REPRESENTATION OF KNOWLEDGE AND ALGORITHMS FOR ECONOMIC SYSTEMS

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Abstract: *The paper presents the representation of knowledge and algorithms for economic systems that ensure the right way to solve various problems. An economic system is a complex software program that must answer to the requirements of the inside environment of an economical society and the outside environment which provides inputs for these types of systems. A complex problem requires a different approach such as an algorithm derived from artificial intelligence that can process representations of knowledge. The new techniques of the AI have solved complex tasks, which in the past could not be solved or were much more difficult - costly. Intelligent activity is determined by the human interaction with the external environment, where feedback occurs, closed through the sensory system. In the inner world, reasoning, which determines action decisions, is based on external data, obtained through perception, but also on the basis of an "internal" model of the world. A economical system is considered to have the intelligence property, whether if it can adapt itself to new situations, has the ability to reason, that is, to understand the links between facts, to discover meanings and to recognize the truth. Also, an intelligent system can learn, in other words, improve its performance based on experience. At this point, such economical systems implements high levelalgorithms such as backtracking methods that applies to problems where the solutions can be represented as a vector containing different variables.*

Keywords: *Representation of knowledge, business environment, programing algorithms, information systems, artificial intelligence.*

JEL Clasification: C23, C26, C38, C55, C81, C87

1. Introduction

Expert systems are a field of artificial intelligence, the branch of information technology that aims to develop intelligent programs and applications. What is remarkable for expert systems is the wide range of applicability, which has already covered many areas of activity.

An expert system consists of the following main components:

— Knowledgebase - serves for storing all knowledge elements (facts, rules, methods, solving, heuristics) specific to the application domain, taken from human or other sources.

— Inference engine - is a program in which the knowledge of control, procedural or operative is implemented, which exploits the knowledge base for making judgments in order to obtain solutions, recommendations or conclusions.

— User Interface - allows user dialogue during consultation sessions as well as access to basic facts and knowledge for adding or updating the database.

— The Knowledge Enrichment Module - helps the expert user to introduce new knowledge in a form that is supported by the system or to update the knowledge base.

— The explanatory module - is intended to explain to users both the knowledge of the system and its rationale for obtaining solutions during consultation sessions.

Explanations in such a system, when properly designed, also improve the way the user perceives and supports the system (feedback) [2], [4].

Chronologically, the first applications of artificial intelligence have been their expert systems. They emulate (imitate) human reasoning for specific tasks and in small areas and were well received by companies.

2. Artificial Intelligence and Knowledge Based Systems

Intelligence can be defined as the ability to sense certain relationships between objects and phenomena. This sensation can be sensory (in animals) and in this case it is due to conditioned or intellectual reflexes (in humans), and here the language and concepts interfere.

Researchers in the AI field have sought to define intelligence from a perspective that then allows for the definition of AI. For example, researchers show "that a system is considered to have the intelligence property, whether it can adapt itself to new situations, has the ability to reason, that is, to understand the links between facts, to discover meanings and to recognize the truth. Also, an intelligent system can learn, in other words, improve its performance based on experience. "Other scholars appreciate that intelligence appears to be an amalgam with many properties of information representation and processing. In this form, the definition on the one hand shows us the difficulty of specifying this notion, but also the proximity to the field of computers. They, through their programs, represent and process the information. From here, it can be said that AI is a discipline that deals with computer programming. This assertion takes into account the fact that programs have the property of representing the most different situations through symbols and logical operations. Other definitions of IA are based on the concept of intelligence, using this notion as such.

In general, AI is defined as a field of computer science that aims at conceiving intelligent computing systems, ie those systems that show properties that we usually associate with intelligence in human behavior (understanding of language, learning, solving problems). So IA can be understood as a way to simulate intelligent behavior on different technical systems [1], [5].

In addition, there is another conception that no definition of intelligence can be given because it can not be isolated and defined as a stand-alone concept. Instead, intelligence can be researched on the basis of the following.

a) Only behavior can be observed and appreciated qualitatively. Thus, the intelligence of humans or beings in general can only be deduced from their behavior or communication. From here we can say that intelligence is a hypothetical construction. Can not build one its measure without measuring the behavior of the subject for which we want to emphasize the intelligence.

Intelligent activity is determined by the human interaction with the external environment, where feedback occurs, closed through the sensory system. In the inner world, reasoning, which determines action decisions, is based on external data, obtained through perception, but also on the basis of an "internal" model of the world.

This is a model of the external world, which man fictionally carries out actions in an inner world, making a kind of simulation. Based on such a scheme, an important conclusion was reached for AI, which of the necessity of introducing into the computer a model of the world, called in the AI model of knowledge representation. Hence, one of the most important sub-domains of AI has been derived: representation of knowledge - representation of reality that can be implanted into a computing system.

b) Intelligent behavior is relative. We can not have an absolute measure, but only one obtained by reporting. For example, intelligence tests give a score that reports the subject to an average behavior.

c) A smart manifestation taken in isolation does not provide intelligent behavior in general. If a subject has intelligent behavior in a particular situation, we can not draw the conclusion of his intelligence in general. Under this aspect, AI is still far from the natural intelligence, as it is currently manifesting itself in particular situations.

d) In order to measure intelligence, we must have a measure of the complexity of the task that the subject solves. If we had such a measure - there is no single metric of complexity, universally accepted by all fields of activity, then we can say about a behavior that is smarter, the more complicated the task to solve.

If we take these four aspects into account and use them as criteria for defining computer intelligence, AI, we obtain:

– The intelligence of a program can only be deduced from its behavior.

– The intelligence of a program is always relative.

– Intelligent behavior of a program must occur in as frequent and varied situations.

– In order to appreciate the intelligence of a program, we need to measure the complexity of the input task.

Based on such criteria, one can conclude that programs now have only a primitive level of intelligence. In this respect, the current AI systems would not pass the Turing test. It was proposed by Alan Turing in 1950 and consists of interrogating a person and a computing system by a human evaluator. If he / she fails to discriminate between computer responses and those of the person, then it means that the AI has been obtained. Current systems can not pass the Turing test, and then there is the question of whether "artificial intelligence" exists. How in some approaches intelligence is equated with thinking and how, following the aforementioned test or other criteria in the field of physiology, it can be concluded that the current technical systems do not think, it follows that AI is a combination of metaphoric terms. Even in such a vision, AI remains important today because of the techniques useful for the practice that were created "trying" to obtain artificial intelligence.

The new techniques of the AI have solved complex tasks, which in the past could not be solved or were much more difficult - costly. Therefore, the following definition of IA can be proposed: IA is a branch of computer science that studies the development of advanced programming techniques to solve complex tasks [2], [6].

According to this definition there is a rapprochement between AI and the classical field of informatics. In the classical part there is a program that can use a model to process according to an algorithm. Instead, if in the case of classical computer science the database contains the information organized in a particular form, related to the algorithm used and to serve it, in knowledge bases are stored not only facts but also relations that exist between them, and rules, that is, ways to prefigure what will happen in the outside world as a result of actions. The second important difference is that in an AI program instead of the algorithm, usually deterministic in the problems addressed in the classical programming, a heuristic method appears guiding the solution. Heuristic is a method based on rules derived from experience, introducing in many situations a degree of uncertainty. Unlike the algorithm, it is often not guaranteed to obtain the solution. Even so, heuristic methods are frequently used in AIs as they can determine solutions in situations where an algorithm does not exist or is inefficient to implement.

2.1. Logical reasoning

Logical reasoning or symbolic reasoning is based on classical logic-mathematical theory and analyzes how new knowledge can be derived from existing ones, deductively, based on inference rules. As a preparatory course for the AI study, a computational logic course is recommended. Applications such as Lisp, Prolog, and Clips automated theorem demonstration systems.

2.2. Representation of knowledge

It is a fundamental area of AI because it studies the ways in which real world knowledge can be expressed and symbolized for computational manipulation. The optimal choice of the knowledge representation method is an important step in building a fair and efficient knowledge based system. Representation of knowledge means the description and encoding of objects (entities) belonging to a particular field of application of a form of artificial reasoning. The definition refers to two complementary aspects of knowledge representation, expression and manipulation of knowledge.

Knowledge is expressed in a formal language, called the language of description of knowledge. The language has a syntax that includes a set of valid expressions in terms of language and a semantics that attributes the meaning of the syntactic formulas used in a particular context. Manipulating knowledge consists in applying procedures for the organization and use of formally represented knowledge.

The main families of formal (formalism) knowledge representation methods, now considered sufficiently theoretically consolidated to allow the development of complete Knowledge Management applications, are:

- Semantic networks,
- Terminological logic,
- Object-oriented representation,
- Conceptual charts.

Each of these formalisms proposes concrete mechanisms of formalization (expression and manipulation) of knowledge.

2.3. The perception

It examines the representation in a computationally accessible form of stimuli that cause reactions in human sensory organs, such as visual perception and auditory perception. For example, Smart Optical Character Recognition can print or handwriting recognition.

2.4. Evolutionary calculation. Genetic algorithms

It studies how the solution can be found through mechanisms inspired by biological evolution processes, from the so-called natural calculation. In general, any abstract task to be accomplished can be regarded as solving a problem, which in turn can be perceived as a search in the space of potential solutions. Because, as a rule, we are looking for the best solution, we can view this process as an optimization process. For reduced spaces, classical exhaustive methods are sufficient; for larger spaces, special IA techniques can be used.

Methods of evolutionary computation are among these techniques; they use algorithms whose search methods have as a model some natural phenomena: genetic inheritance and struggle for survival.

The best known techniques in the evolutionary class are:

- Genetic algorithms,
- Evolutionary,
- Genetic programming,
- Evolutionary programming.

There are other hybrid systems that incorporate the different properties of the paradigms above; moreover, the structure of any evolutionary calculation algorithm is largely the same. Genetic algorithms occurred around 1950, when more biologists used computers to simulate biological systems. The results of the work came after 1960, when at the University of Michigan, under the guidance of John Holland, the genetic algorithms appeared in the form they are known today. As the name suggests, genetic algorithms use principles of natural genetics. Several fundamental principles of genetics are borrowed and artificially used to build search algorithms that are robust and have the great advantage of asking for minimal information about the problem. Genetic algorithms were invented using the adaptive process model. They mainly operate with binary strings and use a recombination and mutation operator.

2.5. Neural Networks

Neural networks are based on the analogy with how the human nervous system is organized for the implicit storage of knowledge and for processes of learning and generalization in incomplete or affected information by reception disturbances. They are parallel systems, distributed, with the ability to learn by example. Neural networks characterize assemblies of simple, strongly interconnected and parallel processing elements that seek to interact with the environment in a biologically-related and learner-like manner. There is no generally accepted definition of these types of systems, but most researchers agree with the definition of artificial networks as a network of simple elements strongly interconnected by means of links called interconnections through which numerical information is propagated [3], [5].

The origin of these networks must be sought in the study of neural network's bioelectric networks and their synapses. The main feature of these networks is the ability to learn on the basis of examples, using previous experience to improve their performance. Although it resembles functioning with the human brain, neural networks have a different structure than the brain. A neural network is much simpler than the human correspondent, but like the human brain, it is composed of powerful computing units, much inferior to the human correspondent, the neuron.

2.6. Game theory

It studies the strategies that two or more competitors whose interests do not coincide should follow in a confrontation with well-defined rules. In virtual examples imagined by various theorists, gameplay means a situation involving two or more decision-makers, called players who are faced with the situation of choosing a strategy to maximize the rewards received as a result of their own actions reported to the moves of others.

In these games, players have opposite interests, wholly or partly, this aspect causing a certain behavior and strategy in approaching the game. Strategies or combinations of player strategies are rewarded with a certain score. At the end of the game there is a comparison of the results and their correlation with the strategies made.

2.7. Automatic learning

Machine learning is a core area of the IA, which deals with the development of algorithms and methods that allow an information system to learn data, rules and even algorithms. Machine learning is focused on designing and developing algorithms and techniques that allow computers to “learn” by inductive or deductive methods. Inductive learning machines extract rules and shapes from massive data blocks.

The most important applications for machine learning are:

1. Processing natural language;
2. Syntactic recognition of forms;
3. Recognition of objects;
4. Search tools;
5. Medical diagnosis;
6. Bioinformatics;
7. Detection of computer fraud;
8. Electronic voice;
9. Robot movement;
10. Games etc.

Automatic learning implies, first of all, identifying and implementing a more efficient way to represent information in order to facilitate search, reorganization and change. The choice of how to represent these data lies in both the general conception of how to solve the problem and the characteristics of the data that is being worked out.

2.8. Intelligent agents

A smart agent is an autonomous entity (program, robot, etc.) that acquires and acts on and based on data and knowledge. Intelligent agents are adaptive and autonomous programs that can be used to create software that resolves tasks in the name of a particular user, based on explicit or implicit instructions. Smart agents can facilitate human-computer interaction by:

- Hiding the complexity of difficult tasks,
- Performing laborious tasks,
- Conducting transactions on behalf of the user,
- Training and learning,
- Helping certain users to collaborate,
- Monitoring events and various procedures.

Intelligent agents operate within a software environment such as operating systems, databases, or computer networks. Technology behind intelligent agents is a combination of IA techniques and system development methodologies such as object-oriented programming that allows programs to learn from and react to the environment. Intelligent agents interact with the environment they are part of through rule-based data selection criteria. An intelligent agent develops appropriate rules through explicit user instructions, imitation of the user, positive or negative feedback received from the user, and instructions obtained from interacting with other agents [2], [4].

There are two types of intelligent agents:

• Simple Agent: The most common agent variety is the agent that is built to learn and process permanent routine or repetitive tasks of the user. Such an agent can recognize, for example, that the user constantly ignores the emails from a particular sender and automatically deletes such an e-mail when it arrives (the user does not even know that he has received such a e-mail, and he is not retained in Inbox).

• Fire-and-forget agent: A user can instruct an agent to find specific information and then send it to search for that information. For example, the intelligent agent so trained can be launched on the network, and he can route his way to a computer system to research / ask if and where to find the information he is looking for. The user is thus freed from the laborious task of searching the Internet for the information he is interested in, which is done by his intelligent agent who, after some time, perhaps even a few days, will provide him with the search result. During this time, the user can focus on creative issues. Routine tasks will be controlled and performed by such an agent. Other operations that a "fire-and-forget" smart agent can do is: scheduling appointments, making purchases in the electronic markets, reporting the emergence of certain opportunities (where the user is interested) and alerting, and possibly automatic troubleshooting of software issues.

From the point of view of an agent's mobility abilities, there are also two categories:

• Static agents: they can not leave their place and can not cross the network to reach other servers and can not communicate with agents in the same environment;

• Mobile agents: they are formally characterized as objects possessing behavior, status and location. In order to accomplish the task assigned to it, an agent in this category may leave the site for which it was created and can navigate the network at any point in identifying itself through a particular location (the site it reached) a certain behavior (the task he / she performs in that situation / condition) and the corresponding condition[1], [4].

3. The main components of an algorithm for intelligent agents

The backtracking method applies to problems where the solution can be represented as a vector – x = (x1, x2, x3, …xk,… xn) € S, where S is the set of solutions and the problem S = S1 x S2 x… x Sn, and Si are finite sets with s elements and xi € si , (¥)i = 1..n. For each problem there are relations between the components of vector x, which are called internal conditions; the possible solutions that satisfy the internal conditions are called solutions. The method of generating all possible solutions and then determining the resulting solutions by checking the fulfillment of the internal conditions takes a long time.

The backtracking method avoids this generation and is more efficient. The elements of the vector x get values in ascending order of the indices, x [k] will only get a value if values of elements x1 .. x [k-1] have been assigned. Upon assigning the value of x [k], the fulfillment of continuation conditions relating to x1 ... x [k-1] is checked. If these conditions are not met at step k, this means that any values we assign to x [k + 1], x [k + 1], x [n] will not reach a resulting solution. The backtracking method builds a solution vector progressively starting with the first component of the vector and going to the last with eventual returns to previous assignments.

The source program is the following:

```
Private Sub Button1_Click()
 cit_n „n = „, n
 back_perm
End Sub

Sub back_perm()
 Dim k As Integer
 k = 1
 While k > 0
  Do
   succesor am_suc, st, k
   If am_suc = True Then
    valid1 ev, st, k
   End If
  Loop Until (Not am_suc) Or (am_suc And ev)
  If am_suc Then
   If solutie(k) Then
    tipar_r
   Else
    k = k + 1
    init k, st
   End If
  Else
   k = k - 1
  End If
 Wend
End Sub

Sub valid1(ev As Boolean, st As stiva, k As
Integer)
 ev = True
 For i = 1 To k - 1
```

```
    If (st.ss(i) = st.ss(k)) Then
     ev = False
    End If
   Next
  End Sub

  Sub tipar_r()
   Dim i As Integer, b As String
   b = „ ”
   For i = 1 To n
    b = b + Str$(st.ss(i)) + „,”
   Next
   MsgBox b
  End Sub

  Sub succesor(am_suc As Boolean, st As stiva,
  k As Integer)
   If st.ss(k) < n Then
    am_suc = True
    st.ss(k) = st.ss(k) + 1
   Else
    am_suc = False
   End If
  End Sub
```

Backtracking routine:

```
k:=1; CALL init(1,st);
while k>0
 do
  CALL succesor (as, st, k) ;
   if as then CALLvalid(ev,st,k) then
    loop until (not as) or (as and ev) ;
    if as then
     if solutie(k) then
      CALL tipar
     else
      k:=k+l;
      CALL init ( k, st );
     end;
    else
 k:=k-1
wend
```

Stack k + 1 must be initialized (to select the k + 1 elements in order). Initialization should be done with a value (in the order of order considered for the Ak + 1 set) before all the possible values in the set. For example, to generate the permutations of the set {1,2 ..... n}, any stack level will take values from 1 to n. Initialize a level (any) with 0 [2], [6].

4. Conclusions

Logical reasoning or symbolic reasoning is based on classical logic-mathematical theory and analyzes how new knowledge can be derived from existing ones, deductively, based on inference rules. As a preparatory course for the IA study, a computational logic course is recommended for applications, such as Lisp, Prolog, and Clips, or automated theorem demonstration systems [1], [3]. Intelligent agents operate within a software environment such as operating systems, databases, or computer networks. Technology behind intelligent agents is a combination of IA techniques and system development methodologies such as object-oriented programming that allows programs to learn from and react to the environment. Intelligent agents interact with the environment they are part of through rule-based data selection criteria. An intelligent agent develops appropriate rules through explicit user instructions, imitation of the user, positive or negative feedback received from the user, and instructions obtained from interacting with other agents. The logical reasoning and itelligent agents may help to implement the business logic and the economic rules for enterprise applications.

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