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Procedia Computer Science 154 (2019) 260–266

Procedia Computer Science

www.elsevier.com/locate/procedia

8th International Congress of Information and Communication Technology, ICICT 2019

Particle Swarm Optimization in Managing Construction Problems

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Abstract

Problems of engineering design optimization are usually implemented in the particular literature to display the new constrained o ptimization algorithms success The environment of the business of the construction project tend to change rapidly and consciousl y throughout the world. Problem will raised due to the inability of the organizations to adjust and respond to new environment co mplexity.

The author gather these information from the documents of the projects and construct the model to find the best solution, 5 projec ts with each projects has 3 problems and every problem has 10 possible solutions , the PSO tries to find the best solution.

The results show that the PSO is considerably fast and find the best solution with high accuracy and it has been shown even that some problems have high effect but it didn't chosen because the constrain show high cost and long time therefor they become o ut of the selection.

PSO proved to be powerful and accurate toll in solving the construction problems and it can be used as base for other problems in other area.

Keywords: Optimization ,Engineering Problems, PSO , Solutions

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10.1016/j.procs.2019.06.039

1. Introduction

The industry characteristics have often been noted and assessed, and several doubts whether construction is actually an industry [1], or fairly a system of projects [2]. In these observations of the construction nature and mainly the project that consider strong and regarded as the center of the industry has often been recognized as a main cause of many of the industry limitations and problems [3]. Some have recognized specific individualities of construction causing the problems, including the temporary organization.[4] Problems of engineering design optimization are usually implemented in the particular literature to display the new constrained optimization algorithms success . The environment of the business of the construction project tend to change rapidly and consciously throughout the world. Problem will raised due to the inability of the organizations to adjust and respond to new environment complexity [5]. Hence , the contractors must have the ability to improve their performance not only to the complexity but also the increase the requirements for the users', environmental responsiveness and inadequate resources on one side, and extraordinary competition for marketplace of construction business on the other side [6]. The amount of the information that needed through the life cycleof the projects are enormous and specially in design ,construct and maintain buildings, thus their management is a difficult challenge. The influence on overall costs of construction ,out-of schedule , mislaid or inconsistent information, producing delays, errors and costly re-building, is very common both to practitioners and academics [7]. Recently the extensive availability of personal computers and the "information superhighway" made by the Internet provide the essential infrastructure for efficient computeraided document management. Thus the computer science techniques have important role in solving the construction projects problems.Particle Swarm Optimization (PSO) is a comparatively modern bio-inspired met heuristic, that has been found to be extremely competitive in extensive diversity of optimization problems[8]

In this paper ,PSO has been used to manage the construction projects problem ,the PSO is a computational technique that made optimization for a problem by iteratively tending to enhance a possible solution with respect to a given degree of quality. The problem been solved by having a population of possible solutions, here called particles, and these particles will be traveled around in the search-space in which follow simple mathematical formulae over the particle's position and velocity. Every movement of the particle's is impacted by its local best recognized position, but is also directed toward the best recognized positions in the search-space, then these positions are updated with respect by other particles. This is anticipated to move the swarm toward the best solutions.[9]

2. 2. Particle Swarm Model

The model of the problem consist of the following

$$\sum Ci * MAXj(xi.j) \text{ less } 0.6\ B \qquad .(1)$$

$$\sum Sj - \sum\sum Si,j * xi.j \leq 2\ T \qquad (2)$$

$$Xij = (0\text{-}1)$$

$$MAX\ Z = \sum \sum (ei,j * xi.j \qquad (3)$$

Where
B is the total budget of the project
T is the total time of the project
Ci cost of the solution of the problem
Sij the time taken for solving the problem
Sj the delay caused by the problem
Eij the effect of each solution
i the solution
j the problem

The author gather these information from the documents of the projects and construct the model to find the best solution, 5 projects with each projects has 3 problems and every problem has 10 possible solutions , the PSO tries to find the best solution

Main function for using PSO algorithm.

```
%  inputs:
% N:  Number of agents.
% max_it: Maximum number of iterations (T).

fdata;
tmax=max(fdata(:,5));       %  T Period of execution Time(days)
ci= fdata(:,1);             % spendind Cost
sj=(fdata(:,2));            % Delay time
sij=tmax*fdata(:,3);        % Treating time
bmax=max(fdata(:,4));       % B Budghet
eij=fdata(:,6);             % reating factor

 %% Mathematical model of the problem
% MAX Z= ? ? (ei,j *xi.j )
% Subjected to
% Ci , Sj , Sij  , eij ,T, B    are constant
% ? Ci *MAXj(xi.j) less  0.6 B
%  ? Sj- ?? Si,j *xi.j ? 2 T
% Xij= (0-1)
% i problem solution
% j problem
% i=(1-30)
% j=(1-3)
% for one project
% for example
% take the C from the R1 and C2 from the R2 and for the Sm like that too
% Cm=?458426200*MAX (.5)
%
%  Cm=  229213100
% Cm1=114606550*MAX(.3)
%       =34381965
% Sm=?(21.96-(0.03*.5)+
%    =21.95
% Sm=21.96-( 0.025 *.3)
%     =21.9675
% Mean select strategy  1 for R1 and strategy  2 for R2
% If Cm less  .6B  and Sm ? 2*T
% MAX  Z
%    Cm=458426200*MAX (.5)
% Cm=  229213100
% Sm=?(21.96-(0.03*.5)+
%    =21.95
% If Cm less  .6B  and Sm ? 2*T
% MAX Z
```

This part of the code that has been used to solve the problem

The objective function was calculated using

```
%calculation of objective function
```

```
      xij(i)=X(1,i);
%       ci=X(2,i);
%       sij=X(3,i)*tmax;

  Cmij(i)=ci(i)*max(xij);
Smij(i)=sj(i)-(sij(i)*xij(i));
if Cmij(i)< 0.6* bmax && Smij(i)<= tmax
   for n=1:N
      if n ~i
   Zz=eij(i)*Xij;
 break
Cmij(n)=ci(i)*(X(1,n));
Smij(n)=sj(i)-(sij(i)*X(1,n));
Zz= eij(i)* X(1,i);
 break

end

% else

   end
else
    Zz=0.001;
end

% return
%  Zz= eij(i)* X(1,i);
```

The author made GUI for the calling instead of using each problem individually

```
%% Select the number of studied cases such as project1, R1,R2,R3..... up to project5, R1, R2, R3

testcase = inputdlg({' Studed Cases 11,12,13up to 53:','Max or Min:','Max Iteration','PSO(1) or GSA(2)'},'Input',4,{'11','00','20','01'});
cr = cellstr(testcase);
wr=cell2mat(cr);
css=str2num(wr);
 ncase=css(1);     % Assign Studied cases such as pjt-11- means project 1 , R1 and 21 project 2, R1 and so on
 min_flag=css(2);         % 1: minimization, 0: maximization
maxiteration=css(3);% Optimization Max iteration number
alg=css(4);        % Algorithm GSA(1) ,PSO(2
%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%
%% Call data
readat;
```

The results of the PSO as follow

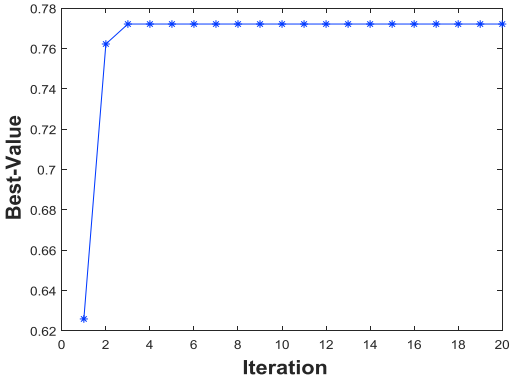

Fig .1 The best solution for problem 1 project 1

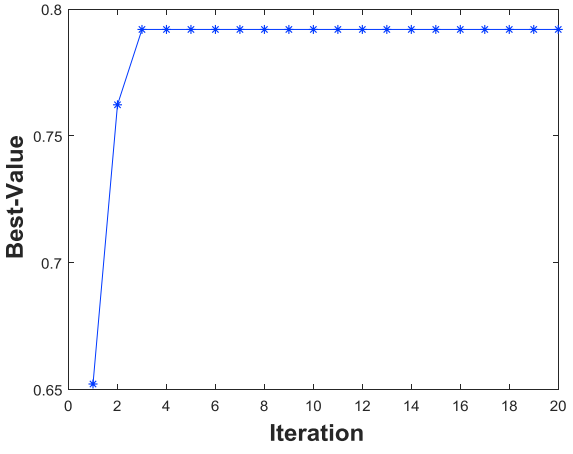

Fig.2 The best solution for problem 1 project 2

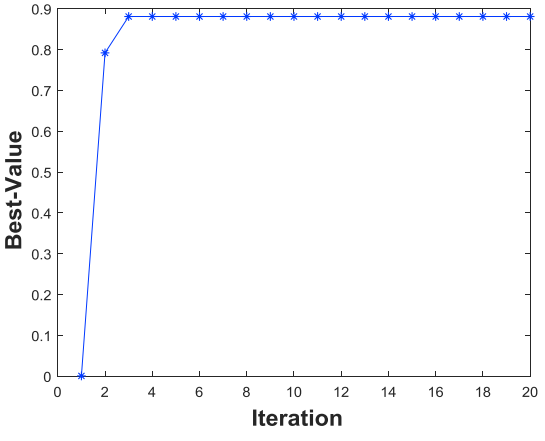

Fig .3The best solution for problem 1 project 3

Table .1 Show the results of the PSO

V	e	T	B	Sij	Sj	Ci	pso	x	Project
0	0.78	732	4.58E+09	0.406667	21.96	45842620	0.7722	0.99	11
0	0.79	732	4.58E+09	18.3	21.96	77932454	0.7821	0.99	12
0	0.88	732	4.58E+09	29.28	73.2	45842620	0.8712	0.99	13
0	0.8	602	1.02E+09	12.04	18.06	10197550	0.792	0.99	21
0	0.9	602	1.02E+09	0.9.03	60.2	214148550	0.891	0.870	22
0	0.8	602	1.02E+09	0.02	30.1	1019755	0.792	0.99	23
0	0.89	713	3.42E+09	17.825	28.52	66653999.75	0.8811	0.99	31
0	0.78	713	3.42E+09	14.26	21.39	35081052.5	0.7722	0.99	32
0	0.89	713	3.42E+09	24.955	71.3	242059262.25	0.881	0.99	33
0	0.78	780	3.27E+09	14.18	21.27	36958990	0.7722	0.99	41
0	0.8	780	3.27E+09	14.18	21.27	36958990	0.792	0.984307	42
0	0.88	780	3.27E+09	28.36	70.9	36958990	0.8712	0.99	43
0	0.88	580	6.19E+09	78	156	32747320	0.8598	0.99	51
0	0.9	580	6.19E+09	11.7	78	687693720	0.891	0.99	52
0	0.8	580	6.19E+09	156	265.2	327473200	0.792	0.99	53

3. Conclusions

The results show that the PSO is considerably fast and find the best solution with high accuracy and it has been shown even that some problems have high effect but it didn't chosen because the constrain show high cost and longtime therefor they become out of the selection

PSO proved to be powerful and accurate toll in solving the construction problems and it can be used as base for other problems in other area

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