Towards a mathematics of terrain

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My big unsolved problem: Invent mathematics to easily represent legal terrain (elevation).

Terrain properties: many maxima • few minima • often monotonically decreasing • occasional discontinuities.

Applications: To put terrain operations like visibility, hydrography, compression on a proper formal foundation • To process large databases.

Tools: very large memory • parallel HW (openMP, CUDA).

Accomplishments to date: external memory algorithm to compute hydrography on 50000 $\times$ 50000 terrain and viewsheds on 100000 $\times$ 100000 terrain much faster than others • parallel algorithm to compute viewsheds on 8000 $\times$ 8000 terrain achieves 5$\times$ speedup with OpenMP, or 20$\times$ speedup with CUDA.

International collaboration: M Andrade, UF Viçosa Brasil.

Parallel geometry on large datasets

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Context: Complicated data structures don't parallelize • Bad asymptotic times: even $T = \theta(N \log N)$ too slow.

Proof of principle: Compute mass properties of the union of 100M overlapping cubes in 1800 seconds using OpenMP.

Other projects

Compression of 5D environmental datasets by solving overdetermined linear system.

Modeling of levee failure by overtopping including geotechnical centrifuge tests • with Cutler and Zimmie.

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