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SMACH : Multi-Agent Simulation of Human Activity in Households

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Abstract. The SMACH platform is a multi-agent based simulator supporting the study of human activity at the scale of a household, and its impact on the electricity consumption. It generates both activity diagrams and load curves for every electrical appliance in the household. Three different user interfaces can be used to manipulate the simulator: a participatory simulation interface, an educational interface and a technical interface for energy experts. This demonstration for PAAMS presents all three interfaces and the features offered by the SMACH platform.

Keywords: Agent-Based Simulation · Energy Consumption · Simulation Of Human Activity · Buildings

1 Introduction

In the context of energy consumption reduction, studying and understanding the residential sector appears as a key factor. Indeed, 57% of the final energy consumption in Europe is used for space heating [6]. However, the residential sector is characterized by a high variability due to the impact of human activity [1]. Predicting human activities and energy loads of buildings are thus of crucial importance to predict energy consumption.

Today, two kinds of models exist to simulate such household consumption. The first model are based on stochastic models [5]. One limitation is that the simulated behaviors do not correspond to real life situations and lack variability. The second approach relies on multi-agent simulations (MAS) [2]. Such models allow a fine-grained simulation of the human activity. The SMACH platform, developed in collaboration between EDF and several academic partners, is one of them.

2 Main Purpose

SMACH simulates household activity and electrical consumption. It uses statistical data based on time-use surveys [4] to produce varied and realistic lists of

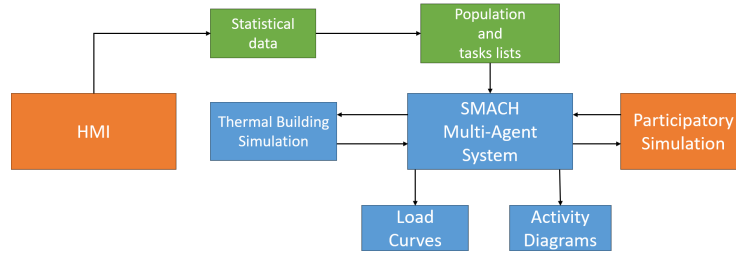


Fig. 1. SMACH general architecture

daily tasks for each inhabitant of the household. Based on this information, a multi-agent system simulates the human activity in households. At every time step, the agents of the SMACH platform select the activity to perform, using control parameters such as the current activity of other inhabitants, the price of the energy, their previous activities and the parameters of the tasks. Each task can be associated with the use of electrical appliances that consume electricity. A multi-zone thermal model of the household simulates indoor temperature and the energy consumption for room heating [3].

The SMACH engine is thus able to generate load curves coupled with activity diagrams. It is used at EDF for research purposes, to understand the electrical energy consumption in existing households, to study the impact of new households configuration or public policies and to anticipate future situations like collective self-consumption at the scale of a neighborhood or electrical vehicles.

3 Demonstration

Our demonstration will illustrate the possibilities of the SMACH multi-agent simulation through three different user interfaces. Figure 1 illustrates the connection between these interfaces and the platform.

3.1 Interface for load curves generation by energy experts

While it is possible to manually configure all the details of the household (number of inhabitants, list of tasks with their duration parameters, list of electrical appliances, etc), the SMACH platform can generate these parameters automatically from statistical data. With this expert interface (Figure 2), the household generation is configured by selecting several parameters including the number of households, their geographical area, the characteristics of the building and appliances, and the inhabitants policies related to energy use. The system then generate as many households as asked (often thousands for large scale studies), which are then individually simulated by SMACH, producing one load curve and one activity diagram for each household. In the demonstration we will generate a city population and produce the activity diagrams and the load curves. The user interface is used by energy experts to study a large variety of configurations.

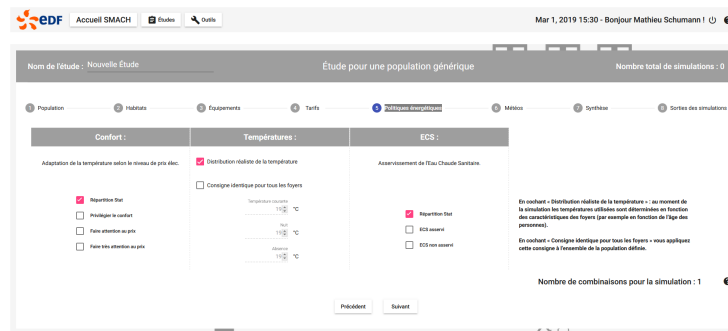


Fig. 2. Load curves generation interface

3.2 Participatory simulation

Participatory Simulation bridges the gap between simulated and real inhabitants.

The dedicated interface (Figure 3) allows modellers to demonstrate to people the simulation of their own household in real time. The participants can interact with the simulation and change the behavior of each member of the family during the simulation. In the demonstration, we will show how people can interact with the platform to modify the behavior of the agents. This interface has been used to validate the SMACH model and the realism of the produced simulation.

3.3 Educational Interface

EDF developed an Educational Interface for SMACH, with the purpose of increasing awareness of general audience about the impact of occupant activities on the buildings energy consumption.

Thanks to this interface, the user can easily configure a household and set up consumption habits and general policies such as the setpoint temperature



Fig. 3. Participatory simulation interface

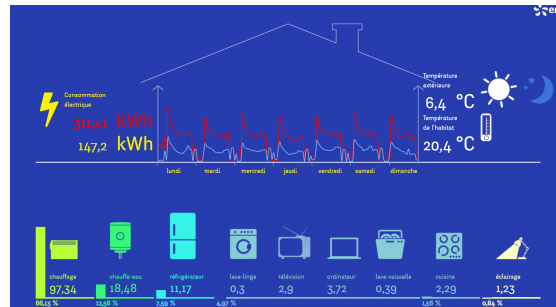


Fig. 4. Educational Simulation

for room heating. It can then see how minimal changes on such parameters impact the energy consumption. The demonstration will present the creation of a household and show the difference between a base case scenario and a modified configuration (Figure 4).

4 Conclusion

The present demonstration showed various interfaces developed with the SMACH multiagent platform and the use cases they answered to. We discuss their operation and results for professional use and for general audience.

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