Parallel & Distibuted Computing: Lecture 18

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Program B for individual projects

1. Extraction of boundary surface from 3D medical imaging
2. Parallel workflow
3. Browsing the code

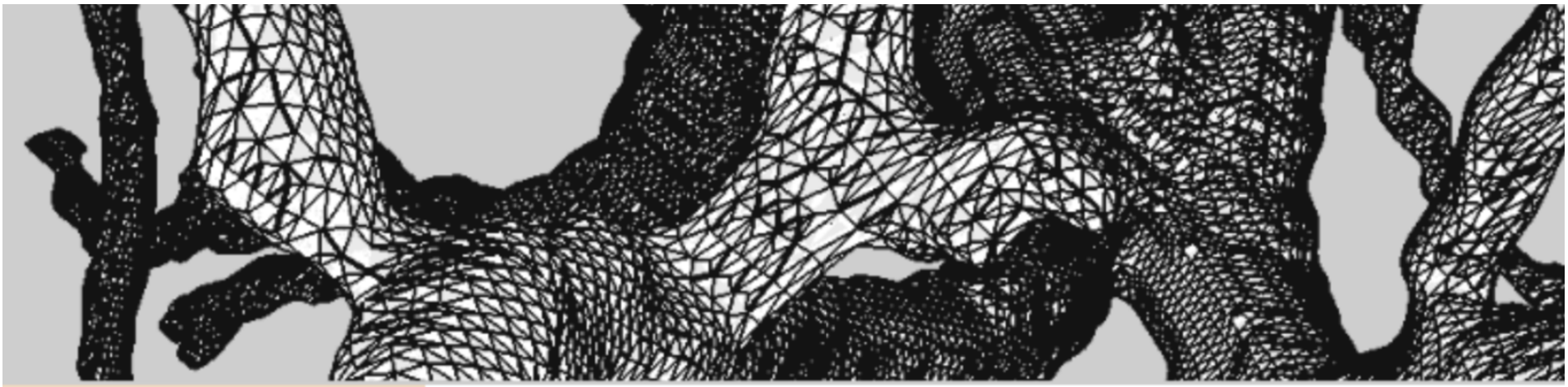
Extraction of boundary surface from 3D medical imaging

Computer modeling for research on liver perfusion

Department of Surgery and Biomedical Center, Faculty of Medicine in Pilsen, Charles University

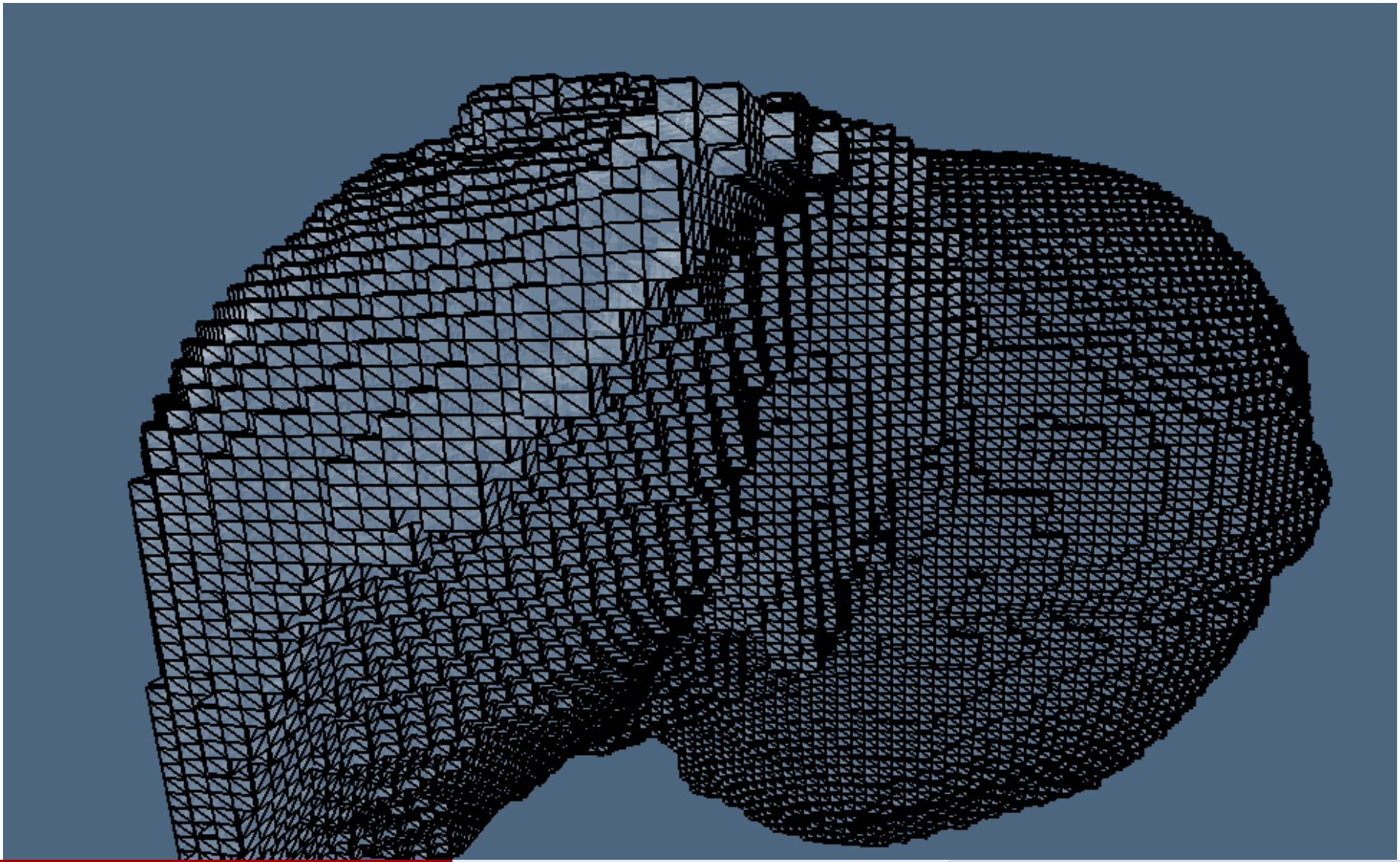
Joint project with

Department of Mathematics and Physics, Roma Tre University



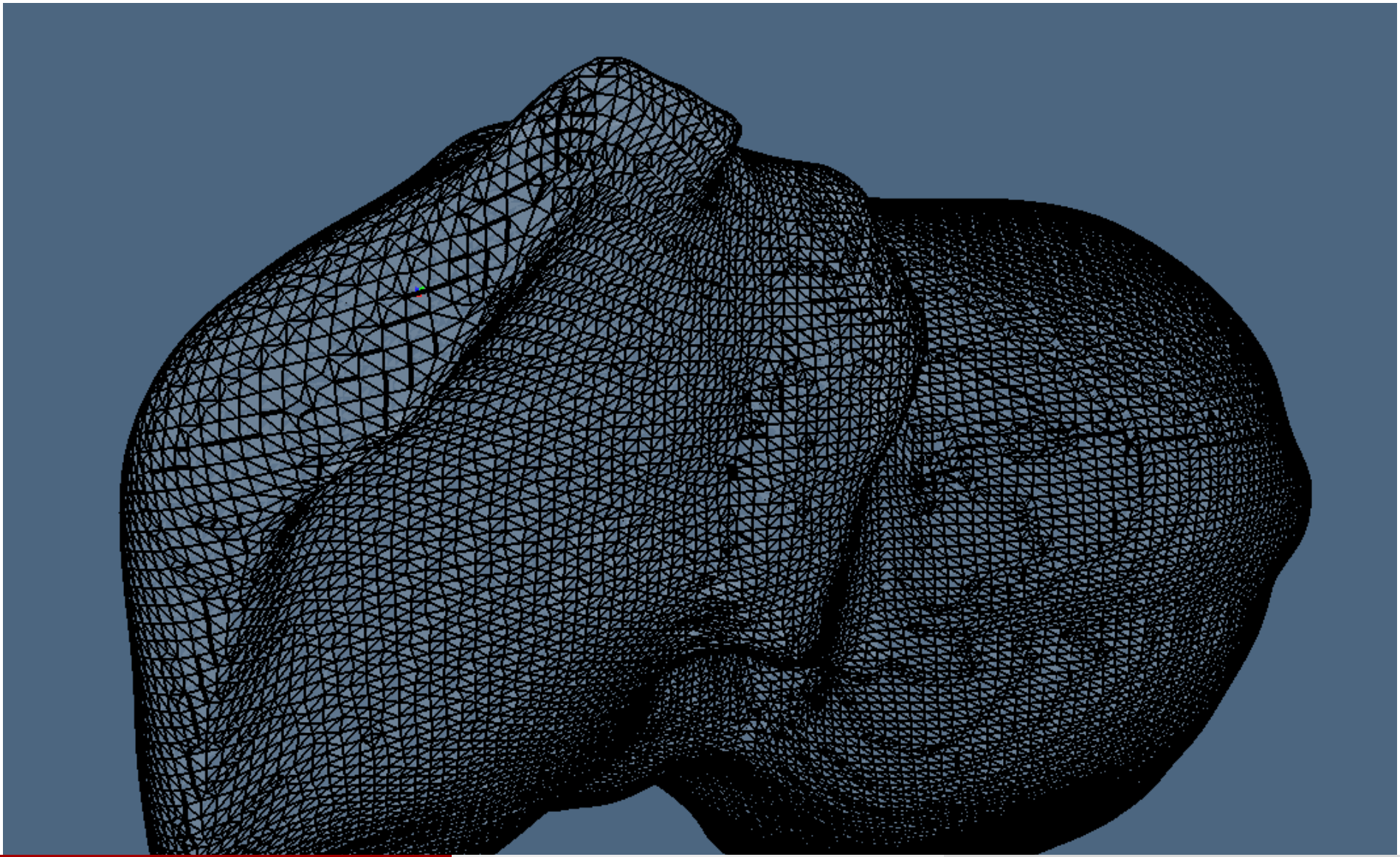
Liver digital surface

Triangulated surface extracted by LAR from 3D digital image

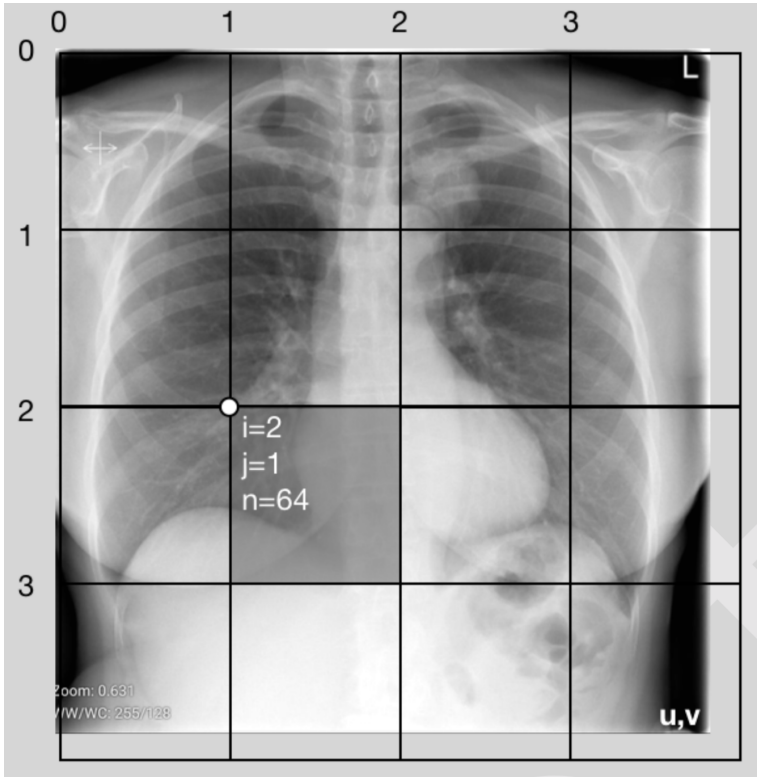


smoothed liver surface

Smoothing by Taubin method



Block decomposition



A possible block partitioning of a radiologic image. The evidenced 2D block, of size $n^d = 64^2$, is sliced by $\mathbf{B}([2, 1, 64]) = \mathit{Image}([128 : 172], [64 : 128)]$

Linear index from Cartesian index

The special `CartesianIndex{N}` object represents a scalar index that behaves like an N-tuple of integers spanning multiple dimensions.

For example:

```
julia> A = reshape(1:32, 4, 4, 2);

julia> A[3, 2, 1]
7

julia> A[CartesianIndex(3, 2, 1)] == A[3, 2, 1] == 7
true
```

https://docs.julialang.org/en/v1/manual/arrays/#Cartesian-indices-1

Construction of boundary matrix $\partial_3^\top = \delta_2$

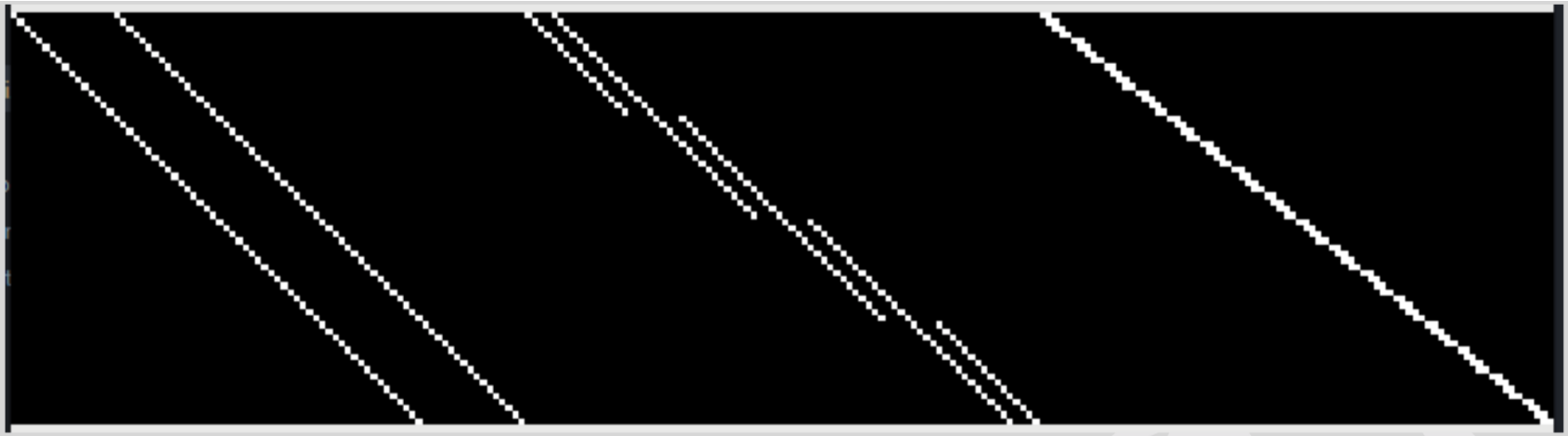
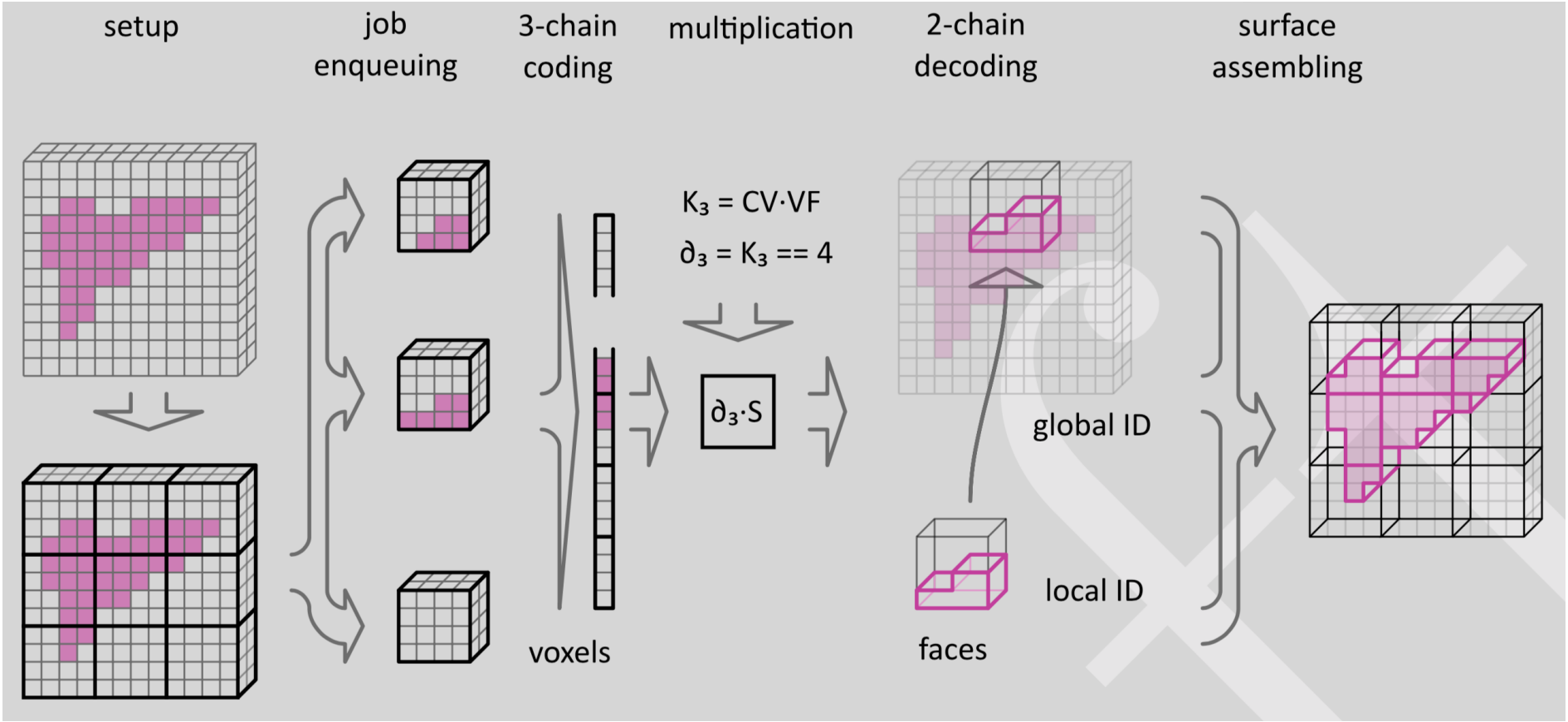


FIGURE 1. A binary image of the coboundary operator $\delta_2 = \partial_3^\top : C_2 \to C_3$, built for a small 3D image with shape $(4, 4, 4)$. Note that the number of rows equates the cardinality $4 \times 4 \times 4 = 64$ of the voxel set; the number of columns is $d\, n\, (1 + n)^{d-1} = 3 \times 4 \times 25 = 300$. Of course, the number of non-zeros per row (cardinality of the facet set of a single voxel) is six, whereas the number of non-zeros per column is two, but on boundary facets.

Parallel workflow

Workflow



Workflow of Lar-surf algorithm

Workflow setup

Job enqueuing

3-Chain encoding

SpMM Multiplication

2-Chain decoding

Assembling and artifact filtering

Taubin smoothing 1/2

- First presentation of method

Curve and surface smoothing without shrinkage

- More readable and general article, with pseudocode

Geometric Signal Processing on Polygonal Meshes

Taubin smoothing 2/2

Browsing the code

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https://github.com/mjirik/LarSurf.jl

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