Towards a true vario-scale structure supporting smooth-zoom

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This is not ‘yet another tGAP story’...
(generalized area partitioning)
Because... SSC, space-scale cube
Early use of additional dimension for scale (importance) representation

- Alternative Reactive-tree (van Oosterom, Auto-Carto 10, 1991)

![Diagram](image)

*Figure 8: The 3D MBRs of the Alternative Reactive-tree*
Generalized Area Partitioning-tree (GAP-tree) history

- Normal GAP-tree (van Oosterom 1993) areas are stored as independent polygons $\rightarrow$ computed redundancy (both at given scales and between scales)

- Vermeij et al. 2003 proposed topological GAP-tree: edges and faces (with importance range, consider as height), reduced redundancy between neighbors $\rightarrow$ scale/imp with 3D prisms
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tGAP example

1. **Collapse** road  
   (split area, merge neighbours)

2. **Delete** forest  
   (merge with farmland)

3. **Simplify** boundary  
   (between water/farmland)
2D+scale $\rightarrow$ 3D integrated

- tGAP DAG to 3D structure
- Parent-child: $\rightarrow$ neighbour above-below
Delta scale

→ no change at all or local shock
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Smooth tGAP

- Remove local shock → no horizontal faces
- Gradual changes → less vertical faces
- Resulting polyhedron → representation of single object for all its scales
Delta scale $\rightarrow$ delta map
Non-horizontal slice → mixed scale map
Non-flat slice $\rightarrow$ mixed scale map
(fish-eye example)

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Smooth simplify

- **Shock change:**
  - 2 rectangles
  - 1 triangle

- **Smooth change:**
  - 3 triangles
Smooth merge for convex neighbour

1. make #nodes shared and target bnd equal (n)
2. connect node pairs
3. 2 triangles + n-3 quadrangles
4. if non-flat $\rightarrow$ split quadrangle into 2 triangle
5. Merge planar neighbours
Alternative (without adding nodes)

Create triangle base at one side and top at other side

$LS_o = 1 + 3 + 1 = 5$

$b_o$ (opposite boundary)

$LS_s = 7$

$b_s$ (shared boundary)

- at scale $s_2$,  
- from $s_1$ to $s_2$,  
- at scale $s_1$
Non-convex neighbour
⇒ subdivide in convex parts

m-shaped neighbour

neighbour with hole

(note: smooth collapse/split similar to smooth merge)
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Selection based on \((n+1)D\) overlap from space-scale cube

Simple initial map

Progressive initial map (sorting lower \(\rightarrow\) higher detail)
(n+1)D overlap selection for zooming

Progressive zoom-in (normal sorting order)

Progressive zoom-out (reverse sorting order)
(n+1)D overlap selection for panning

Normal panning

Progressive panning (normal sorting order)
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Some future work

- Semantic aspect (incl. attributes) needs further attention
- Lower dimension primitives (lines, points) do also fit in the structure, but need further investigations
- Not per se object by object creation (but multiple objects in parallel → see paper)
- Sliver before disappearing
- Lot of implementing and testing needed
Conclusions, true vario-scale

- tGAP is well suited for web environment (progressive)
- True vario-scale nD maps based on (n+1)D representations and slicing (selecting) with hyperplanes:
  - tGAP structure translates 2D space and 1D scale in an integrated 3D topological representation: no overlaps and no gaps (in space and scale)
  - Starting with 3D space and adding scale results in 4D
  - Starting with 3D space and time (history) and adding scale results in 5D topological structure (again no gaps/overlaps in space, time or scale), well defined neighbors in space, time and scale directions
3D smooth merge
(more details in patent claim)
Generic 3D smooth merge

High detail

Opposite boundary (5 faces)

Equator (ring)

Low detail

Vario-scale
3D Smooth simplify

Simplify boundary of merged object, two options:

1. Keep block shape

2. Tilted roof shape
Pseudo 4D-view

Zone $z_i$ shown for reference purpose