Topologically controlled lossy compression
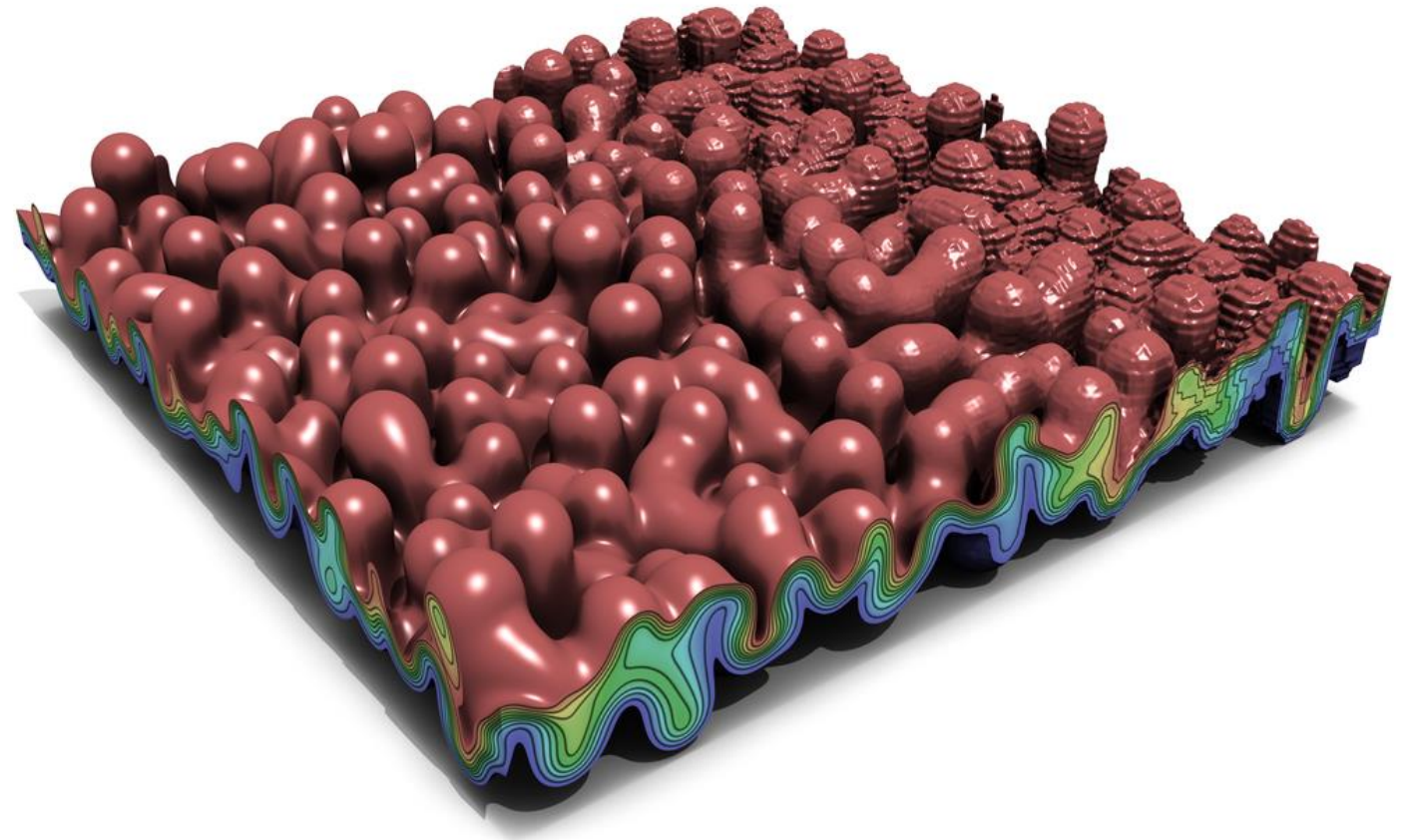
Maxime Soler, Sorbonne University

Agenda

- Context
- Compression algorithm
- Topological compression: 2D image
- Topological compression: medical data

Context

- Data compression
- Problems
  - Lossless: low compression factors
  - Lossy: topological error

Rayleigh-Taylor instability compressed with ZFP [1]. Compression factor from 1 (left) to 64 (right)

[1] *Fixed-rate compressed floating-point arrays,* P. Lindstrom, IEEE Trans. on Vis. and Comp. Graph., 2014.
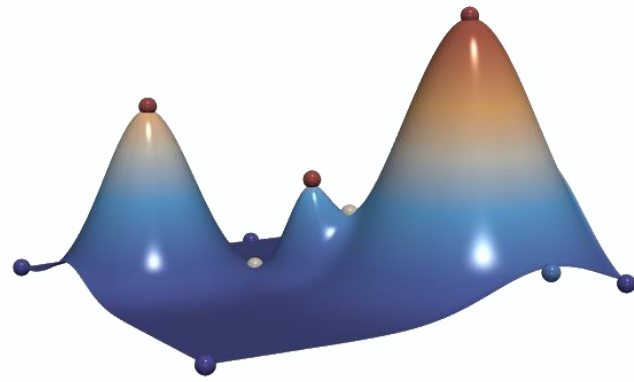
Context

- Data compression
- Topological lossy compression
  - Based on *persistence diagrams*
  - Control of the topological loss
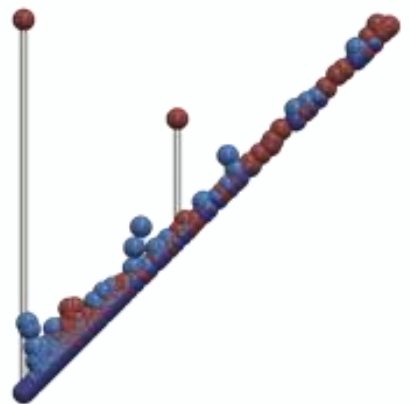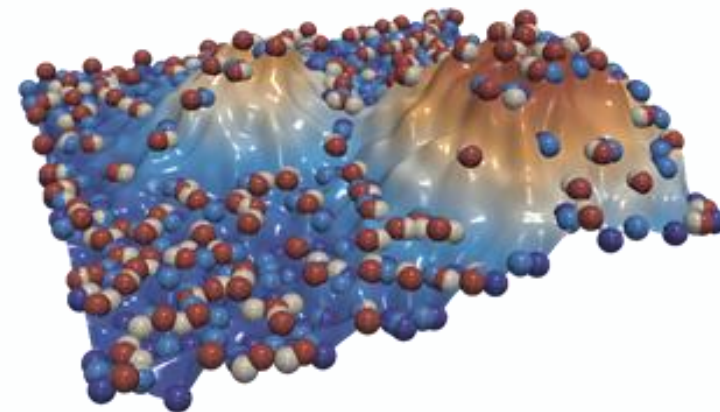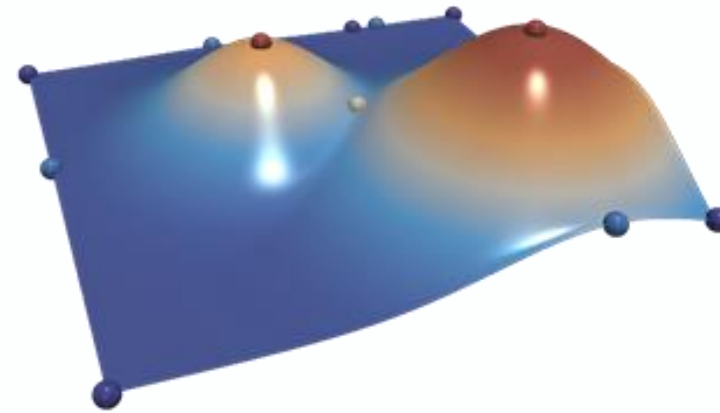
Smooth and noisy 2D functions
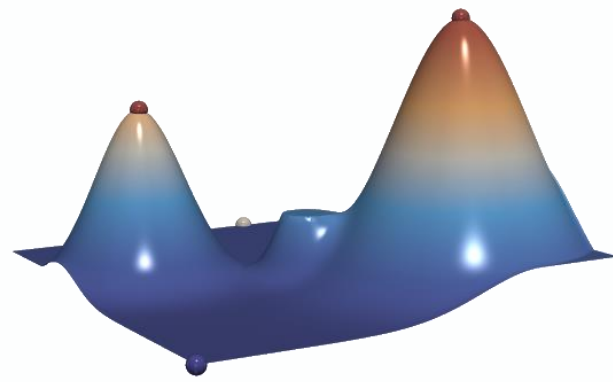with associated persistence diagrams
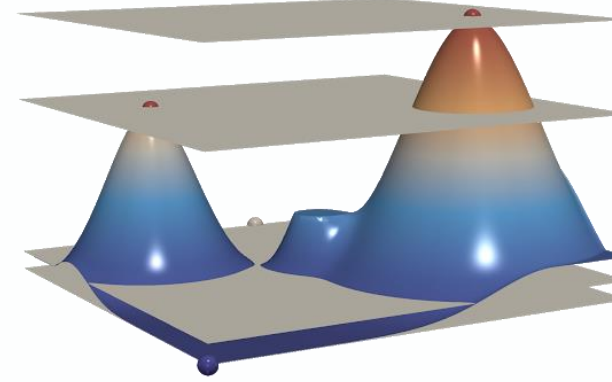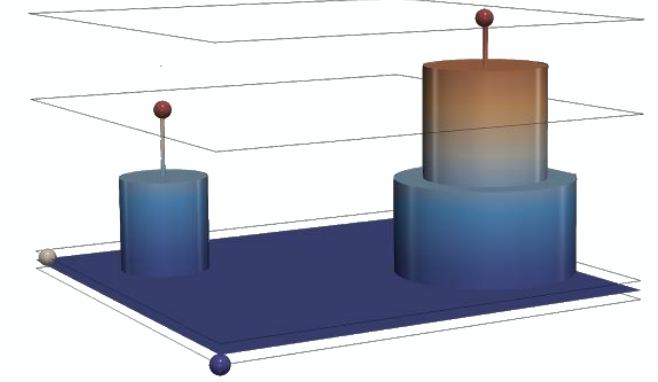
Compression algorithm

Compression

Inputs:
- 2D/3D field
- Threshold ε

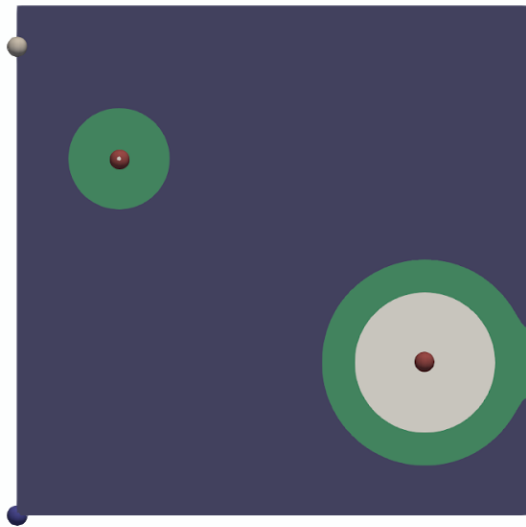1. Topological
ε-simplification

2. Domain
quantization

3. Topological identifier
and value assignment

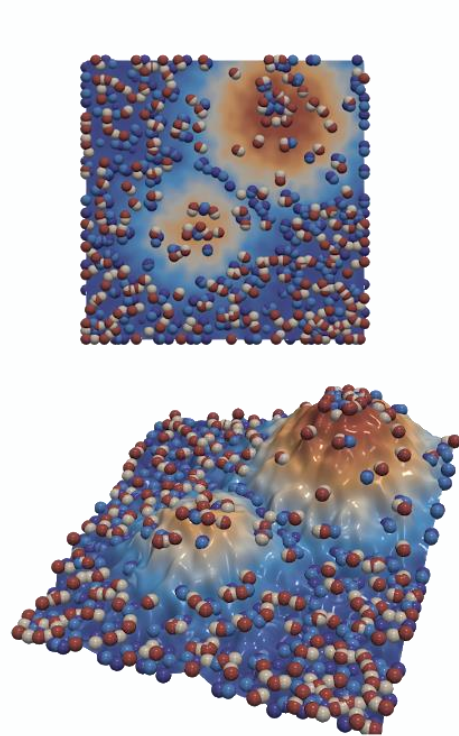4. Lossless compression
of topological identifiers

VIS
2018
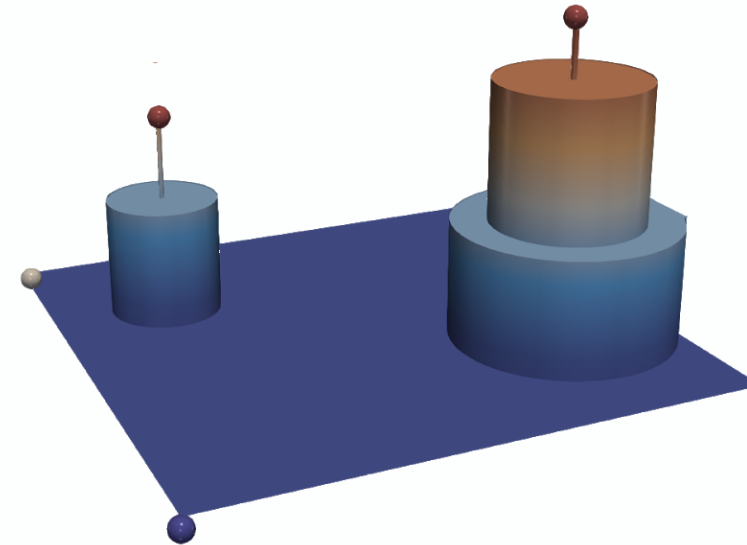
Decompression

1. Lossless decompression
of identifiers

2. Value assignment

3. Topological (ε-)correction
(for extensions)

Topologically Controlled Lossy Compression, M. Soler, M. Plainchault, B. Conche, J. Tierny, IEEE PacificVis, 2018.

Extensions
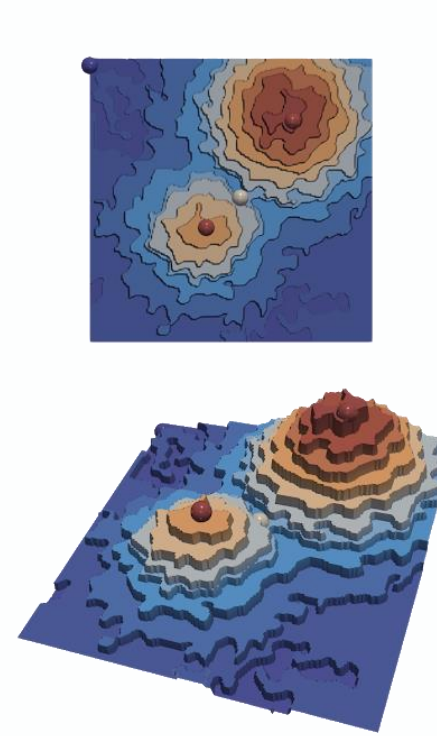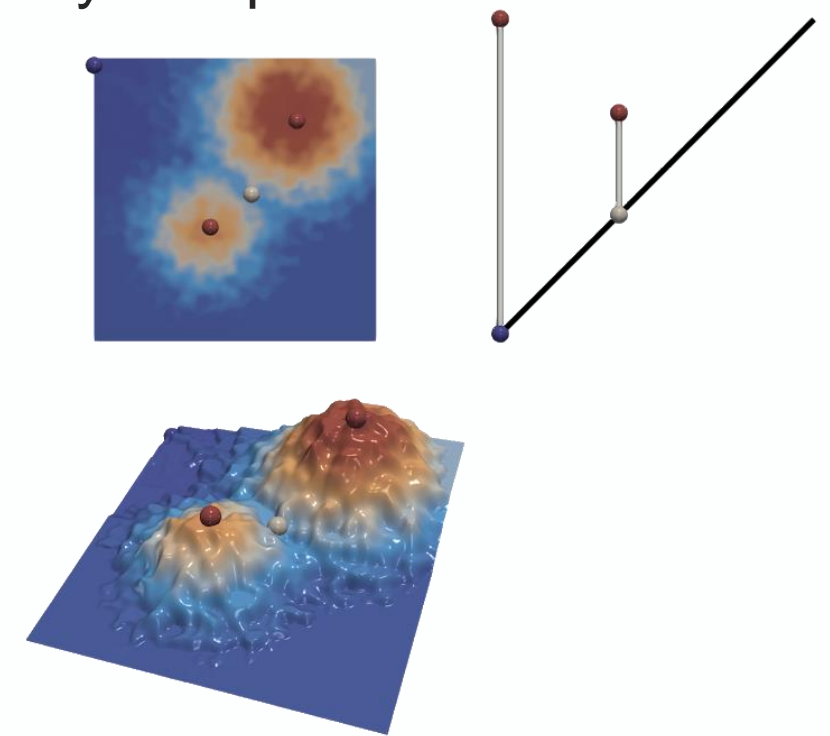
Original (2D) data

Basic approach
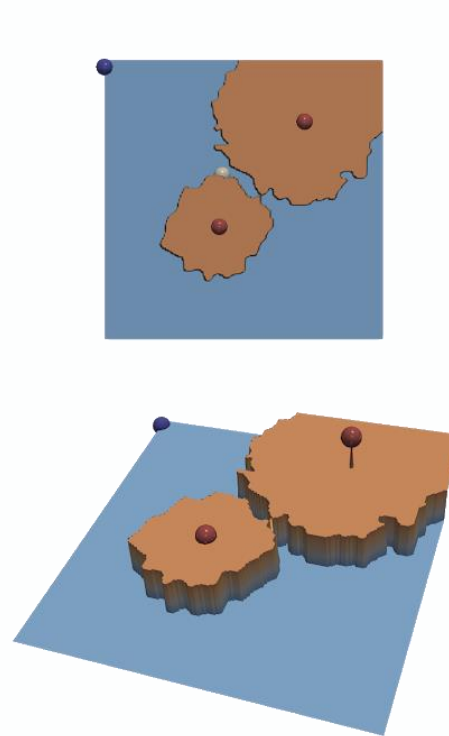
Subdivision

Coupled with a
lossy compressor

VIS
2018

Topological compression

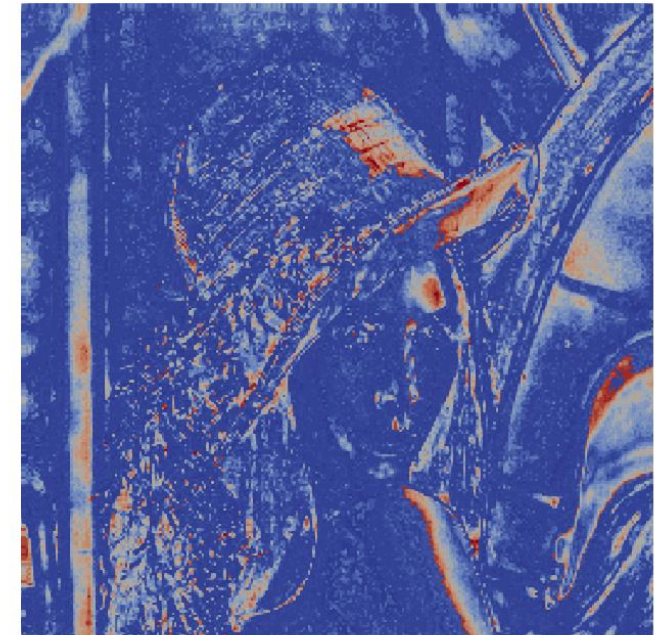# 2D image compression

- Original
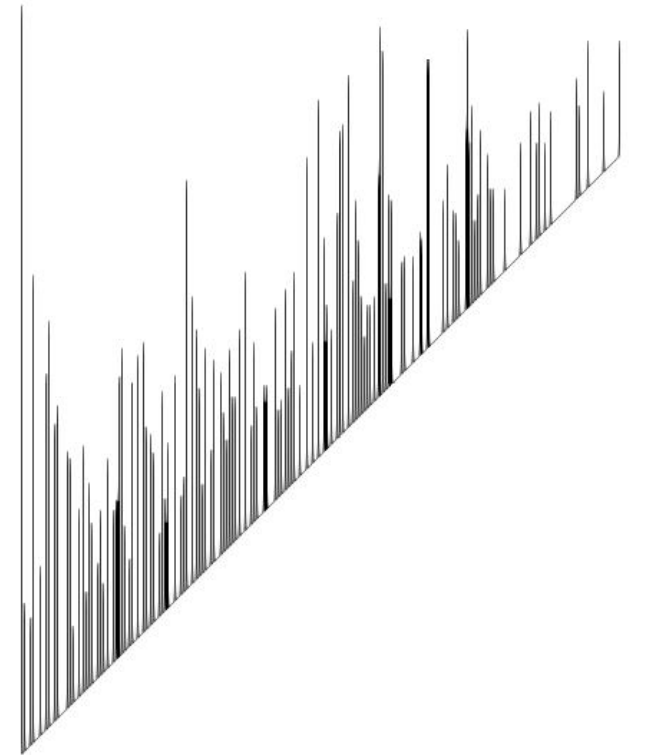
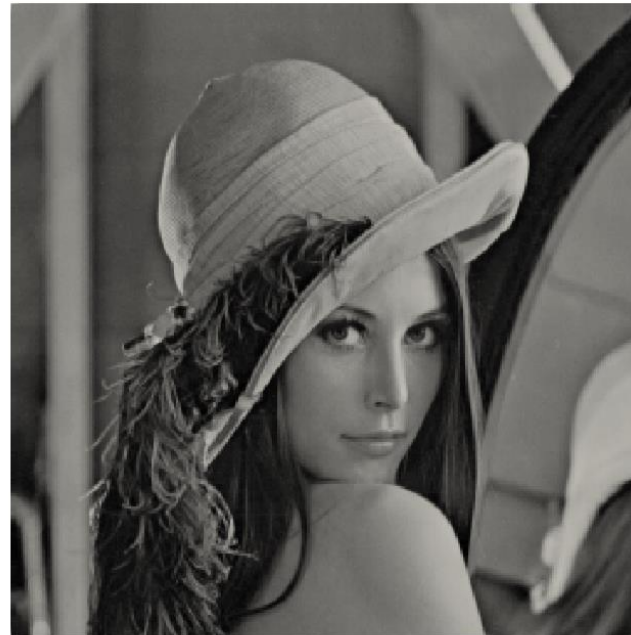# 2D image compression

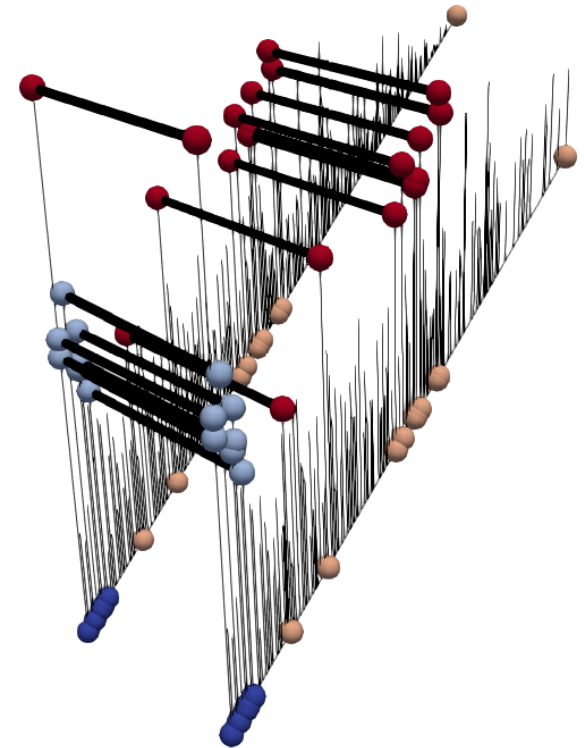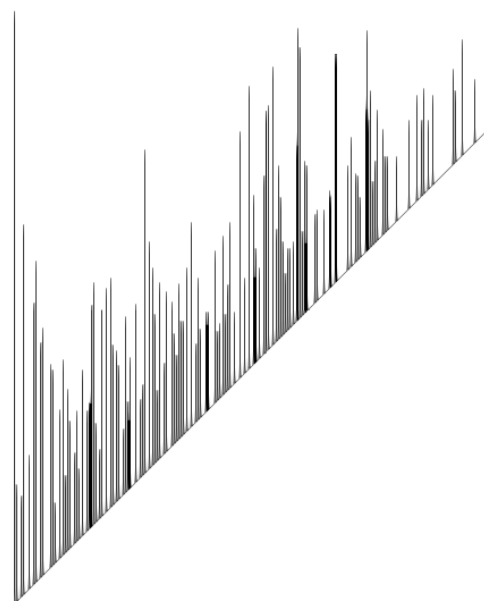- Compression
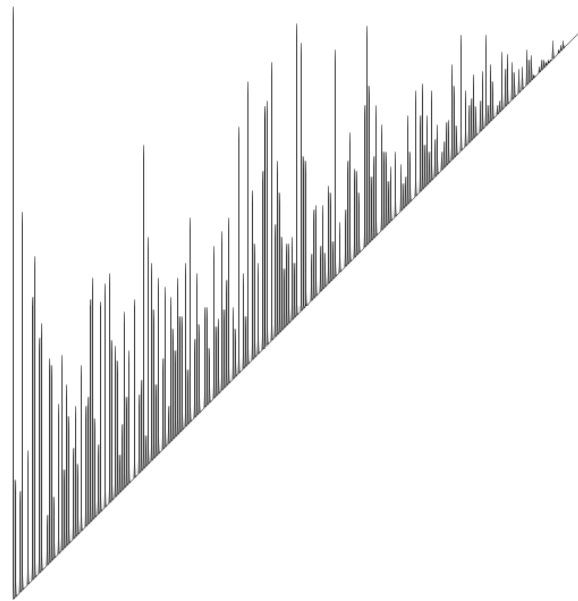
2D image compression
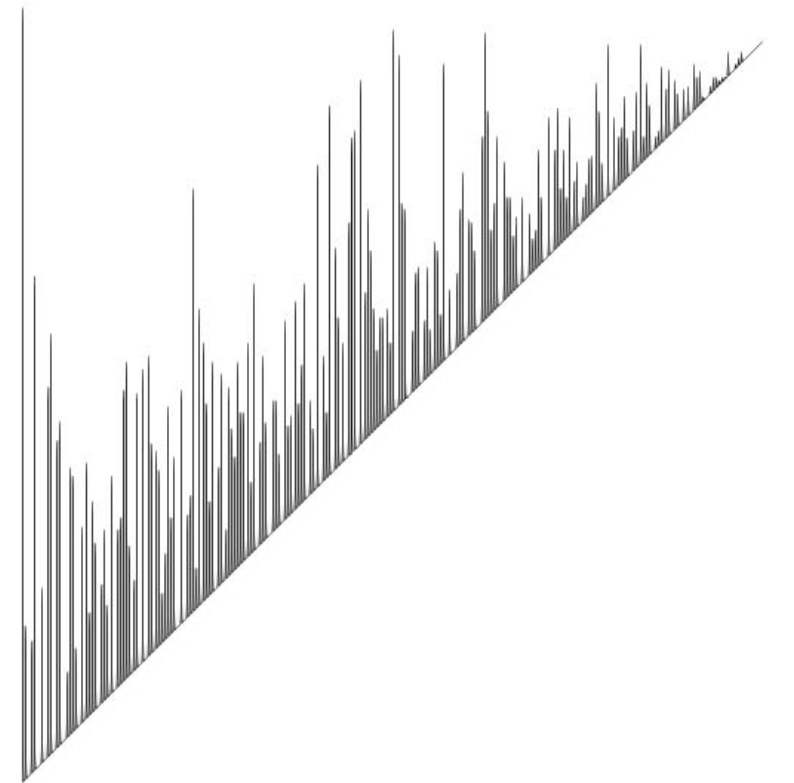
- Compressed

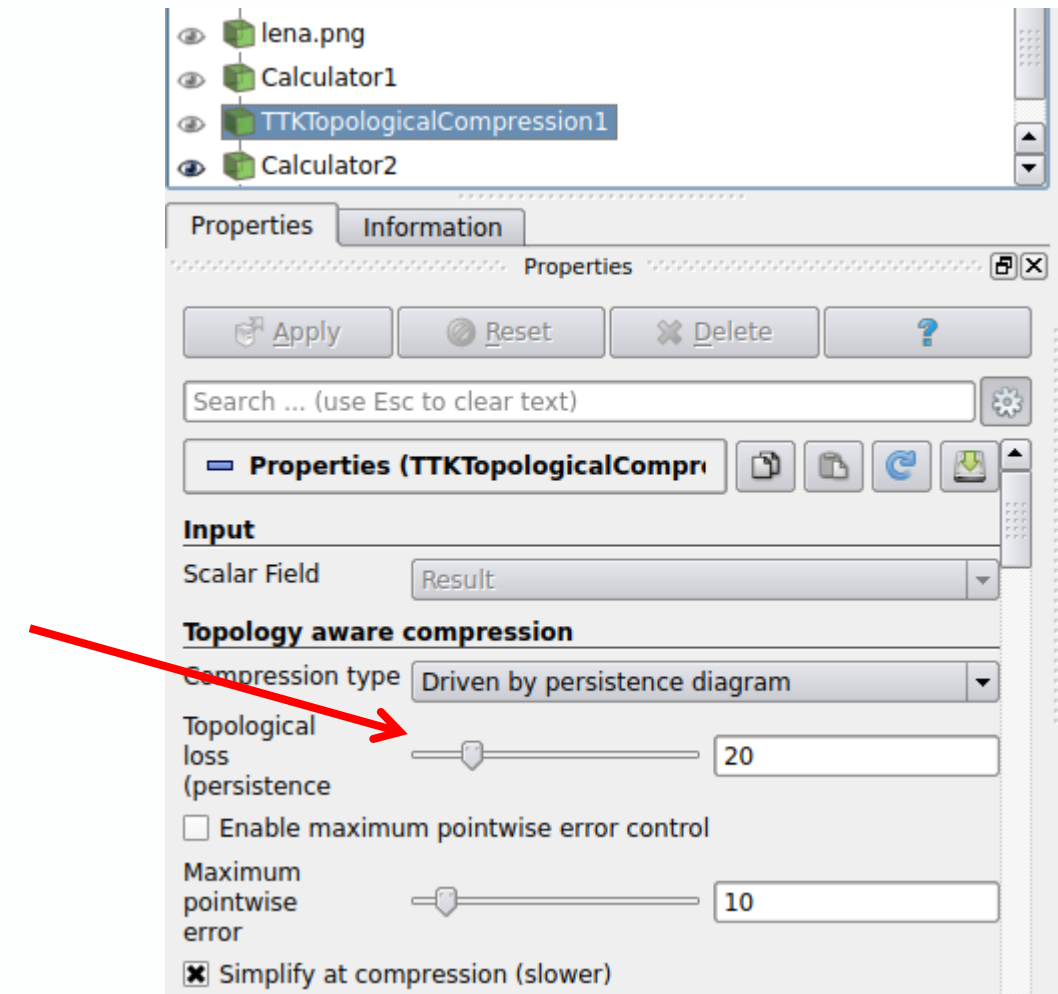# 2D image compression

- Comparison: LDistance

2D image compression

- Comparison: BottleneckDistance
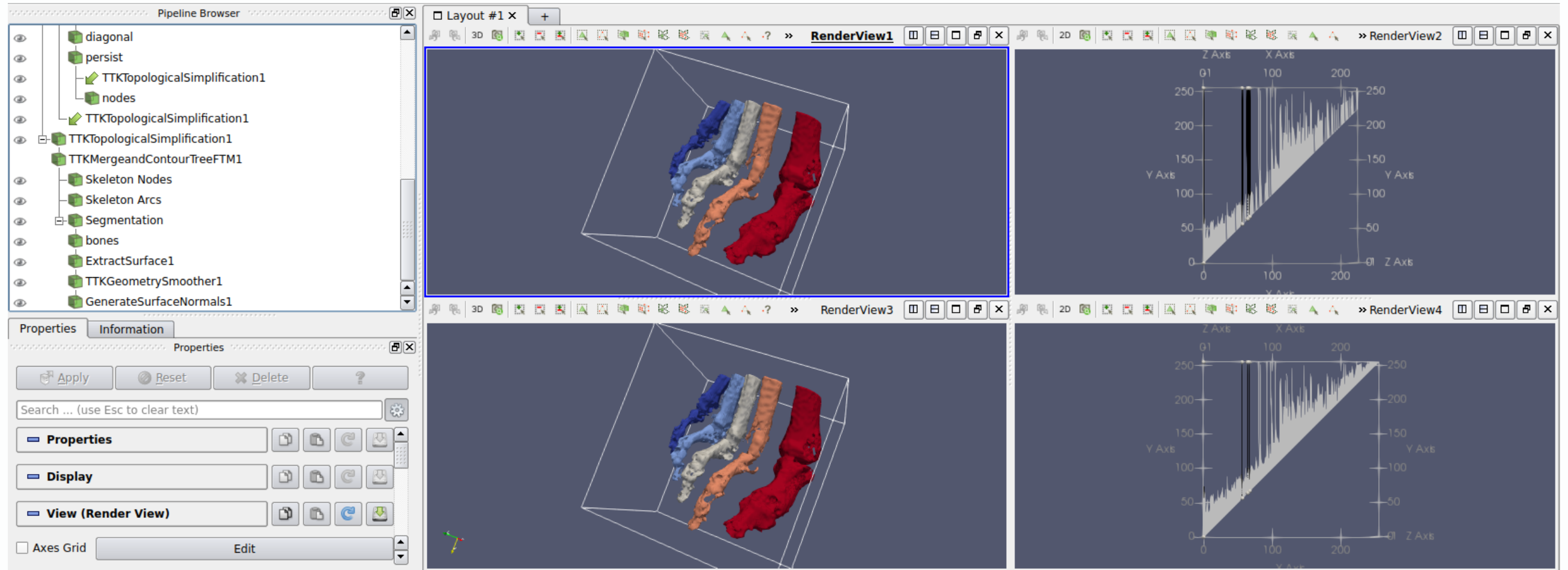
2D image compression

- Compression preview: TopologicalCompression

3D image compression

- Segmentation pipeline
  - Persistence diagram
  - Threshold (p > 187, diagonal)
  - Topological simplification
  - FTM Tree

3D image compression

3D image compression

- foot.vti (22MB)
- footc.ttk (692KB, 32x smaller, 10% persistence threshold)
- footcc.ttk (81KB, 270x smaller, 68% persistence threshold)

Bonus: persistence-driven tracking

Persistence tracking