Simulation of interaction between Robot and User (Human) in order to perform the task using an AI planning approach defined by Domain Definition Language (PDDL)

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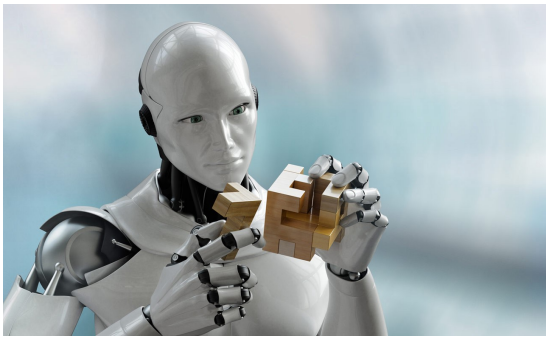
1. ABSTRACT

The project aims to make use of artificial intelligence algorithms to solve various everyday problems. The choices of the project concern an attempt to recreate a simulation of the interaction between the user and the domestic robot. One brief about AI Planning: *The planning problem in Artificial Intelligence is about the decision making performed by intelligent creatures like robots, humans, or computer programs when trying to achieve some goal [1]. It involves choosing a sequence of actions that will (with a high likelihood) transform the state of the world, step by step so that it will satisfy the goal. The world is typically viewed to consist of atomic facts (state variables), and actions make some facts true and some facts false* [2]. The desire to have an interaction between man and robot in such a way that the latter can intelligently plan the execution of a particular task has given way to the project here present [5]. The method chosen as we will see will be the use of Python libraries dedicated to artificial intelligence algorithms [4]. In the following sections, all aspects of the project from structure to the final simulation will be described.

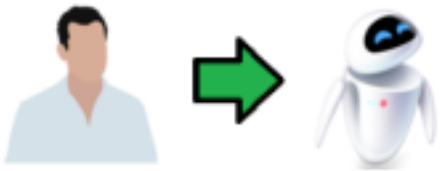
FIG. 1. **Planning robot AI**



2. INTRODUCTION

The project is based on to perform a Gui interaction between Ron(Robot) and the User. Ron is a robot that can perform the same tasks inside the home of the User (see figure 2). The user can decide which tasks Ron can

FIG. 2. **The robot Ron**



do and decide on some aspects that are important to perform each of them. The project uses files of type pickle and txt and uses them as a Database in order to have a track of data that the user selected during one session of the project. So, Ron starts with one only action (Move inside rooms) and the user will select the actions that are necessary to perform the entire task chosen. The project uses aima [4] library that performs many AI algorithms using PDDL formalism to find the solution. These algorithms allow us to find the solutions knowing the information provided by the user and Ron. This project use aima to find a solution and convert all this information included the solution from PDDL into an important representation that we need to create interaction and built all scene about tasks. This algorithm allows us to represent a task with PDDL formalism, thus Ron can perform any task that users decide to choose.

3. THE PLANNING APPROACH: USING AIMA LIBRARY (PYTHON)

As already said, Aima was used as a starting library to use planning algorithms using PDDL language [4]. The starting point of the project was the need to transform what Aima offers as a solution to a structure that can translate the various actions into a sequence of simulated

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actions. The implementation used from Aiam has been the aima.planning that offers many algorithms to give a solution. Thus, the flow of the project is characterized by the implementation of all actions that Ron will be used to perform the task. For example:

- PickupKeys(b, p, r)
- DropKeys(b, p, r)
- PickupFood(b, p, r)
- Move(b, f, t)
- ...

The second aspect has been to create for each task the domain related to it. Thanks aima, the creation of a planning domain has been possible by using a specific class that allows us to create a knowledge of Robot about Home and the relative entity participate in each task. The knowledge has been used to lets to know Ron the relation about rooms of Home. Once, all of this aspect of the task is computed by the interaction of the user, the Aima can resolve the problem with the actions that Ron has at that moment available. It is therefore important to underline that the structure of the project foresees the implementation of these parts just mentioned in such a way as to recall them in the interaction phase. This allows the robot to ask for useful information and to change its domain and problem concerning such received data. The solution will therefore be the final one as soon as Ron has received all the actions he needs to reach the final goal.

4. THE DATABASE

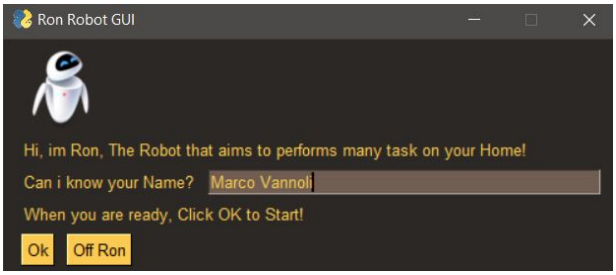
In order to have a sequential interaction between robot and user, it is important to store the various data that the user offers to the robot and therefore the robot will not have to ask for the information again where it is not needed. Therefore a database consisting of pickle and text files was introduced in the project to store this information. Once the user adds actions in the storage, Ron acquires the power of action and can use these actions to perform the various tasks. It is important to underline that the project foresees a reset of the database to repeat the simulation with new data and information.

5. THE FLOW OF STEPS OF THE SIMULATION

The simulation foresees an initial phase where the user must type his name and start the simulation by clicking on the start button. The simulation of a GUI interface is performed through the PySimpleGUI [3] library which allows using various methods that allow a simple GUI display. This GUI allows the selection of various data such as lists and free text. Ron will then take that information.

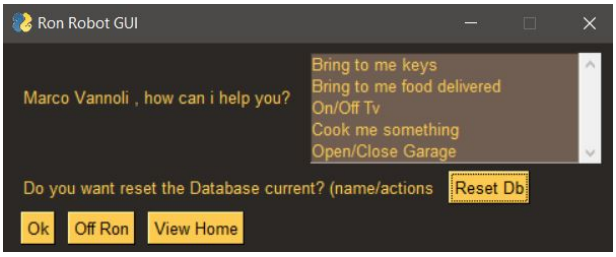
A. The first step of simulation

The first step will be to initiate the first interaction with Ron by writing your name.



B. The choice of Tasks

Then Ron will ask which tasks he will have to perform, which are:



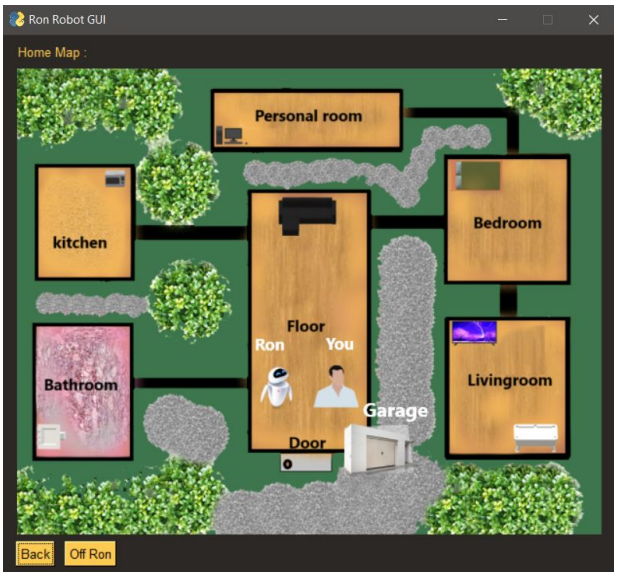
- Bring to me keys
- Bring to me food delivered
- On/Off Tv
- Cook me something
- Open/Close Garage

In this part of the interaction, you can decide to delete all the data received from the database to restart a new session (as if you are another user) or even to view the map of the house (figure 3).

C. The entire planning around each task

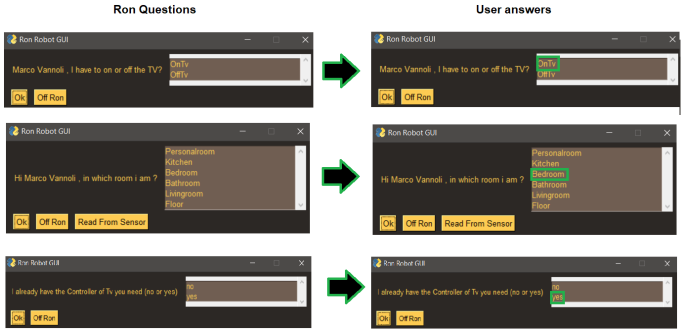
once the corresponding task has been chosen, Ron will ask the user some questions to enrich his knowledge about the problem. The first question will be in which position he is (Ron can also use his sensors, or select one of the rooms in the house randomly). After that, the user will have to tell Ron which room he is located in. Ron at this

FIG. 3. **The first interaction**



point will ask further questions regarding the task chosen by the user to address the problem in the corresponding domain. The following flow represents one of the interactions of task On/Off Tv (see figure 4 and dialogue 5 C).

FIG. 4. **An example of the interaction between Ron and User**



RON: Marco Vannoli , I have to on or off the TV?

USER: OnTv

RON: Hi Vannoli Marco , in which room i am ?

USER: Bedroom

RON: I already have the Controller of Tv you need (no or yes)

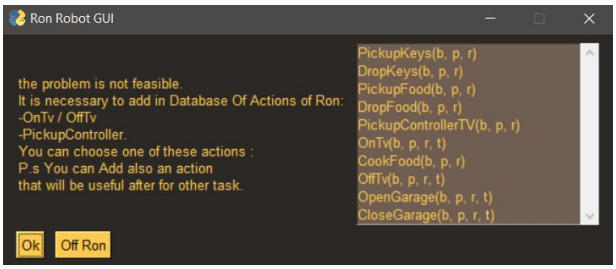
USER: Yes

Of course, Ron already knows that the TV will be in the livingroom. This type of information is given a priori by knowledge of domain of the problem (planning).

D. The Solution proposed by Ron

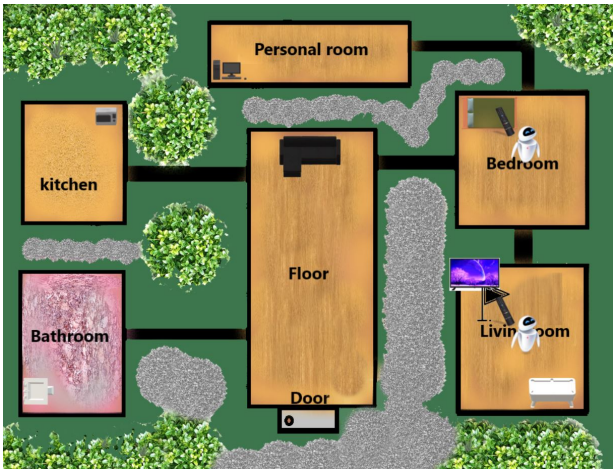
Once Ron has the minimum information in such that to try to find a solution of planning, then he verifies if he has the actions that he needs to resolve the task. In this case, the actions that Ron has to be acquired are: Move (form rooms) and On the Tv. The action of Move is already present in the Database of Ron, so Ron doesn't ask the user to choose the action of moving. If the user would answer to him that he hasn't already the controller of tv, then Ron should also have requested the action of pickup the TV's controller (see figure 5).

FIG. 5. **The user has to add the actions Ron needs**



Once Ron has added the actions that he needs, then he can formulate his solution and simulate all actions of the planning in a sequential way (see figure 6).

FIG. 6. **The task of OnTv computed during simulation**



6. FURTHER ANALYSIS ON FLOW MANAGEMENT

Further analysis of the flow management of this interaction is important to understand the evolution of the project. All the phases of knowledge creation, of the domain and therefore of the problem are managed in such a way as to modify them according to the various tasks that Ron will have to perform. Besides, the addition of

Ron's storage actions can make the user better understand the various phases of planning. This project focuses on implementing a simulated interaction between the robot and the user. The planning artificial intelligence algorithms can make the robot manage a multiplicity of problems also having much more complex domains than the one proposed. Furthermore, the Aima (Python, aima.planning) library used was very useful in approaching the PDDL language in a linear way, giving the possibility to express many planning functions efficiently and clearly.

7. FINAL CONCLUSIONS

This project focuses on implementing a simulated interaction between the robot and the user. The planning artificial intelligence algorithms can make the robot manage a multiplicity of problems also having much more complex domains than the one proposed [1]. Furthermore, the Aima (Python, aima.planning) library used was very useful in approaching the PDDL language in a linear way, giving the possibility to express many planning functions efficiently and clearly.

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[3] Python Library. *Python GUIs for Humans. Launched in 2018. It's 2021 PySimpleGUI is an ACTIVE project. Super-simple to create custom GUI's. 300 Demo programs Cookbook for rapid start. Extensive documentation. Main docs at www.PySimpleGUI.org*. 2015. URL: `https://pypi.org/project/PySimpleGUI/`.

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[5] E. Sebastiani et al. *Dealing with On-line Human-Robot Negotiations in Hierarchical Agent-Based Task Planner*. 2017.