

Boxed Economy Simulation Platform and Foundation Model

Takashi Iba

Graduate School of Media and Governance, Keio University

JSPS Research Fellow

Research Associate of Fujita Institute of Future Management Research

Yohei Takabe

Visiting Researcher of SFC Institute, Keio University

Yoshihide Chubachi

Visiting Researcher of SFC Institute, Keio University

Yoshiyasu Takefuji

Department of Environmental Information, Keio University

Abstract

In this paper, we propose “Boxed Economy Simulation Platform”, which is a sharable basis for agent-based economic simulations. By providing the basic design of the social model, which we call “Boxed Economy Foundation Model”, it enables collaborative research more efficiently. Sharing and cumulating the model components can be promoted by the domain-specific design at the level of social model rather than the level of abstract general-purpose model. It will be able to contribute to remove factors that have been making difficult for social scientists to participate in and conduct the agent-based research.

1: Introduction

The recent advancement of the agent-based modeling and simulation has been revolutionizing the social sciences and other research fields. The agent-based approach enables us to deal with the model that generates macroscopic phenomena by allowing numbers of agents to act at the micro level within the simulation. Therefore, in the social sciences, we can trace and understand the internal mechanisms in society. Since some interesting implications have been derived from the former researches with agent-based approach, expectations are rising in social sciences.

There is, however, a serious problem that needs to be noticed, that is, most of researchers in this area are computer-related scientists and few social scientists are there. One of the reasons for this situation is the agent-based approach has been developed in computer science. Another reasons for the absence of social scientists is there are differences in the research method between conventional and agent-based approaches. For applying agent-based approach, computational modeling and programming are essential, though few social scientists are good at programming. In addition, the high qualities of program, for example zero-defects and reusability, are required for scientific use, but they are hard to be achieved even for professional programmers.

A question then arises: how can we remove factors that have been making difficult for social scientists to participate in and conduct the agent-based research? As a solution, we would like to propose the “Boxed Economy Simulation Platform” as a sharable platform for the agent-based research in social science, especially in economics[1]. By providing the foundation model with the platform, Boxed Economy also enables collaborative research more efficiently.

2: Requirement for sharing model components

In the last some years, several tools for agent-based simulations have been proposed: Swarm Simulation System[2, 3], Ascape [4], RePast[5], MAML[6] and so on. Especially Swarm Simulation System has become one of the most famous and most growth toolkit in many research fields.

Although these tools have promoted to share some kind of components such as graphical user interfaces (GUI) among researchers, they have been less successful in sharing and cumulating the parts of simulation models. It is because the provided basis are too high abstract for users to follow in order to build the sharable components. To design the sharable and reusable models, the domain-specific design is required at the level of social model rather than the level of abstract general-purpose model. To put it another way, the social scientists really need not only the abstract basis, such as mathematical operators, but also the model components, such as production function or consumption function in economics. Indeed, economists usually specify their model with using the typical model components. There are, for example, some types of production functions: Cobb-Douglas type, CES type, and Translog type in economics. They hardly ever make the model components from scratch each time ¹.

We, then, would like to provide the model framework specializing in agent-based model of economic society, incorporating the idea of object-oriented framework that define the basic architecture of economic and social models. We call our model framework “Boxed Economy Foundation Model”.

3: Boxed Economy Foundation Model

Boxed Economy Foundation Model provides the main framework for modeling the economic society². The foundation model is an abstract model of a real society from the viewpoint of economy. Figure 1 shows a part of the classes and their relationships in the Boxed Economy Foundation Model, which is expressed in Unified Modeling Language (UML)[8].

We especially suggest that the design with object-oriented framework is more significant than the design simply with components or objects in the field of the economic and social simulations[9]. This is because the introduction of the frameworks makes it easier for the simulation builders to build, share and co-improve the economic simulations.

¹On the contrary, most of the simulation models are built from scratch each time in agent-based research. Enormous developing time and costs are required in this style of simulation studies.

²In our previous paper[7], we introduced the definition of the classes, their correspondence to the real society and the relationship with other classes in the model by catalog style. Note that the “agent” which is defined in the Boxed Economy, is formed by the following classes: [Economic Actor] as its core, [Function] and [Memory]. [Economic Actor] reacts with these classes that surround it and becomes an economic agent, for example each individuals and social groups such as government or corporations.

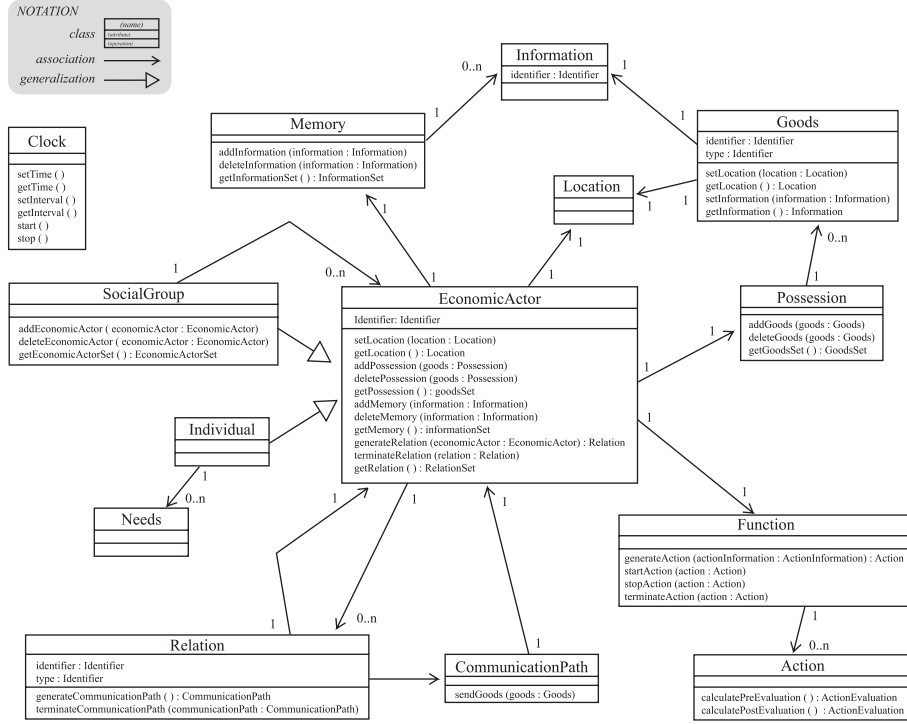


Figure 1: Boxed Economy Foundation Model (UML Class Diagram)

Framework is the architecture that is specialized to a certain domain. Framework provides many kinds of plug-points (container) to connect the components that would be implemented by the simulation builders in each simulation. Frameworks are important for reusing and co-improving due to define a “context” for the components developed in the future, although it is usually difficult to combine the components developed by independent groups, because they have inconsistent assumptions each other. The framework keeps the components and objects on track. Boxed Economy introduces the idea of framework to simulate the economic society and keep the architecture on one track.

To build a realistic model step by step, it is necessary to urge the researchers and some businessperson from other areas to participate in the development. Boxed Economy Foundation Model has the definition of the relationship between each part of the model, so that it is possible to make the model work even when components were developed independently. The simulation builders can make the models in parallel as long as they keep the same framework, and they can concentrate on the object related to their major: consumer, corporation, and so on (Figure 2).

This is based on the domain-specific fact that the structures of economic simulation models are/will be often very similar, due to that the modeled targets are almost the same, and the objectives of simulations are also the similar. We can see them in predictions of the macroeconomic trends, explanations of the past phenomena, and impact analyses of policies. These frameworks can be the base of continual metabolism in economic models among the simulation builders.

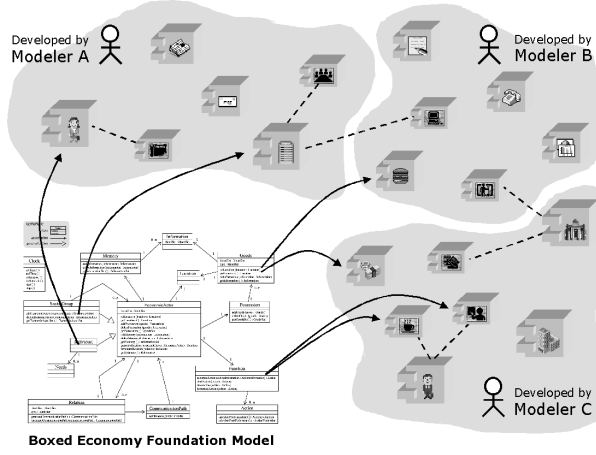


Figure 2: Parallel Development with Boxed Economy Foundation Model

4: Boxed Economy Simulation Platform

Boxed Economy Simulation Platform realizes the simulation environment for the simulation model based on Boxed Economy Foundation Model. Boxed Economy Simulation Platform is implemented by one of the object-oriented language, Java, which is portable and independent of the computer platform (Figure 3). In addition, the extensible design is realized also at this level, using Design Patterns[10].

Boxed Economy Simulation Platform provides the efficiency to the incremental simulation research made by each individual researcher. The incremental simulation research, which is quite common as “constructive approach” in the field of complex systems research, is the process that tries to understand the target during the process of building its mechanism into the computer. In many cases, some part of the model that constructs the social simulation is not proved scientifically or might just be an *ad hoc* hypothesis. In those situations, the researchers have to experiment with a variety of models for each of the unreliable function in the model and raise the reliability step by step.

In the Boxed Economy, we support the incremental research by sharing both, a form of social description, Boxed Economy Foundation Model, and an environment for the simulation research, Boxed Economy Simulation Platform.

5: Conclusion

In this paper, we proposed “Boxed Economy Simulation Platform” and “Boxed Economy Foundation Model”, which can be used as a sharable foundation for agent-based economic simulations. We believe that sharing and cumulating the model components, which is promoted by the domain- specific design at the level of social model, will be able to contribute to remove factors that have been making difficult for social scientists to participate in and conduct the agent-based research. Creating the foundation for the social simulation researches is an oversized project for our members to complete. We’d like to realize this by collaborating with many researchers in various fields.

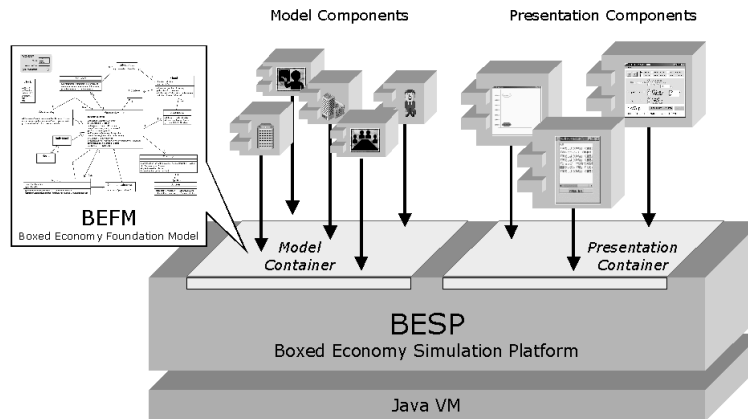


Figure 3: Boxed Economy Simulation Platform and Boxed Economy Foundation Model

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