Medial axis transform

GEO1004:
3D modelling of the built environment

https://3d.bk.tudelft.nl/courses/geo1004

3D geoinformation
Department of Urbanism
Faculty of Architecture and the Built Environment
Delft University of Technology

Midterm exam info

- Wednesday (May 21), 13:45-14:45 (1 hour), 6 open questions
- Lessons 1.2 - 4.2, equivalent to Chapters 1-4 and 9-10
- Open book, open laptop
- Not allowed to communicate with others, no phone

- https://3d.bk.tudelft.nl/courses/geo1004/midterm/

Homework 1 feedback

- Very good work overall
- Common issues:
  - incorrect face orientations (normals)
  - sometimes limited testing: different tiles, different LoDs, different expansion thresholds, etc.
  - limited analysis: no metrics, missed limitations of method (overlapping blocks, orientation inconsistencies, etc).

Homework 1 marking

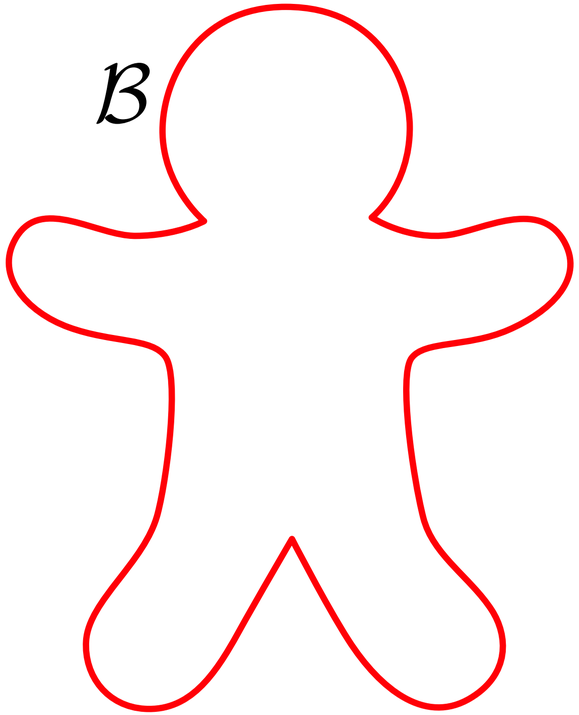
- Code working - 2 points
- Code produces simplified blocks for tile 10-282-562 with no obvious issues - 4 points
- High-quality report with description of method with validation performed - 4 points

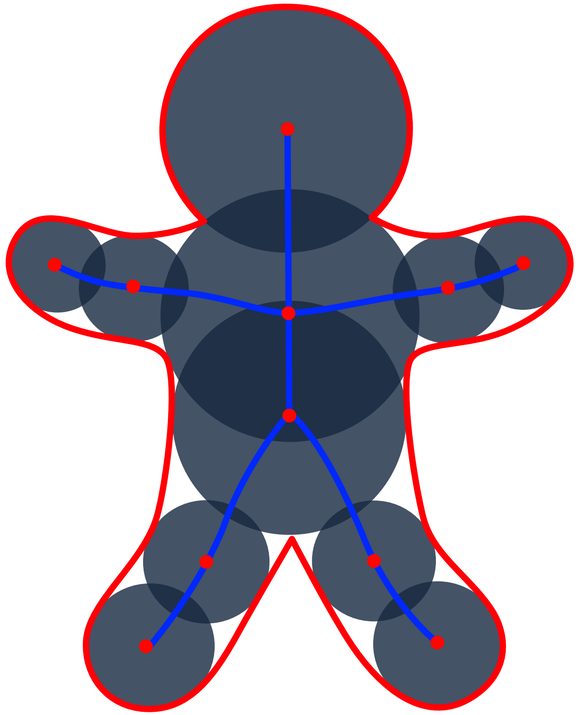
- Questions about your mark? ask me

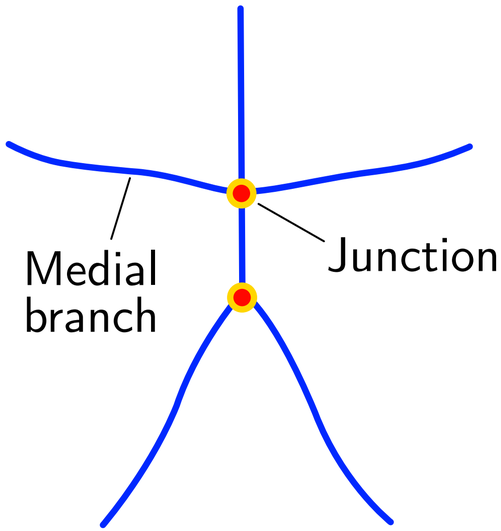
My solution

Medial axis transform (MAT)

What is the MAT?



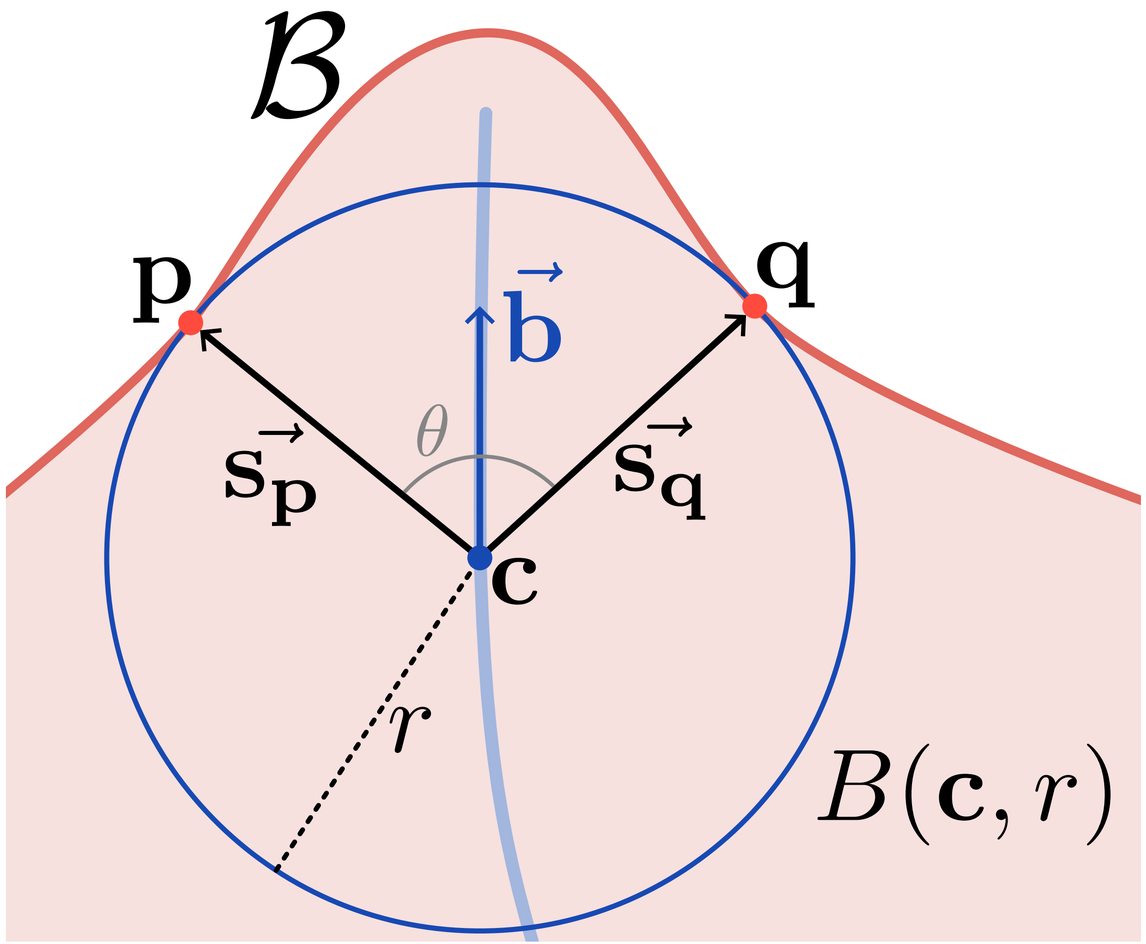




Why?

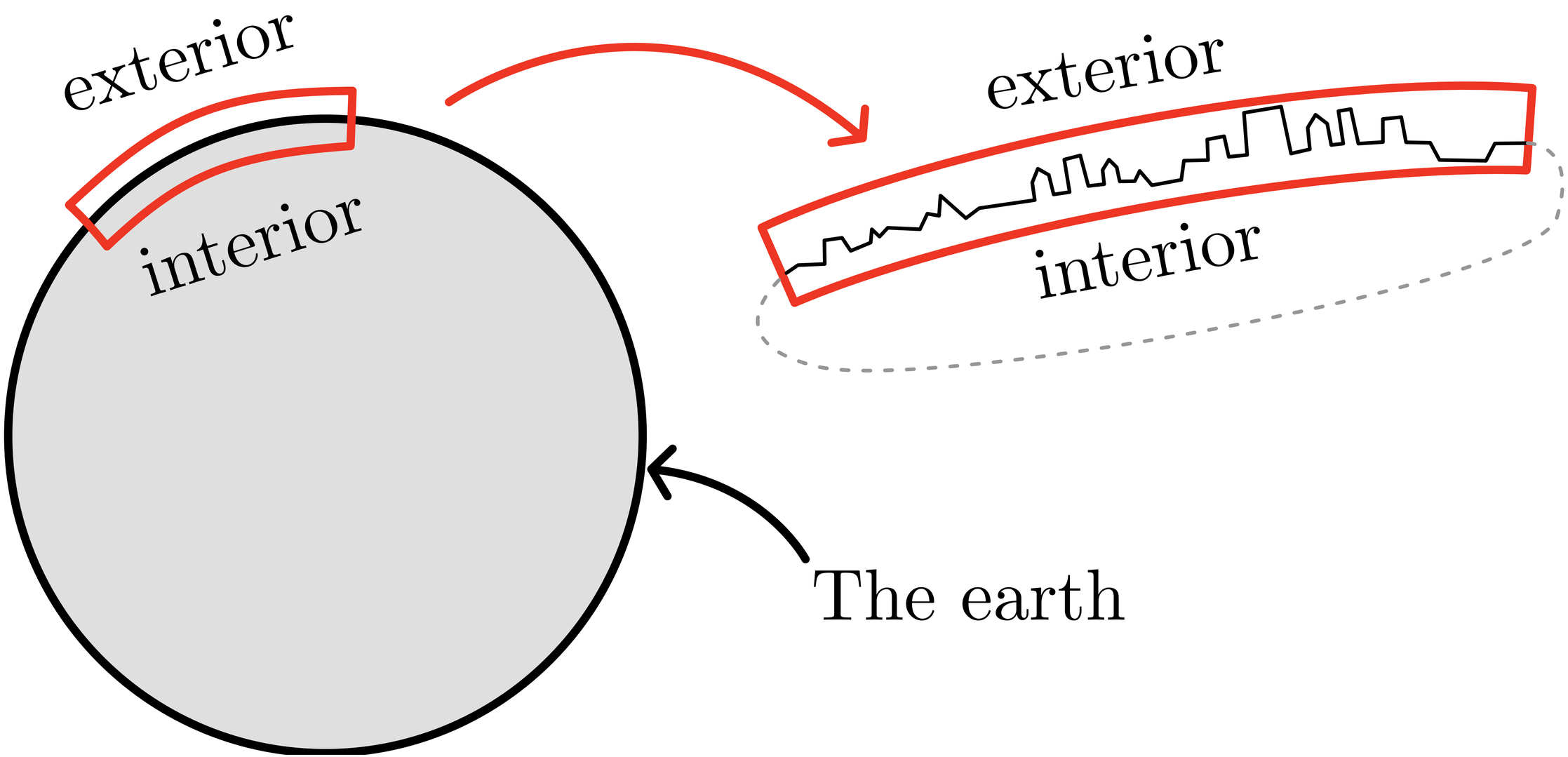
- More natural representation for some questions: branches, thickness, length, etc.
  - In BK: how many hallways? how wide? how long?
- Data processing method:
  - Dimensionality reduction (like b-rep): from areas to lines, from volumes to areas
  - Extraction of features, segmentation, noise removal, etc.

MAT (parts)

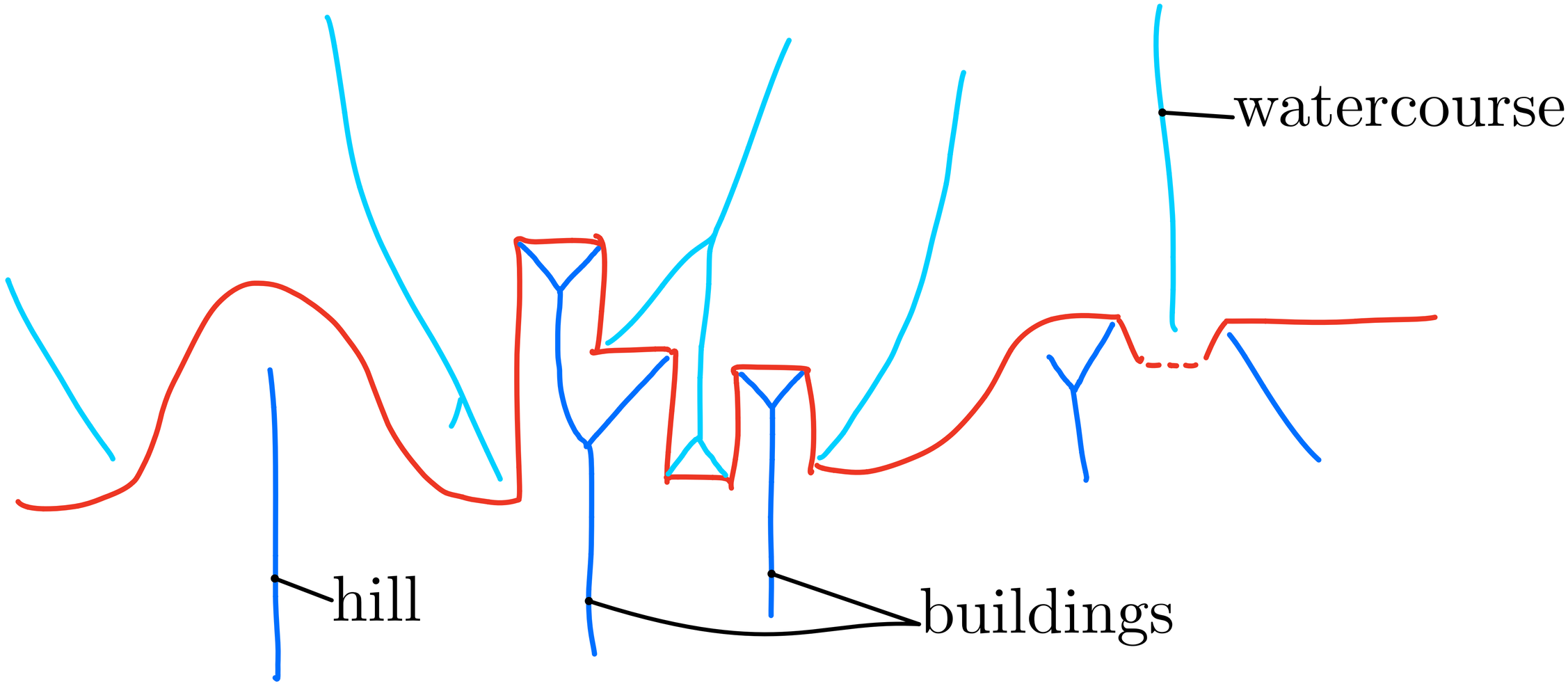


Symbol	Description
$B(\mathbf{c}, r)$	medial ball
$\mathbf{c}$	medial atom
r	radius
$\mathbf{p}, \mathbf{q}$	feature points
$\vec{\mathbf{s}}_\mathbf{p}, \vec{\mathbf{s}}_\mathbf{q}$	spoke vectors
θ	separation angle
$\vec{\mathbf{b}}$	medial bisector

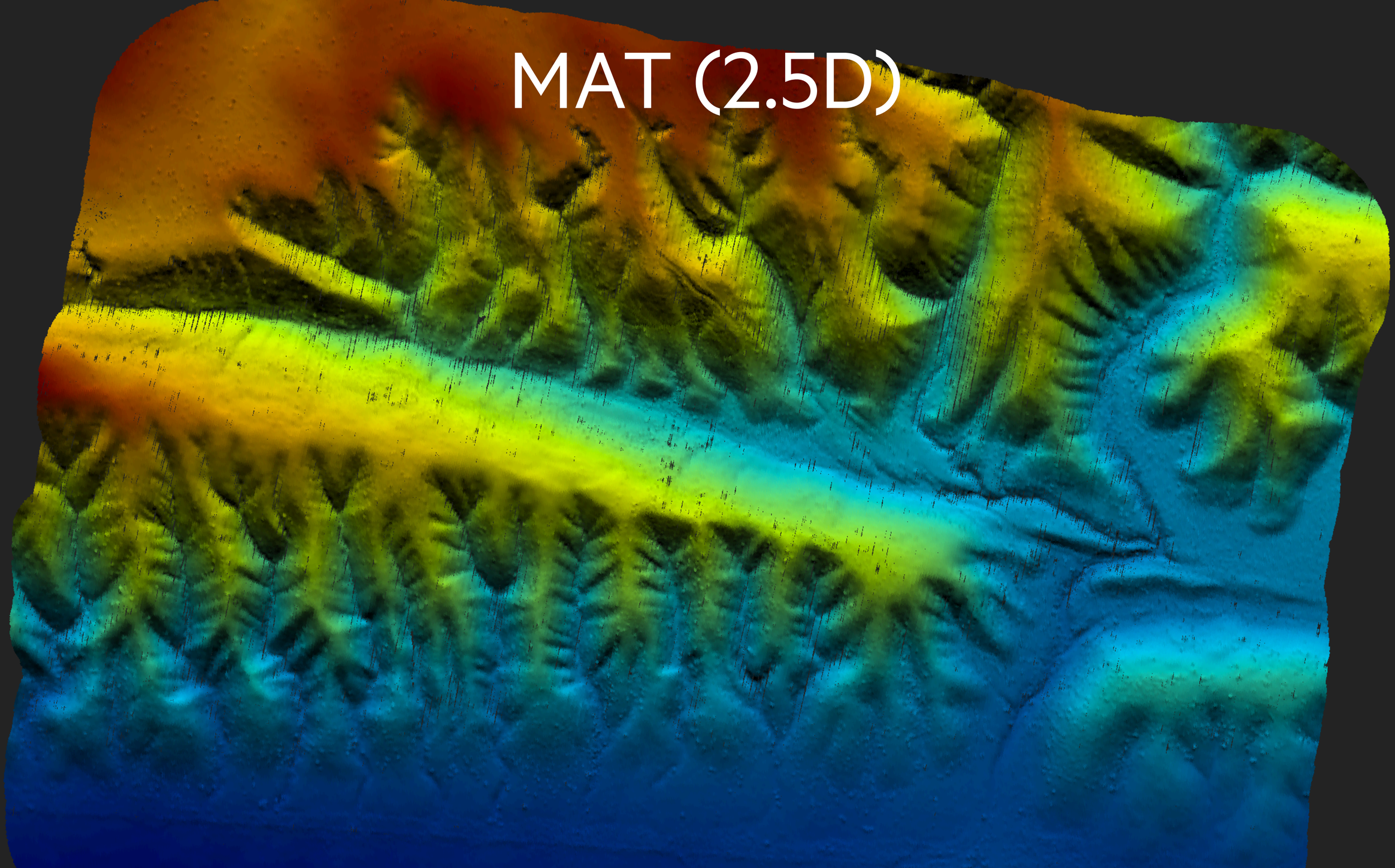
MAT (vertical section / 2.5D)



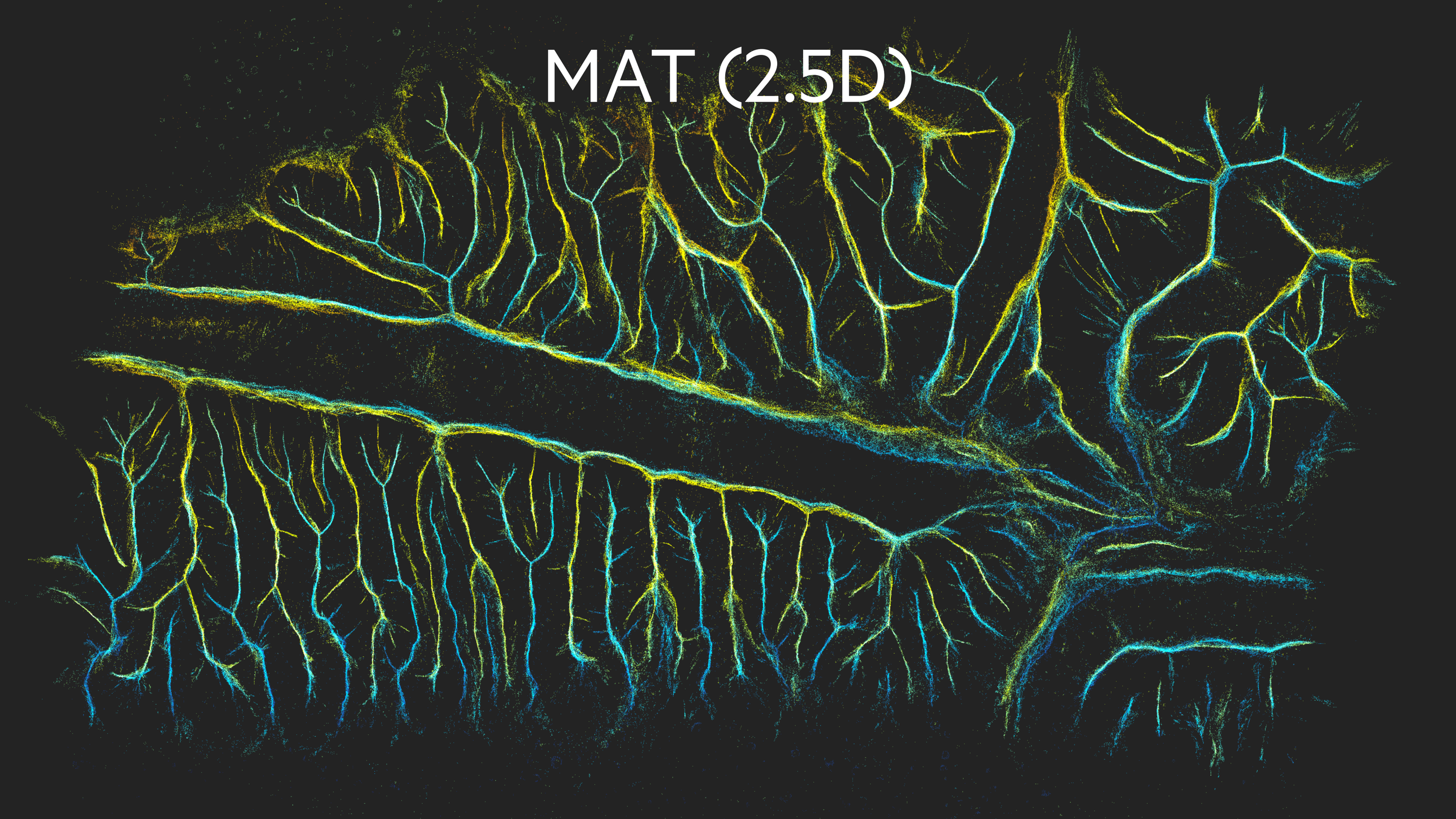
MAT (vertical section / 2.5D)



MAT (2.5D)



MAT (2.5D)



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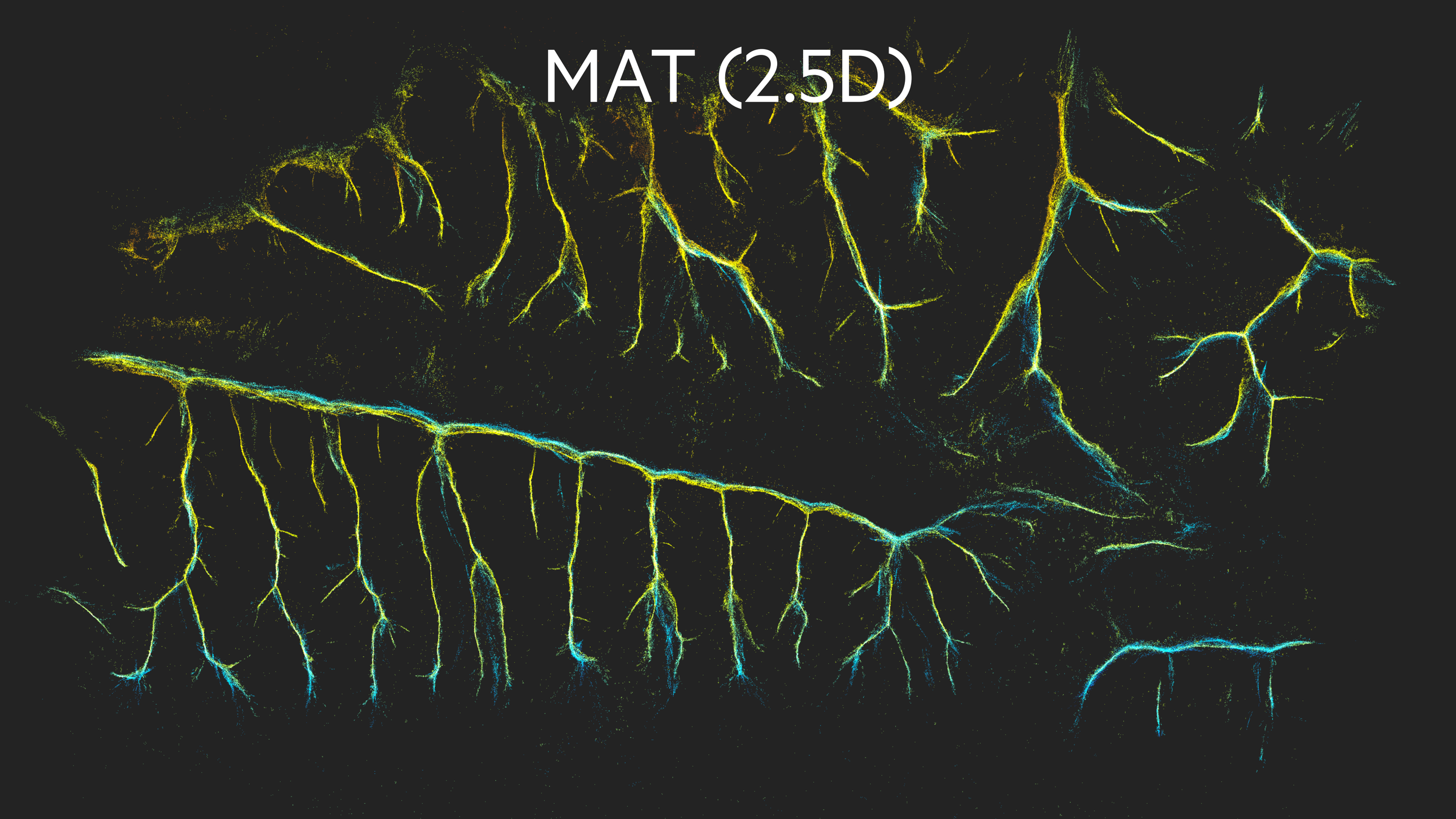
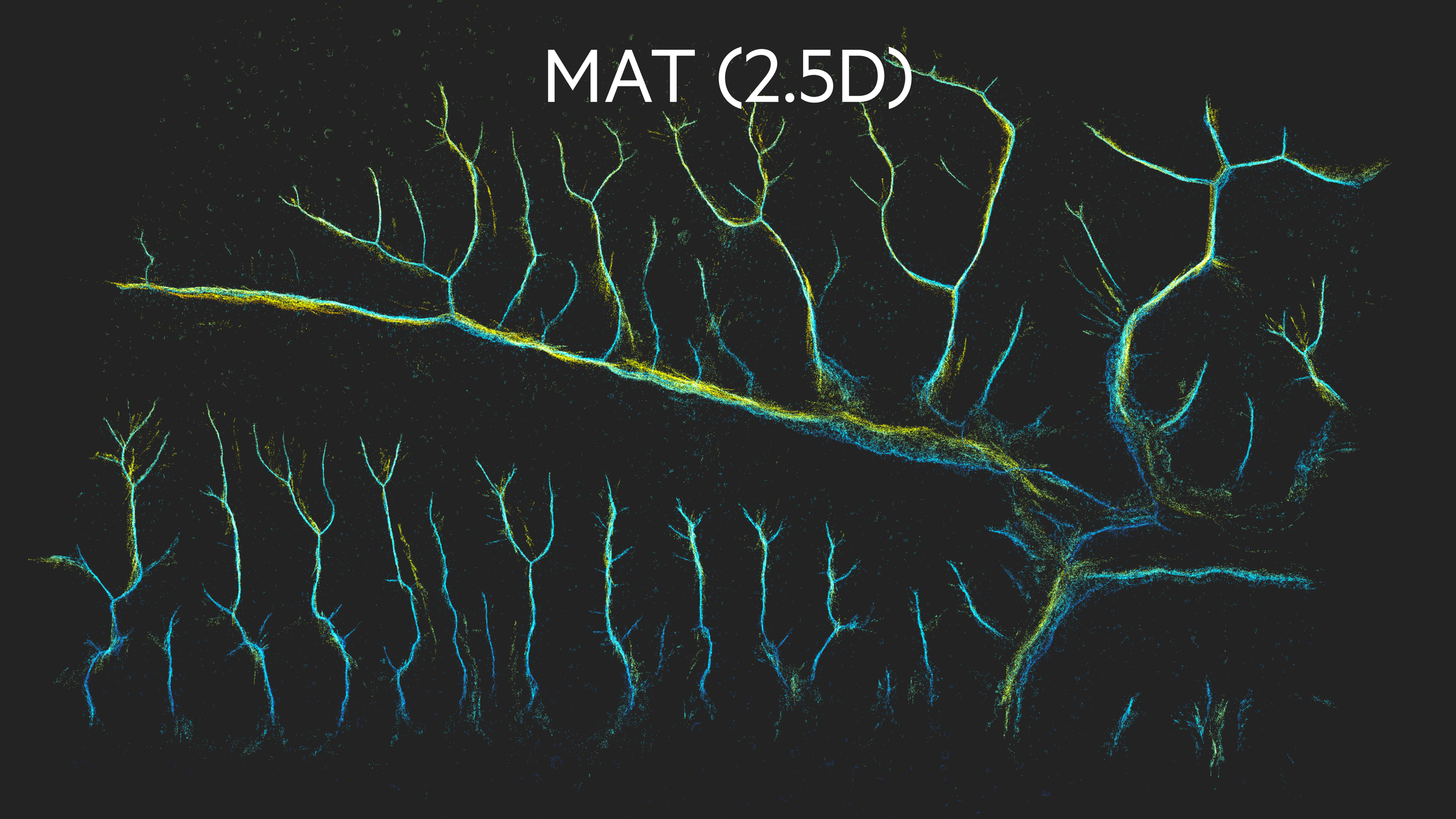
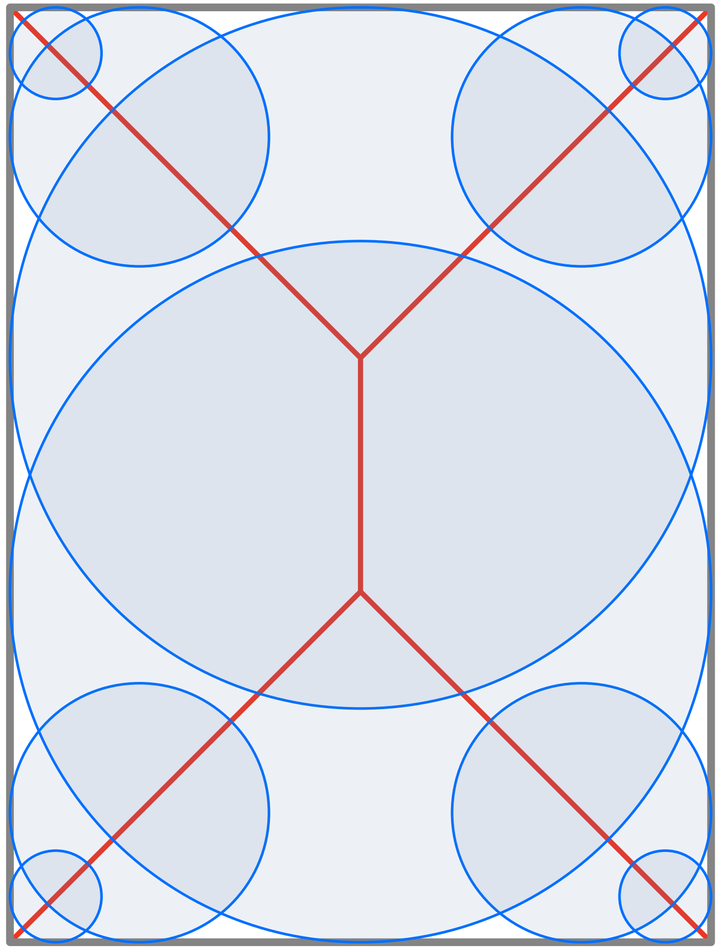


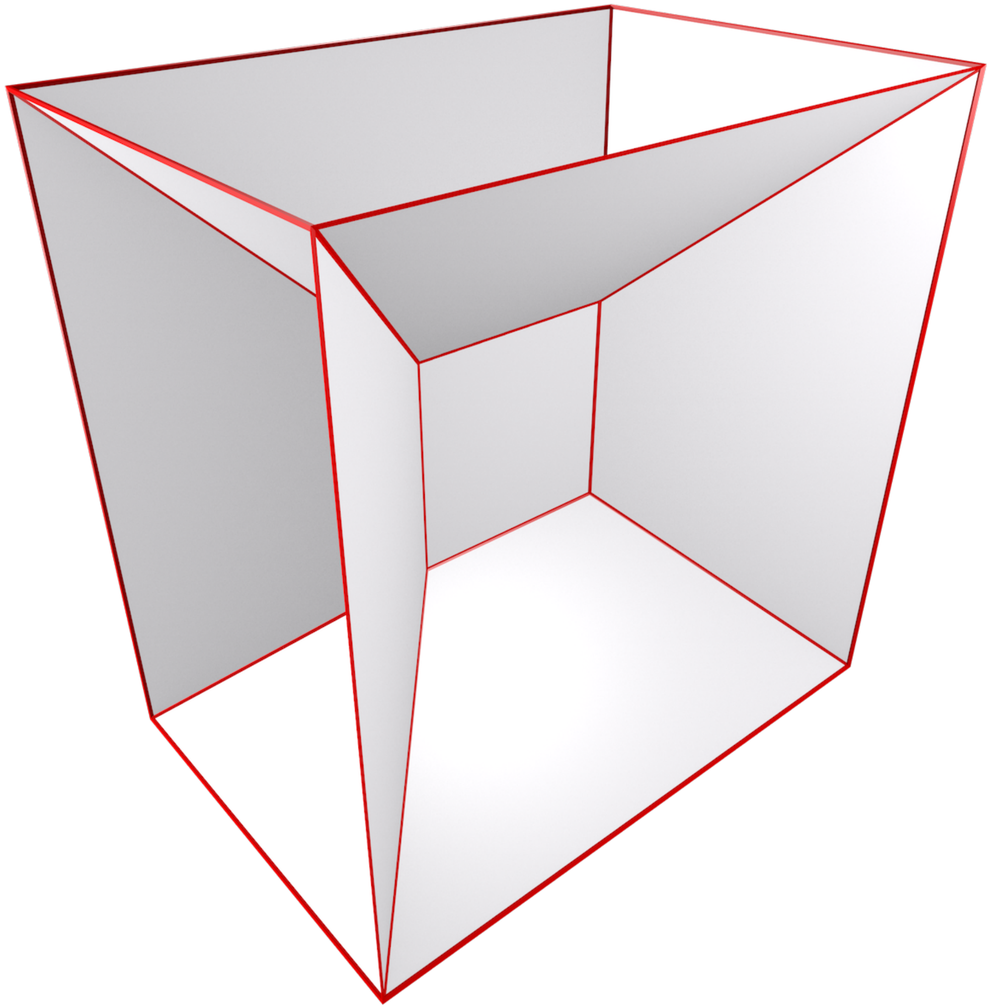
MAT (2.5D)

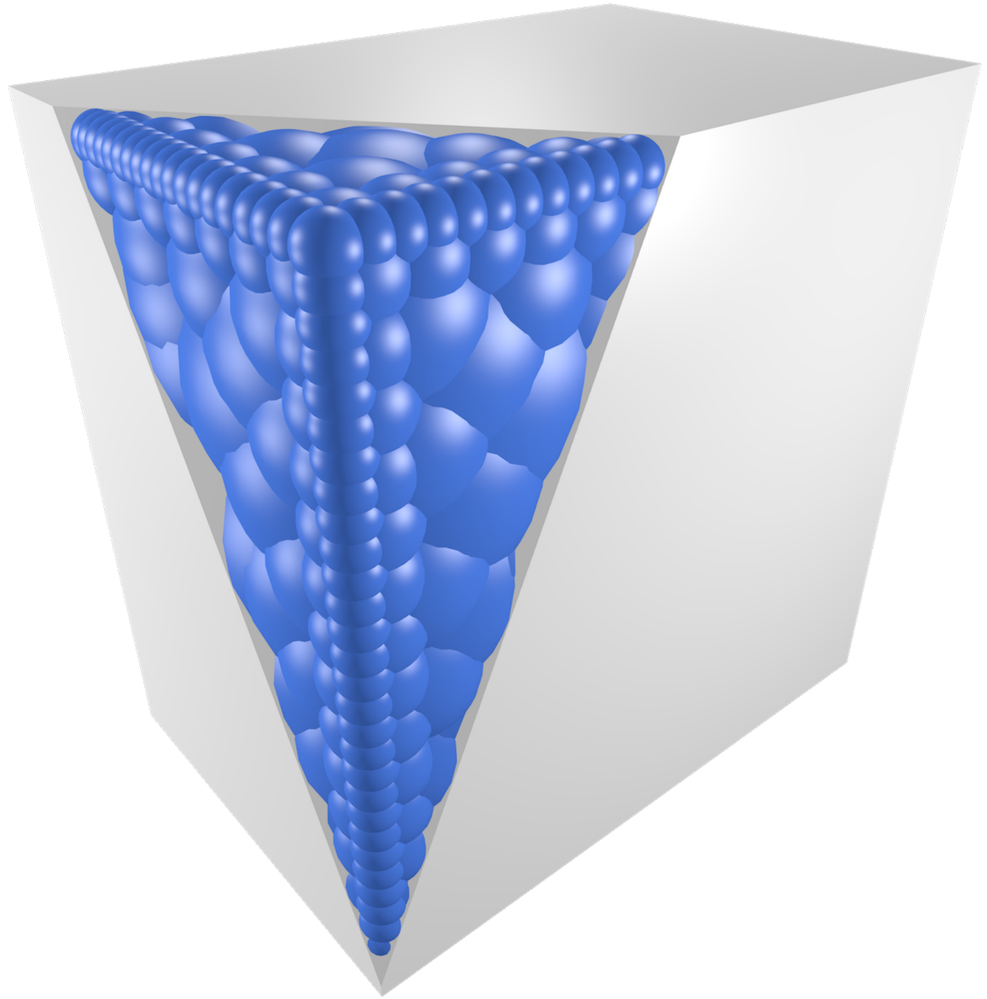


MAT (3D)

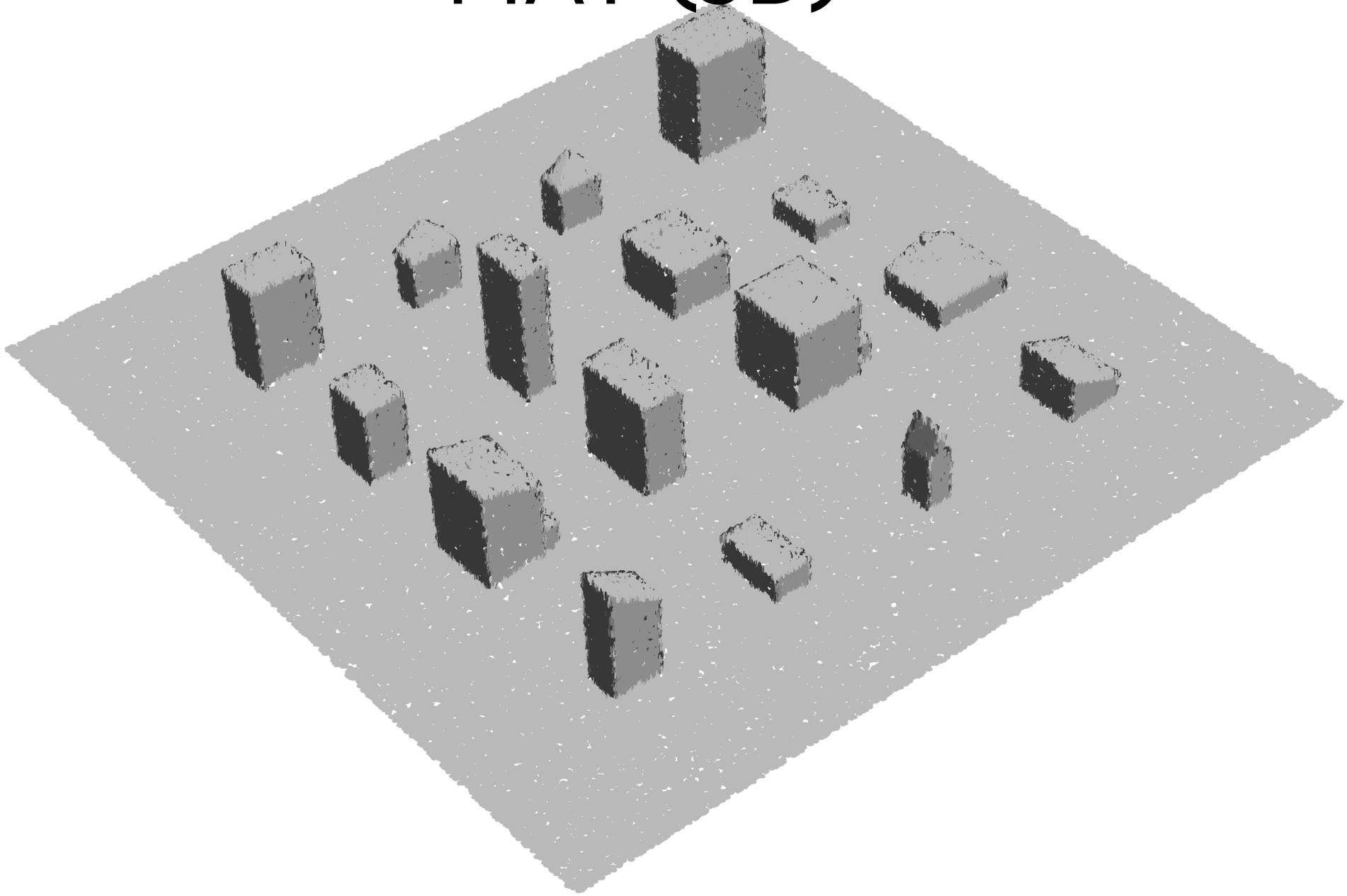


MAT (3D)





MAT (3D)

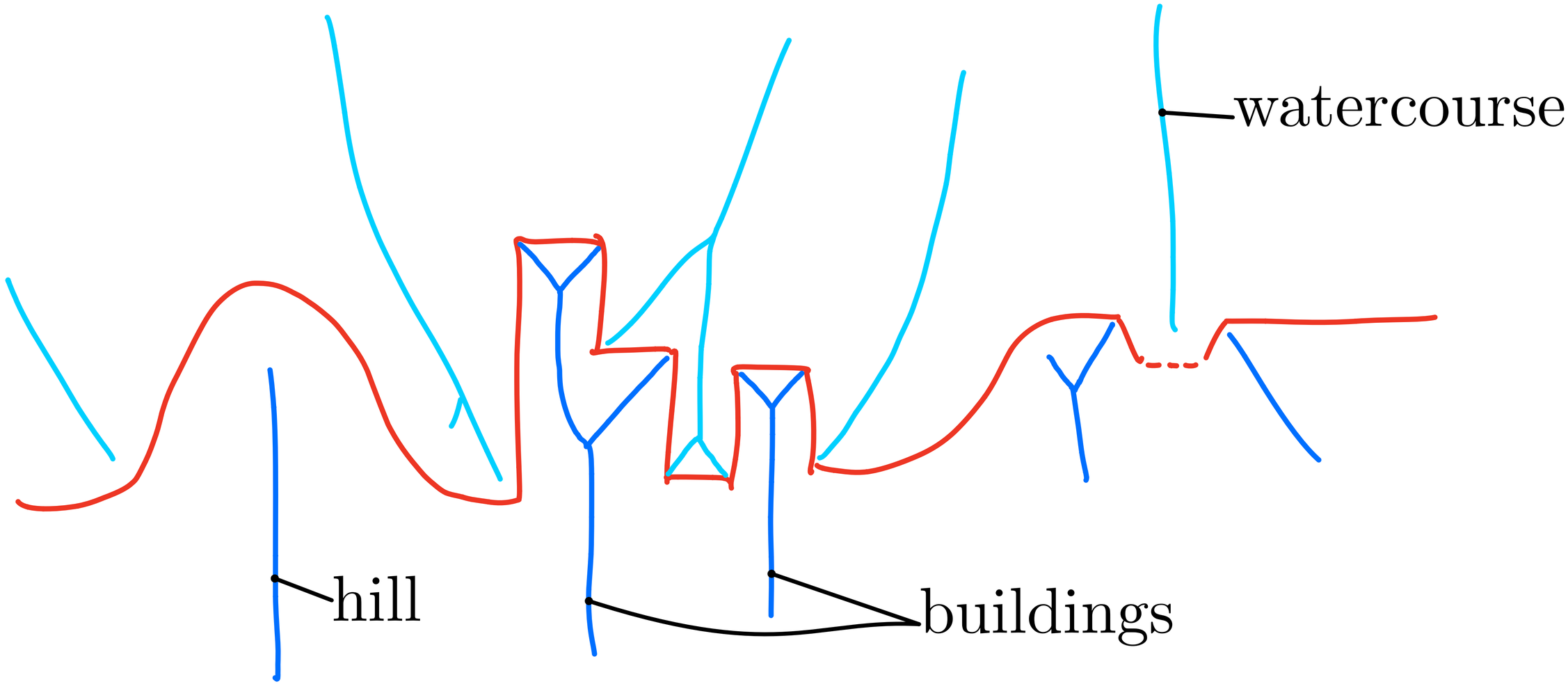


point cloud

MAT (3D)

MAT from PC

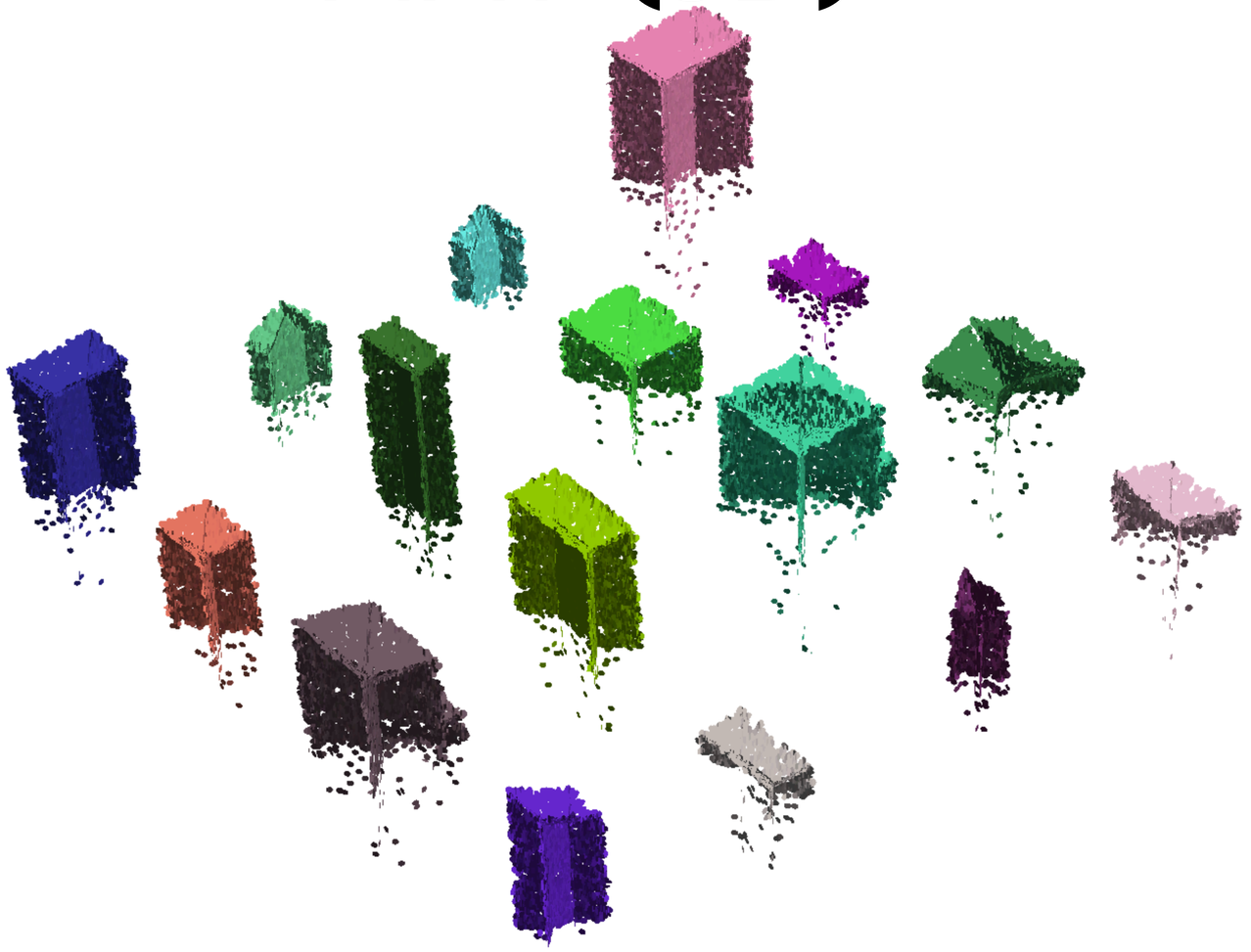
MAT (vertical section / 2.5D)



MAT (3D)

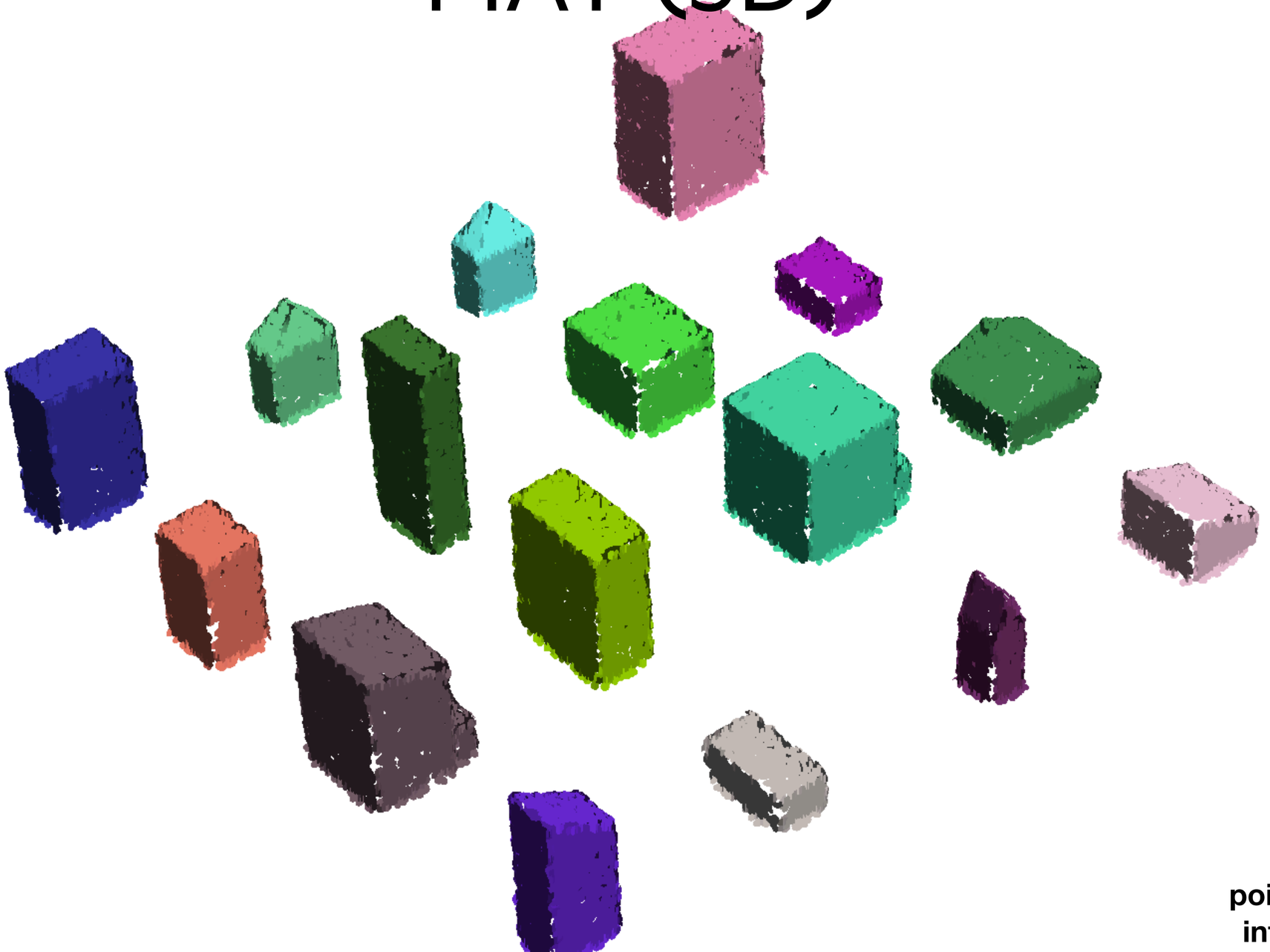
medial clusters

MAT (3D)



interior medial clusters

MAT (3D)

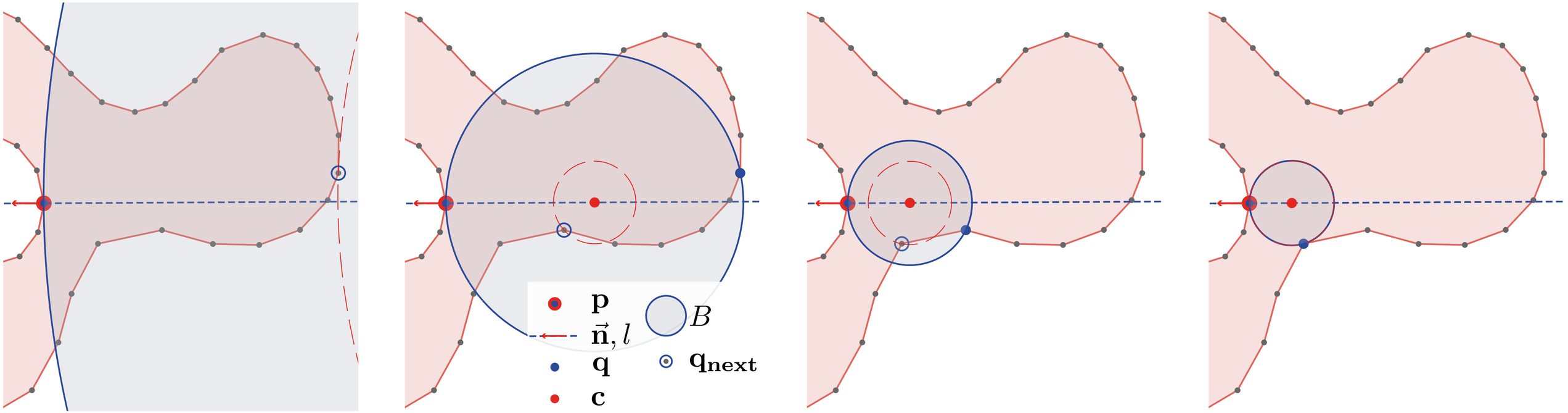


points corresponding to interior medial clusters

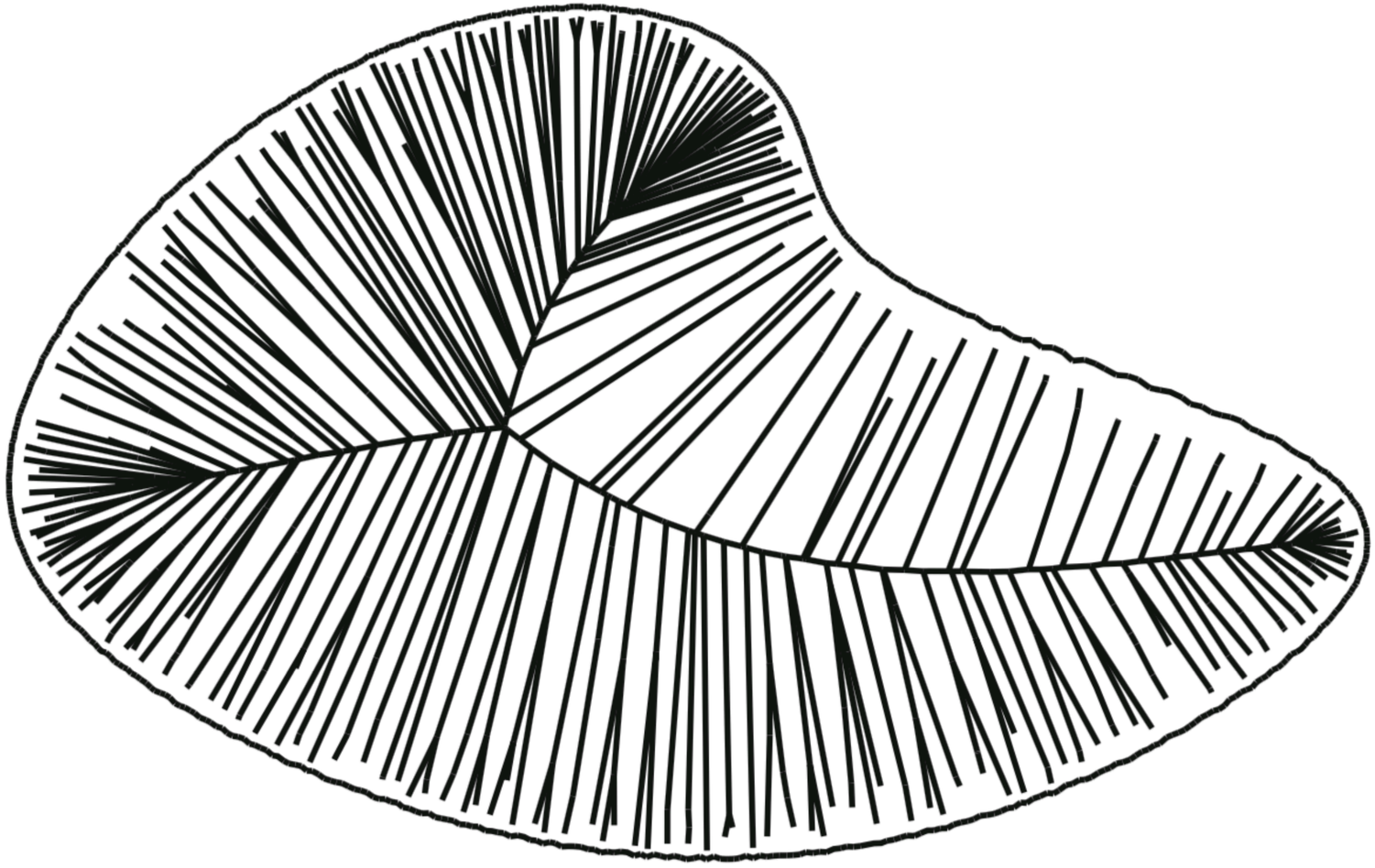
How to compute the MAT?

- Some methods:
  - voxelisation, then iterative removal of boundary voxels (thinning)
  - voxelisation, then computing distance to exterior (distance transform), then finding ridges
  - sampling of boundary, then Voronoi diagram, then selection of cells inside the original shape
  - shrinking ball algorithm directly from PC with normals

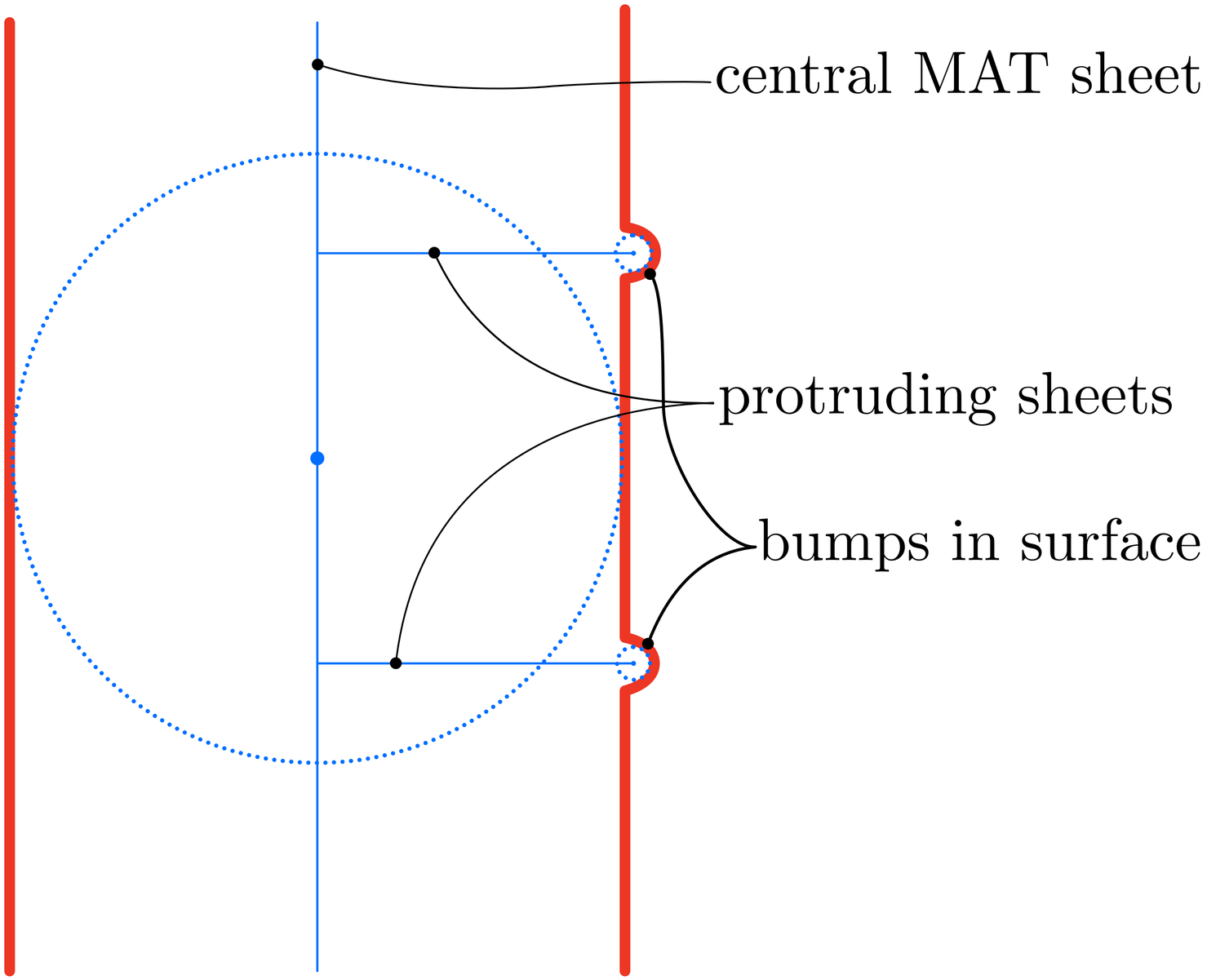
Shrinking ball algorithm



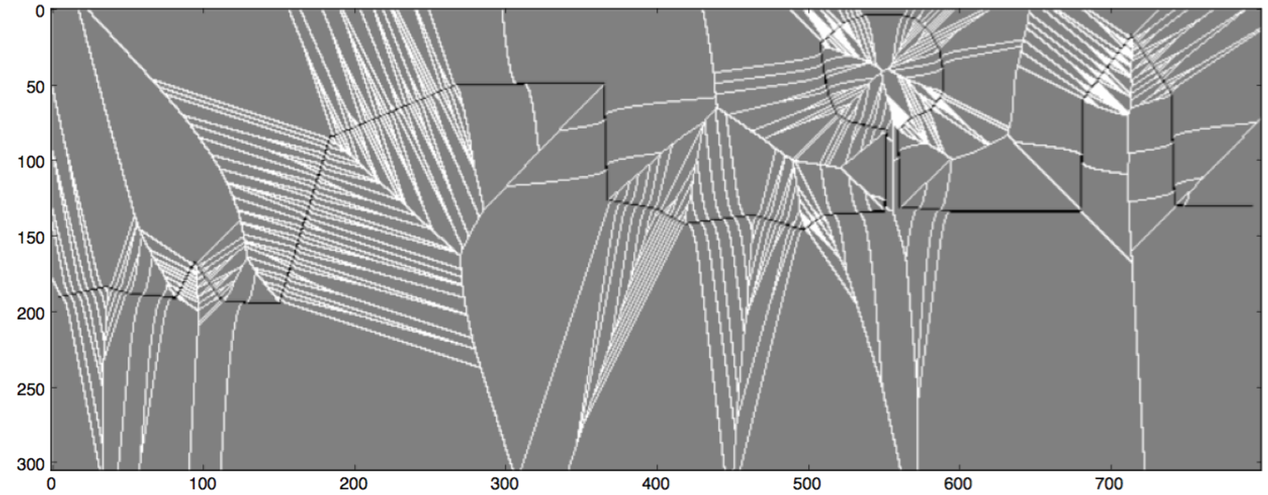
Pruning



Pruning



Pruning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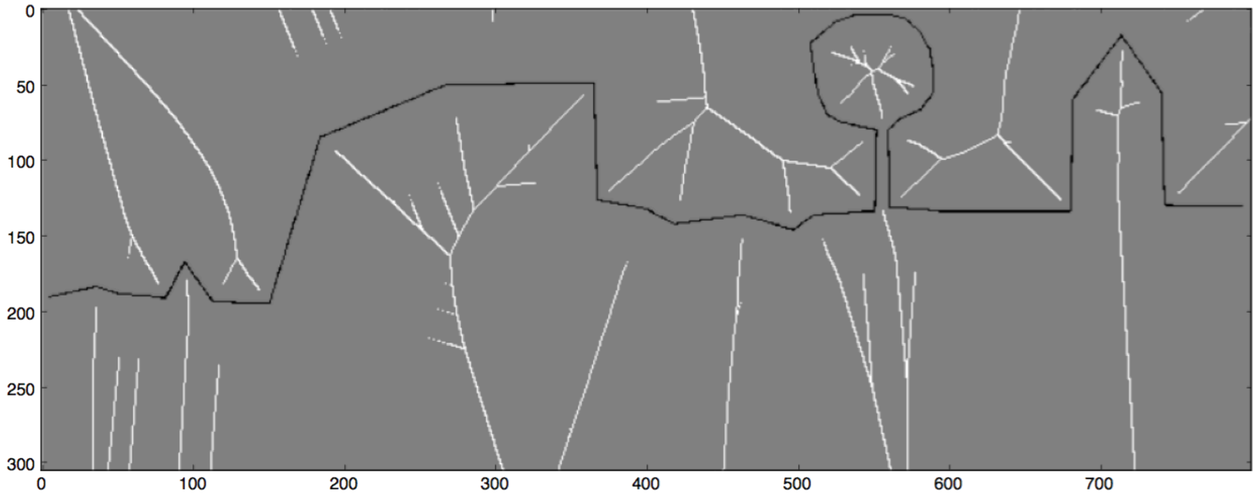
0
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What to do next?

1. Today:
   - Continue with Homework 2 (due May 28)
   - Prepare for midterm (3D book Chapters 1-4 and 9-10)
   - Go to geo1004 website and study today's lesson (3D book Chapter 7)
   - If you have extra time: study Monday's lesson (3D book Chapter 6)
2. Wednesday: midterm exam, then help with lessons or Hw 2
3. Next Monday: intro to CSG and Nef polyhedra

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