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

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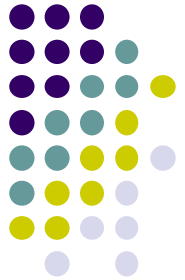
Objective



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

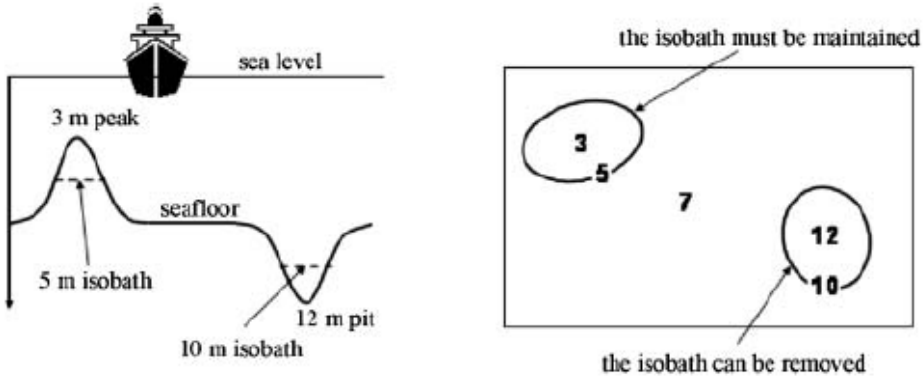
Background

- 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

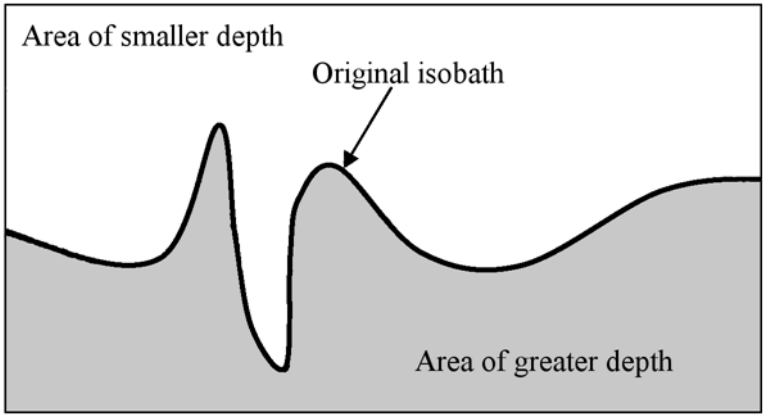
Example for generalization of nautical chart
Lines before and after manual generalization

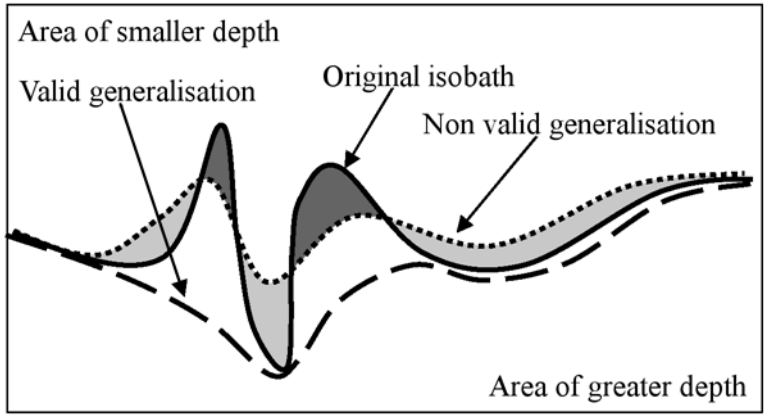
Generalization of nautical chart

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

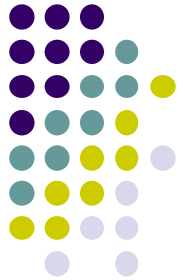


  - Deformation – direction of movement should be considered





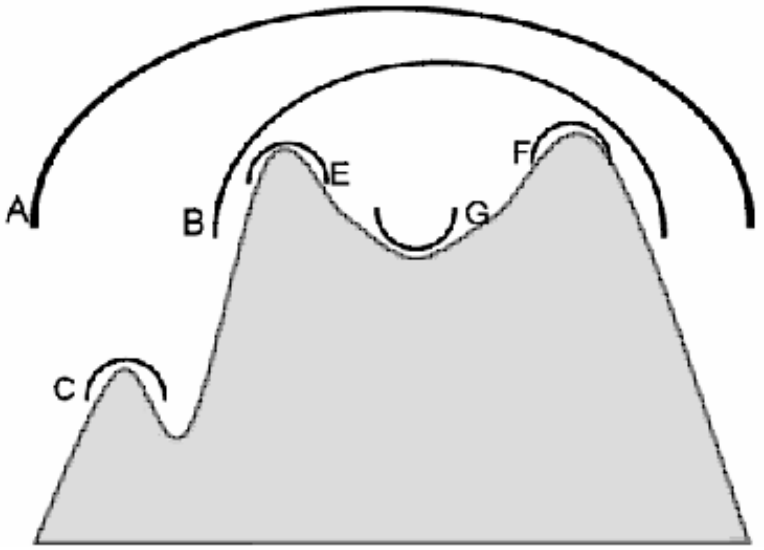
Constraints of generalization of isobath map



- Constraint of safety:
  - the depth of isobath $\leqslant$ 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

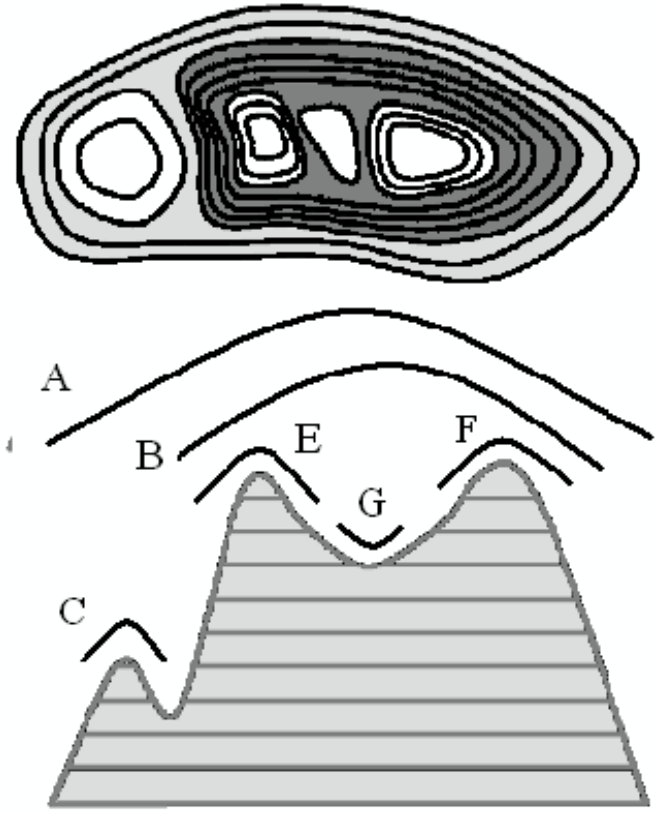
Definition of feature

- 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

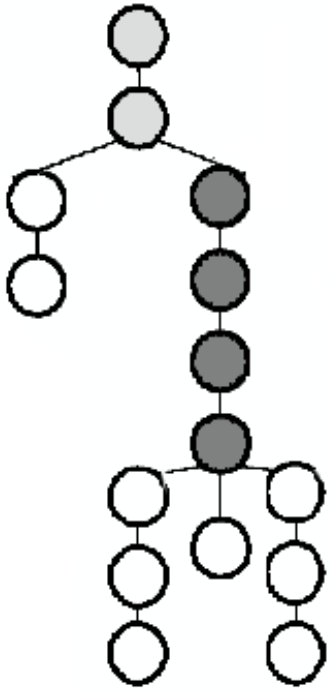


Contour and feature trees

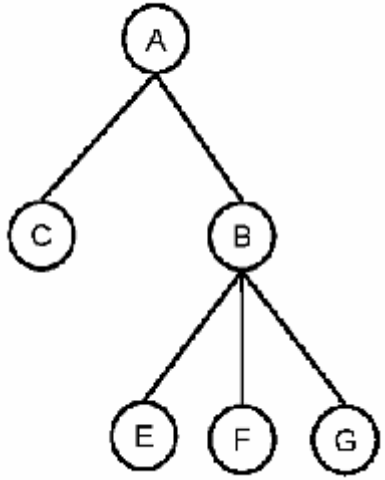
- Contour Tree and Feature Tree



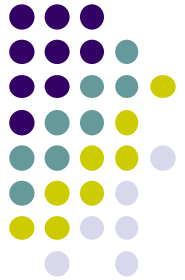
Contour Tree



Feature Tree



Multi Agent System

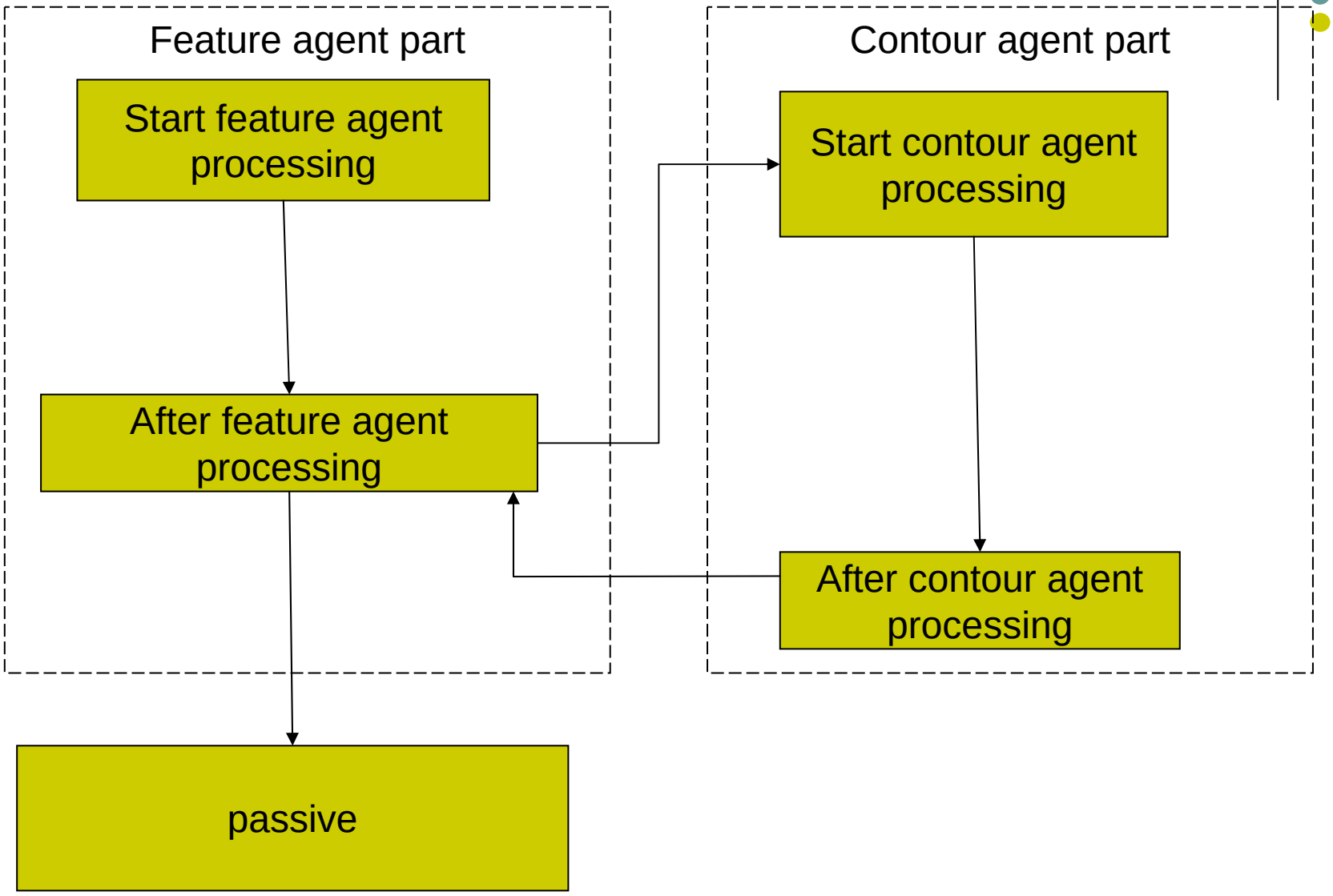


- Tool for feature and contour generalization
  - Choose operators based on feature information
- Two levels of agent are considered
  - Micro level – contour agents
    - Smoothing…
  - Macro level – feature agents
    - Omission…
- Feature type information can be exchanged
  - Between features
  -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

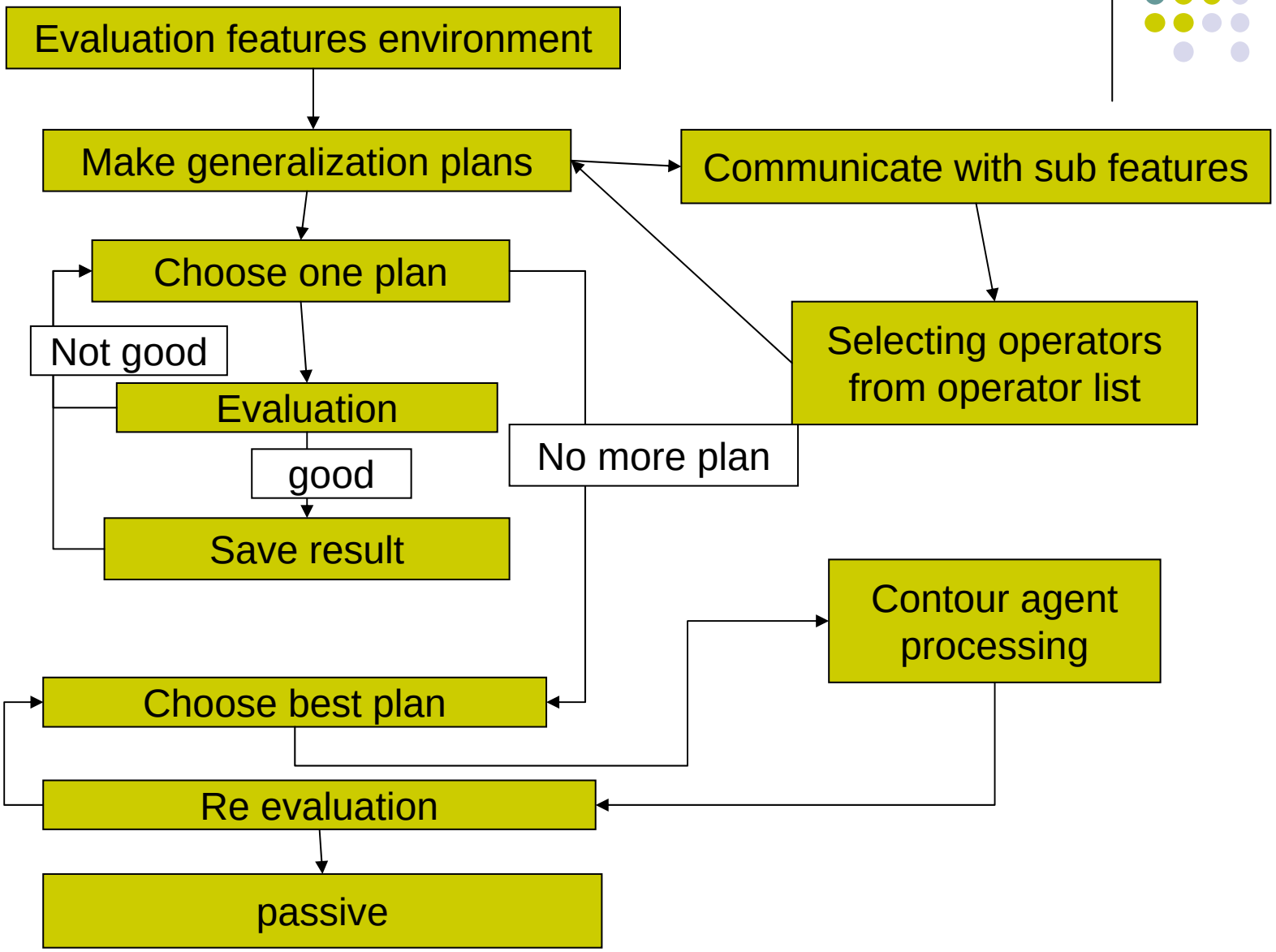
Agent processing

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

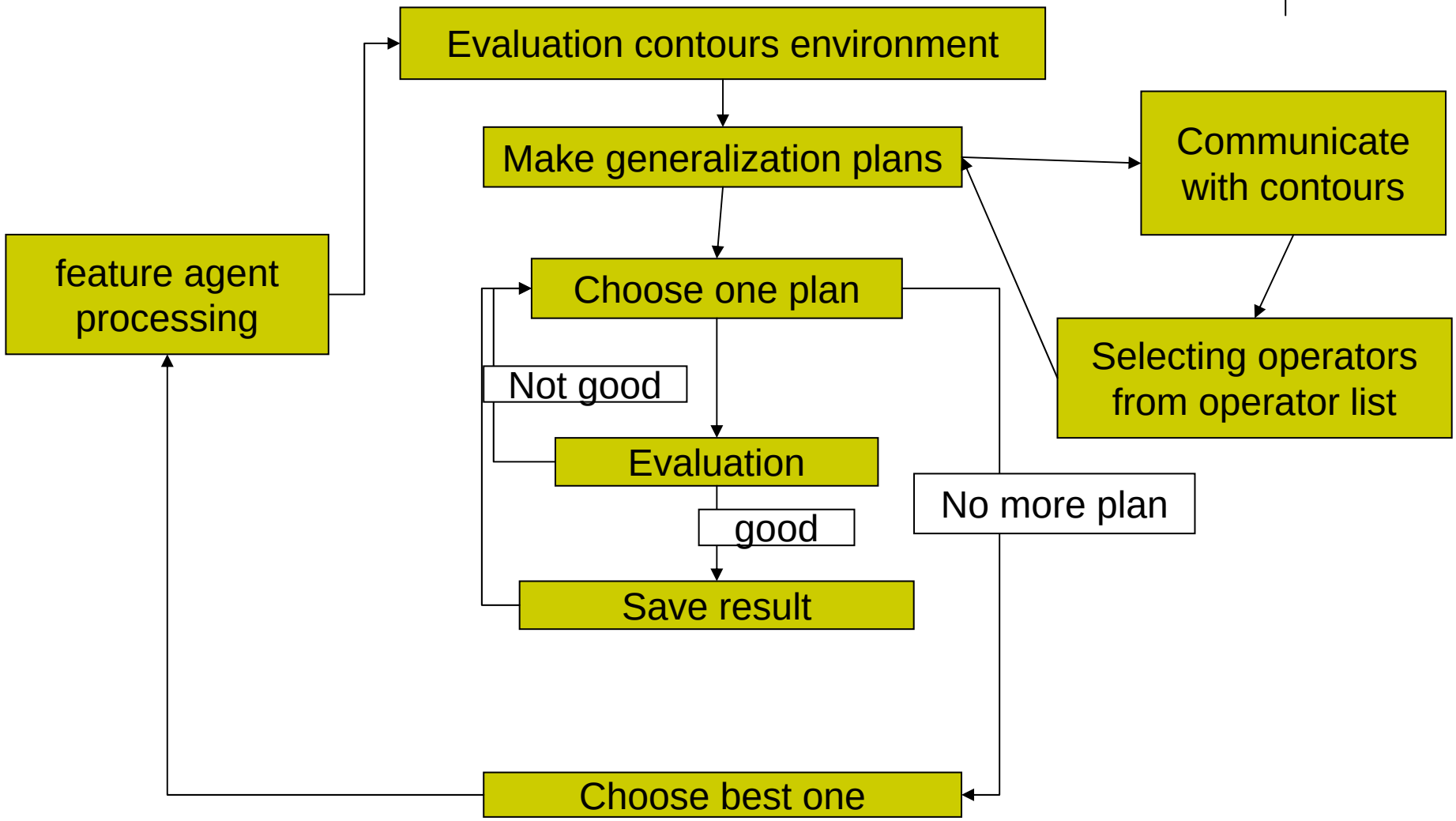
Step of processing of agents



Process of feature agent

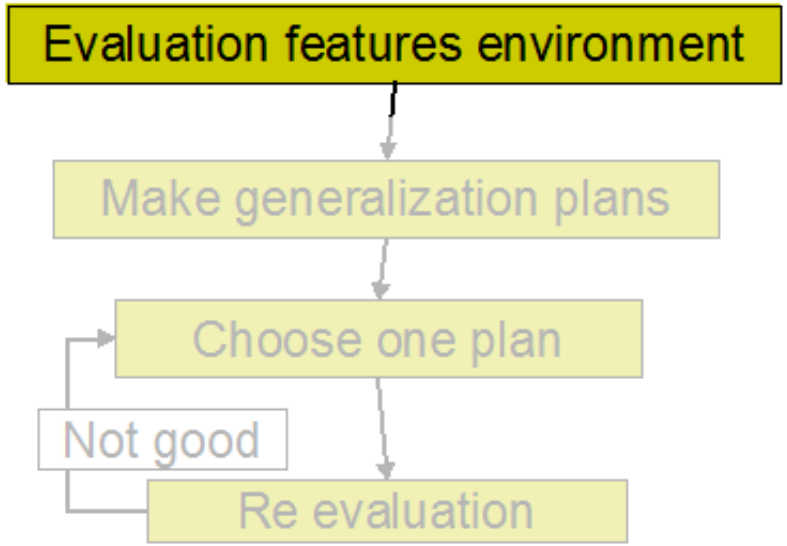


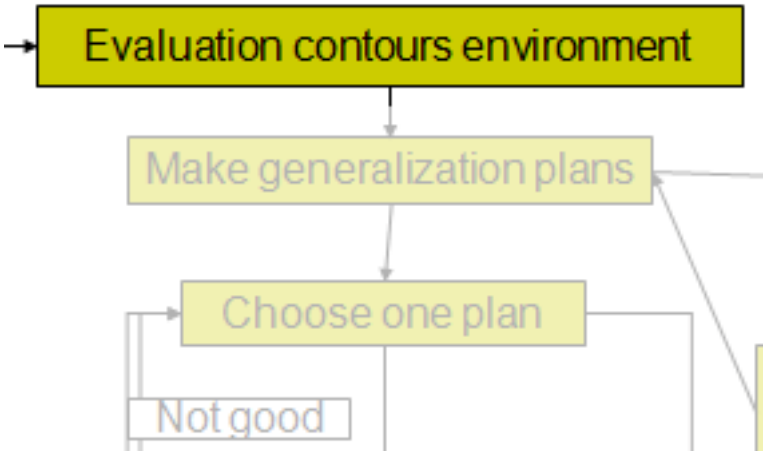
Process of contour agent



Evaluation environment of agents

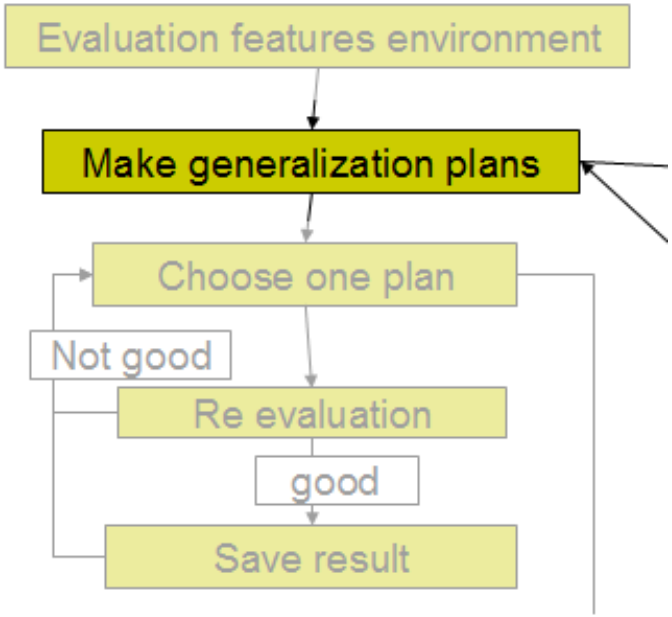
- Check environment of agent
- Evaluate legibility constraints
  - geometrical value (distance, area) among agents

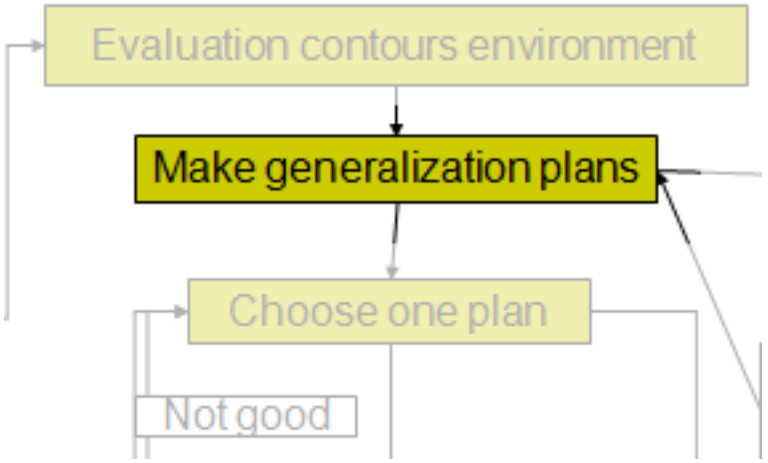




Agents control

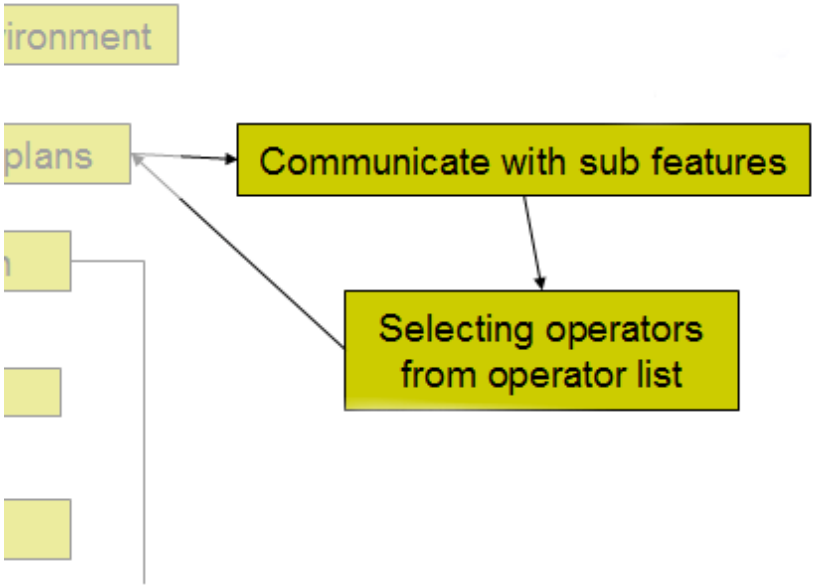
- Make plan of operators will consider:
  - Safety constraint:
    - Select operators based on the feature type
      - peak feature can perform enlargement
  - Structure constraint:
    - Preserves spatial relationship and
      - Feature aggregation operators can only performed when two lines have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

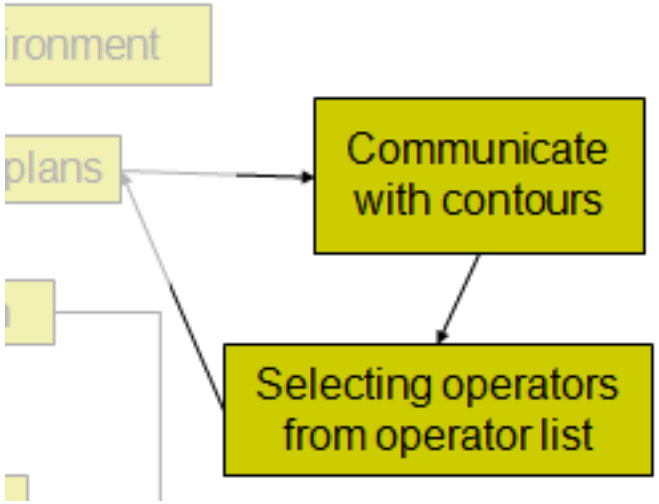




Agent control

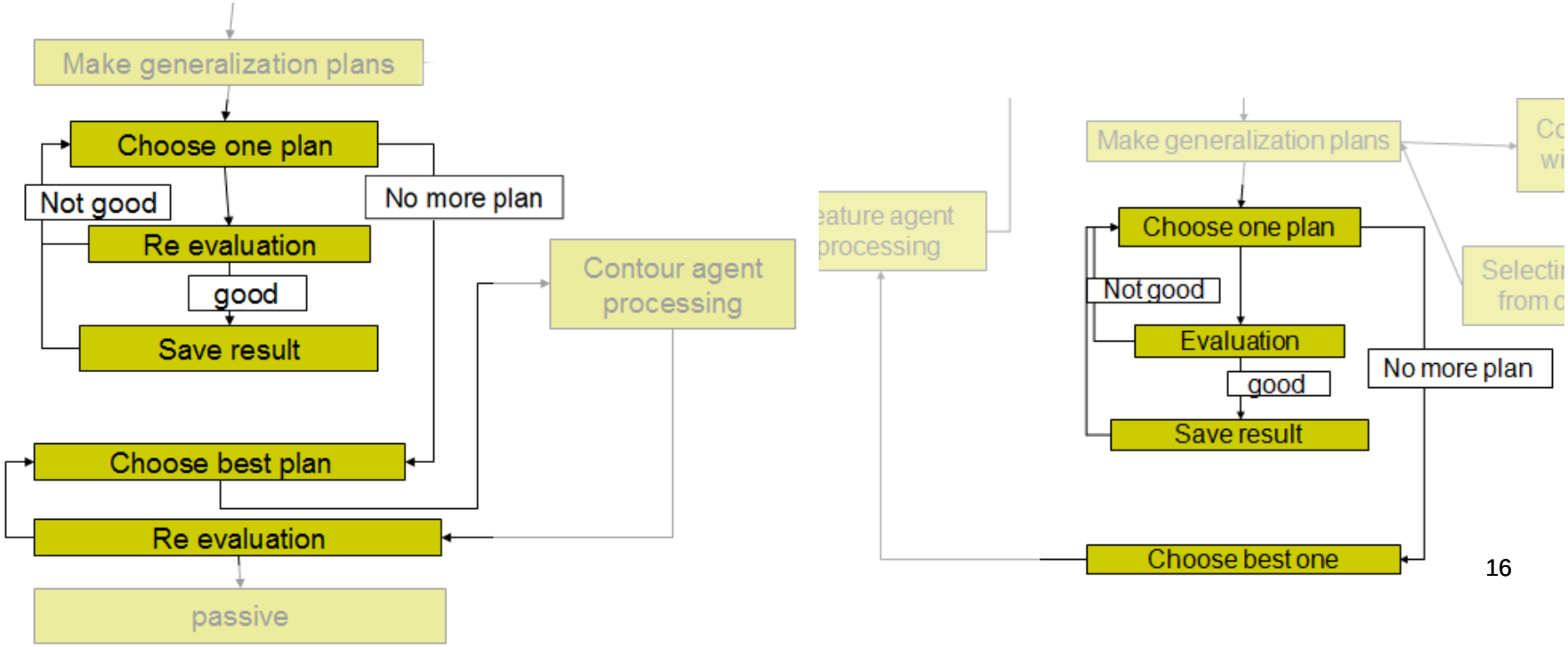
- Operators for choosing
  - Agent communicate with other before choosing operators
  - Feature and contour have different operators
  - Different feature types have different operators





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

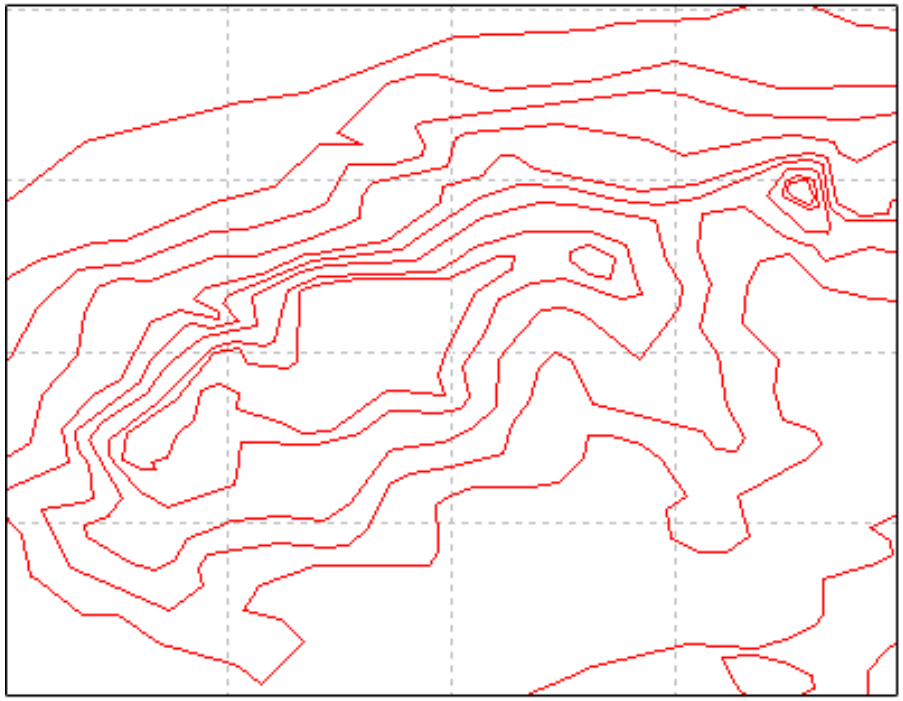


Evaluation of agent state

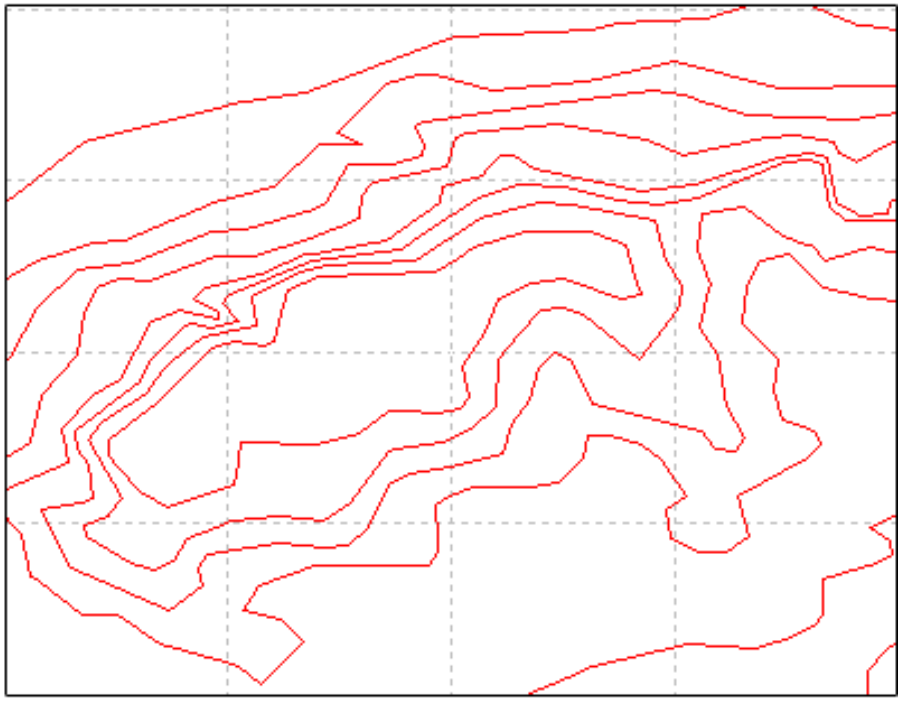
- Based on legibility and preservation constraints
  - Preservation constraint: maintain the terrain of features (shape, area, slope)
- Importance between different constraints is different
  - Safety has the highest importance:
    - if it violate this constraint, the plan will be rejected
  - safety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

Results

- Selecting



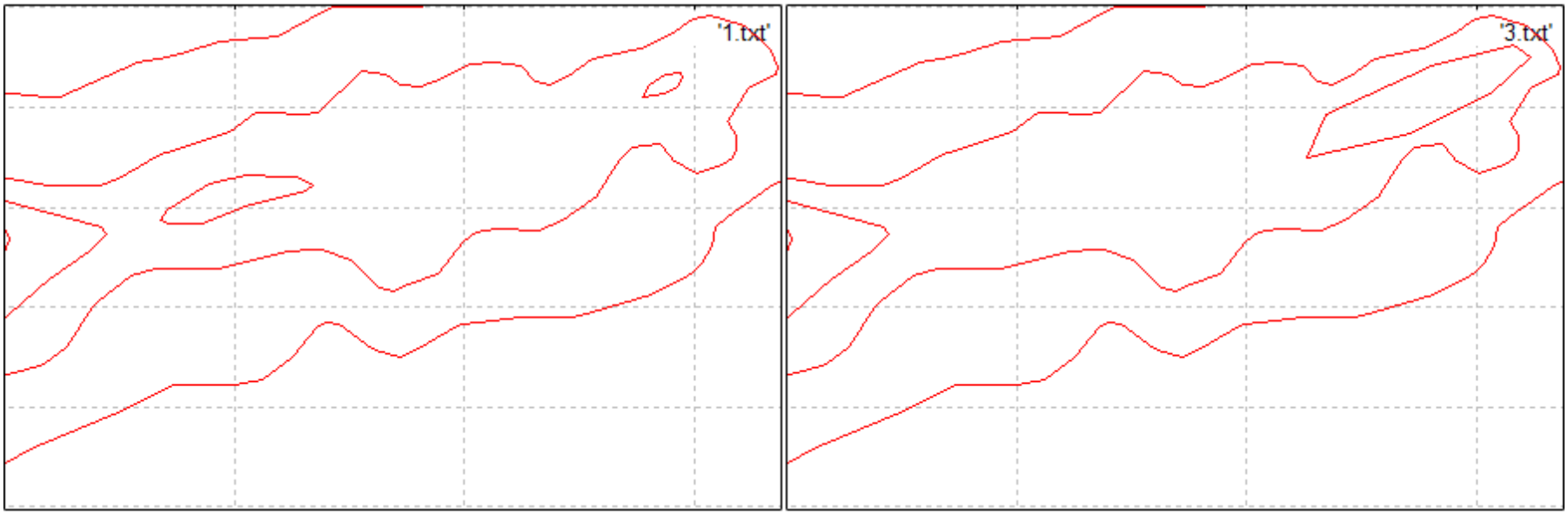
Original data source



Generalized data source

Results

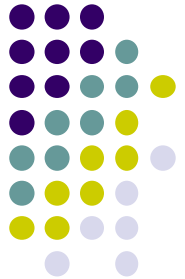
- Enlargement



Original data source

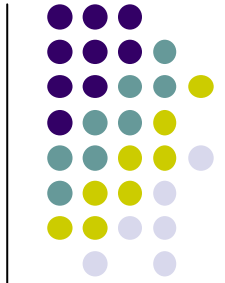
Generalized data source

Conclusion

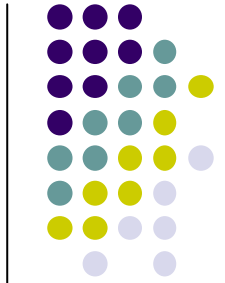


- Generalizing Isobaths on nautical chart
  - Four constraints are considered
    - Constraint of safety
    - Constraint of legibility
    - Shape preservation constraint
    - Topological constraint:
- Feature driven generalization
  - Generalization depends on terrain
  - Define feature type as peak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