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Research on Process Modelling through Simulation

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Abstract

It is certain that a bad decision lead to catastrophic results (in some cases) and a decision good causes benefit. The problem is compounded when decisions are reduced to a imposed set (view the restrictions) and when the objectives are multiple. If the system has a low coefficient of confidence, then the solution is given by modelling, simulation and verification system on the model system (simulated) effects of adoption each decision. In terms of a set sufficiently comprehensive we use a technique of optimization for determining the solution. The paper deals with issues simulation.

Key words: *simulation approach, process modelling*

Introduction

The study of decision-making and methods that help establish a decision from a lot, in terms of restrictions imposed, is the operational discipline research.

Among the analytical methods of operational research is highlighted [12]:

- Linear programming,
- Neural networks methods,
- Queuing Theory,
- Game theory,
- Methods of simulation.

Simulation means designing the model of a real process to establish the values that model sizes out of the process to modify data entry or modifying procedures for the operation of the process. Simulation model determine a better understanding of the process, allowing verification of theories and assumptions about the investigation, offering and developing new ways of operating the process in order to increase the effectiveness of the system.

Another issue relates to the optimization simulation, considered the meaning of a set of controllable parameters $\theta \in \Theta$ that minimize a given objective function $\min_{\theta \in \Theta} J(\vartheta)$, where θ is the entries vector, Θ is the restrictions (explicit or implied) and $J(\theta)$ is the goal function [3].

The Scope of Simulation Models

Simulation models have been imposed without restrictions both in the technical processes (especially in the study of artificial intelligence), in the economic field, in financial, medical and social field - human.

Simulation method **is indicated** when the various activities (policies, plans, projects) are not immediate - the result of action is to delay a lower or higher and is unable or not economic to conduct real tests.

On the other hand simulation methods are useful when you can not estimate accurately the outcome of an appeal, meaning the existence of an uncertainty of the outcome. In this case it will use probabilistic simulation methods, which provides the likelihood that it will get a result or another.

If the data come from several areas and the process has multiple interactions is unlikely that a single person to have knowledge of all fields in order to understand the interactions between the system and take the best decision. Which is why it is appropriate to use a method of simulation and model-building simulation must be done by an interdisciplinary team of specialists (each with its field of competence) [9].

In the banking in addition to specialists in the field of finance is required to be co-opted economists and mathematicians with knowledge in the field of computer programming. There are also **contraindications** adopting simulation methods, namely when the problem can be solved analytically, you may be conducted smoothly experimental (a different policy) directly in the process, you do not have sufficient data and information on the process, when the benefits exceed the cost of modelling and when we do not have human resources (specialists) to carry out appropriate modelling process.

The Advantages and Disadvantages of Simulation Models

In many works, for example in [5, 12], are given the advantages and disadvantages of using simulation models. The main elements are presented below.

The **advantages** of simulation models:

- The model can be used whenever necessary;
- The cost of simulated data is much lower than those obtained by experimental;
- Simulation models are easier to implement than the analytical models and simplifications are made without achieving the necessary analytical models;
- Custom distributions of the data can use;
- Allow highlighting the overall development of the system during the time;
- Allow explaining the interaction of random events;
- The majority of software development model have implemented optimization functions.

Disadvantages of simulation models:

- Due to statistical simulation models many simulations are needed to obtain a plausible result, simulations that require sometimes very long time;
- Utility model depends on the ability of the team modelling process;
- Establishing the validity of data entry for the model is burdensome and carried out in a timely enough;
- Simulation models are not an optimal solution, depending on the beneficiary of the process and how to understand modelling team.

Classification of Simulation Models

The criteria for the classification of simulation models take into account the various views, such as dynamic, data uncertainty, continuity.

From the viewpoint of development in time, simulation model can be:

- Static, where time is not a variable process;
- Dynamic, in which sizes are out of office when the time of the assessment.

Another classification is about the uncertainty of data, both that will apply to the model (the input data) as well as those that led to the establishment of model:

- Deterministic models, based on rules;
- Stochastic or probabilistic models, in which the data input, model and model results contain a dose of uncertainty (estimated).

The classification process modelled on continuity determines:

- Discrete models, which exits the upgrade (and testing of entries) is the discrete moments of time or the occurrence of events;
- Models continue to upgrade that output is continuing.

Simulation models do not contain only model system investigated but also a software package (for example *GoldSim*, *Arena*), in which it builds model and generate a code (through which it will conduct exercises). However the model does not necessarily require the use of a software package, may use a general programming language (such as *Fortran, C + +, Java*) or a language simulation (such as *Siman V, GPSS*) [2].

We note that most software is based on one of the specialized programming languages - for example, the package *Arena* uses *Simian* language, the package *Quest* uses the language of simulation and control *Deneb/Quest* and package *Extend* use programming language *Modl.* Features that should have the two components of the model simulation are below [4].

Software simulation must have the following characteristics:

- Transparency, so that the user can understand the functionality of the model;
- Accessibility, in the sense that can be run on usual operating systems (for example Microsoft Windows);
- Flexibility, in the sense that they can model processes that contain elements from different fields;
- Do not be limited only to a type processes (continuous or discrete);
- Extensibility, as regards the possibility of adding new modules of code or massive data expressed in another way (in other words be able to use different databases on the market);
- No bugs, which allows the user to be convinced of the correctness of the results (if and conceptual module is correct!);
- Efficiency, in terms of cost of investment and in terms of time (reasonable) of calculation.

The model simulation is necessary to have the following characteristics:

- Transparency, the model can be read by the user;
- Traceability, in the sense that the assumptions on which the model was done are documented - are a result of the study of the real process;
- Credibility - model and data were validated by experts;
- Controlled in terms of quality, meaning that corresponds to the wishes of the user (specifications required by the design theme);

The model simulation consists of several elements that are separated namely:

- *Conceptual model*, expressing how the system reacts to the modification of data entry (algorithm);
- *Computer model*, which is the code (built with the software package) of conceptual model;

- *Model of data*, which contains data in a format accessible by the computer model (for example, *Excel sheets* or other databases).

The three components of the model (resulting from the practice of simulation models) is done in three consecutive stages:

- Study the process to determine modules and the interaction of different elements, the collection and data relating to the selection process in question;
- Building conceptual model based on assumptions about the structure of the system and how the system reacts to changing in external environment;
- Translation conceptual model in a computer model based on a software package or based on a programming language;
- Repeating the first three steps (a process called calibration of the model) to obtain an acceptable model, by adding or removing a few packages of data, by introducing additional assumptions or by removing some assumptions about the structure of the process.

In the stages of building a simulation model two major problems appear relating to validate data collected (what degree of confidence shows how real are) and the other on the criteria that lead to the acceptance of the model (when we were pleased with the results of a model). Validation of the model tests are subjective - bearing the model chats with the beneficiary and the team operating the process and objective testing - computing various statistics parameters by which to compare the results of the model with the reality of the process data collected for the same date of entry into the model and trial.

The model, in which it will perform simulations, will integrate all the components through instruments provided by the simulation (software package). A number of tools are general and others depend on the dynamics of the system, in fact depend on how the system moves from a state to another. In light of this criterion (of the instruments provided by the simulation package) simulators may be:

- Discrete Event simulators ***DES***;
- Agent-Based simulators ***ABS***;
- Continuous simulators ***CS***;
- Hybrid simulators ***HS***.

Note: Sometimes, for example [4], is highlighted and category systems that use Excel sheets (Spreadsheet-based).

Discrete events simulators are shaping the process through diagrams (graphic) transfer from one system to another state. The transfer from one state to another takes place in discrete moments of time only to the emergence of the event. The model contains entities, resources (services - items that serve entities) and elements of control (which determine the status of both entities and resources). ***DES*** have been applied successfully in modeling of production processes in society, systems of loading on a ship, distribution systems (settlement) of goods in a warehouse, systems, call (call centers) of units mobile, etc.

It notes that ***DES*** has applications in systems with discrete units, both in terms of time and space. ***DES*** simulators are *Arena, ProModel* and *Witness*.

Continuous simulators are applications where the flow of material (or energy or information) is a continuous variation from one point to another, which requires a description of the evolution of the system by means of differential equations.

In addition to the classic continuous systems (eg systems that shape the processes of flow) Simulators ***CS*** applies to discrete systems with many entities, so their movements can be described by a process flow.

CS simulators are *Vensat, Stella, iThink* and *Powers*.

They operate with stocks, flows and converters. Allow highlighting logical structure of systems (and reactions model), not to lose in detail, which provides a global perspective - the overall system. They have applications in modeling and simulation of organizing the business and commercial business.

Hybrid simulators (***HS***), have applications where discrete steps between two processes are continuing. That means that can describe both the transfer between phases of substance (by differential equations) and how to browse the stages (for example through graphic methods).

In the classification drawn to add different customizations, for example:

- Probabilistic simulators;
- Simulators based agents ABS (Agent-Based simulators).

Probabilistic simulators have applications especially in the financial, banking, business and in any application involving the uncertainty of data entry, data output or model parameters. They are characterized by the fact that allows the definition of the probability distribution of data. For example in this category are *@ Risk, Crystal Ball* and *GoldSim*. The first two are based on Excel (Spreadsheets). The added environmental Excel (Microsoft Office package) with different functions which can be implemented uncertainty data and how that links between the entry and exit system.

Agent-Based simulators are characterized by the fact that the entities defined by ***DES*** are called agents. Agents are in addition to the entities properties (sometimes called attributes) specifying how they interact with the resources and control methods (attributes or functions).

Simulation Approach

To develop a simulation model often uses a software package allowing highlighting the flow of data (or material) in the process, the quantities of input and output sizes and the way the sizes of entry or change the structure of the system generates the output.

For this purpose methods are used graphic interface called GUI (Graphical User Interface) that displays various tools (for example blocks of entry and exit separate blocks of the decision, arrows transfer between elements, etc.) that was provided software package. The user builds the model by selecting and combining graphics.

Behind each graphic element (tool) is the appropriate lines of code, which means that the model graph will have associated a computer program (consisting of the lines of code associated with graphics that was developed model).

A number of packages are using the concept of programming and other objects using procedural programming. In terms of language programming software packages can use general purpose languages or language.

We find that the graphical interface (in the software) is aimed at facilitating the work program, to draw up the appropriate model of a process. This means that the model can be achieved without the graphical user interface, using the appropriate programming language and a part of the code modules already tested.

Under the commercial generation of simulation models were imposed four general ways to approach simulation systems with discrete events [10]:

- Event-Scheduling method,
- Activity Scanning method,
- Process - Interaction method,
- Three-Phase method,
- Four-Phase method.

In addition to the methods set forth in the classification, called classical methods, have been a series of methods related to Web technology, of which mention Simulation & Animation Remote, Local Simulation & Animation and Remote Visualization & Local simulation [1].

We note that the methods related to Web technology are not new approaches to simulation, as in fact enlargements of one of the methods outlined in the classification above, the extension to allow different processing at a distance, for different purposes, through links wired or wireless.

One of the features relate to the presentation of the results (or data entry, as a temporal stream of data) in the form of animated images. Animation is undeniably an advantage because it highlights the flow of information and facilitate understanding of the process (the phenomenon).

Event-Scheduling method is based on events that change the state system is the occurrence of an event, which is why the time is amended (increase) only in a event. It is based on the events shaping process is oriented events that cause change its status.

ES method uses a list of events that contains the type of event, the moments of time that will act on the system and other necessary enforcement action to change the parameters of the system.

In addition to the list of events to define a list of future events KIND (for Future Events List), which contains moments of time ordered they will run an event or another.

By activity means while it takes an event or service, which sometimes uses the term duration of the service. Values that time are known deterministic or probabilistic.

Unlike the activity in which the duration is known, the delay is a period of time which is known as value after the conclusion of the event, being dictated by the conditions in which the process is conducted. Developments in time of a process are conditioned by a generator of quantum appointed time clock.

Following the simulation to obtain a list states at moments of time when the state has changed. In addition to the variables that define the status of the state list contains entries in the process, work in progress and when the time at which these activities will be closed.

The method of event scheduling shows the advantage that can be implemented on any procedural language, but has the disadvantage that hide logic process (not indicate flows of only states at different points in time) [11].

Among the software packages that use the method of planning events to remark (by the frequency with which they are used) *Supply Chain Builder, Factory Explorer, GoldSim* and *ShowFlow* [6].

Activity Scanning method uses as exploration activities during the simulation, a clock that moves with increments of time limits.

Unlike ES events planning method, where only the clock forward to the emergence of an event where the method shall be amended as time and situation when there is not any event (that is scheduled to move ahead with a fixed interval).

Modeling is oriented activities and the conditions under which they can begin. In these circumstances the software can be modularized, each business unit with specific code. At each moment of time activities are scanned and if the conditions are fulfilled enter into action (is on) how to code properly.

They say that the method of exploration is a two-phase (first stage in advancing the clock and in the second run activities appropriate moment of time reached).

Method exploration activities are used by the software package *FirstSTEP*.

Process - Interaction method aims to highlight how the deployment process itself, defining the entities and how they are moving in order accession to the resources (limited) system.

Are implemented that saves the lists events, activities, delays, requests for resources. As in the method of planning events there is a list KIND events that are to take place. The clock is advanced when an event occurs, which may consist of activating or temporary suspension of a process (other processes continue to run).

Variants are known method of interaction, namely *Transaction-flow method* and *Stock and Flow method.*

Transaction-flow method which is a simplification of the method interactions. Using the concepts of entity (drive traffic), resource (element serving entities) and control element (which establishes state entities and state resources).

The system is thought to the idea that drives traffic (called transactions) moving from one point to another in a competition for the permanent seizure of resources. The method is applied to transactions of more simulation software packages such as *ProModel*, *Arena, Extend, Witness, GoldSim Web*.

Stock and Flow method uses the concepts of storage, flow and converter. It is used especially in the case of dynamic systems.

Among the software packages that use the method of stocks and flow are: *Stella, iThink, Vensat* and *Powers.*

Three-Phase method is designed to simulate the deployment process in systems that can be distributed or not. The method is carried out in three phases (marked A, B, C) due to the inclusion of events in the activities.

The events are considered long void, so that the activities are of two kinds:
- Activities of the type B, where the fall events and activities unconditional;
- C type activities, which included events and activities taking place only under certain conditions (set).

A. In the first phase is searched first event following the current moment of time. The clock is advanced at the event are found and removed from the list below KIND events take place all current events.
B. B. Phase two is the implementation of all events (activities unconditional) type B (eliminated in the first phase) by changing the appropriate state system. A number of resources are released to be reallocated in the next stage or in moments of time later. C. Phase deals with the events of the third type C verifying the conditions that lead to execution of appropriate instructions or failure event.

Four-Phase method MCA is to implement the concept of programming objects OOP (Object Oriented Programming). Represents both an approach to simulation processes and a method of generating automatic code, corresponding to the process investigated [7, 8].

An entity model may be one of the states: inactive, active, waiting (possibly in a queue) or committed for a certain time, together with other entities in a given activity. Each node network (representing one or more processes ranked) are associated with a number of waiting in which entities are placed on their arrival (at the core respectively). Distinction is made between nodes that delay ***DN*** (Delay nodes) with a particular time transmission entities to which it calls nodes and nodes that do not delay transmission ***UnDN*** (Undelay nodes).

The Four Phases of the Method, Resulting as Follows:

1. In the first phase is boot, which is establishing the first work to be done and what activities are in progress. It moves the clock simulator to the first activity.
2. Phase two begin to stop all activities that do not have to run at that time and continue putting in its own queue the incoming entities.

3. Phase three is reserved to ***UnDN*** nodes, launching in execution process not be postponed.
4. The fourth phase deals with pending process, the DN nodes. Calculates and stores the time at which those process will start and if necessary it launches execution.
After you have completed the four stages, test of interruption or the end.

Conclusions

In the paper were highlighted elements from which it may adopt the decision to implement simulation techniques for a process. We presented techniques for simulation approach, specifying the major software packages and cases that can be applied.

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Tehnici de simulare a sistemului în procesul decizional

Rezumat

E sigur că o decizie proastă conduce la rezultate catastrofale (în anumite cazuri) iar adoptarea unei decizii bune determină beneficii. Problema se complică atunci când deciziile sunt reduse la o mulțime impusă (de către restricții) şi când obiectivele sunt multiple. Dacă şi datele privind sistemul au un coeficient de încredere redus, atunci soluția este dată de modelarea, simularea sistemului şi verificarea pe modelul sistemului (simulat) a efectelor adoptării fiecărei decizii. În condițiile unei mulțimi a deciziilor suficient de cuprinzătoare se recurge la o tehnică de optimizare pentru determinarea soluției. Lucrarea abordează problematica simulării.