Multi-agent Based simulation for Decision-Making: an application to Rungis food market

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1. Introduction

Multi-agent based simulation can be a very useful tool for decision making [Tesfatsion 2002]: first, the modelisation and validation step helps to clarify actors behaviors, which makes easier to see which rules or characteristics of agents (variables) affect final results. It also allows proposing new market organizations or strategies to improve efficiency, robustness or other personalized objective. Financial markets are the most commonly used in simulation because they are the most "perfect" ones – perfect and widely diffused information, atomic products and actors. Less perfect markets are certainly more challenging. Main difficulties are the collection of data and the construction of a model of strategies of negotiation that are used by human. A Fruits and Vegetables wholesale market, for example, requires dealing with official price conception, diffusion and impact, negotiated and individual prices, perishable goods and trust agreements between actors [Weisbuch 2000]. Our goal is to simulate negotiation and price formation based on observed strategies on the wholesale market of Rungis, near Paris. We aim to understand negotiation and price formation mechanisms, and explain their impact on macro variables (like the difference between the official price and the average price used on the market). In this abstract, we will summarize our model in section 2, present the simulation in section 3 and conclude in section 4.

2. Model Formulation

Context

Rungis is the largest wholesale market in the world for fresh products, with 1,5 billion tons of products per year, 500 wholesalers and 20000 regular buyers. Only for the Fruit and Vegetable submarket, there are 5 covered pavilions, each one gathering around 20 displays (stands), which a total of 1 million tons of products sold each year.

Our model is based on a on-site study with actor interviews and observations which allowed us to deduce the negotiation behaviors of the actors [Curchod 2007].

Environment

Our study focuses on fruits and vegetables. The market, open for buyers from 5AM to 10AM, is composed of 5 pavilions, each one composed of 20 displays (see figure 1). Products exist in different qualities and are bought by the sellers from producers. Even if product quality is modeled with a continuous variable, agents can only perceive a limited (and fluctuating) number of quality range.

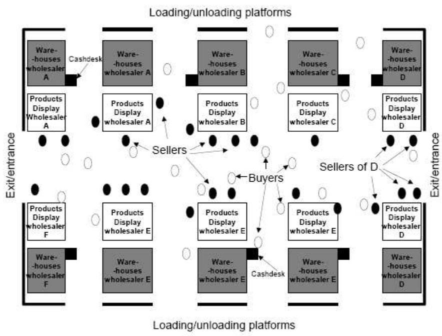

Figure 1: One pavilion with buyers and sellers agents.

Agents

We distinguish three main kinds of agents: sellers (who buy bags of homogeneous products from producers and sell them in smaller bags to buyers); buyers (who buy from sellers and sell to final consumers); official state-agent (who gathers information and gives the official quotation of day n-1 for each product before the market opens on day n).

The seller is around his display waiting for buyers. He buys the products from producers, always at the same price. Before buyers arrive (at 5AM), he walks around the market to know how severe the concurrence on each quality submarket he can perceive.

The buyer walks from seller to seller to buy his products. We distinguish between four buyer objectives/behaviours: Restaurateurs (each one has fixed need for his restaurant, and has previously negotiated the prices for each product, this system being called a "trust agreement"), Barbes and Neuilly (consumer market sellers, each one has a list of product and a minimum quality level (high for Neuilly, low for Barbes), and wants a minimum profit rate), and TimeFree buyers (who seek good opportunities on the market).

State agent collects data from the sellers to publish one price for each product at the beginning of each market day.

Negotiation

To match observed transaction sequence, negotiations are composed of series of propositions made successively by each actor (each proposition is composed of a product, a minimum quality, a minimum/maximum price and a quantity). Negotiation stops when actors agree on the price or when one agent decides to quit the negotiation, eventually to negotiate another product (buyers can always try to come back later to negotiate again).

Each agent type (Seller, Restaurateur, TimeFree, …) has a small number of parameters and rules deduced from real negotiation observation, concerning which price to choose, when to change it and when to leave.

3. Simulation presentation

Our simulation is conducted using the BitBang Framework [Baptista 2006]. One advantage of this framework is the liberty allowed for the type of brain used by the agent. We use a rule-based brain that is well adapted to model and understand the behavior of our agents.

To validate the model and the simulation, the first experiments are conducted with one pavilion (20 sellers), a limited number of products (5) and buyers (100). Validation is done both by observing the behavior of the simulated actors (e.g. number of sellers visited for each buyer, number of negotiations for each product, time on the market, …) compared to human actors and by measuring aggregated values (average price, difference between official price and observed one, standard deviation of official prices for each product, …).

4. Summary and conclusions

In this paper, we present our first results obtained with a multi-agent based simulation of the fruit and vegetable Rungis market. Based on observation of real behaviors, our first goal was to obtain a valid model of negotiation mechanism by building a realistic simulation. To achieve this, we tested the realistic behavior of the agents and the realism of the macro-variables evolutions (price variation, number of transactions and stocks). Many extensions are considered, both to study further the mechanisms involved (what are the important characteristics (variables) and behaviors (rules) in the model? Are the negotiation strategies robust and/or optimal?) and possibly to seek out for other strategies for different actors (e.g. will an evolutionary algorithm applied to agents strategies converge toward the current situation?).

5. References

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