

CS 247 – Scientific Visualization

Lecture 20: Volume Visualization, Pt. 6

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Reading Assignment #10 (until Apr 9)

Read (required):

- Paper:

Markus Hadwiger, Ali K. Al-Awami, Johanna Beyer, Marco Agus, and Hanspeter Pfister

SparseLeap: Efficient Empty Space Skipping for Large-Scale Volume Rendering, IEEE Scientific Visualization 2017,

http://vccvisualization.org/publications/2017_hadwiger_sparseleap.pdf

http://vccvisualization.org/publications/2017_hadwiger_sparseleap.mp4

Read (optional):

- Real-Time Volume Graphics, Chapter 6
(Global Volume Illumination)

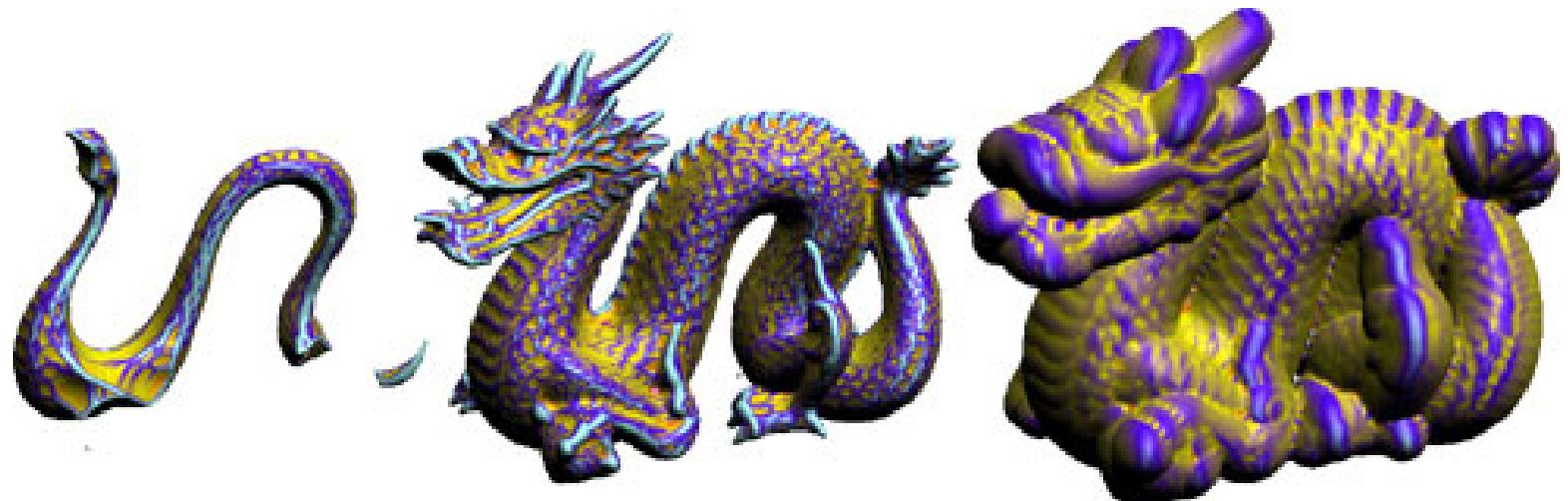
Isosurface Ray-Casting

Isosurface Ray-Casting



Isosurfaces/Level Sets

- Scanned data (fit signed distance function to points, ...)
- Signed distance fields
- CSG (constructive solid geometry) operations

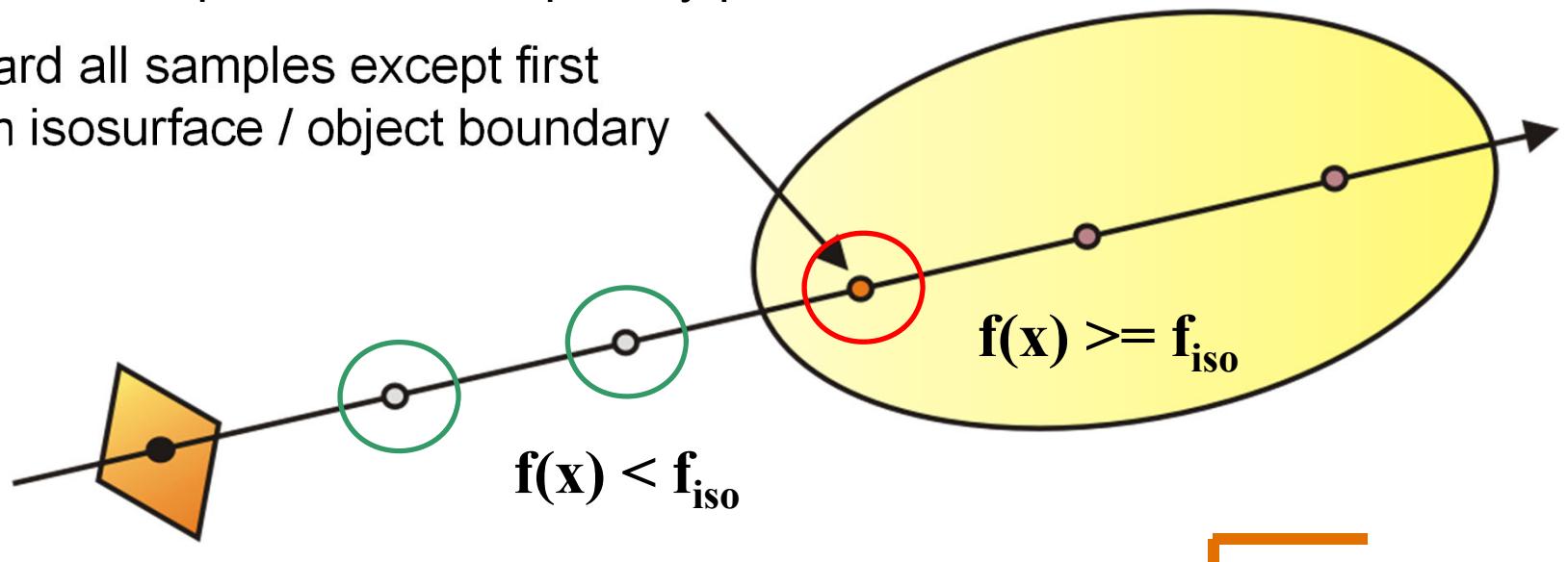


Isosurface Ray-Casting



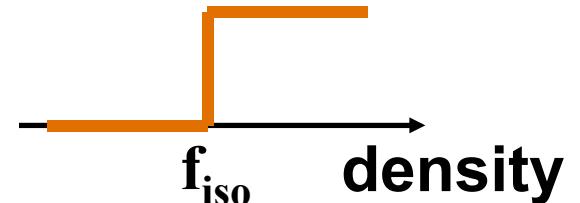
Opaque isosurfaces:
only one sample contributes per ray/pixel

Discard all samples except first
hit on isosurface / object boundary



Threshold transfer function / alpha test

First hit ray casting



Intersection Refinement (1)

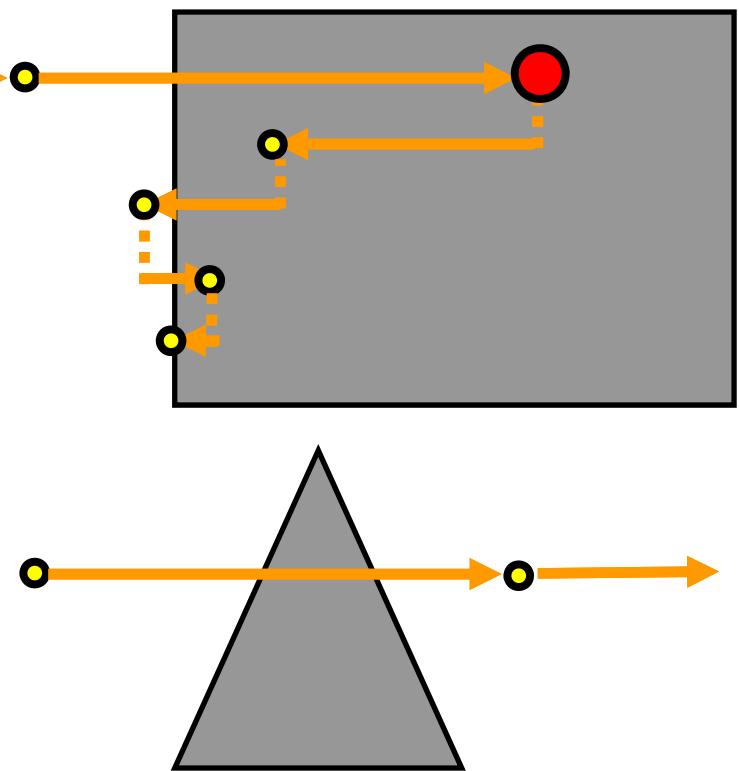


Fixed number of bisection / binary search steps

Virtually no impact on performance

Refine already detected
intersection

Handle problems with small
features / at silhouettes with
adaptive sampling



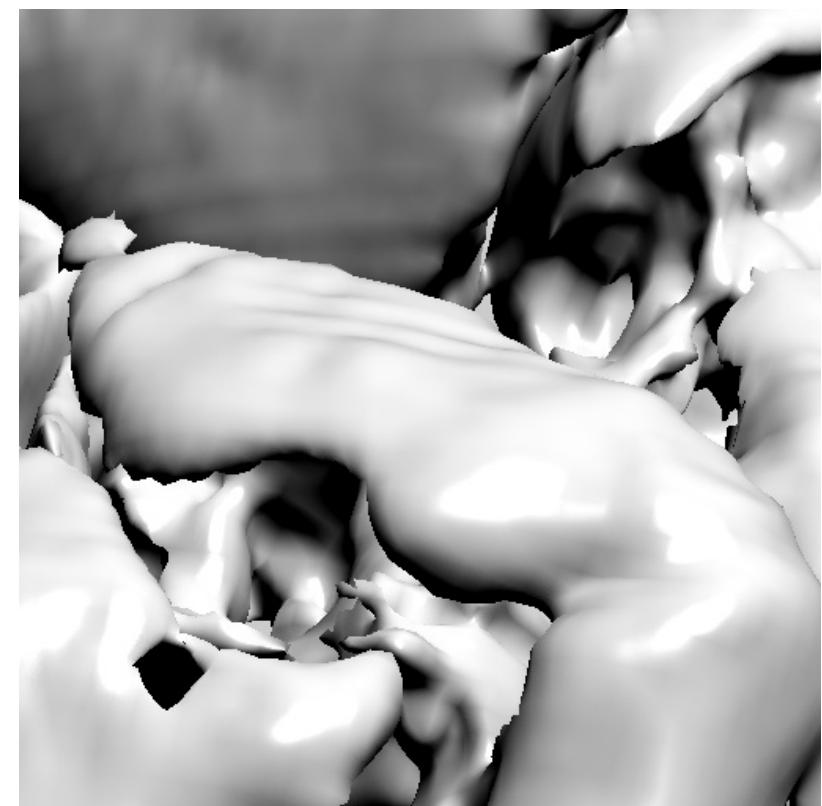
Intersection Refinement (2)



without refinement



with refinement

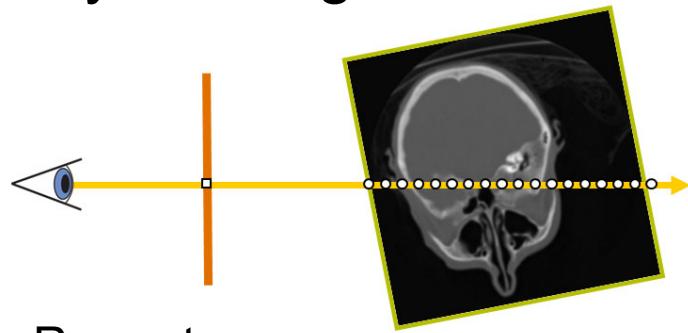


sampling distance 5 voxels (no adaptive sampling)

Ray-Casting vs. Isosurface Ray-Casting



Ray-Casting



Ray setup

Loop over ray

Sample scalar field

Classification

Shading

Compositing

Isosurface Ray-Casting

Ray setup

Loop over ray

Sample scalar field

if value \geq isoValue (i.e., first hit)

break out of the loop

[Refine first hit location] (optional)

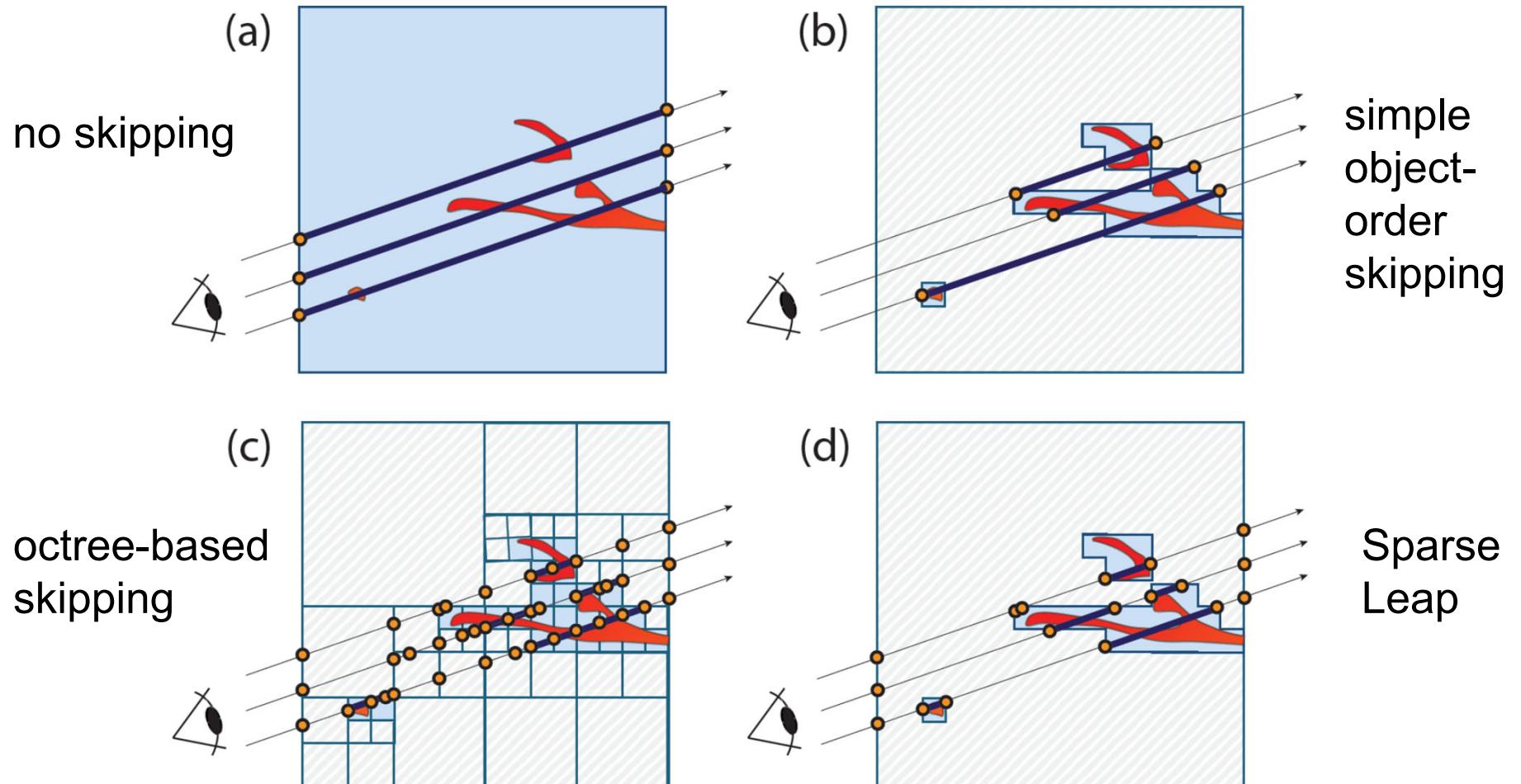
Shading

(Compositing not needed)

Empty Space Skipping



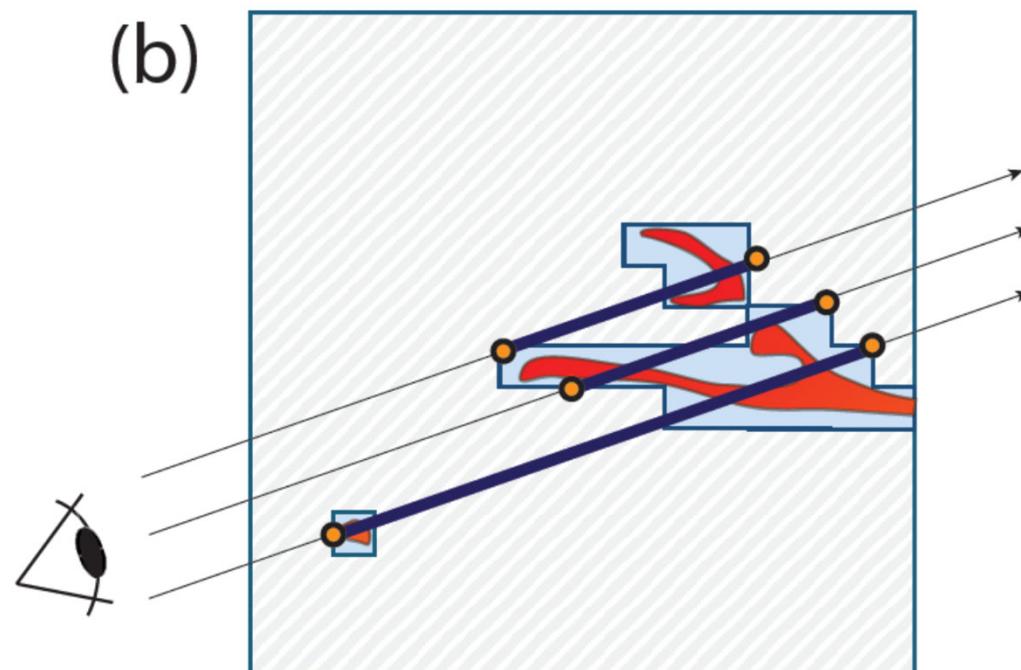
Different Approaches





Object-Order Empty Space Skipping

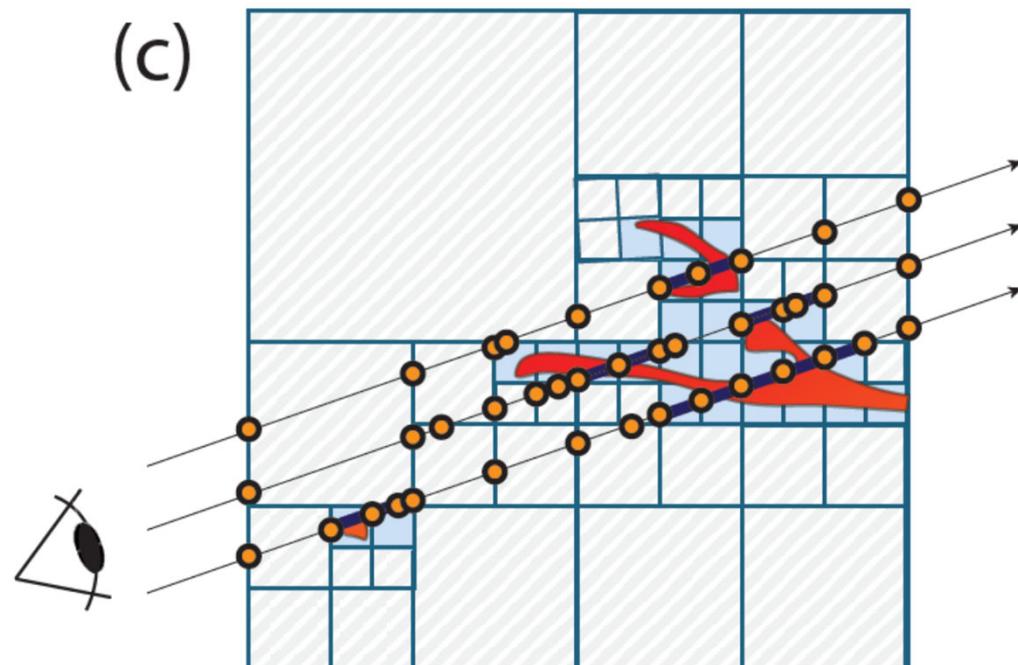
Modify initial rasterization step for ray setup





Octree-Based Empty Space Skipping

Everything is done during tree traversal along the ray



More on Transfer Functions

Classification – Transfer Functions



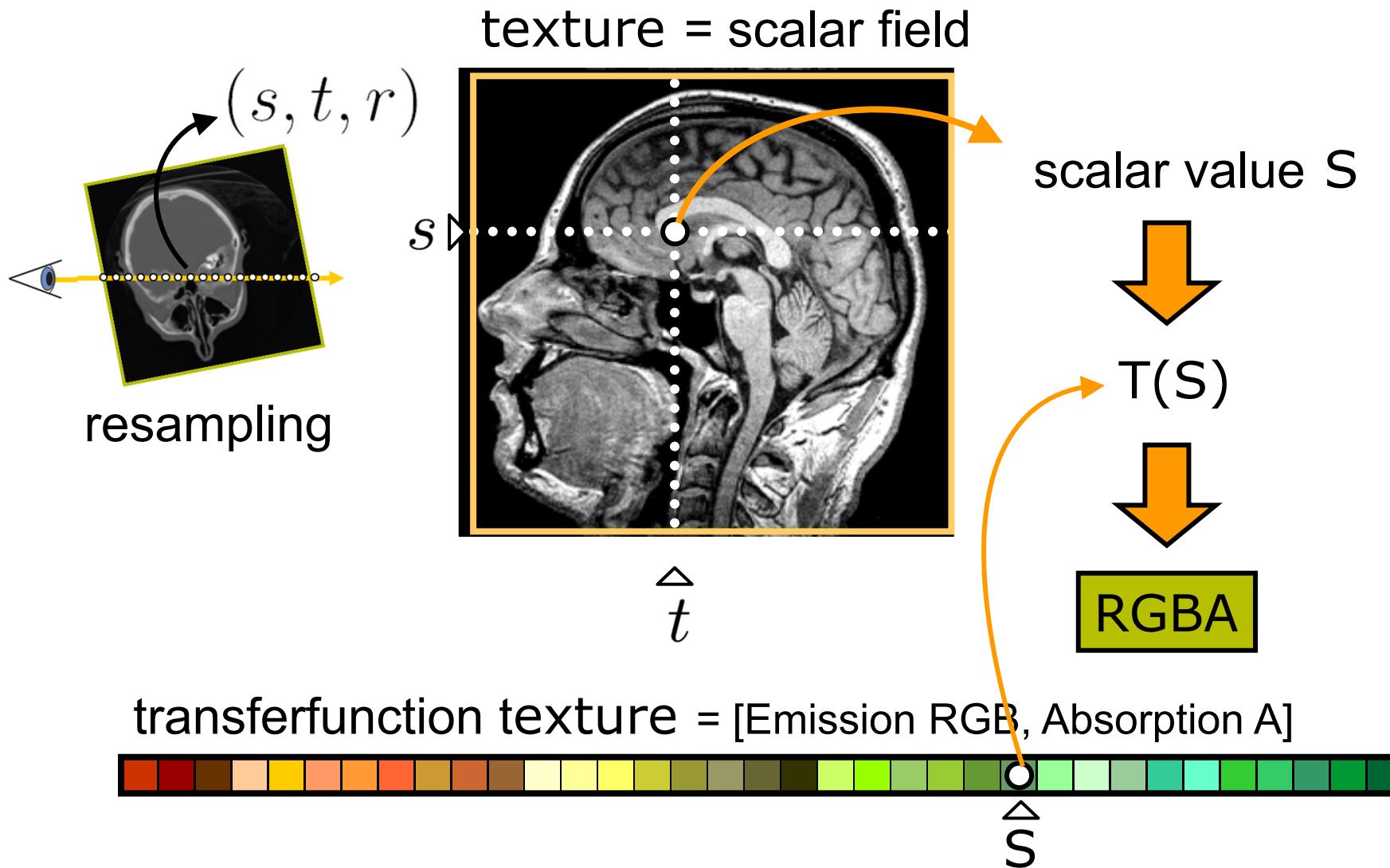
During Classification the user defines the “*look*“ of the data.

- Which parts are transparent?
- Which parts have what color?

The user defines a *transfer function*.



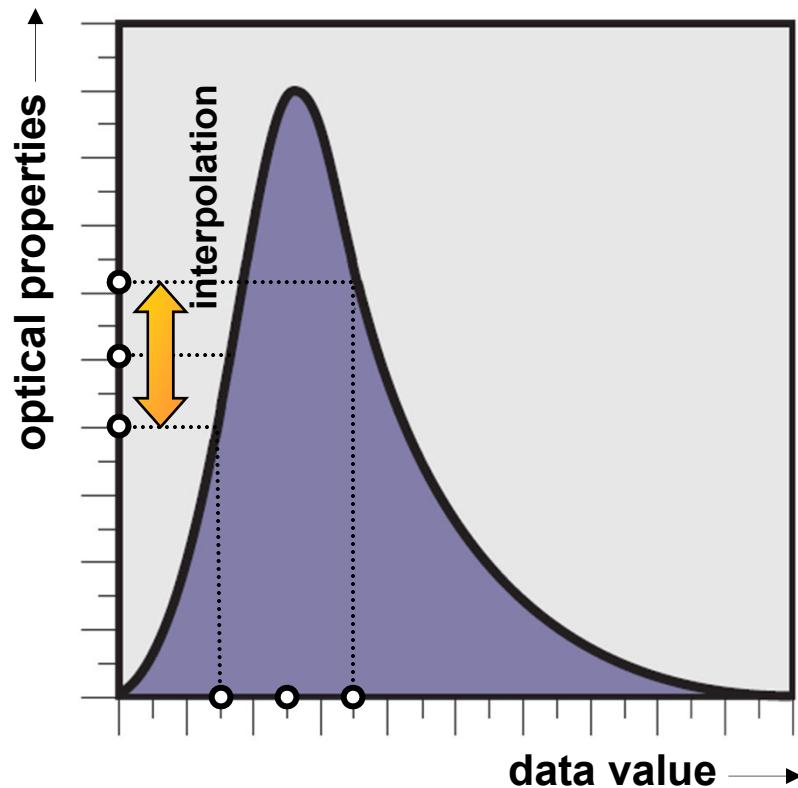
1D Transfer Functions



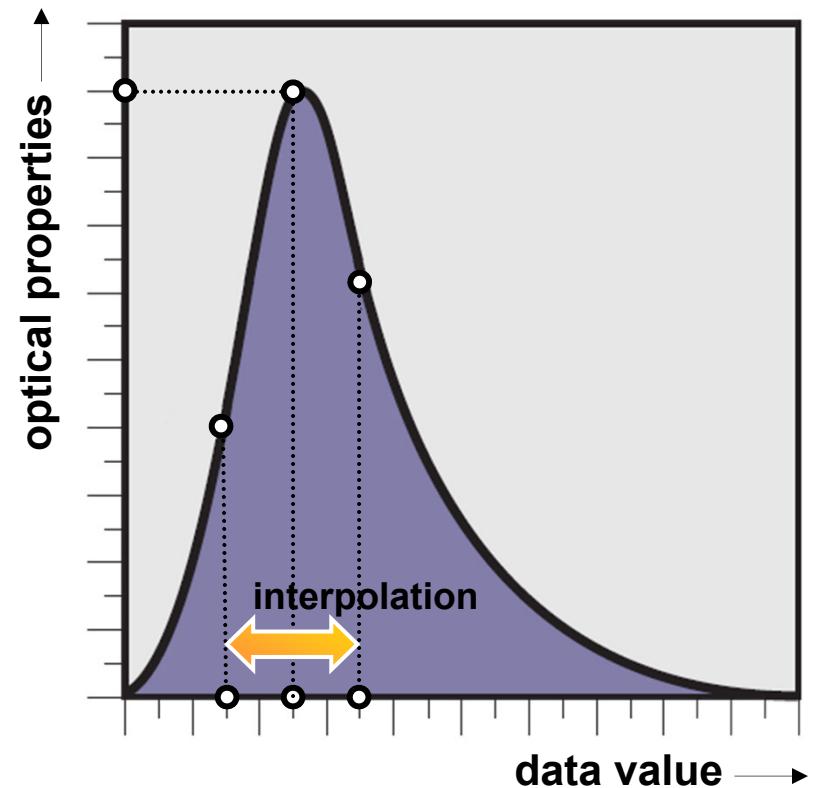
Pre- vs Post-Interpolative Classification



PRE-INTERPOLATIVE



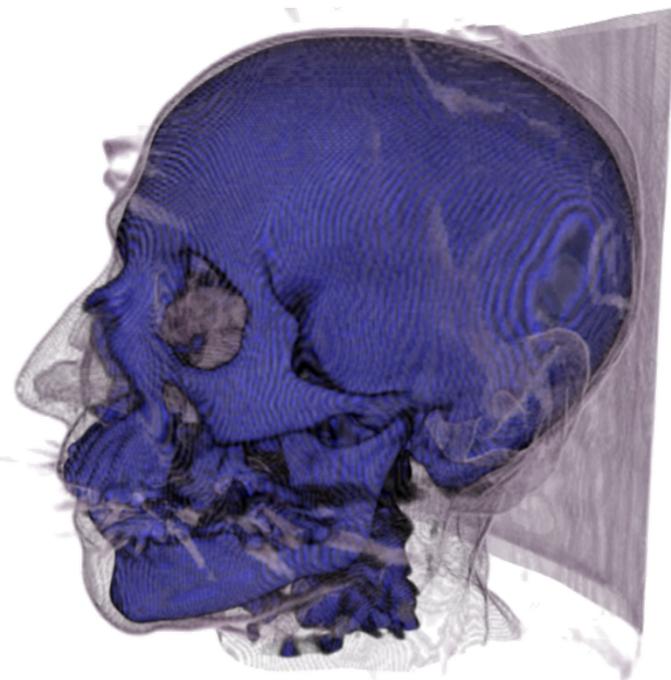
POST-INTERPOLATIVE



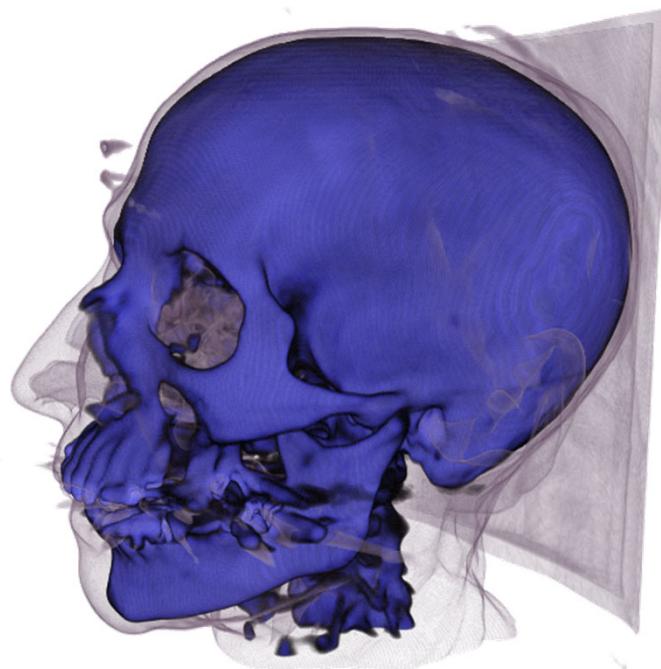
Quality: Pre- vs. Post-Classification



Comparison of image quality



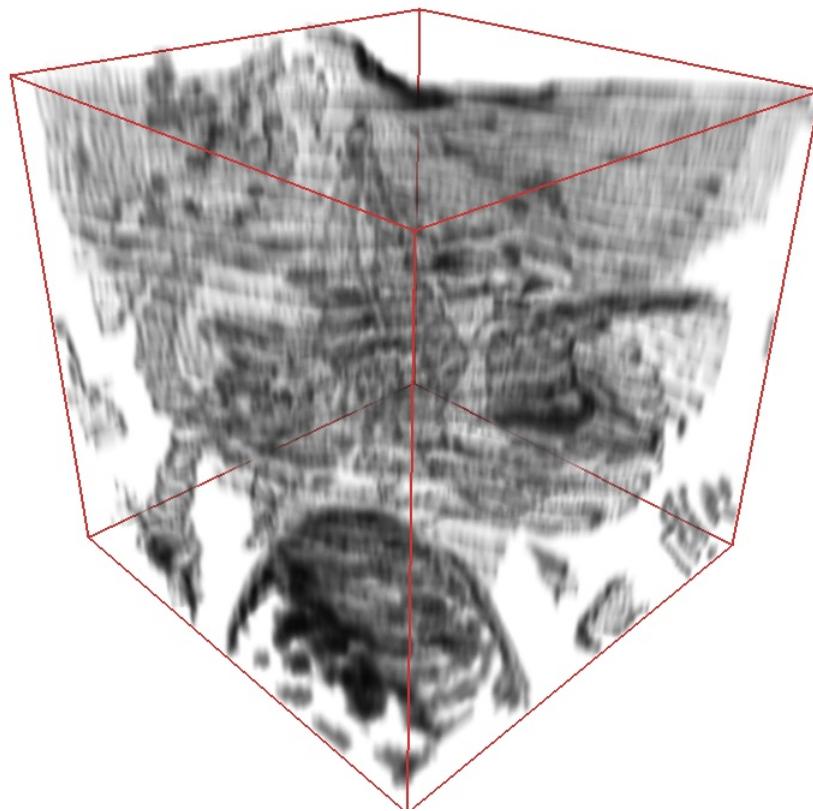
Pre-Classification



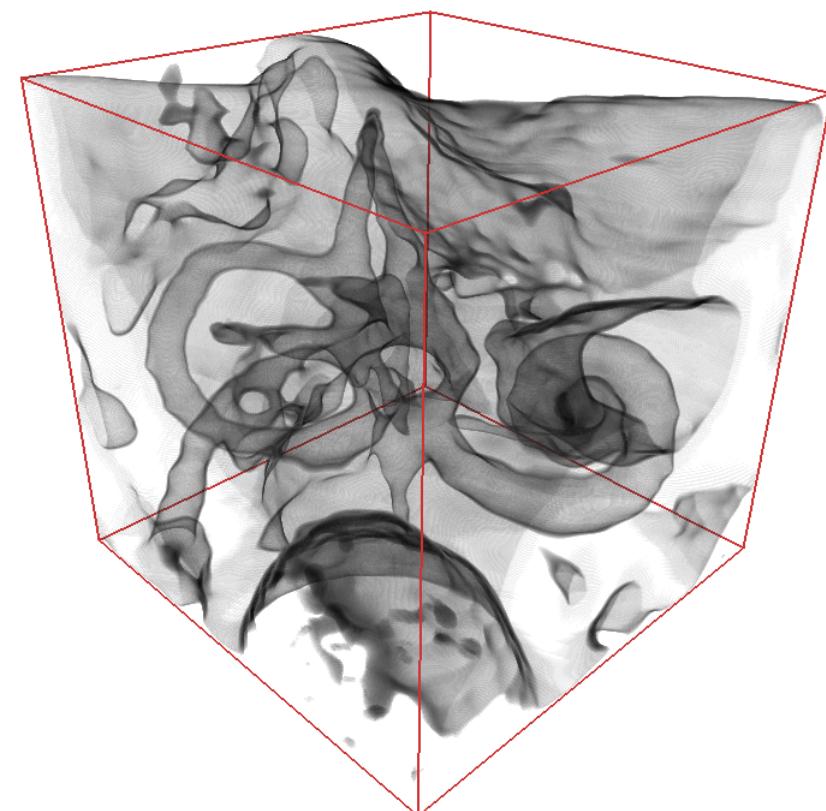
Post-Classification

same TF, same resolution, same sampling rate

Quality: Pre- vs. Post-Classification



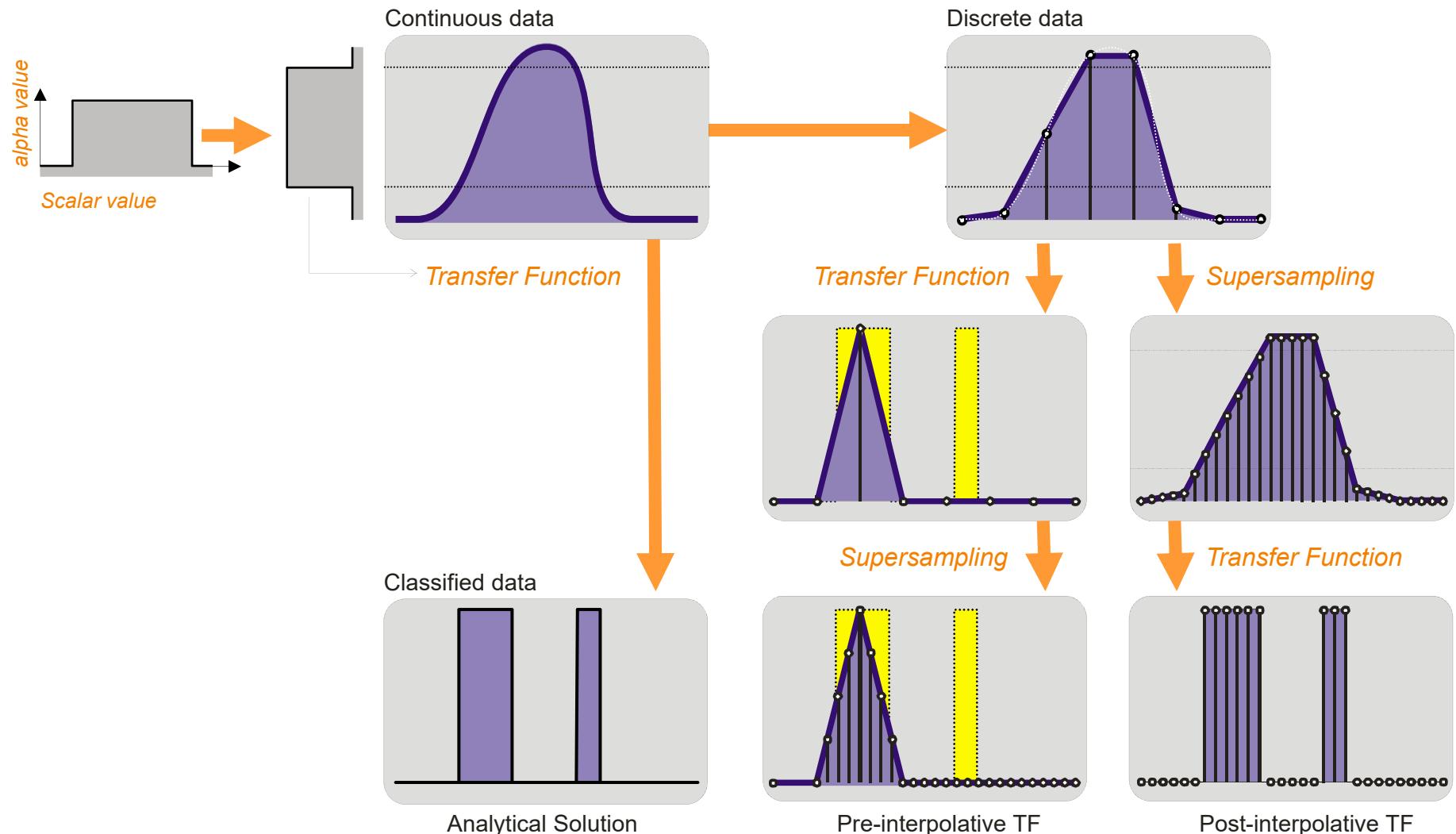
Pre-Classification



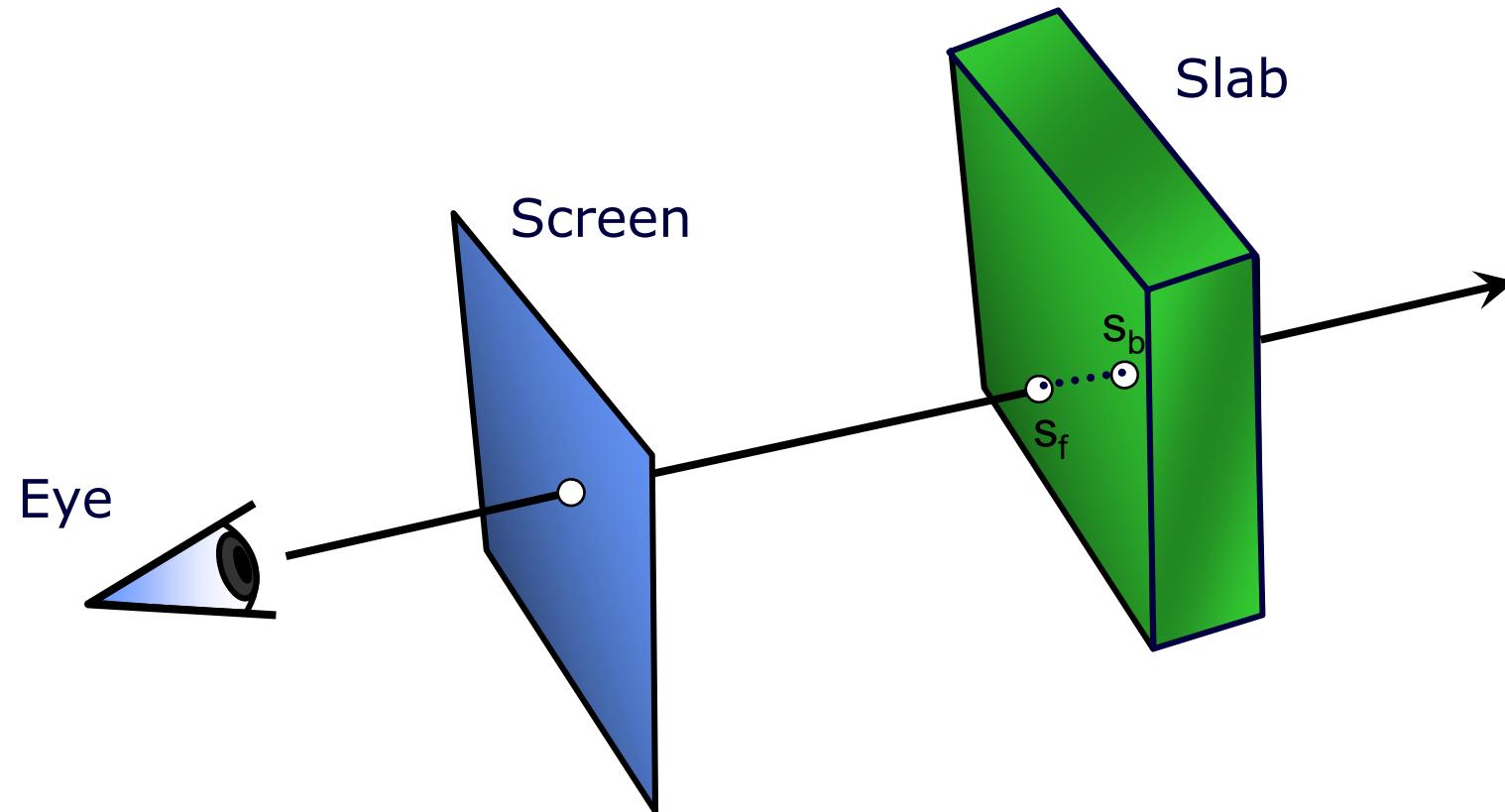
Post-Classification



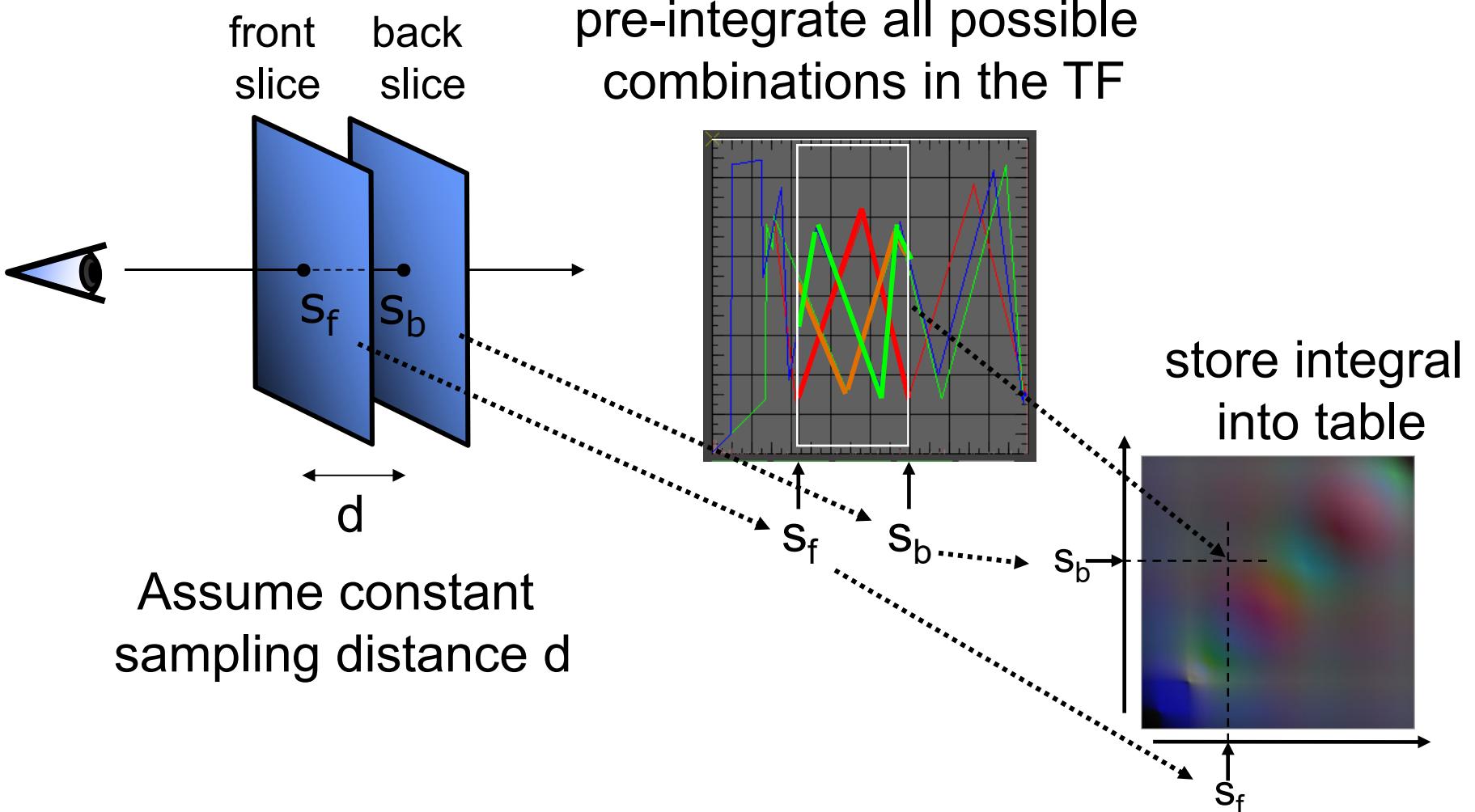
Pre- vs Post-Classification



Pre-Integrated Classification



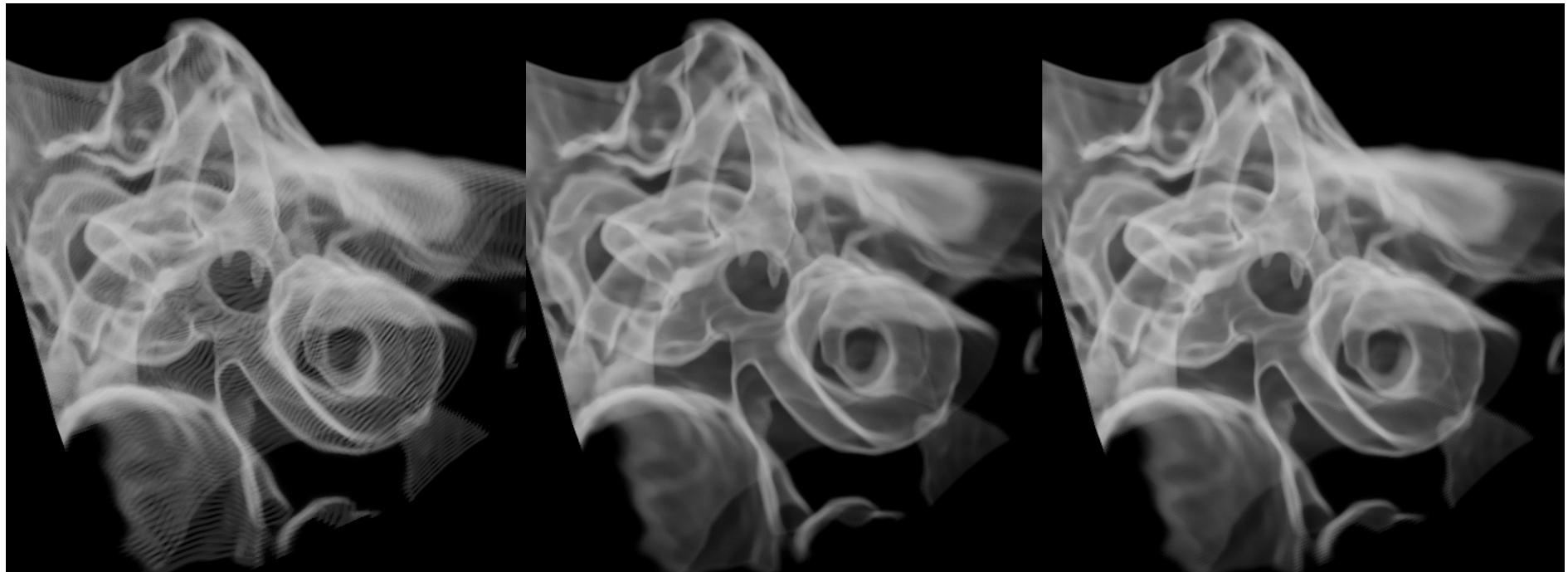
Pre-Integrated Classification





Pre-Integrated Classification

Quality comparison



128 Slices

284 Slices

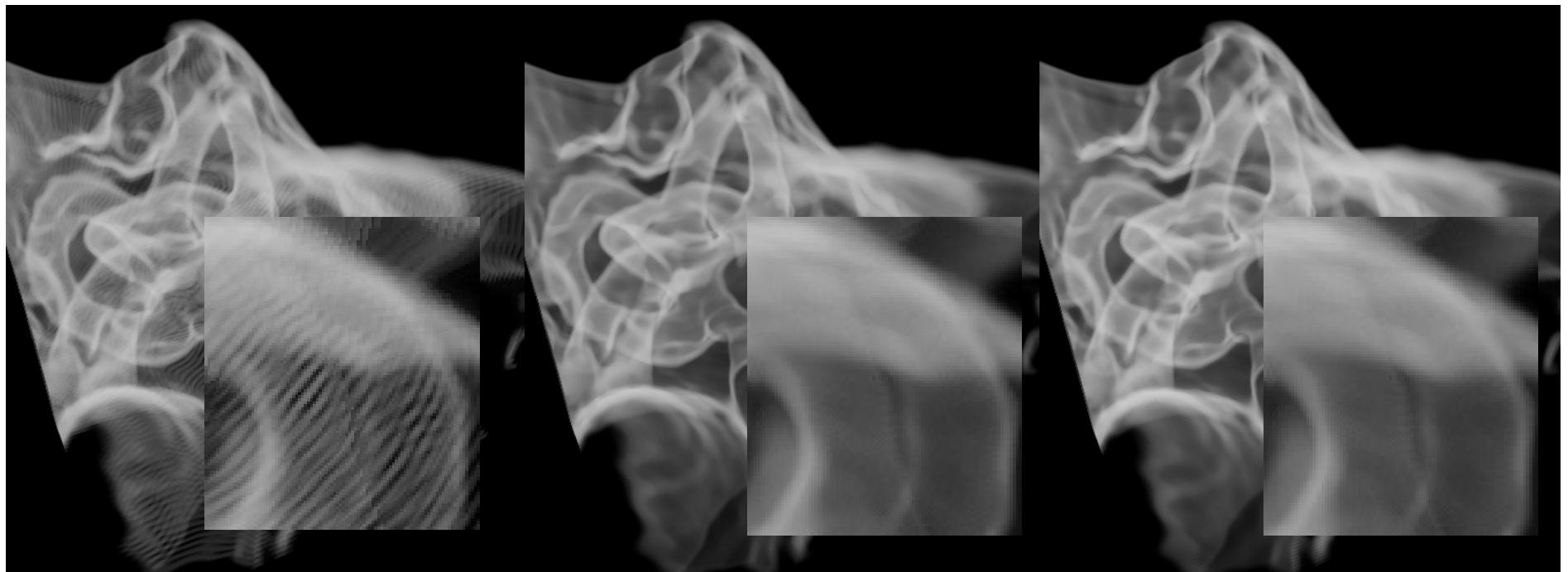
128 Slabs

© Weiskopf/Machiraju/Möller



Pre-Integrated Classification

Quality comparison



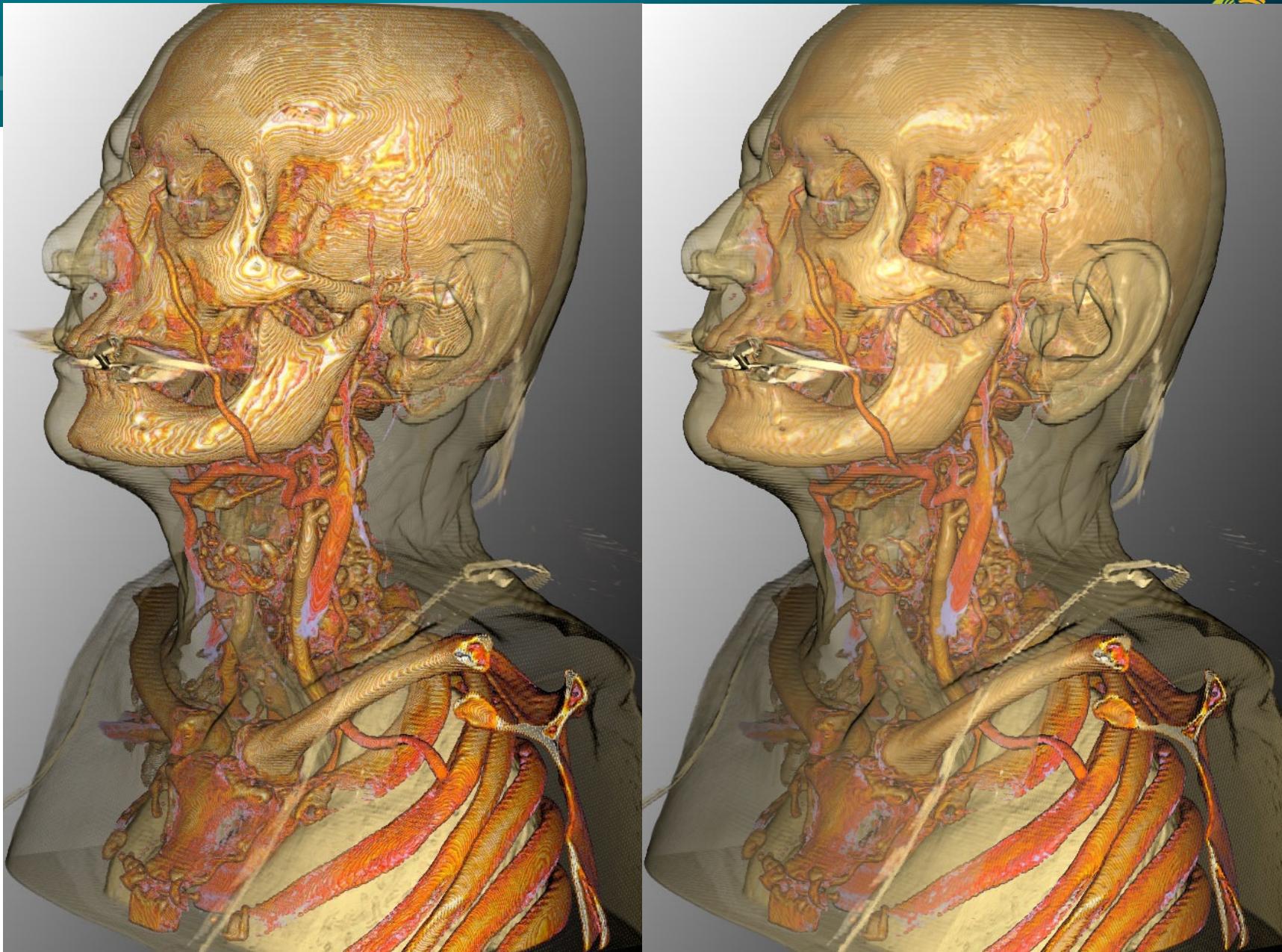
128 Slices

284 Slices

128 Slabs

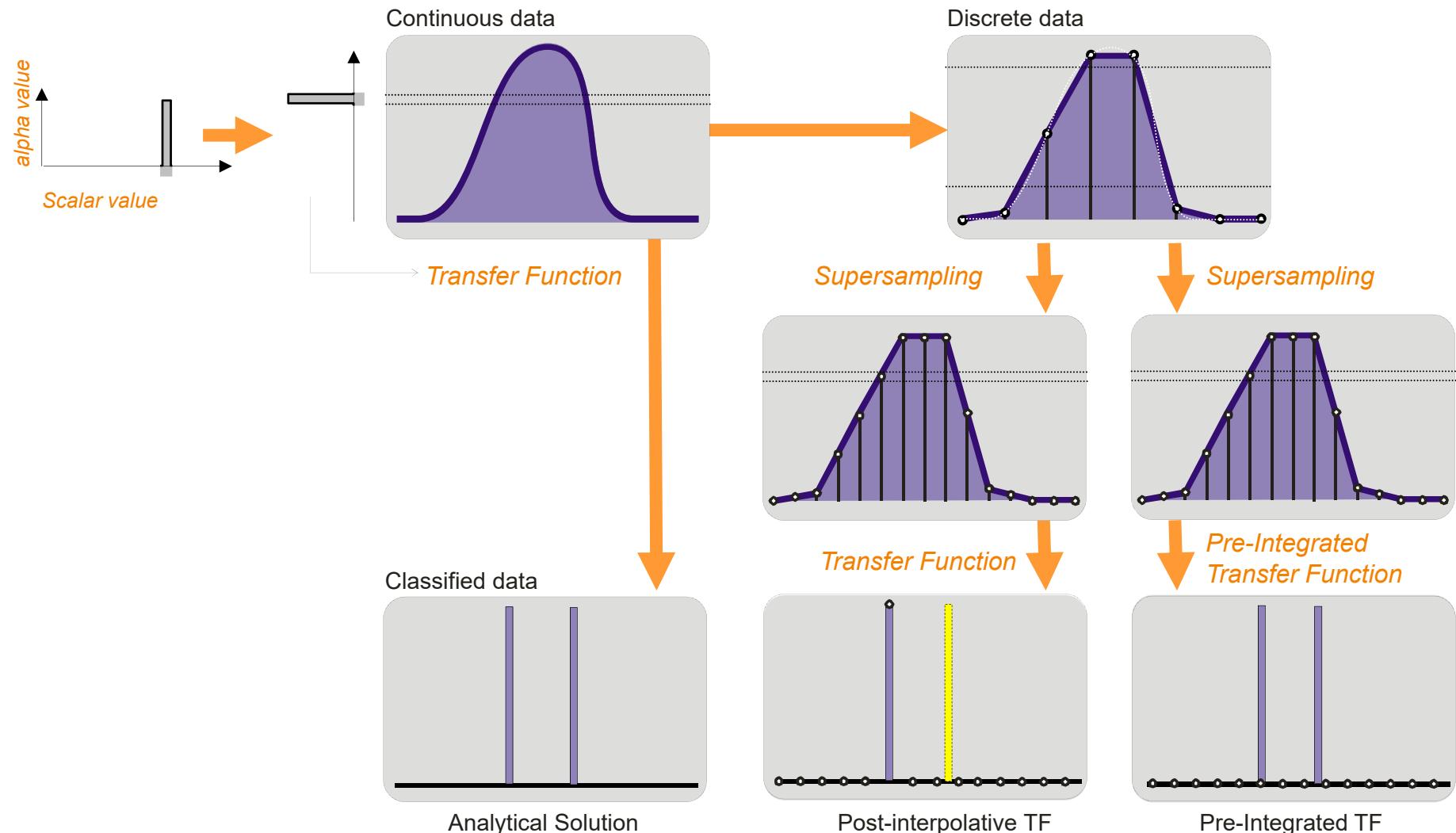
© Weiskopf/Machiraju/Möller

Pre-Integrated Classification





Post- vs. Pre-Integrated Classification



Thank you.

Thanks for material

- Helwig Hauser
- Eduard Gröller
- Daniel Weiskopf
- Torsten Möller
- Ronny Peikert
- Philipp Muigg
- Christof Rezk-Salama