A Multi-Agent System Approach for Feature-Driven Generalization of Isobathymetric Lines

ZHANG Xunruo, Eric. GUILBERT
The Hong Kong Polytechnic University
Department of LSGI
Objective

- Feature driven generalization of isobaths on nautical chart
- Multi Agent System approach for isobath lines generalization
Background

- Nautical chart is used for planning navigation route
- Isobath is contour under water
- Only isobaths will be considered in this project
- Only closed lines will be considered in this project

Example for generalization of nautical chart
Lines before and after manual generalization
Generalization of nautical chart

- Safety of Navigation
  - Selection – peak can not be eliminated

- Deformation – direction of movement should be considered
Constraints of generalization of isobath map

- Constraint of safety:
  - the depth of isobath ≤ the real depth
- Constraint of legibility:
  - Increase the legibility of map
- Shape preservation constraint:
  - Preserve the shape of main relief
- Topological constraint:
  - Preserve spatial relationship
Definition of feature

- Safety and preservation constraints
  - Emphasize peaks
  - Preserve main elements of terrain
- Generalization depends on terrain morphology
  - Peak (elevation)
    - Enlarge, merge,…
  - Pit (depression)
    - Omission, shrink,…
- Hierarchical representation
Contour and feature trees

- Contour Tree and Feature Tree
Multi Agent System

- Tool for feature and contour generalization
  - Choose operators based on feature information
- Two levels of agent are considered
  - Micro level – contour agents
    - Smoothing…
  - Macro level – feature agents
    - Omission…
- Feature type information can be exchanged
  - Between features
  - From features to contours
Agent processing

- Processing steps of agents
- Evaluation environment of agents
- Choice of generalization operators
- Agent evaluation
Step of processing of agents

Feature agent part
- Start feature agent processing
- After feature agent processing
- passive

Contour agent part
- Start contour agent processing
- After contour agent processing
Process of feature agent

1. Evaluation features environment
2. Make generalization plans
3. Choose one plan
4. Evaluation
   - Not good
     - Re evaluation
     - passive
   - good
     - Save result
5. Choose best plan
6. Communicate with sub features
7. Selecting operators from operator list
8. Contour agent processing
   - No more plan
Process of contour agent

- Evaluation contours environment
- Make generalization plans
  - Choose one plan
    - Evaluation
      - Not good
      - good
        - Save result
        - No more plan
  - Choose best one
- Communicate with contours
- Selecting operators from operator list
Evaluation environment of agents

- Check environment of agent
- Evaluate legibility constraints
  - geometrical value (distance, area) among agents

Evaluation features environment
- Make generalization plans
- Choose one plan
- Not good
  - Re evaluation

Evaluation contours environment
- Make generalization plans
- Choose one plan
  - Not good
Agents control

- Make plan of operators will consider:
  - Safety constraint:
    - Select operators based on the feature type
      - peak feature can perform enlargement
  - Structure constraint:
    - Preserves spatial relationship and
    - Feature aggregation operators can only performed when two lines have same elevation
Agent control

- Operators for choosing
  - Agent communicate with other before choosing operators
  - Feature and contour have different operators
  - Different feature types have different operators
Evaluation of agent state

- Save the result of possible plans
- Compare plans
- Choose best one
- Then
  - Feature agent: Trigger contour agent generalization
  - Contour agent: Back to feature agent to re-evaluation
Evaluation of agent state

- Based on legibility and preservation constraints
  - Preservation constraint: maintain the terrain of features (shape, area, slope)
- Importance between different constraints is different
  - Safety has the highest importance:
    - if it violate this constraint, the plan will be rejected
  - safety constraint > legibility constraint > shape preservation constraint
Results

- Selecting

Original data source

Generalized data source
Results

- Enlargement

Original data source  Generalized data source
Conclusion

- Generalizing Isobaths on nautical chart
  - Four constraints are considered
    - Constraint of safety
    - Constraint of legibility
    - Shape preservation constraint
    - Topological constraint:
  - Feature driven generalization
    - Generalization depends on terrain
    - Define feature type as peak or pit
Conclusion

● Multi agent system
  ● Two levels
    ● Feature agent
    ● Contour agent
  ● Communication between agents
    ● Same level
    ● Different level
  ● Not all operators are implemented yet

● Perspectives
  ● Improve evaluation
  ● Performance communication between agents
  ● Open lines may considered
  ● Extending agent model (for example soundings)
Thank you!