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MODELLING DECISION UNDER UNCERTAINTY CONDITIONS USING THE HURWICZ TECHNIQUE THROUGH THE CLIPS PROGRAMME

1. Introduction

The development of management theories and their implementation within successful companies has become almost impossible without the extensive use of technical processes and especially of elements of artificial intelligence.

Understanding the variability and peculiarity of the phenomena that occur in management cannot be achieved through empirical methods exclusively based on simple observation and the experience of specialists or managers. This involves the participation of several sciences with the purpose of discovering, defining, isolating, measuring and characterizing the rules and principles that occur and of conceiving new management systems, methods and techniques that should ensure the achievement and increase of competitiveness. Classical knowledges, as well as the *unconscious* one can be achieved faster and more effectively by means of artificial intelligence. [1, p. 79].

The emphasis is increasingly laid on the multi-disciplinary and inter-disciplinary approach of all fields of activity that should permit a wide coverage of the scope of the respective science in agreement with the new demands of the social and economic life. Great emphasis is also laid on expanding the method of research by means of methodological loans from other sciences so as to enlarge the range of researched phenomena. Artificial intelligence plays a distinct role through the contribution it brings to the study of economic and social phenomena, of the laws governing them, of the regularity of their occurrence and in the prompt processing as wide a range of data as possible, in analyzing the performance of the implemented strategies and programmes. In addition there is the great advantage offered by the simulation of economic processes and of the outcomes of activities, their comparison and hierarchy.

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Any complex problem in the field of economy pertains to the approach by methods and techniques of artificial intelligence to find an optimal solution. Lately numerous successful companies have developed their own solutions, some going as far as designing new programmes, adapted to their field of activity and their particular experience. This is why it is difficult to offer a complete and final solution to some issues / subjects. Many books about this topic published in the 90's only provide principles and working suggestions and little in the way of concrete solutions. [1, p. 82] In this paper we propose a general method of approach of management decisions under uncertainty circumstances, using elements of Artificial Intelligence, using the example the adoption of a solution according to the Hurwicz optimality principle by using the Clips programme.

2. Particular features of the use of Artificial Intelligence in solving management problems

In management, the basis of decision-making, the selection of *the best decision* occupy a central place. [2, p. 10]. In this attempt one can face many difficulties due mainly to the high degree of uncertainty ubiquitous in any field at present. An established point of view states that this state of uncertainty is enhanced by methodological reasons too. Thus, M. Maliţa and C. Zidăroiu emphasise the existence of several factors. A first technical difficulty is due to the volume of information and the complicated calculations involved in defining the best alternatives. Another difficulty in choosing the best decision arises from the possibility of objective comparison of its consequences. These difficulties can be overcome by means of specific instruments, some of which are provided by features of artificial intelligence, both software and hardware. The progress in the field of artificial intelligence permits the management of a huge volume of information, starting from easy systematization, standardization and processing of the data by means of accessible user interfaces. It also permits the easy and fast approach of a very wide range of calculations. Finally, one has to deal with uncertainty as being a ubiquitous phenomenon in any management-related decision, to whose reduction and quantification artificial intelligence has contributed greatly.

Having in view on the one hand the diversity of problems existing in the real economy and on the other the massive development of AI, a few general ideas come to the forefront.

There is a series of features one has to take into account when using artificial intelligence in approaching management-related problems and not only.

- artificial intelligence problems generally require a predominantly symbolic reasoning;
- these do not easily pertain to algorithmic solutions. Very often the solution can be the result of a search within an area of possible solutions;
- the problems that require an investigation by means of artificial intelligence are those that manipulate incomplete or indeterminate information;
- the necessary solutions need not be the best or the most exact ones. Sometimes it is enough if a solution is found or an approximate formulation is achieved.
- In solving problems of artificial intelligence huge quantities of specific information come into play. Determining a medical diagnosis cannot be expressed as an algorithm because the differing data depending on each patient incorporate different solutions. This is why doctors assert that there are no illnesses, only ill people.
- The nature of the knowledge being manipulated in problems of artificial intelligence can be easily discriminated as *procedural* and *declarative.* [3, p. 27].

Management-related problems occurring under uncertainty circumstances can be solved by means of classical algorithms, but the solutions would probably be complex, difficult to generalize, unnatural and awkward.

Solving a management-related problem by means of artificial intelligence involves the going through the following stages:

- the first stage presupposes the recognition of the existence of a general problem and delimiting its instances;
- the second stage aims at recognizing a state and assessing the dimensions of the space of the states;
- in the third stages the most adequate methods of representation of the states are sought;
- the fourth stage is aimed at representing the transition between the states, and its set of rules;
- in the fifth stage one seeks to identify the best research methods and the entrance into the space of states, which should find a path between the supposed initial state and a final one;

– the final stage involves the selection of the optimal solution in order to implement it.

CLIPS is an advanced shell for the development of expert systems. It is part of the languages based on rules of production and employs a *forward search*. CLIPS was developed by Software Technology Branch at the NATO Lyndon B. Johnson Space Center. The first version was launched in 1986 and in August 1998 there was already a 6.10 version, this evolution exposing an impressive series of revisions and expansions of the language.

To solve a CLIPS problem the programmer defines the knowledge base and chooses the search strategy, while the system develops a process of rule application that continues as long as there are rules left to apply. [progr. clips, 69].

The fields of applicability of artificial intelligence are numerous and extensive. In this material we shall use a symbolic processing language of the rule-based paradigm type: CLIPS.

3. Modelling decision under uncertainty conditions according to Hurwicz optimality technique through the CLIPS programme

In the decision-making process the decisional factors become interdependent and lead to the occurrence of three decision-making situations: of certainty, risk and uncertainty, respectively. Decisions under uncertainty circumstances are characterized by a great number of variables and it is impossible to determine the probabilities of the occurence of states of the nature in which decision-making is reached. These decisions are specific to superior management and have multiple and profound implications on most of the company activities. [4. p. 207].

At the base of adopting these decisions lie some long-established rules or techniques: *pessimistic* (Abraham Wald), *optimistic, of optimality* (Leonid Hurwicz), *Equiprobability* (Bayes-Laplace), *regret minimizing* (L. Savage).

The selection of the optimality technique was not made randomly. This is due to the α quotient that also permits the simulation of the first two decision rules: pesimistic(α=0) and optimistic (α=1). The model employed is:

$$V_{opt} = \max_i(\alpha * A_i + (1-\alpha) * a_i))$$

V_i – optimal decisional variant;

R_{ij} – decisional consequence related to variant i and the objective state j;
A_i – the most favourable element of the variant = max R_{ij};
a_i – the most unfavourable element of the variant = min R_{ij}.

The α quotient can be in turn modeled by means of the programme both on the basis of the managers' experience and of the past experience stored by the computer regarding both the macroeconomic indicators of the national economy and the outcome of the economic and financial activity of the company.

Various decisional variants can be simulated based on its different values. In this programme we will perform a simulation for 3 fixed values introduced by the manager.

It has been often demonstrated that the heuristic nature of the decision-making optimization techniques under uncertainty conditions generates different decisional variants. [4. p. 229] Employing one or another of the listed techniques depends on the decider, the manager's psychology and last but not least on the company's financial and economic state. Under these circumstances, knowing all the optimal variants regardless of the technique used becomes a prerequisite. Simultaneous simulation of these techniques is achieved through programming. Also, several decisional situations can be simulated by assessing more rigorously decisional consequences.

```
CLIPS
(deftemplate opt_dec
   (slot varianta)
   (slot max)
   (slot min)
   (slot opt_H)
)
(deffacts ovar_deciz
   (opt_dec (varianta var1)  (max 0) (min 100)
   (opt_H 0))
   (opt_dec (varianta var2)  (max 0) (min 100)
   (opt_H 0))
   (opt_dec (varianta var3)   (max 0) (min 100)
   (opt_H 0))
   (opt_dec (varianta var4)  (max 0) (min 100)
   (opt_H 0))
```

```
)
(deftemplate cons_dec
   (slot varianta)
   (multislot consdec)
)
(deffacts consec_decizionale
   (cons_dec (varianta  var1) (consdec 5  2  4  3))
   (cons_dec (varianta  var2) (consdec 6  3  4  5))
   (cons_dec (varianta  var3) (consdec 4  3  5  4))
   (cons_dec (varianta  var4) (consdec 8  4  6  5))
)
(deffacts numere
    (coefα  0.5)
    (optim 0)
)
(deffrule maxminactualizeaza
    (declare (salience 10))
    ?cns ((cons_dec (varianta ?var ) (consdec ?x
    $?rest )
    ? ov <-((opt_dec(varianta
    ?var)(max?omax)(min?omin?))
    =>
    ( if (> ?x ?omax) then ( modify ?ov (max
    ?x))
    ( if (< ?x ?omin) then ( modify ?ov (max
    ?x))
    (modify ?ov (opt_H=(+(* coefα ?omax)(* (- 1 coefα)?omin))))
    ( modify ?cns (consdec  $?rest))
)
(deffrule alegvaroptH
    (?ov<-((opt_dec     (opt_H  ?oh)
    ? m (optim ?op)
    =>
    if (< ?op ?oh) then (assert optim ?oh)
    retract (?m)
```

```
)
(deffrule alegvaroptH
    ? ov <- ((opt_dec  (varianta ?var ) (opt_H
    ?oh)
    ? m (optim ?op)
    =>
    if (eq ?op ?oh) then (prinout "varianta
    optima" ?var
                "cu optimul" ?oh)
)
```

4. Conclusions

Solving a management problem by means of artificial intelligence involves two aspects:

- formalizing the problem;
- launching a search in the space of states which should find a path between the supposed initial state and a final state.

The main point of the field is to determine the most adequate procedures for the representation of problems and to find the most effective procedures of navigation in the spaces of states.

There are many advantages to using such instruments:

- managers have access to a greater volume of information in an optimal period of time – a first prerequisite of adopting the optimal decision;
- processing, storage and access to a huge volume of data;
- easy-to-use / user-friendly presentation of information;
- they take over some of the routine activities;
- they permit near instant communication, de-centralizing the decision-making process and ensure a high degree of participation in the decision-making process;
- simulating an infinite number of scenarios associated to decisional problems;
- implementing the instruments and methods of several disciplines in order to characterize the results, identify an optimal variant etc.

Future management of successful companies will rely completely on researched knowledge by means of information technologies, information networks, and elements of artificial intelligence. Classical knowledge (derived from ideas, data, facts, values) and the *unconscious* one (experience, intuition, imagination) will be processed, stored, accessed, utilized by means of artificial intelligence. The advantages of the progress in this field and in the field of information technology make the approach of the decision-making process by such instruments a prerequisite of the immediate future.

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