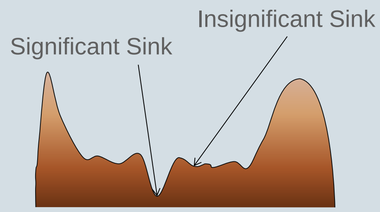
MADALGO
CENTER FOR MASSIVE DATA ALGORITHMICS


Morten Revsbæk
University of Aarhus

TerraSTREAM: Hydrological Conditioning

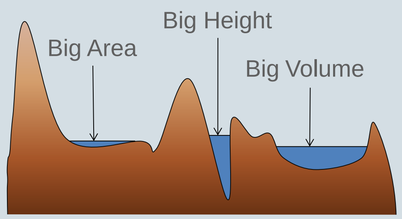
Motivation

- **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 numeric value – **persistence value** - with each sink.
  - Persistence value can be the **height, area or volume** of sink.
- Define a **persistence threshold** and remove all sinks with a persistence value lower than the threshold.



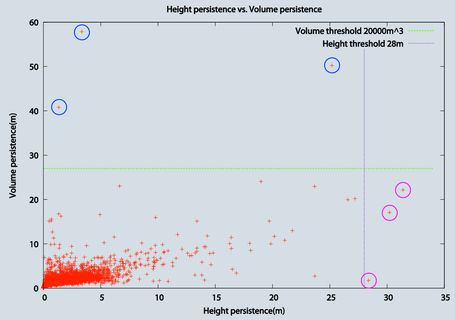
I/O-Efficient Algorithm

- Hydrological conditioning 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 both height, area and volume persistence (or any combination of these) can be calculated I/O-efficiently.

Hydrological Conditioning and Flow Routing

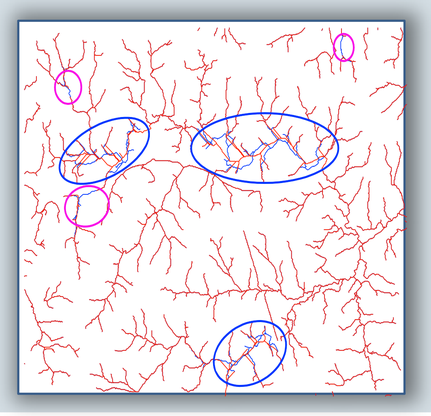
Calculating Persistence

- 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.



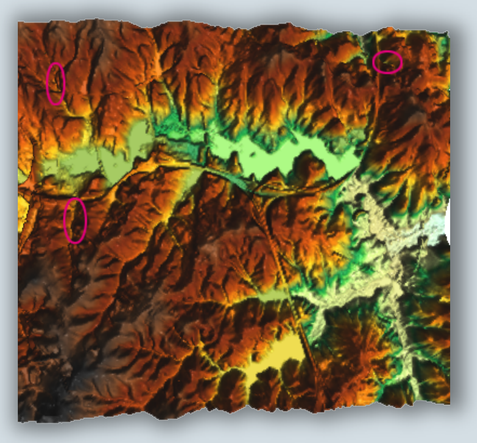
Flow Routing

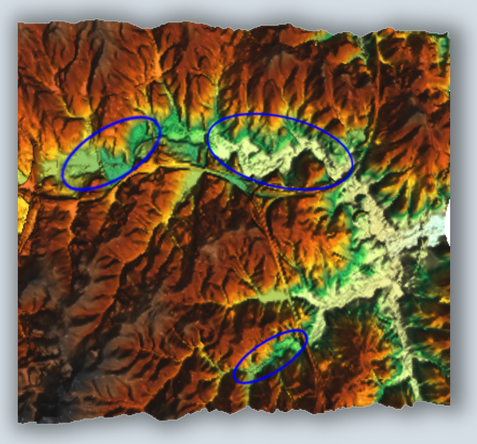
- The **red river network** is generated from the height conditioned terrain.
- The **blue river network** is generated from the volume conditioned terrain.
- **Conclusion:** Blue network is connected in the purple circles and the flow is more "natural" in the blue circles.



Removing Sinks

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





Conditioning 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 conditioned using volume persistence.
- **Red contour lines** were generated from a terrain conditioned using height persistence.
- 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 persistence removes many insignificant contours (top) that are kept when using height persistence, whereas height persistence removes contours that seem significant (bottom).