Oregon State University OSU

CARTO GROUP GRAPHY & GEOVISUALIZATION

Automating the Local Adaptation of Illumination in Analytical Relief Shading

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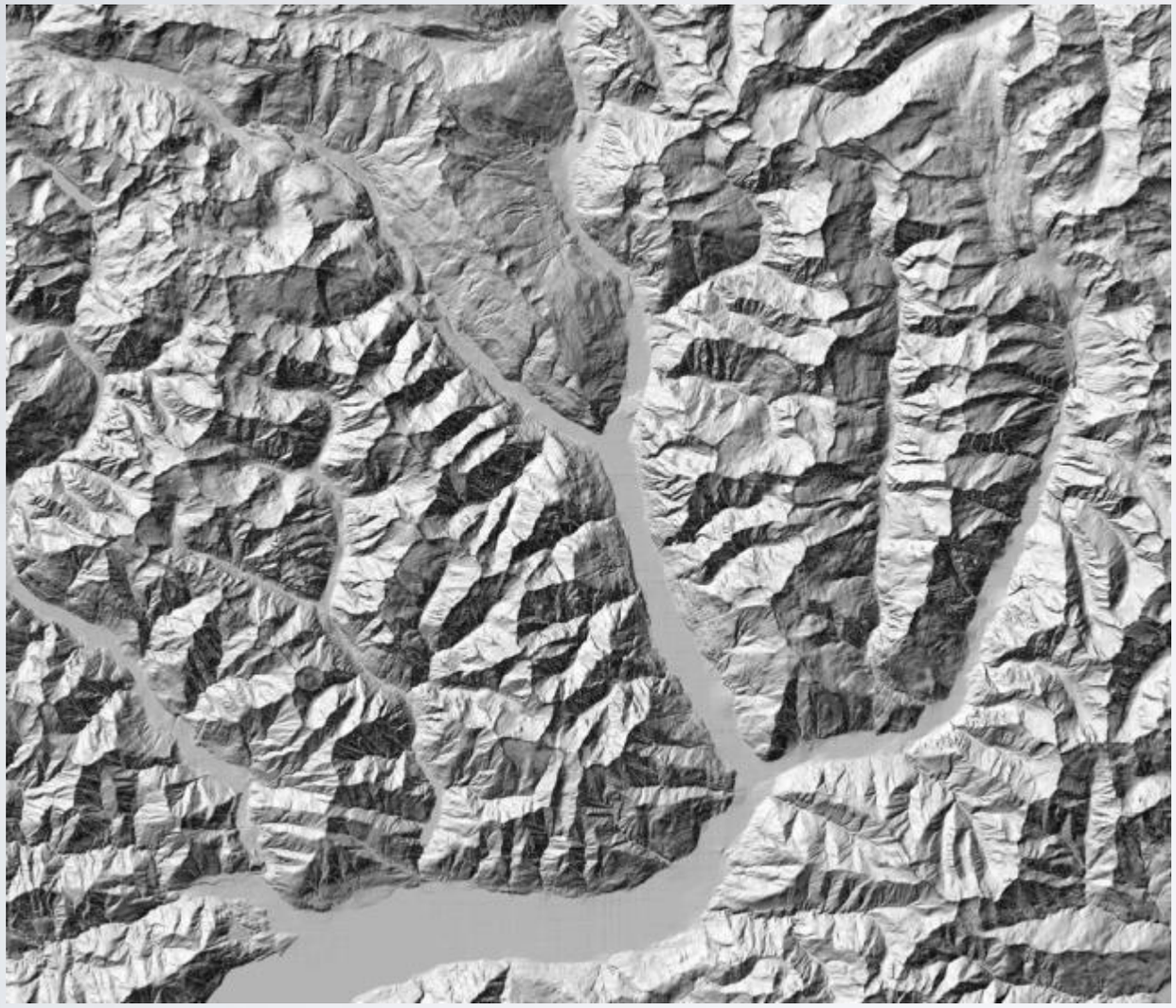
Adviser: Dr. Bernhard Jenny, Oregon State University

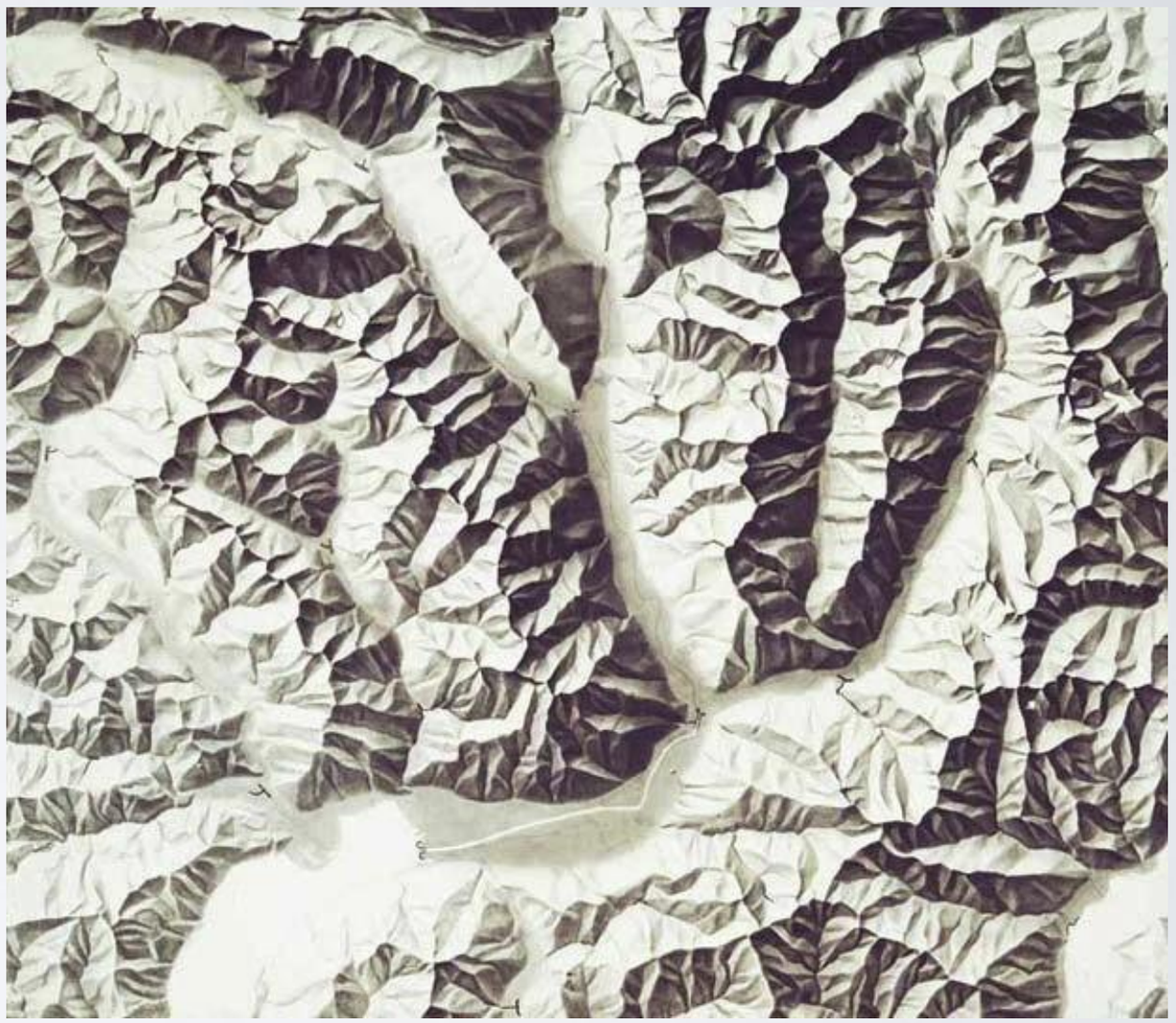
ICA Mountain Cartography Workshop, Banff, Canada
April 24, 2014

Relief Shading

Analytical



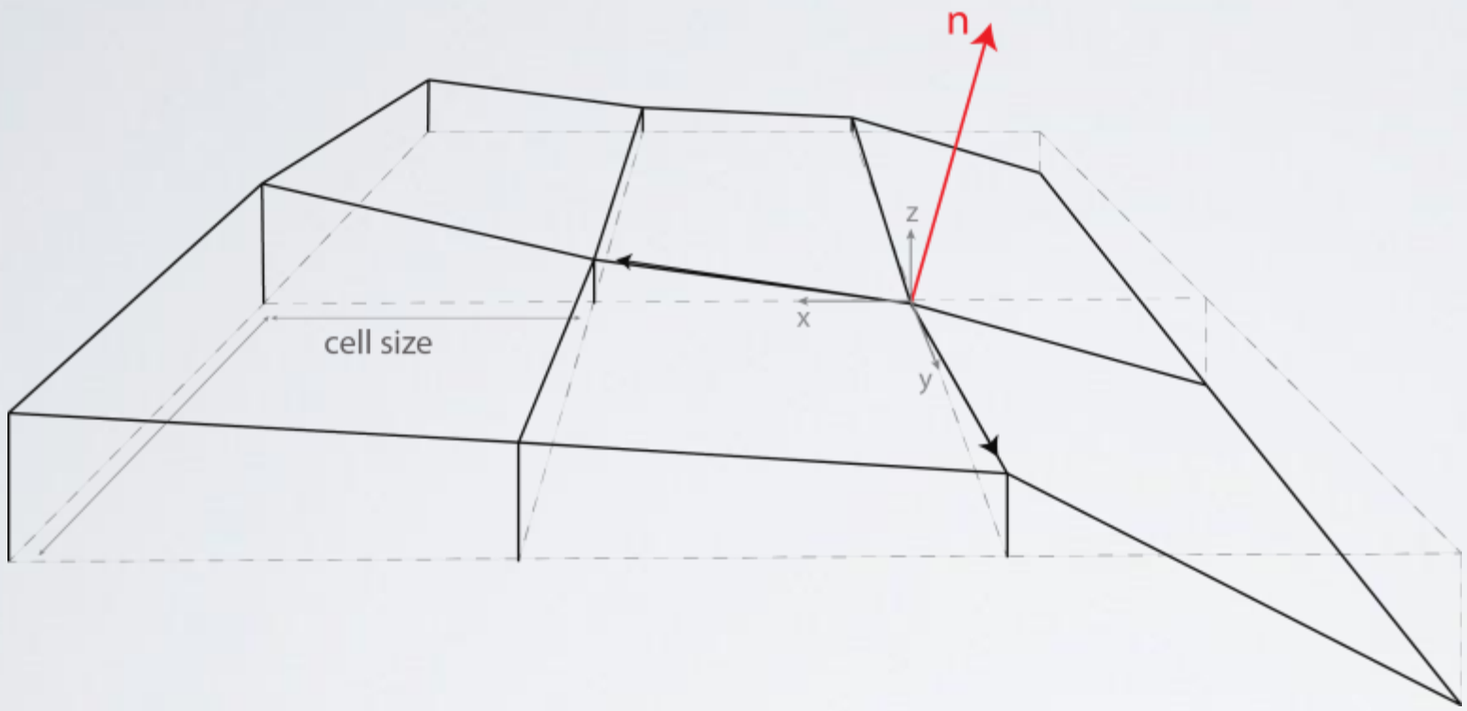
Manual

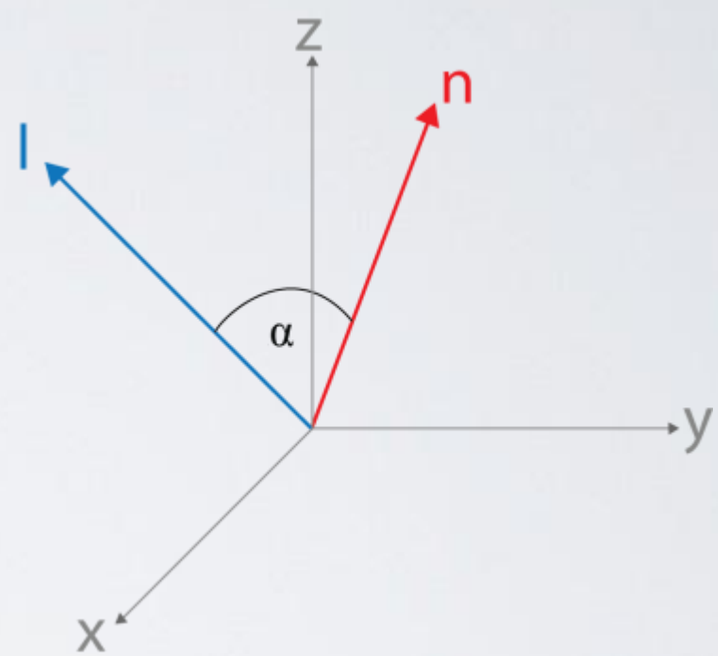


Source: reliefshading.com

Current Analytical Relief Shading

Lambertian Reflection Algorithm





l = direction of illumination

n = normal vector

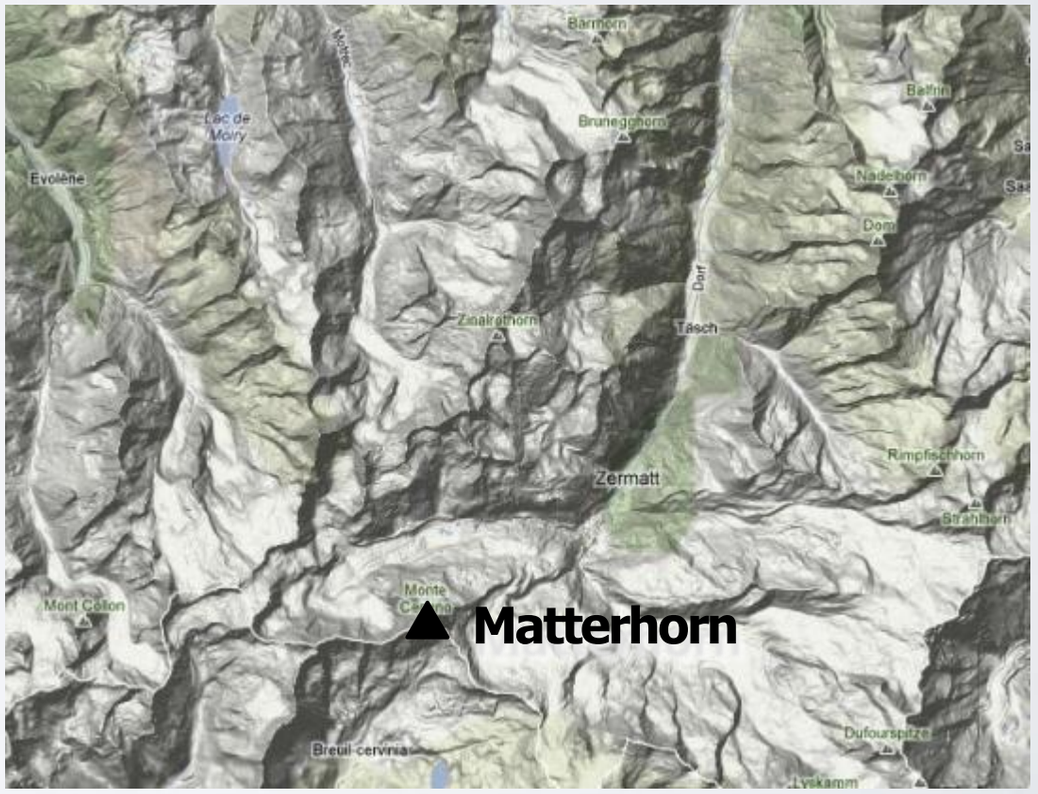
$$\text{Pixel gray value} = 255 \times \cos(\alpha)$$

Source: B. Marston

Why is manual preferred?

- Locally bright and dark slopes improve legibility and aesthetic quality

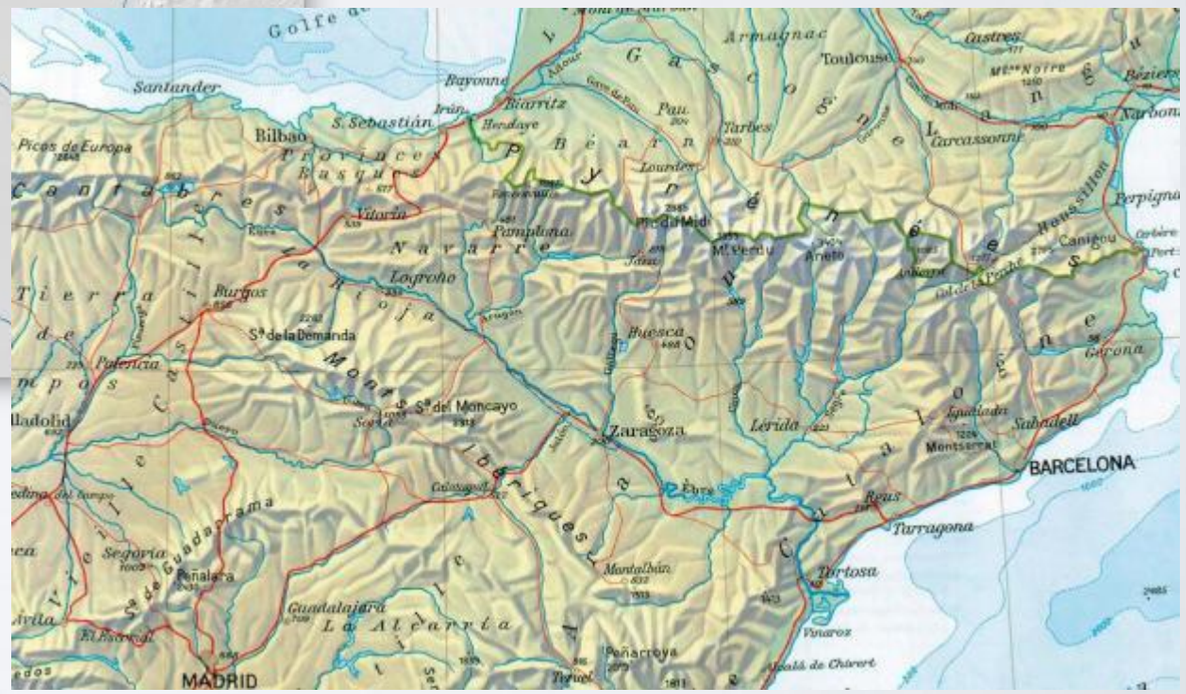
- Easier and faster for the user to interpret topography



Source: reliefshading.com (left) Google Maps (right)

Why is manual preferred?

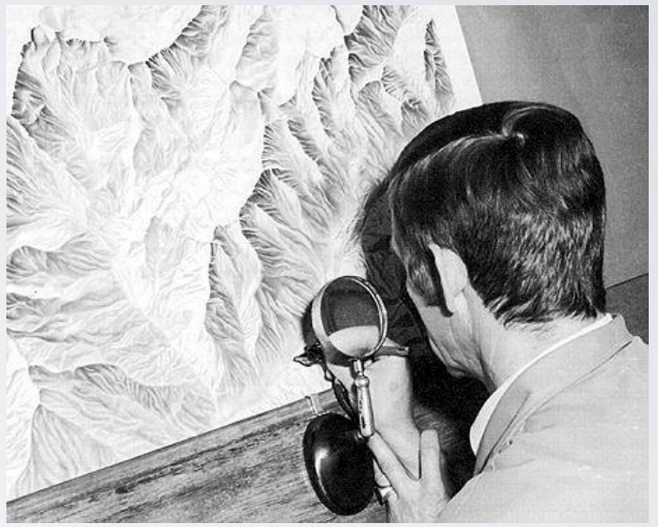
- Better for small-scale maps where contours degenerate

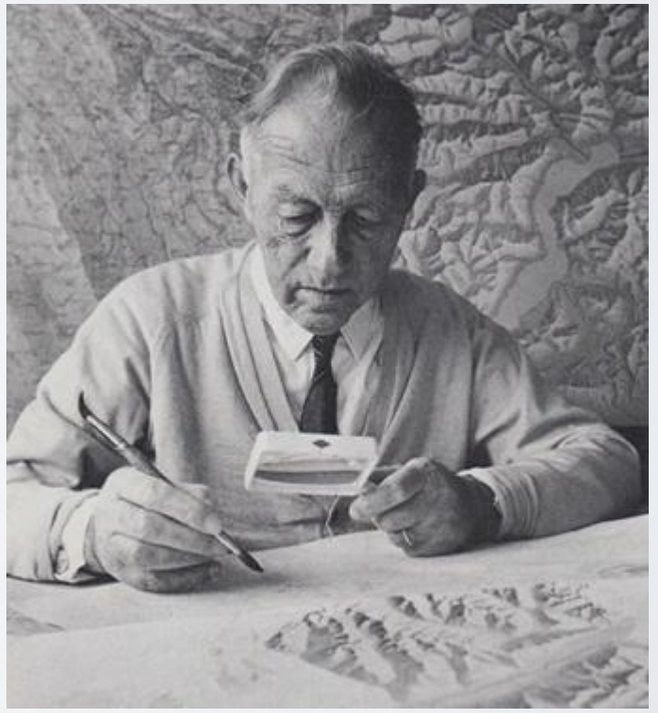


Source: reliefshading.com

Why aren't there more manually shaded relief maps?

- Expense of present manual methods of production
- Time-intensive
- Requires skilled artists with good insight into cartography



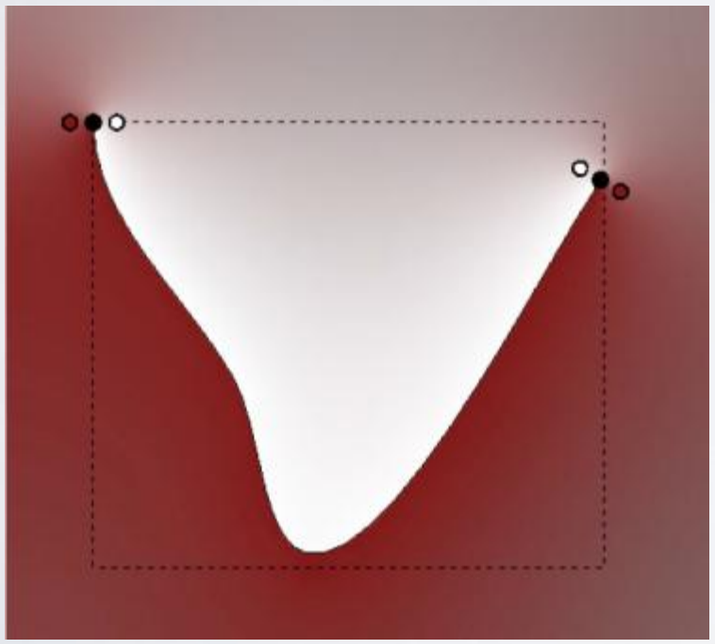


Source: reliefshading.com

Diffusion Curves

Diffusion Curves

- Developed by Orzan et al. (2008)
- Vector-based primitive for creating smooth-shaded images
- Curve that diffuses colors on both sides of the space it divides

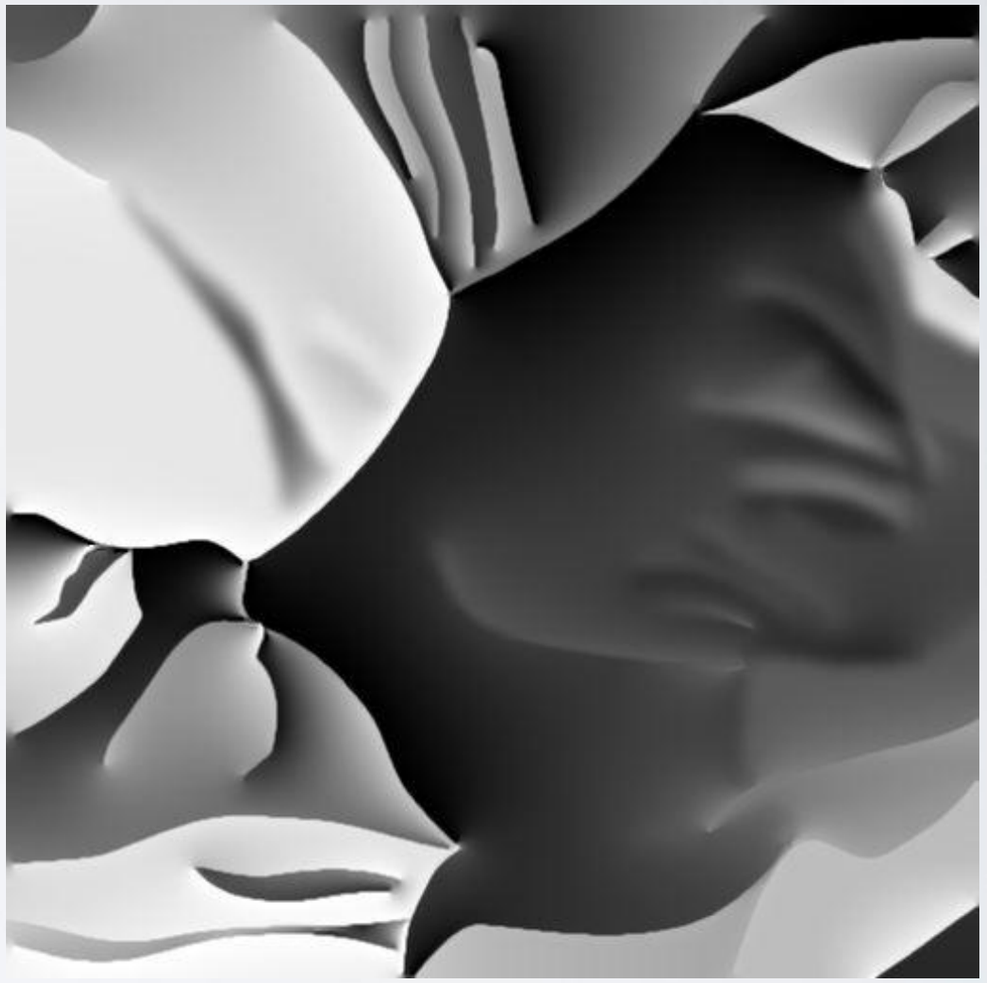


Source: Orzan et al. "Diffusion Curves: A Vector Representation for Smooth-Shaded Images." *ACM Transactions on Graphics (Proceedings of SIGGRAPH 2008)*, 27(2008): 1–8.

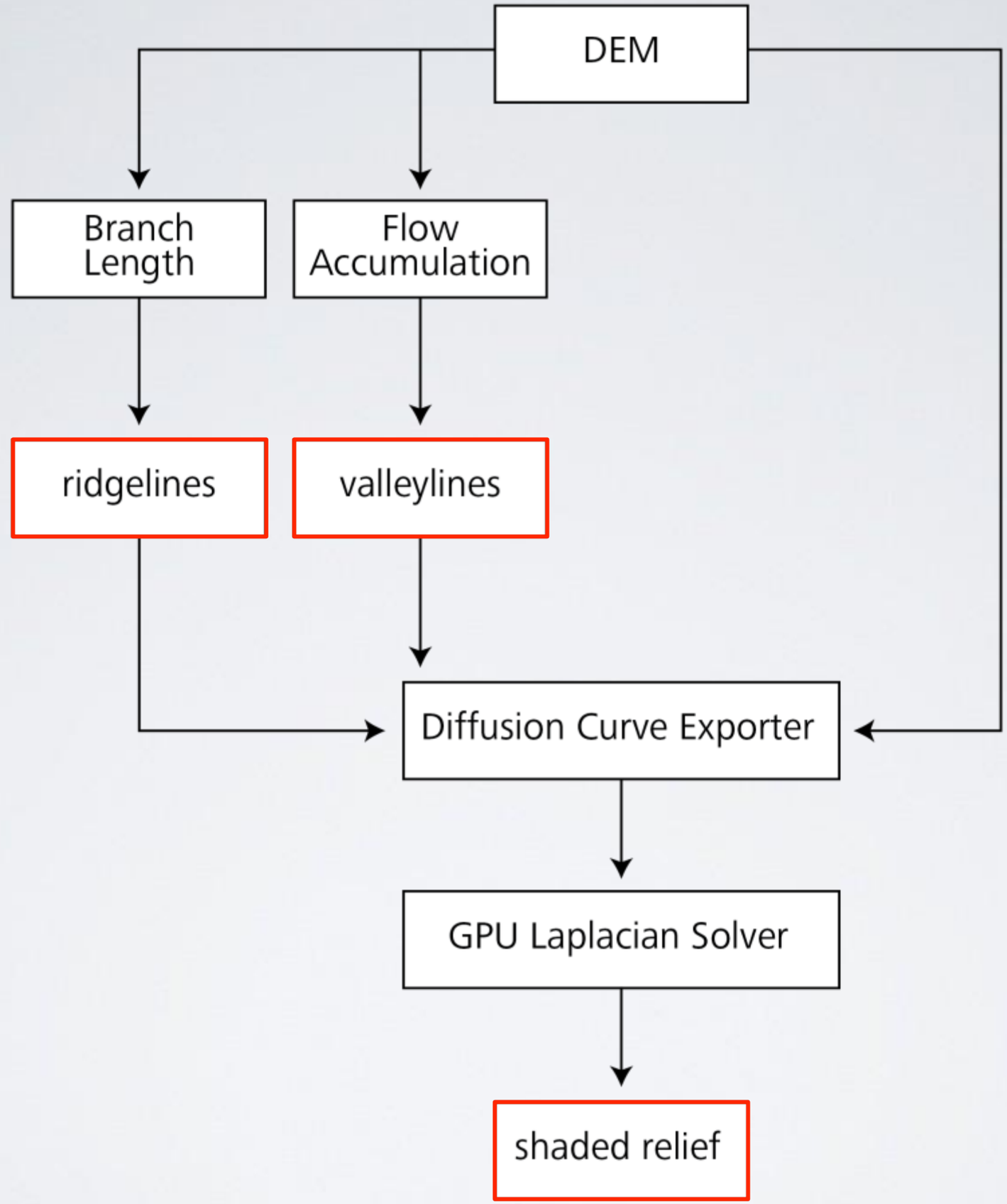
Diffusion Curves

E. Imhof manual relief shading

Reproduction using Diffusion Curves



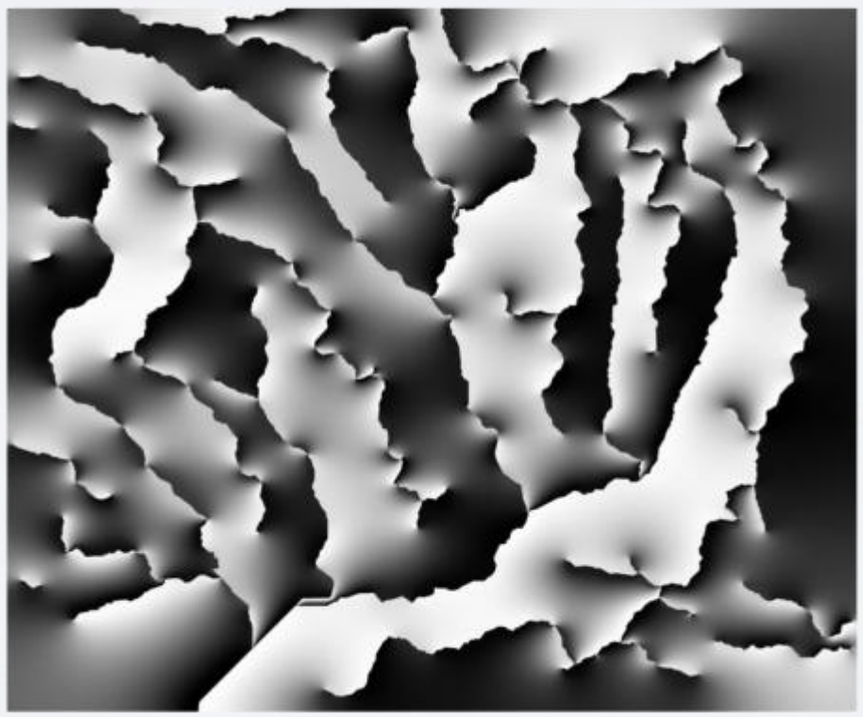
Source: library.ethz.ch (left), B. Marston (right)


DEM
Branch Length
Flow Accumulation
ridgelines
valleylines
Diffusion Curve Exporter
GPU Laplacian Solver
shaded relief

ridgelines

valleylines

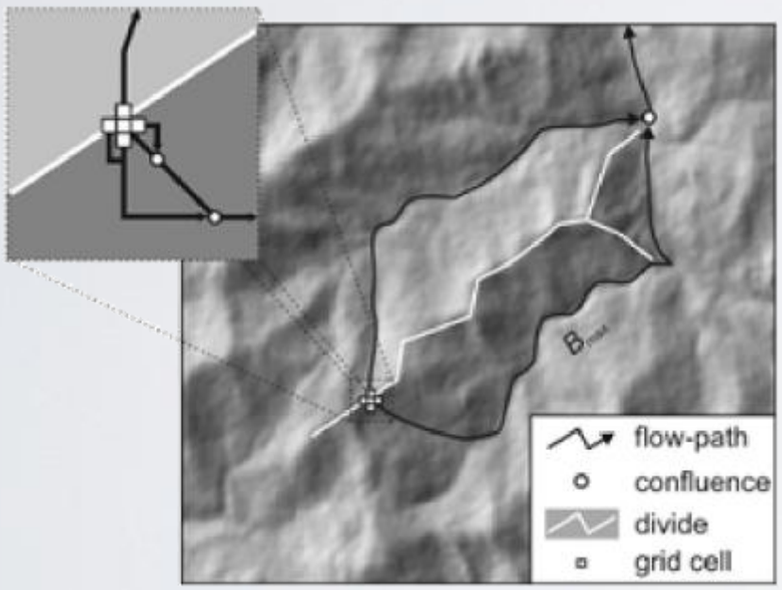
shaded relief

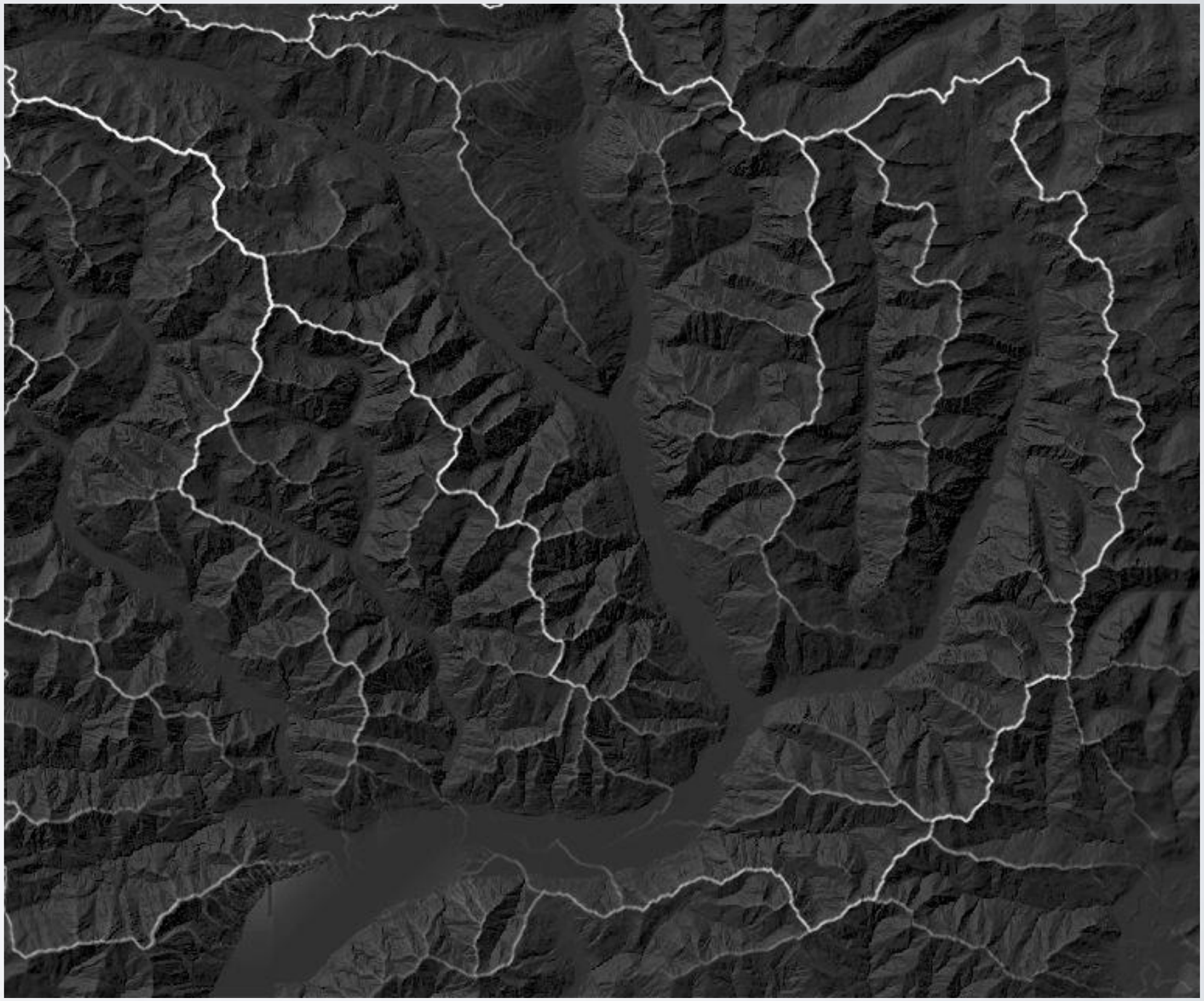


Source: B. Marston

Maximum Branch Length

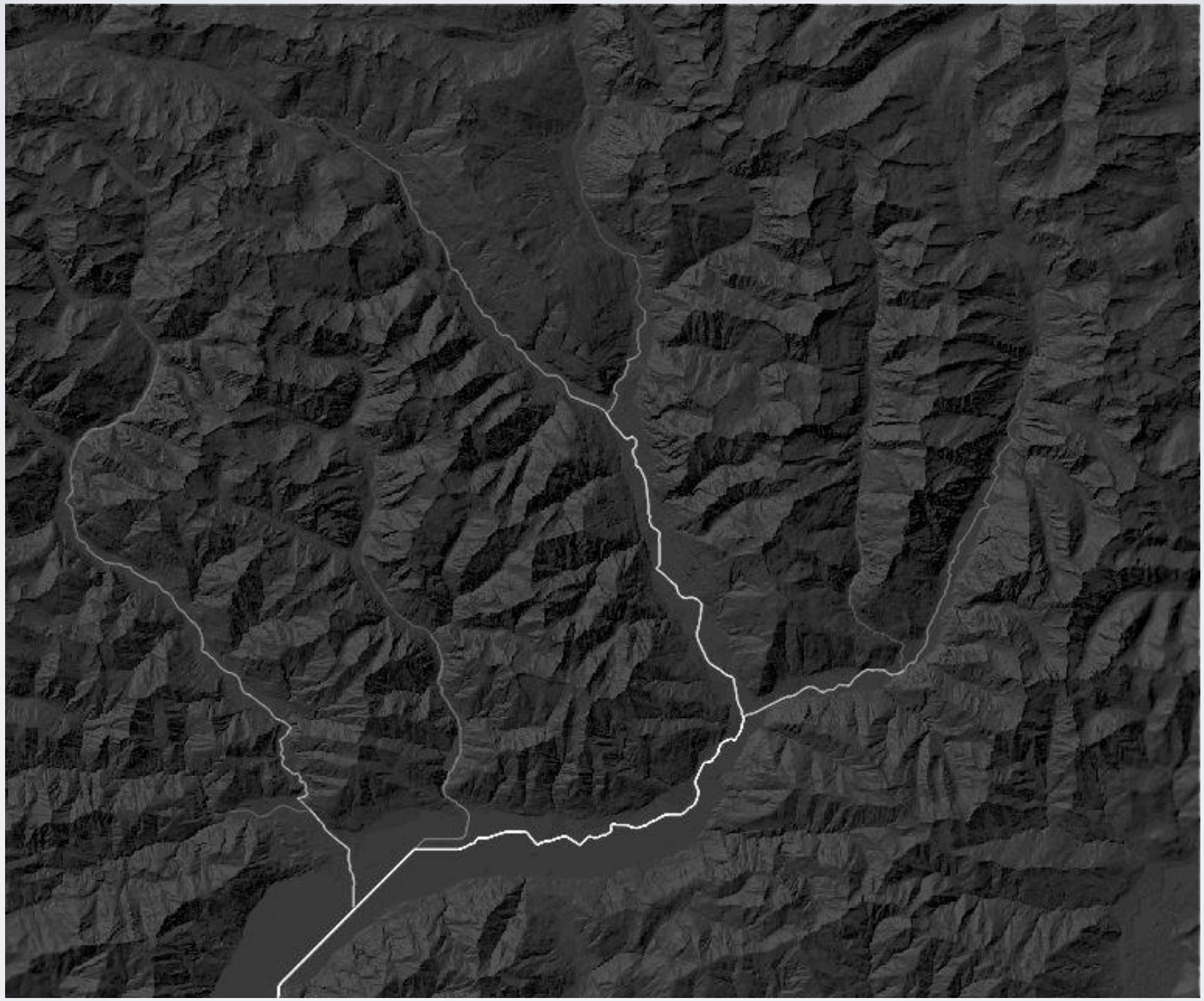
The longest branch length between a grid cell's flowpath and the flowpaths initiated at each of its neighbors





Source: Lindsay, John B. and Jan Seibert. "Measuring the significance of a divide to local drainage patterns." *International Journal of Geographical Information Science* 27, no. 7 (2013): 1453–1468 (image, left); B. Marston (image, right)

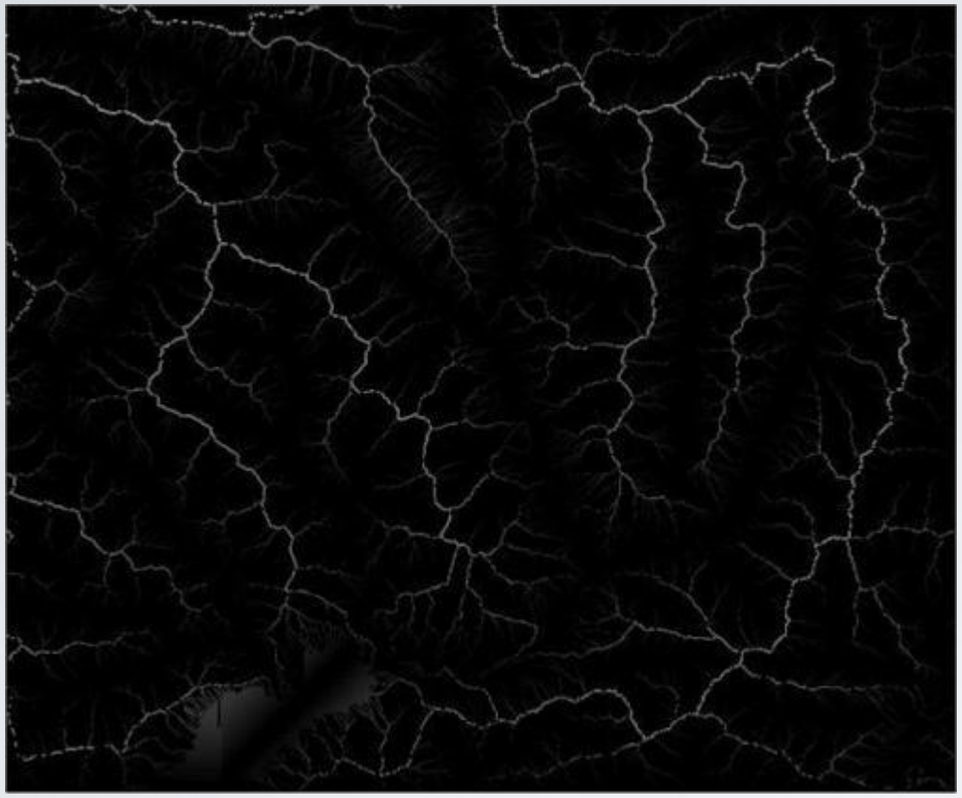
Flow Accumulation



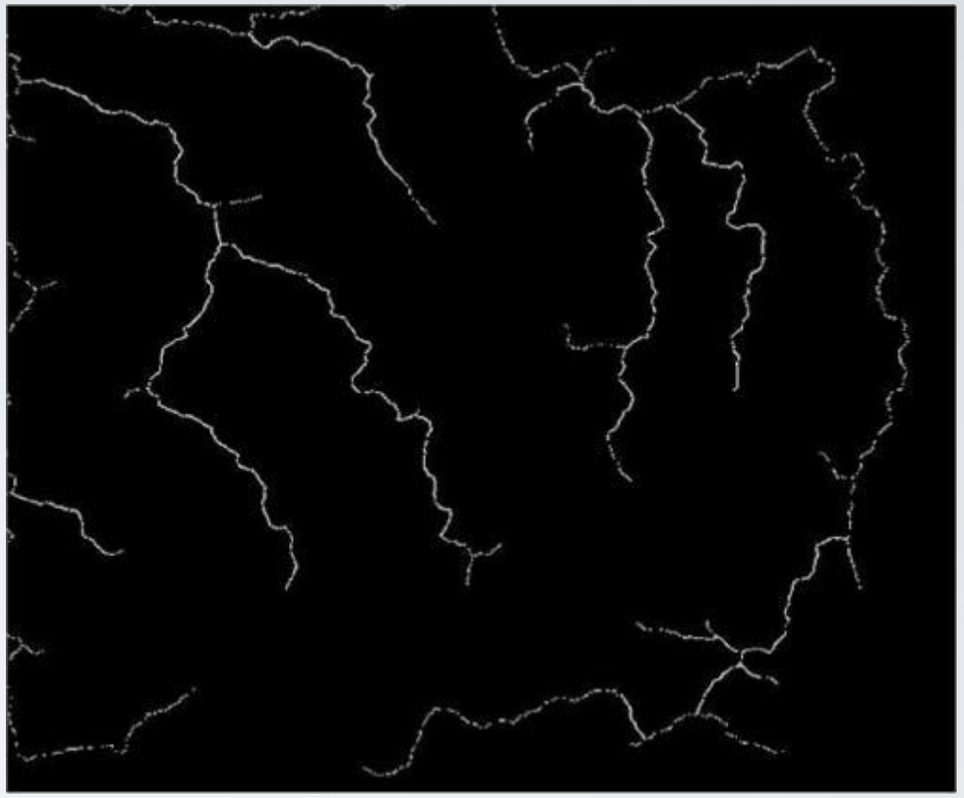
Source: B. Marston

Vectorizing Lines

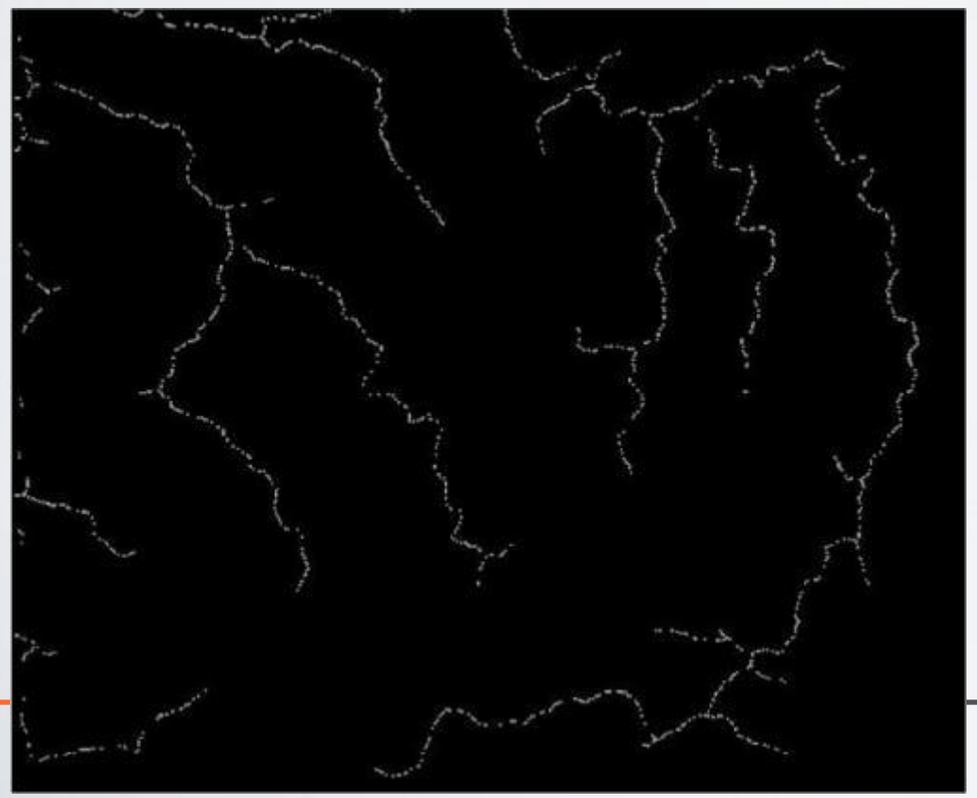
1. Grayscale



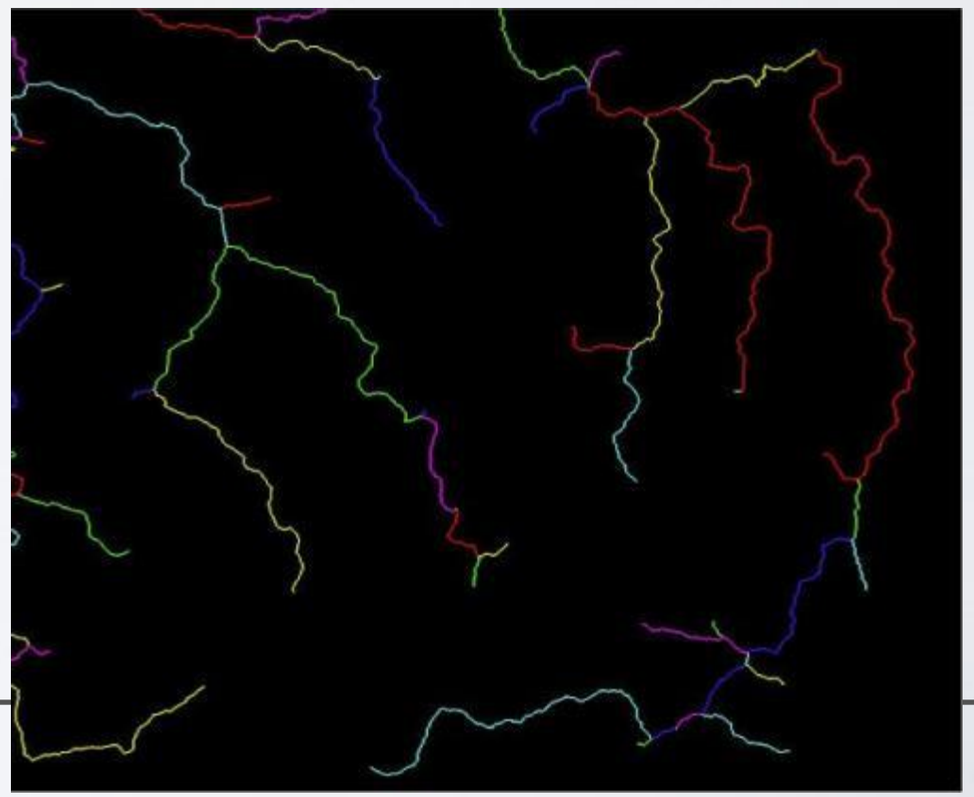
2. Binary



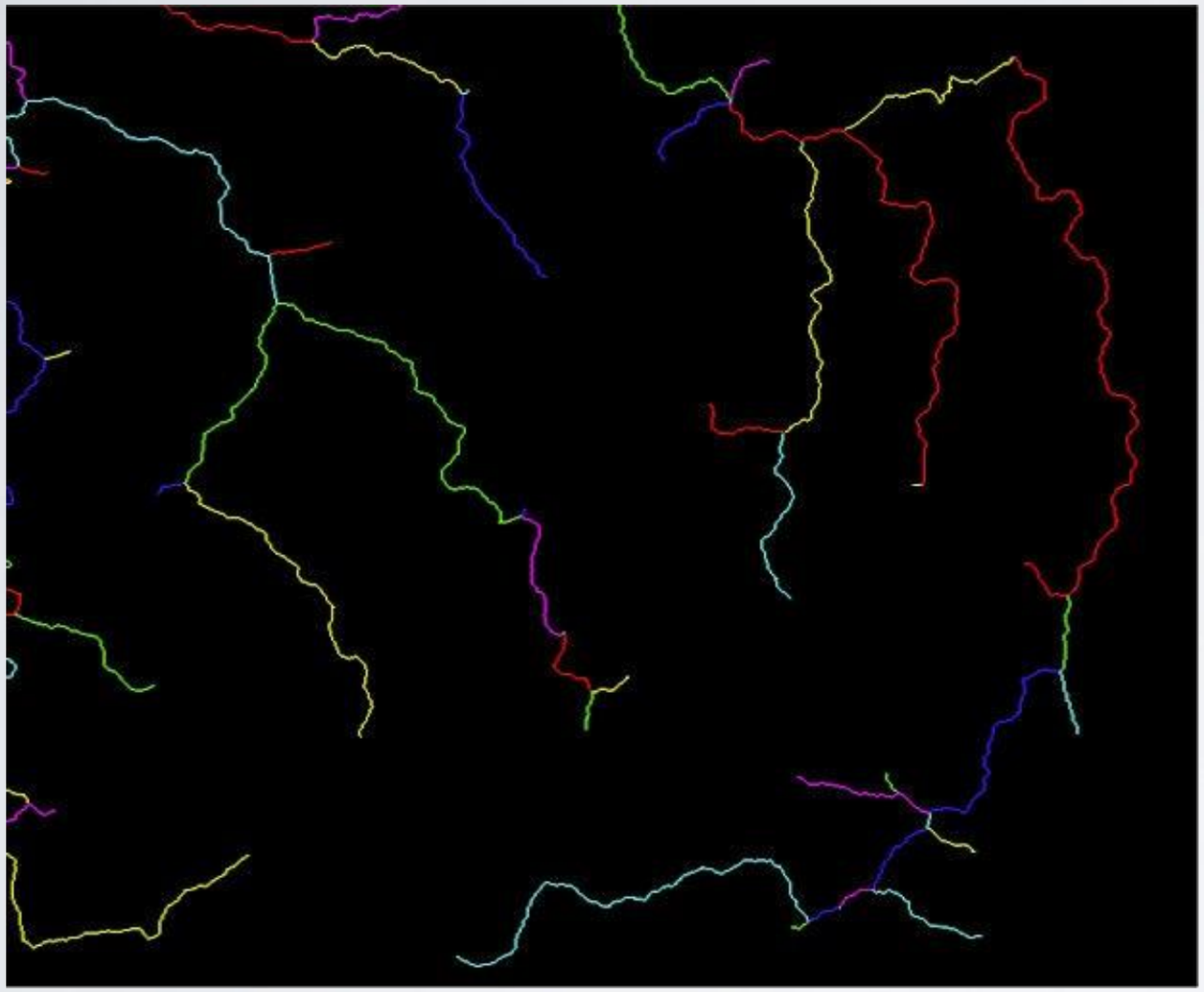
3. Skeletonized



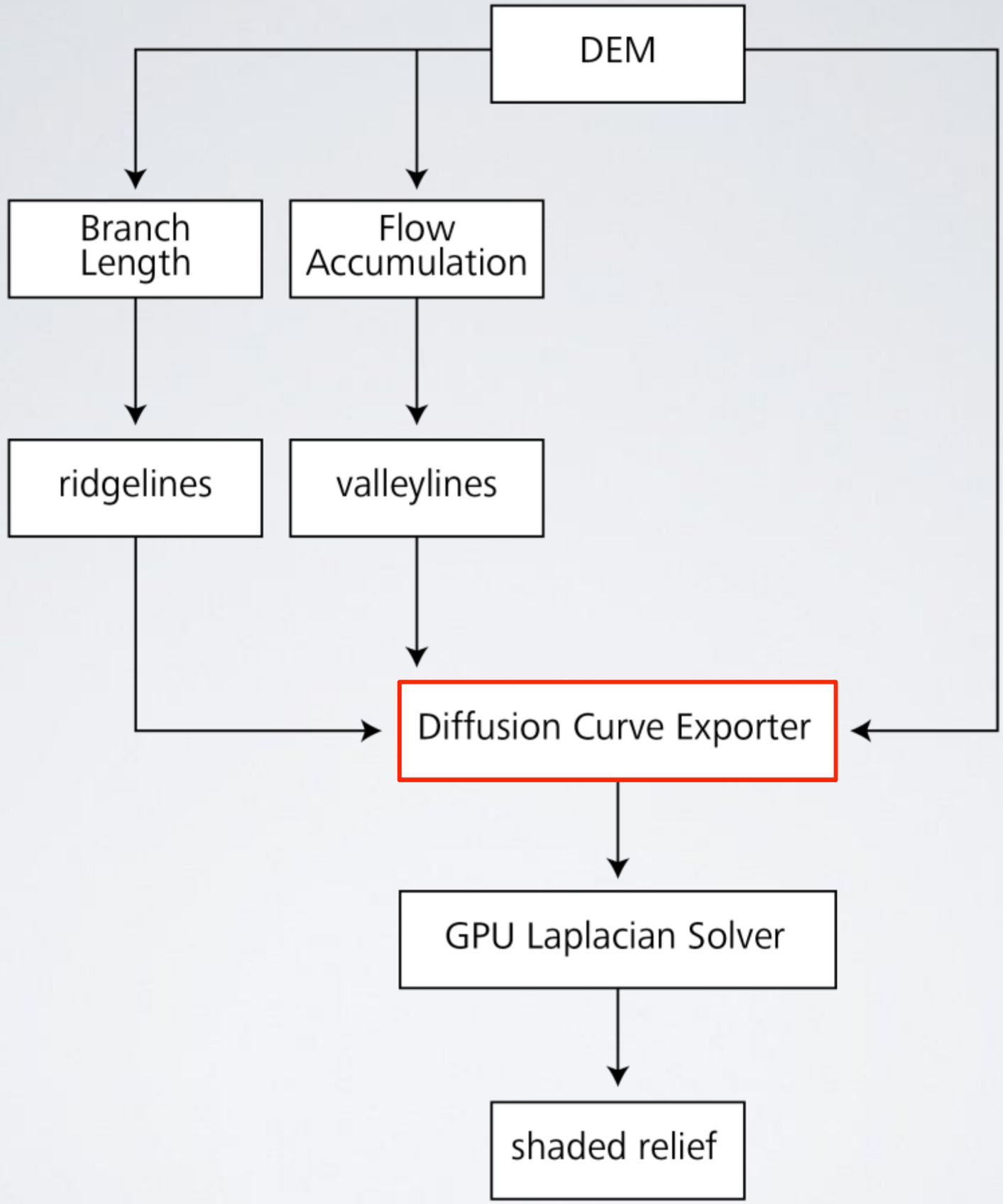
4. Branch Points



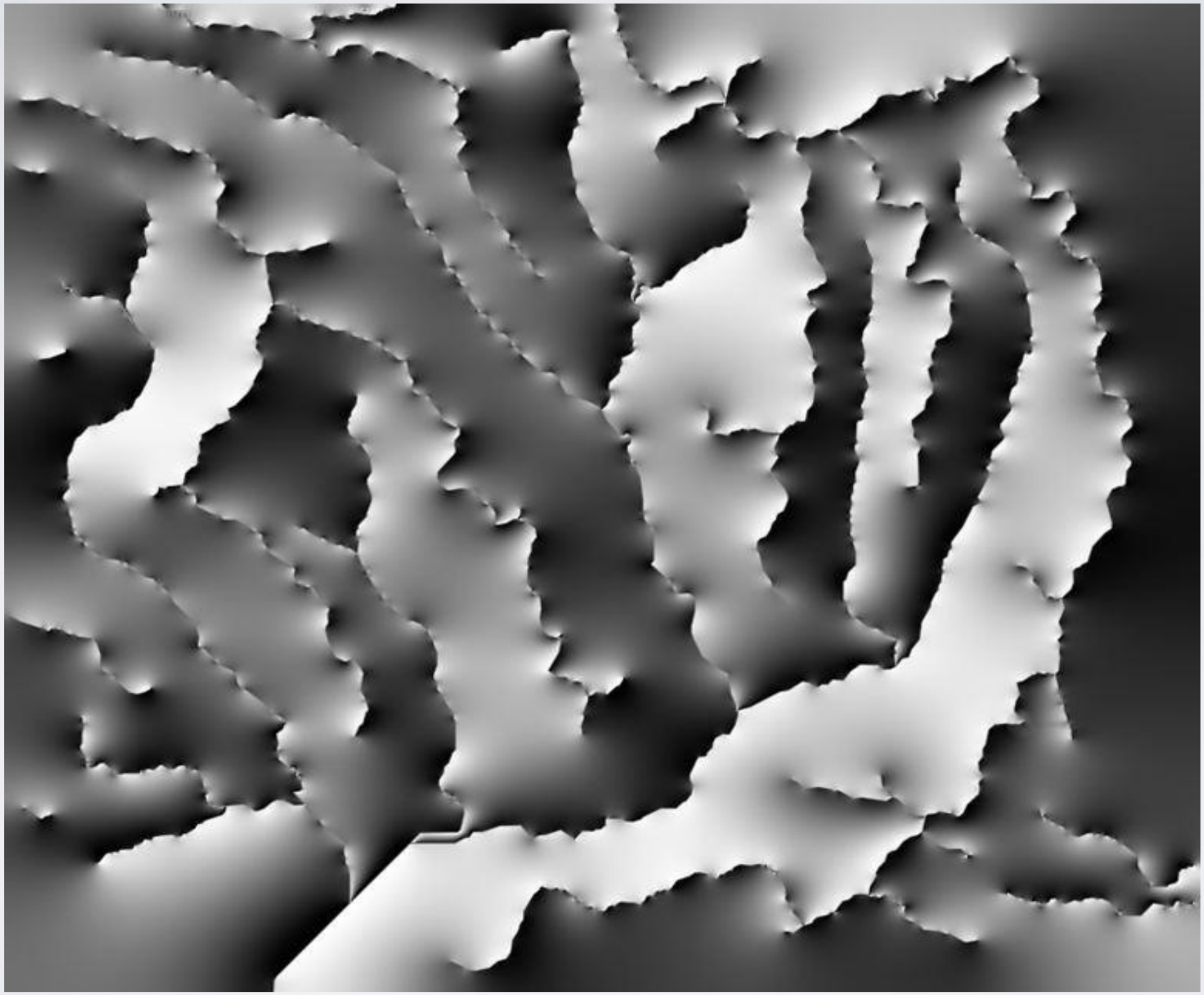
Branch Points



Shapefile

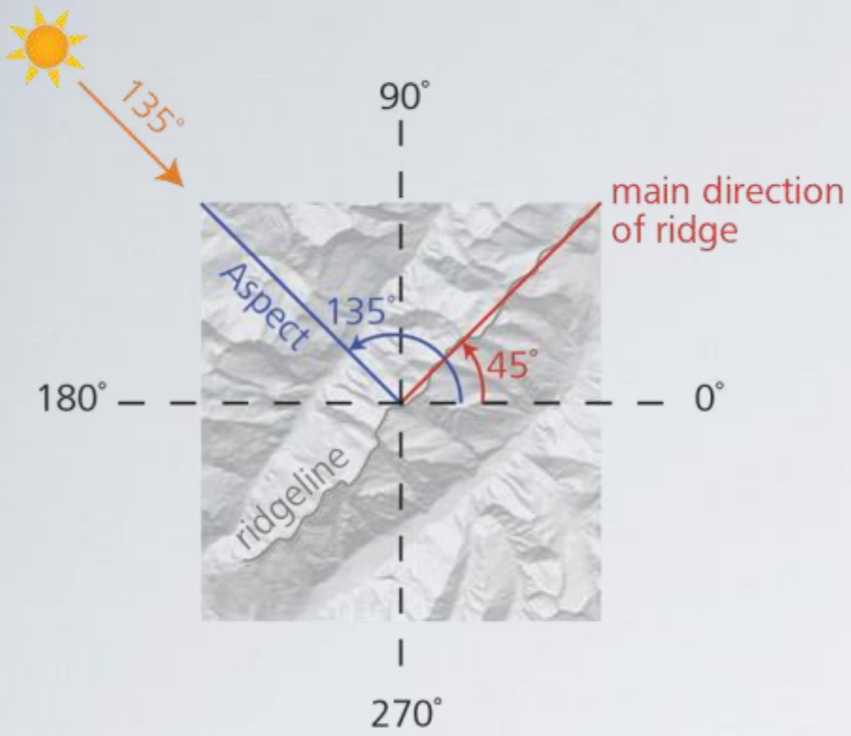

DEM
Branch Length
Flow Accumulation
ridgelines
valleylines
Diffusion Curve Exporter
GPU Laplacian Solver
shaded relief

Initial Output

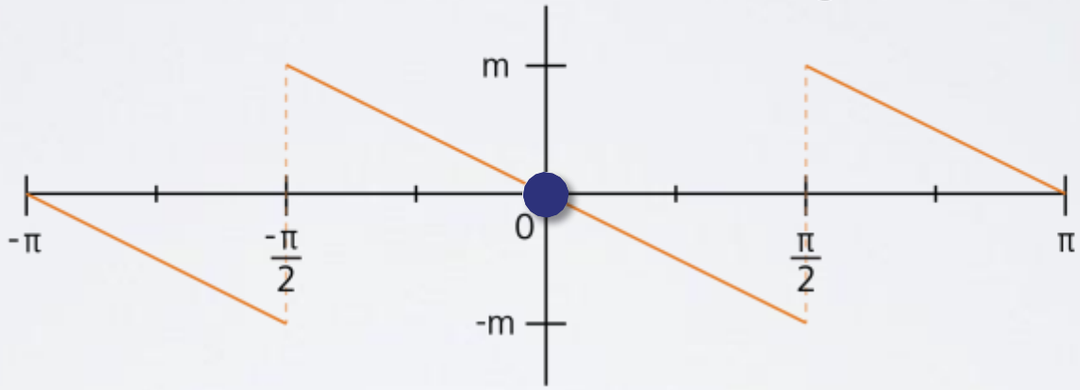


Source: B. Marston

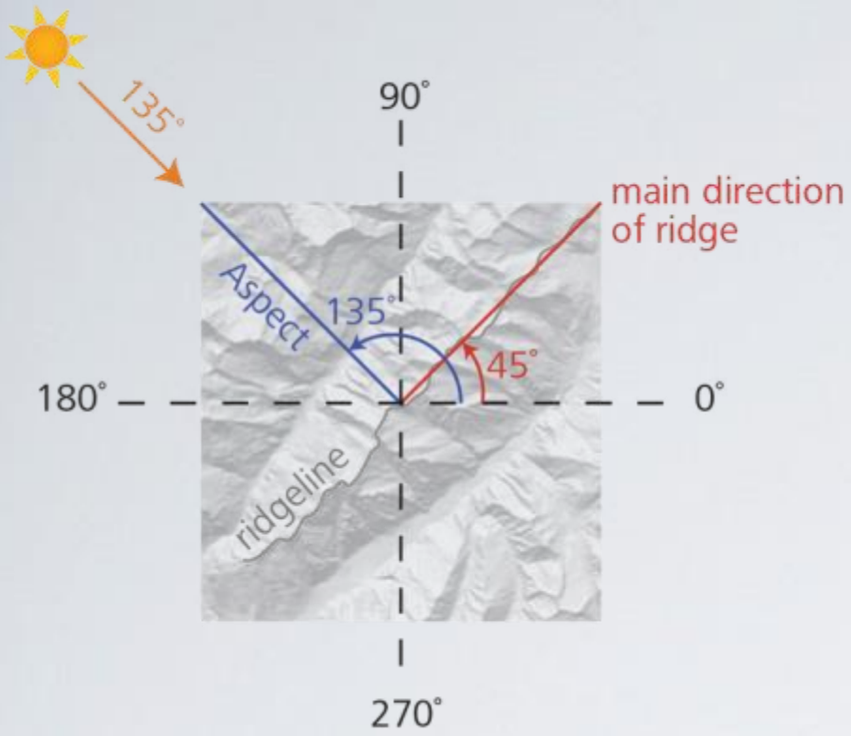
Adjusting Illumination

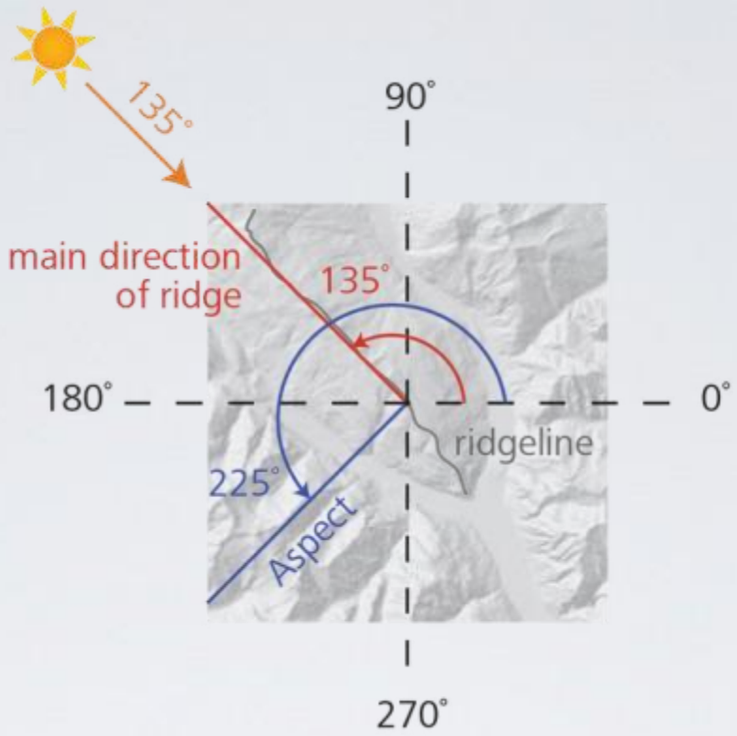


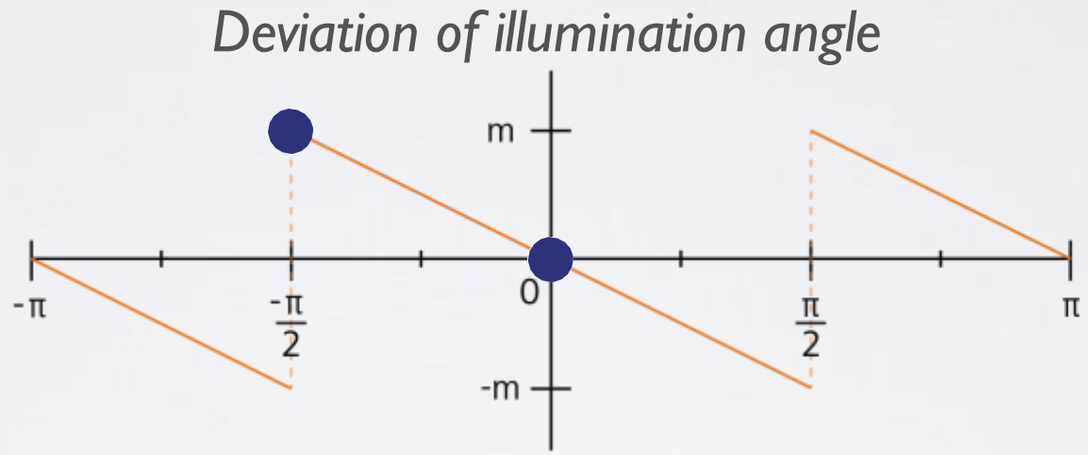
Deviation of illumination angle



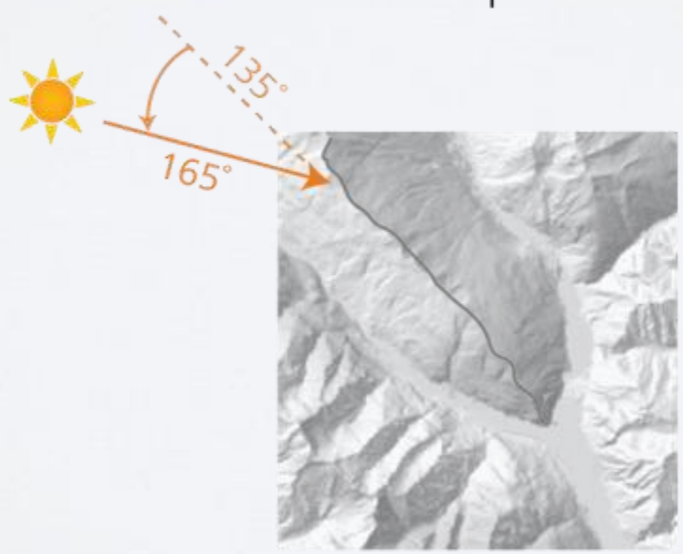
Illumination - aspect

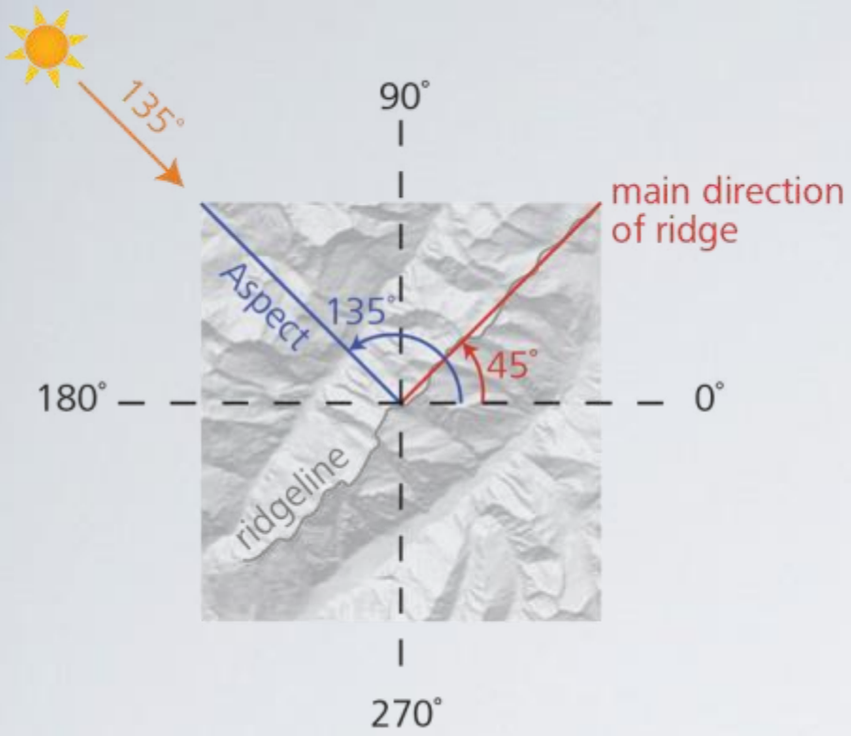


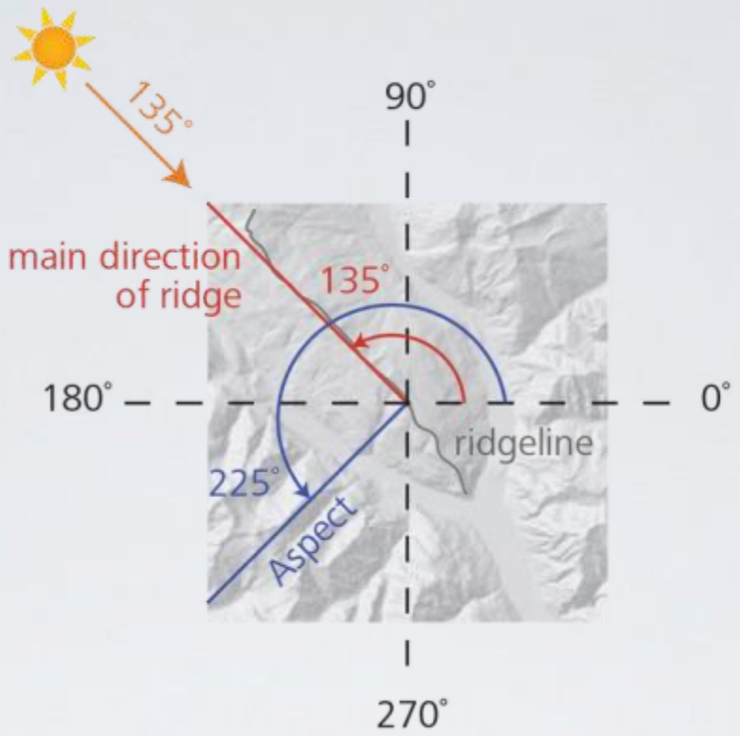


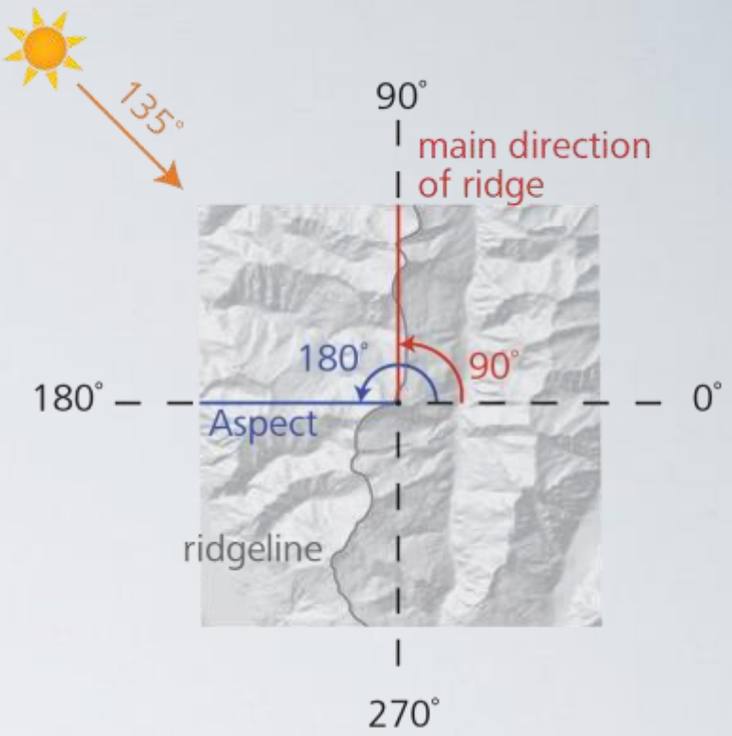


Illumination - aspect

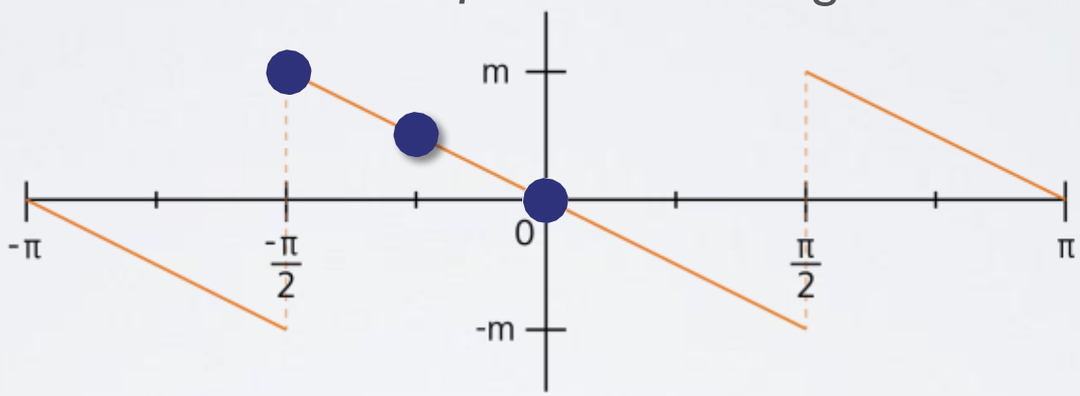




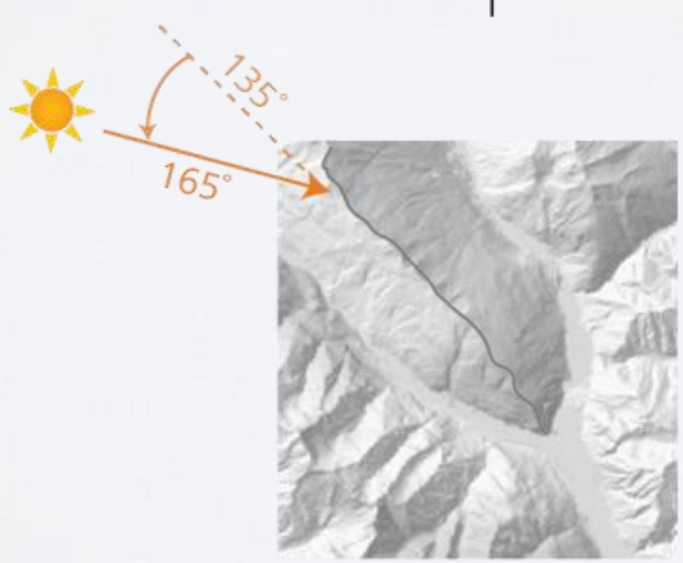


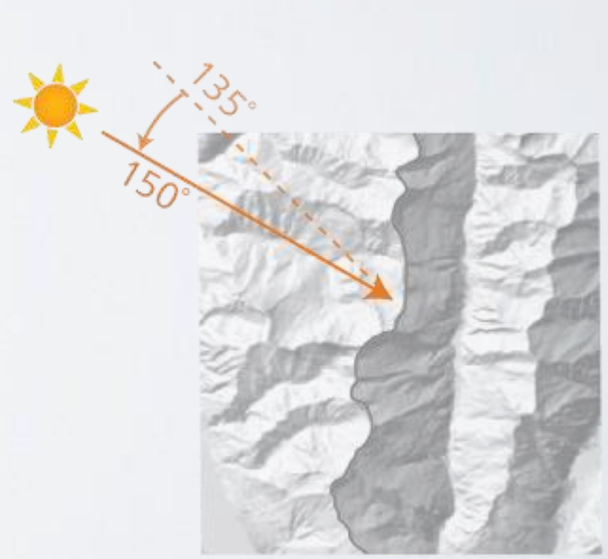


Deviation of illumination angle



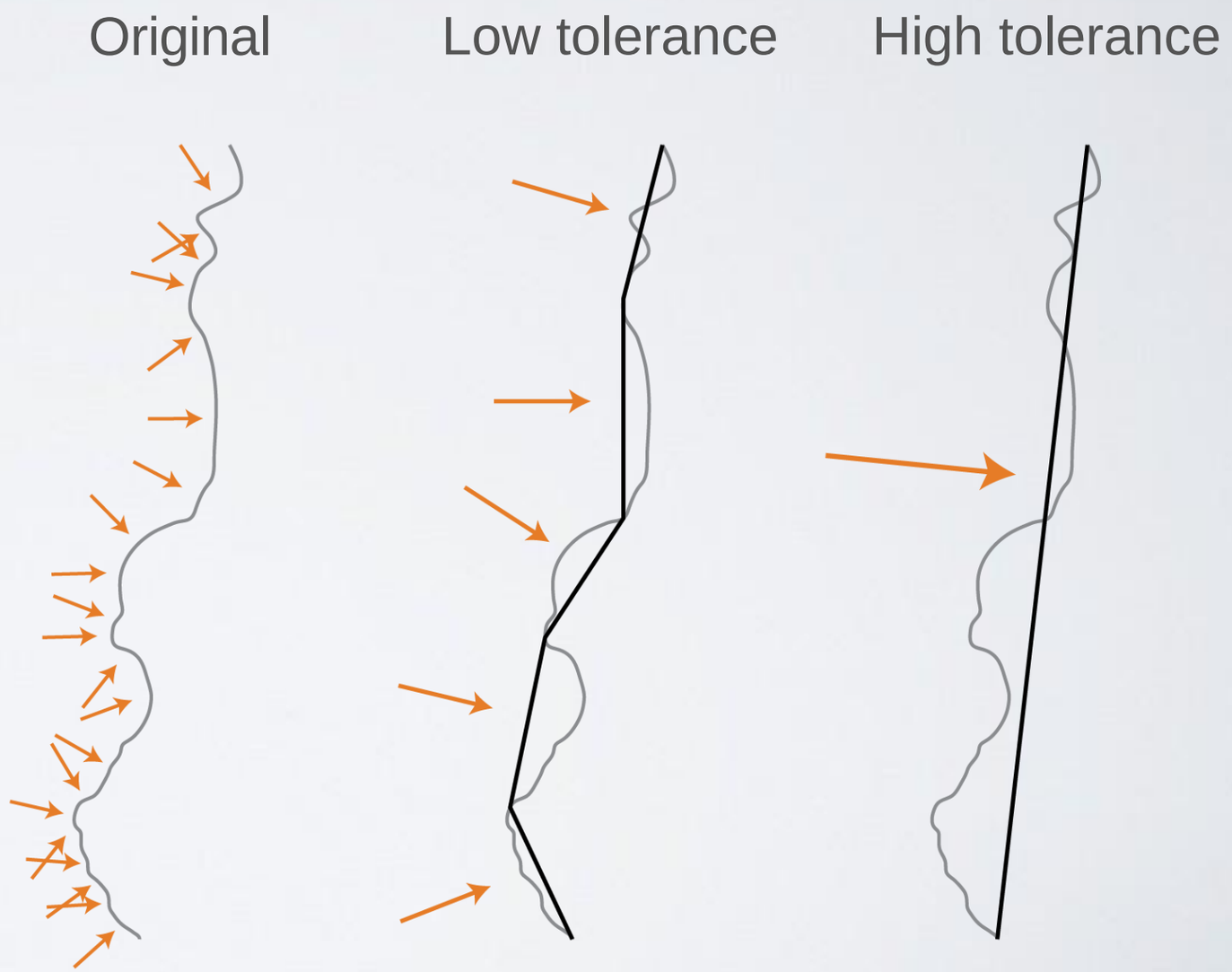
Illumination - aspect





Douglas-Peucker Simplification for Adjusting the Variability of Illumination

Aspect for Adjusting the Illumination Direction



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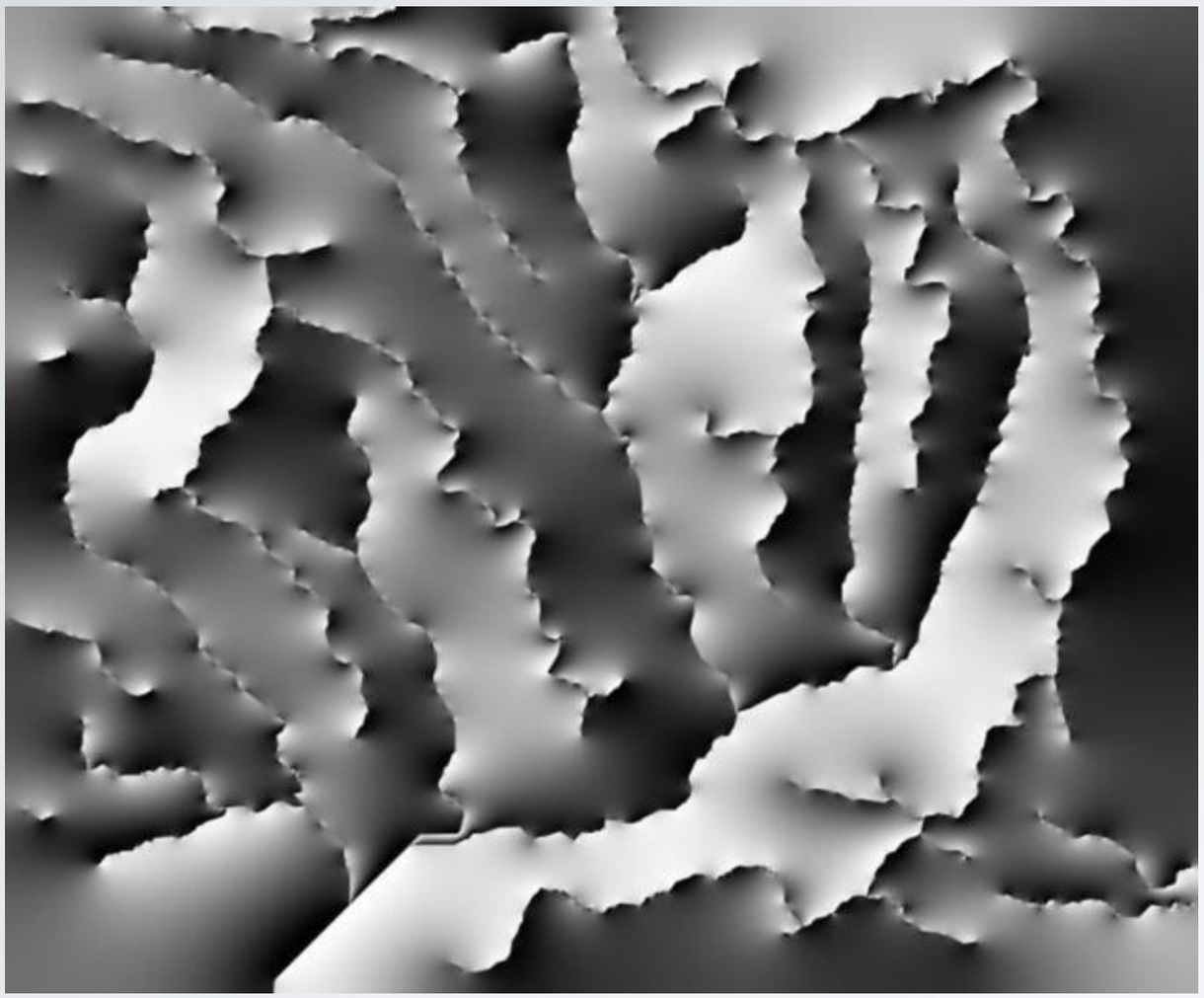
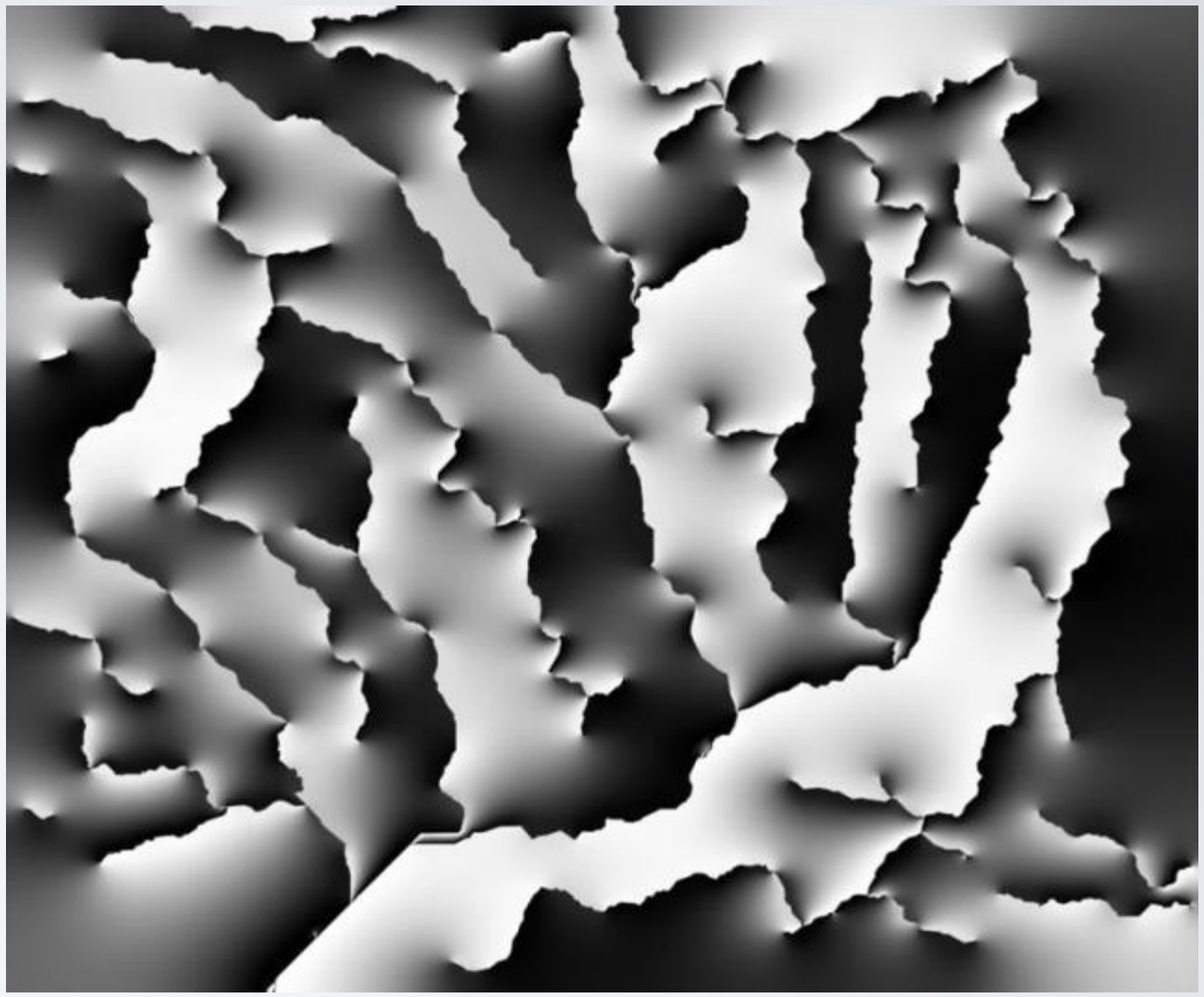
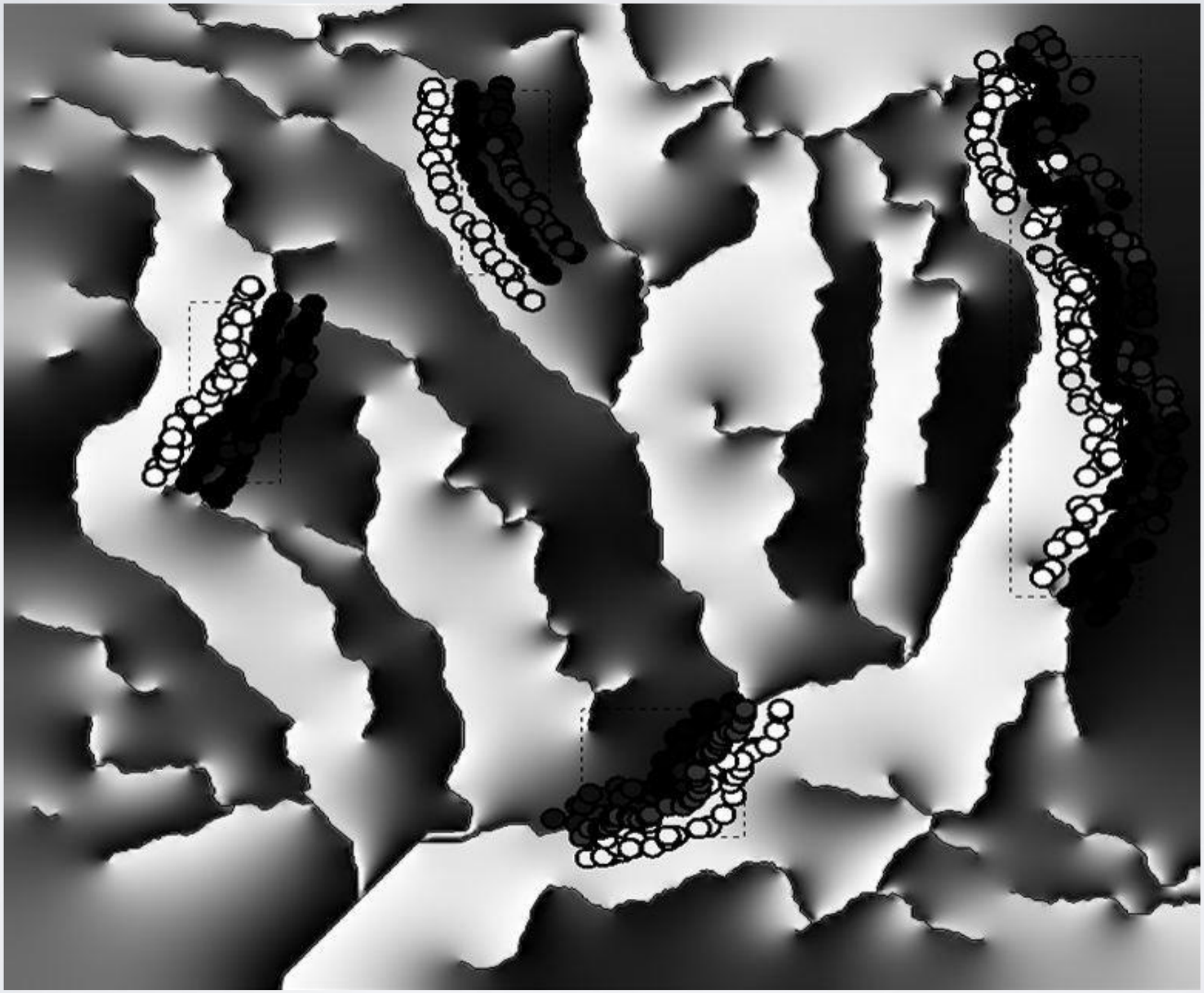


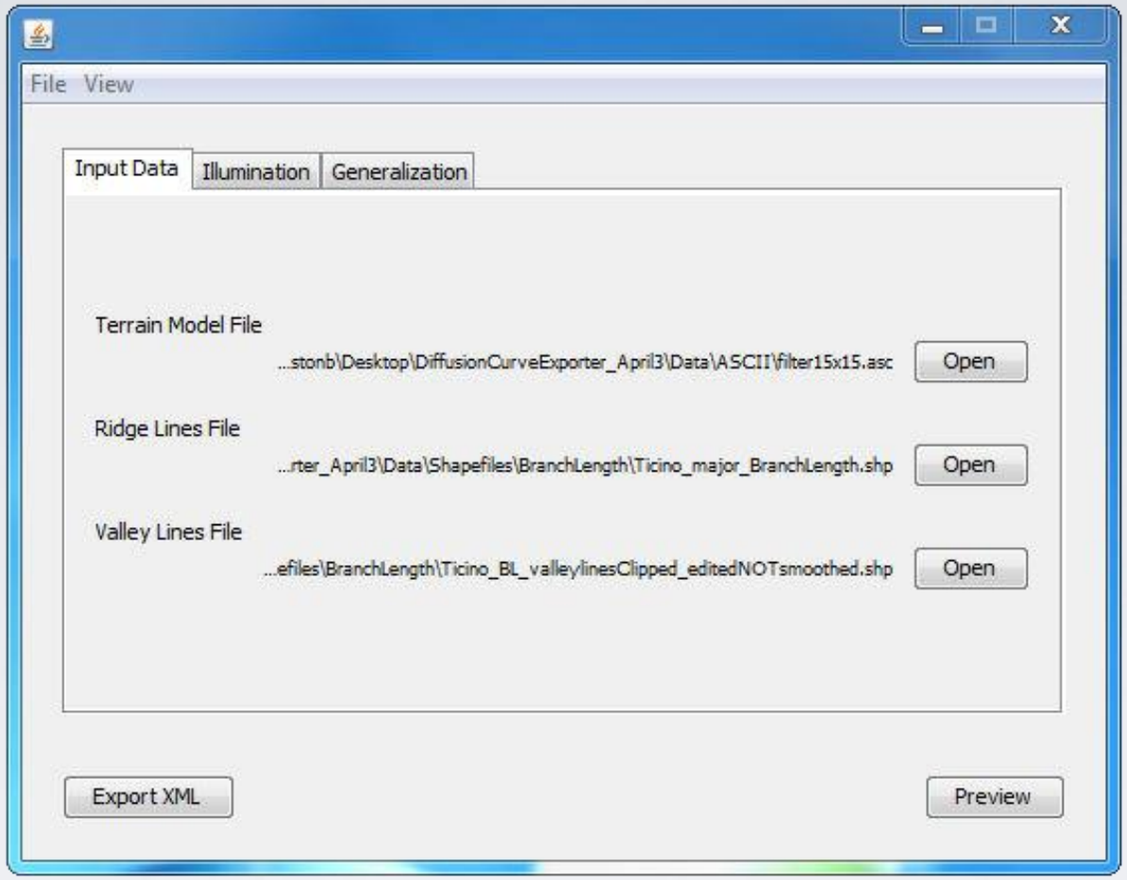
After

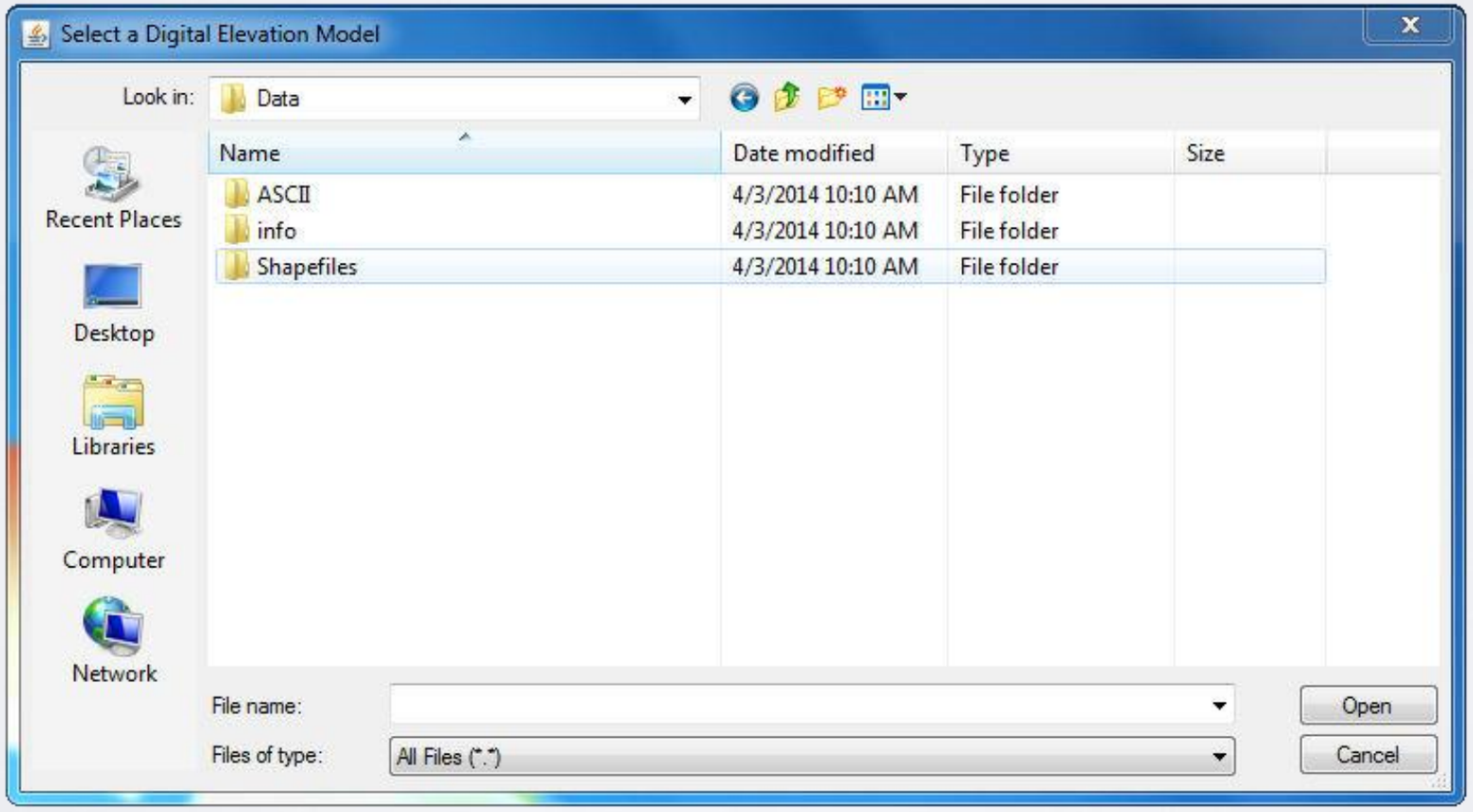


Diffusion Curves Shading



Graphical User Interface


File View
Input Data
Illumination
Generalization
Terrain Model File
...stonb\Desktop\DiffusionCurveExporter_April3\Data\ASCII\filter15x15.asc
Open
Ridge Lines File
...rter_April3\Data\Shapefiles\BranchLength\Ticino_major_BranchLength.shp
Open
Valley Lines File
...efiles\BranchLength\Ticino_BL_valleylinesClipped_editedNOTsmoothed.shp
Open
Export XML
Preview


Select a Digital Elevation Model
Look in:
Data
Recent Places
Desktop
Libraries
Computer
Network
Name
Date modified
Type
Size
ASCII
4/3/2014 10:10 AM
File folder
info
4/3/2014 10:10 AM
File folder
Shapefiles
4/3/2014 10:10 AM
File folder
File name:
Files of type:
All Files (*.*)
Open
Cancel

File View

Input Data | Illumination | Generalization

Horizontal Angle

0 45 90 135 180 225 270 315 360

Maximum Deviation

0 30 60 90

Horizontal Angle Adjustment

- (•) Marston & Jenny
- ( ) Veronesi & Hurni

Details 500

Tolerance value for Douglas-Peucker line simplification.

Export XML | Preview

File View

Input Data | Illumination | Generalization

Ridge Lines Simplification 15

Valley Lines Simplification 15

Tolerance values for Douglas-Peucker line simplification.

Minimum Mean Branch Length 10

Increase to filter less important ridge lines.

Export XML | Preview

Results

Analytical

Marston & Jenny

Source: B. Marston & B. Jenny

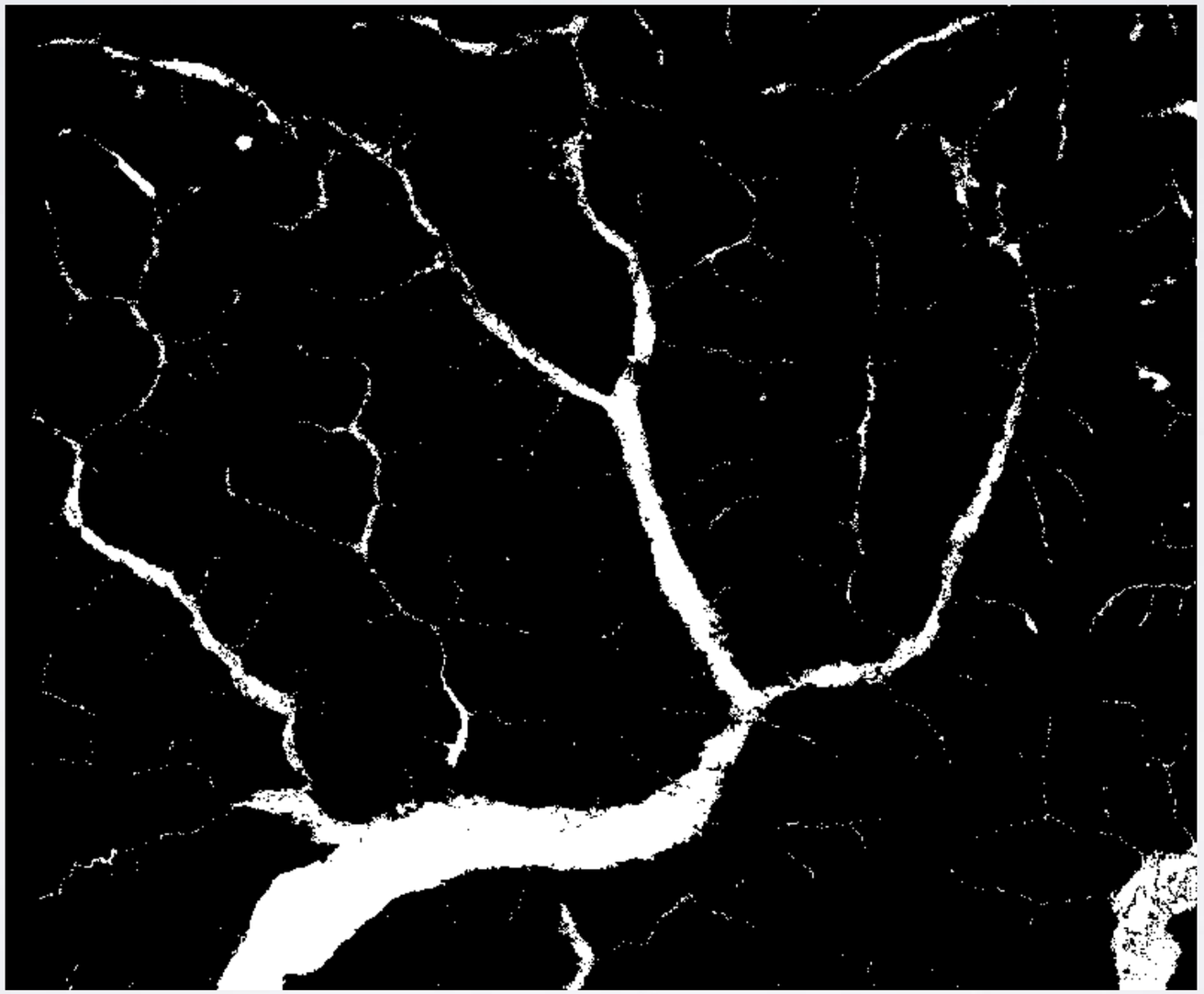
Manual

Marston & Jenny

Source: reliefshading.com (left), B. Marston & B. Jenny (right)

Future Work

- Improve valley floor extraction



Source: B. Marston

Future Work

- Network analysis
- Adjust illumination and detail according to scale
- Incorporate hypsometric tinting

Acknowledgments

- Dr. Bernhard Jenny, Oregon State University
- Tom Patterson, National Park Service
- Johannes Liem, Oregon State University
- ICA Commission on Mountain Cartography
- AAG Cartography Specialty Group
- Phi Beta Kappa

Oregon State University OSU

CARTOGRAPHY & GEOVISUALIZATION GROUP

Thank you

Questions?

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