A Comparison Between Intelligent Aalgorithms for Solving Site-selection Problems in GIS

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SUMMARY

As an essential domain, the site-selection methods have always performed a significant role in spatial decision-making processes. Traditional methods used at the beginning of necessity for site selection appearance, developed relatively by analysts and specialists based on multi-criteria methods. A main disadvantage of these methods relates to dependency of the final results to personal privillays of participant experts. In addition, using different multi-criteria methods for one problem makes different results, not a unique or even similar results. To resolve these issues, Artificial Intelligence was used for Site Selection problems, in the context of GIS GEOCOMPUTING. However, these methods have still their own drawbacks such as: "the process of problem solving is a Black Box to the users" and "the final result is sensitive to the Fitness Function". This paper first reviews and compairs different methods which have been used for site selection problems and then proposes proper (integrated) methods for solving site selection problems.

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1 INTRODUCTION

One of the systems which are emerged by information technology is Geographic Information system. In addition to create management, search, analyze and displaying geographical and descriptive data, GIS is able to work as a Decision Support System (DSS). Site Selection is one of the issues which have received so much concern along with introduction of GIS. A simple which can be used to perform Site Selection is included action Site Selection to choose a proper location for particular usage, which analyzes abilities and capabilities of a region considering having proper and enough land (with regard to pre-determined evaluation standards) and also liaison of that particular usage with urban usage.
Site Selection requires to consideration of a bunch of comprehensive factors and to balance different proposes in determination of level of symmetry of one region for a pre-determined usage. For example, electing some regions to construct residential apartments including an array of important factors, including physical, demographically, economic, political, and environmental factors. Position decision making procedure may use several systematic methods to perform multi-standard decision making with regard to physical harmony condition.
By analyzing artificial intelligence algorithms including Fuzzy, neural network algorithm and Evolutionary (genetic) algorithms and Cellular Automata, advantages and disadvantages of these are going to introduce in this assay.

2 ARTIFICIAL INTELLIGENCE METHODS

Recent advances in positional analysis shows that AI provide new chances to analyze Site Selection. It's been widely expressed that AI includes modern computational algorithms which may be of great help in modeling and describing comprehensive systems to in deduction and decision making. AI's main field is to simplify calculations. With this in mind, AI is looking to develop systems which trays to imitate human intelligence, without having in claim to understand constitutional procedures. Commonality among all of these algorithms is that despite all previous tradition points of view may stand against ambiguity, skepticism, carelessness, and inaccuracy. AI is a general idiom which includes some of Evolutionary algorithms, genetic programming, artificial neural networks, cellular automata and Fuzzy systems.

2-1 Fuzzy logic algorithms

Fuzzy was first introduced by Iranian professor Asgar Lotfi Zadeh, professor of Brekly University – USA to implement in uncertainty condition. This theory is able to provide several of phenomena, variables and the ground to deduction, control and decision making in uncertainty condition.

One of critical levels in tradition Site Selection analysis which it's hypothesizes, assured accuracy of fully unreal incoming data. In a comprehensive analysis, is too hard and sometimes impossible to provide accurate numeric data required by traditional methods base on Boolean algebra. For an example, for a particular activity it's possible to have a natural partitioning border between proper and non-proper regions, but in many cases of description cases about location conditions, they do not have natural cut offs determined threshold limit. In the common approach to a threshold limit, for example in a manner which defined that an acceptable site should be located in 1 KM from the river. But such a threshold limit is not natural. Why a site in 0.99km from the river will be acceptable, and a site located at 1.01km from the river will be placed in an acceptable class? Usually there a kind of ambiguity and lace of explicitly in such conditions. In addition usual methods always assume that criteria weights are given in a numeric form, which provide a preference from the most important to most unimportant of Site Selection standards. So related discussion to ambiguity, doubt and inaccuracy should find a solution in Site Selection problems, which this may work well with Fuzzy set theories and Fuzzy logic.

Fuzzy logic is a universalization of classic binary logic, which provide the chance to define without border and clear bunches and membership of part of elements belongs to a group. Principally a Fuzzy set is a bunch which its member may have different membership degrees between zero and one. Main meaning of Fuzzy set theory is a function of membership which shows belonging level of each given elements to a group and provides a framework for displaying method, behavior method with uncertainty resulted from ambiguity, doubt, indelicacy, lack of information and trivial facts. There are three points of view to define Fuzzy membership: semantic import model, similarity relation model, and experimental analysis.

Meaning of membership function has been used in some number of researches of Site Selection. These researches particularly focus on land analysis and land classification, rather than Site Selection analysis. But a lot of aspects of Fuzzy logic approach for assessing and classification of land are more related to Site Selection modeling. For example, it proposes a processing and Fuzzy information display method on a GIS background which leads to development of a Fuzzy Site Selection measurement. Several researches have used Fuzzy membership function meaning along with MCDA to develop Site Selection analysis methods based on GIS. [5] and [6]. [5] Based on AHP method, discus about level of Fuzzy in GIS Site Selection analysis. [6] Suggest a Fuzzy prediction to conduct multi-standard assessment using OWA meaning as a framework for Site Selection analysis based on GIS.

Using Fuzzy logic in Site Evaluation issues generally and Site Selection model particularly,

have several advantages comparing to traditional methods. Having geographical phenomena changes such as plant coverage classes and type of soil [2] [3] [7] suggests that Fuzzy membership approach is very suitable among different classes of land usage symmetry in task of Site Selection. They also have proved that in traditional approach when a Site Selection issue includes data which have been changed without enough accuracy, it will loss the information and also increases the chance of error. Fuzzy set methods save all sectional membership information while having in mind estimation error. Although it's been showed that Fuzzy Site Selection approach has much less limitation comparing to traditional techniques although these points of view have some negative aspects as well. The most important problem which has been mixed is lack of an absolute method to determine membership function.

2-2 neural networks

Neural network model is derived from a simulation of human mind. Main purpose of this model is simulation of an ideal form of basic processors in brain and self continuity, signal processing and self-organization abilities. Construction of a neural network is like a simple human brain which is connected by several individual processing elements which are connected by a group of weights. It is simple to look at neural networks based of the three stages which will come as following: income (such as data for Site Selection analysis), model (such as Site Selection model) and outcome (such as the most proper place). In a neural network every entrance enters through a training stage which correct outcome for every group of incomes informed to the network. Network is offered with several of these incomes and outcomes and works with relation between data.

There are a lot of surveys on level of neural efficiency in analyzing spatial data, especially Site Selection analysis. [18] Used a neural network after propagation of level of symmetry of some pieces of lands to develop, and compared the approach base on neural network with several traditional cartography modeling techniques. Both [8] and [18] consider neural networks as a proper tool for Site Selection analysis in GIS system. [9] Emphasizes on ability of arbitrate and compatibility rule and neural network to perform different consolidations of inter-dependence factors and Site Selection. [10] Used a neural network approach with genetic training algorithm instead of post-propagation algorithm.

Instead of determining absolute solution for complex problems of Site Selection Neural networks provide estimated solutions. It's possible to consider a neural network as a compatibility system which organizes itself advancing. Therefore this approach requires an analysis to determine accurate and inaccurate stages to reach to an answer. This philosophy of solution can be seen as an advantage our weakness, which depends on the operator and purposes. One of advantages of neural network methods is that the operator may focus on details on the issues instead of details of technique. Neural network approachs has the best usage for the operator how has a little and uncompleted knowledge about structure of the problem. Also with regard that this algorithms are data-deriven they would have better efficiency for problems with data great groups.

Neural network's major weakness is that the structure of the network is not so clear (i.e. how many middle layers and neurons and each layer are required) . This structural problem leads to another issue in utilizing neural network in Site Selection analysis. For example, internal function of this approach is out of sight of observation of analyzers (and decision makers). During developing neural networks there are several parameters which should be take care of very well, and each one of them may effect accuracy of the algorithm. To mention properties of these parameters requires on having complete understanding of a complex algorithm with data group by the operator, however this is not the case usually which leads of lower optimum utilization. Another issue in the need to training more than it is required, where it seems that the network is trained well, but actually just working on remembering solutions and specially training data and there is little efficiency for real data. The solution is especially relates to neural network methods of to bound as it is required by real world requirements. It is acceptable that decision makers and beneficiary groups are not interested in the solutions which perform Site Selection using a technique which they cannot observe what is going on and understand it.

2-3 Evolutionary Algorithms (Genetic Algorithm)

Evolutionary algorithms are search methods which imitate biological evolution of nature. Evolutionary algorithms are different from previous optimizing algorithms in that they include a search of a set of solutions. Solutions with high capability combine through transaction of elements of a solution. Through effecting a little change on an individual elements, solutions also evolution through one solution. Re-combination and evolution for production of new solution tending to some areas of the answer are used to which proper solutions indentifies in them. Genetic algorithm is particularly suitable for combinational problems with big searching space such as complex multi-propose Site Selection. In general form, major function of a genetic algorithm is simple. First a set developed from all better solutions (e.g. a set of potential Site Selection models). Then more proper method combines with each other to introduce new solutions. Finally new solutions combine with each other to replace weaker primary solutions and this procedure repeated again. Each time the new genetic solution is introduced, a purpose functions (for example to minimize the price to take the lane, maximizing availability to welfare facilities and etc.) will be evaluated, and answer ranking in the current up dated based on compatibility level actively. Such ranking takes place in process which finally the best answers will have the greatest chance to be chosen as parents, just like survival of the fittest principle in the nature. Solutions with proper functions can be selected several times to replacing the election, while inefficient structure may never be selected. Genetic algorithm functions in Site Selection analysis have been used widely in Site Selection analysis based on GIS recently. [10] Shows a combination of neural network and GA as method for Site Selection analysis base on GIS. [12] Shows that genetic algorithm may increase traditional Site Selection approach's abilities in determining a location for specified activities. [13] Suggests that genetic algorithm may be a key element of designing land usage for Site Selection and management backup system. [14] and [15] have combined agent based approach and genetic algorithm in GIS environment. To survey land usage change, [9] shows that a model based on complementary

algorithm may have better results comparing to traditional methods such as WLC. [14] and [16] have used genetic algorithm and multi-standard assessing method based on GIS. [14] Have confirmed that Site Selection issue should be analyzed in a standard space (place properties space) and also in a geographical space (properties position space) and suggests that approach based on genetic algorithm is a proper way to create a connection between these two spaces.

Genetic algorithms are the best choice in instances which traditional multi-standard optimization are not enough for Site Selection issue modeling, or in the events which decision making is very complex (big and hard to understand) and space of the possible answers are very big. Also particularly in the cases which there is no extra information to guide the search and the result of that current solutions are non- effective, these algorithm are very proper choices. Although genetic algorithms do not guarantee to find an absolute answer, they are powerful method to find a set of answer which it is proper enough (they are near to overall optimal). One GA problems is that we can never be sure that overall optimal is recognized enough. [11] have emphasized that one of the major problems in using GA in guiding position issues is the problems in relation with utilizing GA abstract framework to a specific issue and indentifying compatibility standard for that issue, so that if one knows how describe a proper answer, should know how to find it without using GA.

2-4 Cellular Automata

A CA is a separated dynamic system which is formed by a group of cells in a single/multi dimensional network. Position of each cell in this positional network depends on previous position and position of neighbor cells. Situation of cells get updated by a set of local probable or absolute rules. Clearly situation of a cell depends only to its situation in previous time round and position of near neighbors in previous time. All cells of a automaton get updated simultaneously and in parallel manner. As the result condition of all automaton advance in separate time stages. System general condition by completion of situation of all cells will be determined as the result of several interactions. Place of occurrence of interaction between a cell and its neighbors is a defined property of CA. since CA models are clearly spatial, they can be used for urban planning simulation and other utilization such as simulating land usage change, freeways traffic and fire advancement as well.

CA logic does not try to introduce a description of a complex system in a general approach, rather it is seeking to model major action related to it interactions, and lets that system's complexity be clear through simple interactions related to simple rules which are coming at below. In this way a physical procedure may be displayed by a computational procedure and simulated directly into computer.

A CA's relaxation based on simulation theory of separate events develops CA efficiency to describe non-autonomous geographical processes. Such a relaxed CA may be used in different points of views, such as constrained CA or combination of CA with GIS and multi-standard assessment. In addition CA method has been universalized through mixing agent-like behavior

or non-local search [11]. Agent technologies, is developing agents in database real world or purposeful search on the internet. In an agent-based model, agents symbolizing human or other subjects are in a simulated world of real world [11]. It is possible to define agent-base systems as a group of agents which have internal interaction in a common space and can change themselves and their environment as well. For example, the environment may be symbol of an urban area and agents may by beneficiary group working in land usage design. Having these scenes and advantages, agent-based approachs are new type of modeling pattern which provides some facilities to have simulation more close to reality [17]. Especially spatial agent-based models confirm this fact that land usage is developed by non-centralized human decisions. Therefore these models are trying to protect human environment interaction main agents through providing tools which are included human made decisions and without losing the power related to organization meaning. [14] and [15] provide some examples of using agent-based modeling methods along with other AI algorithms in GIS environment. It's been expressed that agent models combined with GIS is a powerful tool for Site Selection analysis [17].

3- CONCLUSION

In short, that implementation which combines GIS with AI, we can expect new capabilities in supporting knowledge-based decision making and automation. As we discussed, AI algorithms can solve complex Site Selection decision making issues. it is clear that AI approach generally in a some cases includes followings which are proceeding traditional methods: 1- data great set or unpredictable non-linearity 2- hidden patterns for decision making cases is so important, 3- human opinions and ambiguous related factors and decision making conditions [9].

AI and GIS combination is a new field in research and software developing, while it not easy to AI systems settings to be set to connect through GIS. Present leakage about connections between GIS and AI which can be used easily, which provide a hard obstacle to decision makers and designers without program developing. Furthermore, advanced principles on neural networks and required works to establish connection between current AI systems to GIS, which has challenge this chance for the managers, decision makers and designers to have access to such facilities. It is also to be mentioned also that AI technology does not guarantee more accurate decision making, but it's possible to have make decision more consciously [9].

Unfortunately AI internal approach function in several cases, have been omitted from decision makers sight intentionally. Importantly spatial analysis discusses with this Black Box style is the main limitation in utilizing AI-GIS approachs in Site Selection analysis in reality. It is not expected the resulted solution by AI-GIS algorithms can be accepted by those how wants make decision about method and Site Selection condition, if it is not possible to explain AI model internal function clearly. One needs better answers about location of Site Selection suggested in this method, comparing to this answer that "this is the case since my AI model says so" [11].

At the end, although every AI has their own advantages, there are also disadvantages, which can be overwhelmed through combining AI combinational algorithm and reach to better results.

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