IA369E

Tópicos em Engenharia de Computação VI

Segundo Semestre de 2013

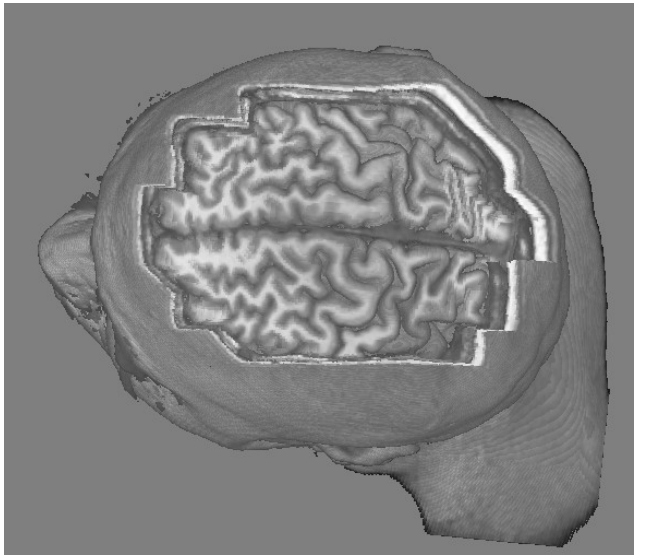
Técnicas de Renderização Volumétrica

Profa. Ting

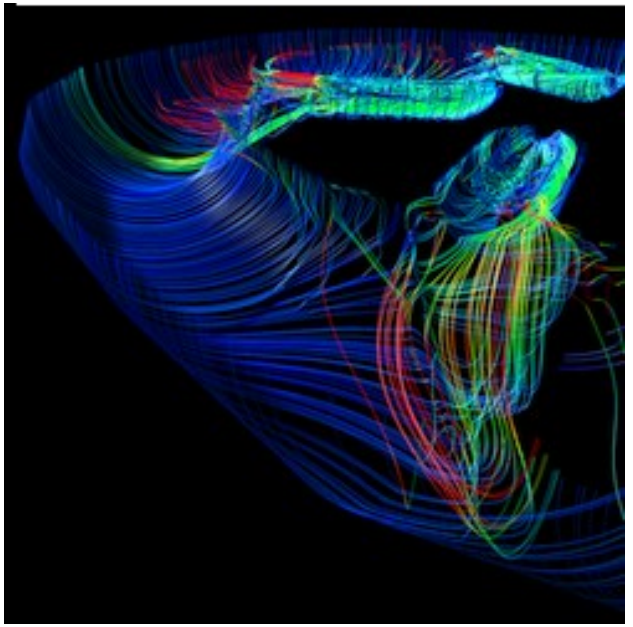
Renderização Volumétrica

Amostras

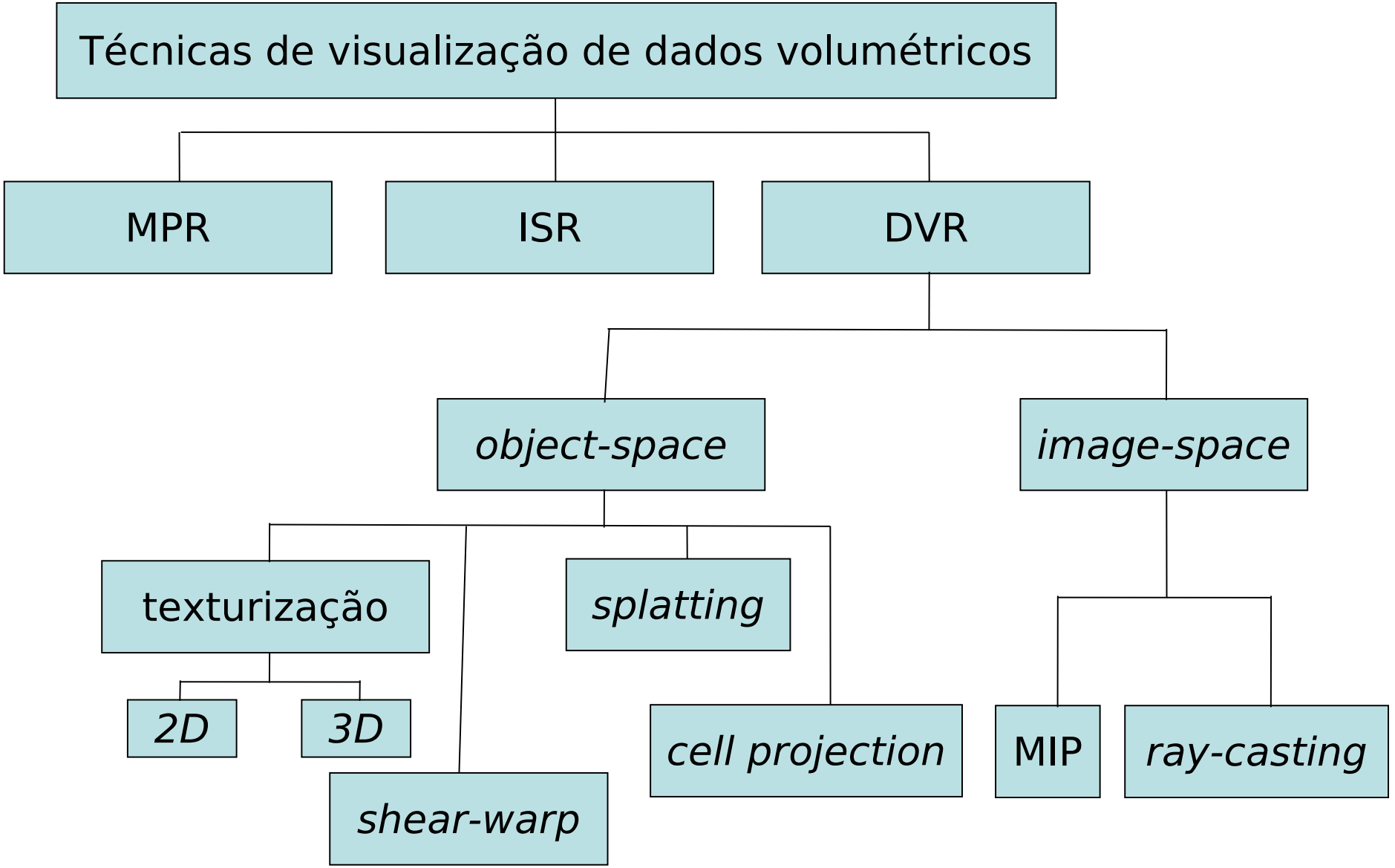
escaneadas



simuladas

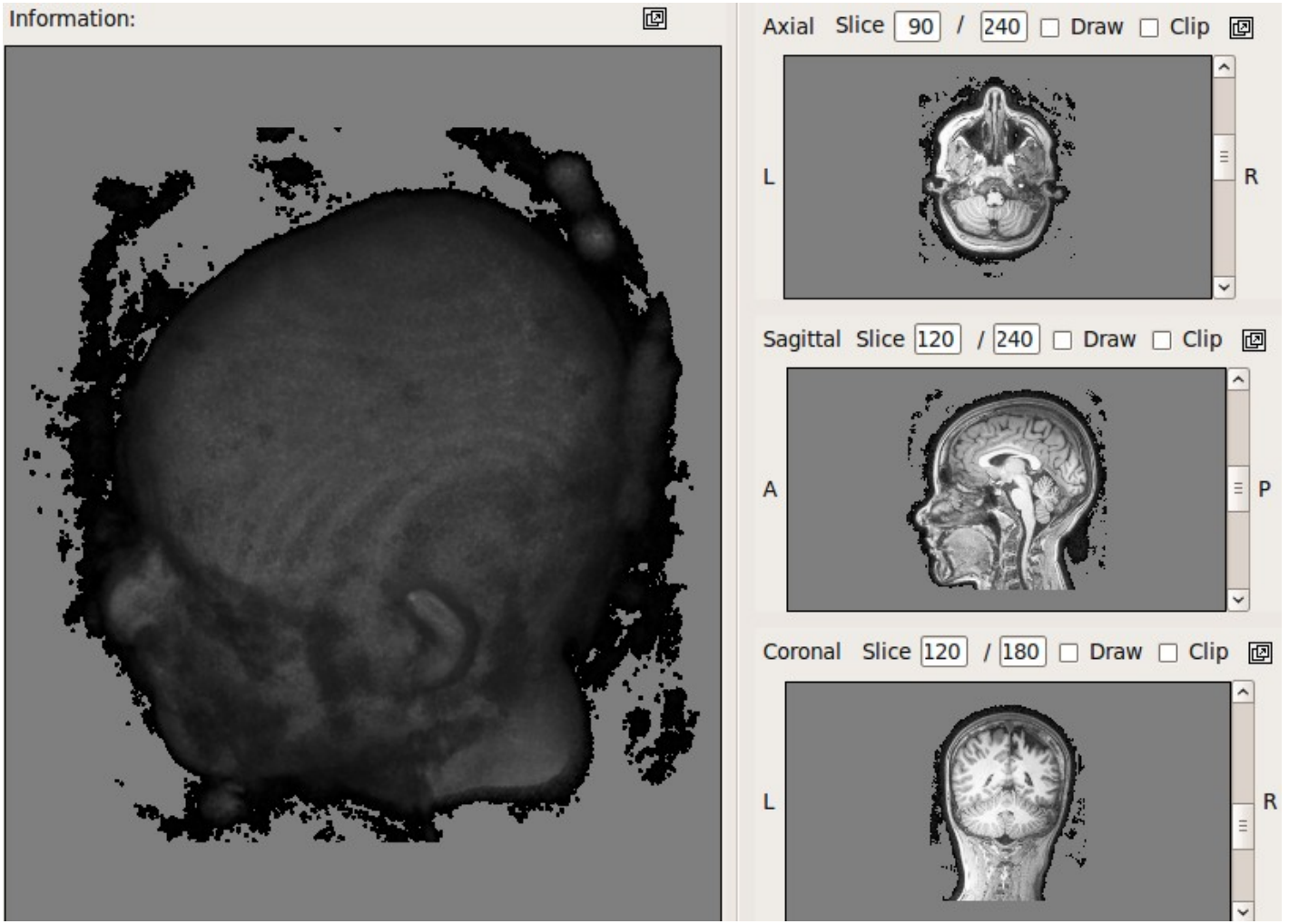


Uma Classificação



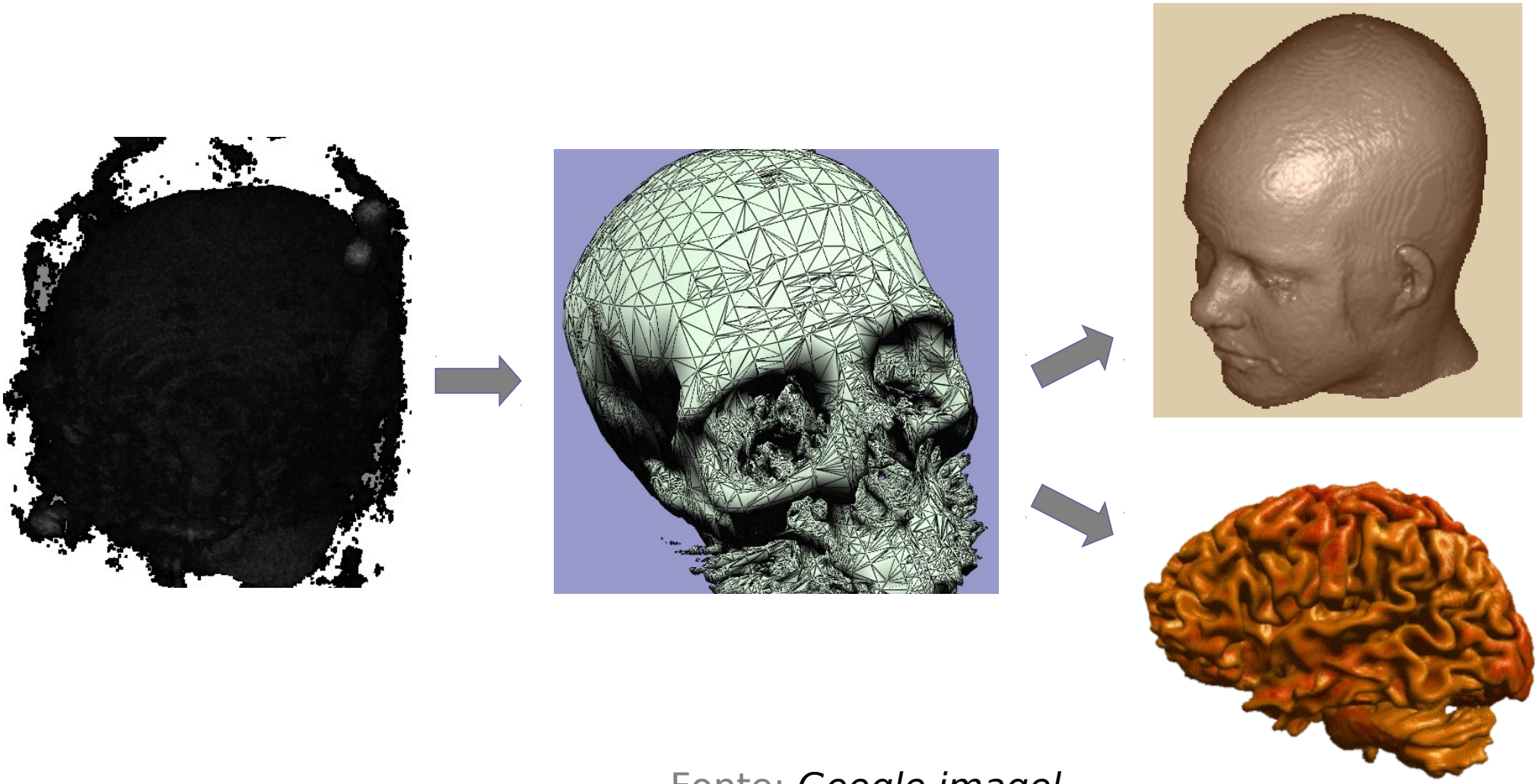
MPR

- Reformatação Multiplanar



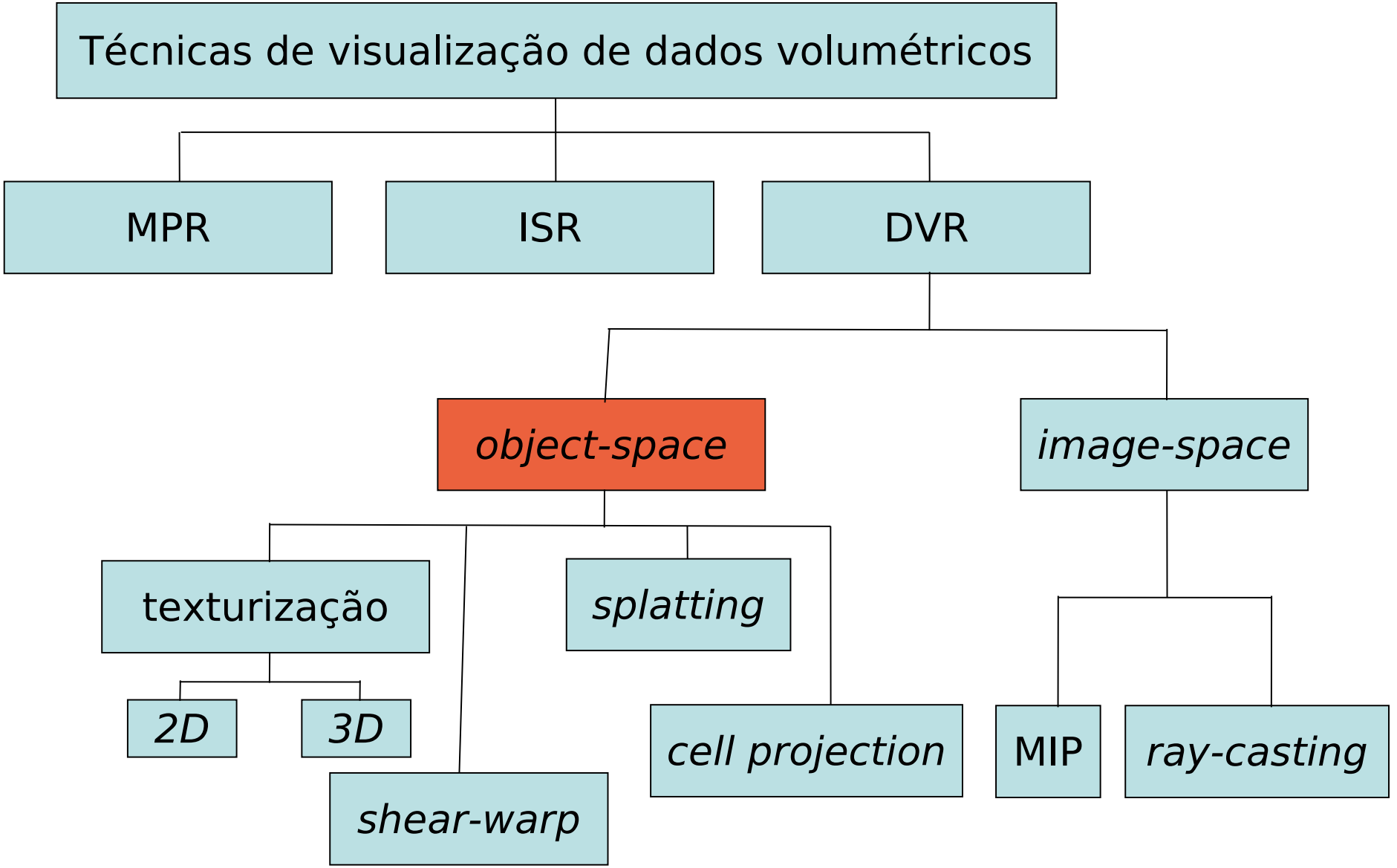
ISR

- Renderização Indireta via isosuperfície



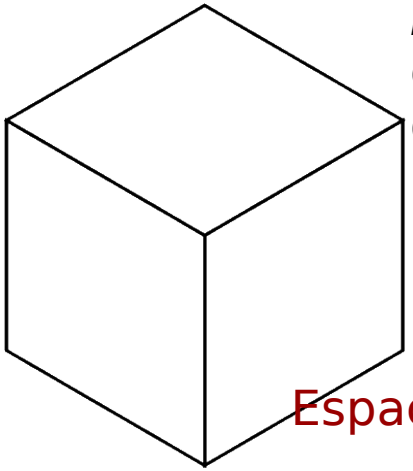
Fonte: *Google imagel*

Uma Classificação



Texturização 3D

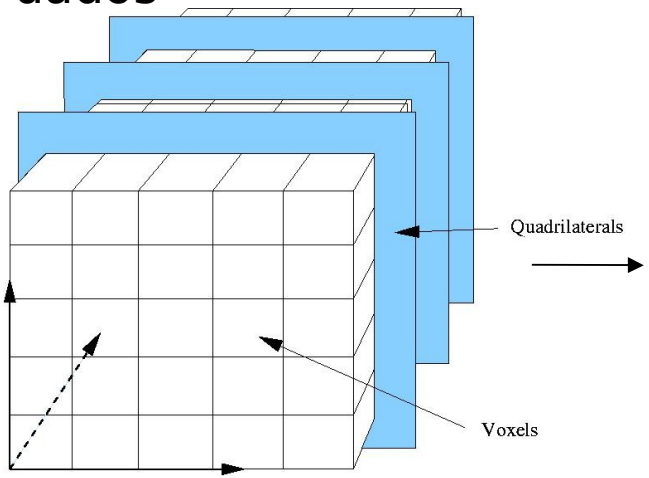
- "Texturizar" um cubo (*proxy geometry*) com o volume de dados de interesse



Proxy Geometry
em dimensões reais
do volume de dados

Espaço do objeto

(1,1,1)



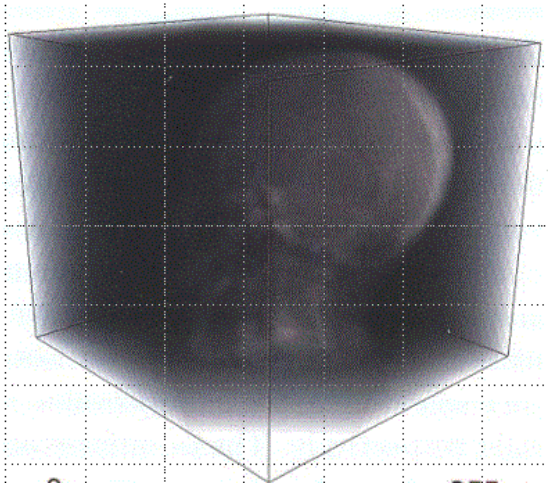
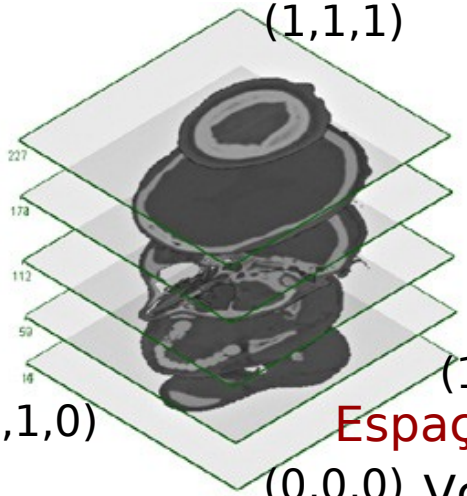


Imagem Final



(1,0,0)

(0,1,0)

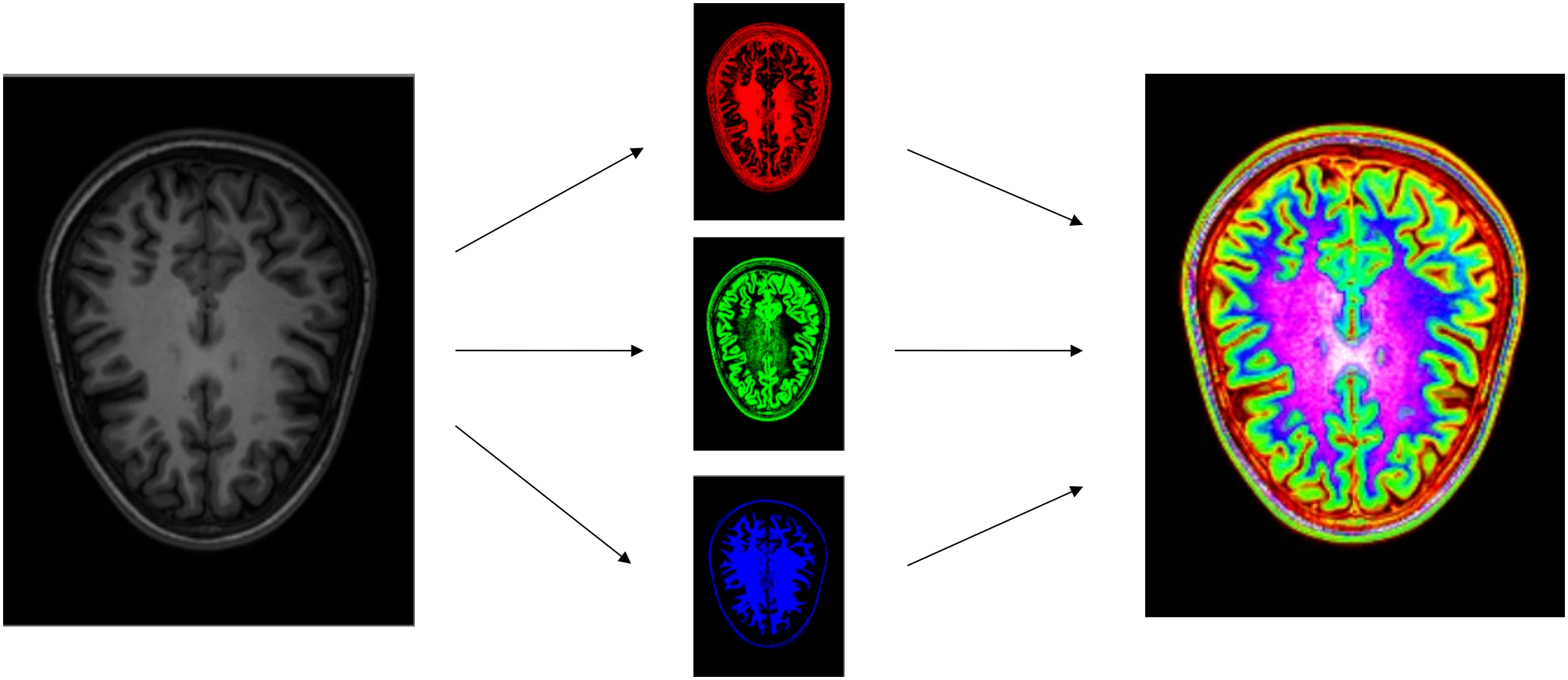
Espaço de textura

(0,0,0) Voume de dados

Alinhamento dos dois espaços pelas coordenadas de textura e coordenadas espaciais dos vértices

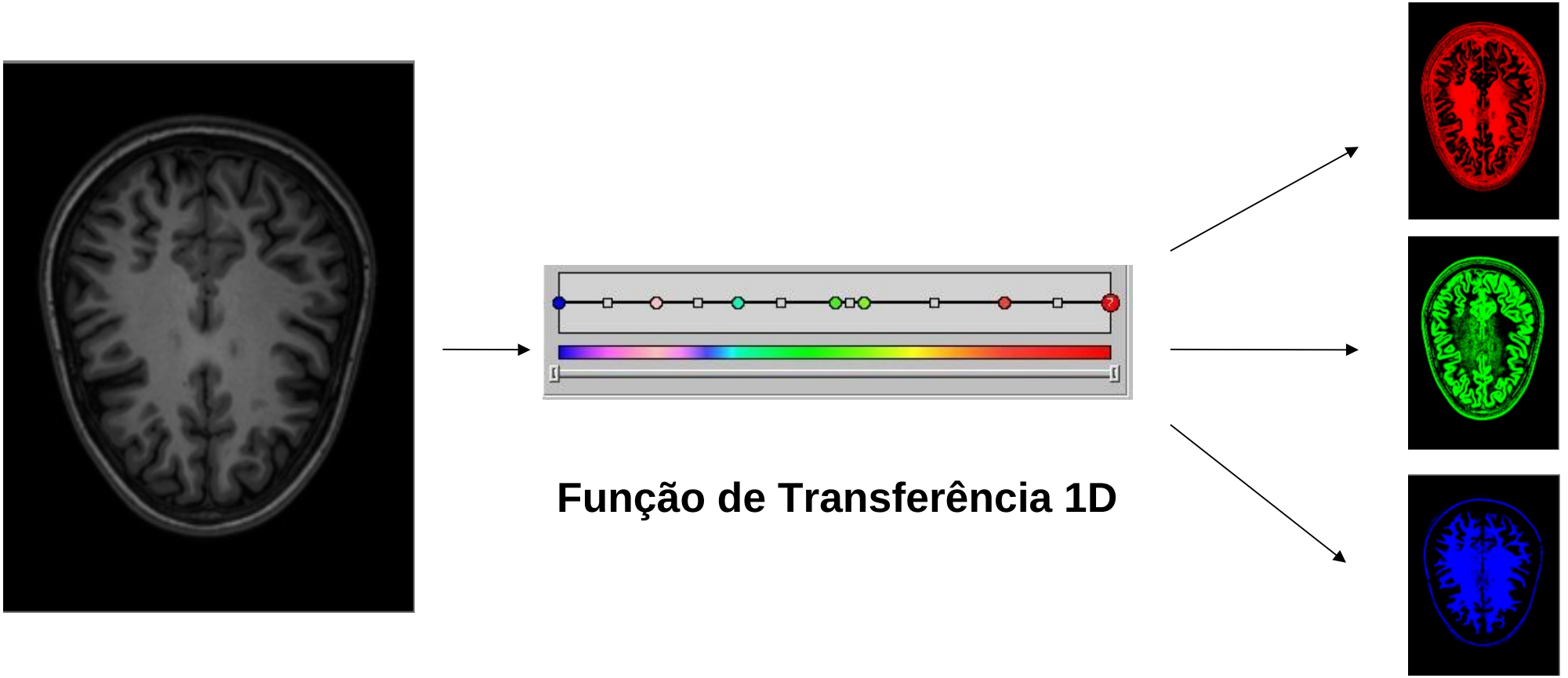
Imagens Coloridas

- Como alterar o mapeamento dos valores das amostras para diferentes cores?
  - Ao invés de um valor escalar, associe um vetor RGB

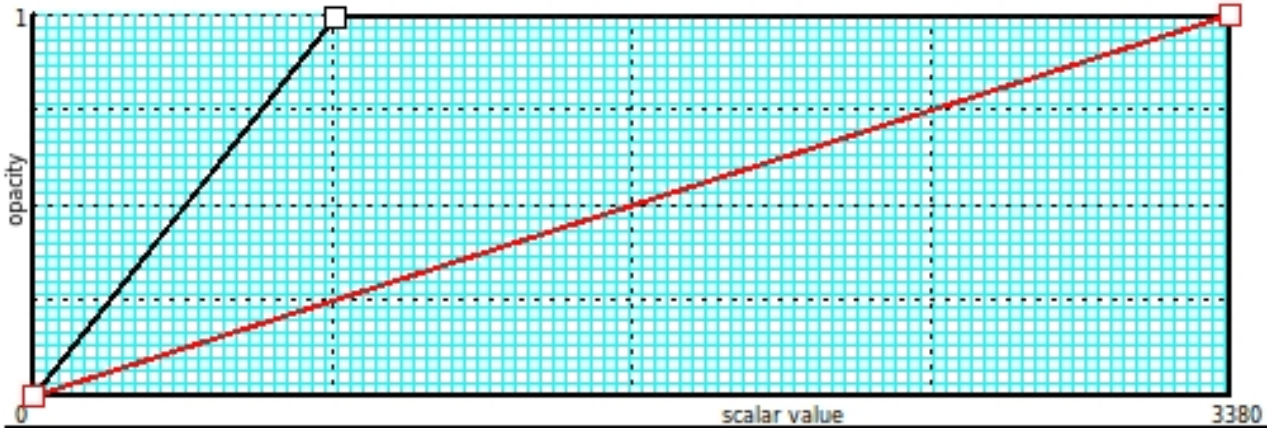


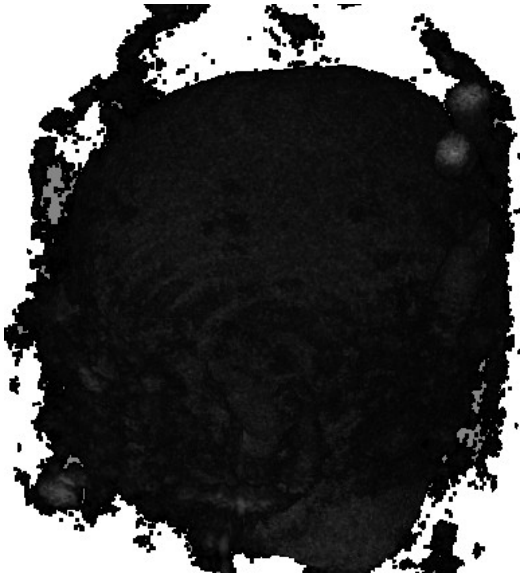
Função de Transferência

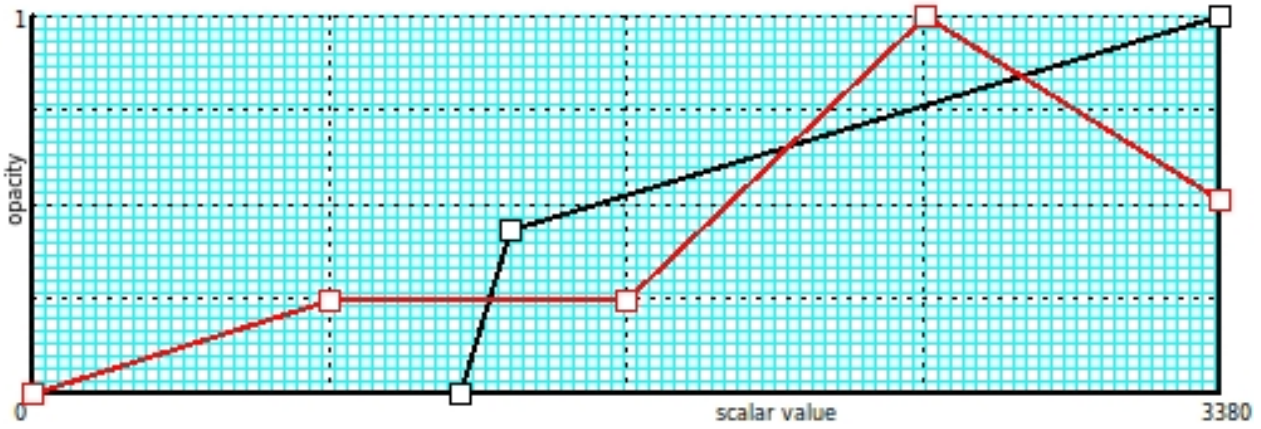
- Como tornar mais modulável o mapeamento?



Funções de Transferência

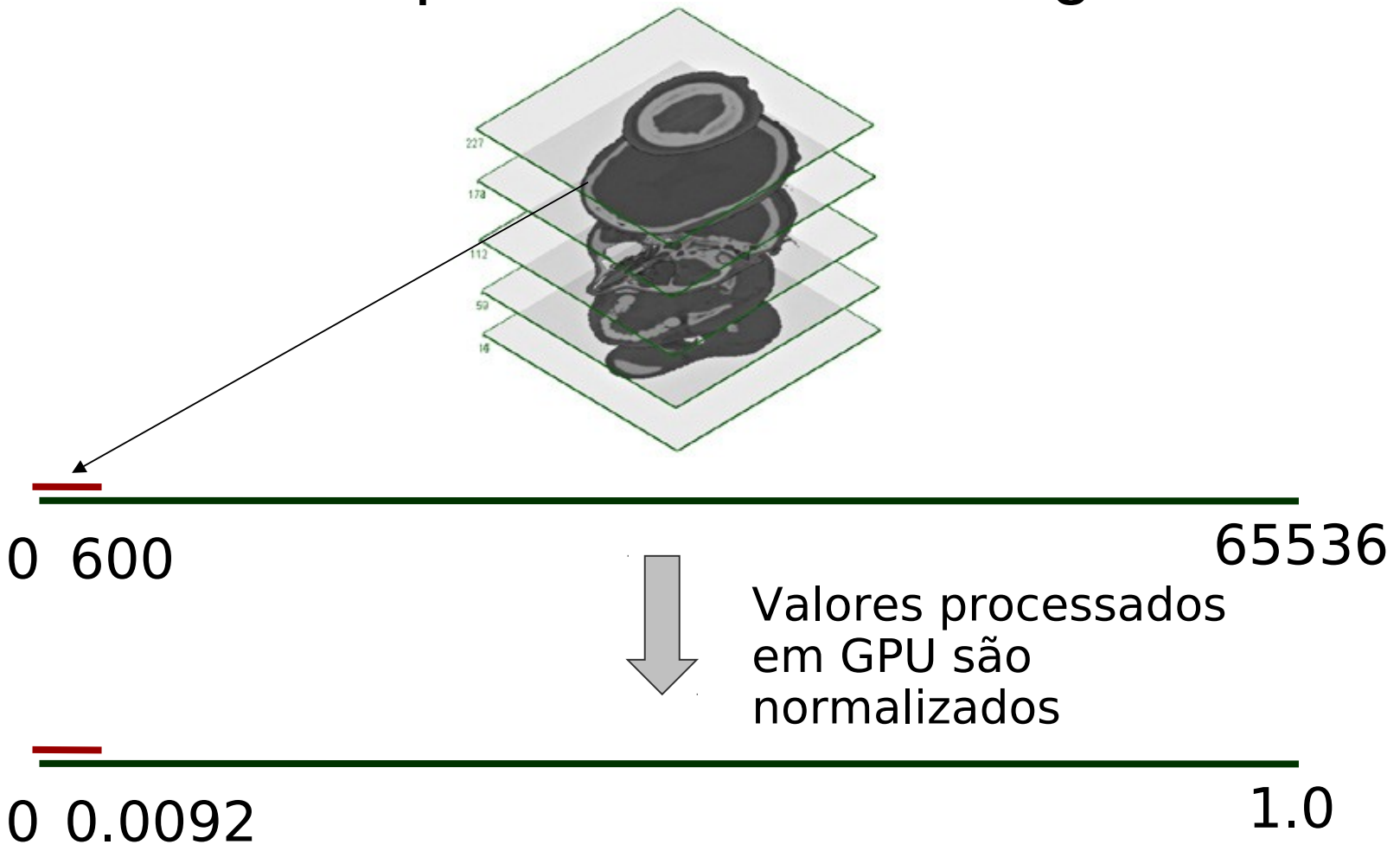




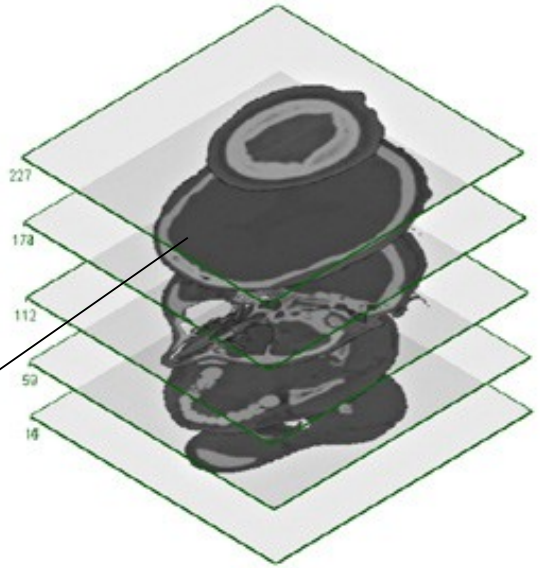


Normalização em TMUs

- Processamento dos dados pelas TMUs → os níveis de cinza podem ficar indistinguíveis!



Equalização



0 600 — 65536

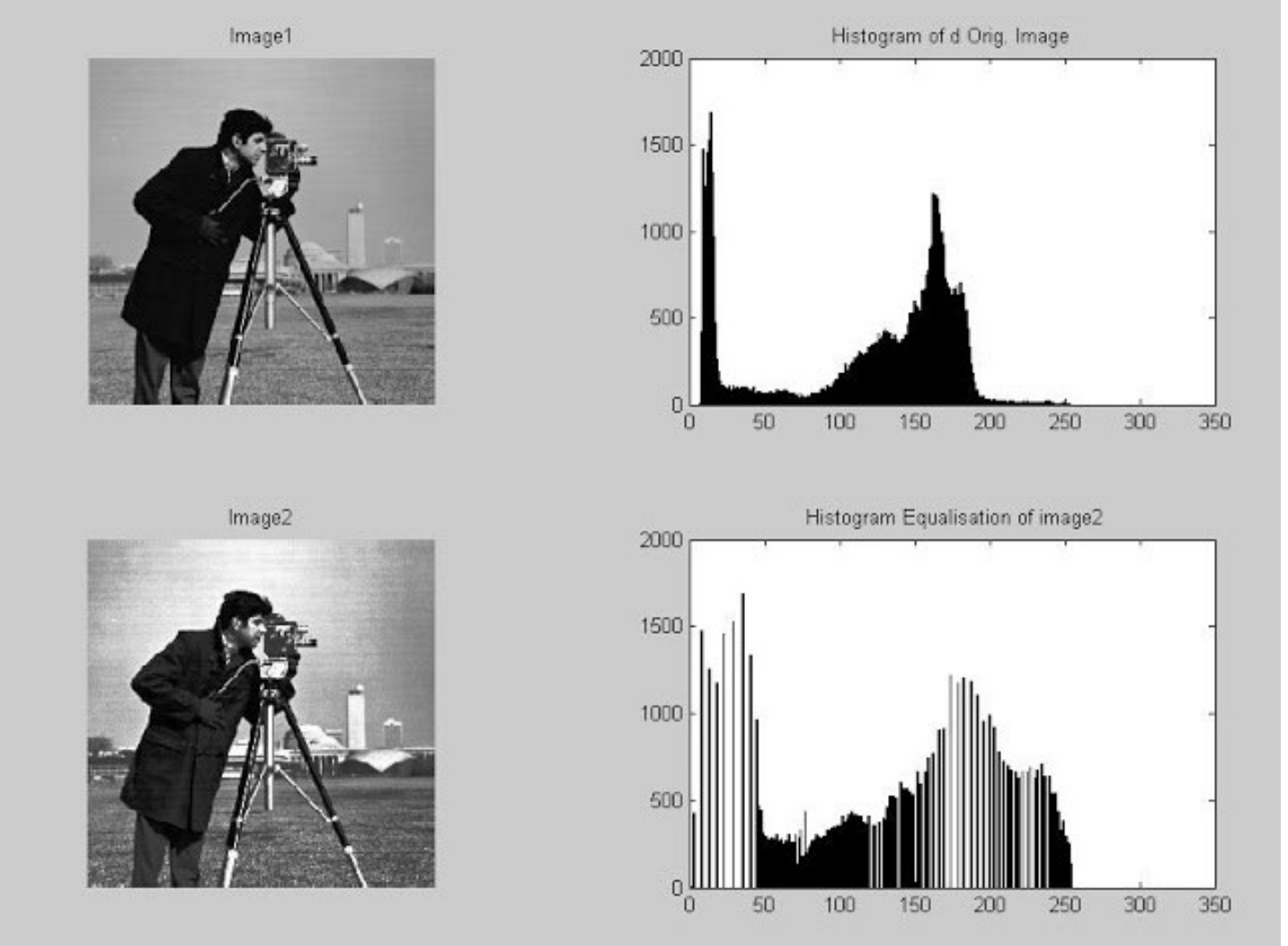
Valores processados em GPU são normalizados

0 0.0092 — 1.0

Equalização ↔“Estica” a escala

0 0.0092 — 1.0

Equalização de Histograma



Fonte: Matlab

Algoritmo

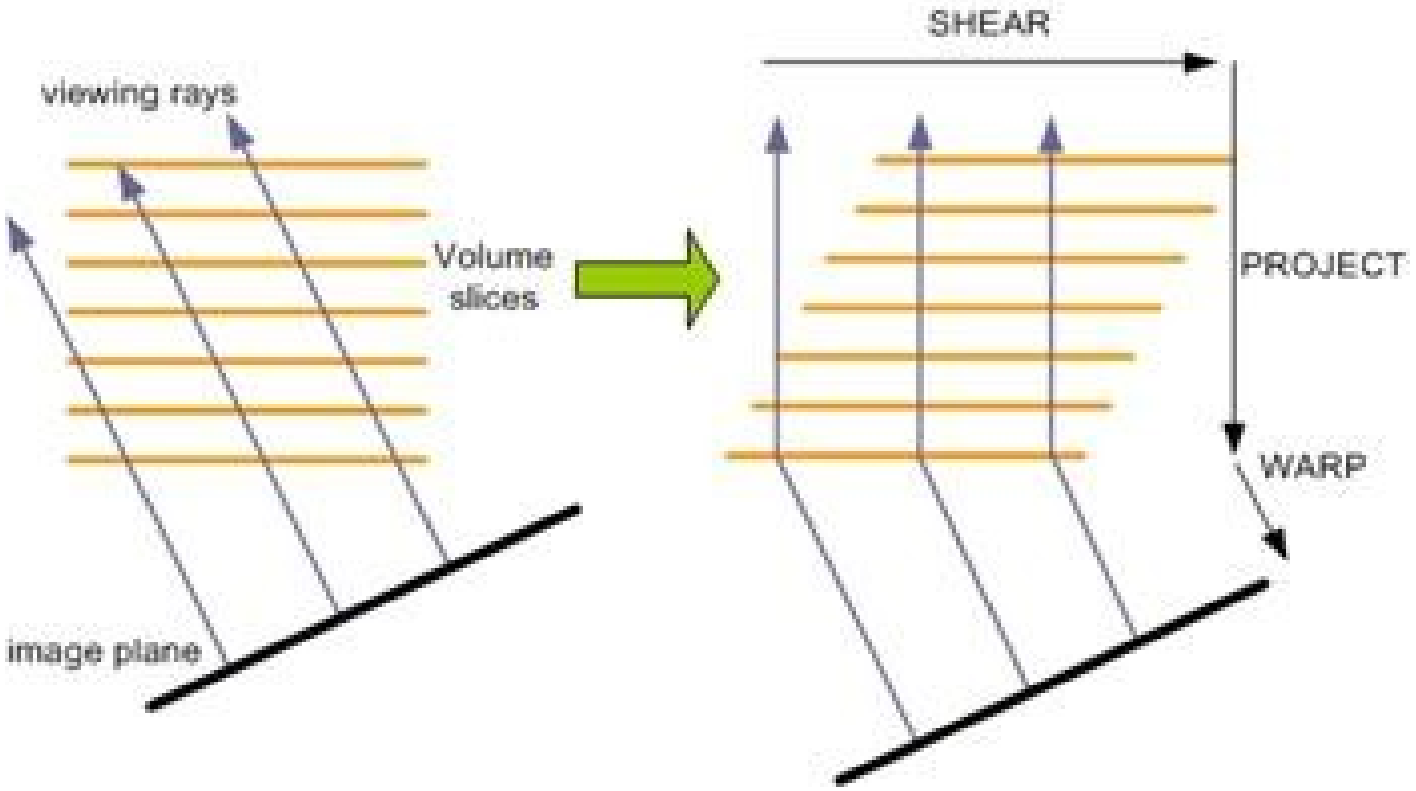
- Imagem 3D com LxMxN amostras com K níveis de cinza
  - Determine a função de distribuição acumulada (cdf)
  - Recalcule cada intensidade i

$$Novo(i) = \frac{cdf(i) - cdf_{min}}{(L \times M \times N) - cdf_{min}} \times (K - 1)$$

Shear-Warp

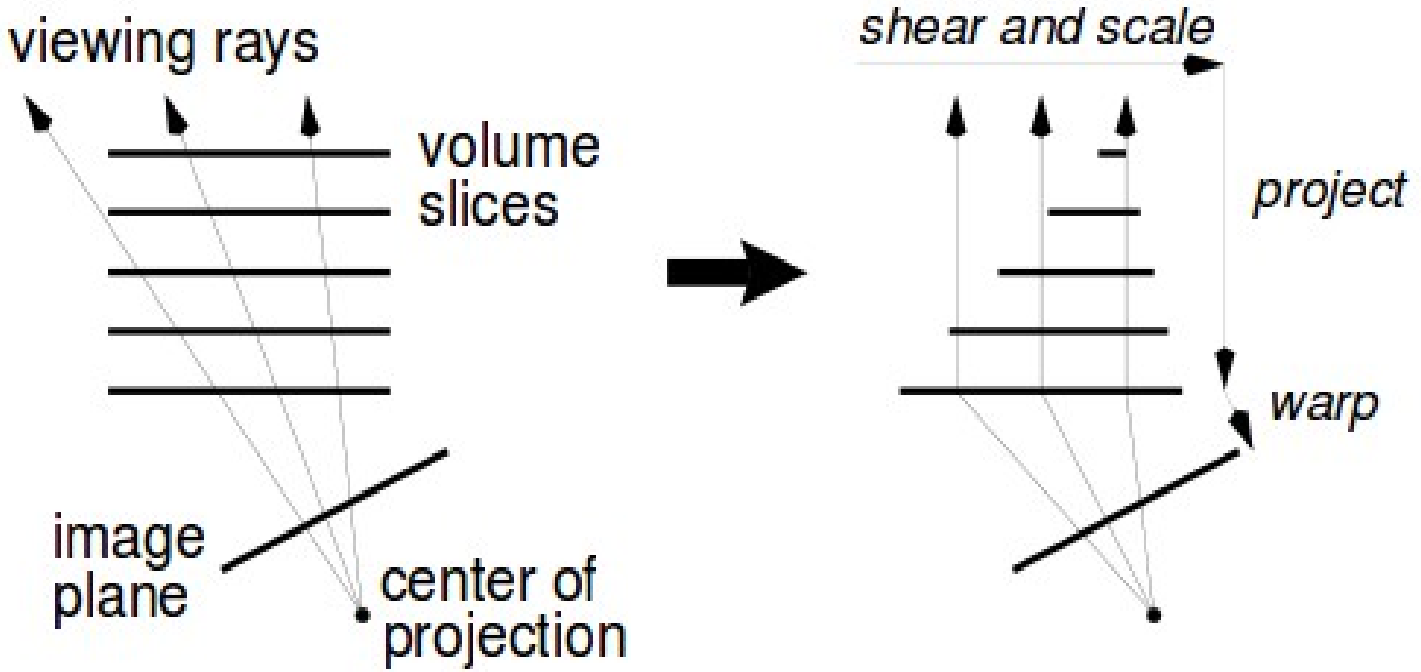
- Fatoração da matriz de projeção em 3 transformações: cisalhamento, projeção das fatias cisalhadas de frente para trás e deformação no plano de imagem.

Paralela



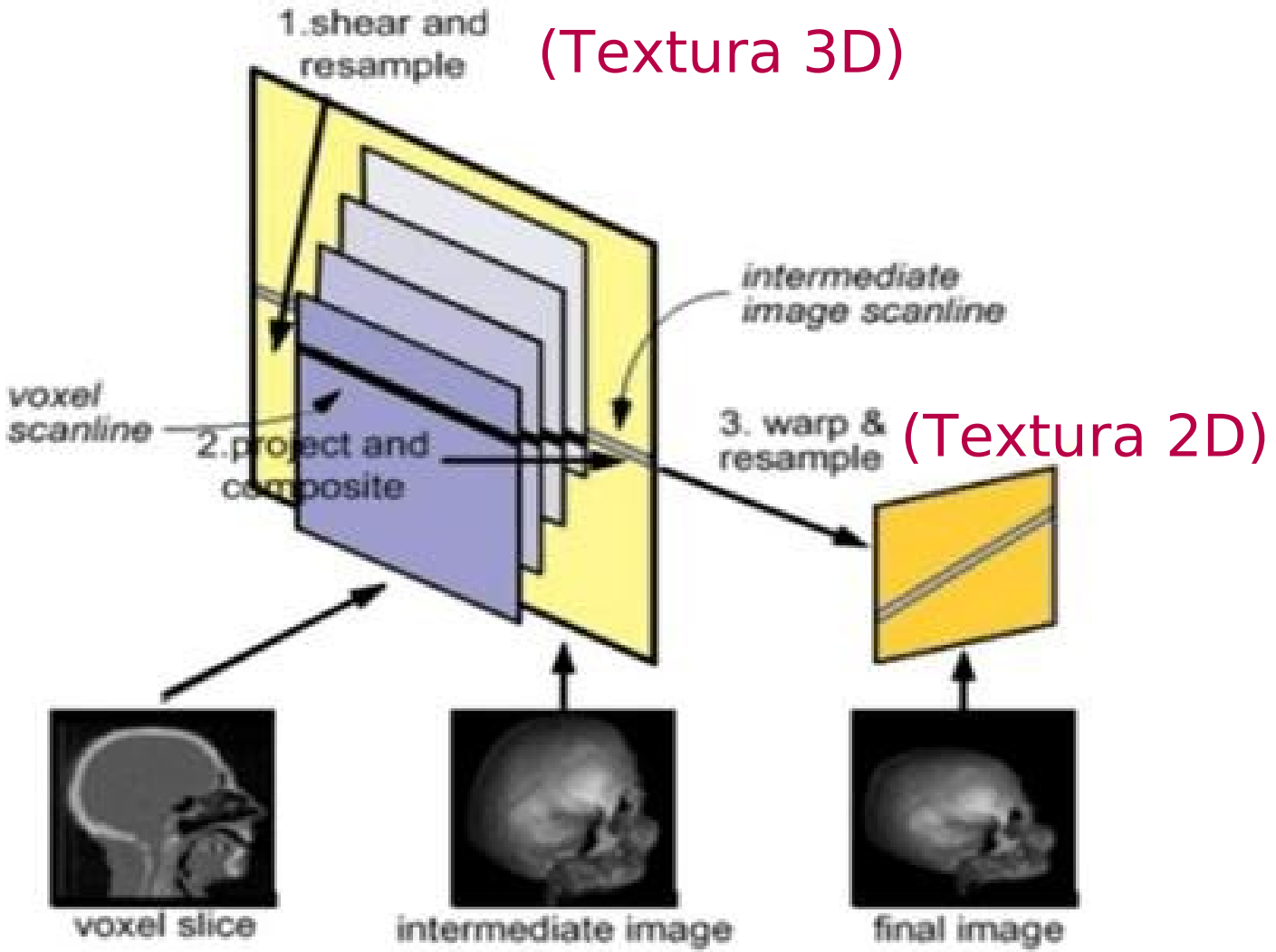
Shear-Warp

Perspectiva



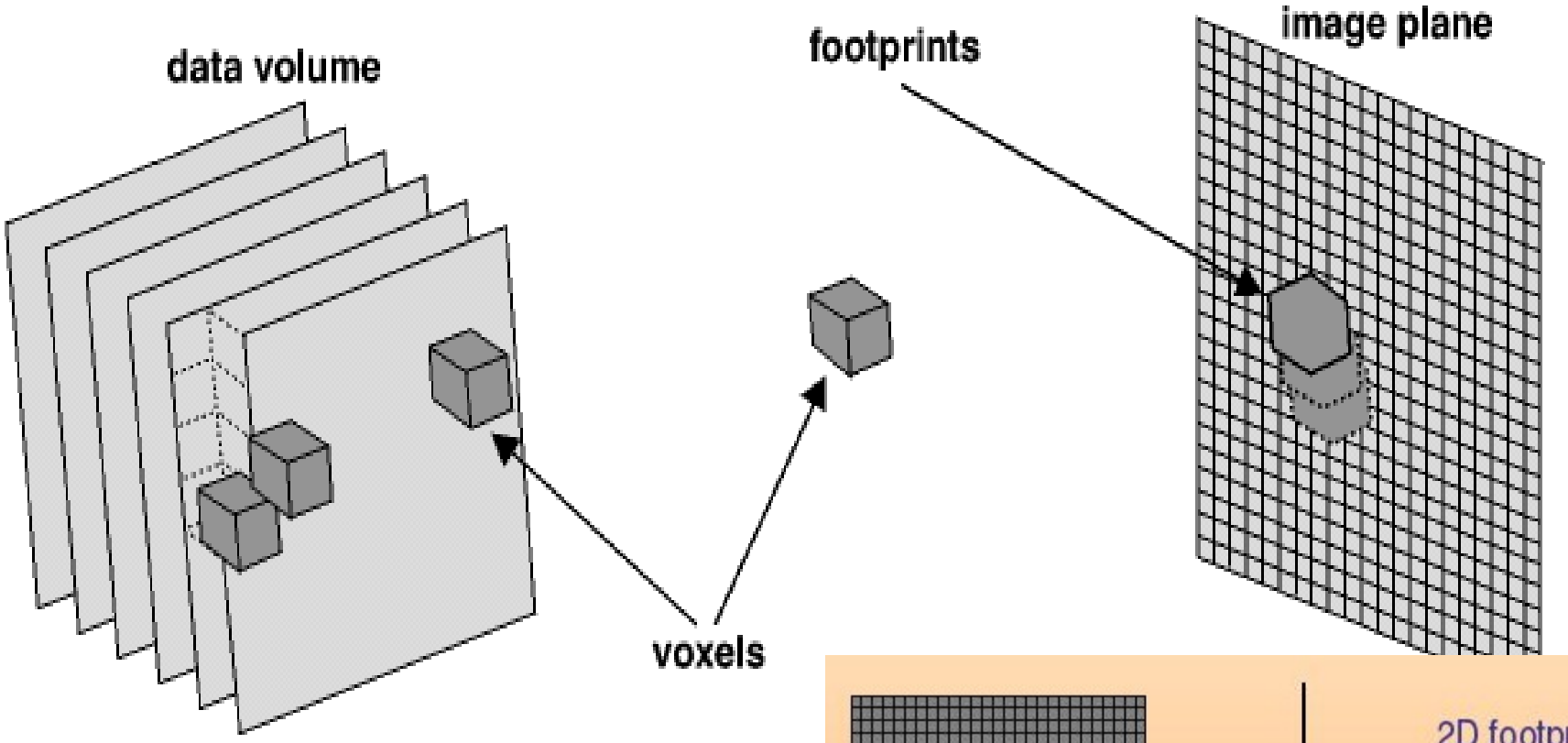
http://www.cs.virginia.edu/~gfx/courses/2002/BigData/papers/Volume%20Rendering

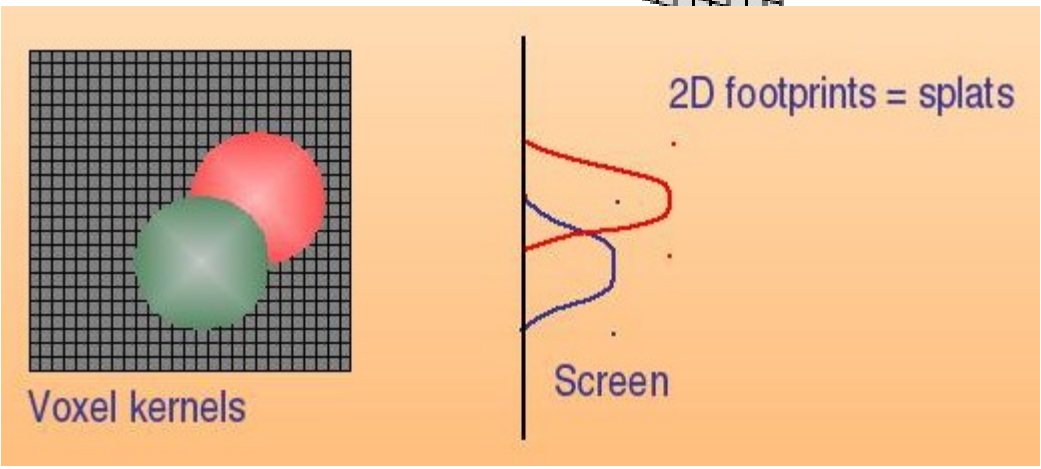
Reamostragens



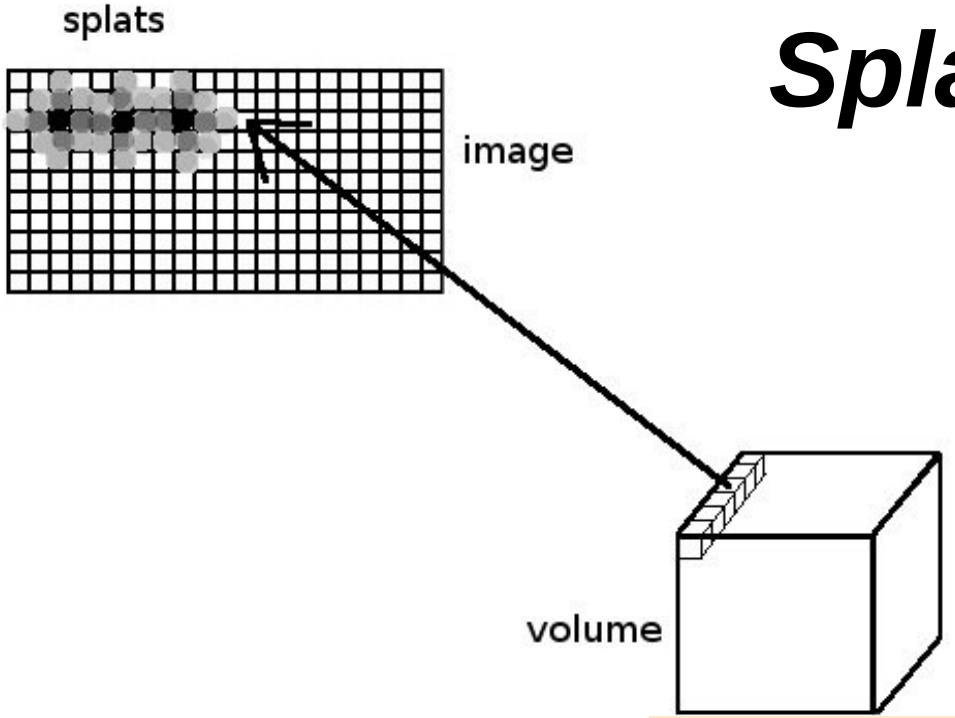
Splatting

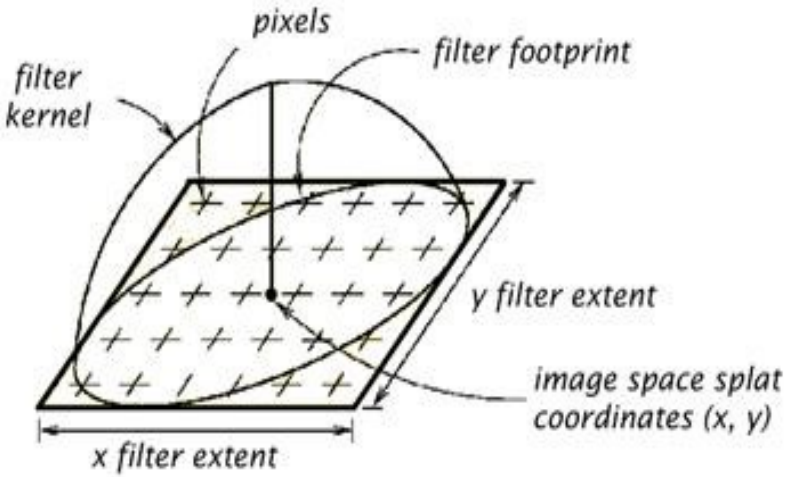
- Projeção dos *voxels* na ordem frente para trás sobre o plano de imagem.

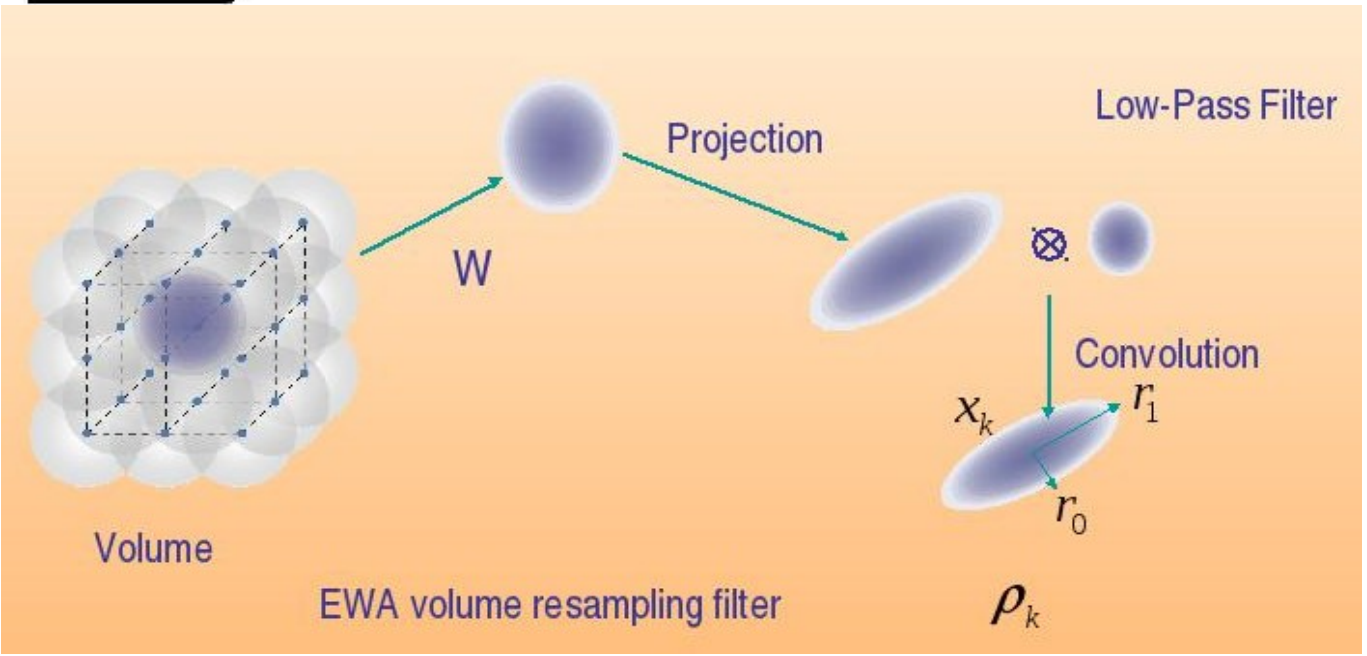




Splatting

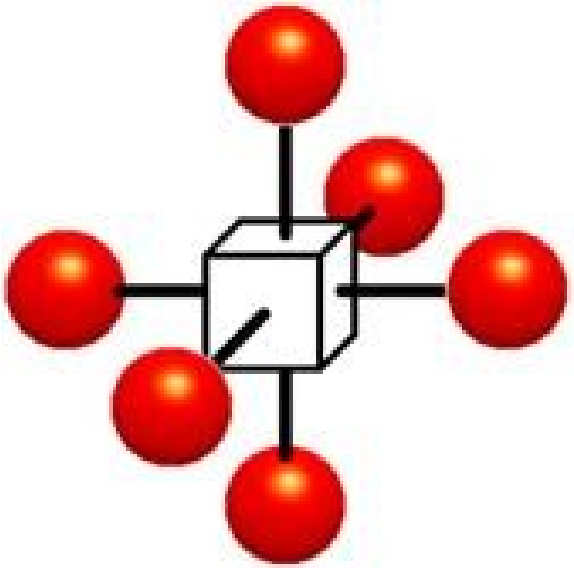




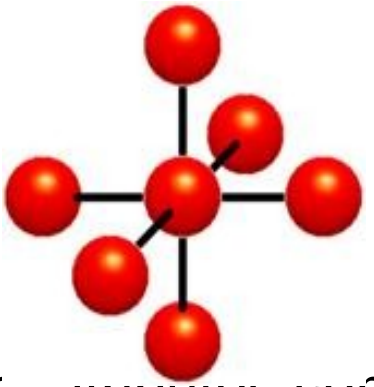


http://www.cs.unc.edu/techreports/91-029.pdf

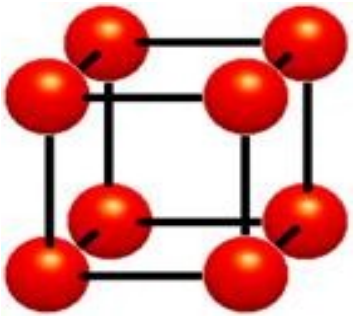
Voxels e Células



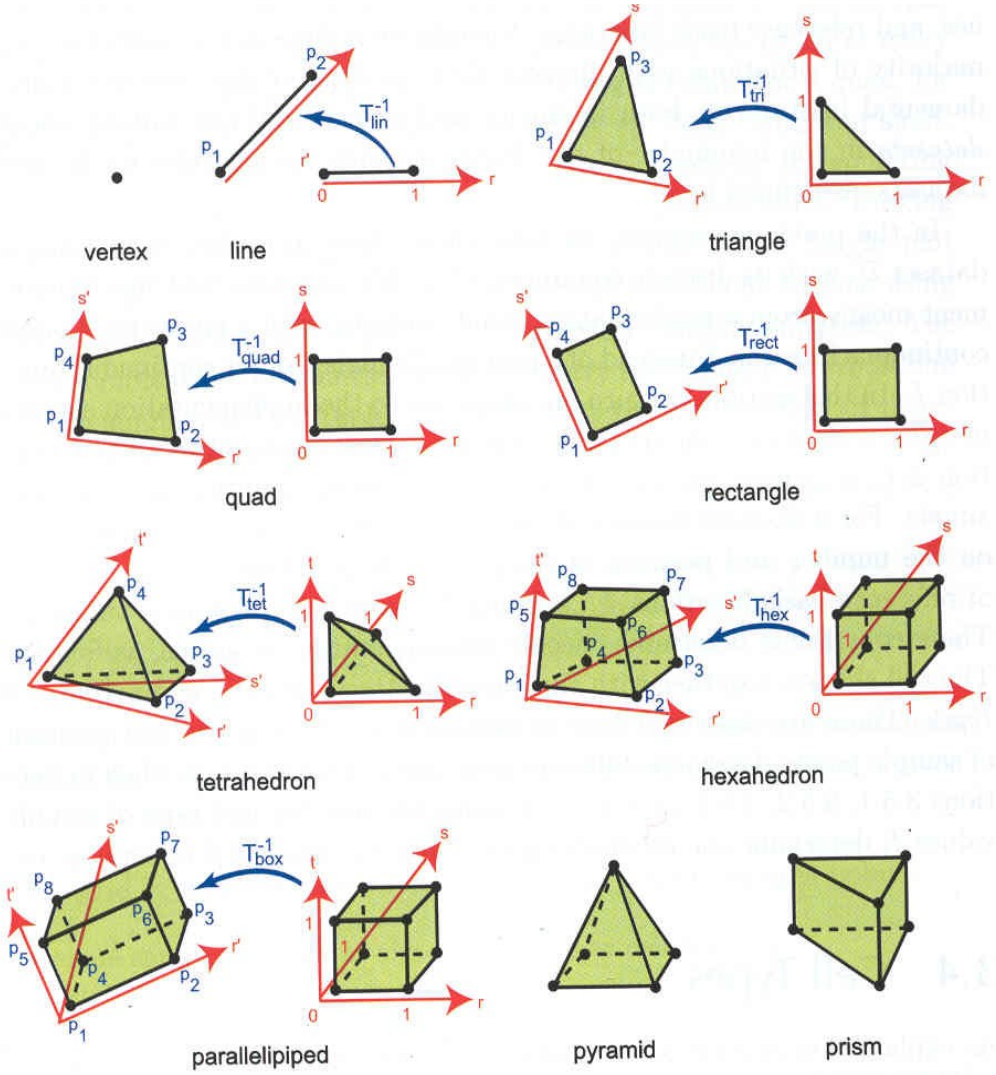
- *Voxels*: atributos com mesmos valores em cada elemento volumétrico



- Células: atributos com valores diferentes

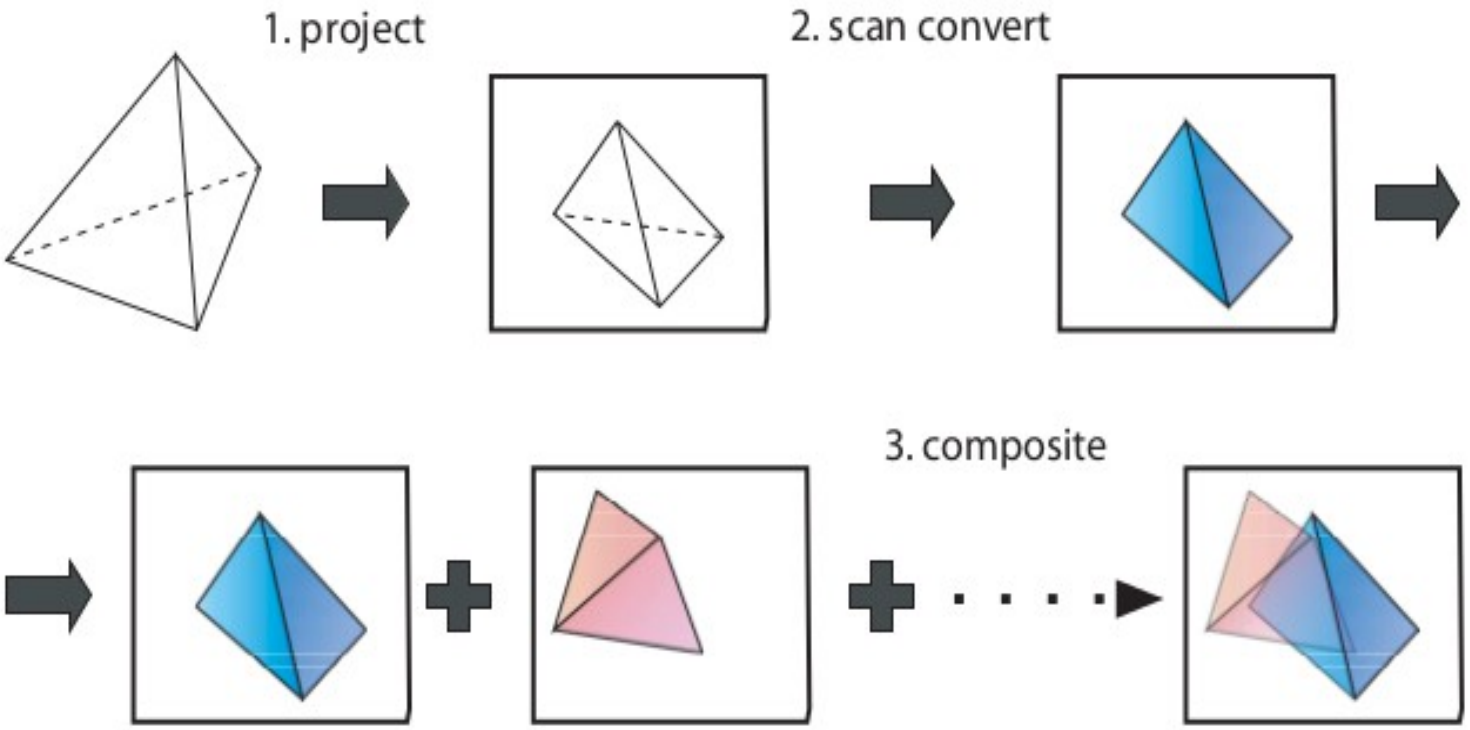


Tipos de Células

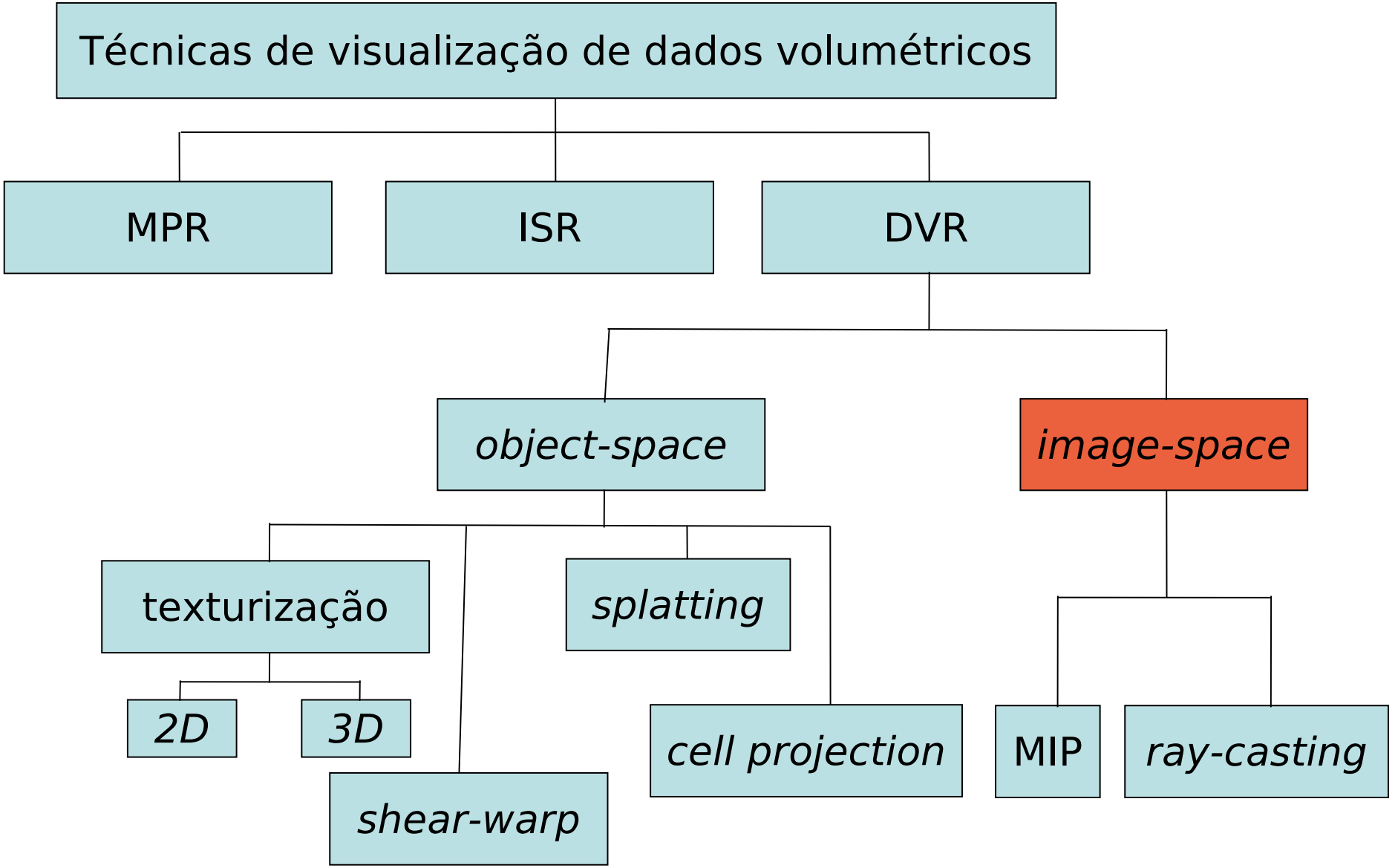


Cell Projection

- Projeção de células na ordem frente para trás sobre o plano de imagem.



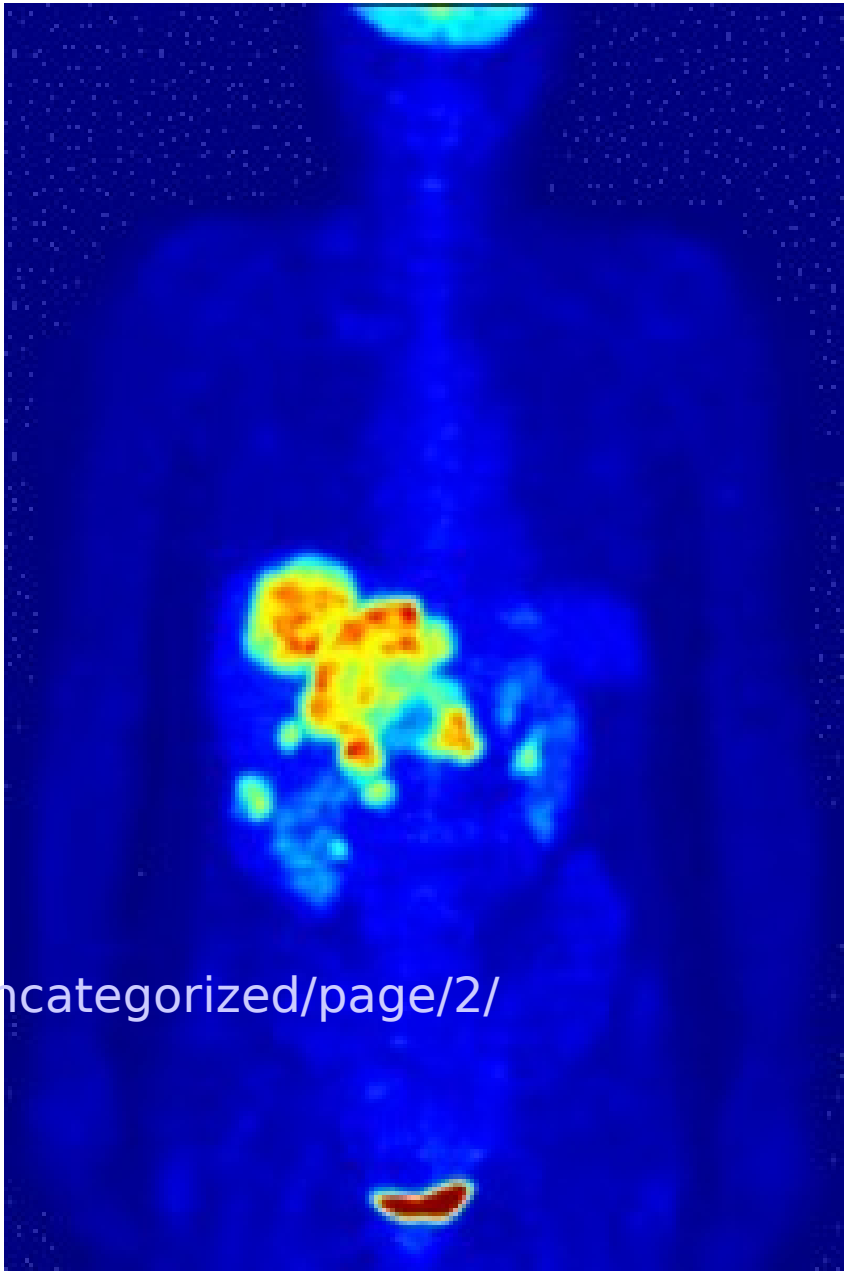
Uma Classificação



Projeção de Intensidade Máxima (MIP)

Problema: não contém informação de profundidade.

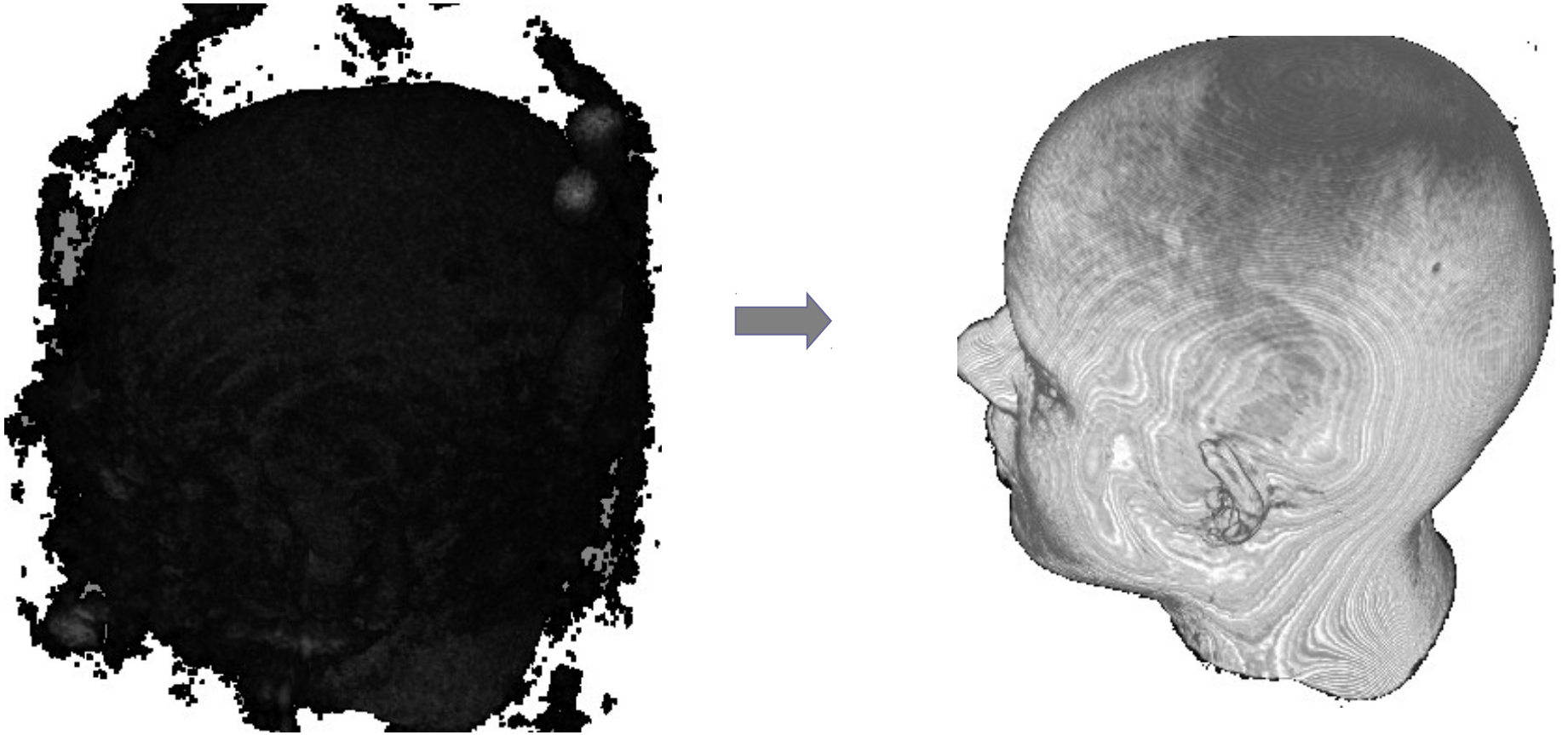
Imagens MIP Animadas



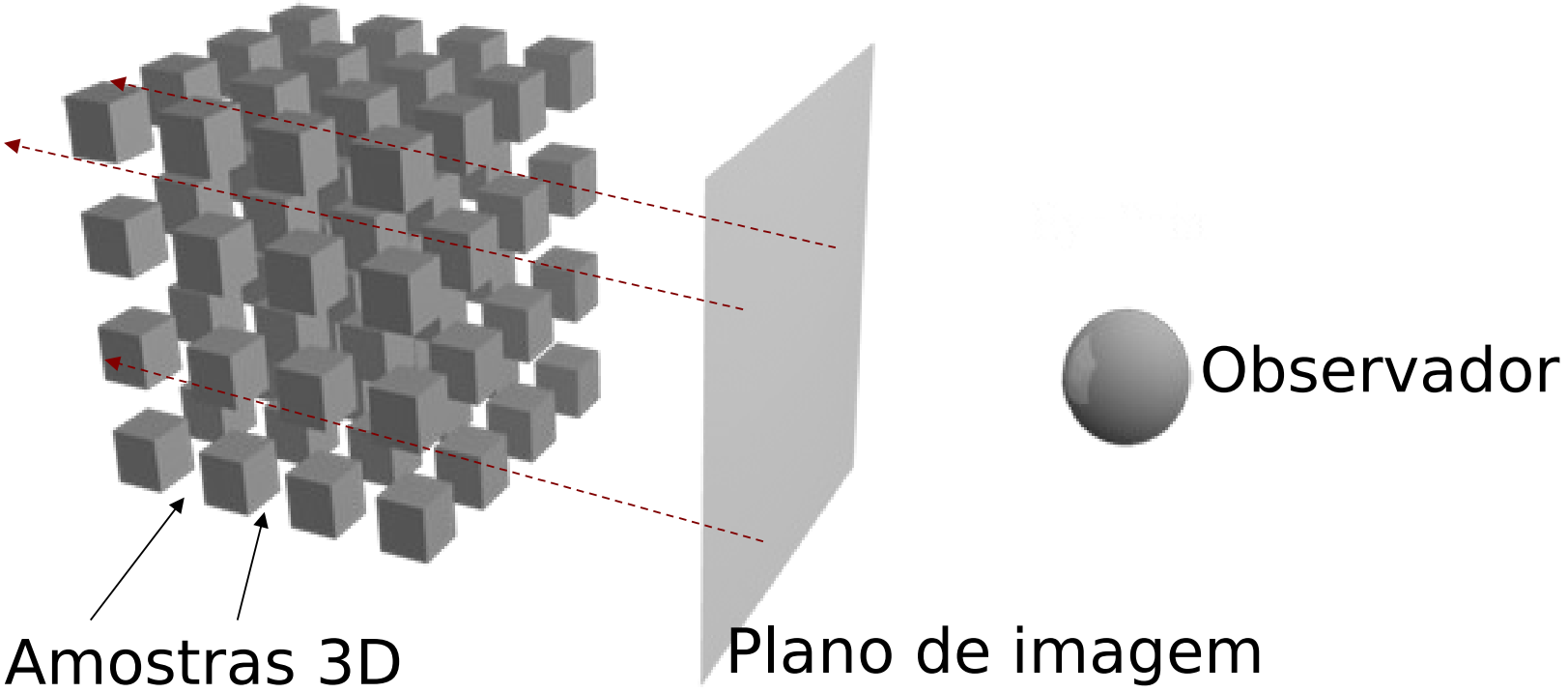
Fonte:
http://tomographyblog.com/category/uncategorized/page/2/

Ray-Casting

- Renderização Direta
  - *Direct Surface Rendering* (DSR)
  - *Direct Volume Rendering* (DVR)



Princípio de *Ray-Casting*



Fonte: http://www.volviz.com/topics.php

Composição Frente-Trás

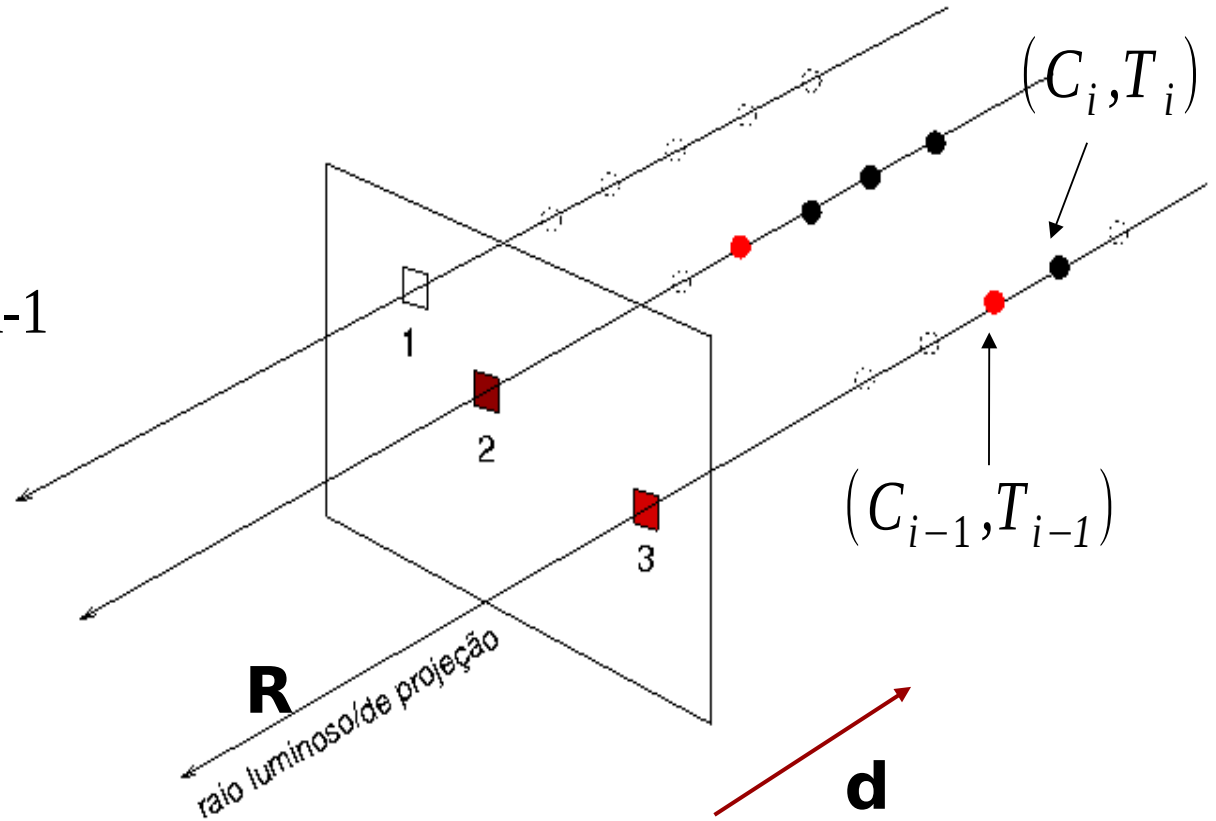
$$\hat{C}_i = \hat{T}_{i-1} C_i + \hat{C}_{\text{i-1}}$$

$$\hat{T}_i = \hat{T}_{i-1}(1-\alpha_i)$$

Sabendo que $\hat{\alpha}_i = 1 - \hat{T}_i$

$$\hat{C}_i = (1-\hat{\alpha}_{i-1}) C_i + \hat{C}_{\text{i-1}}$$

$$\hat{\alpha}_i = \alpha_i + \hat{\alpha}_{i-1}(1-\alpha_i)$$



ComposiçãoTrás-frente

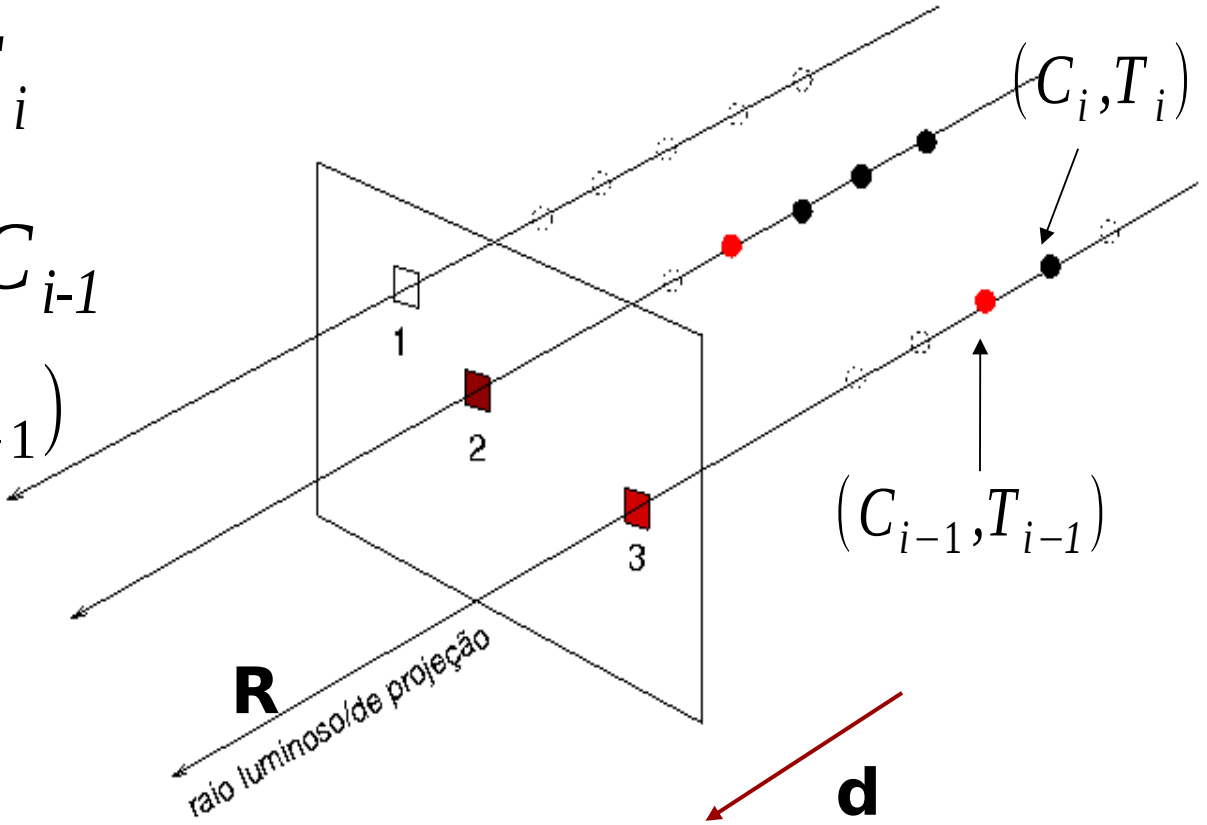
$$\hat{C}_{\text{i-1}} = \hat{T}_{i-1}\hat{C}_i + C_{i\text{-}1}$$

$$\hat{T}_{\text{i-1}} = \hat{T}_i\left(1-\alpha_{i-1}\right)$$

Sabendo que $\hat{\alpha}_i = 1-\hat{T}_i$

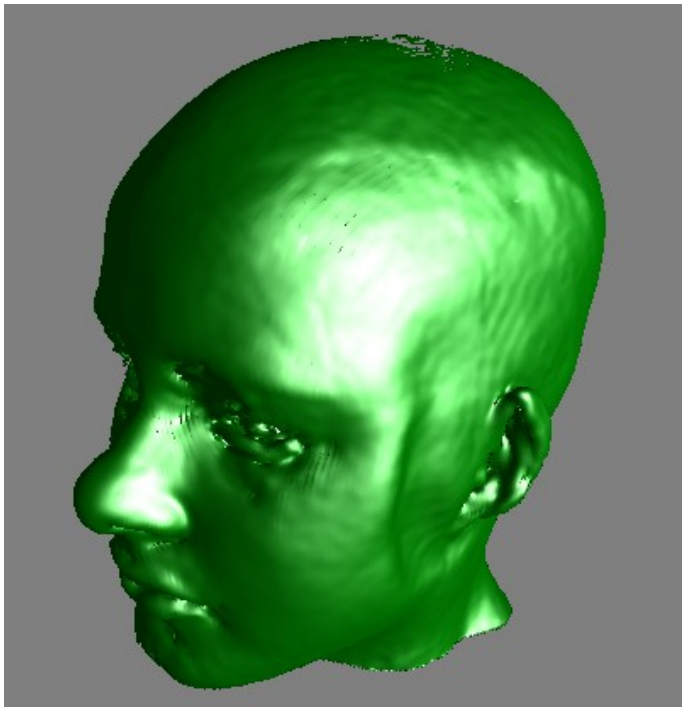
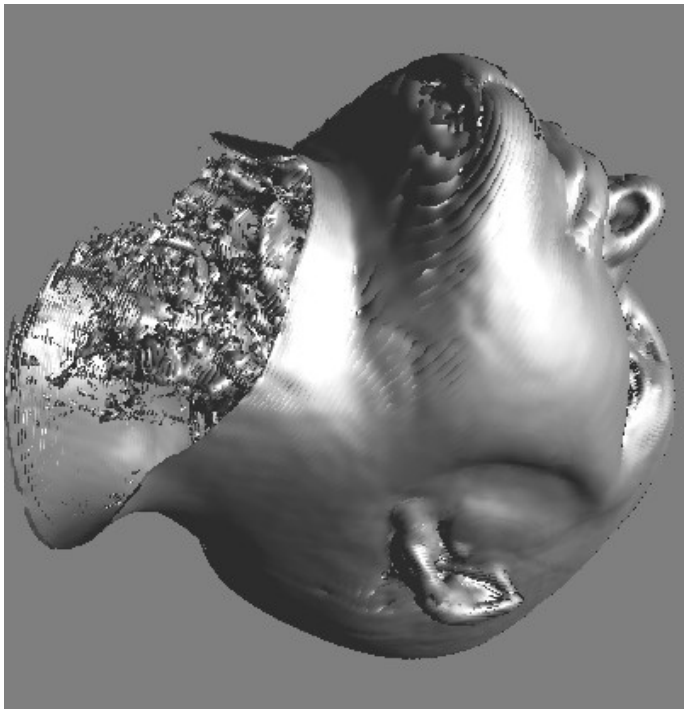
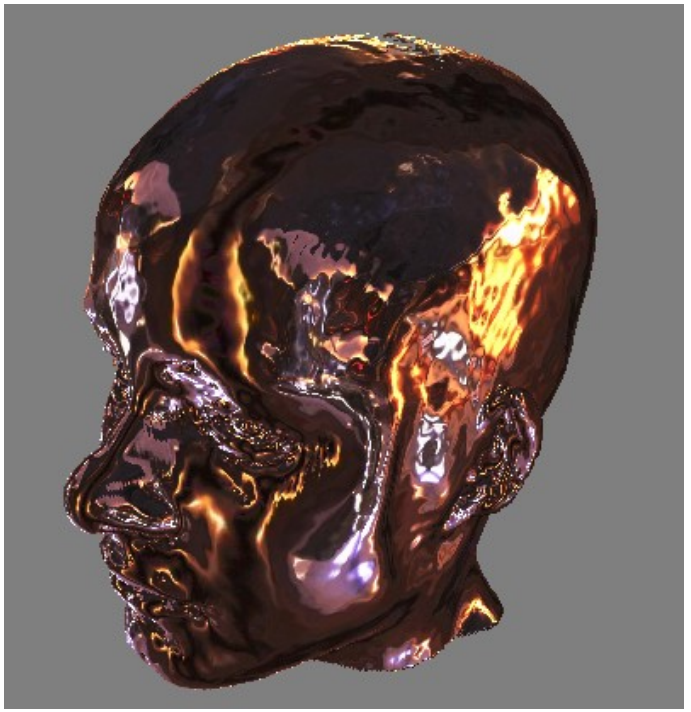
$$\hat{C}_{\text{i-1}} = \left(1-\hat{\alpha}_{i-1}\right)\hat{C}_i + C_{i\text{-}1}$$

$$\hat{\alpha}_{\text{i-1}} = \alpha_{i-1} + \hat{\alpha}_i\left(1-\alpha_{i-1}\right)$$



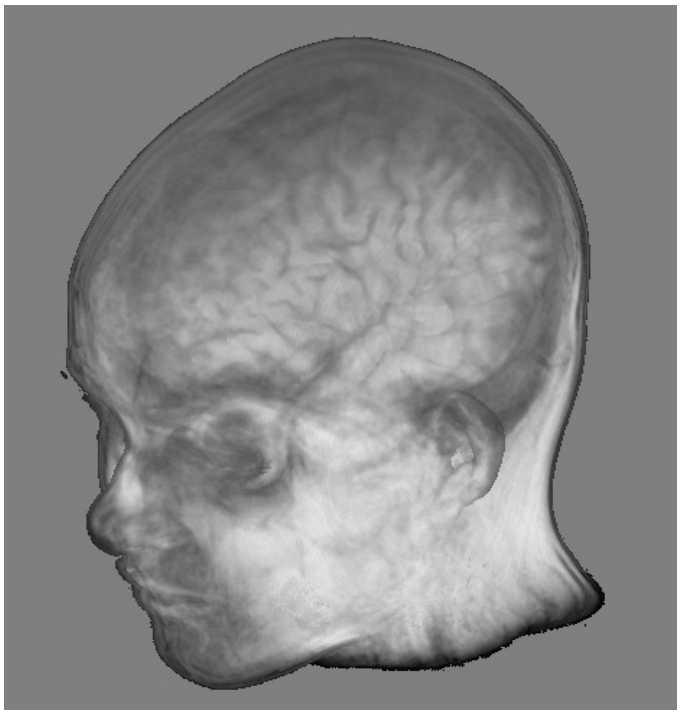
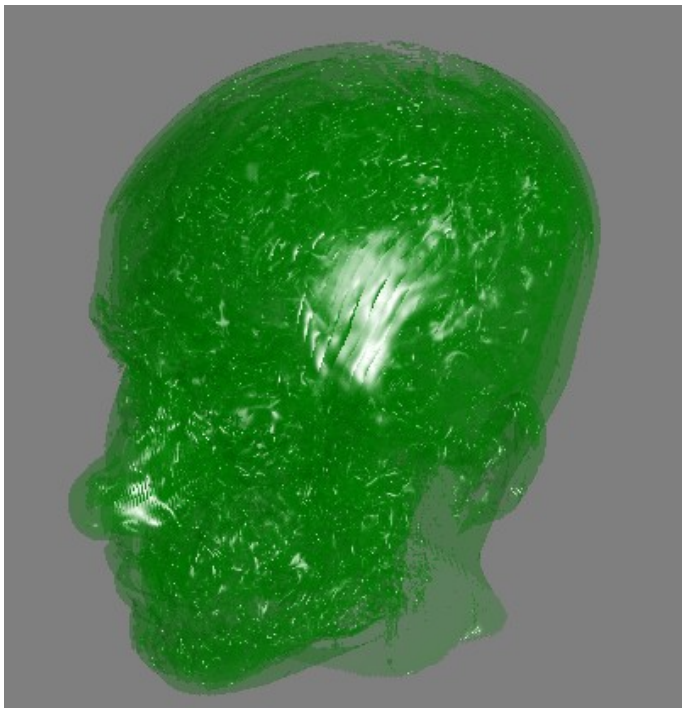
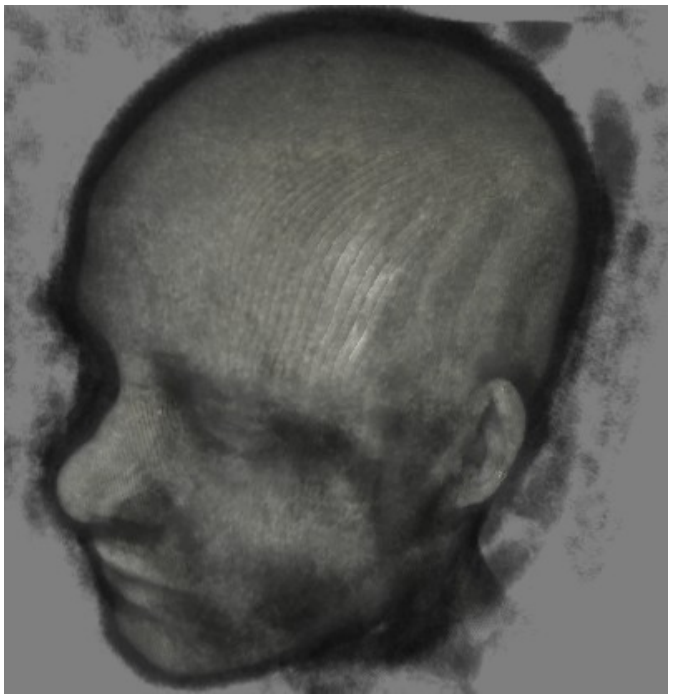
Ray-Casting + Modelo de Iluminação

- Modelo de iluminação clássica em amostras visíveis
  - Gradientes das intensidades → vetor normal

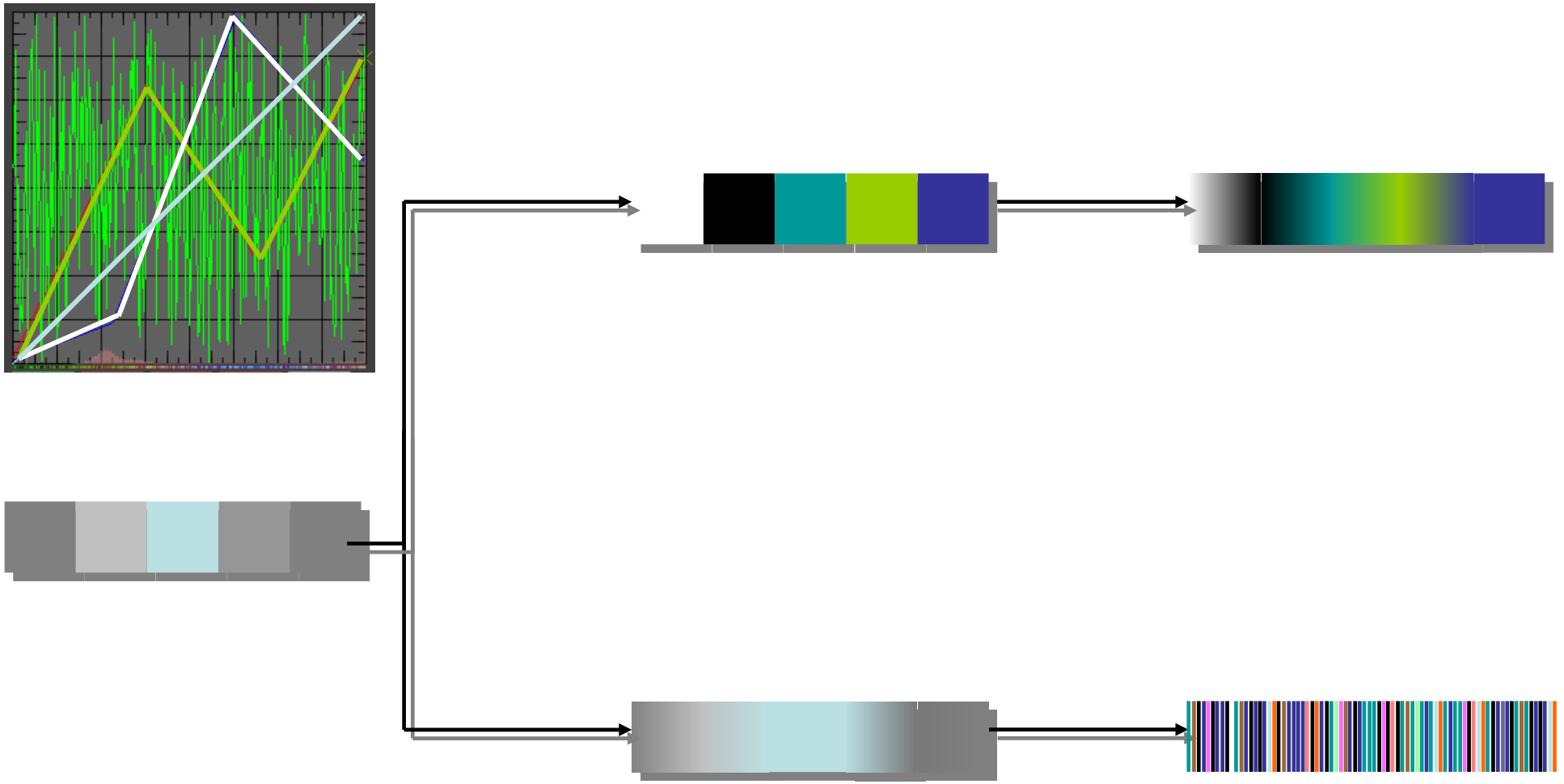




Ray-casting

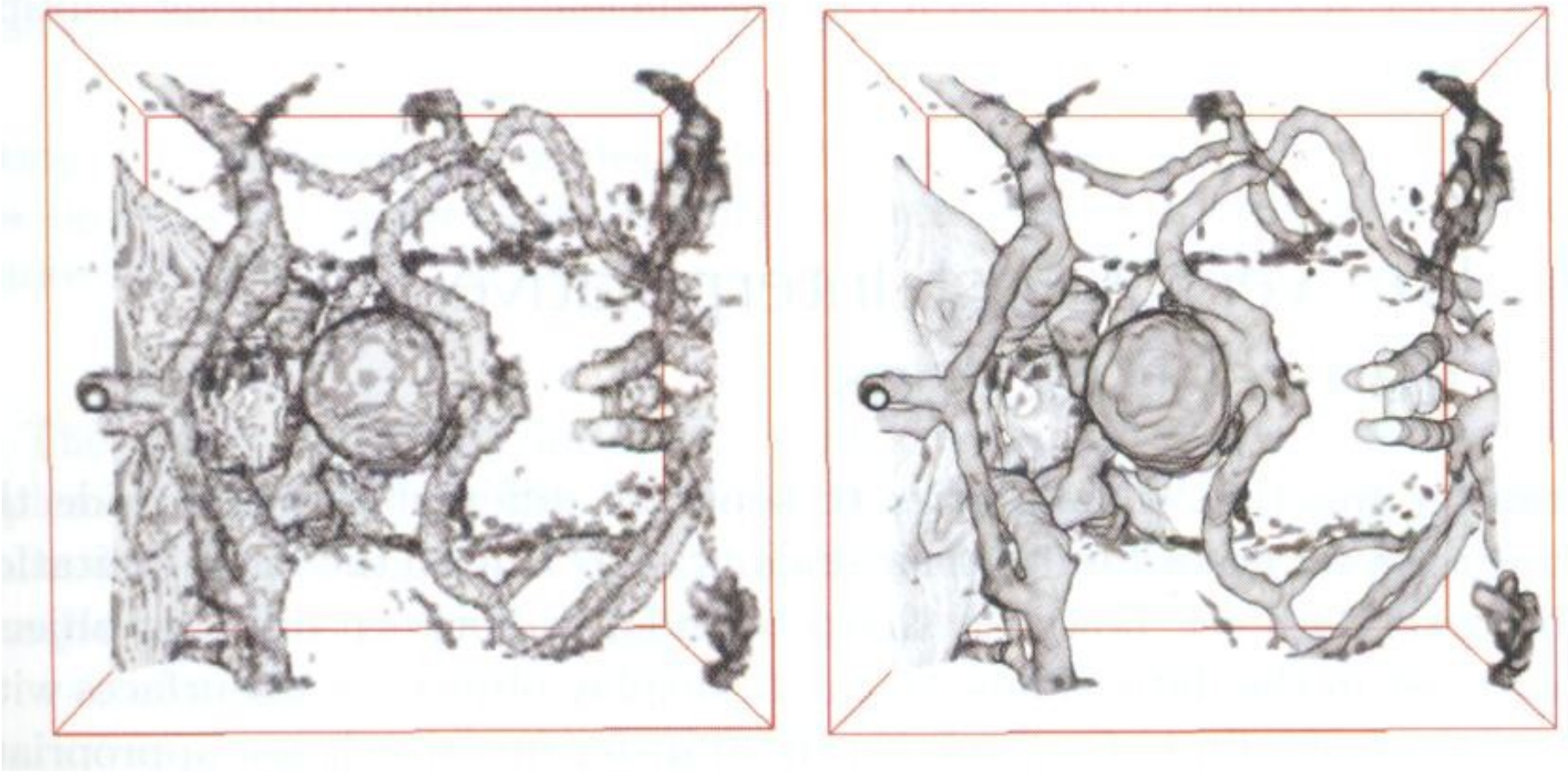
- Composição das intensidades
  - intensidades → cor e opacidade

Interpolação Pré- ou Pós-Mapeamento?



Interpolação Pré- ou Pós-Mapeamento?



Mesma função de transferência, mesma resolução, mesma taxa de amostragem

Aplicação 1

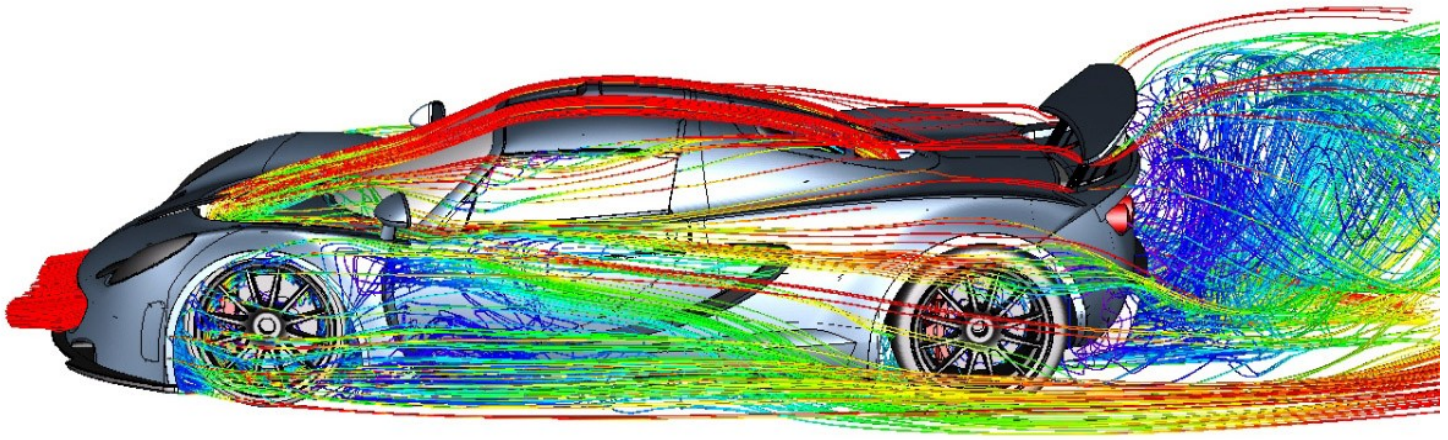
- Renderização dos dados de simulação do fluxo de um fluido
  - CFD – *Computational Fluid Dynamics*

http://www.ceisoftware.com/cfd-data-formats/

  - SPH – *Smoothed Particle Hydrodynamics*

??????

Computational Fluid Dynamics - CFD



http://www.nas.nasa.gov/assets/pdf/techreports/1991/rnr-91-026.pdf

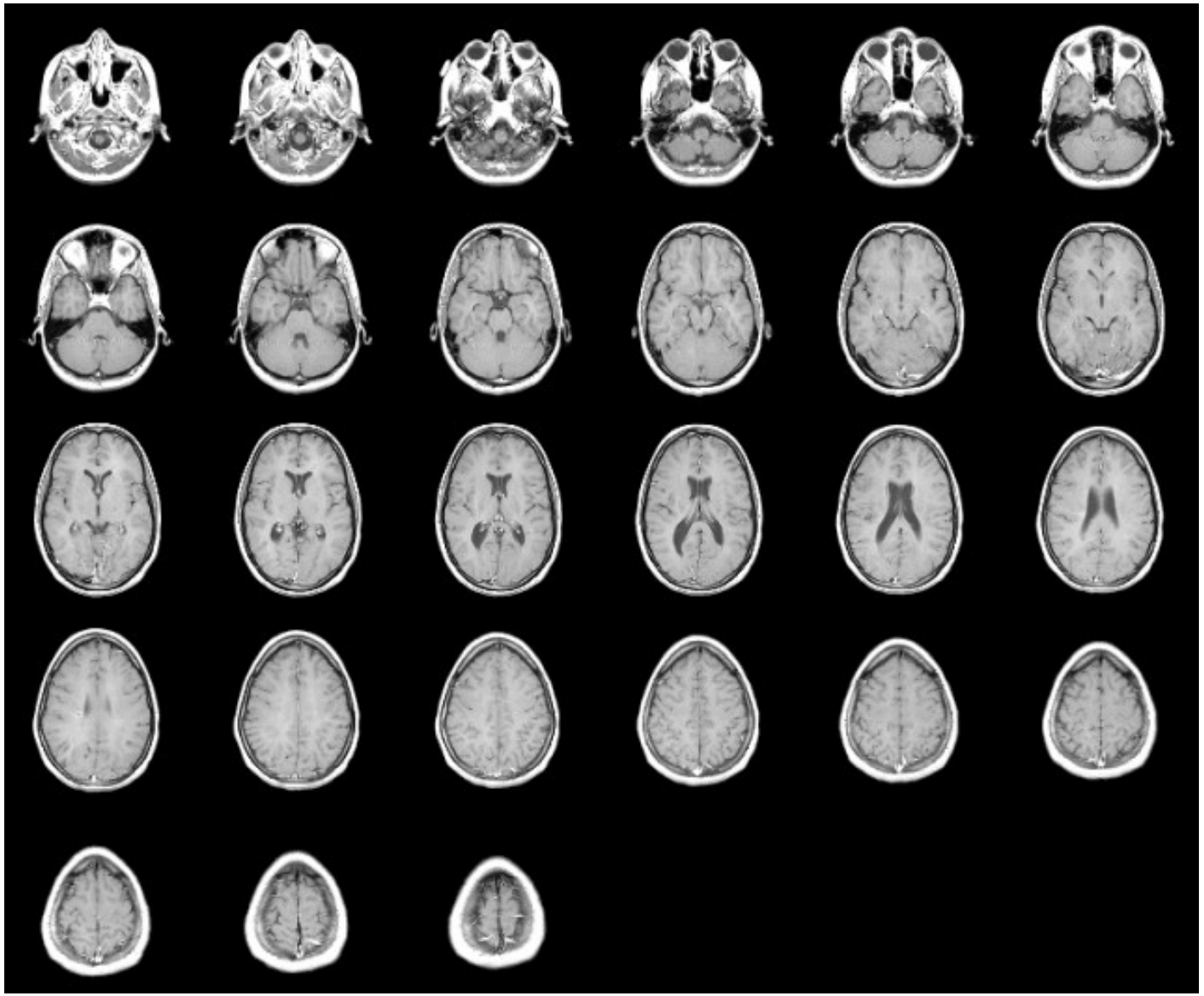
http://http.developer.nvidia.com/GPUGems/gpugems_ch38.html

Smoothed Particle Hydrodynamics - SPH

http://arxiv.org/pdf/0709.0832.pdf

http://www.in.tum.de/fileadmin/user_upload/Lehrstuehle/Lehrstuhl_XV/Research/Publications/2010/Vis10EfficientSPHRendering.pdf

Aplicação 2: Neuroimagens 3D

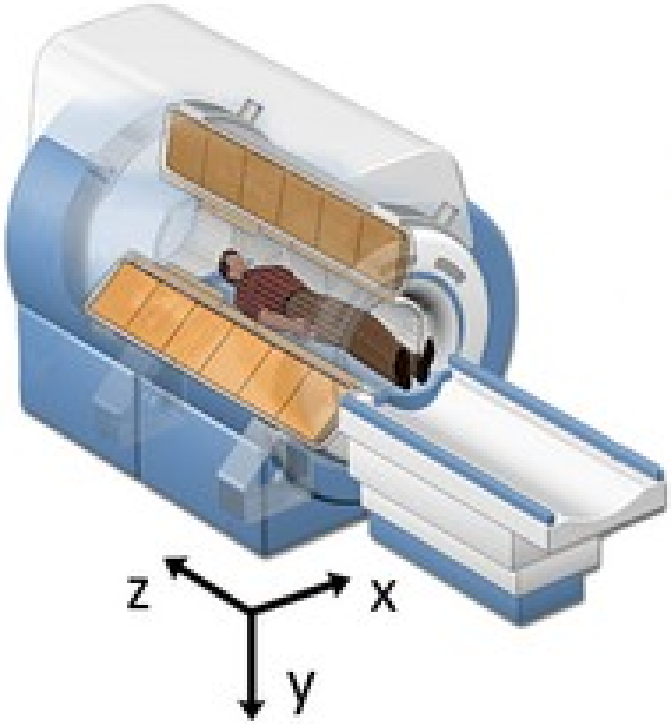


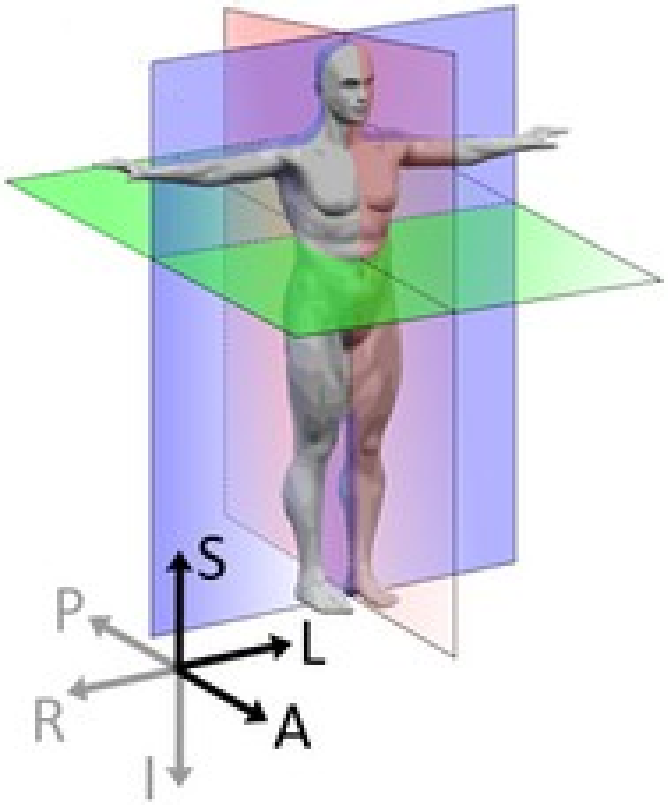
Formatos de Imagens Médicas

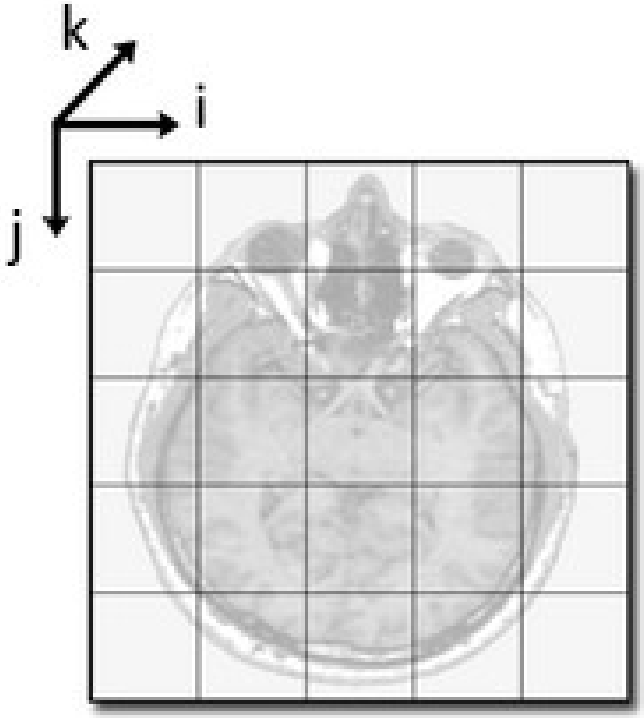
- Mayo-Analyze
- GIPL: *Guys Image Processing Lab Format*
- Interfile
- NIFTI: *Neuroimaging Informatics Technology Initiative*
- DICOM: *Digital Imaging and Communications in Medicine*
- *Flat Image Format*

http://www.nf.mpg.de/vinci3/doc/image-formats.htm

Espaços Referenciais





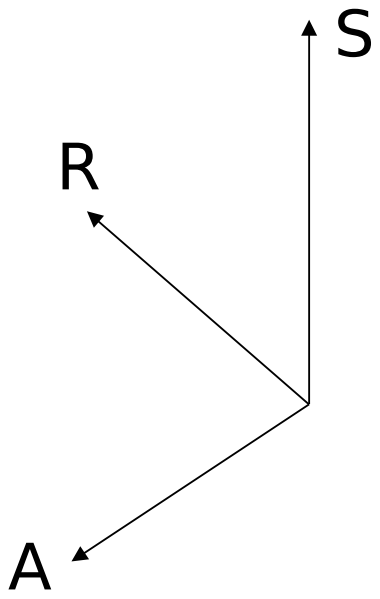


"Universo" Paciente ou anatômico Imagem

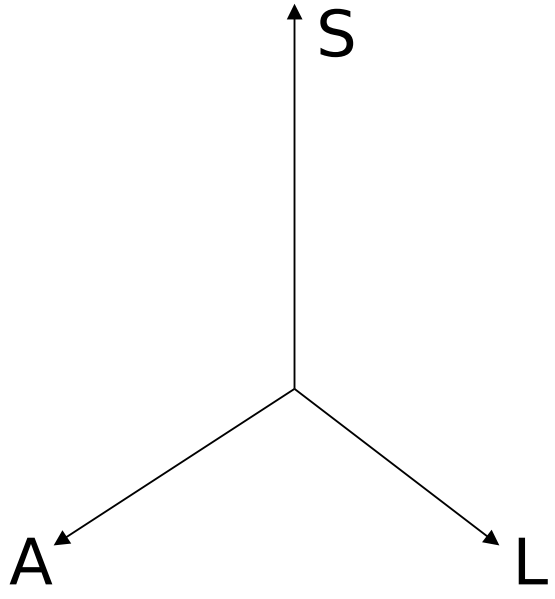
Fonte: http://www.slicer.org/slicerWiki/index.php/Coordinate_systen

Espaço Anatômico: Versores

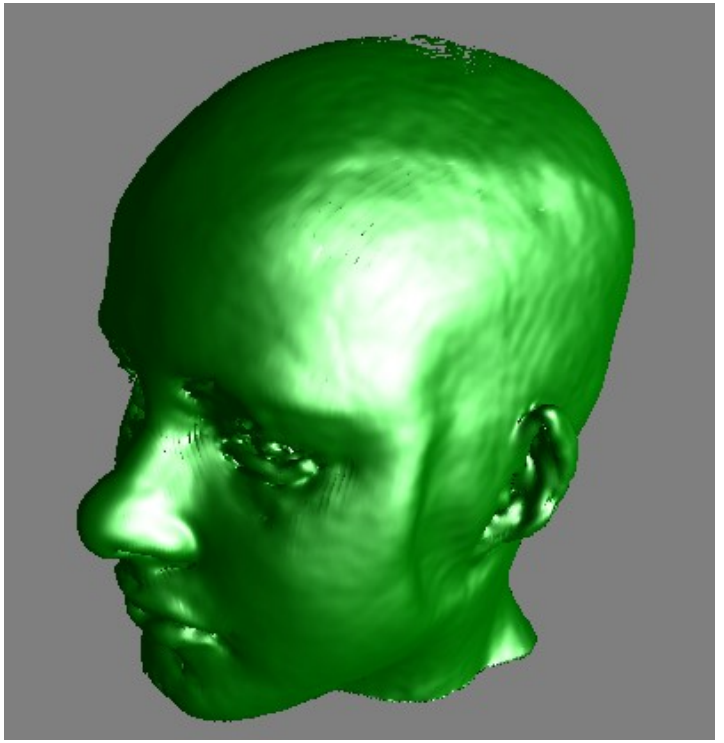
- Vetores-base são descritos em relação ao espaço-universo.



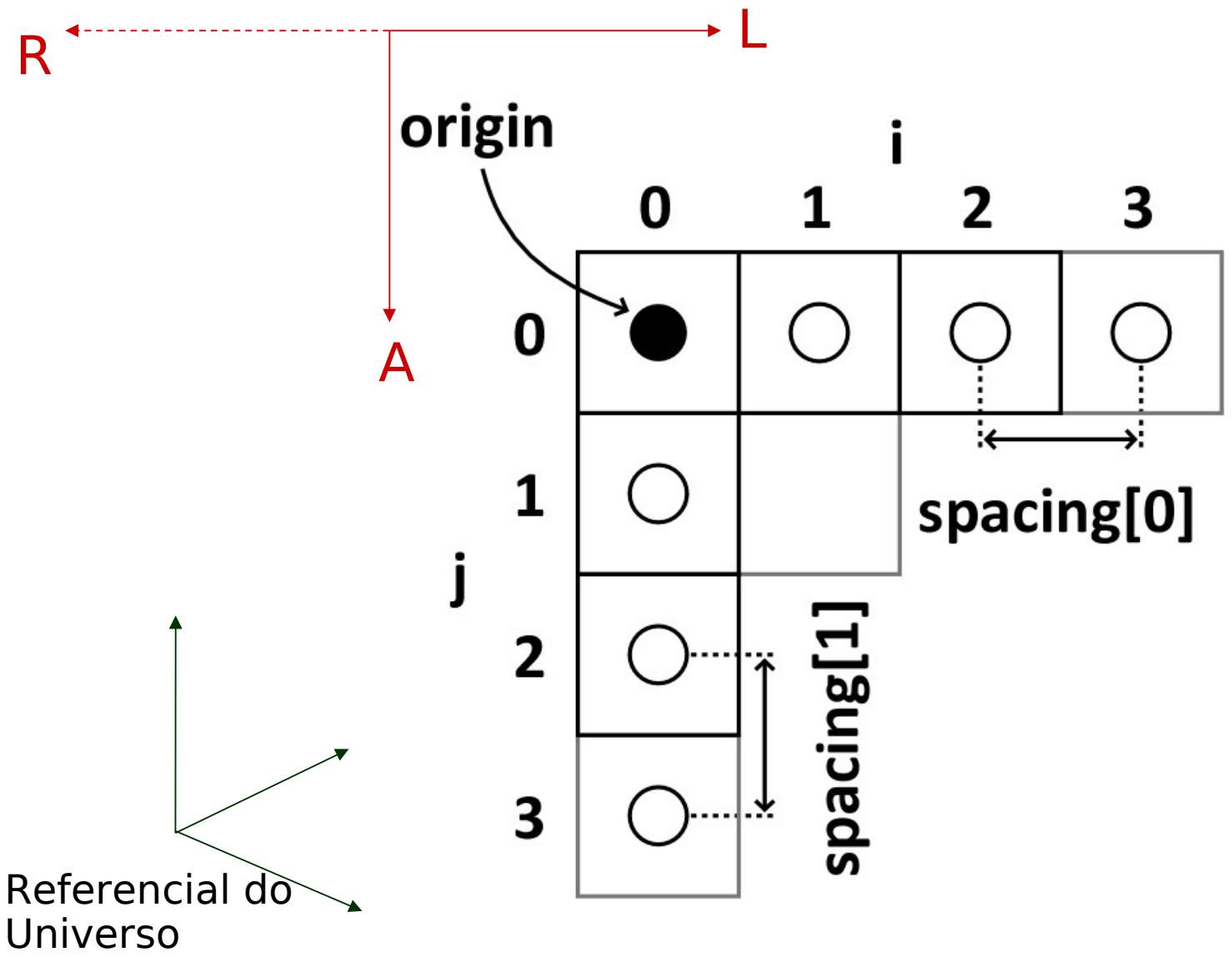
Convenção Neurológica
RAS



Convenção Radiológica
LAS

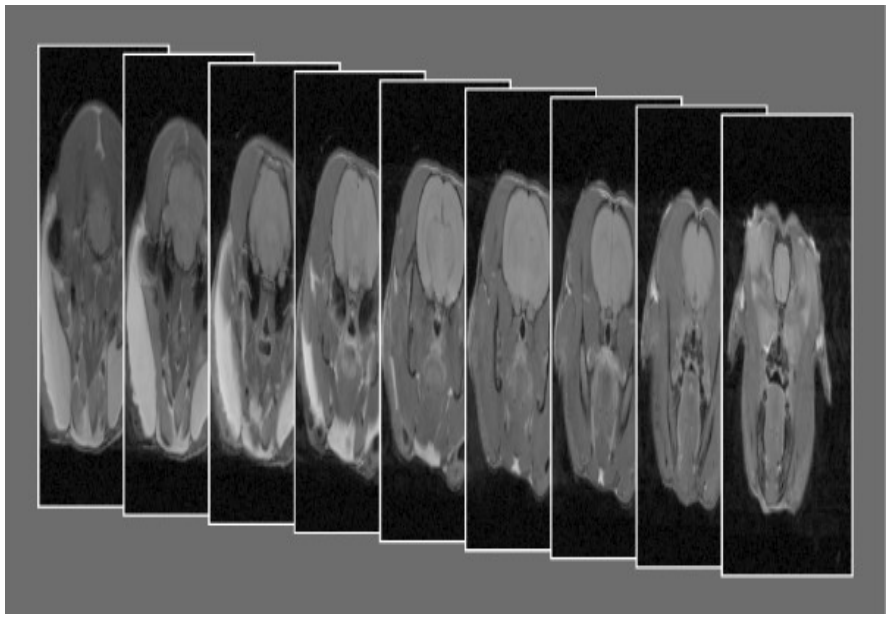


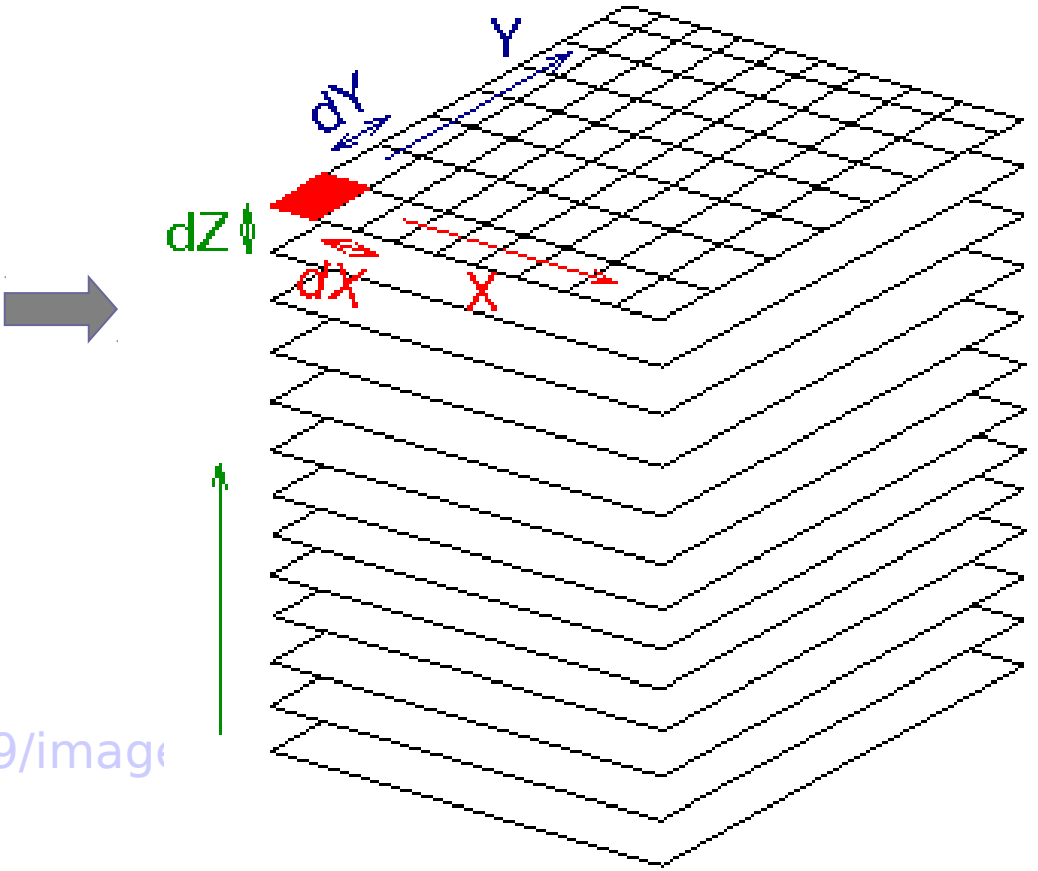
Espaço Anatômico: Discretização



Modelo Matemático

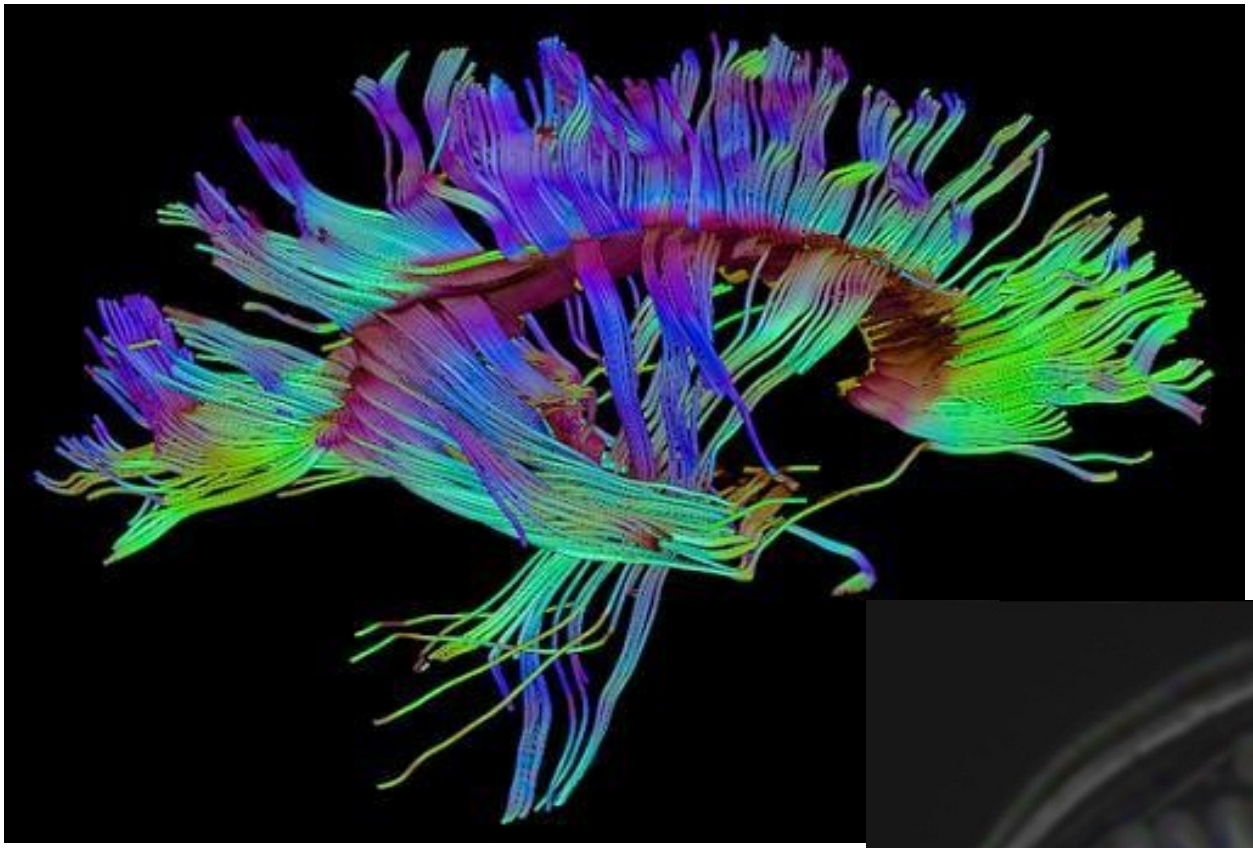
- Volume de dados é um arranjo tridimensional retangular de amostras adquiridas segundo o referencial anatômico.





Fonte:
http://www.omicsonline.org/2155-9929/imag

Tractografia



http://www.cs.unc.edu/Researc