KNOWLEDGE NETWORK AND INFERENCE MODEL ON INTELLIGENT INTERPRETATION OF TM IMAGE

Qiming Qin

(Postdoctor, Peking University Mathematical Department, Beijing, China, #1261)

Abstract

The TM image understanding based on knowledge is the key to completeintelligent interpretation of image. In this paper, the author discussedthe model on knowledge network which is the tree of regional knowledge, and given the algorithm on operation of knowledge node, furthermore, put forword the model of correlation analysis, according tothe model, the intelligent interpretation of a simple landuse type is implemented by inference.

Keywords: Interpretation of image; Knowledge network; Correlation analysis; Inference;

1. Building the model of knowledge network

Geographical region _ oriented knowledge network is developedbased on the features of knowledge and knowledge representation structure. The knowledge network can be described as follows:

The knowledge network has many nodes, each node represents a region. the region is a hierarchic system according to the basic idea of comprehensive natural regionalization (Zhao, 1983), a large region includes middle regionsand a middle region includes smaller regions. A region tree is designed to represent the relationship among region and knowledge of background and interpretation. The region tree is defined as follows:

(1) root node is the largest region, it covers a set of all regions which discussed. Root node has the unique geo — code, stores the common knowledge of background and interpretation which is fit to all regions.

(2) Not—leaf node is the region which includes middle or smaller regions, it is indicated by geocode and has unique knowledge of background and interpretation different from other brather node's knowledge.

(3) Leaf node is the smallest region in which TM image interpretation is completed. Leaf node is appended with the knowledge which can be used to image recognition of this region and has geocode too.

Geocode indicates the hierarchy of regions. Each node has the unique geocode, amount of number in node shows the lever of region. Root node has the one Geocode, first lever has two geocode and records second geocode in storage structure, and second lever has three geocode and records third geocode in storage structure, and so on. Leaf node is inn lever of region hierarchic system and records last geo—code in storage structure.

2. The algorithm on operation of knowledge node

Here given three major algorithms, in which the storage structure of knowledge node and variables are printed as follows:

geocode: this integer indicates code of region node;

leftlink: left pointer link son _ node;

uplink: up pointer link father _ node;

rightlink: right pointer link brother _ node;

variables in algorithm include:

count is the integer counter of depth in region tree.

region — code is the retrieval geocode for the knowledge

node in regional tree.

success is the state of operation.

root _ node is the pionter to root node of regional tree.

p and p1 are the pointer to stored structure.

retrieval _ node algorithm is as follows:

```
    transfering paraments include:
    region _ code, p, p1, count, root _ node,
succese;
    Begin
    if root _ node = nil then goto step 4
   else count = length of region _ code;
        i = 1;
        p1= p = root _ node;
    step 1:
      if p→geo _ code =region _ code[i];
        goto step 2
      if p→geo _ code < region _ code[i];
        goto step 3
      if p→geo _ code > region _ code[i];
        goto step 4
    step 2:
      if i=count, then goto step 5
      else p1=p;
          p=leftlink
          if p= nil, goto step 4;
          else i =i+1 goto step 1;
    step 3:
      p1=p
      p = p→rightlink
      if p=nil, then goto step 4
      else goto step1
    step 4: success =0, return(p1)
            end of retrieval node because
            knowledge node doesn't exist
    step 5: success =1, return(p)
            end of retrieval node because
            knowledge node has been found.
    end of arlorithm.
```

insert _ node arlorithm is given as follows:

```
transfering paraments include:
region _ code, p, p1, count, root _ node, succese;
Begin
    call retrieval _ node(region _ code,p,p1,
count,root _ node,succese);
if success = 1 ;
    end of insert _ node because knowledge
has exist.
else execute followinf procedures;
if root _ node = nil,
then insert new _ node(1);
    else p =p1,i =1;
    step1:
      if p=root _ node, goto step 2;
      else p=p→uplink ,i=i+1,
          goto step1;
    step 2
      if p1→geo _ code <region _ code[i];
      then p1=p1→rightlink;
        when p1 =nil,insert new _ node[i],
      goto step 3;
        when p1 not nil,goto step2;
      else if p1→geo _ code >region _ code[i]
      then insert new _ node[i],
      goto step 3;
      else goto step3;
    step 3
      if i=count ,complete insert operation,
exit;
      else i =i+1,p1=p1→liftlink,
          goto step 2;
    end of arlorithm.
```

inherit _ knowledge arlorithm is following list:

```
transfering paraments include:
region _ code, p, p1, count, root _ node, succese;
Begin
    call retrieval _ node(region _ code,p,p1,
count,root _ node,succese);
if success = 0;
```

end of inherit _ oparation because knowledge _ node doesn't exist.

else p1 =p;

step 1:

p=uplink;

oparation of inherit _ knowledge;

goto step 1;

step 2

if p=root _ node,

stop inherit operation, exit;

else goto step1

end of arlorithm.

Using above algorithm, a knowledge node can be retrieves from knowledge network, or added into knowledge network, of course, knowledge in parent node can be inherited by son node when requiring more knowledge in image interpretation. In this way, redundancy of knowledge storage is reduced and matched speed between data and rules is increased in small knowledge base. In knowledge base, knowledge of background and interpretation can be represented for produce rules and classified into several categories according to task of interpretation (Qin, 1990).

3. Intelligent interpretation based on model of correlation analysis

As you know, landuse type is tne geographical complex, which has many featuresin different data plane of TM image. Suppose X is a landuse type which has N kind of features , X_i is ith feature on its data plane. its overlay model is $X = X_1 \cap X_2 \cap X_3 \cap \cdots \cap X_n$.

According to overlay model, many data planes of TM image are overlayed and formed mapping units (Burrough. P. A., 1986). between a mapping unit (the set of the point per region)and geographical data there is one —to —many relation in the database, geographical data may be geographical attributes, shape featute and spatial relationship feature of landuse . the geographical attributes are provided to correlation analysis model.

The idea of correlation analysis comes from correlation of many geographical attribute of the same landuse in different data planes. For example, in specail landform, landuse type exists a special soil type and vegetation. the abstract model of correlation analysis is as follows:

Suppose: there are quastions $P = (Q, F)$ and $P' = (Q', F')$, in which Q is the set of possible appearing geographical facts in P, Q' is the set of possible appearing facts in P', F and F' are a kind of binary relation separately in Q and Q', if exist a surjective map

$$h: Q \to Q'$$

make any ordered pair $(q_i, q_j) \in F$ $(q_i, q_j \in Q)$

if and only if $(h(q_i), h(q_j)) \in F'$ that is, they exists a surjective map between F and F',

$$h': F \to F'$$

then P' is regared as P quastion of homomorphism, P is initial quastion of P', h is a homomorphic mapping from P to P',

notation as $P \overset{h}{\Rightarrow} P'$

By change of homomorphism, correlation analysis is changed into sign inference based on rules.

Inference is data _ driven. A task of interpreting image can be divided into several son tasks, the task will be implemented when all son tasks of the task are completed . Blackboard , common data storage area, is used to store initial state, intermediate and last inference result. A face can be read from and written into blackboard too.

The task interpreter interprets and executes rules from knowledge network . A basic inference step has the following phases:

(1) Matching: the data are sent to blackboard , the inference engine check the condition parts of each production rule once again to see if the data match these rules.

(2) Acting: when match occurs, the rule is triggered and its operationis executed or its function for pattern recognization is called.

The above step are repeated until inference engine derives the correcting results for TM image.

4. The discussion about the test result

The development of simple interpreting system is completed in 1991.

The system program is implement by C language (Qin, 1991). The author puts the system to the test of landuse classification using TM landsat image (date: Oct. 3, 1984) in Beijing region. The test shows that it is of correcting in landuse type such as city land type, grassland type, vegetable plot type and cultivated landtype. In addition, lake and river can be recognized by shape of water in data plane. Meanwhile, the author pay more attention to that there are namy job to do, which include the building geo _models and appending image interpreting knowledge to knowledge base, applying parallel processing algorithm in reference engine in future.

Reference

Burrough. P. A., 1986. Principles of Geographical Information Systems for Land Resources Assessment, Clarendon Press, Oxford, pp. 20—22.

Qin Qiming, 1990. Desigh and implementation of Knowledge Base on LandEvaluation. In: 14th International Congress of Soil Science, Japan, Vol. V. pp. 132—135.

Qin Qiming., 1991, A approach of recognition Based on Knowledge to Image, Proceedings of the Chinese Joint Conference on Pattern Recognition and Artificial Intelligence, China, pp. 691—694.

Zhao Songqiao,, 1983, A new scheme for comprehensive physical regionalizationin China, Acta Geographica Sinica, Vol. 38, No. 1, PP. 1—10.