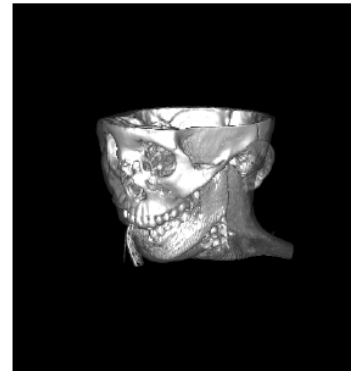
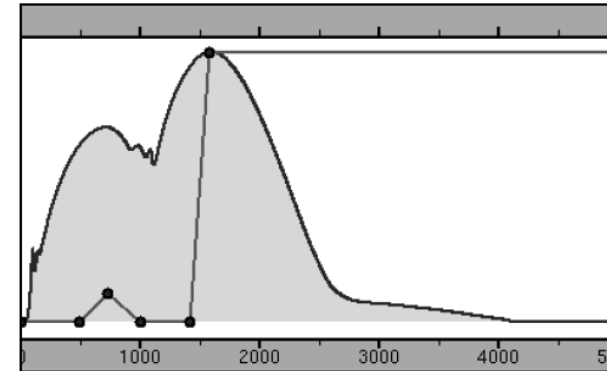
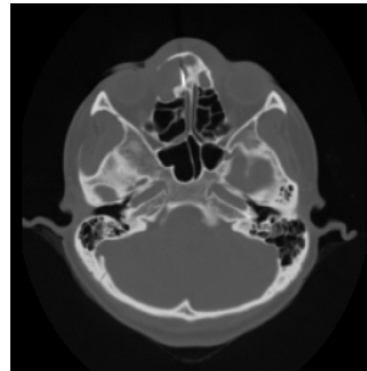
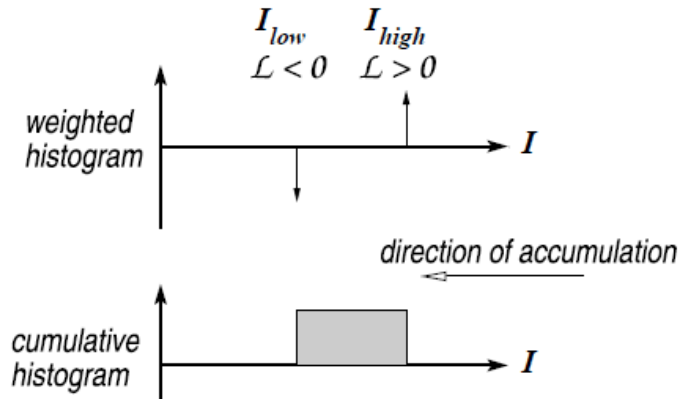


# Revisão de artigos para a pesquisa

Rustam Mesquita

# Fast detection of meaningful isosurfaces for volume data visualization (Pekar et al. 2001)

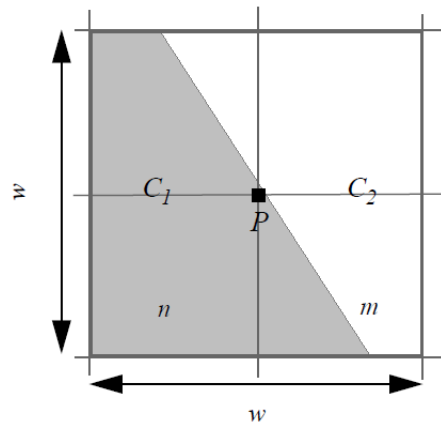
- Bi – Volume binário (0 e 1). Se  $I(x) \geq i$  então  $Bi(x) = 1$ , senão  $Bi(x) = 0$ .
- As interfaces entre 0 e 1 no volume binário são iso-superfícies.
- T – i que separa o volume em materiais distintos, no volume binário.
- T ótimo – T de maior gradiente acumulado:  $F(T)$ , onde  $F(T) = \int_{\Gamma} |g| d\gamma$
- Pelo teorema da divergência  $F(T) = - \int_{\Omega} \mathcal{L}(x) dx$ , onde  $\mathcal{L}(x)$  é o laplaciano na posição  $x$ .



- Referência: <http://ieeexplore.ieee.org/document/964515/>

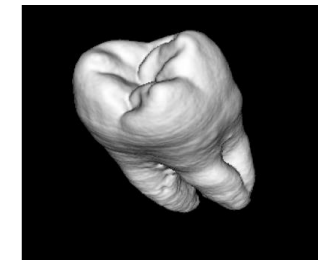
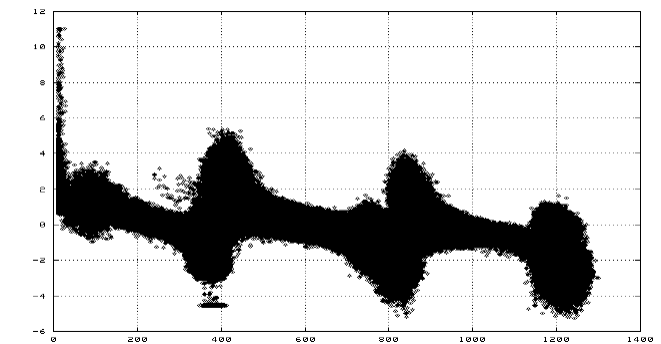
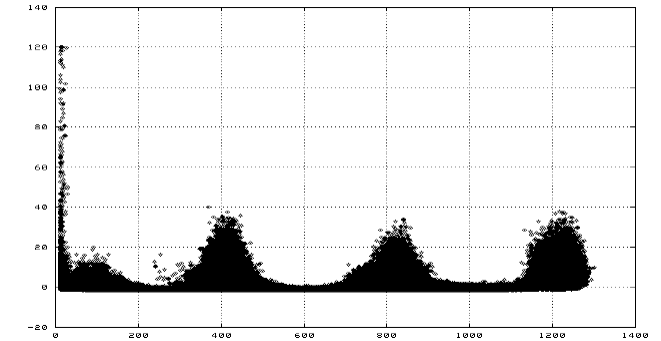
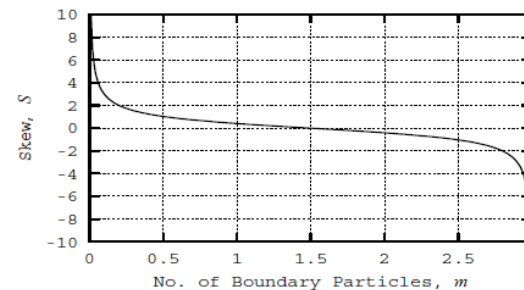
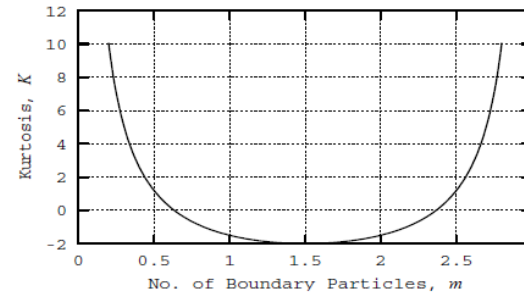
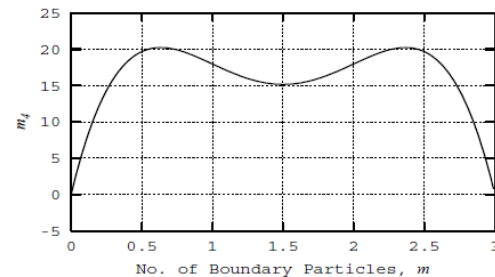
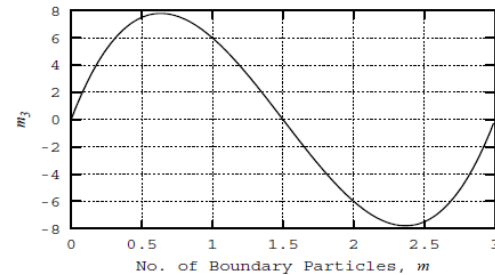
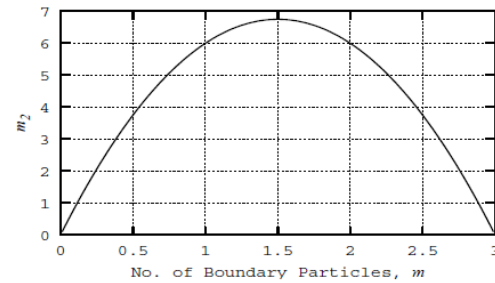
# Salient iso-surface detection with model-independent statistical signatures (Tenginakai et al. 2001)

- Higher Order Moments (HOMs) – Mede a tendência da distribuição em torno de um valor.
- LHOMs – Local HOMs.
- $M_k$  – k-ésima ordem.



$$LM = \frac{1}{2} \sum x$$

$$m_k = \frac{1}{2} \sum (x - LM)^k$$

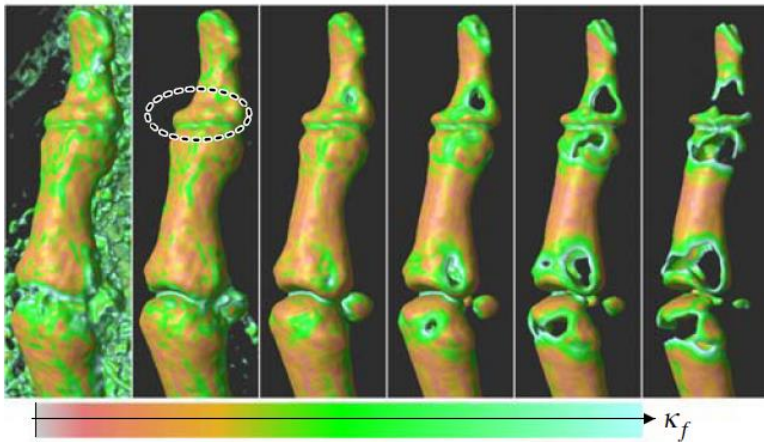


- Referência: <http://ieeexplore.ieee.org/document/964516/>

# Curvature-based transfer functions for direct volume rendering: methods and applications (Kindlmann et al. 2003)

- Visualização de Incertezas de uma iso-superfície.
- $K_f$  – Flowline curvature. O quanto uma isosuperfície muda sua orientação.
- A partir da primeira e segunda derivada extrai  $K_f$ .
- Variação pequena de isovalue com grande variação de curvatura indica incerteza.

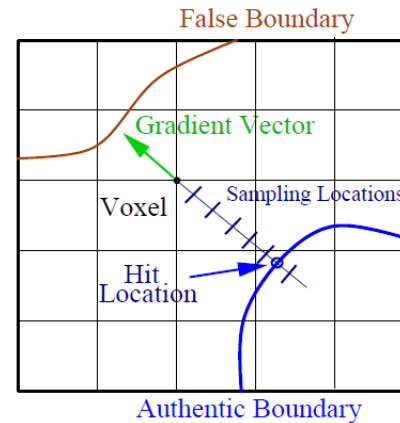
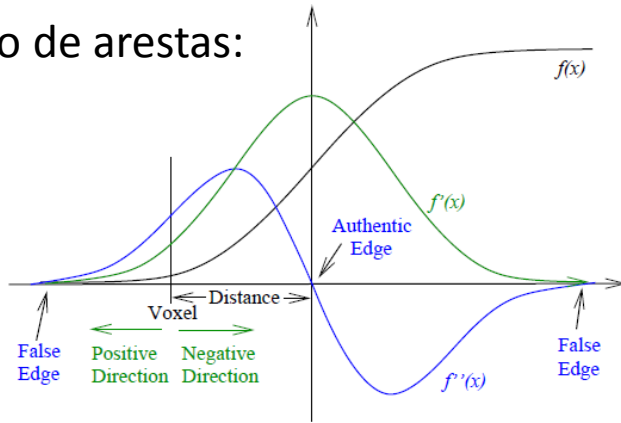
$$\nabla \mathbf{n}^T = -\frac{1}{|\mathbf{g}|} \mathbf{P} \mathbf{H}, \quad \nabla \mathbf{n}^T = \begin{bmatrix} \kappa_1 & 0 & \sigma_1 \\ 0 & \kappa_2 & \sigma_2 \\ 0 & 0 & 0 \end{bmatrix} \quad \kappa_f = \sqrt{\sigma_1^2 + \sigma_2^2}$$



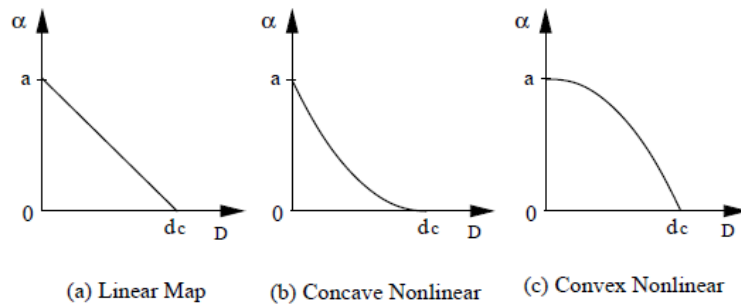
- Referência: <http://ieeexplore.ieee.org/document/1250414/>

# Multi-Dimensional Transfer Function Design for Scientific Visualization (Park e Bajaj. 2004)

- Detecção de arestas:

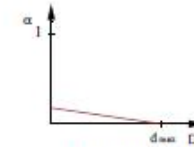


- TF's propostas

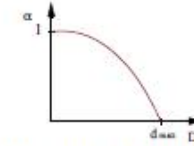
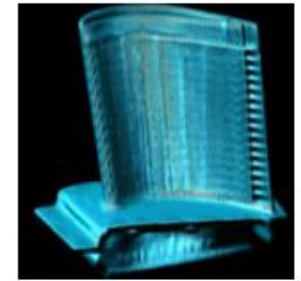


$$D(\vec{x}) = \frac{d_{max} - d(\vec{x})}{d_{max}} \times 255$$

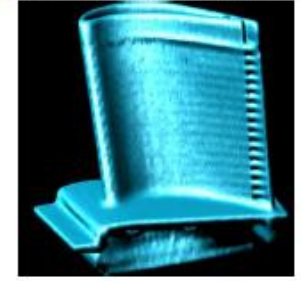
- Referência: [https://www.cse.iitb.ac.in/~sharat/icvgip.org/icvgip2004/proceedings/cg2\\_299.pdf](https://www.cse.iitb.ac.in/~sharat/icvgip.org/icvgip2004/proceedings/cg2_299.pdf)



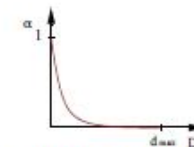
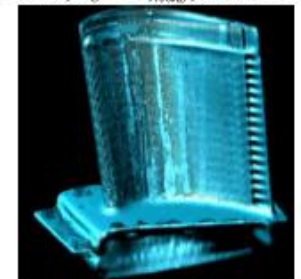
(a) Linear Alpha with  $a = 0.1$  and  $d_c = d_{max}$



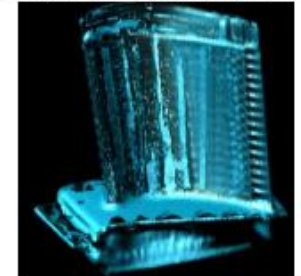
(b) Convex Alpha with  $a = 1.0$ ,  $d_c = d_{max}$ , and  $n = 3.0$



(c) Concave Alpha with  $a = 1.0$ ,  $d_c = d_{max}$ , and  $n = 5.0$

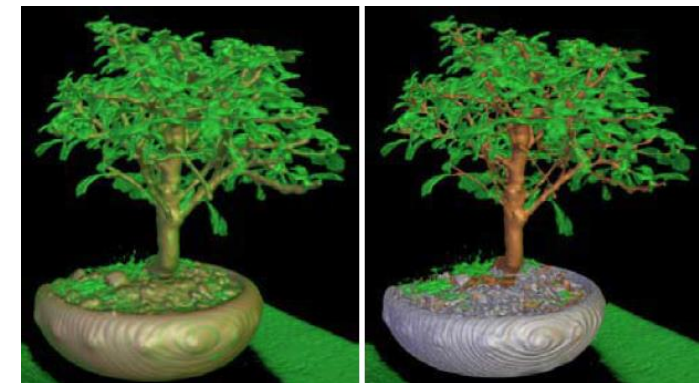
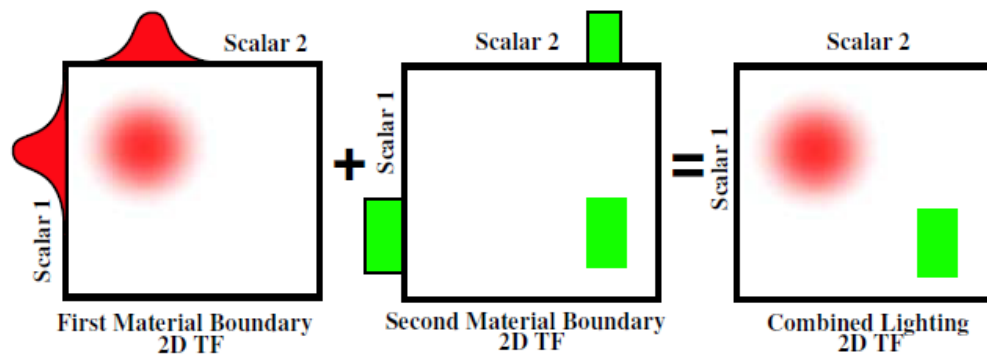
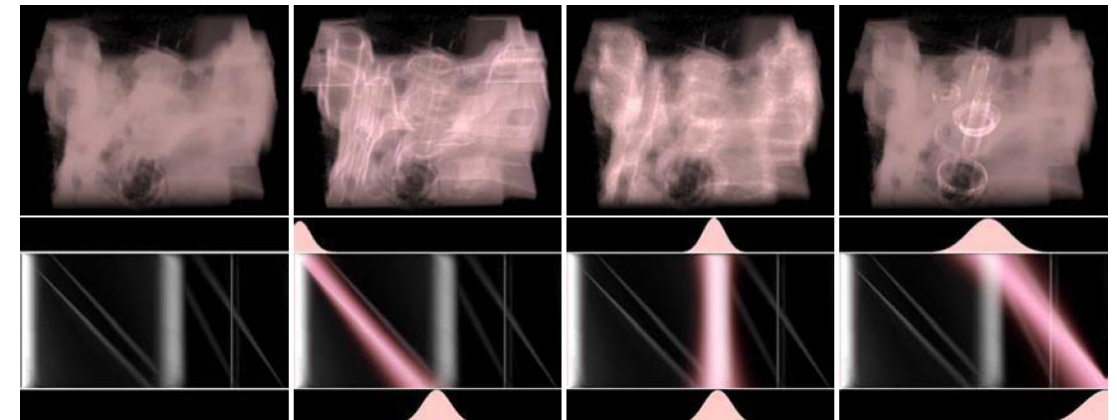
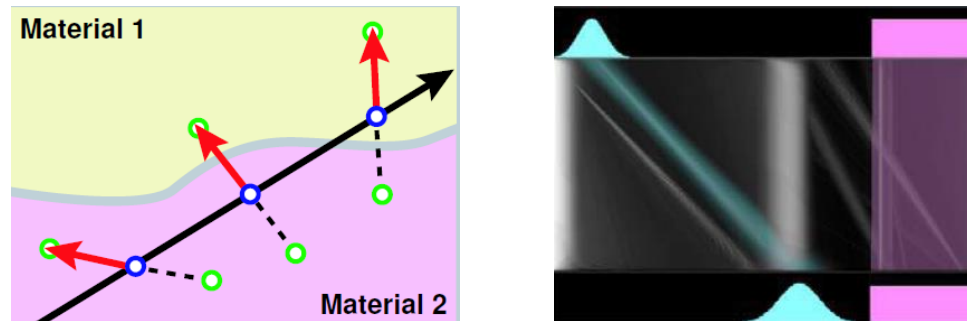


(d) Concave Alpha with  $a = 1.0$ ,  $d_c = d_{max}$ , and  $n = 7.0$



# Lighting Transfer Functions Using Gradient Aligned Sampling (Lum e Ma. 20004)

- Avalia o volume em função do par samples vizinhos, na direção do gradiente.
- Histograma “scalar x scalar” em eixos paralelos.

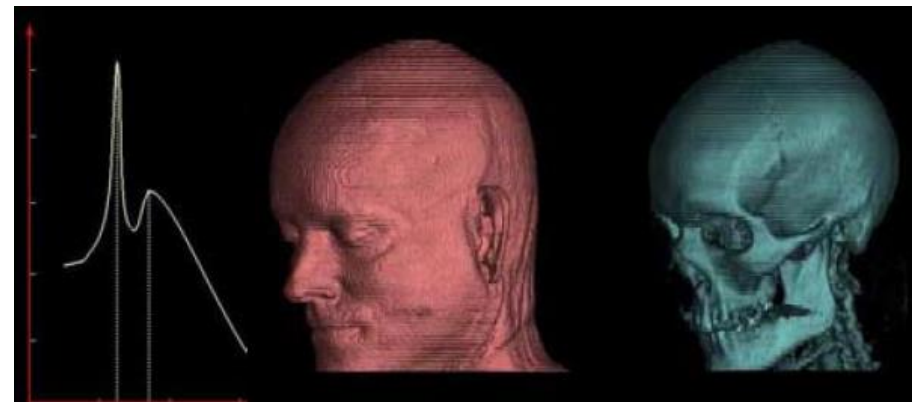
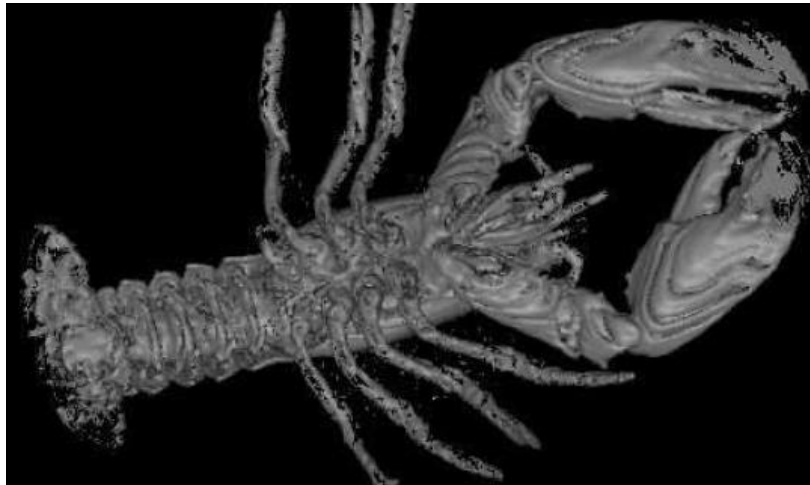


Corrige o Gtresh do Kndlmann

- Referência: <http://dx.doi.org/10.1109/VISUAL.2004.64>

# Boundary Surface Extraction and Rendering for Volume Datasets (Fang e Gupta. 2006)

- Convolução com filtro Gaussiano e Laplaciano (LoG) gera o “Zero-Crossing Field”
- Extração do “Zero-Crossing Surface” com Marching Cubes.
- Render com threshold no gradiente ou range de iso-values na malha poligonal.
- Também propõem extração de isso-superfície em multi-escala.



- Referência: <http://doi.acm.org/10.1145/1141277.1141592>

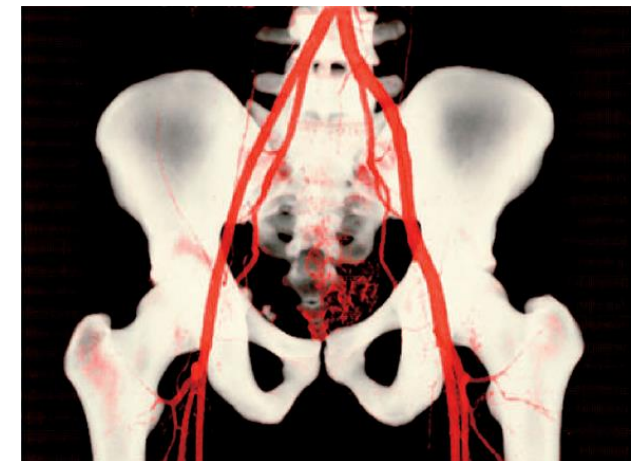
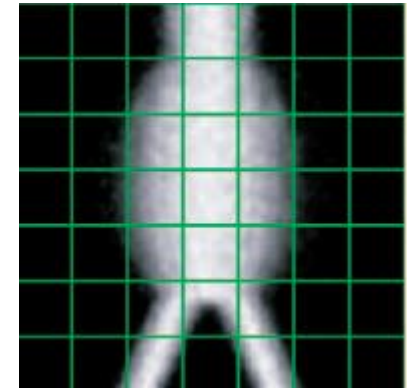
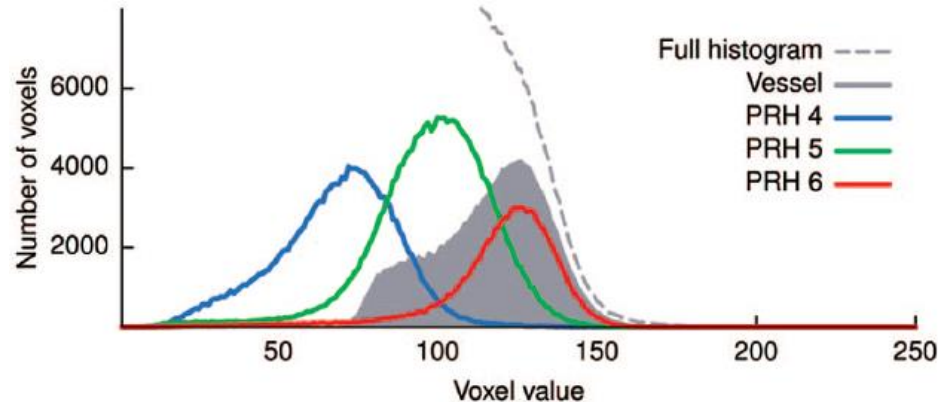


# Local Histograms for Design of Transfer Functions in Direct Volume Rendering (Lundstrom et al. 2006)

- Partial Range Histogram (PRH):  $w_r \geq \epsilon$ , onde  $w_r(\Phi, N) = \frac{|N \cap V_\Phi|}{|N|}$
- Detecta tecidos criando PRH pra cada pico do histograma.
- Para cada PRH, move-o do histograma principal para um acumulador de PRH.



- Faz uso de classificação para resolver a sobreposição de dados.

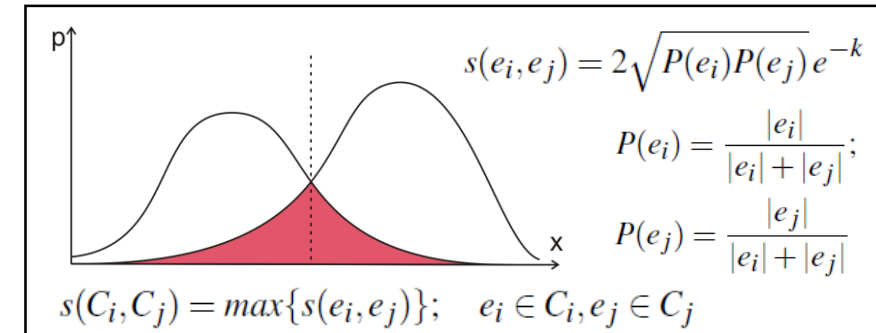


- Referência: <http://ieeexplore.ieee.org/abstract/document/1703376/>

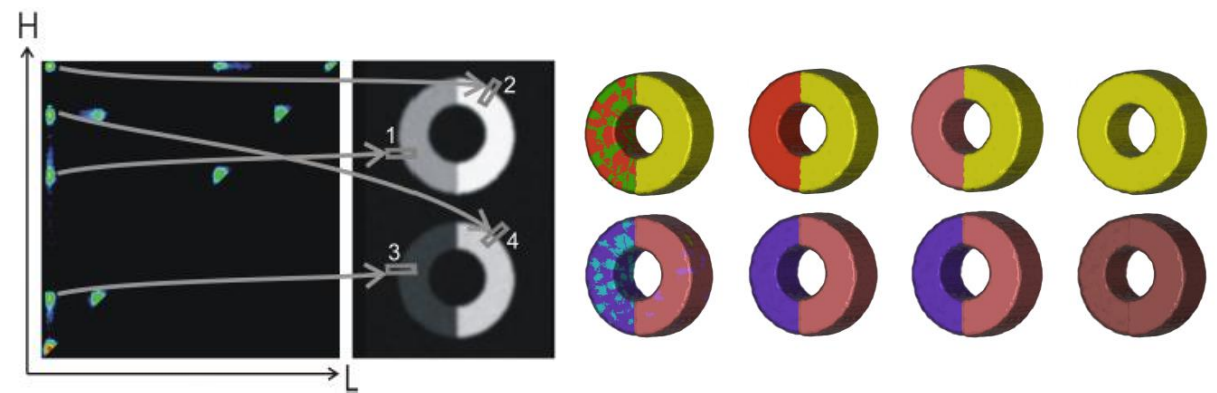
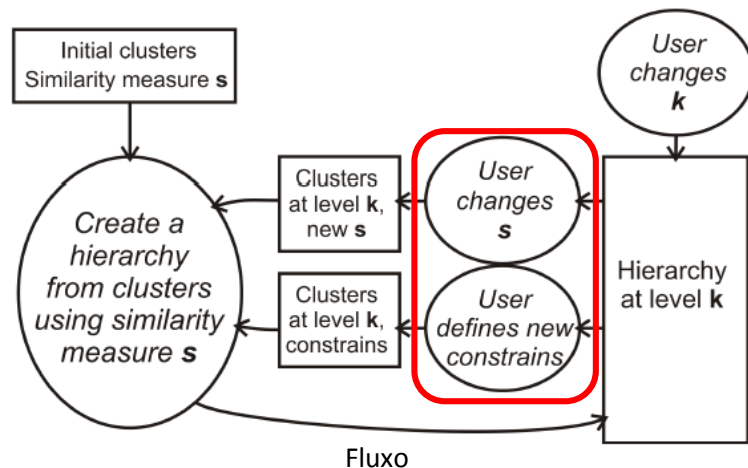


# Automating Transfer Function Design for Volume Rendering Using Hierarchical Clustering of Material Boundaries (Šereda et al. 2006)

- Computa histograma 2D e passa uma gaussiana.
- Clusters iniciais em picos do histograma.
- Clusters com poucos voxels são colapsados com seus vizinhos.
- Clusters colapsados compartilham cor e opacidade.
- Similaridade no espaço LH: O quanto duas distribuições se sobrepõem.
- Similaridade no volume: O quão vizinhos são duas fronteiras.



$$s(C_{i \cup j}, C_k) = \max \left\{ \frac{R(C_{i \cup j}, C_k)}{NR(C_{i \cup j})}, \frac{R(C_{i \cup j}, C_k)}{NR(C_k)} \right\}$$



Histograma LH, fatia do volume e visualizações em diferentes níveis de clusterização.

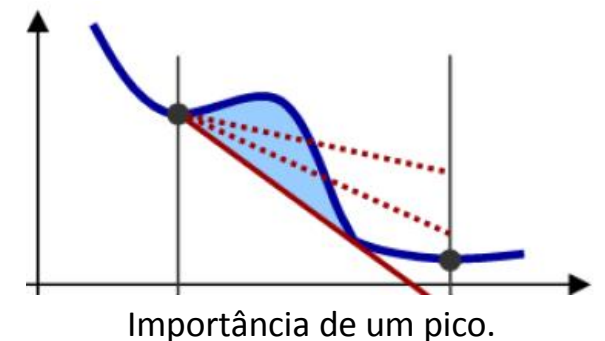
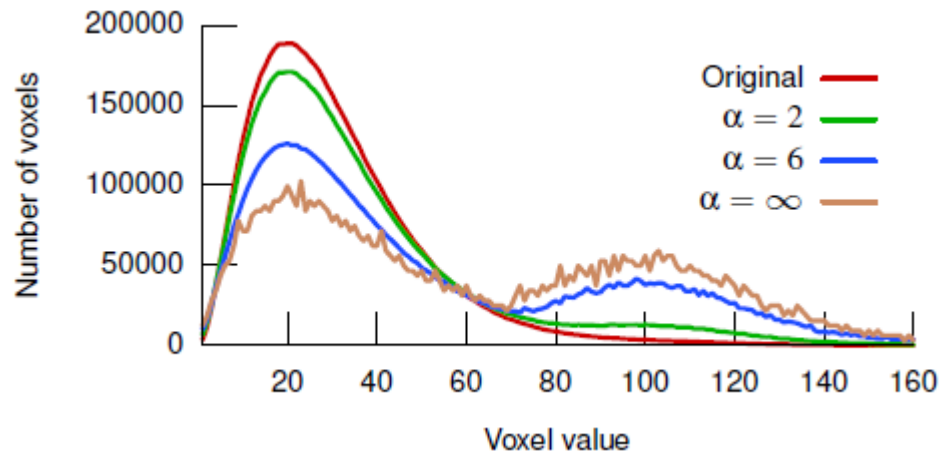
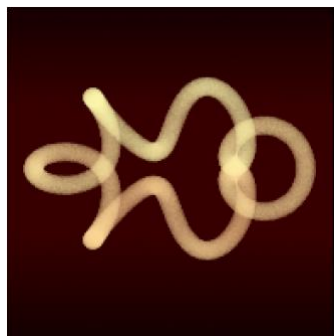
- Referência: <http://dx.doi.org/10.2312/VisSym/EuroVis06/243-250>

# The $\alpha$ -histogram: Using Spatial Coherence to Enhance Histograms and Transfer Function Design (Lundström et al. 2006)

- Histograma que incorpora coerência espacial, dado pela soma de histogramas locais.
- Histograma local – ocorrência de um valor em uma dada vizinhança.
- Normaliza-se o  $\alpha$ -histogram para que tenha a mesma área do histograma original.
- Possui número máximo de picos. Picos de menor importância (área) são removidos.
- Erro e confiança para escolher picos:

$$e_p = \frac{|x_0^* - x_0|}{x_+ - x_-} \quad c_p = \frac{H(x_0^*) - \max(H(x_-^*), H(x_+^*))}{H(x_0^*)}$$

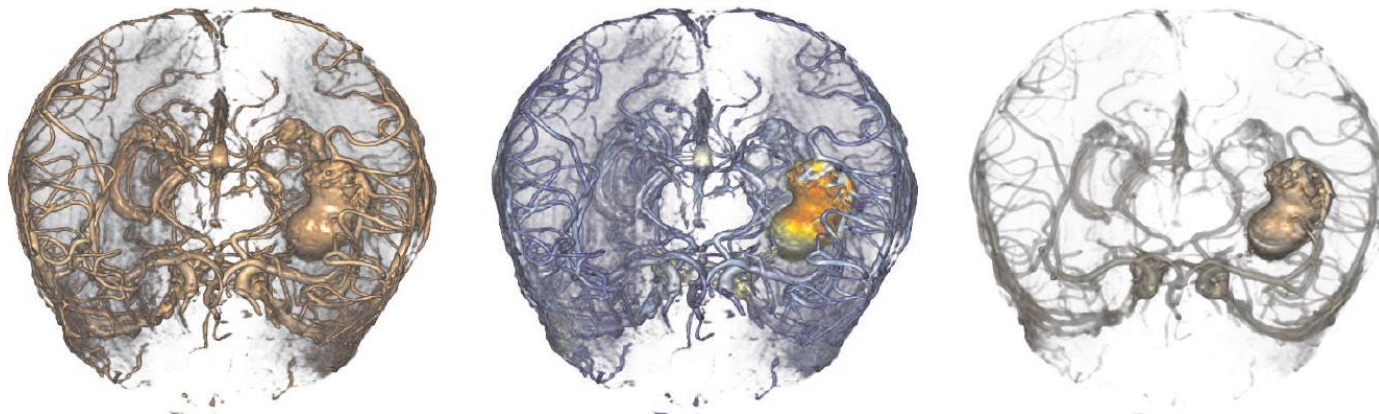
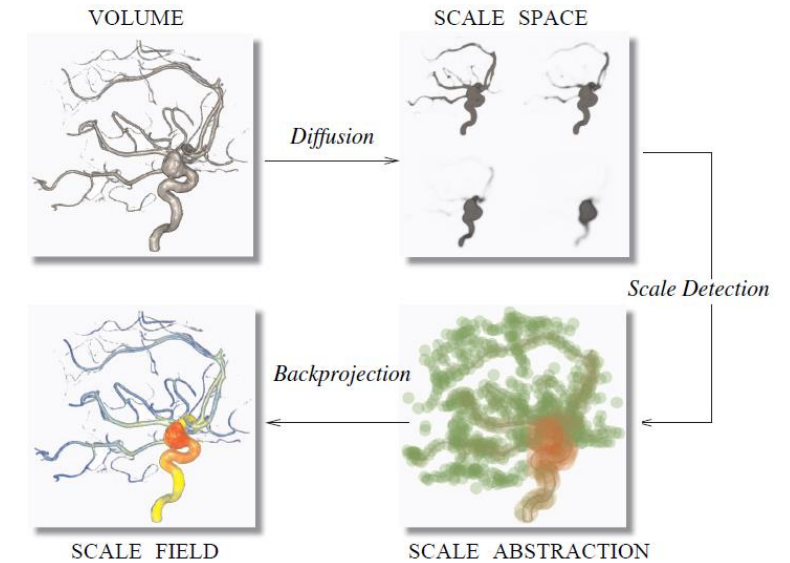
$$H_n(N, x) = |N \cap D_x|$$
$$H_\alpha(x) = \left( \sum_{i=1}^k H_n(N_i, x)^\alpha \right)^{1/\alpha}$$
$$\alpha > 1$$



- Referência: <http://www.diva-portal.org/smash/record.jsf?pid=diva2:22276>

# Size-based Transfer Functions: A New Volume Exploration Technique (Correa et al. 2008)

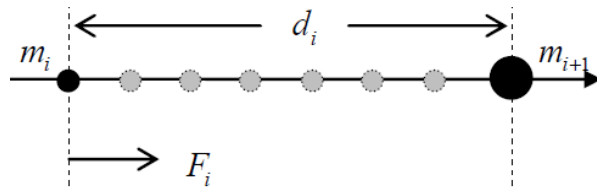
- Campo escalar é criado:
  - Convoluido com gaussianas.
  - Detecção de “manchas” em máximo laplaciano.
  - Scale Field  $\rightarrow S(\mathbf{x}) = \max_{\mathbf{x}_i \in N} \{ \Theta(\|\mathbf{x} - \mathbf{x}_i\|) t_i \}$  ou  $S(\mathbf{x}) = \sum_{\mathbf{x}_i \in N} \Theta(\|\mathbf{x} - \mathbf{x}_i\|) t_i$
- Não há avaliação de fronteira entre materiais.
- Domínio da TF é o espaço de escalas encontradas no volume.



- Referência: <http://ieeexplore.ieee.org/document/4658153/>

# Transfer Function Design Using Acting Force Model (Zhang et al. 2009)

- Usa coerência espacial:



- Gravitação + Energia cinética:

$$opa_i = c \cdot tf(m_i) \cdot \|g_i\|^2 + k \cdot \frac{tf(m_i) \cdot tf(m_{i+1})}{d_i}$$

- Referência: <http://ieeexplore.ieee.org/document/5437956/>

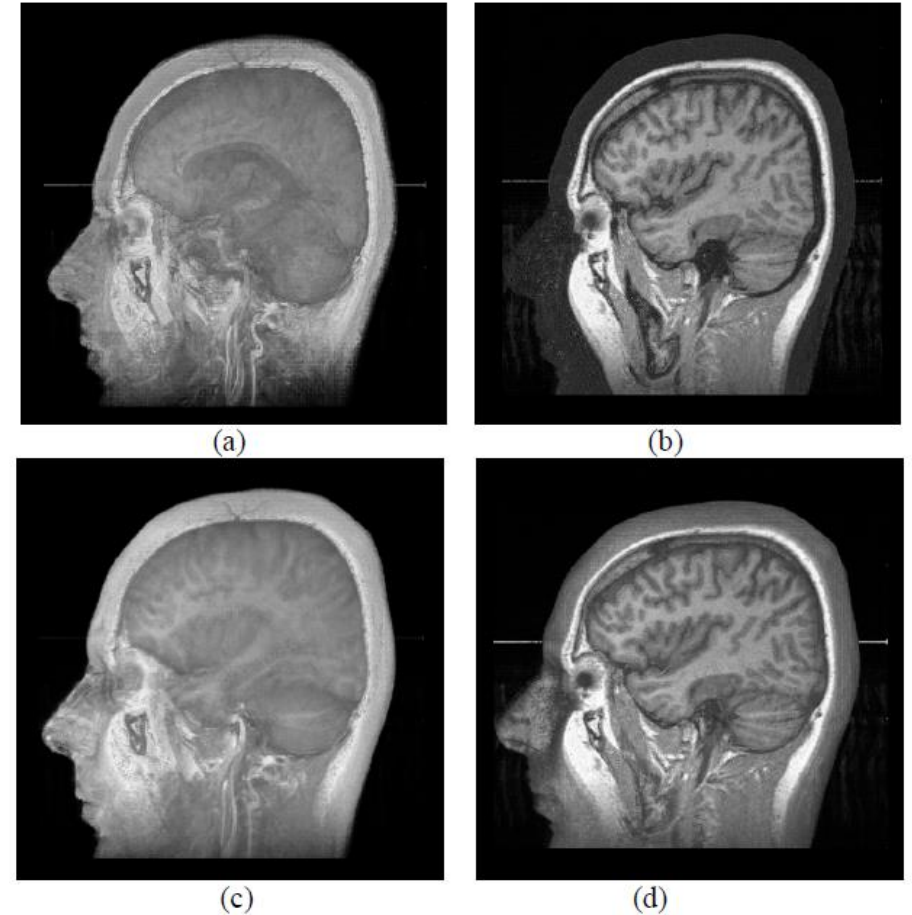
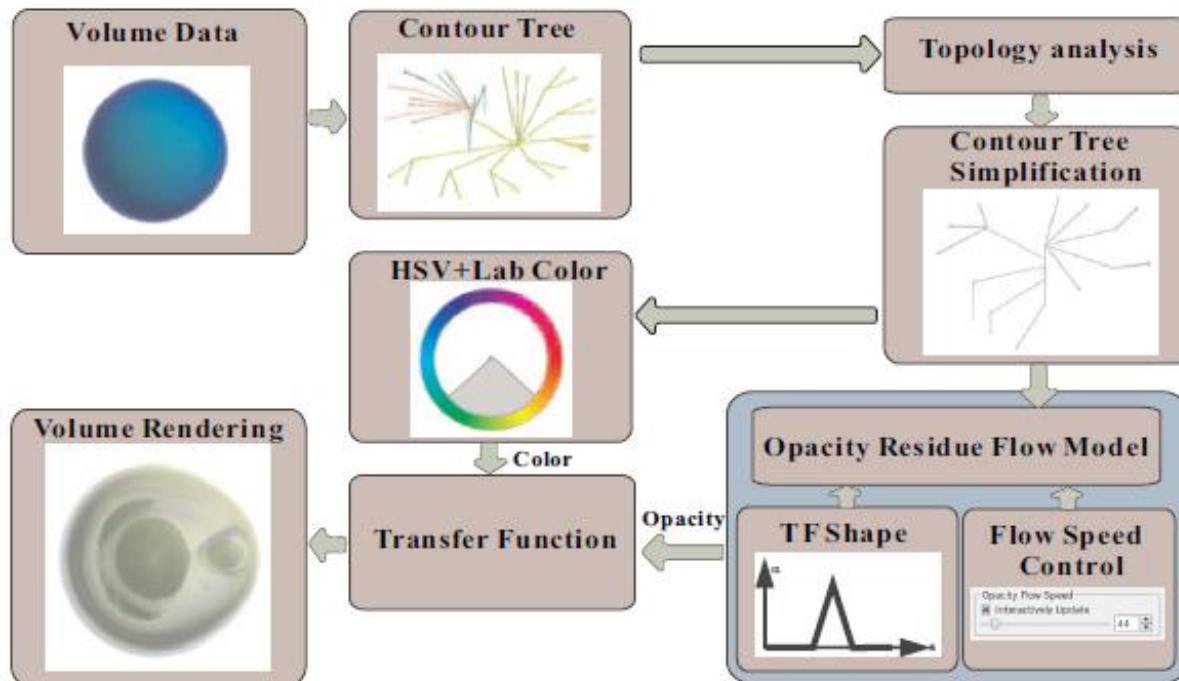


Figure 3: Results with parameter varying. (a)  $f_s$  of AFM used only with  $c = 13$ . (b)  $f_s$  of AFM used only with  $c = 970$ . (c)  $f_d$  of AFM used only with  $k = 0.0021$ . (d)  $f_d$  of AFM used only with  $k = 0.023$ .

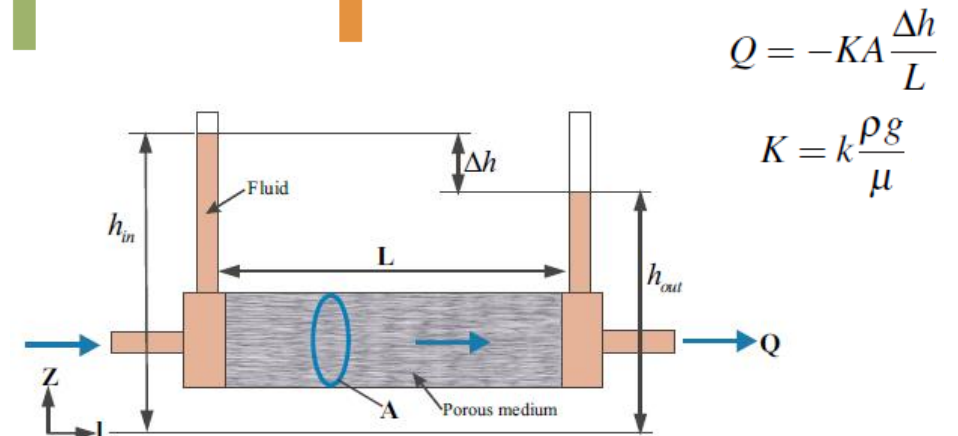
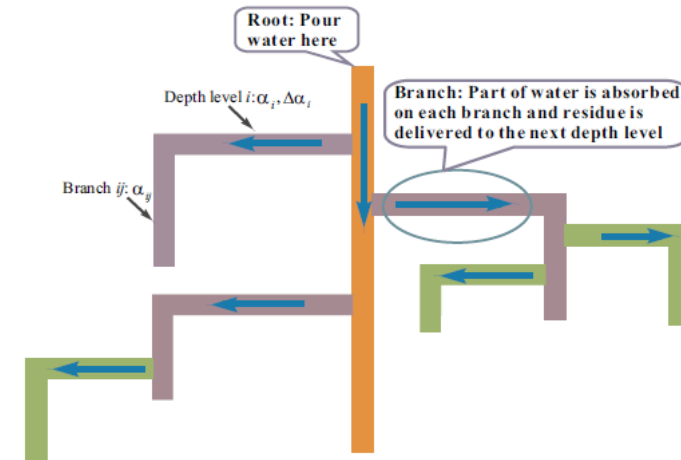


# Automatic Transfer Function Generation Using Contour Tree Controlled Residue Flow Model and Color Harmonics (Zhou e Takatsuka. 2009)

- Contour Tree organiza o volume em regiões topologicamente distintas.
- Decomposição em ramos revela relações de inclusão (estruturas internas).
- Aplica lei de Darcy aos ramos utilizando métricas da contour tree como persistência, número de ramos filhos e etc. Opacidade como fluido residual.



- Referência: <http://ieeexplore.ieee.org/document/5290764/>

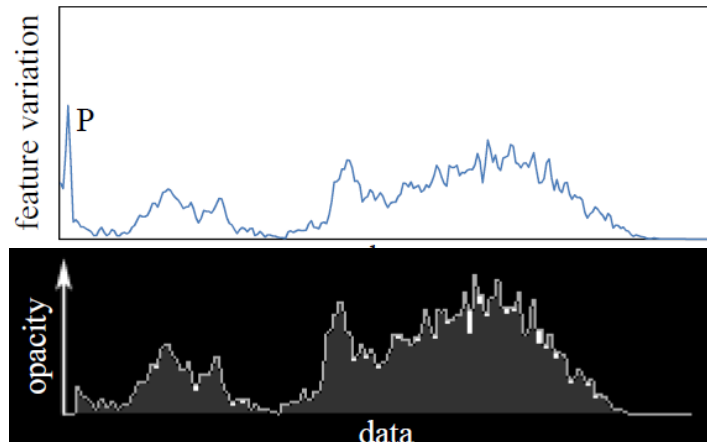


# Feature variation curve guided transfer function design for 3D medical image visualization (Chu et al. 2010)

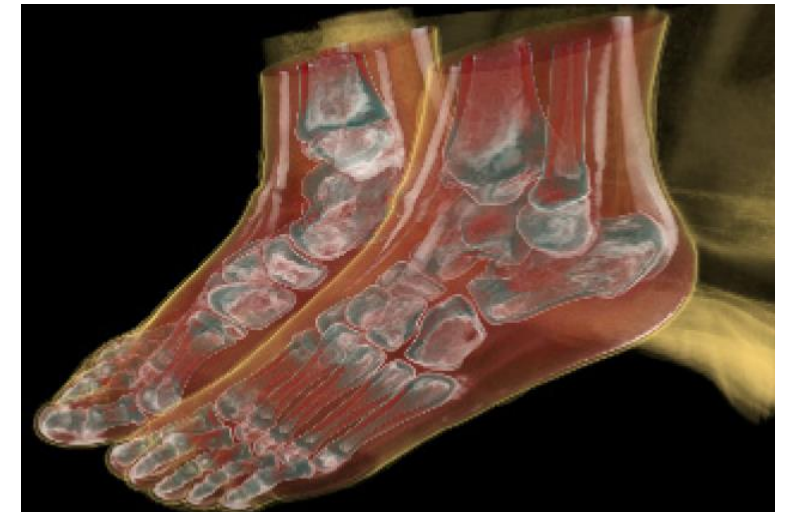
- Imagens 2D geradas a partir de 10 pontos de vista distintos (para cada v).
- Para cada imagem, extrai-se um descritor de Fourier baseado no centroide do contorno ( $d_i$ ).

$$f_n = \frac{1}{N} \sum_{i=0}^{N-1} d_i \exp(-\frac{j2\pi ni}{N}), n = 0, 1, \dots, N-1$$

- Distância entre descritores – somatório das diferenças entre os descritores:  $d(F_i, F_j) = \sum_{k=0}^{N-1} |f_{i,k} - f_{j,k}|$
- Distância entre duas intensidades:  $d(A_i, A_j) = \sum_{h=1}^{10} d(F_{i,h}, F_{j,h})$
- Curva de variação característica (diferença central entre as distâncias):



$$V_i = \begin{cases} d(A_1, A_2) & i = 1 \\ (d(A_i, A_{i-1}) + d(A_i, A_{i+1}))/2 & 1 < i < n \\ d(A_{n-1}, A_n) & i = n \end{cases}$$



- Referência: <http://ieeexplore.ieee.org/document/5639464/>

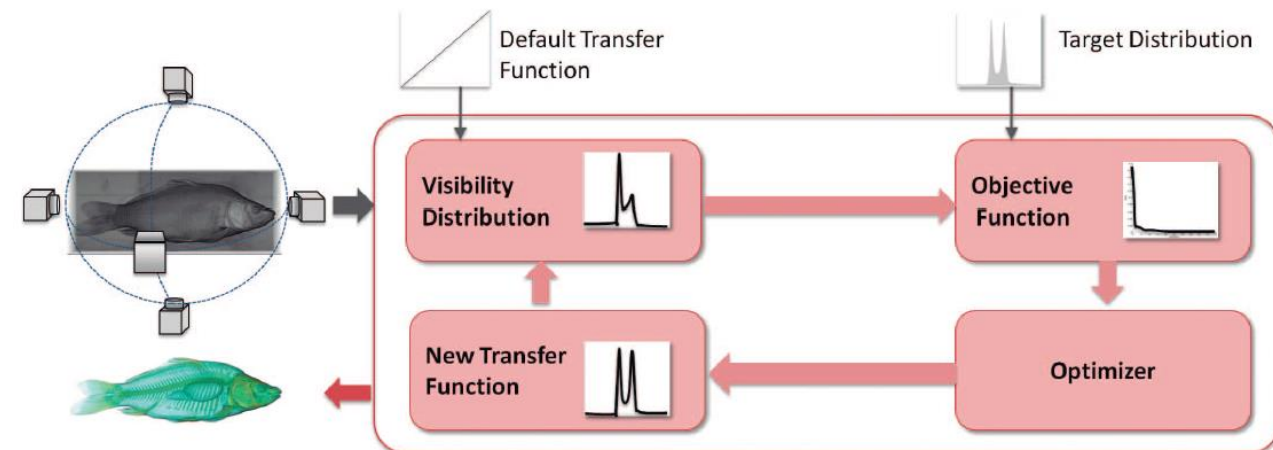
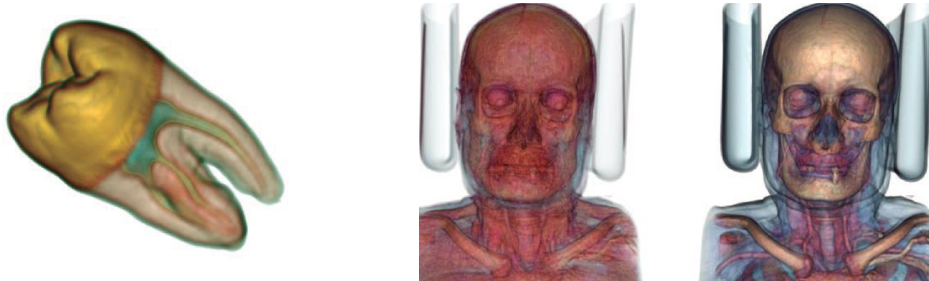


# Automatic Transfer Functions Based on Informational Divergence (Ruiz et al. 2011)

- Visualiza o volume, de ângulos variados (TF inicial) e computa uma distribuição de visibilidade.
- Bin: conjunto de voxels com mesma intensidade.
- Distribuição pretendida é extraída do volume a partir de estratégias que definem probabilidade de visibilidade para os bins, na imagem final.
- Otimiza a TF minimizando a distância entre a distribuição atual e a pretendida. (Algoritmo do gradiente descendente)
- $vis(b|v)$ : visibilidade do bin  $b$ . Soma das contribuições de todos os voxels de intensidade  $b$ .

- Distribuição de visibilidade corrente:  $p(b) = \sum_{v \in \mathcal{V}} p(v)p(b|v)$
- Distribuição esperada:  $q(b) = gradient(b) / \sum_{i \in \mathcal{B}} gradient(i)$ .
- Divergência:  $D_{KL}(p, q) = \sum_{x \in \mathcal{X}} p(x) \log \frac{p(x)}{q(x)}$

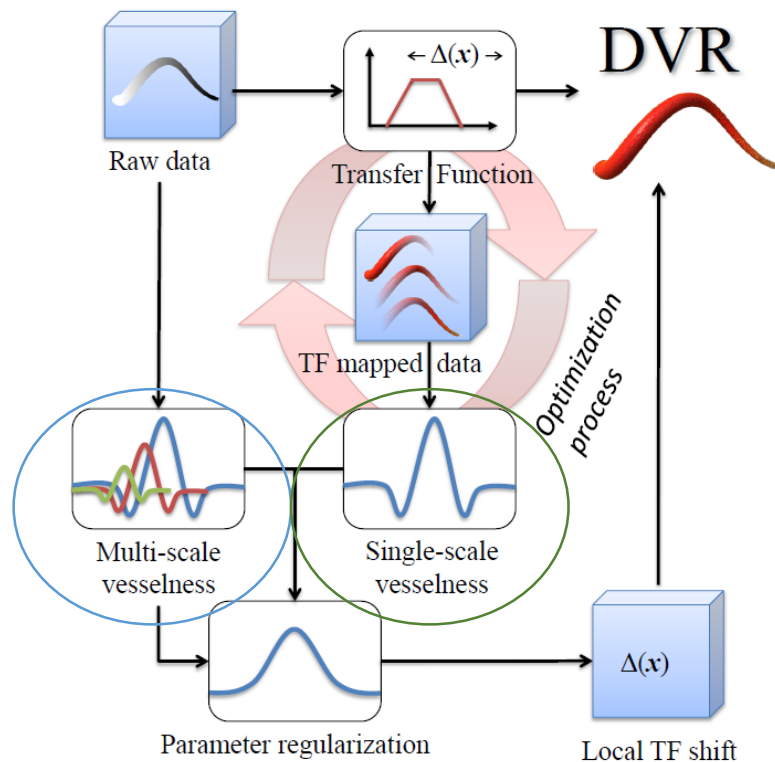
$$p(v) = vis(v) / \sum_{i \in \mathcal{V}} vis(i). \quad vis(v) = \sum_{b \in \mathcal{B}} vis(b|v) \quad p(b|v) = vis(b|v) / vis(v)$$



- Referência: <http://ieeexplore.ieee.org/document/6064956/>

# Automatic Tuning of Spatially Varying Transfer Functions for Blood Vessel Visualization (Läthén et al. 2012)

- Varia a TF localmente, corrigindo a visualização do vaso sanguíneo.
- Propõem uma equalização de intensidades dos vasos sanguíneos.
- $TF(\mathbf{x}, I(\mathbf{x}), \Delta(\mathbf{x})) = TF_{preset}(I(\mathbf{x}) - \Delta(\mathbf{x}))$



- Referência: <http://ieeexplore.ieee.org/document/6327239/>

