More efficient terrain viewshed computation on massive datasets using external memory

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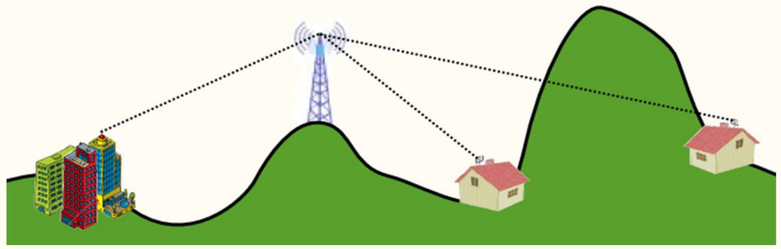
Visibility on Terrains

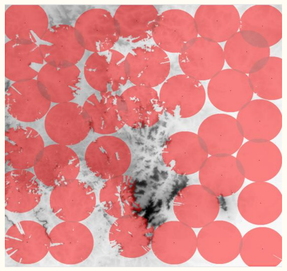
Visibility: determine which points can be viewed from a given observer *O*.

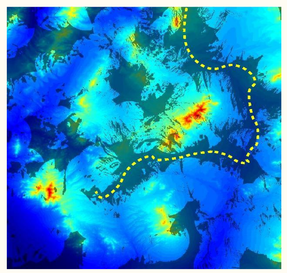
A target *T* is visible from *O* if the segment *OT* is always strictly above the terrain.



The region composed of such points is known as the *viewshed of O*.

Some applications:





Most viewshed algorithms assume the terrain fits in internal memory at once.

But these algorithms do not scale up well for huge terrains bigger than the internal memory.

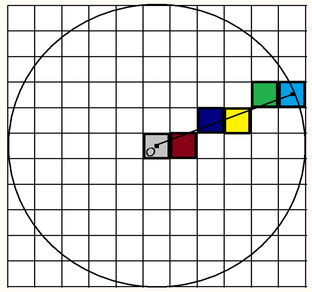
It is important to optimize such algorithms simultaneously for computation and data movement between internal and external memories.

The *TiledVS* Method

An efficient method for viewshed computation on huge DEM terrains stored in external memory.

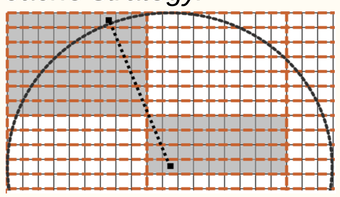
It is based on the *Randolph et al.* alg. which computes the visibility along a vertical cut defined by a ray connecting the observer to a cell in the viewshed bounding box.

This ray is counterclockwise rotated around the observer.

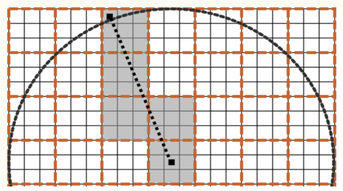


This access pattern is not efficient for external memory.

The *TiledMatrix* library is used to subdivide the matrix in blocks, store them sequentially in external memory, keep some blocks internally and manage them using an *LRU cache strategy.*

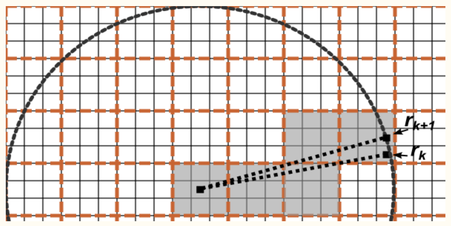


Conventional cache



Using *TiledMatrix*

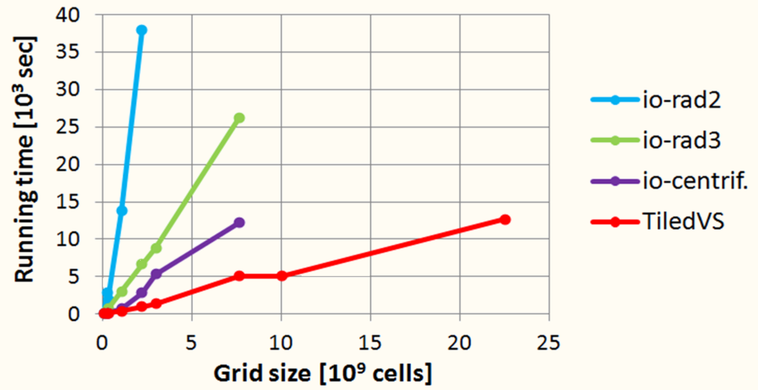
Two consecutive rays (in the radial sweep) intersect, at most $2(\rho/\omega + 2)$ blocks where ρ is the radius of interest and ω is the block width.
If the cache memory can keep these $2(\rho/\omega + 2)$ blocks then the LRU policy will evict a block only if it is no longer needed.

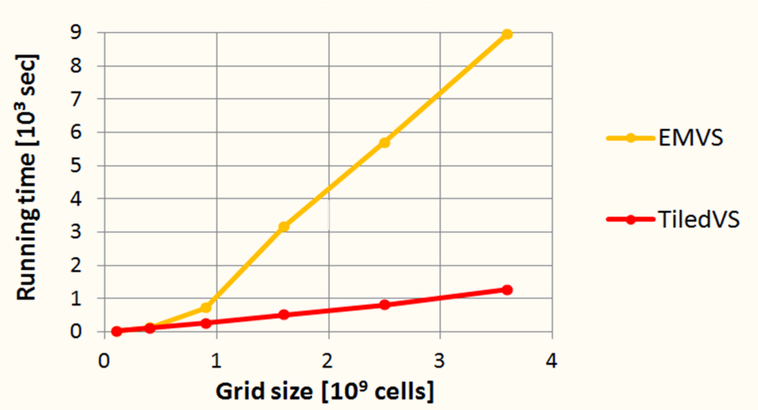


It is not hard to satisfy; we´ve been able to process a 40GB terrain very efficiently using only 128MB of RAM.

Results

TiledVS was tested against the most recently published methods: io-radial2. io-radial3. io-centrifugal and EMVS





REFERENCES

[1] M. V. A. Andrade, S. V. G. Magalhães, M. A. Magalhães, W. R. Franklin, and B. M. Cutler. *Efficient viewshed computation on terrain in external memory*. GeoInformatica, pages 381-397, 2011.

[2] J. Fishman, H. J. Haverkort, and L. Toma. *Improved visibility computation on massive grid terrains*. In O. Wolfson, D. Agrawal, and C.-T. Lu, editors, GIS, pages 121-130. ACM, 2009.

[3] W. R. Franklin and C. Ray. *Higher isn't necessarily better - visibility algorithms and experiments*. In 6th Symposium on Spatial Data Handling, Edinburgh, Scotland, 1994.

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