INTRODUCTION :

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- **The CISRG**

You may like to look at our web-site still under construction.

http://www2.dcs.hull.ac.uk/CISRG/

OVERVIEW

- Refer to OHP illustrations

1. Introduction

Aim of paper

2. Some ideas for discussion

Requirements within Stages in Generalisation
Objectives of generalisation

Some complementary approaches
- Linear components
- Areal components
- Other techniques for line generalisation

3. The CISRG approach to line structuring

4. Conclusion

1. Introduction

Aim of Paper

- **SCOPE**
- **PROBLEMS**
- **PROJECT**

SCOPE

It is ***Aspects*** of Line Generalisation.

It is ***not all about*** Line Generalisation.

PROBLEMS

Many believe that :

1. The problem of Line Generalisation has been solved

2. We only need to learn how to use existing algorithms such as the Douglas –Peucker algorithm more effectively.

I find it difficult to subscribe to this view. My aim is to:

- explain my concern
- address new problems in line generalisation

I believe that the RDP algorithm:

- is good for curve approximation (simplification)
- but it does not facilitate caricatural generalisation (our aim)

Caricatural generalisation involves :

- the **recognition** of a line in terms of the entities it is seen to represent (eg spits, rivers, branch roads, car parks etc.)

- the construction of a line model using such **meaningful entities**

- purpose-oriented generalisation by :

  - **elimination** of model components (model generalisation)

  - adjustment and rendering of retained components

While approximation seeks to minimise deviation, generalisation often involves deliberate deviation from the original line through omission, warping or displacement.

It is therefore not appropriate to evaluate **caricatural generalisation** using concepts which were designed for **curve approximation**.

I therefore do not agree with this item in Weibel's (1995, p 58) list of requirements of model generalisation.

1. Predictable and repeatable results
2. ***Derived model (line) should not exceed a maximum given threshold***
3. Data volume should be minimised
4. Topological consistency
5. Few parameters, whose impact should be Predictable
6. Speed of Computation

Discussions are also not helped by words, like feature, model and structure, which have ambiguous meanings.

Guptill and Starr's - scope of cartography useful for:

- locating the focus and scope of CISRG project
- discussion

2. Some ideas for discussion

- Overview - (OHP - Visvalingam 1989)

2. 1 Where do requirements fit within the stages in Generalisation?

A **Digital Mapping** (simplify & structure)

1. curve approximation during metric modelling (simplify)

2. topological modelling of lines (structure)
- design for multi-purposes, including interaction

B **Visual Mapping** (filter & render)

3. model-based generalisation (component reduction)

4. display generalisation (legibility, aesthetics etc.)

A current research project focuses largely on stages 2 – 4.

So, if we exclude generalisation in a real-time data capture environment, it appears that the requirements map as follows;

Requirement	**DM**	**VM**	
Predictable and repeatable results	Y		Multiple outcomes in VM
Derived model (line) should not exceed a maximum given threshold	Y		Ditto
Data volume should be minimised	Y	Y	For storage, interaction and transmission
Topological consistency	Y	Y	
Few parameters, whose impact should be predictable		Y	DM is reference
Speed of computation	Y	Y	

2.2 Objectives of Generalisation

Research on line generalisation attempts to:

1. Reduce data requirements (pragmatic)

2. While preserving the ***character of the line*** (cognitive)

Discussions

- Focus on the primary cognitive aim in the initial first instance

- Consider the pragmatics later.

Vague notion of ***the character of the line***

>>> focus on different aspects of line generalisation

>>> complementary approaches

2.3 Complementary Approaches

2.3.1 Line components for shape generalisation

- **Strip Trees**

◊ Chop a line into two at the extreme point.
RESULT : 2 component **lines**

◊ Line segmentation is sensitive to the bounding start-end points.

◊ The selection of extreme points by the Douglas-Peucker algorithm often ***segments user-perceived entities.***

* Visvalingam and Whyatt (1990) - Carmarthen Bay
* Visvalingam and Herbert (1999)
  - Large-scale road data
  - Coastline of Humberside
* Animated demo

- **Other Approaches** (We need to fill these in?)

There are other approaches which focus on shape of line sections (Dettori & Falcidieno, Li and Openshaw, Plazanet, Dutton ….). They differ with respect to the process used for segmenting the line into sub-lines.

2.3.2 Cognitive elements for component reduction

◊ Chop a line into **regions** corresponding to meaningful entities, such as rivers and spits.

◊ Whyatt (1991) refers to my algorithm as the area-based algorithm.

◊ Some results of the clues provided by Visvalingam's algorithm:

- Visvalingam and Whyatt (1990)
  - Carmarthen Bay
- Visvalingam and Herbert (1999)
  - Large-scale road data
  - Coastline of Humberside

- Animated demo

a) My algorithm may be used to filter points.

b) More importantly, it may be used to recognise and structure the cognitive elements within lines.

c) These elements are defined by areas or regions.

- Animated demo

Advantages of a region-based model

- semantic modelling for ***knowledge-based generalisation***, as opposed to deconstruction
- the adoption of an object-oriented approach to ***vary the behaviour*** of different parts of the line as suggested by Visvalingam and Whyatt (1993).
- scope for applying a wider range of ***currently available generalisation operators***, such as collapse and re-classification, more intelligently and at a finer resolution.
- the scope for intelligent (informed) derivation of ***multiple generalisation solutions***
- large ***data reductions*** whenever it is possible to cut out sections of the original line, e.g. long meandering rivers.
- convenient for Internet transmissions; just transmit the connected components

2.3.3 Other complementary techniques

The region-based approach does not preclude the use of :

- other structuring methods
- spatial tesselations
- shape-encoding schemes
- shape-preserving algorithms
- Work in Cognitive Psychology, Pattern Recognition and Computer Art
  - ◊ Computer-drawn sketches

How do all the above come together?

3. Conceptual Entities Used to Segment Lines

Some areal units for object modelling.

- Convex hulls
- unidirectional ***parts*** for recognition
- nested shape-defining and part-defining triangular regions for elimination
- bi-directional bends for elimination (Wang, 1996)
  Bend elimination on its own may provide better results than the integrated Bendsimplify algorithm
  - Visvalingam and Whyatt (1990)
    - Carmarthen Bay
  - Visvalingam and Herbert (1999)
    - Large-scale road data
    - Coastline of Humberside
- nested branches
  (mentioned by Wang and Muller)

  van der Poorten and Jones (this Workshop)
  similar aims to CISRG but different means.

4. The CISRG approach to line structuring
(Case study - large-scale road boundary)

- Pre-process with Visvalingam's algorithm to rank points.

- Use rank in post-process to segment parts

  Problems:
  - ◊ points which share rank can be in different regions
  - ◊ regons can become segmented due to spurious data
  - ◊ not all regions should be segmented; some are shape-defining
  - ◊ semantic components may overlap
  - ◊ the bounding points of regions need adjustment

  Segmentation also requires:
  - ◊ domain knowledge to identify semantic entities, e.g. branch roads, filleted curves, curves and inflections in road, car parking bays.
  - ◊ additional data-dependent rules

- Segmentation is recursive and yields a hierarchic part structure.

- Parts are distinguished from shapes on geometric criteria.

5. Conclusion

- The region-based approach to line structuring is here in concept.
- It complements the band-based approach but differs from it in that seeks to trim off irrelevant component sections.
- It offers scope for varied generalisation of line components, using already existing ideas
- There have been different experiments using different conceptual entities (from parts to branches)
- There are different algorithms being investigated for segmentation and structuring
- Preliminary results from different groups look promising.
- It has highlighted a need for clarification of terms and requirements of model generalisation.
- This paper attempts to start discussions.

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