73 NRP Sustainable Economy
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Multi-model
Simulation Specification and Execution

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Project Description

Background

The Post-fossil Cities project aims at developing a serious game that will enable stakeholders to identify and test different trajectories from the present state to carbon neutrality in a fictional Swiss city. The game addresses both, natural environment and societal constraints.

Project Components

The main components under development are:

1. The serious simulation **game**
2. The socio-economic metabolism **model**(s)
3. The **software system** linking the role-playing (simulation) game with the background computer (simulation) models

Goal and Scope

The software system needs to fulfill multiple functional requirements:

1. Enable the game actors to interact with the simulation experiment
2. Enable flexible plugging of new models into the system
3. Give feedback from the simulation to the game actors

Research Questions

What strategy is successful in integrating models of different types with a role-playing game?

The functional requirements of responsiveness to the real-time game play, flexible simulation runs and models integration create a challenge that has not been resolved. Running experiments with models still heavily relies on manual and hard-coded work of researchers.

We propose an **"Agents Using Models"** approach to automate such process and enable its incorporation in larger experimental and research setting.

What software architecture is flexible enough to accommodate the large design space of such a modelling project?

In order to implement a design flexible enough to address the project needs, the software system leverages the nature of Multi Agent Systems. However, using a more standard software design abstraction, a first iteration of the architecture is presented (Fig. 1).

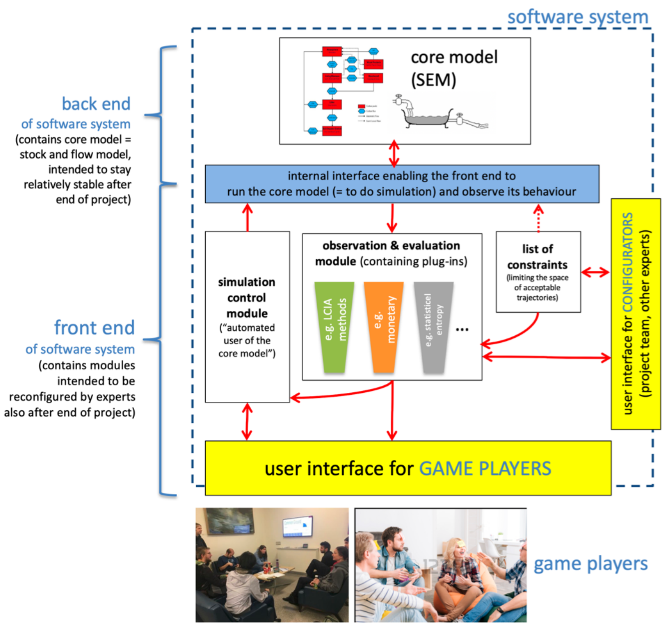
software system
back end
of software system
(contains core model = stock and flow model, intended to stay relatively stable after end of project)
front end
of software system
(contains modules intended to be reconfigured by experts also after end of project)
core model (SEM)
internal interface enabling the front end to run the core model (= to do simulation) and observe its behaviour
simulation control module ("automated user of the core model")
observation & evaluation module (containing plug-ins)
e.g. LCIA methods
e.g. monetary
e.g. statisticel entropy
...
list of constraints (limiting the space of acceptable trajectories)
user interface for CONFIGURATORS (project team, other experts)
user interface for GAME PLAYERS
game players

***Figure 1:** Architecture of the software system*

How to provide a higher abstraction level to specify complex experiments with simulation models?

To allow system users to focus on the experiment's conceptual aspects rather than on the technical ones, we define various agent types who leverage today's ubiquitous computing power and do the most of the heavy work. We define ontologies and protocols for their communication.

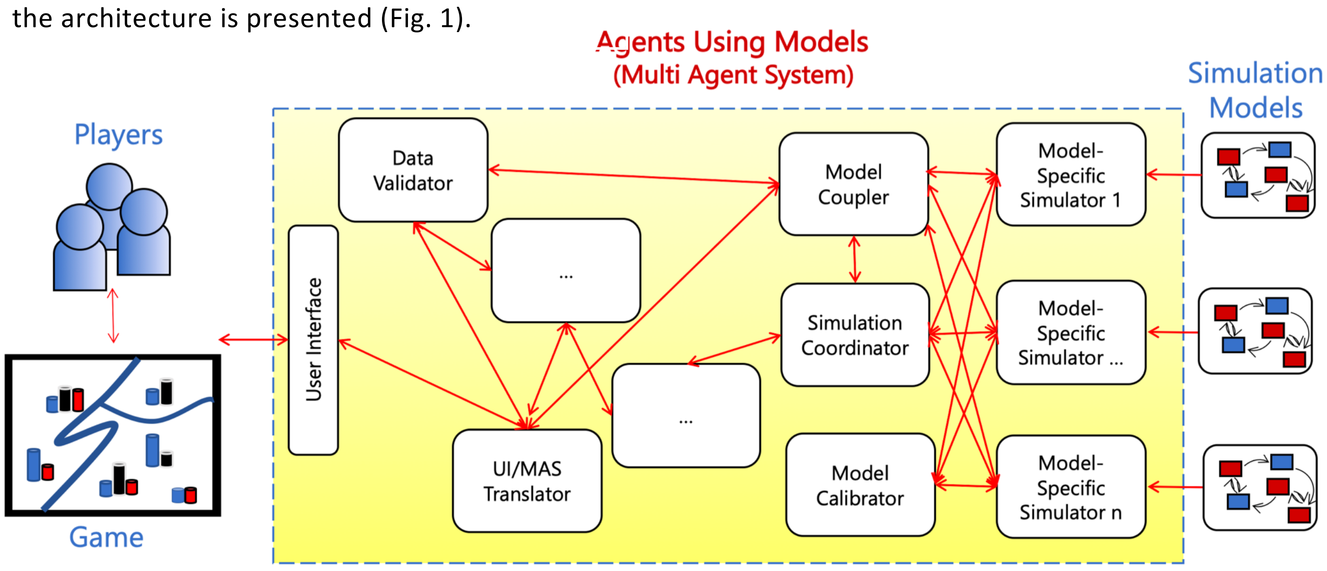

***Figure 2:** The Agent System translates the game input and runs the simulation using defined models*

"Agents Using Models"

The "Agents Using Models" approach we are developing defines a set of agent types, their ontologies and communication protocols. In our context, "using models" refers to setting up and executing experiments with models – i.e., simulation. An **elementary model experiment** consists of three steps: First, the model parameters and initial conditions are set. Second, the model is run. Finally, the results are evaluated. **Complex model experiments** can involve several models and themselves consist of model experiments executed within them, both in parallel or in sequence. They may involve loops which feed results back into the process.

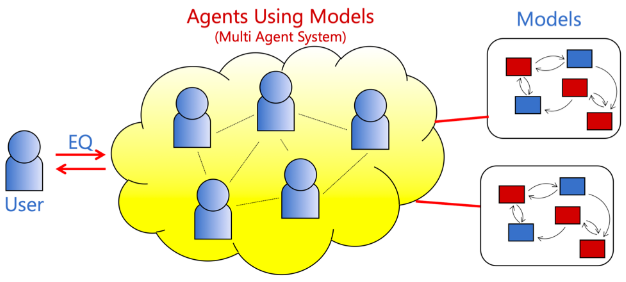

***Figure 3:** The "Agents Using Models" approach enables researchers to define Experiment Questions (EQ) and let the system couple the models and run the simulation for them*

Model experiments can be designed for a range of purposes, such as simulating a given scenario, a set of scenarios, or calibrating a model. We are designing a set of agents which support frequent tasks occurring in setting up and executing complex model experiments. The user who has a specific question or purpose for which to design a model experiment will then be able to specify the experiment at a sufficiently high level of abstraction, i.e., without having to care about details of model coupling and coordination of their execution.

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