation sensors. They increase the light in the room by the external light value.

Statuses:
status:
- up: curtains is open
- down: curtains is closed

Actions:
open_curtains: open the curtains
close_curtains: close the curtains

Heating

Every room has an independent thermostat and heating. The temperature is lowered in case of non-occupancy and gets heated when the residents are home. Heating consumes gas.

Statuses:

status:

- on: heating is in progress
- off: heating is off

Actions:

start_heating: start the heating process
stop_heating: stop the heating process

Boiler

The water boiler is used for domestic water heating. It can operate with both gas and solar hot water panels. It tries to keep water at a minimum temperature, increasing it when below that threshold. If the solar temperature is high enough then solar energy is used to increase the water temperature, otherwise the gas water heater is used.

Statuses:

heating_gas:

- on: heating with gas in progress
- off: heating with gas not in progress

heating_solar:

- on: heating with solar in progress
- off: heating with solar not in progress

Actions:

start_gas: heat water with gas combustion
start_solar: heat water with solar fluid
stop_gas: stop gas combustion
stop_solar: stop solar pump

Vacuum

The vacuum robot cleans the rooms. It can move between rooms that share a sliding door and clean them. It needs to be charged, and it can clean two rooms with a full battery.

Statuses:

status:
    on: heating with gas in progress
    off: heating with gas not in progress
in_room:
    room: room where it is
battery:
    number: charge value from 0 to 100

Actions:

move_to_room: move to a room
clean: clean the room
charge: recharge the battery

Metrics

Gas cost

Gas is used to warm up water, both for house heating and for domestic water heating. Cost of gas is 1€/mc, and the estimated annual use for house heating is 800mc for keeping temperature 20°C, while the annual usage for hot water is 200mc without solar panels. Heating gas usage can be assumed to vary linearly in the temperature in a range close to 20°C (18 - 22), with a saving of 80mc/°C.

Electricity consumption

Electricity is consumed by devices. In particular lights can be dimmed to obtain a target light intensity and to decrease consumption. Also charging the vacuum robot consumes electricity.

Cleaning time

The vacuum cleaner robot takes 15 minutes to clean a room, 5 minutes moving between different rooms and 30 minutes for charging a full battery. If a room can not be cleaned the robot choses a different while the previous frees.

People and agents

People

The residents in the house are 2 people, Anna and Bob. A person can be in one room at a time, or out of home. Anna is out-of-house from 7.45 to 13.00 from monday to friday, while Bob works outside home from 6.30 to 18.00. On saturday and sunday there is no strict routine so they might leave at different hours and usually they spend some time in the garden. Sometimes they might also set up some parties at home and invite guests. People can move between adjacent rooms (that share a door) and can act on devices (by calling their methods).

House agent

The house agent manages the smart devices in order to provide an autonomous behavior combining them to meet the goals and to optimize consumption. The house agent is responsible for the activation and deactivation of events for all house devices.

Lights

The agent switches on the lights when people enter a room based on the occupancy sensor, and the light intensity is dimmed to save energy. The lights can be operated manually via switches. In this case the agent overrides the automatic behavior giving a full brightness level. The agent returns to an automatic light behavior after some time no room occupancy is detected.

TurnOnLightGoal (TurnOnLightIntention)
It switches on the light calling the device method if the light is off in auto mode.

TurnOffLightGoal (TurnOffLightIntention)
It switches off the light calling the device method if the light is on in auto mode.

LightIntensityGoal(LightIntensityIntention)
If modifies the light intensity value based on the light probe belief, in order to reach a target illumination value.

ReturnToNormalGoal (ReturnToNormalIntention)
This goal is posted when a light is overridden and the room becomes unoccupied. The intention waits for some time after which if the room has not been occupied the light returns to auto mode, otherwise the goal fails.

LightOccupationGoal (LightOccupationIntention)
This goal waits for an occupation change of the room posting a TurnOnLightGoal if the room gets occupied or a TurnOffLightGoal if it gets unoccupied. If the room gets unoccupied with an overridden light, then a ReturnToNormalGoal is posted.

Heating

The agent warms up the rooms based on a floor temperature and the room occupancy. The room heating is activated when temperature lowers under a certain point and reaches a target temperature. Moreover the heating increases when a persistent occupation in a room is detected.

KeepHeatedOccupationGoal (KeepHeatedOccupationIntention)
If the room is occupied, wait for a long occupation. If the room is still occupied then start heating to achieve a high temperature target. If the room is already heating up, wait for the other intention to finish, then keep the room heated between a medium to high temperature until the room gets unoccupied.

HeatUpGoal (HeatUpIntention)
If the room temperature is low then heat it until a medium temperature level is reached.

HeatRoomsGoal (HeatRoomsIntention)
When the room temperature drops low, post a HeatUpGoal.

HeatOccupationGoal (HeatOccupationIntention)
This intention subscribes to an occupation change of the room, and posts a KeepHeatedOccupationGoal if the room gets occupied.

Irrigation

The irrigation system is activated at scheduled times based on the rain probability provided by weather forecasts and the soil humidity sensor reading. If the garden is not occupied by people detected via surveillance video data analysis, the irrigation process starts and the time needed is computed by the previous readings. If the garden area gets occupied with a certain persistence then the agent stops the irrigation waiting for a non occupation time to resume the process later.

IrrigationGoal (IrrigationIntention)
Schedule of the irrigation, when a certain time is reached, a IrrigateGoal is posted.

IrrigateGoal (IrrigateIntention)
If the rain probability is high or the ground humidity is high then the goal fails, otherwise start irrigating. If an occupation of the garden is detected, the irrigation stops, and resumes when the garden is unoccupied.

Curtains

The automated curtains are opened by the agent when residents are home (wifi connection detected), and are closed when the house is empty.

OpenCurtainsGoal (OpenCurtainsIntention)
It opens the curtains if they are not already opened, otherwise it fails.

CloseCurtainsGoal (CloseCurtainsIntention)
It closes the curtains if they are not already closed, otherwise it fails.

CurtainsHouseOccupiedGoal (CurtainsHouseOccupiedIntention)
This goal waits for an occupation change of the house, posting a OpenCurtainsGoal if the house gets occupied or a CloseCurtainsGoal if it gets unoccupied.

Boiler

The agent also manages the hot water system, acting over the boiler in order to minimize gas usage. The boiler water temperature is kept over a minimum value, and gets warmed up when the solar panels temperature is higher allowing for almost free heat exchange. In absence of solar energy the water is warmed with gas combustion, and the agent activates the process based on the scheduling and the need for hot water by residents. Provided that the gas combustion mode has a high power and the boiler capacity is enough, the agent allows for a lower boiler temperature (with respect to solar mode) when idling to save energy and costs, while still providing enough hot water activating the combustion when needed.

HeatGoal (HeatSolarIntention, HeatGasIntention)
This goal aims to heat up the boiler water. The HeatSolarIntention tries to heat up the water with the solar fluid, and it keeps heating until the solar fluid temperature is reached. If the solar temperature is low, then this intention fails, and the HeatGasIntention heats up the water.

Robot vacuum agent

The vacuum agent is an autonomous planning agent, and has the ability to plan the movements and the cleaning between the not occupied rooms. The robot is able to autonomously move among the rooms through the sliding doors and clean them daily. The robot tries to clean a room if it is not occupied. It needs to be charged every two cleaned rooms, and to accomplish that it moves to the charging station and waits until it is fully charged. The agent tries to minimize the cleaning time

moving to the free rooms and clean them waiting for the others to be not occupied. In case the rooms to be cleaned are all occupied the robot charges fully while waiting.

```
;; domain file: vacuum_domain.pddl
(define (domain vacuumbot)
      (:requirements :strips)
      (:predicates
            (in-room ?r)
            (door ?from ?to)
            (room_occupied ?r)
            (cleaned ?r)
            (base ?r)
            (charge-high)
            (charge-med)
            (charge-low)
      )
      (:action Move
            :parameters (?from ?to)
            :precondition (and (in-room ?from) (door ?from ?to))
            :effect (and (not (in-room ?from)) (in-room ?to))
      )
      (:action Clean1
            :parameters (?r)
            :precondition (and (in-room ?r) (not (room_occupied ?r))
(charge-high))
            :effect (and (cleaned ?r) (charge-med) (not (charge-high)))
      )
      (:action Clean2
            :parameters (?r)
            :precondition (and (in-room ?r) (not (room_occupied ?r))
(charge-med))
            :effect (and (cleaned ?r) (charge-low) (not (charge-med)))
      )
      (:action Charge
            :parameters (?r)
            :precondition (and (in-room ?r) (base ?r))
            :effect (and (charge-high) (not (charge-low)) (not
(charge-med)))
      )
)
```

Planning domain file

Predicates

in-room ?r: indicates if the robot is in room *r*
door ?from ?to: indicates if rooms *from* and *to* are adjacent
room_occupied ?r: indicates if the room *r* is occupied
cleaned ?r: indicates if the room r is cleaned
base ?r: indicates if the base is in room *r*
charge-high: indicates if the robot has high battery level
charge-med: indicates if the robot has medium battery level
charge-low: indicates if the robot has low battery level

Actions

Move: allows the robot to move between rooms that share a door
Clean1: cleans the room the robot is in, if not occupied and with high charge
Clean2: cleans the room the robot is in, if not occupied and with medium charge
Charge: allows to fully charge the robot if it is in the charging base room

```
;; problem file: vacuum_problem.pddl
(define (problem cleanhouse)
      (:domain vacuumbot)
      (:objects kitchen bedroom studio entrance livingroom)
      (:init
            (in-room livingroom)
            (base livingroom)
            (charge-high)
            (door livingroom kitchen)
            (door kitchen livingroom)
            (door livingroom bedroom)
            (door bedroom livingroom)
            (door livingroom studio)
            (door studio livingroom)
            (door livingroom entrance)
            (door entrance livingroom))
      (:goal
            (and
                  (cleaned livingroom)
                  (cleaned kitchen)
                  (cleaned bedroom)
                  (cleaned studio)
                  (cleaned entrance)
                  (charge-high)))
)
```

Example problem the planner can solve, cleaning all rooms and then charging the robot

CleanRoomsGoal (CleanRoomsIntention)
This goal aims at cleaning the rooms that have been given by the house agent. It assumes that the rooms should be cleaned so initializes the agent belief for the rooms as *not cleaned*. Then it asks for room occupation at the house agent, updates the belief set based on occupation, and pushes a pddl goal to clean the available rooms and obtain a plan from the OnlinePlanner. The resulting pddl goal is then posted, and executed by the pddl action intentions. If the plan fails, a new iteration as the one above is run again until a maximum number of trials is achieved. If all the rooms to be cleaned are occupied, a subscription for a change of the occupation to the house agent is made, and after waiting for a change a new iteration is performed.

Move - pddlActionIntention
This intention represents the move action of the planner. It checks for preconditions and then applies the device move method, applying the effects after it concludes.

Clean1 - pddlActionIntention
The clean intention allows the root to clean a room. Before checking the preconditions the bot agent updates the belief about the target room occupation asking the house agent. If the room is clear, then the device method and effects are applied, otherwise the plan goal fails.

Clean2 - pddlActionIntention
Same as above, with the difference in the effect of the action, since the above intention is applied with a high battery level to achieve a medium level, and this one with a medium battery level to achieve a low one.

Charge - pddlActionIntention
This intention is for charging the vacuum device, which requires to be in the charging base room. If the precondition is valid, the device method is called, which charges the battery to the maximum level.

Implementation

Environment

The agents act in a world environment that is represented by the house object. It contains some properties that are observable. The change of the state of these properties is controlled via a simulated environment behavior.

External light

It is simulated increasing during daytime and decreasing during nighttime, and it influences the internal light of the rooms.

Rain probability
It is set for every day, representing the weather forecast and influences the decision of the agent of irrigating the garden.

Humidity probe
It is set externally every day and its belief is used for the irrigation system.

Solar probe
It increases and decreases gradually during the day, simulating the temperature change in the presence of sunlight.

Room temperature
The room temperature is simulated to be lowering gradually when no heating in the room is in process.

Sensors and agent perception
The sensors of the environment properties are implemented as goals and intentions of the house agent that updates its internal belief set when a change is notified. Both probes and device status are sensed.

Light probes
Rooms have light probes that are influenced by external light, room lights and curtains. The agent belief set of a light sensor can be:

- light_low <room name>
- light_med <room name>
- light_high <room name>

Temperature probes
Rooms have temperature probes that are influenced by the heating, the value increases and decreases constantly when heating is on or off. Belief values can be:

- temperature_low <room name>
- temperature_med <room name>
- temperature_high <room name>

Occupation
Rooms have occupation sensors that detect if at least one person is in the room or in the house. Predicates are:

- room_occupied <room name>
- house_occupied

Boiler probes

Water boiler has probes that read the temperature of the boiler water and of the solar fluid.

- boiler-temperature-low: water in boiler is cold
- boiler-temperature-high: water in boiler is warm
- heat-solar: use solar fluid to heat up water
- heat-gas: solar fluid is cold, use gas

Irrigation probes

The irrigation system uses a humidity sensor to decide if irrigation is needed, and it also senses the weather forecasts (probability of rain) and changes the agent beliefset.

- humidity-low
- humidity-high
- rain-probability-low
- rain-probability-high

Agents acting in a shared environment

The agent acts on devices reflecting the internal beliefs (not sensors directly) and takes actions (reacts) based on belief set changes or schedule. The agent acts on the devices by activating their own method, which triggers an environment change (which should correspond to the agent expectation). And the control loop acts again modifying sensor statuses and agent beliefs that lead to other agent intentions.

For example when lights are turned on the light probe value increases and the light intensity is changed to reach a target value. If curtains are up, light changes and this reflects a new change in the light bulb intensity.

The heating device action triggers a gradual temperature increment, which is then sensed and the agent stops the device.

Agent interaction and coordination

The setting is of benevolent agents and the cooperation level is with information sharing. Agents can communicate with each other. The communication mechanism is by means of goals that are pushed from one agent to the other. In particular a request response mechanism has been implemented with goals. For example an agent can request a belief to another agent, or it can subscribe to a belief change of the other agent. This is used for the botagent that has no sensing capability and requires the house agent to communicate the occupation beliefset. With this setting, agents can also delegate to other agents some goals, for example the house agent at a certain schedule time delegates to the botagent the goal of cleaning the house since it does not have this capability.

Scenarios

Two scenarios have been considered. An example of weekdays (3) with mostly autonomous agent activation of devices, and an example of a weekend day with an added person in the house, and different actions of the people in the house with manual behavior.

Running the scenarios - Scenario1

```
0:06:00 Bob moved to livingroom
houseagent>SensePeopleIntention#2 sense: person Bob in room livingroom
houseagent  Belief changed: not in_room Bob bedroom
houseagent  Belief changed: in_room Bob livingroom
houseagent  Belief changed: room_occupied livingroom
houseagent  Trying to use intention TurnOnLightIntention to achieve goal
{TurnOnLightGoal#48:{light:"livingroom"}}
houseagent>TurnOnLightIntention#48 Intention started
houseagent  Trying to use intention Probe light livingroom is 100
livingroom light turned on
houseagent>SenseLightProbesIntention#4  sense:  light_probe  livingroom
switched high
houseagent>SenseLightsIntention#3 sense: light livingroom switched on
houseagent>TurnOnLightIntention#48 Intention success
houseagent  Succesfully  used  intention  TurnOnLightIntention  to  achieve
goal {TurnOnLightGoal#48:{light:"livingroom"}}
```

This log snippet shows the first movement in the house. Bob moves to the living room, and it triggers the turn on of the living room lights.

```
0:06:15 Bob moved to kitchen
Probe temperature water is 35
houseagent  Belief changed: boiler-temperature-low
houseagent  Trying  to  use  intention  HeatSolarIntention  to  achieve  goal
{HeatWaterGoal#59:{water_heating:{boiler:"boiler",water_probe:"temperat
ure water",solar_probe:"temperature solar"}}}
houseagent>HeatSolarIntention#59 Intention started
houseagent  Failed  to  use  intention  HeatSolarIntention  to  achieve  goal
{HeatWaterGoal#59:{water_heating:{boiler:"boiler",water_probe:"temperat
ure water",solar_probe:"temperature solar"}}}: Failed heating solar
```

```
houseagent Error: Failed heating solar
houseagent Trying to use intention HeatGasIntention to achieve goal
{HeatWaterGoal#59:{water_heating:{boiler:"boiler",water_probe:"temperat
ure water",solar_probe:"temperature solar"}}}
houseagent>HeatGasIntention#60 Intention started
boiler heating_gas on
0:06:20 Probe temperature water is 45
0:06:25 Probe temperature water is 55
0:06:30 Probe temperature water is 65
houseagent Belief changed: boiler-temperature-high
boiler heating_gas off
houseagent Succesfully used intention HeatGasIntention to achieve goal
{HeatWaterGoal#59:{water_heating:{boiler:"boiler",water_probe:"temperat
ure water",solar_probe:"temperature solar"}}}
```

The movement of Bob in the kitchen triggers an usage of hot water. As a consequence the boiler water temperature lowers and the house agent activates a heating goal. To fulfill the goal it tries with a solar heating intention, which fails due to a low solar water temperature and then the goal is satisfied by a gas heating intention that increases the temperature of the boiler after a few time steps.

```
0:07:00 Alice moved to livingroom
houseagent>SenseLightProbesIntention#4 sense: light_probe livingroom
switched med
houseagent>SensePeopleIntention#2 sense: person Alice in room
livingroom
houseagent Belief changed: not light_low livingroom
houseagent Belief changed: light_med livingroom
houseagent Belief changed: not in_room Alice bedroom
houseagent Belief changed: not room_occupied bedroom
houseagent Belief changed: in_room Alice livingroom
houseagent Belief changed: room_occupied livingroom
houseagent Trying to use intention ReturnToNormalIntention to achieve
goal {ReturnToNormalGoal#66:{light:"bedroom",after:10}}
houseagent>ReturnToNormalIntention#67 Intention started
houseagent Trying to use intention TurnOnLightIntention to achieve goal
{TurnOnLightGoal#67:{light:"livingroom"}}
houseagent>TurnOnLightIntention#68 Intention started
Probe light livingroom is 125
livingroom light turned on
houseagent>SenseLightProbesIntention#4 sense: light_probe livingroom
switched high
```

```
houseagent>SenseLightsIntention#3 sense: light livingroom switched on
houseagent Belief changed: not light_med livingroom
houseagent Belief changed: light_high livingroom
houseagent Belief changed: light_on livingroom
houseagent Belief changed: not light_off livingroom
Probe light livingroom is 75
livingroom light intensity turned 25
houseagent>SenseLightProbesIntention#4 sense: light_probe livingroom
switched med
houseagent Belief changed: light_med livingroom
houseagent Belief changed: not light_high livingroom
houseagent>TurnOnLightIntention#68 Intention success
houseagent Succesfully used intention TurnOnLightIntention to achieve
goal {TurnOnLightGoal#67:{light:"livingroom"}}
0:07:05 Alice moved to bedroom
houseagent>SensePeopleIntention#2 sense: person Alice in room bedroom
houseagent Belief changed: in_room Alice bedroom
houseagent Belief changed: room_occupied bedroom
houseagent Belief changed: not in_room Alice livingroom
houseagent Belief changed: not room_occupied livingroom
houseagent Trying to use intention TurnOffLightIntention to achieve
goal {TurnOffLightGoal#70:{light:"livingroom"}}
houseagent>TurnOffLightIntention#71 Intention started
Probe light livingroom is 50
livingroom light turned off
houseagent>SenseLightProbesIntention#4 sense: light_probe livingroom
switched med
houseagent>SenseLightsIntention#3 sense: light livingroom switched off
houseagent Belief changed: not light_on livingroom
houseagent Belief changed: light_off livingroom
houseagent Failed to use intention ReturnToNormalIntention to achieve
goal {ReturnToNormalGoal#66:{light:"bedroom",after:10}}: Failed, room
got occupied
houseagent Error: Failed, room got occupied
houseagent No success in achieving goal
{ReturnToNormalGoal#66:{light:"bedroom",after:10}}
houseagent Succesfully used intention TurnOffLightIntention to achieve
goal {TurnOffLightGoal#70:{light:"livingroom"}}
0:07:10 Alice moved to livingroom
houseagent Trying to use intention ReturnToNormalIntention to achieve
goal {ReturnToNormalGoal#71:{light:"bedroom",after:10}}
houseagent>ReturnToNormalIntention#72 Intention started
0:07:15 Alice moved to bathroom
```

```
0:07:20 Alice moved to livingroom
bedroom light turned off
houseagent>SenseLightsIntention#3 sense: light bedroom switched off
houseagent Belief changed: light_off bedroom
houseagent Belief changed: not light_off_override bedroom
houseagent>ReturnToNormalIntention#72 Intention success
houseagent Succesfully used intention ReturnToNormalIntention to
achieve goal {ReturnToNormalGoal#71:{light:"bedroom",after:10}}
```

When Alice wakes up and moves from bedroom to living room, the lights of the living room lights turn on, and since the bedroom is not occupied, the house agent tries to reach a goal of returning on automatic behavior of the bedroom lights that were overridden manually. At the next time step, Alice moves again to the bedroom and the return to auto behavior goal fails. When the bedroom is not occupied again, another goal for returning to auto is posted and after a few steps the intention succeeded.

```
0:07:45 Alice moved to null
houseagent>SensePeopleIntention#2 sense: person Alice in room null
houseagent Belief changed: not in_room Alice garage
houseagent Belief changed: not room_occupied garage
houseagent Belief changed: not house_occupied
houseagent Trying to use intention CloseCurtainsIntention to achieve
goal {CloseCurtainsGoal#93:{curtain:"kitchen"}}
houseagent>CloseCurtainsIntention#94 Intention started
houseagent Trying to use intention CloseCurtainsIntention to achieve
goal {CloseCurtainsGoal#94:{curtain:"livingroom"}}
houseagent>CloseCurtainsIntention#95 Intention started
kitchen curtains down
Probe light kitchen is 0
livingroom curtains down
Probe light livingroom is 0
houseagent>SenseLightProbesIntention#4 sense: light_probe kitchen
switched low
houseagent>SenseLightProbesIntention#4 sense: light_probe livingroom
switched low
houseagent Belief changed: not curtain_up kitchen
houseagent Belief changed: curtain_down kitchen
houseagent Belief changed: light_low kitchen
houseagent Belief changed: not light_med kitchen
houseagent Belief changed: not curtain_up livingroom
houseagent Belief changed: curtain_down livingroom
```

```
houseagent  Belief changed: light_low livingroom
houseagent  Belief changed: not light_med livingroom
houseagent>CloseCurtainsIntention#94 Intention success
houseagent  Succesfully used intention CloseCurtainsIntention to achieve
goal {CloseCurtainsGoal#93:{curtain:"kitchen"}}
houseagent>CloseCurtainsIntention#95 Intention success
houseagent  Succesfully used intention CloseCurtainsIntention to achieve
goal {CloseCurtainsGoal#94:{curtain:"livingroom"}}
```

When Alice moves from home, the house is not occupied and the kitchen and living room curtains close, which reflects to a 0 reading of the light probes in those rooms.

```
0:13:00 Alice moved to garage
houseagent>SensePeopleIntention#2 sense: person Alice in room garage
houseagent  Belief changed: in_room Alice garage
houseagent  Belief changed: room_occupied garage
houseagent  Belief changed: house_occupied
houseagent  Trying  to  use  intention  OpenCurtainsIntention  to  achieve
goal {OpenCurtainsGoal#111:{curtain:"kitchen"}}
houseagent>OpenCurtainsIntention#112 Intention started
houseagent  Trying  to  use  intention  OpenCurtainsIntention  to  achieve
goal {OpenCurtainsGoal#112:{curtain:"livingroom"}}
houseagent>OpenCurtainsIntention#113 Intention started
kitchen curtains up
Probe light kitchen is 100
livingroom curtains up
Probe light livingroom is 100
houseagent>SenseLightProbesIntention#4   sense:   light_probe   kitchen
switched high
houseagent>SenseLightProbesIntention#4  sense:  light_probe  livingroom
switched high
houseagent  Belief changed: curtain_up kitchen
houseagent  Belief changed: not curtain_down kitchen
houseagent  Belief changed: curtain_up livingroom
houseagent  Belief changed: not curtain_down livingroom
houseagent>OpenCurtainsIntention#112 Intention success
houseagent  Succesfully used intention OpenCurtainsIntention to achieve
goal {OpenCurtainsGoal#111:{curtain:"kitchen"}}
houseagent>OpenCurtainsIntention#113 Intention success
houseagent  Succesfully used intention OpenCurtainsIntention to achieve
goal {OpenCurtainsGoal#112:{curtain:"livingroom"}}
```

When Alice returns home, the house gets occupied and the curtains open, with an increment in the light reading of the sensors.

```
0:13:20 Alice moved to kitchen
Probe temperature water is 35
houseagent  Belief changed: boiler-temperature-low
houseagent  Trying  to  use  intention  HeatSolarIntention  to  achieve  goal
{HeatWaterGoal#125:{water_heating:{boiler:"boiler",water_probe:"tempera
ture water",solar_probe:"temperature solar"}}}
houseagent>HeatSolarIntention#126 Intention started
boiler heating_solar on
Probe temperature water is 35
0:13:25 Probe temperature water is 45
houseagent  Belief changed: not boiler-temperature-low
0:13:30 Probe temperature water is 55
0:13:35 Probe temperature water is 65
houseagent  Belief changed: boiler-temperature-high
0:13:40 Probe temperature water is 75
Probe temperature kitchen is 18.5
0:13:45 Probe temperature water is 85
0:13:50 Probe temperature water is 95
boiler heating_solar off
Probe temperature water is 95
houseagent>HeatSolarIntention#126 Intention success
houseagent  Succesfully  used  intention  HeatSolarIntention  to  achieve
goal
{HeatWaterGoal#125:{water_heating:{boiler:"boiler",water_probe:"tempera
ture water",solar_probe:"temperature solar"}}}
```

When the kitchen gets occupied during midday, the boiler water temperature is decreased. In order to heat the water, the house agent uses a heat solar intention, since the beliefs for the solar temperature allows it. The boiler water gets heated to the solar temperature (highest possible) value, since it is free.

```
0:14:00
botagent>PostmanAcceptAllRequest#1     Reading     received     message
{CleanRoomsGoal#130:{rooms:["livingroom","kitchen","bedroom","studio","
entrance"]}}
```

```
botagent    Trying to use intention CleanRoomsIntention to achieve goal
{CleanRoomsGoal#130:{rooms:["livingroom","kitchen","bedroom","studio","
entrance"]}}
botagent>CleanRoomsIntention#131 Intention started
botagent    Belief changed: not cleaned livingroom
botagent    Belief changed: not cleaned kitchen
botagent    Belief changed: not cleaned bedroom
botagent    Belief changed: not cleaned studio
botagent    Belief changed: not cleaned entrance
houseagent>PostmanAcceptAllRequest#0    Reading    received    message
{RequestBeliefGoal#131:{agent:"botagent",belief:"room_occupied
livingroom"}}
houseagent Trying to use intention RequestBeliefIntention to achieve
goal     {RequestBeliefGoal#131:{agent:"botagent",belief:"room_occupied
livingroom"}}
houseagent>RequestBeliefIntention#132 Intention started
botagent>PostmanAcceptAllRequest#1    Reading    received    message
{UpdateBeliefGoal#132:{belief:"room_occupied livingroom",value:false}}
botagent    Trying to use intention UpdateBeliefIntention to achieve
goal                    {UpdateBeliefGoal#132:{belief:"room_occupied
livingroom",value:false}}
botagent>UpdateBeliefIntention#133 Intention started
botagent    Belief changed: not room_occupied livingroom
[...]
botagent    Belief changed: room_occupied kitchen
botagent    Belief changed: not room_occupied bedroom
botagent    Belief changed: not room_occupied studio
botagent    Belief changed: not room_occupied entrance
0:14:45
botagent    Trying to use intention OnlinePlanning to achieve goal
{PddlGoal#144:{goal:["cleaned  livingroom","cleaned  bedroom","cleaned
studio","cleaned entrance","charge-high"]}}
botagent>OnlinePlanning#145    Intention started
0:14:45 Alice moved to livingroom
botagent>OnlinePlanning#145    Plan found:
botagent>OnlinePlanning#145    - (clean1 livingroom)
botagent>OnlinePlanning#145    - (move livingroom bedroom)
botagent>OnlinePlanning#145    - (clean2 bedroom)
botagent>OnlinePlanning#145    - (move bedroom livingroom)
botagent>OnlinePlanning#145    - (charge livingroom)
botagent>OnlinePlanning#145    - (move livingroom studio)
botagent>OnlinePlanning#145    - (clean1 studio)
botagent>OnlinePlanning#145    - (move studio livingroom)
```

```
botagent>OnlinePlanning#145    - (move livingroom entrance)
botagent>OnlinePlanning#145    - (clean2 entrance)
botagent>OnlinePlanning#145    - (move entrance livingroom)
botagent>OnlinePlanning#145    - (charge livingroom)
botagent>OnlinePlanning#145        Starting sequential step (Clean1
livingroom) Effect: cleaned livingroom,charge-med,not charge-high
botagent>Clean1#152            Intention started
houseagent>PostmanAcceptAllRequest#0    Reading    received    message
{RequestBeliefGoal#163:{agent:"botagent",belief:"room_occupied
livingroom"}}
houseagent Trying to use intention RequestBeliefIntention to achieve
goal     {RequestBeliefGoal#163:{agent:"botagent",belief:"room_occupied
livingroom"}}
houseagent>RequestBeliefIntention#164 Intention started
botagent>PostmanAcceptAllRequest#1     Reading     received     message
{UpdateBeliefGoal#164:{belief:"room_occupied livingroom",value:true}}
botagent   Trying to use intention UpdateBeliefIntention to achieve
goal                        {UpdateBeliefGoal#164:{belief:"room_occupied
livingroom",value:true}}
botagent>UpdateBeliefIntention#165 Intention started
botagent   Belief changed: room_occupied livingroom
botagent>UpdateBeliefIntention#165 Intention success
botagent   Succesfully used intention UpdateBeliefIntention to achieve
goal                        {UpdateBeliefGoal#164:{belief:"room_occupied
livingroom",value:true}}
houseagent>RequestBeliefIntention#164 Intention success
houseagent Succesfully used intention RequestBeliefIntention to achieve
goal     {RequestBeliefGoal#163:{agent:"botagent",belief:"room_occupied
livingroom"}}
0:14:50
botagent>OnlinePlanning#145 Intention failed: pddl precondition not
valid
botagent   Failed to use intention OnlinePlanning to achieve goal
{PddlGoal#144:{goal:["cleaned livingroom","cleaned bedroom","cleaned
studio","cleaned entrance","charge-high"]}}: pddl precondition not
valid
botagent   Error: pddl precondition not valid
botagent   No success in achieving goal {PddlGoal#144:{goal:["cleaned
livingroom","cleaned        bedroom","cleaned        studio","cleaned
entrance","charge-high"]}}
0:15:00
```

```
botagent   Trying to use intention OnlinePlanning to achieve goal
{PddlGoal#177:{goal:["cleaned kitchen","cleaned bedroom","cleaned
studio","cleaned entrance","charge-high"]}}
0:15:30
botagent>OnlinePlanning#178    Intention started
botagent>OnlinePlanning#178    Plan found:
botagent>OnlinePlanning#178    - (move livingroom kitchen)
botagent>OnlinePlanning#178    - (clean1 kitchen)
botagent>OnlinePlanning#178    - (move kitchen livingroom)
botagent>OnlinePlanning#178    - (move livingroom bedroom)
botagent>OnlinePlanning#178    - (clean2 bedroom)
botagent>OnlinePlanning#178    - (move bedroom livingroom)
botagent>OnlinePlanning#178    - (charge livingroom)
botagent>OnlinePlanning#178    - (move livingroom studio)
botagent>OnlinePlanning#178    - (clean1 studio)
botagent>OnlinePlanning#178    - (move studio livingroom)
botagent>OnlinePlanning#178    - (move livingroom entrance)
botagent>OnlinePlanning#178    - (clean2 entrance)
botagent>OnlinePlanning#178    - (move entrance livingroom)
botagent>OnlinePlanning#178    - (charge livingroom)
[...]
botagent   Belief changed: room_occupied studio
0:17:05
botagent>OnlinePlanning#178 Intention failed: pddl precondition not
valid
botagent   Failed to use intention OnlinePlanning to achieve goal
{PddlGoal#177:{goal:["cleaned kitchen","cleaned bedroom","cleaned
studio","cleaned entrance","charge-high"]}}: pddl precondition not
valid
botagent   Error: pddl precondition not valid
botagent   No success in achieving goal {PddlGoal#177:{goal:["cleaned
kitchen","cleaned bedroom","cleaned studio","cleaned
entrance","charge-high"]}}
0:17:15
botagent   Trying to use intention OnlinePlanning to achieve goal
{PddlGoal#211:{goal:["cleaned livingroom","cleaned
entrance","charge-high"]}}
botagent>OnlinePlanning#212    Intention started
0:17:40
botagent>OnlinePlanning#212    Plan found:
botagent>OnlinePlanning#212    - (move studio livingroom)
botagent>OnlinePlanning#212    - (clean1 livingroom)
botagent>OnlinePlanning#212    - (move livingroom entrance)
```

```
botagent>OnlinePlanning#212    - (clean2 entrance)
botagent>OnlinePlanning#212    - (move entrance livingroom)
botagent>OnlinePlanning#212    - (charge livingroom)
botagent>OnlinePlanning#212      Starting sequential step (Move studio
livingroom) Effect: not in-room studio,in-room livingroom
0:19:00
botagent>OnlinePlanning#212    Intention success
botagent   Succesfully used intention OnlinePlanning to achieve goal
{PddlGoal#211:{goal:["cleaned                    livingroom","cleaned
entrance","charge-high"]}}
0:19:25
botagent   Trying to use intention OnlinePlanning to achieve goal
{PddlGoal#245:{goal:["cleaned studio","charge-high"]}}
botagent>OnlinePlanning#246    Intention started
0:19:55 botagent>OnlinePlanning#246    Plan found:
botagent>OnlinePlanning#246    - (move livingroom studio)
botagent>OnlinePlanning#246    - (clean1 studio)
botagent>OnlinePlanning#246    - (move studio livingroom)
botagent>OnlinePlanning#246    - (charge livingroom)
botagent>OnlinePlanning#246          Starting sequential step (Move
livingroom studio) Effect: not in-room livingroom,in-room studio
0:20:40
otagent>OnlinePlanning#246    Intention success
botagent   Succesfully used intention OnlinePlanning to achieve goal
{PddlGoal#245:{goal:["cleaned studio","charge-high"]}}
0:20:45 botagent>CleanRoomsIntention#131 Intention success
botagent   Succesfully used intention CleanRoomsIntention to achieve
goal
{CleanRoomsGoal#130:{rooms:["livingroom","kitchen","bedroom","studio","
entrance"]}}
```

At 14.00 the house agent pushes a cleaning goal to the bot agent. The cleaning belief set is then reset, and the bot agent asks for room occupation to the house agent. The bot agent then uses the online planning intention to get a plan for cleaning the unoccupied rooms (all apart from the kitchen). At 14.30, when the plan is found, the bot starts with the first step which is cleaning the living room. Before starting, the bot agent asks again the house agent for occupation of the living room, which in the meantime got occupied and the planning intention fails. Another iteration is then executed requiring replanning with the available rooms. At 15.30 another plan is found and is started. During the process the studio got occupied and the agents stopped the execution of the plan, requiring replanning again for the available rooms. At 17.40 the new plan is found and executed. After it the agent still needs to clean the studio, a plan for that goal is found at 19.55. The execution finishes at 20.45

when the last room has been cleaned and the robot has been charged, and the *CleanRoomsIntention* of cleaning all the rooms succeeded.

```
0:21:00
houseagent Trying to use intention IrrigateIntention to achieve goal
{IrrigateGoal#245:{irrigation:"garden",time:15}}
houseagent>IrrigateIntention#246 Intention started
garden irrigation on
0:21:05 Bob moved to entrance
0:21:10 Bob moved to garden
houseagent>SensePeopleIntention#2 sense: person Bob in room garden
houseagent Belief changed: not in_room Bob entrance
houseagent Belief changed: not room_occupied entrance
houseagent Belief changed: in_room Bob garden
houseagent Belief changed: room_occupied garden
garden irrigation off
0:21:15 Bob moved to entrance
houseagent>SensePeopleIntention#2 sense: person Bob in room entrance
houseagent Belief changed: in_room Bob entrance
houseagent Belief changed: room_occupied entrance
houseagent Belief changed: not in_room Bob garden
houseagent Belief changed: not room_occupied garden
garden irrigation on
0:21:20
garden irrigation off
houseagent>IrrigateIntention#246 Intention success
houseagent Succesfully used intention IrrigateIntention to achieve goal
{IrrigateGoal#245:{irrigation:"garden",time:15}}
houseagent>TurnOffLightIntention#252 Intention success
```

At 21.00 the irrigation system is activated, and the irrigation starts. While it is irrigating the garden gets occupied by Bob and the irrigation stops. When Bob leaves the garden, the irrigation resumes and the total watering time remains the same.

Running the scenarios - Scenario2

```
Probe temperature kitchen is 19
Probe temperature bedroom is 19
Probe temperature bathroom is 19
Probe temperature studio is 19
```

```
Probe temperature livingroom is 19
houseagent  Belief changed: room_occupied bedroom
houseagent  Belief changed: not room_occupied kitchen
houseagent  Belief changed: not room_occupied bathroom
houseagent  Belief changed: not room_occupied studio
houseagent  Belief changed: not room_occupied livingroom
houseagent  Trying  to  use  intention  KeepHeatedOccupationIntention  to
achieve goal {KeepHeatedOccupationGoal#23:{heating:"bedroom",after:5}}
houseagent>KeepHeatedOccupationIntention#23 Intention started
0:00:05 bedroom heating on
houseagent>SenseHeatingsIntention#8 sense: heating bedroom switched on
houseagent  Belief changed: heating_on bedroom
houseagent  Belief changed: not heating_off bedroom
0:00:20 Probe temperature bedroom is 19.5
0:00:30 Probe temperature kitchen is 18.5
Probe temperature bathroom is 18.5
Probe temperature studio is 18.5
Probe temperature livingroom is 18.5
0:00:35 Probe temperature bedroom is 20
0:00:50 Probe temperature bedroom is 20.5
0:01:00 Probe temperature kitchen is 18
Probe temperature bathroom is 18
Probe temperature studio is 18
Probe temperature livingroom is 18
0:01:05 Probe temperature bedroom is 21
0:01:20 Probe temperature bedroom is 21.5
houseagent>SenseTemperatureProbesIntention#7  sense:  temperature_probe
bedroom switched high
houseagent  Belief changed: not temperature_low bedroom
houseagent  Belief changed: not temperature_med bedroom
houseagent  Belief changed: temperature_high bedroom
bedroom heating off
houseagent>SenseHeatingsIntention#8 sense: heating bedroom switched off
houseagent  Belief changed: not heating_on bedroom
houseagent  Belief changed: heating_off bedroom
0:01:30 Probe temperature kitchen is 17.5
Probe temperature bedroom is 21
Probe temperature bathroom is 17.5
Probe temperature studio is 17.5
Probe temperature livingroom is 17.5
houseagent>SenseTemperatureProbesIntention#7  sense:  temperature_probe
kitchen switched low
```

```
houseagent>SenseTemperatureProbesIntention#7  sense:  temperature_probe
bathroom switched low
houseagent>SenseTemperatureProbesIntention#7  sense:  temperature_probe
studio switched low
houseagent>SenseTemperatureProbesIntention#7  sense:  temperature_probe
livingroom switched low
houseagent  Belief changed: temperature_low kitchen
houseagent  Belief changed: not temperature_med kitchen
houseagent  Belief changed: temperature_low bathroom
houseagent  Belief changed: not temperature_med bathroom
houseagent  Belief changed: temperature_low studio
houseagent  Belief changed: not temperature_med studio
houseagent  Belief changed: temperature_low livingroom
houseagent  Belief changed: not temperature_med livingroom
houseagent  Trying  to  use  intention  HeatUpIntention  to  achieve  goal
{HeatUpGoal#33:{heating:"kitchen"}}
houseagent>HeatUpIntention#33  Intention started
houseagent  Trying  to  use  intention  HeatUpIntention  to  achieve  goal
{HeatUpGoal#34:{heating:"bathroom"}}
houseagent>HeatUpIntention#34  Intention started
houseagent  Trying  to  use  intention  HeatUpIntention  to  achieve  goal
{HeatUpGoal#35:{heating:"studio"}}
houseagent>HeatUpIntention#35  Intention started
houseagent  Trying  to  use  intention  HeatUpIntention  to  achieve  goal
{HeatUpGoal#36:{heating:"livingroom"}}
houseagent>HeatUpIntention#36  Intention started
kitchen heating on
bathroom heating on
studio heating on
livingroom heating on
houseagent>SenseHeatingsIntention#8 sense: heating kitchen switched on
houseagent>SenseHeatingsIntention#8 sense: heating bathroom switched on
houseagent>SenseHeatingsIntention#8 sense: heating studio switched on
houseagent>SenseHeatingsIntention#8  sense:  heating  livingroom  switched
on
houseagent  Belief changed: heating_on kitchen
houseagent  Belief changed: not heating_off kitchen
houseagent  Belief changed: heating_on bathroom
houseagent  Belief changed: not heating_off bathroom
houseagent  Belief changed: heating_on studio
houseagent  Belief changed: not heating_off studio
houseagent  Belief changed: heating_on livingroom
houseagent  Belief changed: not heating_off livingroom
```

```
0:01:45 Probe temperature kitchen is 18
Probe temperature bathroom is 18
Probe temperature studio is 18
Probe temperature livingroom is 18
0:02:00 Probe temperature bedroom is 20.5
Probe temperature kitchen is 18.5
Probe temperature bathroom is 18.5
Probe temperature studio is 18.5
Probe temperature livingroom is 18.5
houseagent>SenseTemperatureProbesIntention#7  sense:  temperature_probe
kitchen switched med
houseagent>SenseTemperatureProbesIntention#7  sense:  temperature_probe
bathroom switched med
houseagent>SenseTemperatureProbesIntention#7  sense:  temperature_probe
studio switched med
houseagent>SenseTemperatureProbesIntention#7  sense:  temperature_probe
livingroom switched med
houseagent  Belief changed: not temperature_low kitchen
houseagent  Belief changed: temperature_med kitchen
houseagent  Belief changed: not temperature_low bathroom
houseagent  Belief changed: temperature_med bathroom
houseagent  Belief changed: not temperature_low studio
houseagent  Belief changed: temperature_med studio
houseagent  Belief changed: not temperature_low livingroom
houseagent  Belief changed: temperature_med livingroom
kitchen heating off
houseagent>SenseHeatingsIntention#8 sense: heating kitchen switched off
houseagent  Belief changed: not heating_on kitchen
houseagent  Belief changed: heating_off kitchen
bathroom heating off
houseagent>SenseHeatingsIntention#8  sense:  heating  bathroom  switched
off
houseagent  Belief changed: not heating_on bathroom
houseagent  Belief changed: heating_off bathroom
studio heating off
houseagent>SenseHeatingsIntention#8 sense: heating studio switched off
houseagent  Belief changed: not heating_on studio
houseagent  Belief changed: heating_off studio
livingroom heating off
houseagent>SenseHeatingsIntention#8  sense: heating livingroom switched
off
houseagent  Belief changed: not heating_on livingroom
houseagent  Belief changed: heating_off livingroom
```

```
houseagent>HeatUpIntention#33  Intention success
houseagent Succesfully used intention HeatUpIntention to achieve goal
{HeatUpGoal#33:{heating:"kitchen"}}
houseagent>HeatUpIntention#34  Intention success
houseagent Succesfully used intention HeatUpIntention to achieve goal
{HeatUpGoal#34:{heating:"bathroom"}}
houseagent>HeatUpIntention#35  Intention success
houseagent Succesfully used intention HeatUpIntention to achieve goal
{HeatUpGoal#35:{heating:"studio"}}
houseagent>HeatUpIntention#36  Intention success
houseagent Succesfully used intention HeatUpIntention to achieve goal
{HeatUpGoal#36:{heating:"livingroom"}}
```

During the night Anna and Bob are in the bedroom. The room is occupied and the *KeepHeatedOccupationIntention* warms up the room. The other rooms that are not occupied instead are kept at a lower temperature. When the temperature drops low they get heated until they reach a medium temperature and the operation repeats.

```
0:09:05
livingroom curtains down
Probe light livingroom is 0
0:13:35 Alice moved to null
Bob moved to null
houseagent>SensePeopleIntention#21 sense: person Alice in room null
houseagent>SensePeopleIntention#21 sense: person Bob in room null
houseagent Belief changed: not house_occupied
houseagent Trying to use intention CloseCurtainsIntention to achieve
goal {CloseCurtainsGoal#105:{curtain:"kitchen"}}
houseagent>CloseCurtainsIntention#106 Intention started
houseagent Trying to use intention CloseCurtainsIntention to achieve
goal {CloseCurtainsGoal#106:{curtain:"livingroom"}}
houseagent>CloseCurtainsIntention#107 Intention started
kitchen curtains down
Probe light kitchen is 0
houseagent Failed to use intention CloseCurtainsIntention to achieve
goal {CloseCurtainsGoal#106:{curtain:"livingroom"}}: Failed, curtain
already closed
houseagent Error: Failed, curtain already closed
houseagent No success in achieving goal
{CloseCurtainsGoal#106:{curtain:"livingroom"}}
0:16:00
Alice moved to garage
```

```
Bob moved to garage
houseagent Belief changed: house_occupied
houseagent Trying to use intention OpenCurtainsIntention to achieve
goal {OpenCurtainsGoal#146:{curtain:"kitchen"}}
houseagent>OpenCurtainsIntention#147 Intention started
houseagent Trying to use intention OpenCurtainsIntention to achieve
goal {OpenCurtainsGoal#147:{curtain:"livingroom"}}
houseagent>OpenCurtainsIntention#148 Intention started
kitchen curtains up
Probe light kitchen is 75
livingroom curtains up
Probe light livingroom is 75
houseagent>SenseLightProbesIntention#4 sense: light_probe kitchen
switched med
houseagent>SenseLightProbesIntention#4 sense: light_probe livingroom
switched med
houseagent Belief changed: curtain_up kitchen
houseagent Belief changed: not curtain_down kitchen
houseagent Belief changed: not light_low kitchen
houseagent Belief changed: light_med kitchen
houseagent Belief changed: curtain_up livingroom
houseagent Belief changed: not curtain_down livingroom
houseagent Belief changed: not light_low livingroom
houseagent Belief changed: light_med livingroom
```

At 9.05 in the morning the living room curtains are closed manually. When Alice and Bob leave home at 13.35 the kitchen curtains turn down automatically while the CloseCurtainsIntention for the living room curtains fails since they are already closed. At 16.00 when they come home the curtains open up automatically.

```
0:20:45 Alice moved to garden
Bob moved to garden
Eve moved to garden
houseagent>SensePeopleIntention#21 sense: person Alice in room garden
houseagent>SensePeopleIntention#21 sense: person Bob in room garden
houseagent>SensePeopleIntention#21 sense: person Eve in room garden
houseagent Belief changed: room_occupied garden
houseagent Belief changed: not room_occupied entrance
0:21:00
houseagent Trying to use intention IrrigateIntention to achieve goal
{IrrigateGoal#191:{irrigation:"garden",time:15}}
houseagent>IrrigateIntention#192 Intention started
```

```
0:22:30
Alice moved to entrance
Bob moved to entrance
Eve moved to null
houseagent>SensePeopleIntention#21 sense: person Alice in room entrance
houseagent>SensePeopleIntention#21 sense: person Bob in room entrance
houseagent>SensePeopleIntention#21 sense: person Eve in room null
houseagent  Belief changed: room_occupied entrance
houseagent  Belief changed: not room_occupied garden
garden irrigation on
0:22:45
garden irrigation off
houseagent>IrrigateIntention#192 Intention success
houseagent  Succesfully used intention IrrigateIntention to achieve goal
{IrrigateGoal#191:{irrigation:"garden",time:15}}
```

At 20.45 Alice, Bob and their guest Eve move to the garden. At 21 the irrigation should start, but the intention waits until 22.30 when the garden is unoccupied and the intentions successfully irrigates for 15 minutes.

Source code organization

The directory structure is as follows:

- **src/devices**
  - The devices folder contains all the devices implementation as observables, with their own methods for each file
- **src/intentions**
  - The intentions directory contains the implementation of goals and intentions for the agents.
- **src/observables**
  - It includes various observables such as probes and people
- **src/scenarios**
  - It includes the scenarios definition with the house definition with the initialization of goals intentions and beliefs for the agents
- **logs**
  - Log files of the scenarios

The source code can be found at the following repository:
https://github.com/emiliantolo/smarthome-multi-agent

Other details can be found in the README file in the repository.