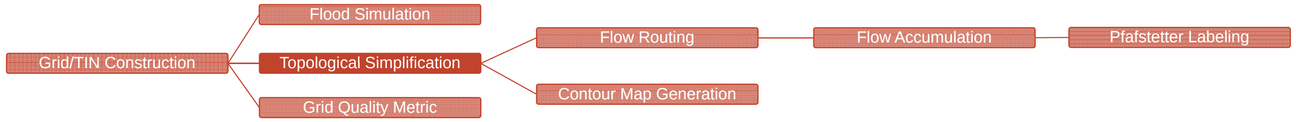
MADALGO
CENTER FOR MASSIVE DATA ALGORITHMICS

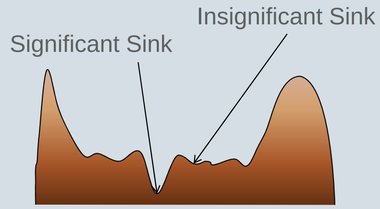


TerraSTREAM: Topological Simplification

Introduction

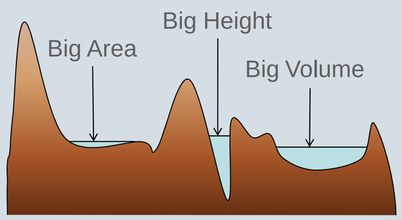
Motivation

- **Problem:** Detailed data set ➡ Many small, insignificant sinks.
- **Flow Routing Consequence:** Disconnected river network.
- **Contour Line Consequence:** Many small and insignificant contours.
- **Solution:** Find insignificant sinks and remove them.



Solution

- We associate a geometric measure with each sink.
- The geometric measure can be the **height, area or volume** (and any combination of these) of the sink.
- Define a significance **threshold** and remove all sinks with geometric measure lower than the threshold.



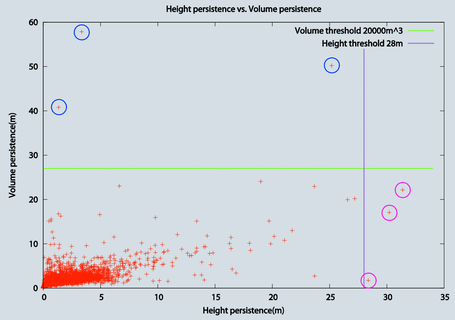
I/O-Efficient Algorithm

- Topological simplification using height persistence can be done I/O-efficiently using I/O-efficient batched union-find as proposed by Agarwal, Arge and Yi in 2006 [SoCG'06]
- We defined and solved the more general batched union-find with dynamic set properties so that a wide range of geometric measures can be computed.

Topological Simplification and Flow Routing

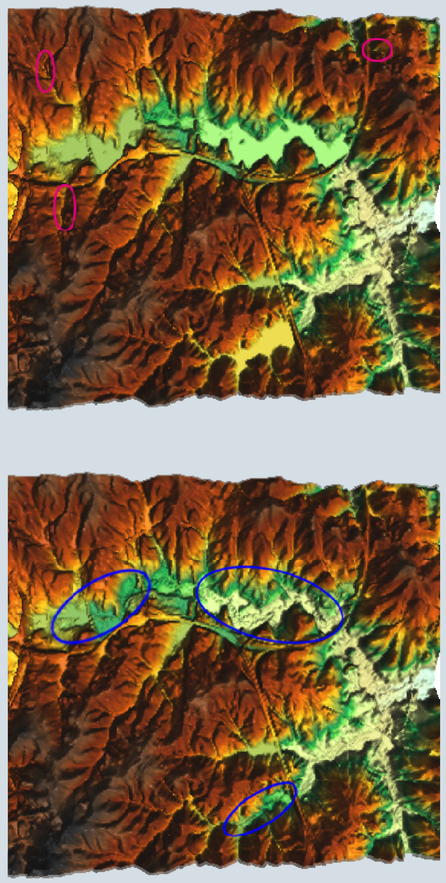
Geometric Measures

- The graph to the right shows both the height and the volume of each sink (**red cross**) in the terrain depicted below.
- **The Vertical line** represents the height threshold that removes all but the three highest sinks.
- **The Horizontal line** represents the volume threshold that removes all but the three largest sinks.



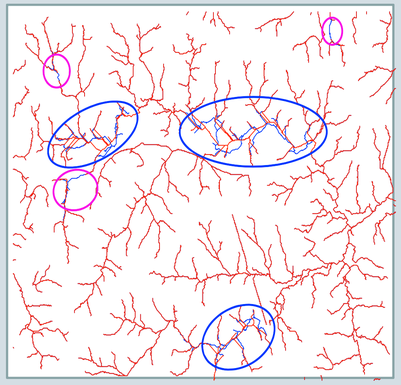
Removing Sinks

- The **top right terrain** has been simplified using height as geometric measure.
- The **bottom right terrain** has been simplified using volume as geometric.
- The thresholds used are the ones given in the graph above, so that in each of the terrains only three sinks are kept after simplification.
- **Conclusion:** The sinks kept when using volume simplification seem much more significant and intuitively they correspond to the sinks that water will realistically flow towards.



Flow Routing

- The **red river network** is generated from the height simplified terrain.
- The **blue river network** is generated from the volume simplified terrain.
- **Conclusion:** Blue network is connected in the purple circles and the flow is more "natural" in the blue circles.



Simplification and Contour Line Generation

Contour Lines

- We can enhance the output of contour line generation, by removing sinks that result in insignificant contours.
- **Black contour lines** were generated from a terrain simplified using volume as geometric measure.
- **Red contour lines** were generated from a terrain simplified using height as geometric measure.
- In the **top figure** the black lines have been drawn on top of the red lines and vice versa in the **bottom figure**.
- **Conclusion:** Volume simplification removes many insignificant contours (top) that are kept when using height, whereas height simplification removes contours that seem significant (bottom).