PBBO: A NEW HYBRID ALGORITHM FOR SATELLITE IMAGE CLASSIFICATION

Harish Kundra¹ and Harpreet Singh²

¹HOD and Asst. Professor, E-mail: hodcset@rayatbahr.com
²M. Tech Student, E-mail: preet.fateh@gmail.com
¹,²Rayat Institute of Engineering and IT, Railmajra, Punjab

ABSTRACT

From last two decades many optimization techniques have been evolved. PSO and BBO are the two techniques that
have been widely used in Swarm Optimization. PSO is better than many genetic algorithms. PSO has applications in
various areas like Optimization, Neural Networks training, Fuzzy controls and etc. BBO is based on science of
biogeography. BBO has some features common to PSO and Genetic algorithms but it has some important features
that make it more reliable than others. In this paper, we have proposed new algorithm that combines the features
of PSO and BBO. It will help in providing more reliability in optimization world.

Keywords: PSO, BBO, GA, optimization, biogeography.

1. INTRODUCTION

PSO algorithm was originally developed by Dr. Eberhart
and Dr. Kennedy. It was based on stochastic optimization
technique. PSO is first populated with random solutions
and then search for optimum solution by repetitions.
In this method, the behavior of bird is simulated. It is
supposed that there are number of birds that are searching
food in a location and there is only single piece of pray
is present there. There are only few birds that know where
the pray is. Then the best solution for remaining birds is
that follow the birds which is nearby to pray. In PSO,
bird is known as particle. We use a fitness function in
which different values are given to particles which is
then optimized. The particles have particular positions
and velocities in starting and then afterwards go on
changing in search of pray. After every repetition, every
particle updates its two values. First one is the value that
it has gained and other one is the best value by
optimization that is achieved so far. These are stated as
pbest and gbest respectively. The two equations are used
by particle to update its velocity and position is

\[ \text{Vel}[t] = \text{Vel}[t] + C_1 + C_2 \] (1)

where

\[ C_1 = \text{const1} \times \text{rand}() \times (\text{pbest}[t] - \text{present}[t]) \]
\[ C_2 = \text{const2} \times \text{rand}() \times (\text{gbest}[t] - \text{present}[t]) \]

and

\[ \text{present}[t] = \text{present}[t] + \text{Vel}[t] \] (2)

Here Vel[t] is the velocity of particle and Present[t] is
current result of particle. const 1 and const 2 are learning
factors. Here both are takes as 1.

Pseudo Code for PSO is

For each particle
    Initialize the particle
End
Do
For each particle
    Find out the fitness value of each particle
    If current value of pbest is good against value in
        history then
        Set current value as pbest
    End
Select the gbest as the best fitness value of all the
particles.
For each particle
    Find out the particle velocity for equation 1.
    Increment the position of particle by using
equation 2.
End
Repeat while maximum iterations or the criteria of
minimum error are not attained.

On each position velocity of particle is equated to a
maximum velocity as Vmax. If the sum of accelerations try
to exceed the velocity from the input value which is given
by the researcher then the velocity is limited to Vmax.

BBO (Biogeography Based Optimization) was
introduced by simon and is used for global optimization.
Here species immigrate or emigrate between islands in
search of more friendly habitats. Each result is known as
habitat and each has habitat suitability index (HSI) which
is a vector. Each individual is represented with some initial random value and good HSI values are retained. Both high and low HSI values share their features. The migration and mutation operators are used for generating the new habitat from all the solution in the problem. BBO migration is helpful to change present solution and modify existing island.

The probability $X_i$ is proportional to the immigration rate $Y_i$ and the source of probability is proportional to the emigration rate $U_j$. Procedure for Habitat migration is

Start
For i = 1 to N
Select $X_i$ with probability based on $Y_i$
if rand (0, 1) < $Y_i$ then
for j = 1 to N
Select $X_i$ with probability based on $U_j$
if rand (0, 1) < $U_j$ then
Randomly select an index vector $\sigma$ from $X_i$
Replace a random vector in $X_i$ with $\sigma$
end if
end for
end if
end for
End

While mutation is based on probability that modifies the index vectors randomly, this depends on the priority of probability of existence. Here we ignore the very high HSI and very low HSI and take the medium HSI. Procedure for mutation is

Begin
for i = 1 to N
calculate the probability $P_i$
select vector $X_i(j)$ dependent on $P_i$
if rand (0,1) $<$ m_i then
replace $X_i(j)$ with randomly generated vector
end if
end for
End

The mutation rate is defined as:

$$m = m_{\text{max}} \left(1 - \frac{P_i}{P_{\text{max}}} \right) \quad (3)$$

Here $m_{\text{max}}$ is user defined and here it is 2.

Diversity of population is increased by this mutation process.

2. PROPOSED ALGORITHM
The proposed enhanced model will use the basics of BBO and PSO.

For each particle
Initialize particle
For each particle
Calculate fitness value
If the fitness value is better than the best fitness value (pbest) in history.
set current value as the new pbest
End
Choose the particle with the best fitness value of all the particles as the gbest
For each particle
Calculate particle velocity according to Eq. 2
Update particle position according to Eq. 1
End
Continue while maximum iterations or minimum error criteria is not attained
Consider each feature as one habitat.
For each particle
Total no. of habitat = universal + feature habitat
Define HSI, Smax, Smin, immigration rate and emigration rate.
Find HSI for each other feature habitat.
Z) Select species from universal habitat and migrate it to one of the other habitat and recalculate HSI.
If recalculated HSI is within threshold then absorb the species to that habitat else.
Check for the other habitats and recalculate the HSI.
If all species in universal habitat are checked then stop else go to step Z.

Here habitat is group of pixels around corners where pixel with best value is located. The particle velocity is related to intensity of pixel while the position of particle with position of image pixel. Sobel edge detector is used as it is the smallest average filter that is used to detect edge values.
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\[ F(Z) = \log (\log (E(I(Z)))) \times \frac{\text{edges}(I(Z))}{M \times N} \times H(I(Z)) \] (4)

Here \( F(Z) \) is the fitness function. And \( H \) is the entropy of the function [4]. Here \( M \) and \( N \) are the size of image.

3. PBBO PARAMETERS

The performance of the algorithms is governed by three parameters

- computing the objective function in terms of the fitness value.
- The computational time per run of each algorithm.
- The efficiency in terms of the number of edges which gives an indication of the performance of the proposed algorithm.

The results are given in Table 1. Here good, better and best ranges are taken as 60-70 %, 70-80% and 80-90% and above respectively.

<table>
<thead>
<tr>
<th>Image/Fitness Value</th>
<th>PSO</th>
<th>BBO</th>
<th>PBBO</th>
</tr>
</thead>
<tbody>
<tr>
<td>Figure 1</td>
<td>good</td>
<td>better</td>
<td>best</td>
</tr>
<tr>
<td>Figure 2</td>
<td>good</td>
<td>good</td>
<td>best</td>
</tr>
</tbody>
</table>

4. RESULTS AND CONCLUSION

In this paper, a new approach to automatic satellite image enhancement using PBBO is implemented by using a suitable fitness function and the number of edges in image.

PBBO gives better results in very less time which is compared with PSO and BBO, the basic methods. BBO gives much better results than PSO. In the future we will try to modify the algorithm so that better results can be derived.

REFERENCES


