A HYBRID PSO/ACO ALGORITHM FOR LAND COVER CLASSIFICATION

Qin DAI, Jian-bo LIU
Center for Earth Observation and Digital Earth, CAS, 100086 Beijing, China

ABSTRACT

Land cover is a fundamental variable that impacts on and links many parts of the human and natural environments, and remote sensing is an attractive source of land cover maps such as those depicting land cover as it provides a map-like representation of the Earth's surface that is spatially continuous and highly consistent [1]. For several decades the remote sensing image classification methods for depicting land cover have gained a great achievements, but with the more multi-source and multi-dimensional data, the conventional remote sensing image classification methods based on statistical theory have exposed some limitation. So in recent years, artificial intelligence techniques have being applied to remote sensing image classification, the purpose of which is to reduce the undesired limitations in nature of the conventional classification methods [2].

Ant colony optimization (ACO) and Particle swarm optimization (PSO) as the two main algorithms in swarm intelligence have been applied successfully to optimization problems in many research areas, but they are still the new research topic in remote sensing data processing [2]. In virtue of the swarm intelligence algorithm is that it is based on rule, and they have self-organization, cooperation, communication and other intelligent merits [3, 4, 5], so it does not make a range of untenable (in remote sensing image processing) assumptions about the datasets used as the traditional methods based on statistics like the Maximum Likelihood classification (MLC) needs. So they have many potential advantages in the remote sensing data processing research area.

This paper introduces remotely sensed image classification using the hybrid ACO/PSO algorithm was developed and studied with supervised classification problems [6]. This hybrid ACO/PSO algorithm can directly cope with continuous data, using this algorithm to remote sensing image classification without the data discretization step, and it can make full use of the advantages of ACO and PSO algorithm. Selecting Landsat-5 TM image located in Beijing area as experimental data, this paper use the algorithm for constructing the classification rules, then use these rules to classify the example data, the experiment results show that ACO/PSO algorithm has provided a new method for remote sensing image classification.

The original image is shown in Figure1; the land cover classification resultant map is shown in Figure 2. The classification rules constructed by ACO/PSO algorithm are shown in Figure3. The confusion matrix of classification validation is shown in table1. Application of the pre-selected test data set, this paper validates the hybrid ACO/PSO algorithm for the land cover classification experiment, an overall accuracy of 98.3% with a

Kappa coefficient of 0.97 was gained. Based on the land cover classification results, we can make a conclusion that the hybrid ACO/PSO algorithm shows a great potential for remote sensing image processing.

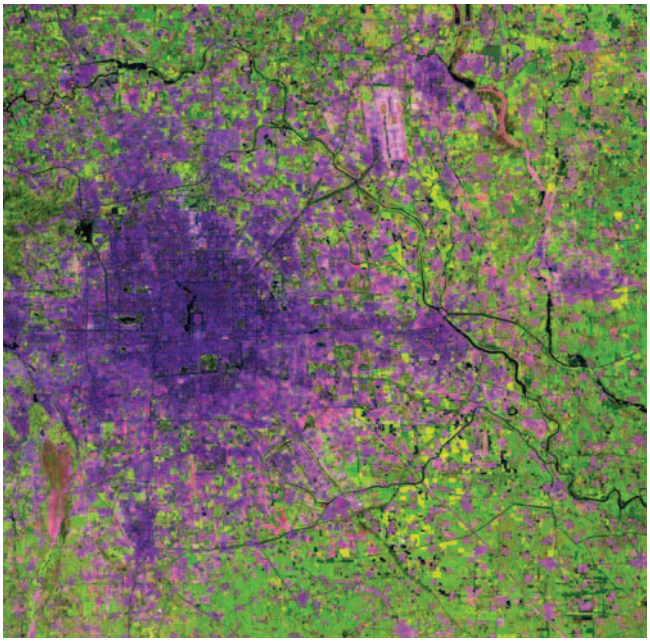

Fig.1 Original experimental Landsat-5 TM image

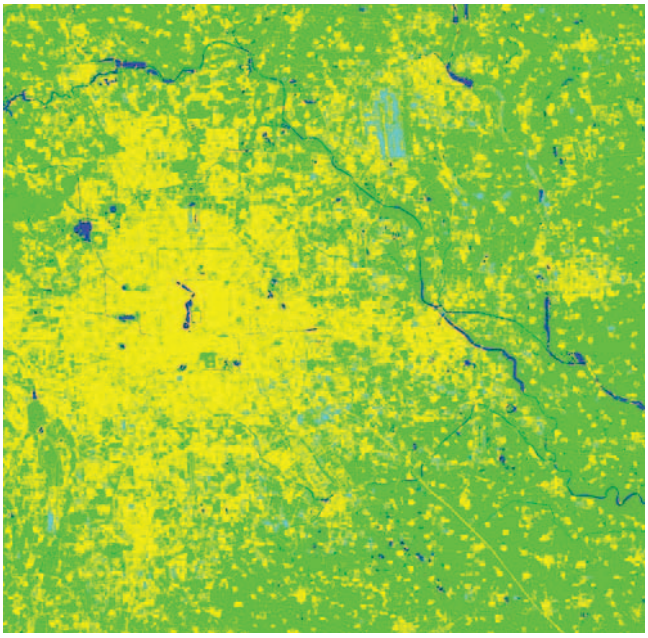

Fig.2 the land cover classified map used ACO/PSO

```
Rule 0 : IF b1 >= 77 and  b4 <= 96 and b5 <= 145 and b6 >= 25  THEN 2
Rule 1 : IF b3 <= 38 and b4 >= 75  THEN 4
Rule 2 : IF b6 >= 108 THEN 1
Rule 3 : IF b4 <= 64 and b6 <= 18  THEN 3
Rule 4 : IF b1 >= 89 and b2 <= 88 and b5 <= 155  THEN 2
Rule 5 : IF b2 <= 58 and b4 <= 127 and b5 >= 152  THEN 1
Rule 6 : IF b3 <= 46 and b5 >= 90  THEN 4
Rule 7 : IF b4 <= 71 and b5 <= 145  THEN 2
Rule 8 : IF b3 >= 102 and b6 >= 93  THEN 1
Rule 9 : IF b1 <= 86 and b4 <= 83 and b5 >= 121  THEN 1
Rule 10 : IF b5 >= 175  THEN 1
Rule 11 : IF b3 <= 49 and  b4 >= 99  THEN 4
Rule 12 : IF b1 >= 96 and b1 <= 114 and b4 <= 96  THEN 2
Rule 13 : IF b3 <= 43 and b6 <= 33  THEN 4
Rule 14 : IF b5 <= 104  THEN 2
Rule 15 : IF b5 <= 151  THEN 2
```

Performance parameters:
Number of particles: 100
Number of iterations: 200

Classification code:
1: bare land
2: urban land
3: water
4: greenland

Fig.3 the rules constructed by ACO/PSO algorithm

Table 1 Confusion matrix of classification validation

Class	Green land	water	Urban land	Bare land	Total
Unknown	0	0	6	8	14
Green land	502	0	2	0	504
water	0	234	0	0	234
urban land	2	10	998	0	1010
Bare land	0	0	7	289	296
Total	504	244	1013	297	2058

Key words: Ant colony optimization (ACO); Particle swarm optimization (PSO); Land cover classification; Remote sensing image

REFERENCES

[1] G.M., Foody , Status of land cover classification accuracy assessment, Remote sensing of environment,2002,80,PP.185-201

[2] Q. Dai, J. B. Liu, "Application of ant colony optimization (ACO) algorithm to remote sensing image classification", Fifth international symposium on multispectral image processing & pattern recognition, Wuhan, China, pp.67881A-1-6, Proceedings of SPIE Volume 6788, November 2007.

[3] M. Dorigo, L.M. Gambardella, "Ant Colony System: A cooperative learning approach to the traveling salesman problem", IEEE Transactions on Evolutionary Computation, 1997, 1, pp. 53-66.

[4] T. Sousa, A. Silva, A. Neves, Particle Swarm based Data Mining Algorithms for classification tasks, Parallel Computing, 2004,30,PP.767-783

[5] R.S., Parpinelli, Lopes H. S., Freitas A A. Data mining with an ant colony optimization algorithm .IEEE Transactions on Evolutionary Computation,2002,6(4), pp. 321-332

[6] N. Holden and A.A. Freitas ,A hybrid PSO/ACO algorithm for classification,GECCO'07,July 7-11,2007,London, United Kingdom