
# Residence Site Selection According to Combination of PSO Algorithm & Linear Regression Case Study: Sanandaj City in IRAN

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**Abstract**

Today optimal residence site selection problem is important for a real world application.These areas should be located so that they could be appropriate in terms of cost, safety and the physical features of the landscape. The Parameters for selecting appropriate areas are: accessibility, attractiveness, physical characteristics of land (e.g. Fault, Slope and Elevation) .In this research we have used Linear Regression for weighting these parameters; and consequently, the PSO (Particle Swarm Optimization) algorithm is used for finding the most suitable situations. The case study in this research is Sanandaj city in Iran. This study on Sanandaj city is particularly important because this city is located in mountainous regions where finding the optimal zone is a multiple criteria problem.

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**Key words:**Linear Regression, PSO, Residences,Site Selection

## 1. Introduction

The goal of finding location is a collection of appropriate location options for special usage. The problem of finding location is a decision making problem, with many factors. Increasing population and immigration are some of the causes that created the need for more residential spaces and this need has been increased lately. Finding location for residential complexes must be somehow that these locations, in each aspect: scientifically, logically, and physically, be appropriate, suitable, and acceptable.

With increase in population, cities spreading wider, and finding residential areas became a big problem (residency problem) which made finding suitable residential areas, in the list of main

policies of governments. Developing residential complexes in Iran, has been not properly planned and not properly documented nor designed properly, also most important factor has been price of lands that has an important affect on total cost. Optimizing location finding for these complexes caused to lower our construction costs for these complexes, also has caused lower pollution and traffic jam in these areas and also it results to lower degree of illness due to being closed to high pressure electricity towers. Therefore, putting ecological factors in modeling could result in increasing values and increasing the credibility of results of this method.Rajabi et al.(2011), located appropriate region in Tabriz city for residence with AHP algorithm and compared it with AHP-OWA and Fuzzy AHP-OWA algorithms.

## 2.Data and Material

### *2.1 PSO Algorithm*

Particle swarm optimization (PSO) is a stochastic optimization method inspired by social behavior of bird flocking or fish schooling. PSO as a population-based search optimization method in which individuals called particles change their position with time (Hinchey et al. (2007)). Particles move around search space. During movement, each particle modified its position according to its own experience and experience of a neighboring particle, making use of the best position encountered by itself and its neighbor.

In the last years, PSO has been successfully applied in many research and application areas. PSO have few parameters to adjust and its One of the reasons that PSO is attractive (Niu et al. (2007)). Particles and the velocity of each particle are actualized according toEqs. 1~2:

$$v_{k+1}^{(i)} = \omega_k v_{k+1}^{(i)} + c_1 r_1\left(p_k^{(i)} - x_k^{(i)}\right) + c_2 r_2 (p_k^{global} - x_k^{(i)}) \quad (1)$$

$$x_{k+1}^{(i)} = x_k^{(i)} + v_{k+1}^{(i)} \quad (2)$$

Where $x_k^{(i)}$and $v_k^{(i)}$are position and velocity vectors of the particle *i* , $\omega_k$is the inertia weight, $c_1$ and $c_2$ are constants, $r_1$ and $r_2$ are two random vectors, $\boldsymbol{p}_k^{(i)}$is the position with the best result of particle *i* and $\boldsymbol{p}_k^{global}$is the position with the best result of the group. In above equations subscript *k* refers to the iteration number (Aline et al. (2008)).The flowchart of PSO algorithm is shown in Fig. 1(Schutte et al. (2003)).

### *2.2 Linear Regression*

A classic statistical problem is to try to determine the relationship between a random variable *Y*. and an independent variable *x*. linear regression attempts to find relationship by fitting a curve to the data. The linear regression model postulates that (Eq. 3):

$$Y= b_0+b_1 x_1+ \ldots +b_n x_n+ e \quad (3)$$

Where the $x_i$ is independent variables and the "residual" *e* is a random variable with mean zeroand Y is dependent variable.

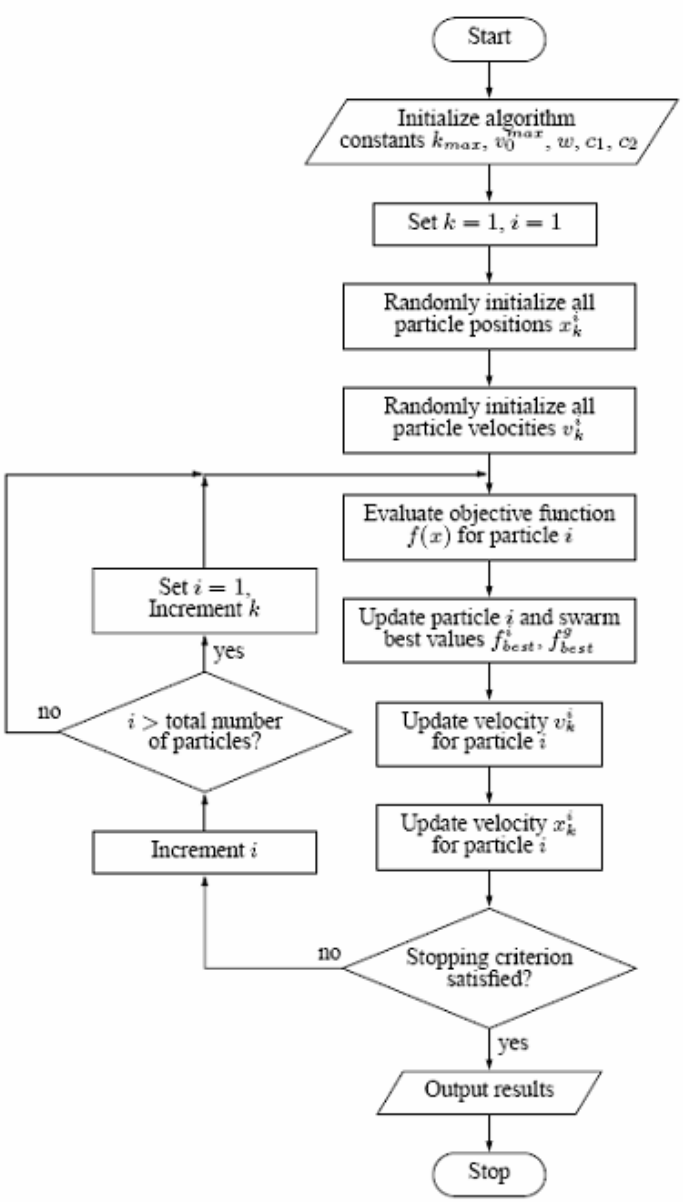


**Fig 1**: The flowchart of PSO algorithm.

## 3. Research Methodology

The parameters that are involved in finding location for complexes (if they are chosen based on optimization method, and if they are science-based), depending on the method that we use, should give us better answers and solutions. Data used in our research, come from two satellite images related to years 2000 and 2006 from land set satellite and are from TM & ETM sensors which, they have Earth pixel size of 28.5 meters. The main road map, attractive areas(such as Parks), Faults, Slope, Elevation, Land use maps and others also are formatted in Shape file, using software Arc GIS 9.3 ESRI. All processes on satellite images are done using software ENVI 4.7. After omitting geometrical errors and fixing image distortions, the related images are prepared based on Maximum Likelihood method which, is one the classified supervised methods. Our parameters are distance to street, distance to attractive area, distance

to fault, distance to city center, slope, elevation.With these parameters, satellite images and linear regression model we obtain Sanandaj urban growth model. Based on satellite images related to years 2000 and 2006 and using linear regression method, we have calibrated the model; we have found weights for each parameter. After raster formatting and making similar scaling of available maps, we normalize maps and this way for each map, each pixel has a value between zero and one. Based on regression model on all maps we can find general value for each pixel which, this value represents degree of appropriateness of pixel for specific usage. The more pixel value is closer to one, means that pixel is more appropriate to our subject, and numbers closer to zero represent lack of appropriateness of that pixel for our specific usage. To assure of accuracy and reliability of results, we use PSO method. So that if one specific pixel, after many times being recognized as appropriate, using PSO method, this pixel is considered one of spots that could have a good potential for our specific application. However, performance of specific method is somehow that there are known number of agentss scattered randomly in specific map's space. Each agent has possibility of finding of a space of 3x3 around its' center and its' move is somehow that in each repeating, program goes to a pixel in that 3x3 space which, has a general value of 9 pixel maximum. This way it is possible that one specific pixel, after many times repeating, can be chosen. To solve this problem and also create a wider space field to search, we have to put one condition, so that if one pixel is chosen 10 times, in repeating of next run, this agent can be randomly scattered in the space. The benefit of this, is that space can be searched more effectively and also this way, we can search other sections of map's space and the pixel which, has been chosen 10 times can be recognized as one of the answers of the program. Another word, it could be one of the places that are appropriate for finding specific location. The Landsat imagery of Sanandaj city is shown in Fig. 2.

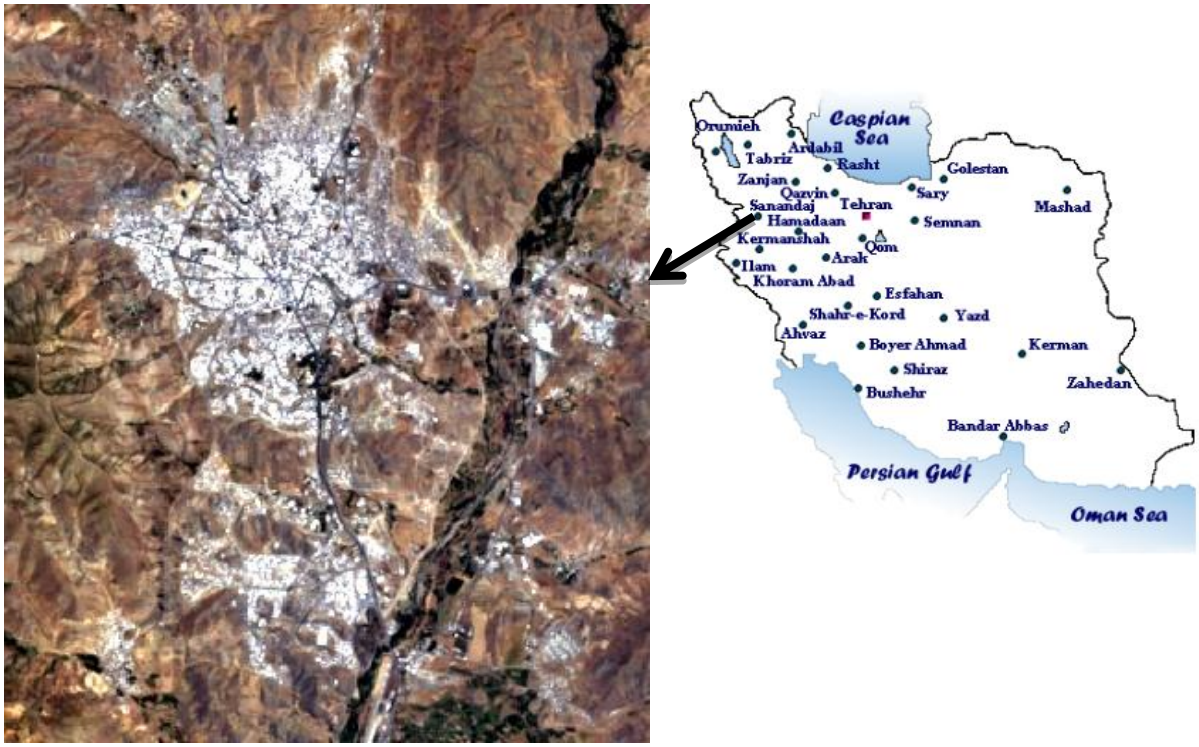


**Fig 2**: Landsat imagery of Sanandaj city (ETM$^{+}$2006)

## 4. Results and Analysis

We have to remember the more agents we introduce, space can be better reviewed and can result to make the running time for program longer which, moves us away from time optimization. And if number of agents is not enough, it is possible that space cannot be reviewed and analyzed in a more effective way, and we have no optimized result. Therefore introducing logical and suitable number of agents is effecting both optimizations of results and optimizes the amount of time for running program. The appropriate location of residences obtained from this analysis is shown in Fig. 3.

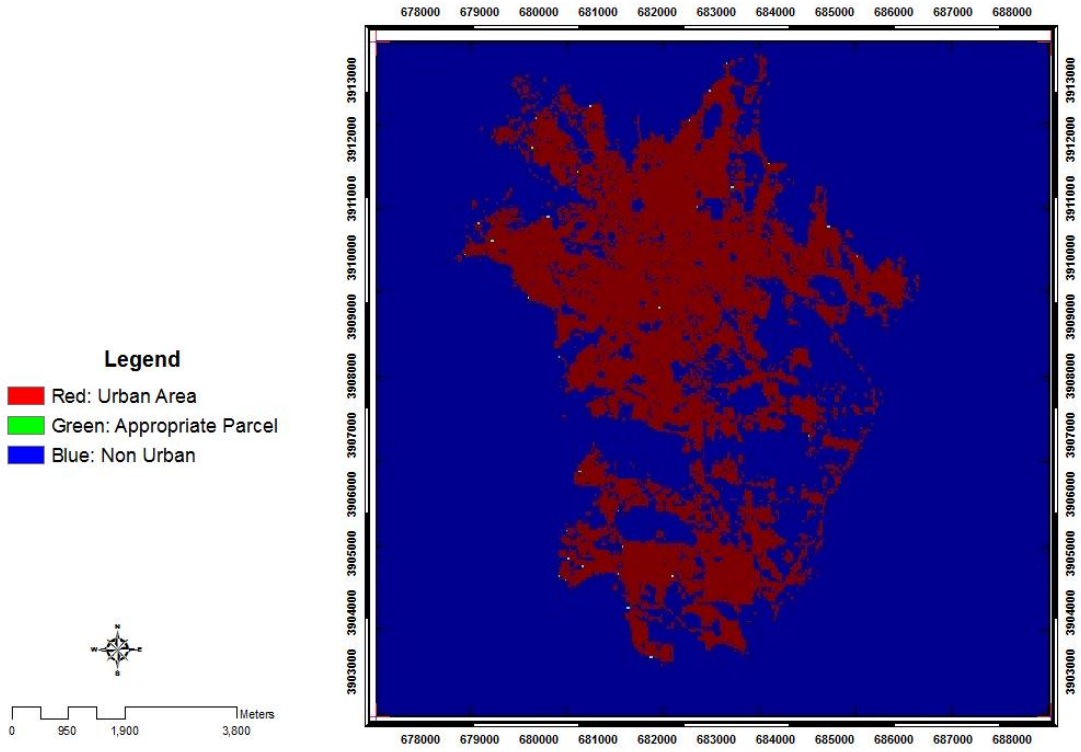


**Fig 3**: The appropriate location of residences

## 5. Conclusions

Algorithms of Meta heuristic have been used in many scientific fields recently. Using these algorithms in building cities, city management and similar fields can be effective and be known as new methods in city management and could be a great help for designers and planners since they can give much more accurate and more reliable results.

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