ACTA UNIVERSITATIS AGRICULTURAE ET SILVICULTURAE MENDELIANAE BRUNENSIS
SBORNÍK MENDELOVY ZEMĚDĚLSKÉ A LESNICKÉ UNIVERZITY V BRNĚ

Volume LVII 16 Number 3, 2009

CONSUMER DECISION MAKING SIMULATION

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Received: February 11, 2009

Abstract

STEJSKAL, L., STÁVKOVÁ, J.: *Consumer decision making simulation.* Acta univ. agric. et silvic. Mendel. Brun., 2009, LVII, No. 3, pp. 147–152

Aim of the paper is to delimitate a partial procedure in the process of modelling and simulation of decision – making results took by individual market subjects. Article's fundamental is an elemental example of agent system (and derivatively multiagent system) utilization by means of computer technology, which represents so – called computer malingering or computer simulation method. Next to classical word argumentations and mathematically– statistical methods this approach represents a relatively new tool applicable in social sciences (principle of autonomous agent was described in the year 1986).
Application is effected by the help of freely accessible software tool. Model's dynamics consists in random selections of agents pair where probability tells whether they will interact or not. Interaction in this case means copying of so – called cultural characteristics.
Introduced construction's output is verification of predicament which says that taking – over postures, behaviour standards, opinions etc. in population though leads to diffusion of definite cultural pattern, nevertheless doesn't lead to populations' homogenization.
In conclusion the deterministic character of introduced application is being specified. Also the direction of next progress at work with it this construction is being foreshadowed. Authors are aware of multiple enlargement necessity of characteristics variety and values that the characters may take. This goes hand in hand with mounting of whole process to the context with next methods dealing wiht motives forming consumer's decisions.

consumer behaviour, decision making modelling, computer simulation

Article deals with introduction and brief analysis of methodology approach in whose application authors see the potential to design simulations and models of decision making of particular market subjects – consumers.

Simulation in social sciences and almost all humanitarian research derive benefit from simplified presentation of social phenomena. Sometimes these simplifications are purely verbal, for example the history research consist of former events representation, whereas some parts are abstracted and some are simplified so other can by emphasized and analyzed in their mutual relations. Exact implications of submitted ideas are often problematic with these oral presentations as for the researcher as for the reader. For example it is often difficult to determine whether incompatibilities among various drafts and terms occured, wheter it is possible to carry out some generalization of pronounced conclusions or where and if at all there was any interference with other events.

In economics for example it is possible as a rule to do much more formal representations often expressed by the help of mathematical or statistical methods. Consistence achievement and generalizations are much easier compared to mere verbal formulations, nevertheless also mathematical and statistical methods application has its disavantages. One of the most important is fact that the at endeavour to describe real social phenomena interferes with excessive complicity and rigidity, especially when modelled phenomena show mutual nonlinear relations that in addition permeate further to the surroundings. Benefits of mathematical formulation totally lose in and common progress is to suggest presumptions simplifying situation as forth as it will be someways solvable. Unfortunately these presumptions are often practically unacceptable and resulting theories misguiding (see expected utility theory which stems from perfect informedness and rationality of subjects).

MATERIAL AND METHODS

Ostrom (1988) first submitted thought that in the reality there are tools applicable in social sciences – except mentioned word argumentations and mathematically – statistical methods also simulations carried out by the help of computer technology. Computer simultions or computer modelling, how he had called this process, constitute behaviour pattern as a program which can be used for work with quantitative and also with qualitative theories and especially useful it shows for simulation of processes. Although nonlinear relations among examined subjects with one another and with their surroundings may implicate definite problems, implying them into computer model isn't as far as so problematic.

Logic of construction of models by the help of computer simulation isn't too different from logic used for more known statistical models. In either cases we construct the model to understand surveyed phenomenon thru abstractedly motivated process of abstraction (model can be set of mathematical and statistical formulas, eventually even word representations, but also a computer program). Subsequently we inquire model's behaviour and if it is possible compare it with surveys of analysed phenomena in real world. If model's outputs and experiential data are similar enough we use it as the evidence of model's validity (eventually lack of similarities as the evidence of invalidity). If the mathematical equation is the form of the model it is possible to conclude its' behaviour with mathematical considerations, if is formed as a statistical equation we can conclude its' behavior by the help of statistical programs, such as SPSS, STATISTICA, UNISTAT or Czech product ADSTAT. If the model has form of computer program its' behaviour can be concluded by multiple initiation, eventually supplemented with input parameters adjustment. Behaviour of the program is then called as a computer simulation.

Computer simulation was widely accepted in natural and technical science, however in social scienc but it is still a relatively new paradigm. Reason can be found in fact that the main contribution of simulations rather lies in definition of theoretic possibilities of development, than directly in capability of prognoses. There are though some solitary cases (for example demographic prognoses of population structure according to age and sex, or predictions of relative fall of economically active population number, respectively growth of the number of retirees in population).

There are two mutually connected reasons for increase of computer simulations popularity in social science (we do not consider technological progress and resultant increase of computation force of modern hardware now). Firstly belongs here the development of so – called agent systems, which represents simulations based on behaviour of partial autonomous units analysis. These units are able to solve definite decision – making situations (rest of the paper is devoted to this tool). Secondly the ability of computer programs to discover and understand deeper connections among surveyed phenomena and formulate adequate hypotheses on the basis of these findings.

Break – through in computer simulations were mentioned agent and multiagent systems. At the beginning of agent systems creation and development stands distributed Artificial Inteligence in which autonomous units that are capable of solving definite problems are called Actors. From these the conception agents of agents has been developed.

Autonomous agent principle (so – called reactive agent) was described in 1986 by Rodney Brooks from MIT's AI laboratory[1]. Mostly agents decide on the basis of their knowledge, then we speak about so – called rational agent. In an intention system agent makes up plan to achieve its targets, eventually using so – called BDI principle agent's behaviour is governed by certain mental state. Here are distinguised two more states of agent's conceptions, namely trust (in information about surroundings and in effects of own actions) and wishes (intentions). the most popular access to solving hereof conception so far is so – called Procedural Reasoning system.

Inclusion of agent systems interaction, or more precisely thinking over more agents in environment at the same time, lead to so – called multiagent systems (MAS) development. MAS defineds as a group of interconnected autonomous systems cooperating on behalf of common aims achievement. These systems usage as a technical solution brings similar benefits as team – work compared to individual work. Regarding to possibility of parallel progress is that especially a considerable shortening of time needed for finding solution. Also a decrease of communication requirements can be expected, because single team members don't transfer all ascertained data each to another. They transmit just their findings (unlike the centrally controlled distributed system).

Motivation of this tool creation was solving complicated decision – making tasks by increasing flexibility and self – government of single knowledge sources in terms of modular architecture, free integration of mutually communicating elements and reduction of central entities role.

Multiagent systems utilization in consumer behavioral and decision making theory involves computer modeling of decision – making environment with all its aspects and characteristics as continuously evolving system, formed by these autonomous subjects. It enables explication of certain phenomena which are characteristic for behaviour on global level (descriptiptive standpoint) as well as ways of general system

1 See http://people.csail.mit.edu/brooks/ (cited 7. 1. 2009).

functioning influence by single units or mechanisms (normative standpoint).

Process of multiagent model system creation resembles laboratory experiments. Initial step is formation of agents population, which together forms a system. According to above – mentioned definition agents can have character of economic subjects for example (consumers, businessmen, banks etc.) or substitute various social or enviromental elements (government, kirk, fashion, weather and so on). Initial model's settings are specified by start values of single agents attributes assesment (type, way of behaviour, way of perception thyself and of others agents, accessible information on other agents etc.) Model is then launched and system (market) develops without further outer interference, whereby all the matters result entirely from historical system development and interactions among agents.

Modelling and simulation of modeled systems' activities represent basic approach to these systems' analyses. Simulational modelling isn't a privilege of investigation consumer's decision – making processes of course. It derives benefit from in many technical, biological, economic, social et al. systems. If the MAS model is going to be created it is necessary stem from an element unit – agent, that can change its inner state and performs actions according to own decisions. Its effort is always directed to achievement of some of the aims. Multiagent systems creation has therefore much in common with modelling open and undeterministic systems. If agent performs action in some state of the system, the system doesn't have to be transformed in the way how agent presumed. It relates to agent's limited knowledge on the basis of which he makes decisions. Agent forms his inner model environment, however this model is opened, because it does not contain all the characteristics that influencees general behaviour of multiagent system. Agent is also able to change his position in the system which leads to requests for changes of system structure along with simulatons run.

RECORD AND DISCUSSION

Realization of BDI agent systems is carried out by the help of implementation tools that have inbuilt principles of knowledge base production, intentions, wishes and scheduling. Here belongs for example class library for language Java JADE[2] or ZEUS[3], which is tool for creation multiagent systems containing possibilities of knowledge scheduling representation, communication and social relations (its strength is proposal's visualization ability, MAS is created hierarchically in three layers – definition, social and organizational – on definition level agents are being defined, their knowledge, purposes, resources and abilities; in social layer the position of agents is designated. It includes knowledge about other agents in group and information on their availability; organizational layer designates way of communication and negotiation, strategies of role assignment etc.). Also open system RETSINA[4] that supports groups of heterogeneous agents, where structures co – ordination can stem from relations among agents rather than as a result pressure of infrastructure itself. Next is the SeSam[5] platform which provides generic environment for simulations and experimentations with agent–based simulations. This platform has been used for construction of decision making model in the following chapters. Next to these there are many other implementation tools available.

An elemental example of agent based modelling approach is simulation of culture spreading in population[6], whereby analysis of people's natural tendency to assume certain attitudes, behaviour patterns, views and so on from the others is understood. This tendency is well known and discussed in specialized literature. But there is also well known fact, that even with centuries of culture spreading no population is entirely homogenized. Aim of the model creation is then study of interaction among culture components. As an implementation tool freely accessible software platform StarLogo[7] had been selected.

Agents are characterized by n cultural signs and by m possibilities that these characters may take (p.e. cultural sign: favourite way of free time spending; possibilities: cinema visit, theatre performance, watching television, reading book etc.). Agent is an n–element vector of numbers 1 to m.

Graphic interpretation of model outputs consist in a grid with an agent (decision making subject) on each field (Tab. I):

Model's dynamics works this way: pairs of neighbours are randomly selected and on the probability basis (which weight is proportional to the number of identical signs). is being decided whether they will interract. Interaction uis understood by copying of one sign by one agent from the other one.

Highlighted agents share the same values of two from five cultural signs, it means that with probability of 40 % they would interact – copy (duplicate) some of the remaining three signs by one of agents. This principle leads to successive forming of regions within the model table. In these regions agents are culturally identical and neighboring regions have nocommon character.

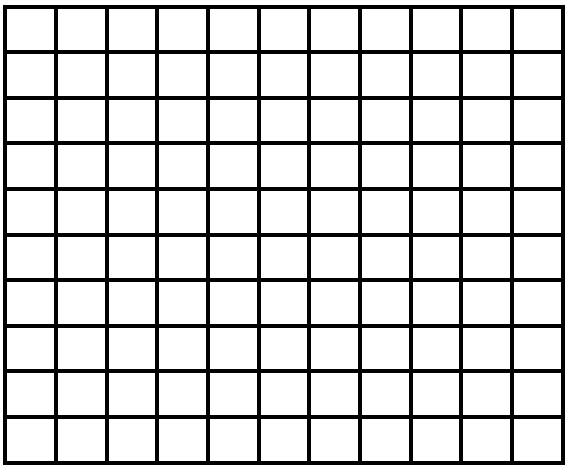
2 See Dostupné na http://jade.tilab.com/ (cited 8. 1. 2009).
3 See Dostupné ná http://labs.bt.com/projects/agents/zeus/ (cited 8. 1. 2009).
4 See na http://www.cs.cmu.edu/~softagents (cited 23.1.2009).
5 See http://www.simsesam.de/ (stav ke dni. 21. 1. 2009).
6 Introduced for example in Mgr. Pelánek's courses, available on *www.fi.muni.cz/~xpelanek/IV109/ slidy/abm.pdf (cited 16. 1. 2009).*
7 See http://education.mit.edu/starlogo/ (cited 11. 1. 2009).

I: *Starting distribution of cultural signs and their values by population members*

74741	87254	82330	17993	22798	82762	87464	26757	99313	32009
1948	09234	67730	89130	34210	85403	69411	81677	06789	24042
49777	46012	42628	86636	27405	39747	97450	71833	07192	87426
22781	85541	51585	19856	18122	60094	71819	51912	32095	11318
09851	89800	72031	55455	08071	97744	42533	33723	24659	03847
56352	34490	48416	45602	88600	78252	69896	96775	86714	02932
46238	38032	24235	17043	39891	84866	38456	78008	27136	50153
88136	21593	77404	81447	39238	81454	29464	74576	41924	43987
35682	19232	80173	30642	22884	58260	53436	13623	05729	33874
37816	55285	33239	84468	36829	13341	43986	45578	64585	47330

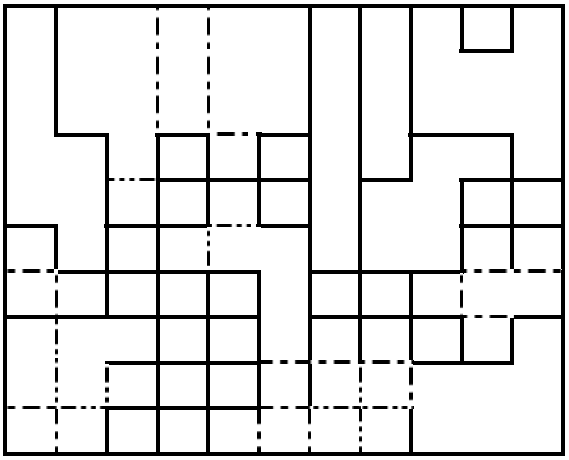
Source: randomly generated values

See next sequence (1–4):



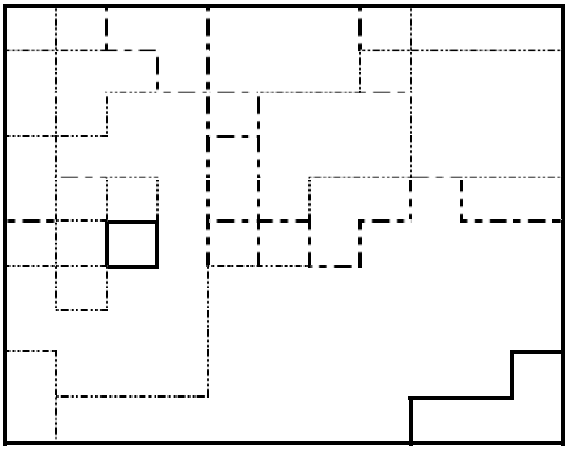
Source: software output, modified

1: *Initial model situation*



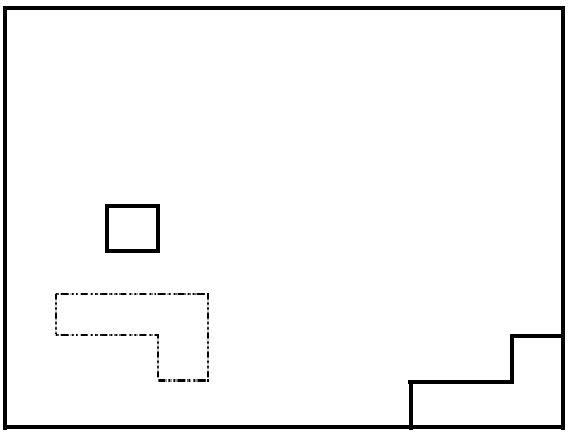
Source: software output, modified

2: *Model grid appearance after 20 000 random selections of neighboring agent pairs*



Source: software output, modified

3: *Model grid appearance after 60 000 random selections of neighboring agent pairs*



Source: software output, modified

4: *Model grid appearance after 80 000 random selections of neighboring agent pairs*

We can see gradual creation of regions of culturally identical agents. Neighboring regions then have no common character. This verifies predication from the beginning of the paper.

This construction is absolutely deterministic of course and in current form not usable for solving research project dealing with consumer behaviour and decision making. Nevertheless it represents very valuable resource and may become a basic unit of such modelling construction, whose outputs will correspond with empirical inquiries. Authors are aware of necessity of multiple extend variety and values that characters may take. Simultaneously it will be necessary to put the whole procedure into context with another methods dealing with motives forming consumer's decisions. Reason is simple – it is definitely not possible to generally presume that market subjects will simply take over various behavioral characteristics on the basis of agreement with others signs. These tasks constitute contens with other research performed by authors on Department of Marketing and Trade, FBE MUAF Brno.

SUMMARY

Paper is devoted to delimitation of partial procedure in the process of modelling and simulation particular market subjects – consumers decision making. Introduction contains contemporary approaches to modelling constructions creation in social sciences generally. Except word argumentation and mathematically– statistical methods there are simulations performed by the help of computer technology. Further in the article these insturmens are paid the main attention. Computer modelling can be used for work with quantitative and also qualitative theories and shows to be especially useful for simulation purposes. Their main contribution rather lies in ability to aoutline theoretical possibilities of future development, than in making concrete predictions.

Break – through in computer modelling was made by so – called agent and multiagent systems. These consist of autonomous units that are able to solve certain problems, eventually of more such units that interact together. This tool enables modelling of consuer's decision making environment including all continuously changing aspects and characteristics, that define this all the time evolving system.

Article outlines process of creation of multiagent system that resemble laboratory experiments. Initialization setting is specified by assessment of start value of single agents attributes, model is then launched and system (market) develops without further outer interferences.

After this follows example of so – called BDI agent system realization by the help of one of freely accessible implementation tools. Model of culture spreading in population, whereby is understood the analysis of people's natural tendency to take over certain attitudes, bahaviour patterns, views and so on from others. This tendency is well known and discussed in specialized literature. But there is also well known fact, that even with centuries of culture spreading no population is entirely homogenized. In conformity with this statement we can observe gradual formation of regions of culturally identical agents. Neighboring regions then have no common character. This construction represents resource for modelling construction, whose outputs will correspond with empirical inquiries results.

SOUHRN

Modelování spotřebitelských rozhodnutí

Článek je věnován vymezení dílčího postupu v procesu modelování a simulování výsledků rozhodovacích procesů individuálních tržních subjektů – spotřebitelů. V úvodu jsou vymezeny soudobé přístupy k tvorbě modelových konstrukcí ve společenských vědách obecně. Kromě slovních argumentací a matematicko-statistických metod se jedná o simulace prováděné s využitím výpočetní techniky, na které je soustředěna autorova pozornost. Počítačové simulace mohou být využity pro práci jak s kvantitativními, tak kvalitativními teoriemi a obzvláště užitečné se jeví pro modelování procesů. Jejich hlavní přínos spočívá v definování teoretických možností vývoje než přímo v tvorbě konkrétních predikcí.

Průlom v počítačových simulacích přinesly tak zvané agentní a potažmo multiagentní systémy, sestávající z autonomní jednotky schopné řešit určité problémy, případně z více takovýchto jednotek, které spolu vzájemně reagují. Tento nástroj umožňuje počítačové modelování rozhodovacího prostředí spotřebitele se všemi jeho aspekty a charakteristikami jako neustále se vyvíjejícího systému.

V článku je nastíněn proces tvorby multiagentního modelovacího systému, který je podobný laboratorním experimentům. Výchozí nastavení modelu je specifikováno stanovením počátečních hodnot atributů jednotlivých agentů, model je poté spuštěn a systém (trh) se vyvíjí bez dalších vnějších zásahů.

Následuje příklad realizace tzv. BDI agentního systému pomocí jednoho z volně dostupných implementačních nástrojů. Model řeší šíření kultury v populaci, čímž se rozumí analýza přirozené tendence lidí přebírat určité postoje, vzory chování, názory atd. od ostatních. Tato tendence je všeobecně

známa a v literatuře diskutována, zároveň je ale také známo, že nevede k úplné homogenizaci populace. V souladu s tímto tvrzením se v modelu postupně vytvořily regiony, v jejichž rámci jsou agenti kulturně identičtí. Sousedící regiony pak nemají žádný společný znak.
Tato konstrukce představuje východisko tvorby nástroje, jehož výstupy budou dosahovat shody s výsledky empirických šetření.

chování spotřebitele, modelování rozhodování, počítačové simulace

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