



The VesselGlyph:

Focus & Context Visualization in CT-Angiography

Matúš Straka

M. Šrámek, A. La Cruz

E. Gröller, D. Fleischmann

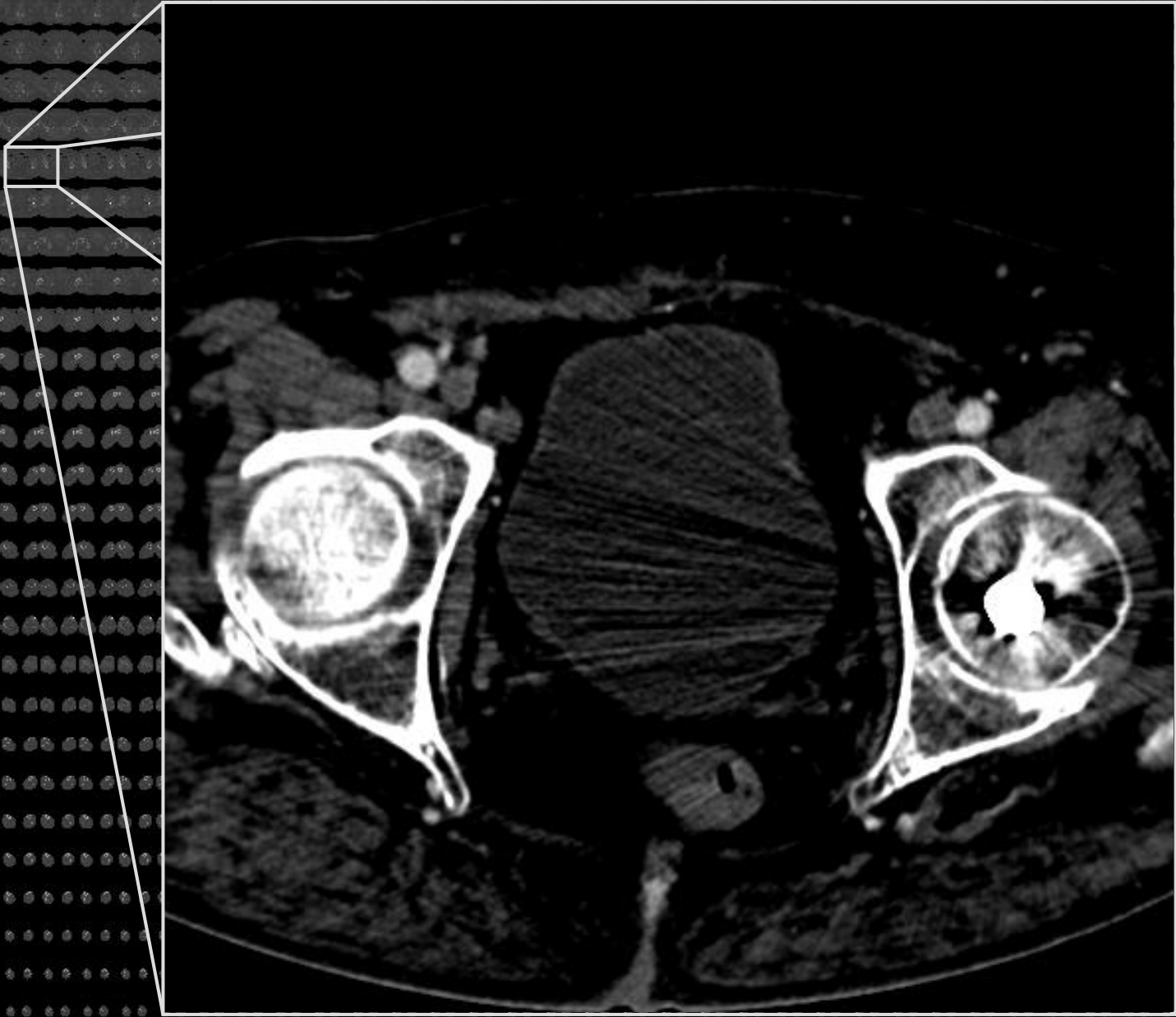


AUSTRIAN ACADEMY OF SCIENCES

ÖSTERREICHISCHE AKADEMIE DER WISSENSCHAFTEN

- ❖ Motivation:
 - » Why again a new visualization method for vessel data ?
- ❖ Concept of the VesselGlyph
- ❖ Patient data examples
- ❖ Algorithm
- ❖ Conclusion

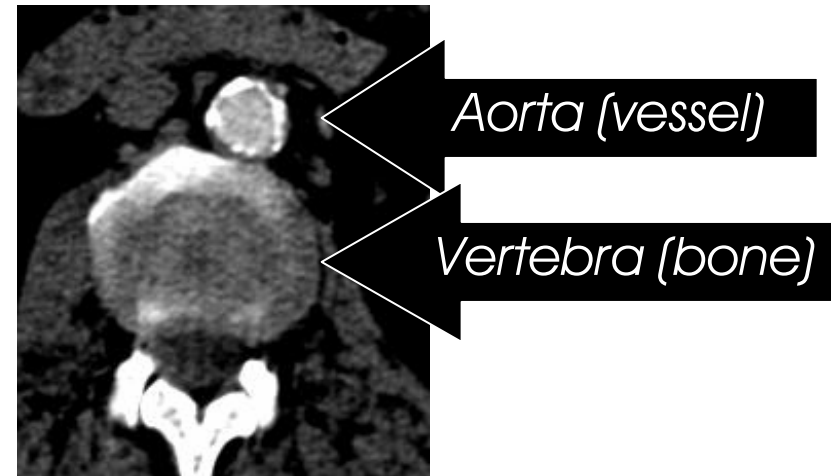
- ❖ Visualization of vessels (angiography)
 - » Diseased vessels, e.g. PAOD
 - » Depiction of soft plaque, calcifications, occlusions, ...
- ❖ Datasets acquired using helical CT scanner
- ❖ Vessels enhanced in CT-Angiography images by injection of contrast agent
- ❖ CT-Angiography data are huge (1200+ slices)



Vessel Visualization Basics

- ❖ Visualization of diseased vessels (PAOD)
- ❖ CT-Angiography data are huge (1200+ slices)
- ❖ Tissue density ranges can overlap, tissues can be spatially very close

- » Problematic segmentation
- » Only centerlines of the main vessels often available



- ❖ Vessels represent a small part of the dataset
- ❖ The rest is important as an anatomic context

The AngioVis Project

- ❖ Interdisciplinary project aimed at visualization and assessment of vessels in 3D CT-Angiography datasets
 - » Development of new methods and SW tools
- ❖ Cooperation of:
 - » Austrian Academy of Sciences
 - » Vienna University of Technology, Austria
 - » General Hospital (AKH) of Vienna, Austria
 - » Stanford Medical Centre, USA

Vessel Visualization Basics

Maximum Intensity Projection (MIP)



Curved Planar Reformation (CPR)

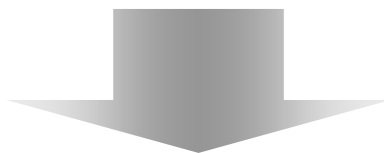


Direct Volume Rendering (DVR)



Why something new ?

- ❖ Objects in focus (vessels) need to be enhanced in the images
- ❖ Anatomic context is important for orientation in the images
 - » No relevant anatomic context in CPR images
 - » Depth perception ambiguous in MIP images
 - » Occlusion in MIP and DVR images
- ❖ Anatomic context should not dominate the images

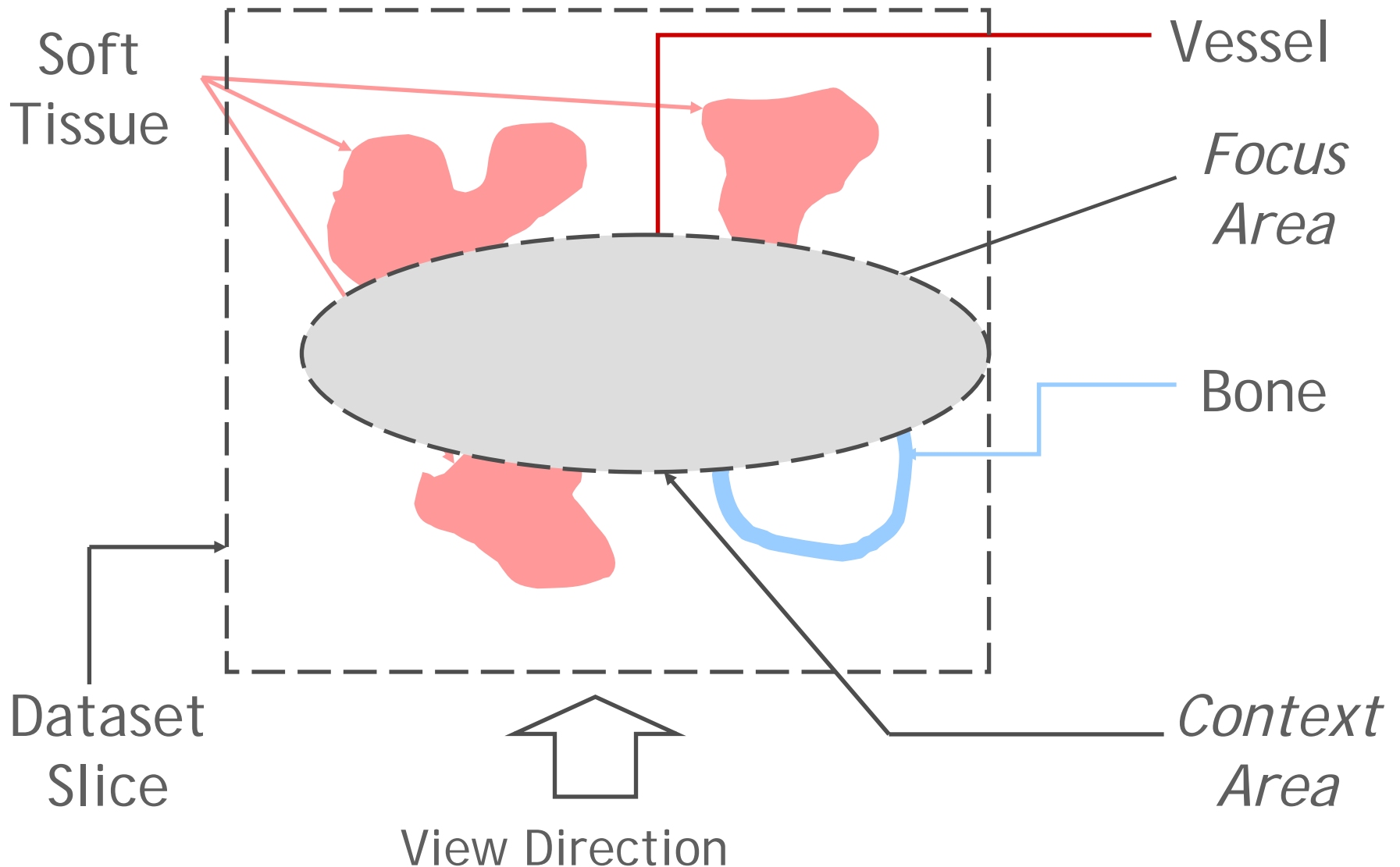


Different visualization techniques and/or parameters for focus and context are needed

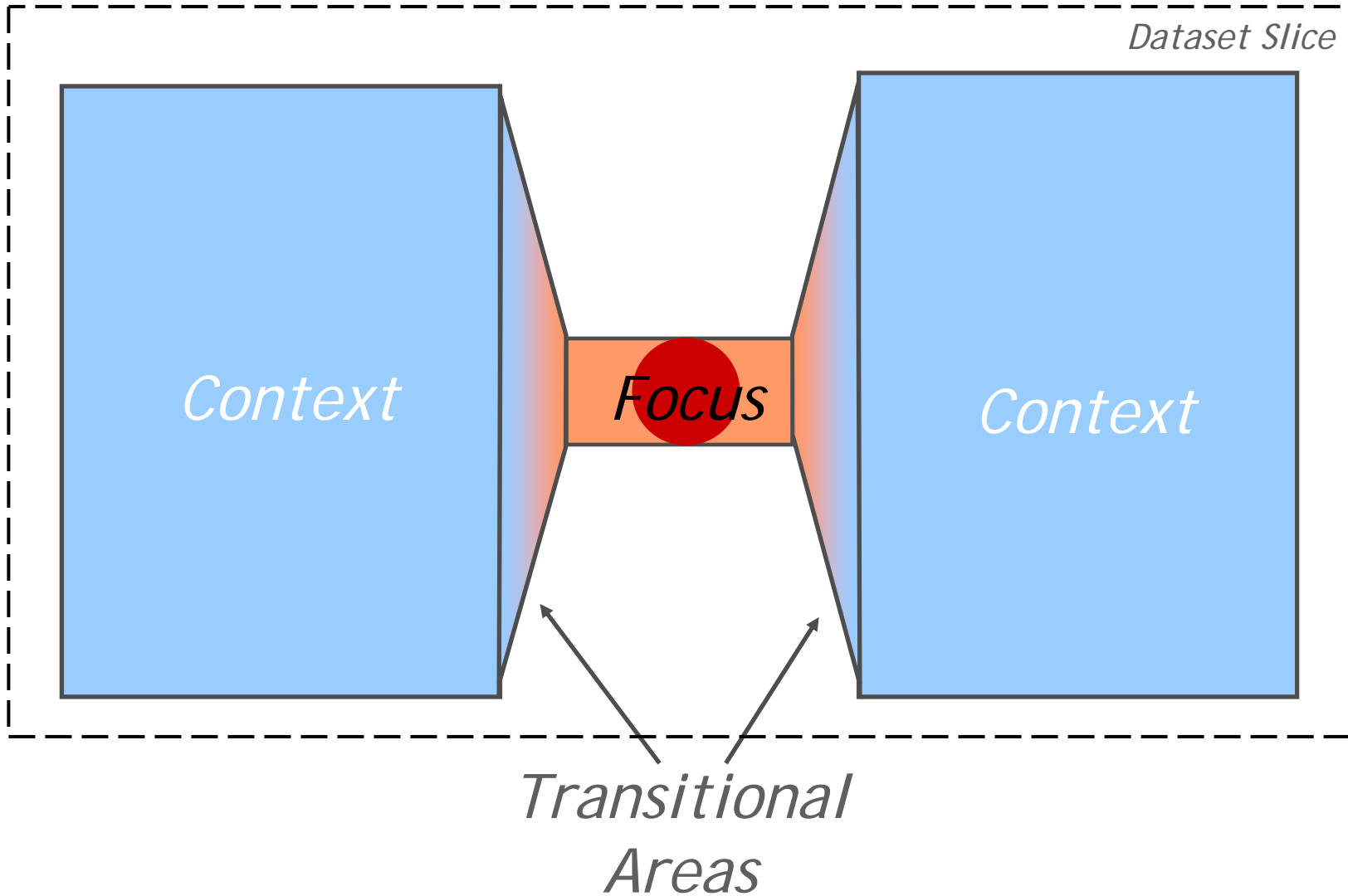
The VesselGlyph

- ❖ Is a concept for:
 - » Spatially dependent definition of focus and context areas
 - » Combination of various visualization techniques and/or parameters therein
 - » If necessary, allows also smooth transition in between
- ❖ Focus and context areas are defined by:
 - » Vessel centerlines
 - » Voxel-to-centerline distances and viewing vector

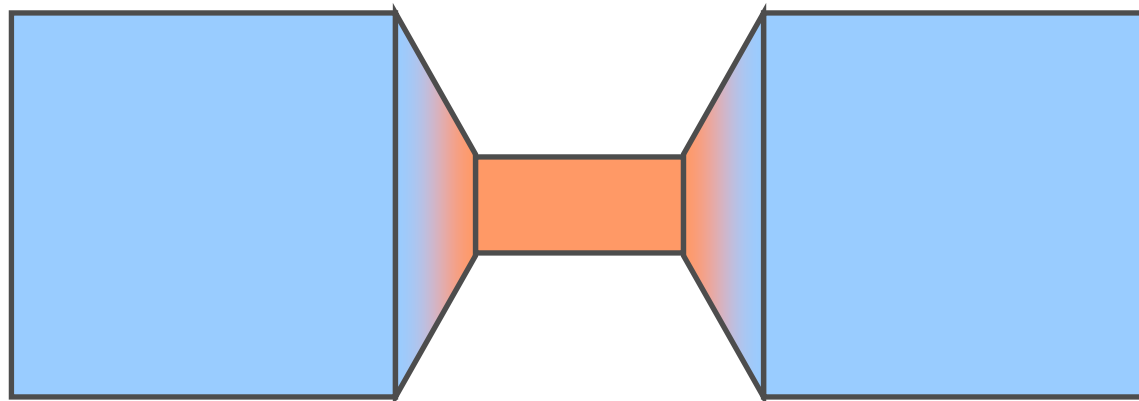
The VesselGlyph Concept



VesselGlyph Construction

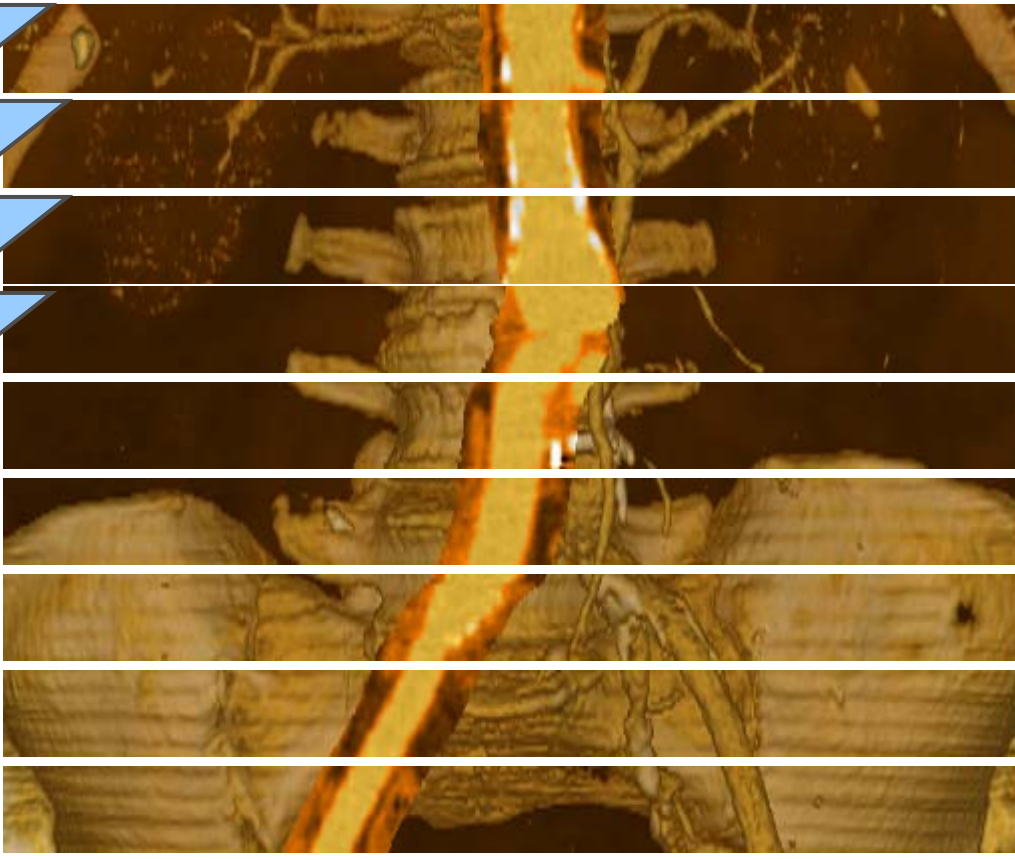
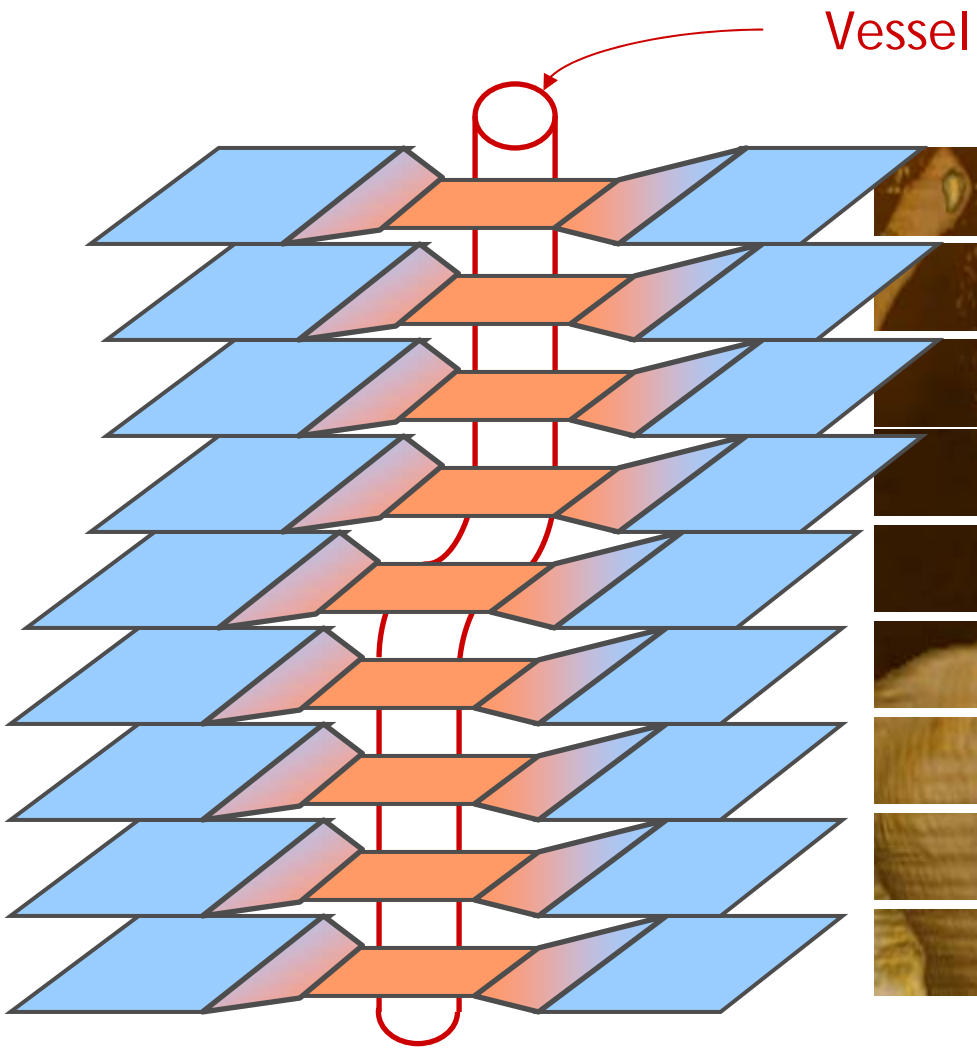


- ❖ For tubular structures, VesselGlyph
 - » can be used as 2D-to-3D interface
 - » Allows easy modification of parameters (size, layout, technique, ...) in 2D widget

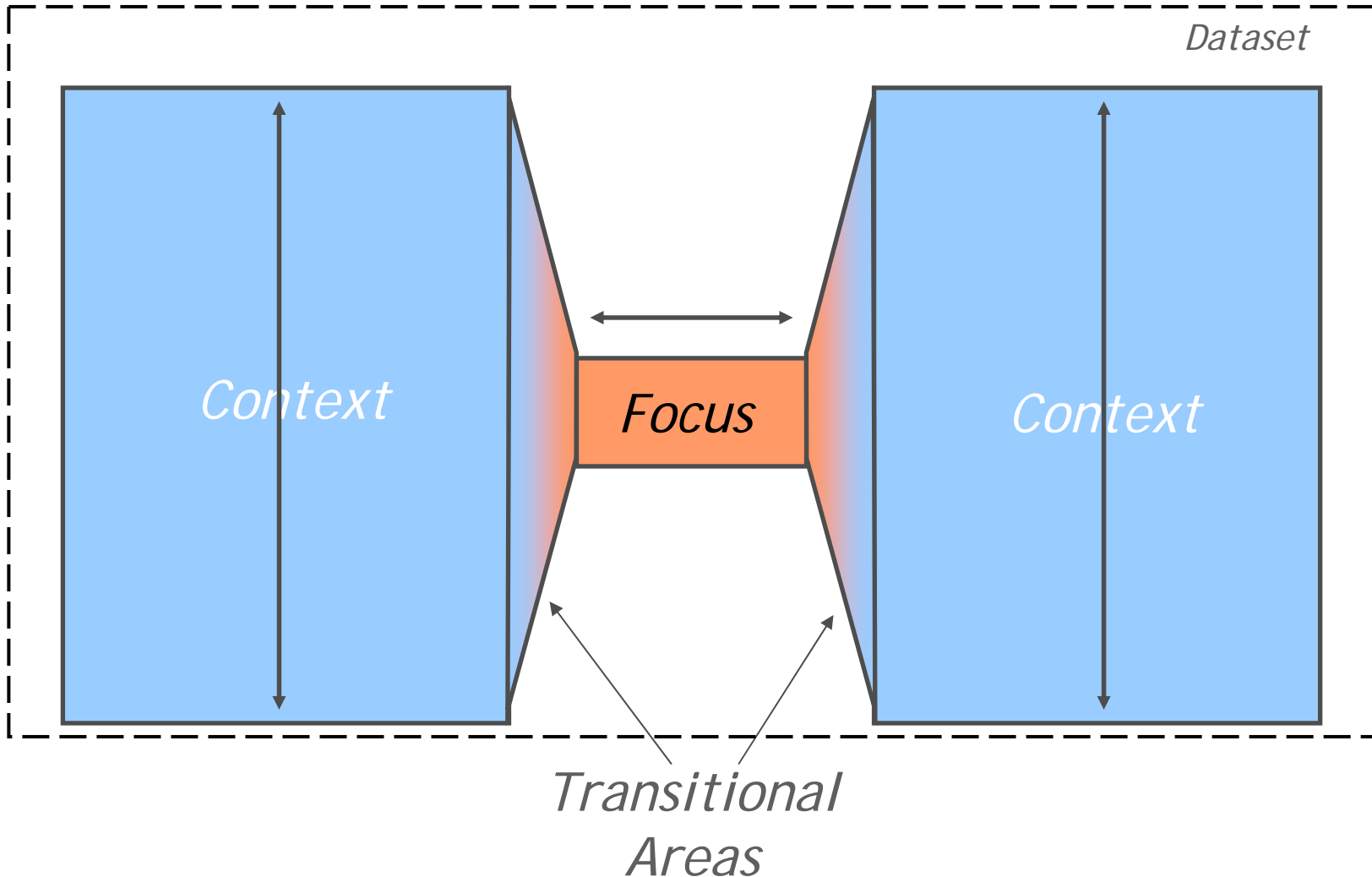


- » Swept along the centerline for 3D results

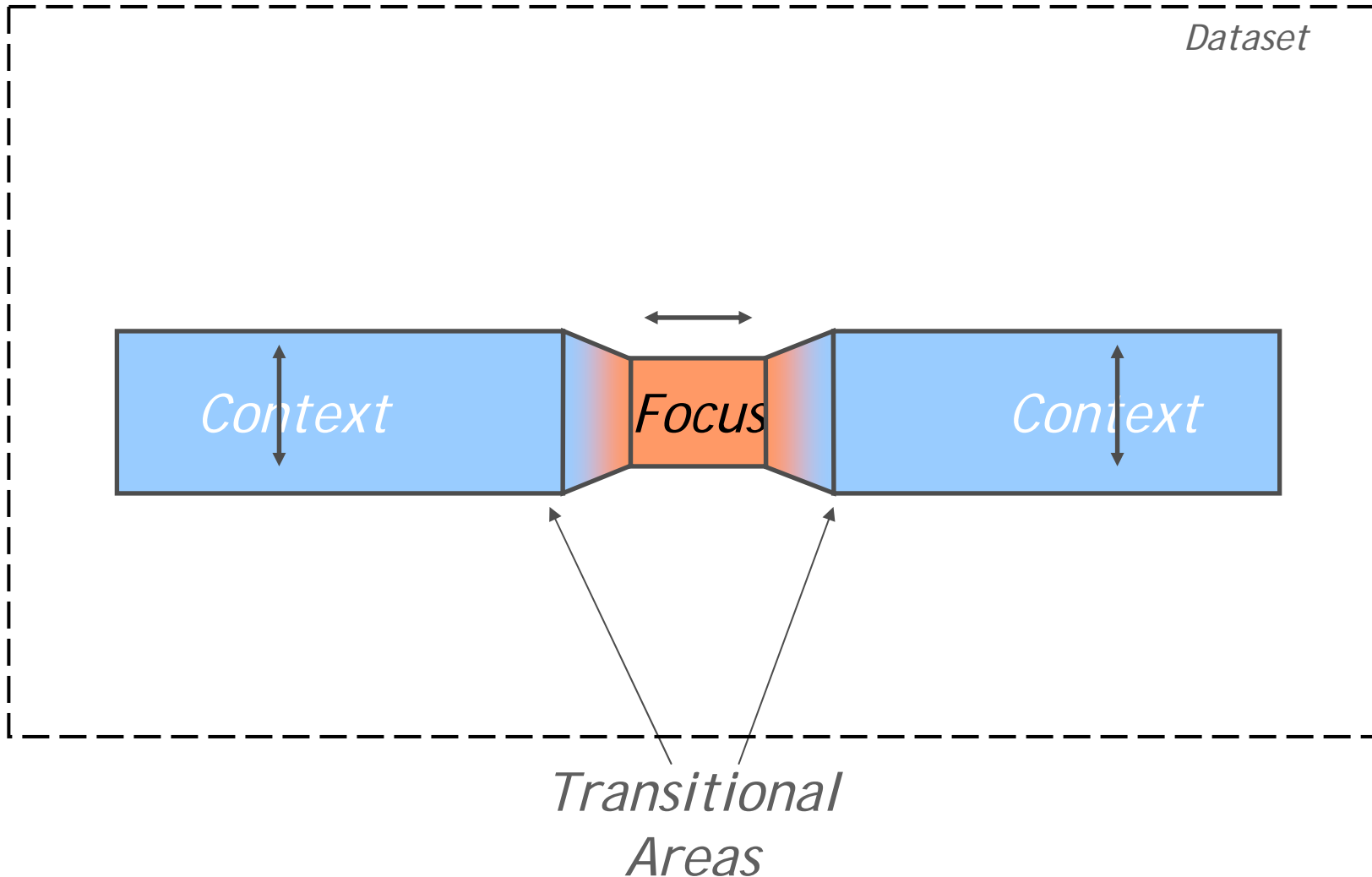
VesselGlyph Application



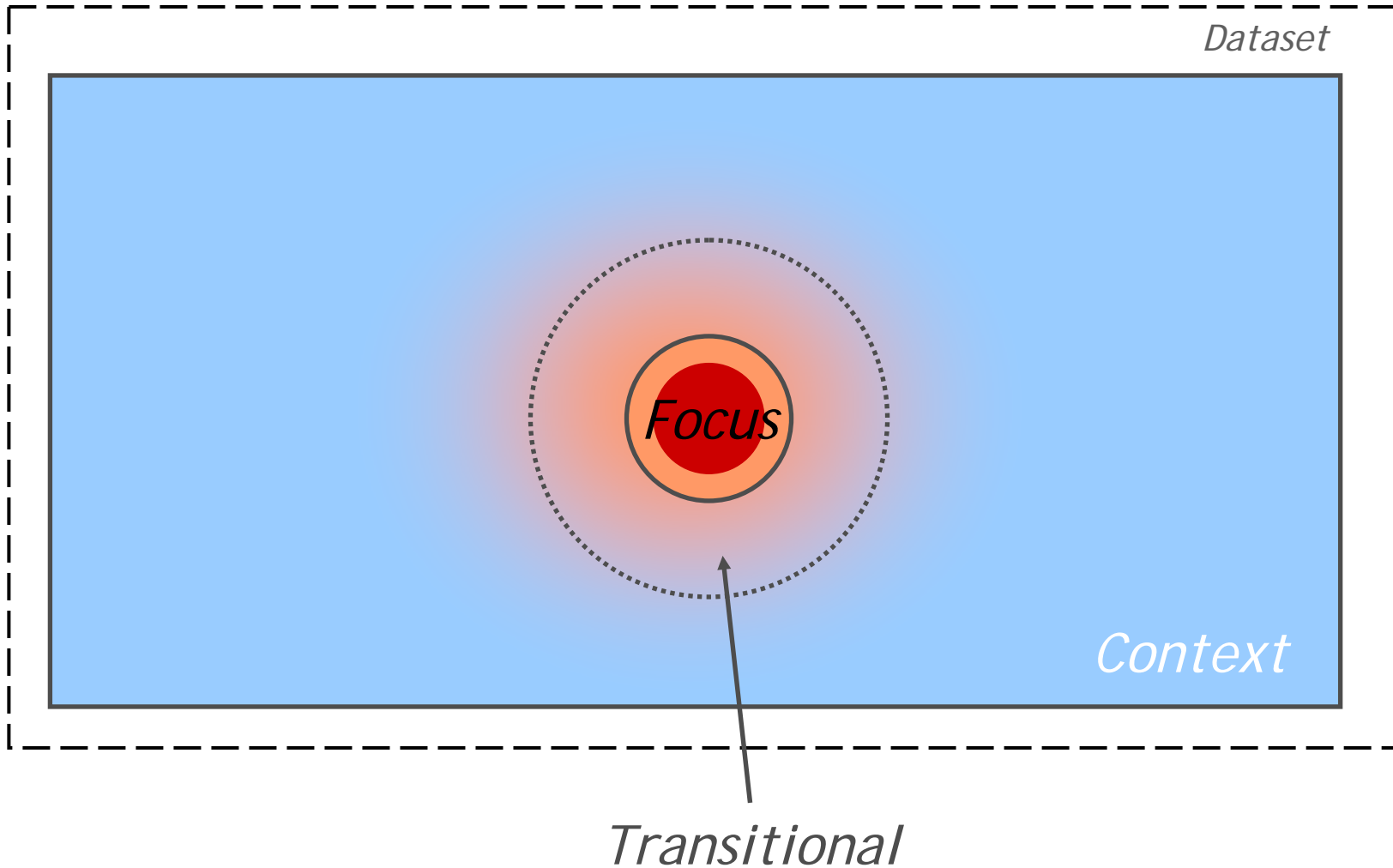
VesselGlyph Layouts



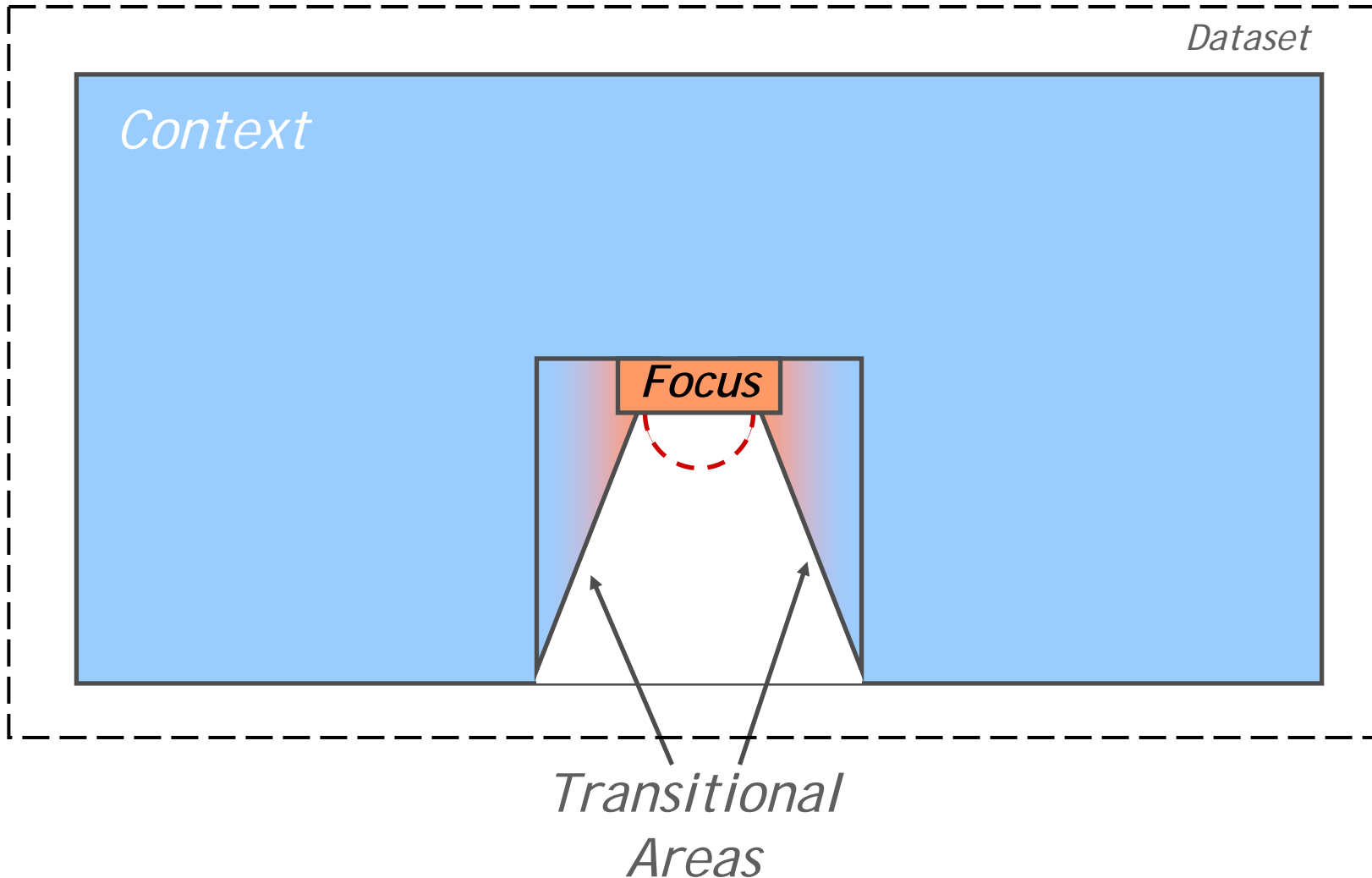
VesselGlyph Layouts



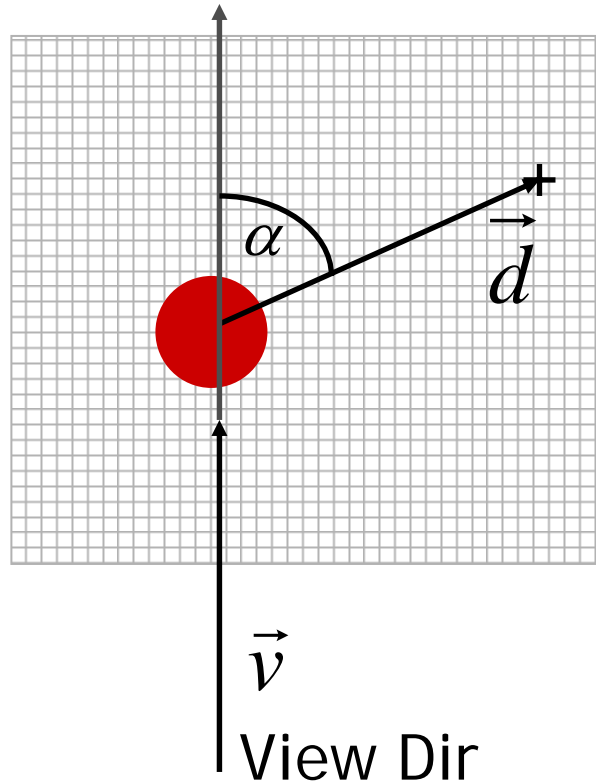
VesselGlyph Layouts



VesselGlyph Layouts



Focus & Context Definition



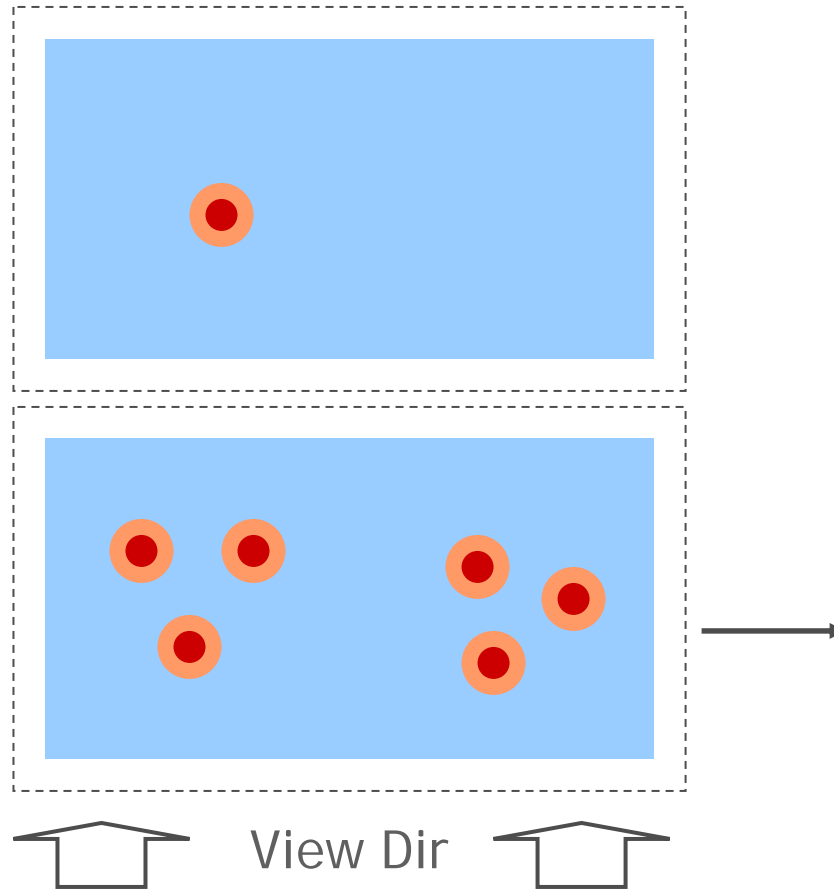
$$f_{f/c} = f(\vec{d}, \vec{v})$$

or

$$f_{f/c} = f(|\vec{d}|, \alpha)$$

Tubular VesselGlyph

- » Normal DVR for focus
- » Transparent DVR for context



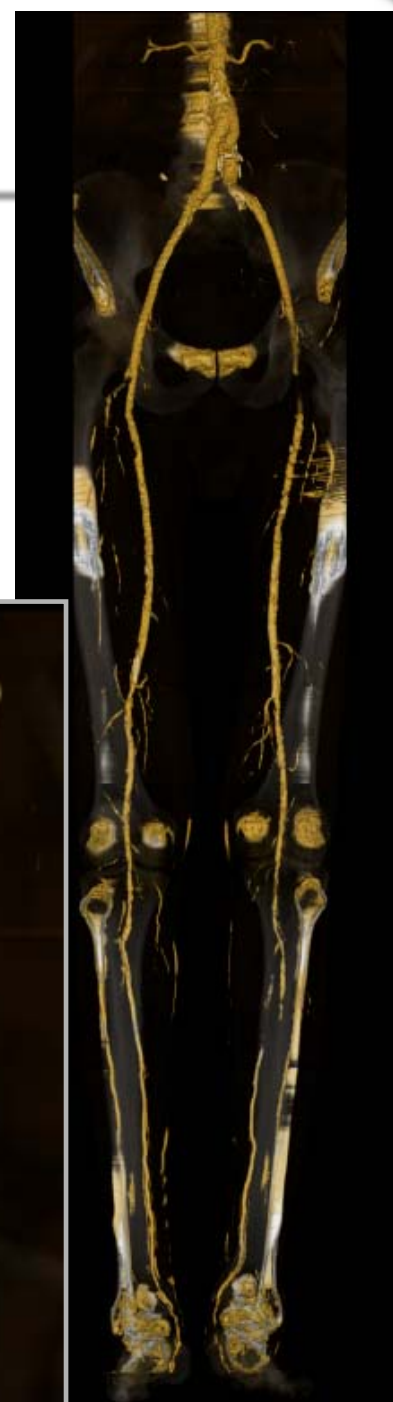


Thick-Slab VesselGlyph

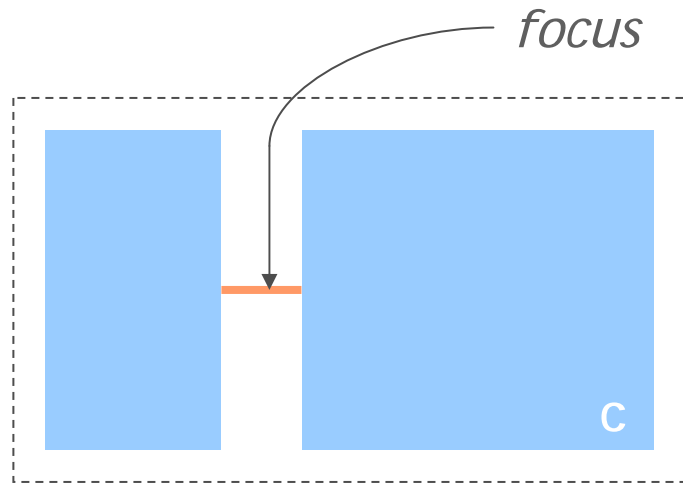


- » Normal DVR for focus
- » Transparent DVR for context

View Dir



CPR-in-DVR VesselGlyph



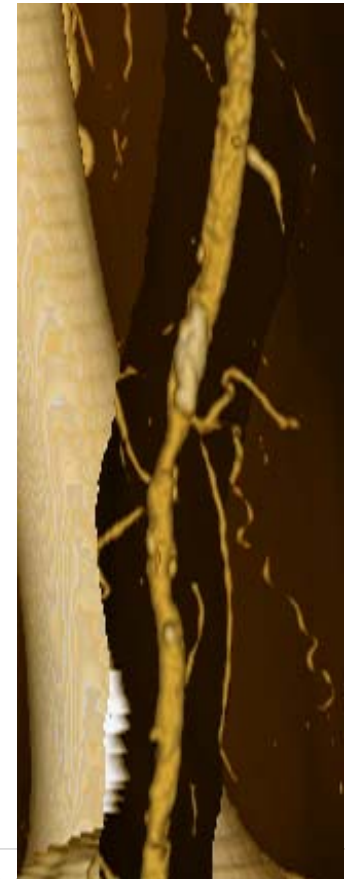
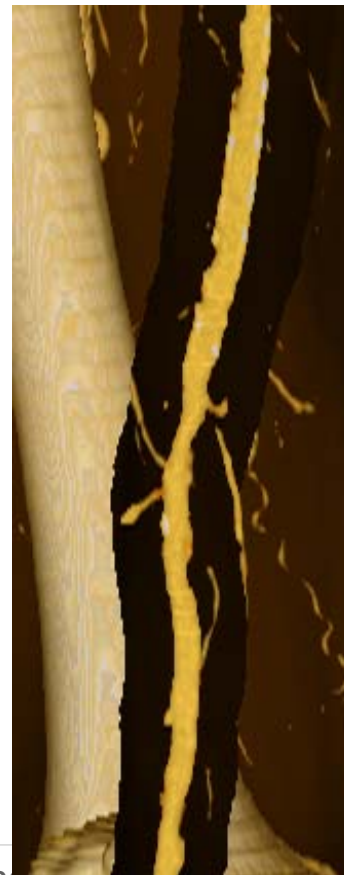
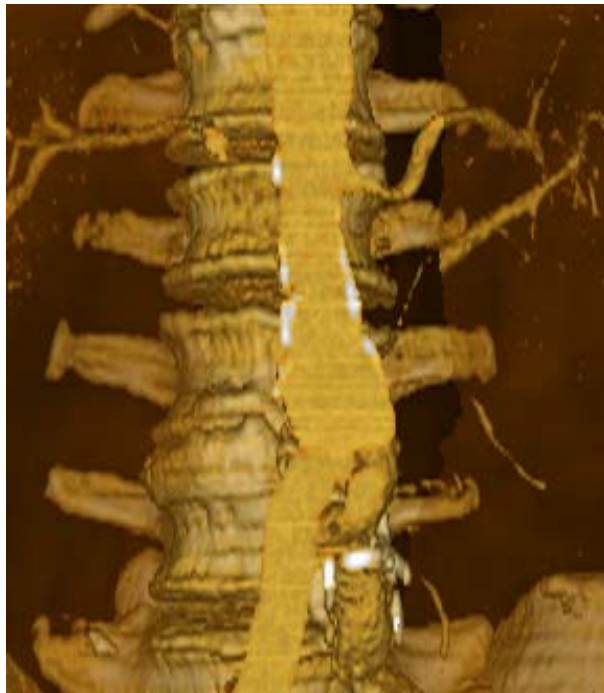
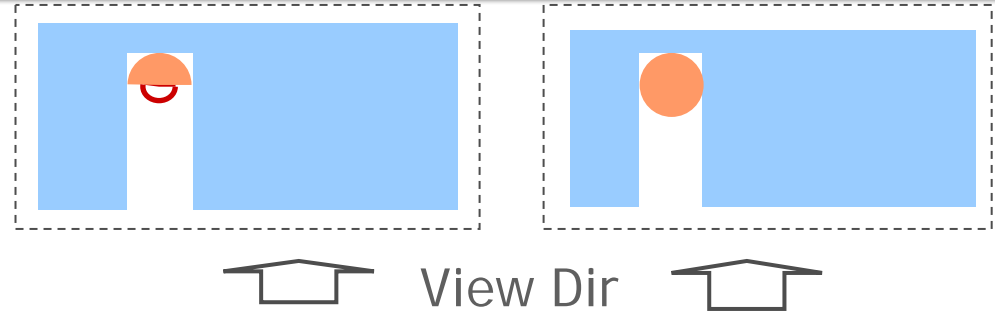
↑ View Dir ↑

- » CPR for focus
- » DVR for context

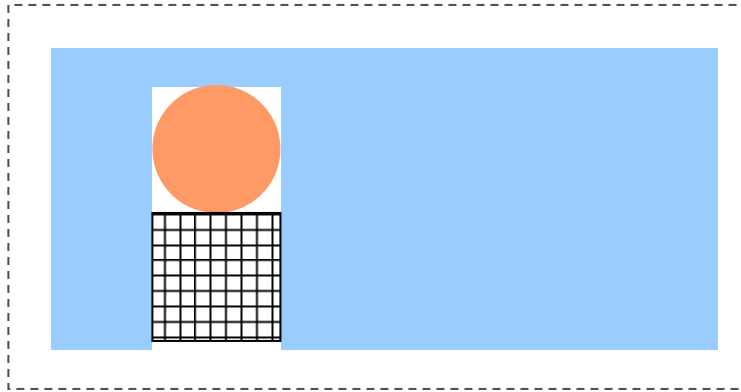


Foreground-Cleft

- » DVR for focus
- » DVR for context



Foreground Cleft with Occlusion Lines



- » DVR for focus
- » DVR for context



↑
Rear view
← Front view

Algorithm

- ❖ Three-stage processing:
 - » 1. Distance-to-centerline evaluation
 - » 2. Focus and context partial rendering
 - » 3. Compositing of partial renderings
- ❖ Compositing of partial renderings can be:
 - » Implicit (F/C rendered at once)
 - » Based on distance
 - » Based on data density



Algorithm

- ❖ Extension of standard DVR algorithm
- ❖ Opacity depends also on spatial location
- ❖ Transparency modifier coefficient:
 - » Influences opacity transfer function
 - » Different for focus and context – $f_{f/c}$
 - » Works for DVR+DVR layouts
- ❖ Special cases - DVR+CPR, DVR+MIP

❖ VesselGlyph:

- » Is a generalization of various visualization techniques (DVR, CPR, MIP, ...)
 - » Displays unoccluded objects in a correct anatomic context
-

❖ Clinical evaluation in progress

❖ Extension to arbitrary shapes using distance fields



Thank you for your attention

matus.straka@assoc.oeaw.ac.at

<http://www.viskom.oeaw.ac.at/~straka/AngioVis>

