Algorithms for GIS
csci3225

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Viewsheds on triangulated terrains

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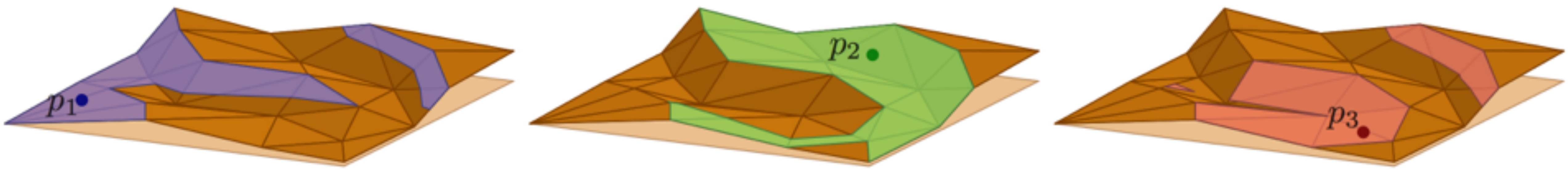
- viewshed(p) contains all points of the terrain that are visible from p



from: http://arxiv.org/pdf/1309.4323.pdf

- viewshed(p) may intersect a triangle multiple times.

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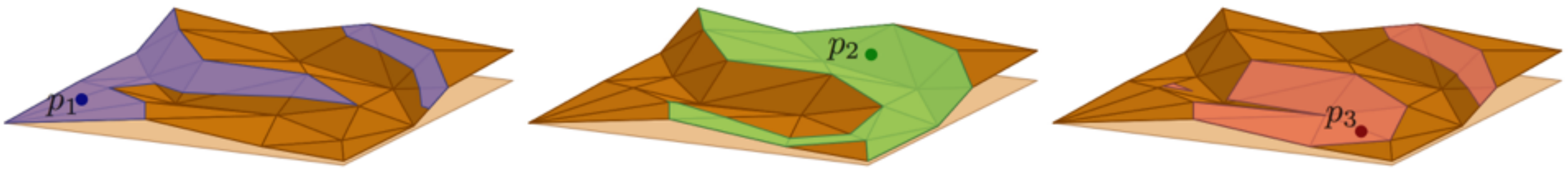

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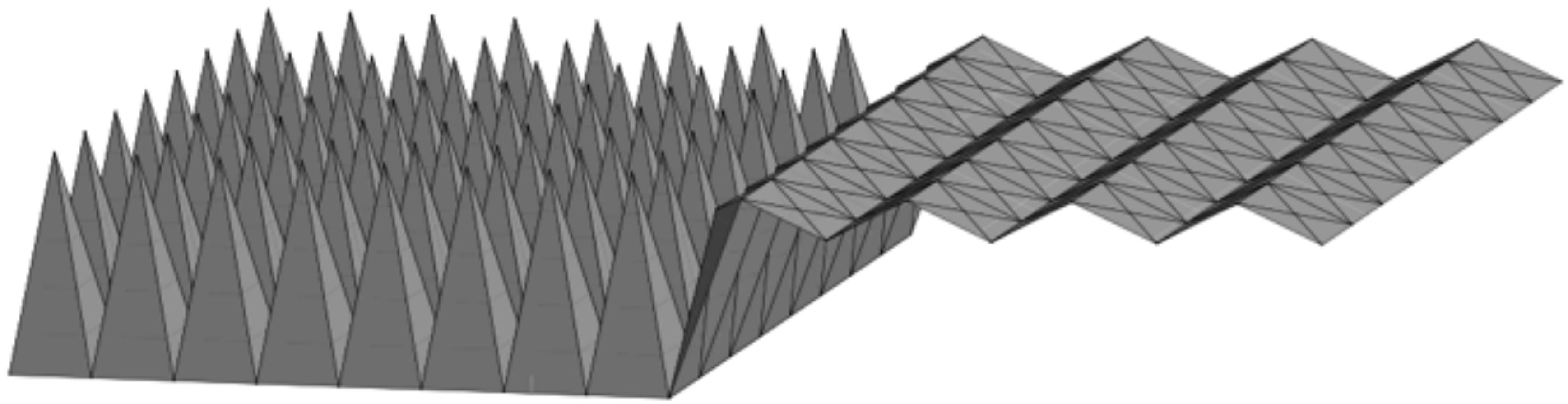
- viewshed(p) may intersect a triangle multiple times.
- Complexity of viewshed(p)
  - Space complexity = number of edges on boundary of viewshed(p)
  - It is known that:
    - the complexity of a viewshed on a triangulated terrain can be Theta(n^2).
    - On a triangulated grid, the complexity of a viewshed can be Theta($n\sqrt{n}$)
  - These worst-case cases exist, but are contrived/not realistic.
  - In practice, on realistic terrains, viewsheds are small. Proving realistic upper bounds still open problem.

The complexity of a viewshed on a triangulated terrain can be Theta(n^2).

from: HH, MdB, KT 2009



The complexity of a viewshed on a triangulated grid can be Theta(n√n).

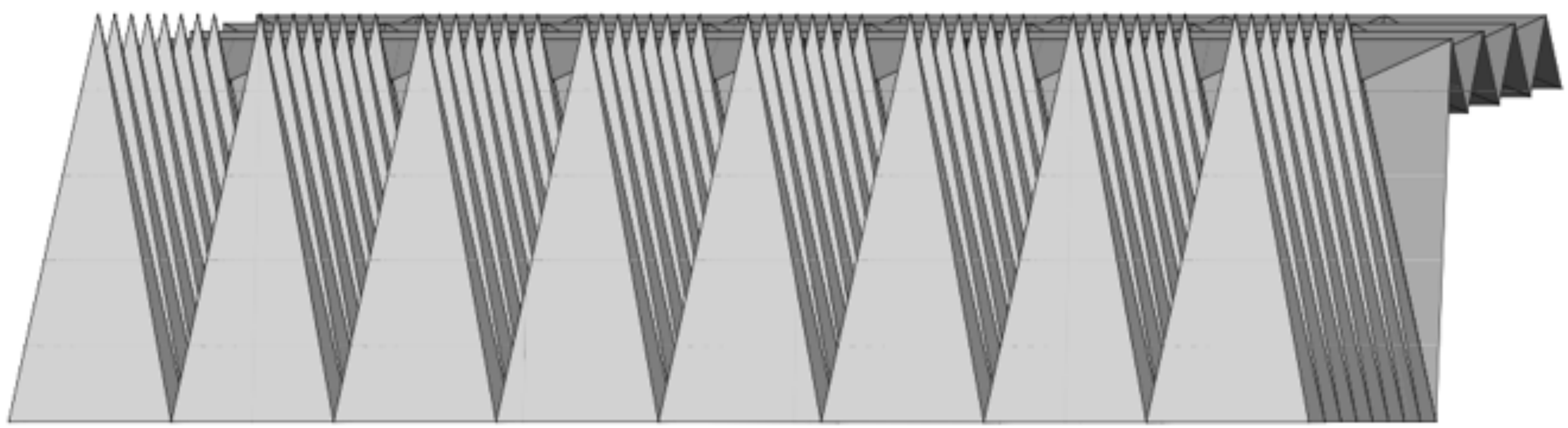


Figure 1: Two views of the same terrain defined by a regular grid. The second view gives a visibility map of complexity $\Theta(n\sqrt{n})$. Note that the terrain can be flattened further without changing the view combinatorially.

Viewsheds on triangulated terrains

- Several algorithms are known
- Based on horizons
  - Idea: traverse triangles in order of increasing distance form viewpoint, and update horizon.
  - Bootstrap with divide-and-conquer

Outline

- Viewsheds on grid terrains
  - size: O(n)
  - algorithms
    - straightforward algorithm
    - radial sweep algorithm
    - viewshed via horizon

- Viewsheds on TIN terrains
  - size: $O(n^2)$
  - algorithms:
    - horizon-based + divide&conquer

- Cumulative viewshed
- Total viewshed
- Find point of maximum/minimum visibility
- Find optimal paths

Beyond viewsheds

Improving Methods for Viewshed Studies in Archaeology: The Vertical Angle

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Abstract

As many authors have observed, binary viewsheds are too simplistic a way to represent visibility around a particular viewpoint. Several deficiencies, very well summarized in Wheatley and Gillings (2000), must be corrected in order to make computer-generated viewsheds more realistic and geared to archaeological purposes. One of those required improvements relates to the vertical angle of vision. Viewing from a low angle gives less perception of detail than viewing from a high angle. Standard viewsheds do not allow the identification of this kind of perceptual issue. In the real world, visible areas at eye level are seen as a narrow strip; however, on the ground they can extend for many kilometres. The map thus gives a false representation of visibility. Dividing the viewshed calculation into several vertical angles helps to analyze the result in a more realistic way than is customary, especially in warlike contexts where dominant visibility could have been important for military purposes.

Keywords

Viewshed, total viewshed, isocrones, ArcGIS, path distance tool.

1. The importance of visual control during the Late Iron Age in Spain

During the Roman conquest period in Spain (II-I centuries BC), in several areas of Andalusia, some new settlements were located on hilltops, with extensive visibility.

This fact has been interpreted in two ways:

- as a wish to visually supervise indigenous settlements;
- as a way to show Rome's presence in the area, and to reinforce its power.

In particular, in the Guadalquivir River Valley, this fact has been observed in two adjoining areas. Romo *et al.* detected two new settlements on hilltops during the Roman republican period in Gilena. The authors think that these sites were established in order to (visually) control indigenous settlements, in the unstable context of the beginning of the roman conquest of Hispania (Romo et

similar phenomenon has been observed east of these zones, in an area shared by the current provinces of Seville and Cordoba, in the Genil River Valley (Zamora in press).

1.1. The Priego-Alcaudete basin

The Priego-Alcaudete basin is located east of the Sierras Subbéticas, in the southern part of the provinces of Cordoba and Jaen (Andalusia, Spain). The area is adjacent to the Genil River Valley (*Fig. 1*).

During the Middle Iberian period (prior to the beginning of the Roman conquest) there was no

Total viewshed

- Input: elevation grid G
- Output: total-viewshed grid
    - tv(i,j) = nb. visible points in viewshed_of(i,j)

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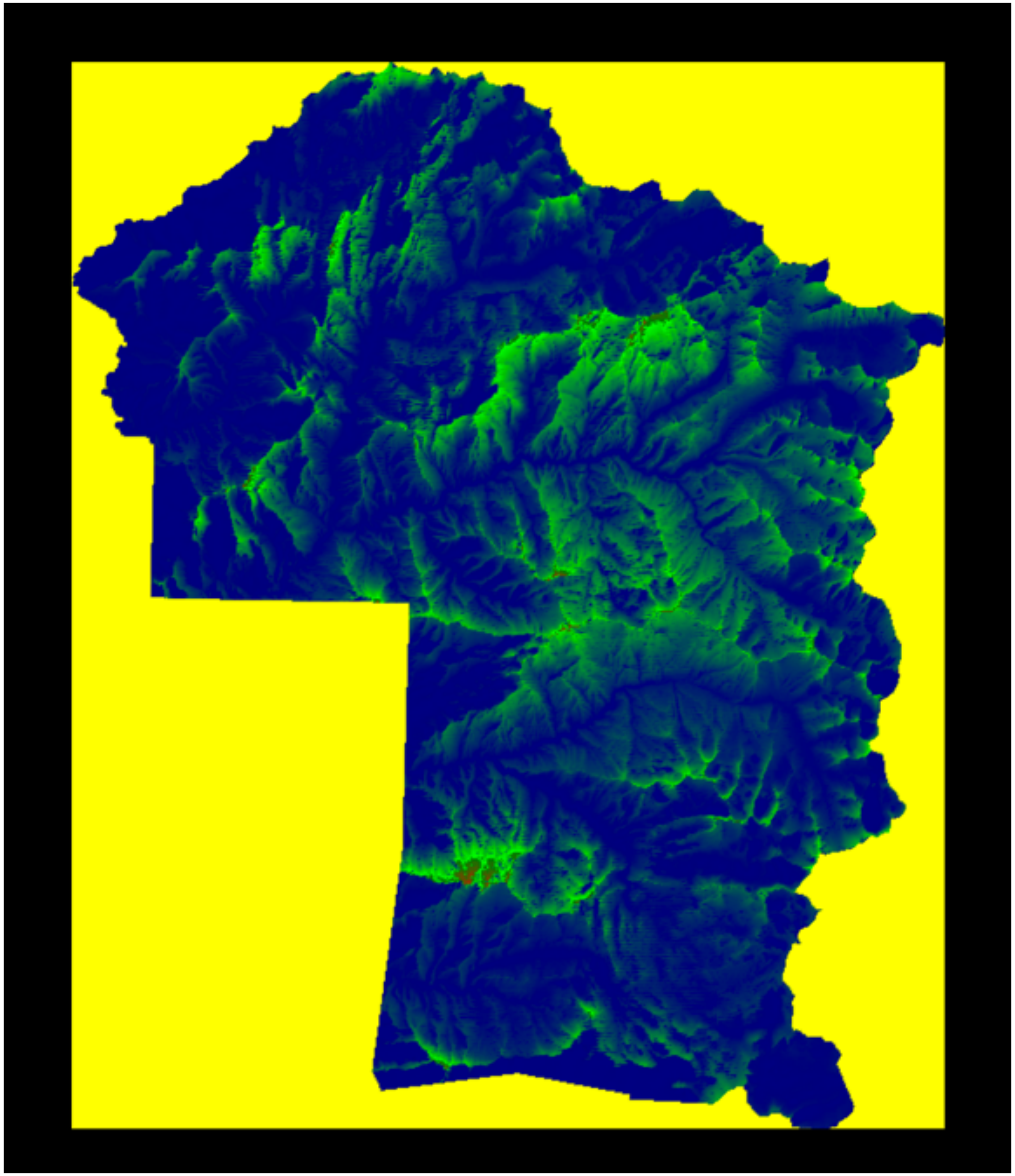
- Output: total-viewshed grid
    - tv(i,j) = nb. visible points in viewshed_of(i,j)

- Algorithms:
    - How to compute the total viewshed?
- Complexity:
    - ?

- Algorithms and complexity:
  - Straightforward solution: $O(n^2\sqrt{n})$
  - With radial sweep: $O(n^2 \lg n)$



total viewshed on kaweah (1M points)
time: 10 hrs

- Algorithms and complexity:
  - Straightforward solution: $O(n^2\sqrt{n})$
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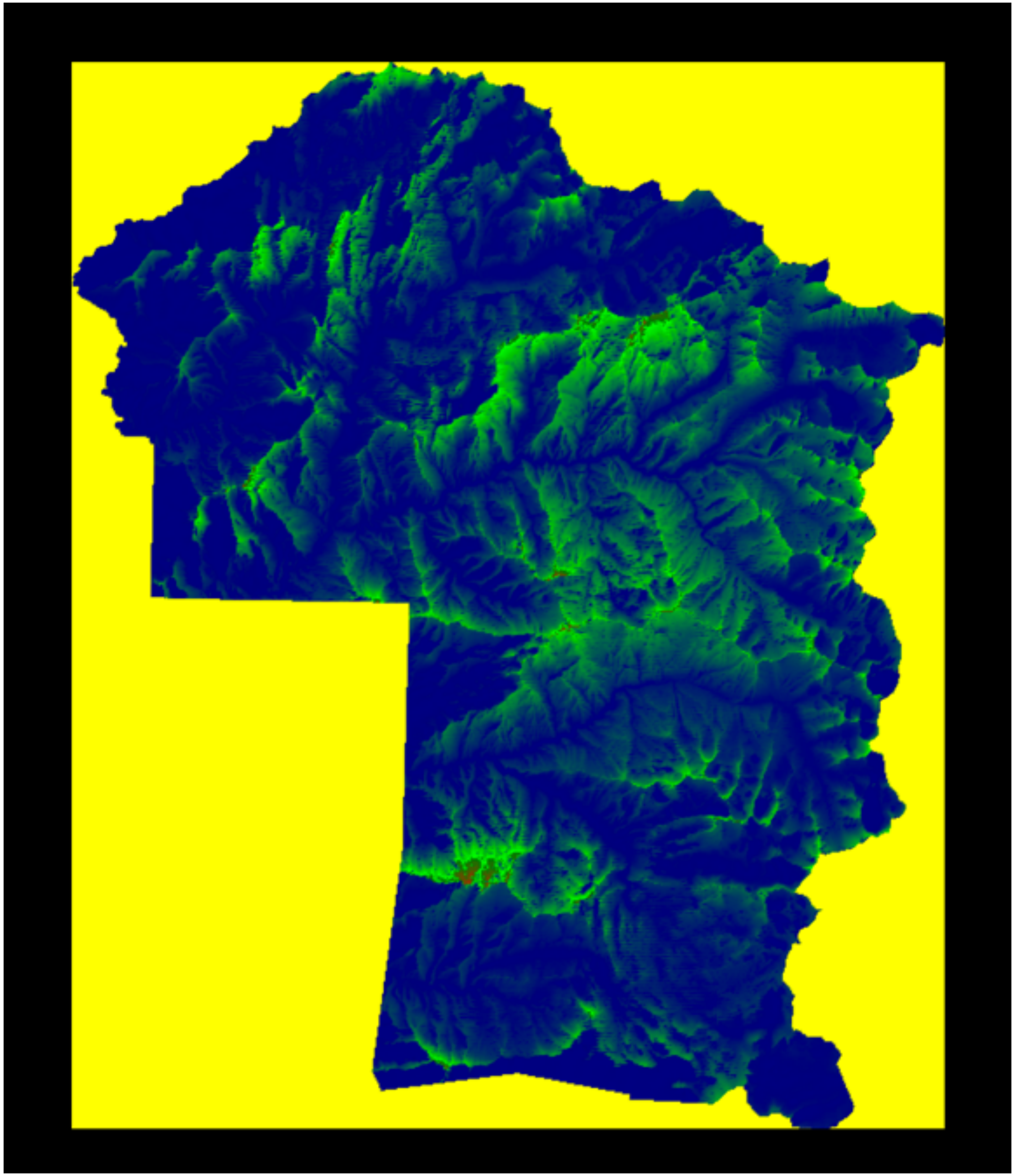
Too slow..

Need better algorithms!
Need parallel algorithms!



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