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The Process of Implementing Rules in the Proposed Model of SOAR Cognitive Architecture in Artificial Intelligence PSO Architecture

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Abstract

Soar is a cognitive architecture invented by John Laird, Allen Newell, and Paul Rosen Bloom at Carnegie Melon University. Soar is actually a representation of what cognitive science is, as well as the implementation and application of that representation using a computer programming architecture for artificial intelligence. The goal of "artificial intelligence" is generally to make a machine that can think. In this article, for the first time, it is mentioned to present the proposed rules for the application of the model in artificial collective intelligence of architecture and the modeling rules are briefly stated. The research method is descriptive and analytical, and the study has a fundamental and epistemological nature. The findings of the research show that the algorithm resulting from the investigation of this behavior in artificial intelligence is called PSO and the pattern of simulating their movement in the group (herd) is called BOID. In the way of reaching the proposed idea of collective intelligence of birds and fishes in architecture, first collective artificial intelligence (swarm) and swarm robotics and how robots work in a swarm (from their modeling to their communication) have been discussed and finally the proposed model for different architectural bodies including the roof, has been told in detail and its applications have been mentioned.

Keywords: *artificial intelligence, thinking and creativity, collective artificial intelligence.*

Introduction and statement of the problem

"*Artificial Intelligence*" is a combination of computer science, physiology and philosophy. This branch of science is very wide and diverse and starts from different subjects and fields of science and technology, such as simple mechanisms in machines, and ends with expert systems. The goal of "*artificial intelligence*" is generally to make a machine that can think. Soar stands for state operator and result, which indicates the representation of problem solving as an application from the operator to a state to get the result. According to the frequently asked questions of the soar community project, soar is no longer written in capital letters. If the decision process described is not able to make a unique decision about the action to be taken, SOAR uses different strategies, which are called weak methods, to solve difficult or complex problems. We know. These methods are suitable for situations where sufficient and abundant knowledge is not available to solve the existing problem. Some examples for this state include mean-end analysis, which calculates the differences between each of the available options and the target state, and also a type of hill climbing problem. Climbing. When a solution to the problem is found using one of these methods, soar uses a technique from this learning called chunking to convert the action into a rule. In the next times, soar will use this new rule to solve problems with a similar situation. Artificial intelligence design is achieved by applying the principles of collective intelligence. Collective intelligence is one of the new growing methods that is considered in artificial intelligence as a function of the social factor of the components. The foundations of collective intelligence are based on the study of the behavior of living beings such as some insects (bees, ants, termites) or even humans. In this article, for the first time, it is mentioned to present the proposed rules for the application of the model in artificial collective intelligence of architecture, and the modeling rules are briefly stated.

Research methodology and background

The research method is descriptive and analytical, and due to the type of study, it has a fundamental and epistemological nature. Also, library studies and translation of texts have been used to evaluate and present model rules.

Research literature

Thinking and intelligence in architecture

According to the words of “Schopenhauer”, a German philosopher, it has been said that: "Thoughts given to the text are like footprints in the sand." It is true that by seeing the footprints, we realize that someone has passed here, but what he saw on the way, we have to take help from our own eyes (Mansouri, 1378, p. 136). It has also been said from the words of the English philosopher that: "thought is something that relies heavily on practice and skill (Lawson, 2004; cited by Pourjafar and others, 2016, p. 95). According to Ibn Arabi, “thinking faculty” is the center of temptation and test given to man by God, and the intellect is exposed to delusion and misguidance by relying on it. Therefore, the Sufis do not trust this faculty, which sometimes gets caught in doubt and loses the path of knowledge; rather, it is the trust of their intellect that they seek help from the soul and heart (Hakmat, 2016, p. 43).

Some researchers consider thinking as a process that organizes a person's past experiences, such as "Vinak" who defines thinking in the book "Psychology of Thinking" as follows: "thinking to organize and reorganize in learning the past it is intended to be used in the current situation. Eason considers thinking as a secret and internal process that leads to a "cognitive domain" that changes a person's cognitive system. Another theory belongs to "Jerome. S. Brunner", which has a basic emphasis on the thinking process. Like Piaget's theory, Bruner's theory also focuses on how children encode information about the universe, organize it, and store it in their minds. The stages of mental development in Bruner's theory include: motor stage, image stage and symbolic stage. Solso (1990) completed these definitions and believes that thinking is a process through which a new mental representation is created by transforming information and interaction between mental characteristics, judgment, abstraction, reasoning and problem solving. Thinking, reasoning and problem solving are all phenomena in which intelligence plays a central role in their implementation. According to this theory, five quantitative cognitive principles that are related to intelligence and

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define intelligence in tests are: ♣ and ♣ fatigue; and ♣ spiritual force; And ♣ Primary abilities; And ♣ Memorizing power and memory.

Types and dimensions of thinking

It must be said that creative thinking can be considered one of the most complex and excellent manifestations of human thought. Sternberg (2001) considers creativity to be the ability to create new ideas at a high level, which is a mixture of the ability to innovate, flexibility and sensitivity to existing beliefs, and gives a person the ability to come up with ideas Logically and wisely, he should think about other findings in order to have beneficial achievements for him and others (Sharifi and Davari, 2008, p. 58). Dubono also discussed this category under the title of lateral thinking and "vertical thinking". In his book "Lateral Thinking", he kindly examines the differences between these two types of thinking. He believes that "vertical thinking" creates "mental templates and their development", while "lateral or creative thinking" changes the "structure" of these templates and creates "new templates". He has analyzed the difference between "lateral thinking" and "vertical thinking" and says: "vertical thinking creates mental states and their development, while lateral or creative thinking changes these forms and creates new forms."(Qasemi and Euclidos, 2015, p. 51).

Artificial intelligence methods in architecture

From one point of view, the goal is to build an artificial brain (artificial neural networks) and if this hardware exists, we can expect a machine equipped with this device to show intelligent behavior. From the second point of view, the goal is to model the way of human thinking, using which humans make smart decisions. In the 50s and 60s, the first axis was considered as the main axis in artificial intelligence creations, but in the 70s, symbolic processing was proposed as an understanding of the way of thinking in the design of intelligent systems. Fortunately, in the last ten years, researchers have come to the conclusion that to build an intelligent system that can work in different domains, and to solve a complex problem, trusting in one method (or insight) is enough. It won't be, and that's why the philosophy of Hybrid Artificial Intelligence has been proposed. In general, three methods of combining artificial intelligence techniques have been presented in order to build an intelligent system, which are discussed briefly below: In the first method, we use a specific technique to implement a function in another artificial intelligence technique. For example, in the design of a fuzzy control system, there are several blocks, each of which performs a specific task. One of these blocks is designed for Fuzzy fiction. In a hybrid system, neural networks can be used to do this. Of course, we will not talk about the advantages or disadvantages of this combination here. In another example, we can mention the use of genetic methods in the learning of neural networks. ♣ In the second method, in order to build a complex system, we break that system down (divide it into smaller subsystems) and then implement each subsystem with a suitable intelligent method. For example, in order to control a complex industrial process, neural networks are used to predict and model a series of key parameters, and the obtained results are given to an expert system for making general decisions. The expert system basically has the authority of an expert process manager who makes decisions using the parameters produced at a lower level. Many complex problems are of this nature, and breaking it into smaller problems and applying the appropriate method to solve each one separately and finally integrating the obtained results will help to solve the main problem correctly. ♣ The last method is to use a smart method in the implementation of another method. For example, we can mention the implementation of an expert system using neural networks. Here, each neuron in the neural network is a rule in the knowledge base, and we implement the inference method using neural

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calculations. Another example is the use of grammars in the analysis and presentation of learned knowledge in neural networks. Of course, it is necessary to pay attention to the fact that an intelligent hybrid system should not necessarily use intelligent methods in implementation.

SOAR cognitive architecture in artificial intelligence

Soar is a cognitive architecture invented by John Laird, Allen Newell, and Paul Rosen Bloom at Carnegie Melon University. Soar is actually a representation of what is cognitive science and also the implementation and application of that representation using a computer programming architecture for artificial intelligence. Since the beginning of SOAR in 1983 and its practical presentation in an article in 1987, it has been widely used by artificial intelligence researchers to model various aspects of human behavior. The main goal of the soar project is to be able to control and direct all the capabilities and capacities of an intelligent agent, from the most common capabilities to the most difficult issues and problems. In order to achieve this, based on the underlying layers, soar should be able to provide and produce representations and use appropriate knowledge formats (including procedural, declarative and implicit). After this soar should specify a set of mental mechanisms. Soar architecture implies that symbolic system is necessary for general intelligence. We know this issue with the physical symbol system hypothesis. Soar's cognitive theory is closely related to the psychological theory presented in Allen Newell's book called "Theories of Cognition". Despite the fact that the processing of signs or symbols is the central mechanism in the SOAR architecture. In the recent versions of this theory, non-sign processing has also been implemented, including reinforced learning, imagery processing, and emotion modeling. Although the ultimate goal of soar is to achieve general intelligence, there is no claim to achieve this goal. Supporters of this system are of the opinion that SOAR still does not take into account some important aspects of intelligence. Some examples of these unconsidered capacities include the creation of automatic representations by the system itself through hierarchical clustering. This system is based on a production system that uses explicit production rules to control behavior (these rules are mainly in the form of if....then...as used in the expert system). Solving the problem in SOAR can be based on searching the problem space (a set of different states that the system reaches in certain states) to reach an elimination state (which represents the solution to the problem). Be) considered. This work is implemented by searching for states that bring us closer to the target state. Each transition between states includes a decision cycle that has a complexity phase (in this phase different pieces of existing knowledge related to this problem are transferred to the internal memory of soar) and a decision process (what which is found in the previous phase and gives priority to each one in order to finally choose the action that should be done. In addition to searching the problem space, SOAR can also be used to introduce reasoning techniques such as reinforcement learning that do not require accurate and complete models of the environment. In this method, soar shows flexible behaviors against different amounts of existing knowledge.

Expression of research findings

Optimizing the building plan

Man is always looking for more prosperity. This effort has appeared in all aspects of his life. The final horizon of this project is in this direction as in the past. The final goal of the project is to make the design of the construction plan intelligent. So that the machine can make the optimal design of a map without human intervention. We will narrow down the problem here to start with. For this purpose, we assume that the ground and the rooms are rectangular. And the input of the program will be in such a way that the user determines the dimensions of the land, the number of rooms he wants, and also the area of the smallest and largest room. There are different algorithms for this. The goal is to produce a desirable and customer-friendly plan, that is, the rooms should be in such a way that: 1. First, the access to the rooms should be correct 2. Secondly, the right light should reach each part of the house. The applications of this project include: ♣ First, he mentioned the preparation of architectural plans intelligently and without human intervention. ♣ Secondly, we can mention the design of large-scale integrated circuits. It helps architects in obtaining different orders of map elements. Many efforts have been made to solve this problem and automate it. Which results in obtaining different algorithms. One of these algorithms is inspired by large-scale circuit designs. In this way, the program takes a number of rooms with different characteristics, priorities and criteria and arranges them next to each other like the blocks of a large-scale circuit. Another relatively recent work in this field is the preparation of an architectural plan for a one-bedroom apartment. The working method is that it searches for the connection of the rooms with each other. And as a result, it displays a list of possible states. Another algorithm used for this task is the genetic algorithm. In the genetic algorithm, there are evaluation functions and generations. The mechanism of this algorithm is derived from nature. In this way, we can finally reach the desired output from the sequence of generations. Another algorithm that can be used is the evolutionary strategy algorithm. This algorithm is effective for optimization problems in continuous space. This algorithm has parts of mutation, combination and replacement.

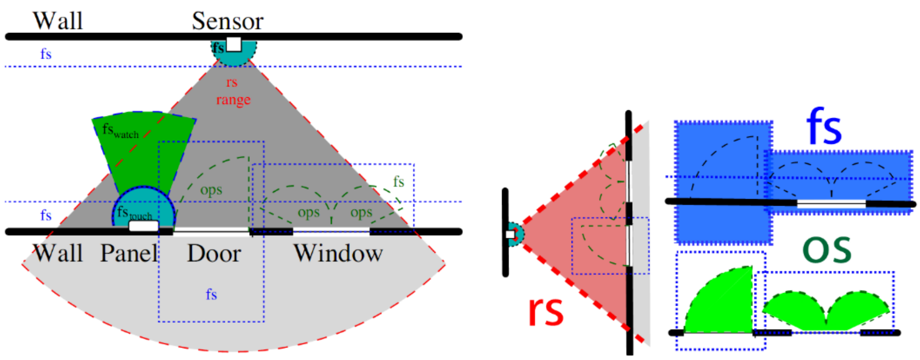

Fig 1. An example of map optimization; Source: the author's drawing.

Experiments on optimization of maps with artificial intelligence

In the implementation phase, only the genetic algorithm is implemented. For this purpose, the deep module of Python language is used. Code description: ♣ First, we take the dimensions of the raw land from the user. Then, we specify the number of rooms as well as the minimum and maximum area of the room by the user. ♣ Then, we have generated a random sequence of chromosomes using ready functions of the used module within the limits of the earth's dimensions. ♣ In the next step, we defined the fitness function, which itself includes several other functions. Then we started producing different generations by using the ruling rules in the genetic algorithm. Note that the number of generations is assumed to be 80. Code testing: For testing, we gave different inputs to the program and received the output of the program, which is in the form of an array. The array contains the coordinates of two corners of the rectangle (rooms). Because having the coordinates of two opposite corners of a rectangle, it can be easily drawn. In this code, all four consecutive numbers in the array indicate the length and width of the two corners of a rectangle.

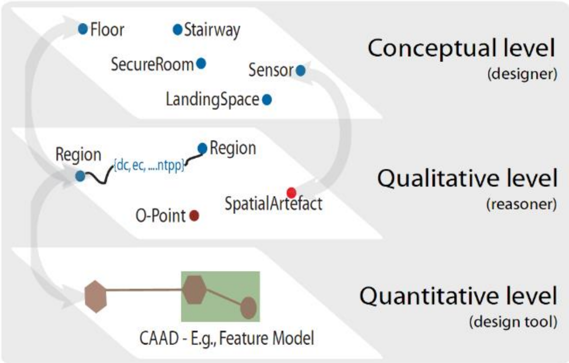

Fig 2. An example of the segmentation of conceptual, quantitative and qualitative stages in design; Source: Edwards, 2015

The fitness function used in this program only evaluates the overlapping criteria of rooms and light. In general, this program does not make us need an architect, as it is in the final horizon of the project. A real architect considers other criteria such as low and high land, wind direction, shape of neighboring houses and other climatic conditions. To implement the length and height criteria, a two-dimensional array consisting of chromosomes can be defined. This can be easily implemented using the deep module used in this project. Another problem in the distance between this program and its wide application in the work of the rectangular problem was considering all the rooms and the ground, which did not work in other shaped fields, and it seems that for these shapes too, considering Taking the two-dimensional genome and this time with the mentioned multi-objective methods, the implementation was somewhat correct: ♣ The suggested method is to express the rooms with a point. We know that each wall is located exactly between two points, in order to divide the building into several rectangles (rooms) with these points, we first draw the wall between the first two points so that the map is divided into two parts, and then we do this for all parts. So that every point is placed in one section, in this way the space factor will be reduced and the empty spaces will be filled with rooms. ♣ Another method that comes to mind is to use the middle points of the halved ranges of the primary land. It means that first we cut the ground in 1/2 and cut each half in half and we continue this process up to a certain amount (for example 8 times) and then the middle points of each area along with the length and width of the ground. We save it somewhere. And use the coordinates mentioned in the evaluation functions and rules governing the problem and reduce the genome of the problem to half the previous size by specifying the length and width of the middle point.

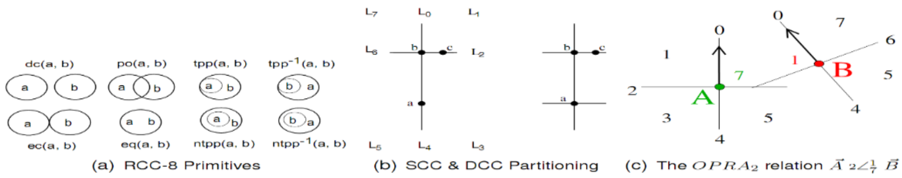

Fig 3. Topological stage in map optimization; Source: Edwards, 2015

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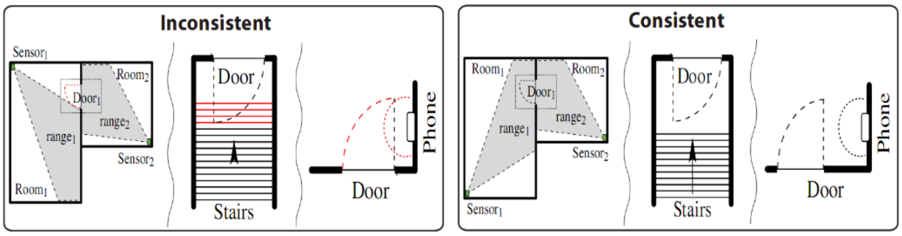

Fig 4. The needs of design and spatial positioning in map optimization; Source: Edwards, 2015

It is possible to define a type of machine learning to make this project more accurate according to users' needs. In such a way that in the output, according to the fitness function and its ratings, we produce one or more outputs. Then, considering which of the designs the user (human) chooses each time, we will establish a knowledge base. The information in this knowledge base is the choice of the user and the criteria he has considered for his choice. The general behavior of the society is formed from the personal behavior of the agents in the society. In fact, there is a two-way relationship between the personal behavior of agents and the behavior of society. The total personal behavior of the agents shapes the behavior of the community, and on the other hand, the behavior of the community affects the conditions on which each agent operates. These activities can change the surrounding environment, which may change the behavior of the agents. A change in the behavior of agents can lead to a change in the behavior of society. As a result, the most important component in collective intelligence is the interaction between agents. The interaction between agents leads to the refinement of knowledge and experiential awareness about the surrounding environment. In other words, structuring in social organisms requires interaction between them, and this factor can be both direct and indirect. Direct interaction is obvious and will be achieved in a direct connection between the elements of society.

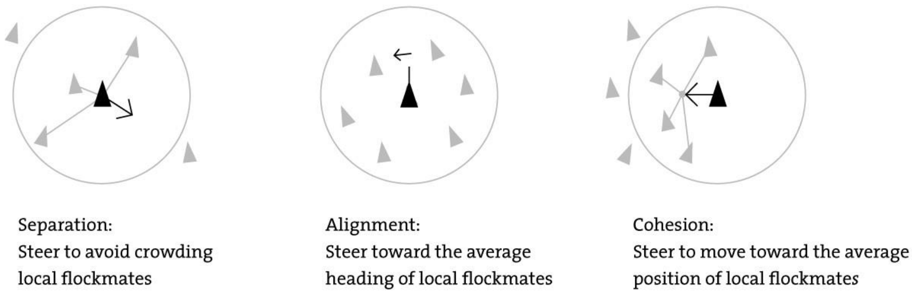

Fig 5. Collective intelligence of birds and fish; Source: Ibid. p. 138

The process of implementing rules in the proposed model for architecture

There are three general rules that optimize the movement of these creatures: ♣ Law of Separation: Each bird tries to get away from its neighbors if it gets too close. Co-direction law: each bird moves towards its best neighbors. ♣ The law of adhesion: every bird tries to move towards the average position of its neighbors" (Samad-Zadegan and Nayini, 2010, p. 26). From the study of the behavior of birds and fish by researchers to find an optimization algorithm, pso algorithm was formed, which is explained in the next section. The process of simplifying the pos algorithm in the proposed architectural structure (which is observed in birds and fish). It can be implemented and simulated with the help of simple mathematical rules.

Conclusion and summary

Inspired by the form, function and behavior of natural phenomena and creatures, architecture was able to create structures and buildings that are original and rich in function and stability and the demands of the audience. Various uses of these forms and functions and behaviors have been seen in bionic architecture. The exact field of work is the collective intelligence of birds and fishes, which behave optimally and efficiently in their movement towards the goal and finding food and actions to protect themselves and their flock. The algorithm resulting from the investigation of this behavior in artificial intelligence is called PSO, and the pattern of simulating their movement in the group (herd) is called BOID. In the way of reaching the proposed idea of collective intelligence of birds and fishes in architecture, first collective artificial intelligence (swarm) and swarm robotics and the manner of robots in a swarm (their modeling until their communication) have been discussed and finally the proposed model for different architectural bodies including the roof, has been told in detail and its applications have been mentioned. An architectural space that, due to various needs and requirements, requires moving and dynamic components that are intelligent in their movements, should be optimal and economical in terms of cost and energy, so that in a period where the focus is on energy conservation and high productivity, can reach mass production. Although architecture in many cases has this feature of the functions of natural creatures. Robots (even the simplest ones) can move components in different directions or in different ways with different algorithms. A flexible and responsive architecture in many cases (even in the best case of static design) sometimes needs to be dynamic. The research conducted focused on the collective intelligence of birds, how this field entered robotics, and the application of swarm robotics in architecture. After presenting the proposed architectural model based on the algorithm of the movement of birds and fishes in their swarm, the types of its application in architecture were mentioned and suggested parts in the building were introduced. From this part, the insight has been obtained that whatever the external factor (motivator) is, with the patterns taken from the optimal behavior of many living beings, it reached the desired and similar responses that were designed, identified and selected in their nature for the purpose. Finally, the activity of the fields of bionics, computers and mathematics in between and architecture and construction technology together, can be a fruitful contribution to the requirements of today's architecture. Because formal design alone is not enough for an architecture suitable for the earth and human needs. For each complex with collective intelligence, there are five general principles in its architectural application, which are: A- Neighborhood: the ability to perform simple spatial and temporal calculations in response to environmental stimuli; B- Quality: the ability to react to quality factors such as food and health; C- Diverse answers: the ability to distribute resources and maintain them against changes in the environment D- Sustainability: the ability to distribute resources and preserve them against environmental changes; E- Adaptability: the ability to change the behavior of the group in order to make it more compatible with the problem.

Declaration of no conflict of interest

The authors declare that there was no conflict of interest for them in conducting this research. (Conflict of interest refers to a situation where the material or non-material personal interests of the author or authors are in conflict with the research results and this affects the research process or the honest announcement of the results).

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