The Multi Control Strategy For Intelligent System

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Iping Supriana
Ririn Dwi Agustin

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Abstract
Control strategy has very important role in the typical intelligent systems. The control strategy provides the search mechanism, forward and backward chaining in order to get the optimal solution given by the system. Thus, it affects the speed and the quality of the system solution. Most of intelligent systems apply one control strategy based on some search strategies such as Deep First Search (DFS), Breadth First Search (BFS) , Good First Search (GFS) or based on AI Computing Ap-proaches such as Neural Network, Genetic Algorithm, and Ant Algorithm. The solution given by such intelli-gent system cannot always be optimal. In Order to have better performance , we propose a development of an intelligent system based on a multi-control strategy. The multi control strategy will be implemented on the search-ing and matching process when developing solution tree. The selection of the next expansion solution tree applies multi-control mechanism that can be either manually chosen by the user or automatically chosen by the sys-tem. Automatic selection by the system will be conducted based on the exploration to the active knowledge base using an automatic selector module developed in the sys-tem. By applying such mechanism, it is expected that the solution given by an intelligent system can be realized optimally. Keyword –component : informatics, problem complexity, intelligent system , multi control strategy, knowledge, searching and matching.

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The Multi Control Strategy For Intelligent System

Prof. Dr. Iping Supriana Suwardi
School of Electronic and Informatics Engineering
Bandung Institute Of Technology, Indonesia
iping@informatika.org

Ririn Agustin, Ir.,MT.
Informatic Engineering
Pasundan University, Indonesia
rriyno@yahoo.co.id

Control strategy has very important role in the typical intelligent systems. The control strategy provides the search mechanism, forward and backward chaining in order to get the optimal solution given by the system. Thus, it affects the speed and the quality of the system solution. Most of intelligent systems apply one control strategy based on some search strategies such as Deep First Search (DFS), Breadth First Search (BFS) , Good First Search (GFS) or based on AI Computing Approaches such as Neural Network, Genetic Algorithm, and Ant Algorithm. The solution given by such intelligent system cannot always be optimal. In Order to have better performance , we propose a development of an intelligent system based on a multi-control strategy. The multi control strategy will be implemented on the searching and matching process when developing solution tree. The selection of the next expansion solution tree applies multi-control mechanism that can be either manually chosen by the user or automatically chosen by the system. Automatic selection by the system will be conducted based on the exploration to the active knowledge base using an automatic selector module developed in the system. By applying such mechanism, it is expected that the solution given by an intelligent system can be realized optimally.

Keyword –component : informatics, problem complexity, intelligent system , multi control strategy, knowledge, searching and matching.

Introduction

The primary role of informatics is as tools to conduct computer-based problem solving. In terms of certainty of steps that be selected by the given conditions, there are two kinds of problems known as deterministic and non-deterministic problem. In the deterministic problem, the solution can be designed and coded directly. The solution step of deterministic problem is fixed, so that if we entered one conditions will result in the same output whenever the problem solving be done. In other words, steps of the solution can be set before being implemented into computers.

non-deterministic problem (e.g. chess problem) determining step is very hard to do. This is caused by a lot of the steps, and each step that be selected may not necessarily lead to the desired solution (win). In the extreme case there is a problem which the steps to resolve the problem cannot be defined.

A problem must have three major components to be solved . The first is related data (the initial state), the second is a state modifier function (operator), the third is information about targeted state(final state). When all of the elements was well defined, problem solving be done through selection of operator that can be applied to the initial state to produces next state . The next step is looping process for select the operator and get next state until find the final state or until there is no more matching state.

For deterministic problems, designer of intelligent systems will enumerate all possible choice of operator based on combination of the initial and the final state. For non-deterministic problem (like winning the chess game), issue of the selection of operators to be less human. There was an explosion of the number of next operators that can be selected after select an operator that produces a set of next state occurs. It would take a very long time to formulate problem solving solutions. Under these conditions, for non-deterministic problem, the solution is built by a computer program which is designed to search and select operators automatically. It also must be considered that implementation of the program in the computer would require a very large data space and a huge process.

In area that was described above, informatics have done computational rationality. The computational rationality term has been surpassed by Artificial Intelligence that be iconed by Mc Carty at the Dartmouth workshop 1956.

Intelligence system and inference engine

In accordance with the description of the main components in problem solving, an intelligent system should consist of the initial states, a collection of operators, set of the target states, and program as an operator selector. Collection of the initial states and the target states can be called a collection of states. Further collections of the states and operator is known as knowledge. Figure 1 described framework of Intelligent system

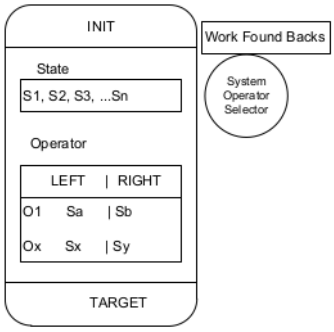


Figure 1. Framework of Intelligent System

Pseudo code of intelligent system is described below .

1. Set WORK as INIT
2. Find operator that the left part of the operator match with WORK, say it FOUND
   a. If FOUND is only one then set WORK as right part of the operator
      i. If WORK is equivalent with TARGET then STOP SUCCED
      Else go 2
   b. If FOUND is more than one then
      i. Set WORK **one of** the FOUND
      ii. Put rest of FOUND on BACKS
      Go 2
   c. If FOUND is empty then
      i. If BACKS is empty then STOP FAILED
      ii. Else
         1. set WORK **one of** BACKS
         2. Go 2

Pseudo code above shows that the quality of an inference engine relies heavily on the selection of **one of** states. The selected state might be that were first discovered or that having the best weight. The weight of state n (f(n)) is the sum of the real costs are used from the initial state to that state n (g (n)) and estimation cost from state n to state target (h (n)). It could be writen that f(n) = g(n) + h(n).

Algorithm to establish a selection model is known as the control strategy. Researchers have found much control strategy which are classified into blind search, heuristic search, and soft computing. There are four criteria to assess a control strategy performance. Those are completeness, optimality, time complexity and space complexity. Searching do through expanding of the search tree that have branch factor (b) and depth (d). The complexity is measured by branch factor (b) and depth (d). These will be briefly described some control strategy.

Depth First Search (DFS)

In the DFS, the selected nodes to be traced first is first node of the children nodes. Where is children nodes= Operator(Initial state/ Current State). Rest of the children node is stored in OPEN queue with insert first method.

The advantages of the DFS is low of its space complexity (O(bm). Its Time complexity is $O(b^m)$ where m is the maximum depth of the search tree. Yet DFS not ensures completeness and not ensure the solution that be found is optimal.[6] If m is large then DFS could get lost in the depths. Improvement of the DFS is Depth limited search (DLS) and Iterative Deepening Search (IDS) Algorithm

Breadth First Search (BFS)

In the BFS algorithm, the nodes in one generation (the same depth) and the smallest depth will be explored first. Children nodes be inserted with insert last in the OPEN queue. Since the next node to be evaluated is the head of the queue (delete first) then the node with a smaller depth will be searched first. BFS is an algorithm that ensures completeness and optimality. However, it have high complexity in time and space, that is $O(b^d)$ where d is the depth of the tree.[6]

Good First Search (GFS)

In the GFS algorithm, state with the best weight will be explored first. Open queue contains the ordered node based on weights. Weight was measured by the formula g(n) + h(n).[6] There are variants of algorithms based on various combinations of the formula for the weights. Algorithms that include h(n) in calculating the weights categorized as heuristic search. The Varian of heuristic search algorithm are Greedy, A*, Hill Climbing, Simulated annealing. SMA* (Simplified Memory Bounded A*) is a variant of the A* that be intended to computing when storage conditions are very limited. UCS (uniform cost search) is an algorithm that uses only g(n) to calculate the weight, so it is still categorized as a blind search.

Bidirectional Search (BDS)

Direction of the search process are of two kinds, the first is FORWARD starting from the initial state towards the targeted state. Conversely called BACKWARD, from initial state to a targeted state. BDS is a search algorithm that does searching from two directions simultaneously and stops when the state that have been evaluated from both directions have intersecting. In the backward and forward searching can be used algorithms that have been described previously. The performance of this algorithm is complete and optimal with complexity O($b^{d/2}$). The consequence is to construct a two-way operator. Not all cases can be formulated its operator in two-way

Genetic Algorithm (AG)

Solutions in AG are modeled as finite combinations of variables that forming solutions (chromosomes) with the best fitness value. The solution obtained from the iterative evaluation of the set of chromosomes (population) through genetic operations such as crossover, mutation, and selection. The complexity of the time and place of the algorithm is relatively low. But the AG does not guarantee a complete and optimal performance. Iterative process can be stuck on a local maximum. ANN was classified as soft computing.

Artificial Neural Network (ANN)

Solutions in ANN was modeled as a combination from sum of its operand multiplication with a constant value that was sought from average of a given experience. In ANN, the representation of the problem must be in numeric variable. The advantages of this algorithm is that AI designers do not need to define the state and operators, but must provide a good quality of experience data. ANN was classified as soft computing. [5]

ANT Algorithm

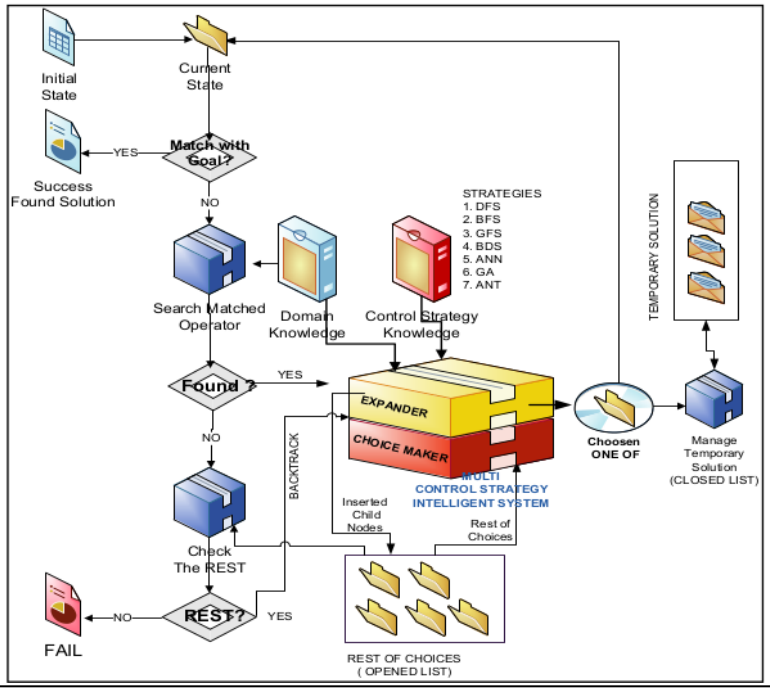
The solution in the Ant Algorithm was searched by selecting the best weight of each segment of the solution. Where is the best criteria derived from the factor that represents the parameters ferome the trail of ant colonies. [3]

Multi Control Strategy

From the brief description about the various control strategy above, we can conclude that any control strategy has advantages, deficiencies and consequences of each. So the suitability of control strategy with the problem that will be solved is very important for efficiency. Search tree is a representation of the problem solving stages. At each branch can be seen as the completion of a sub-problem. The situation of the knowledge relative to one sub problem may be different from the other sub problem. The difference is the reason for the necessity of choosing a more specific control strategies for the current sub problem. If our concern about the context of the sub problems completion will be expanded to snapshot of Opened and Closed List , we will find material that can be treated as data for improvement of the efficiency.

Developing the search tree is actually generating branches that leads discovery the solutions quickly (EXPANDER). Branches was get from operation of the matched operator with current state. At this point the multi control strategy have chance to make improvement about operator choosing pattern , so system get the best search tree. After the new branches are formed, the next process is to choose one branch (one of) that will expand in the next iteration (CHOICE MAKER). At this point multi control strategy system choose the most appropriate control strategy with the knowledge that be associated with sub problems encountered. At the level of implementation in the built software, strategy selection mode automatically by the system can be in-off mode, and users can select its own control strategy.

The main issue in selection of the control strategy is to determine how the level of appropriateness with existing knowledge in the knowledge base. This question is difficult to answer. To provide the opportunity choosing a more flexible control strategy, we attempts to develop the model of intelligent systems that can regulate the use of selection control strategy. The model was described at figure 2.



Discussion

The solution for complex problem can be considered as collection of the sub selection. Thus the presence of multi-control strategy is very important for dealing with complex problems. The main problem is how to divide the problem into a set of smaller problems. And then each sub-problem can be solved with the relevant control strategy. This can only be done when the categories of the complexity of the problem is divisible. For the indivisible problem, that is not as simple as a divisible one . However, due to the natural aspect of intelligent systems is an approach model, so in conditions that no other options, indivisible problem can be made equivalent to divisible. Although the approach give the less satisfactory solution risk.

In the example of the chess game, this phenomenon will be seen easily. Interestingly is that in the chess game of chess, the quality of the answers is not determined solely by the system and its knowledge base but also determined by the strategy of the opponent.

Concluding Remark

Solving the problem with featured as clever as human is an ambitious and challenging direction. In this paper position we described the essential issue about intelligent system on control strategy. The challenges include how to construct a model multi control strategy in dynamic environment, how to efficiently find relevant solution for complex non deterministic problem.

We believe that the insight in this paper an enlightening to researches in this field and the large scale knowledge to infer will lead to many impactful application in the future.

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Prof. Iping Supriana received the docteur-ingénieur degree in Informatics from the Institute National Polytechnique, Grenoble, French in 1985. He is currently a Professor of the School of Electrical and Informatic Engineering, Bandung Institute of Technology, Indonesia.

His research interests include: information automation, dynamic computer graphic, image analysis, recognition system, and image interpretation. He has authored or coauthored over 50 published articles.

He is the inventor and the implementer of the Digital Mark Reader (DMR). DMR is software employed for evaluating examination results automatically using computer scanning. DMR iswidely used in Indonesian education institution.

He is also the inventor and the implementer of the Digital Scan Meter (DSM). DSM is software employed for reading and reporting the electric power consumption. The software convert the image photo contains numbers into the digital format for billing requirement. DSM is widely in used in the National Electrical Company in West Java, Indonesia.

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