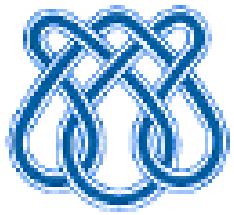
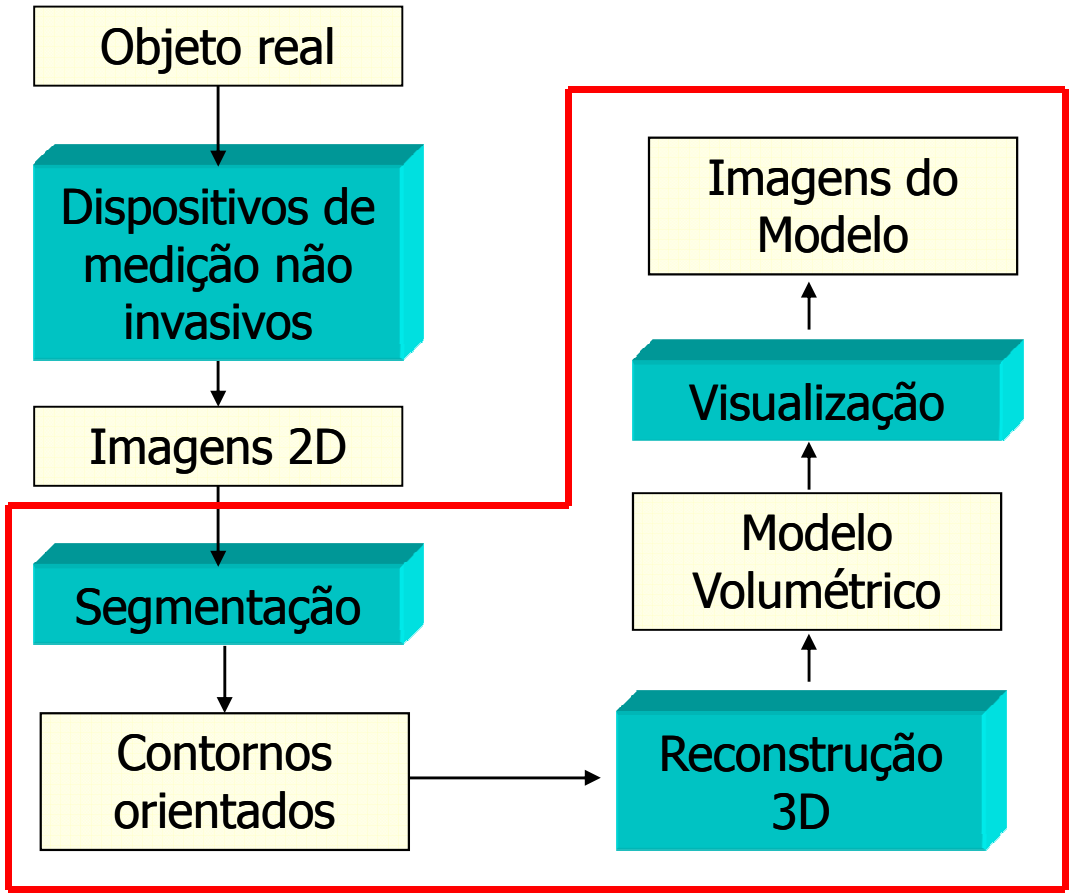


Reconstrução a partir de Seções Planares

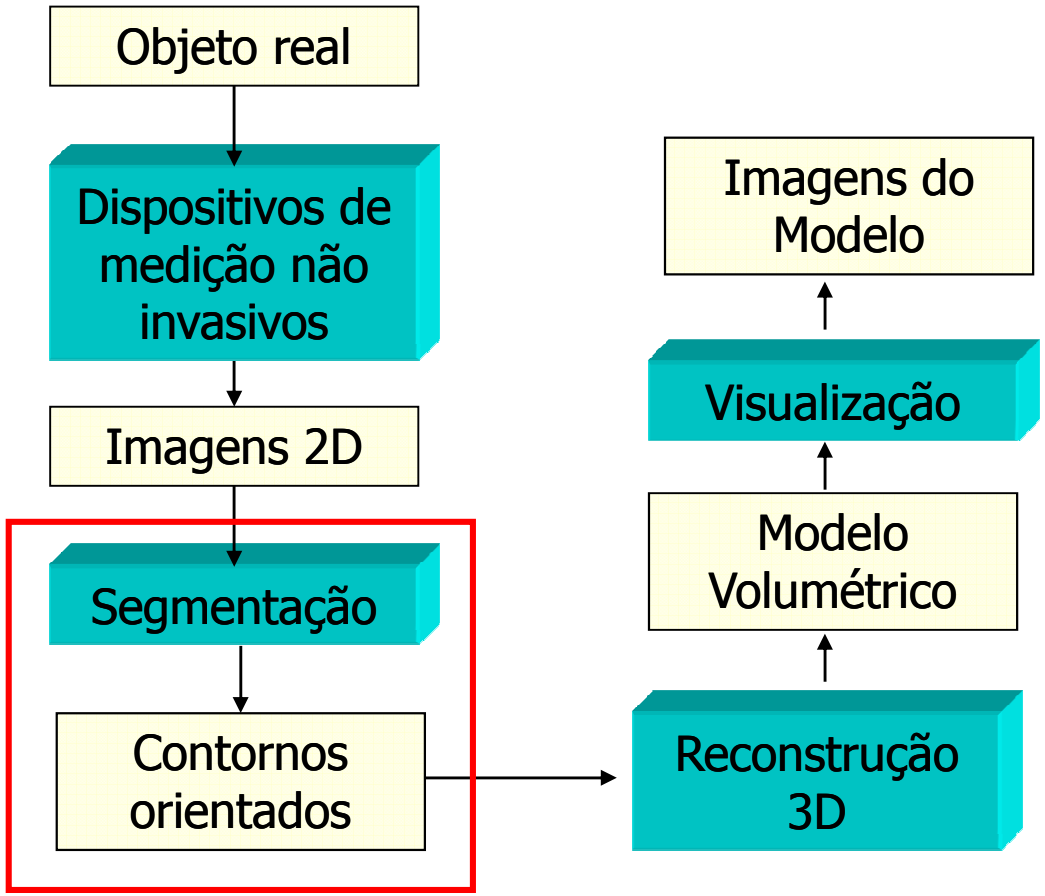
Instituto de Ciências Matemáticas e de Computação
Departamento de Computação e Estatística
VICG - USP - São Carlos

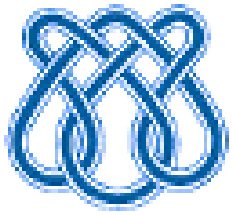
Luis Gustavo Nonato
Rosane Minghim
Maria Cristina F. de Oliveira
Antonio Castelo Filho
João E. S. Batista

Reconstrução a partir de Seções Planares



Reconstrução a partir de Seções Planares





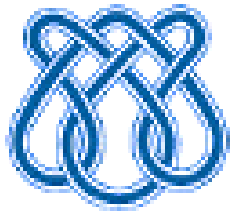
Segmentação e Geração de Contornos

Abordagem topológica baseada em crescimento de regiões:

Morse Operators for Digital Planar Surfaces and their application to Segmentation

Nonato, Castelo, Minghim, Batista

IEEE Transactions on Image Processing, jan. 2004



Segmentação e Geração de Contornos

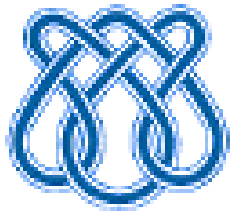
Abordagem topológica baseada em crescimento de regiões:

Vantagens:

- Controle da topologia durante a segmentação
- Pouco sensível a ruídos
- Obtenção dos contornos (orientados) de forma imediata

Desvantagens:

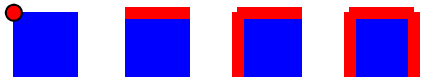
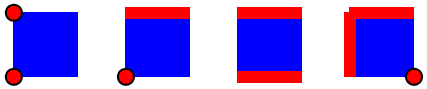
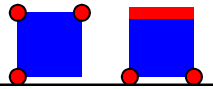
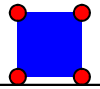
- Necessário fornecer "sementes" (semi-automáticas)
- Qualidade da segmentação depende das sementes



Segmentação e Geração de Contornos

Operadores de Morse:

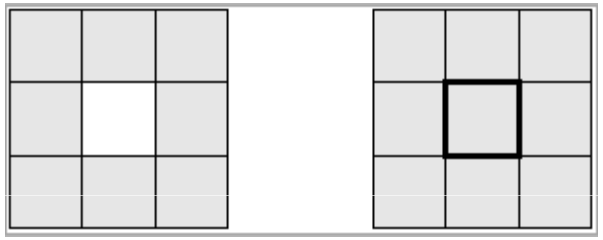
5 classes de operadores:

• (-1)-handle	
• 0- handle	
• 1-handle	
• 2-handle	
• 3-handle	

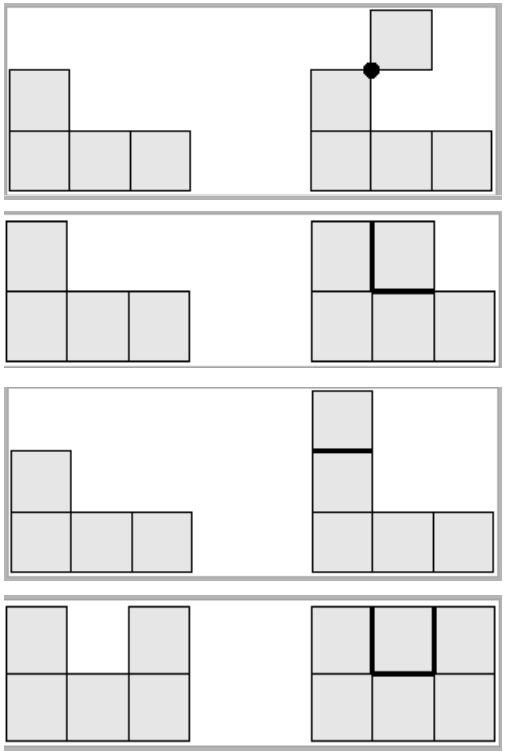
Teorema: Seja S um objeto com característica de Euler $\chi(S)$ e σ uma k-handle, então

Segmentação e Geração de Contornos

- (-1) - handle

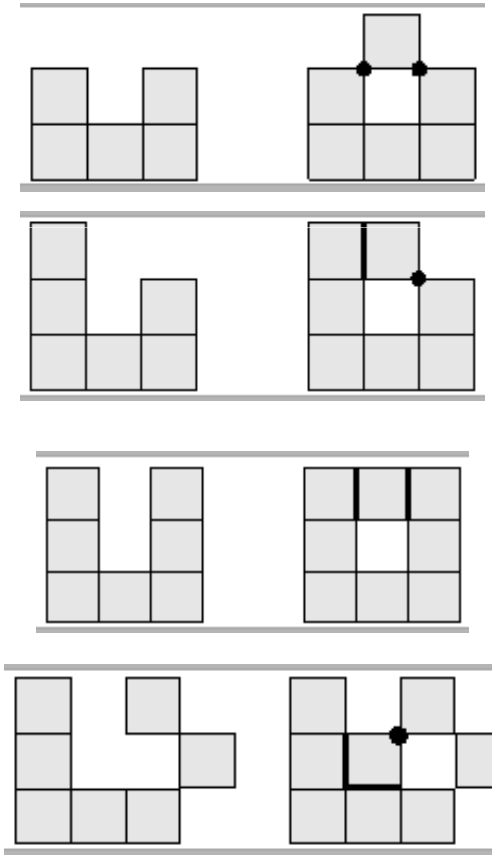


- 0 - handle

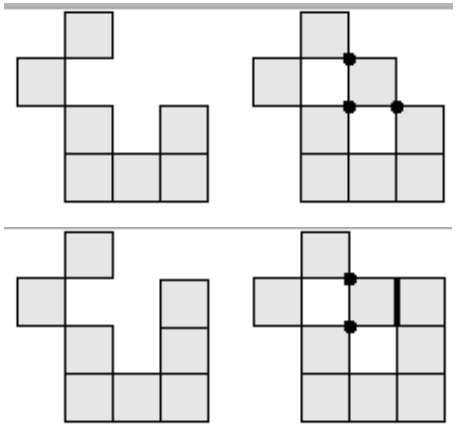


Segmentação e Geração de Contornos

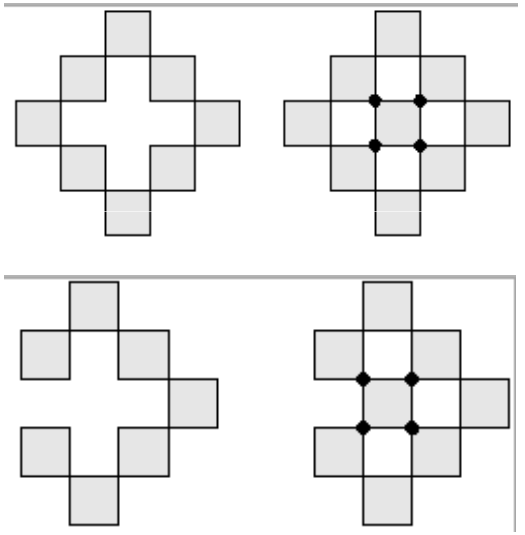
- 1 - handle



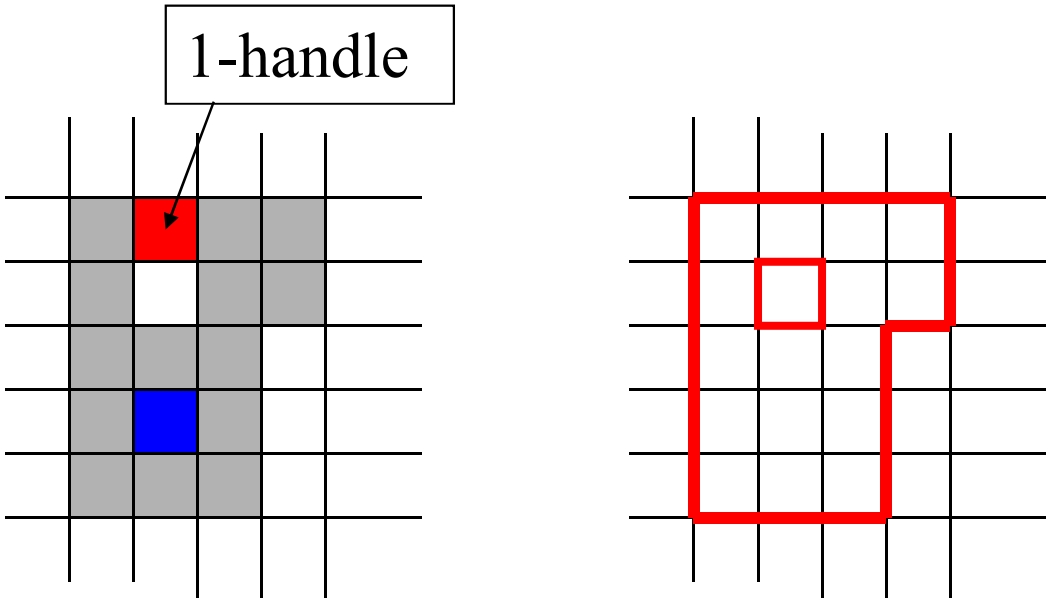
- 2 - handle



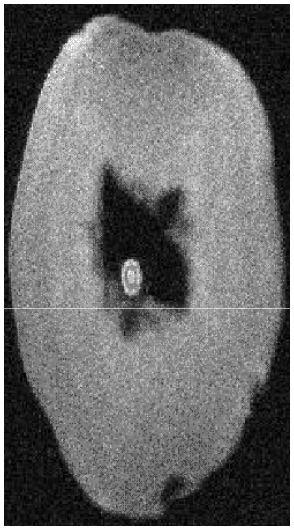
- 3 - handle

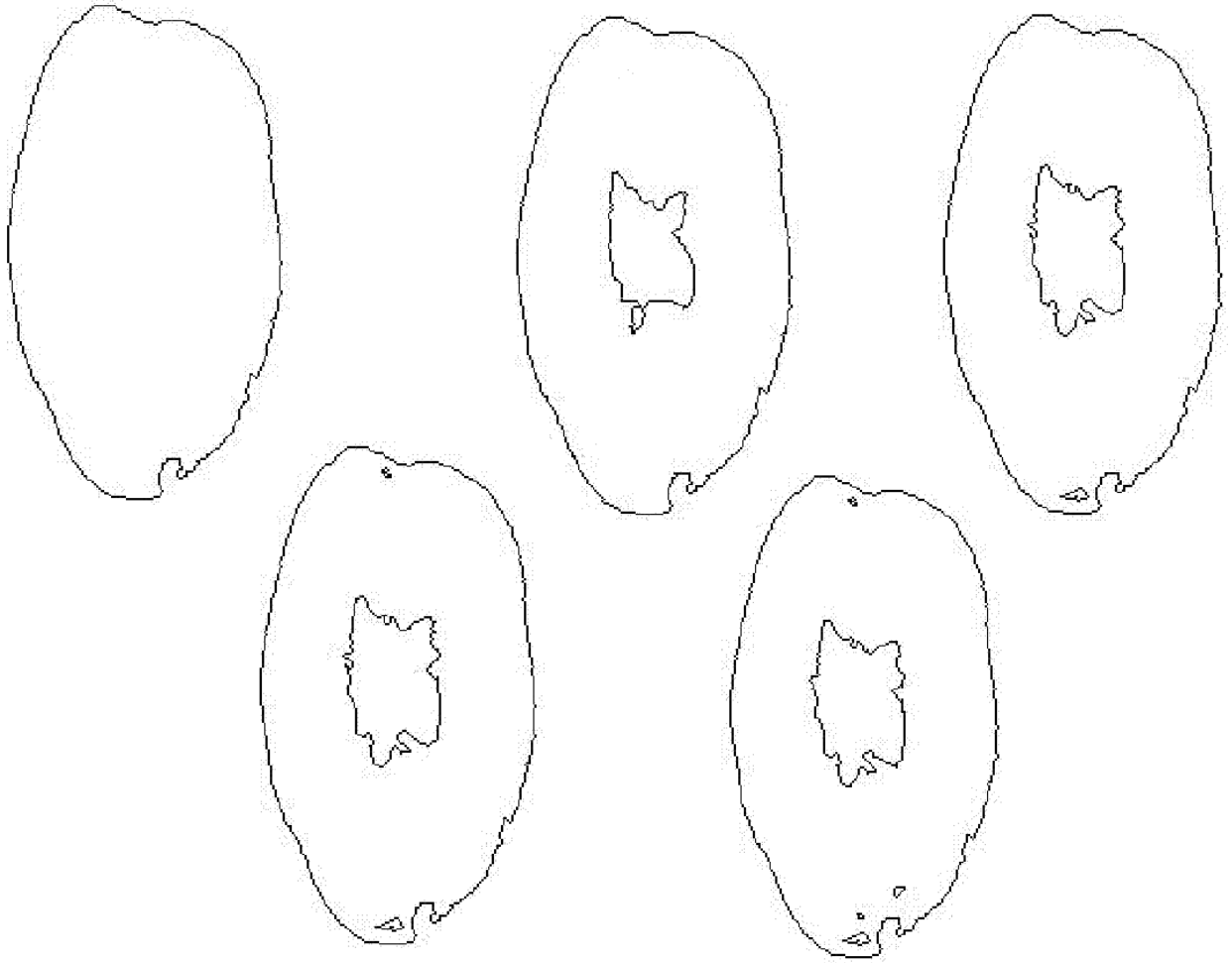


Segmentação e Geração de Contornos



Segmentação e Geração de Contornos

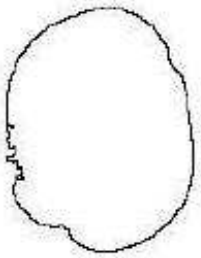




ESCOLHA DAS SEMENTES

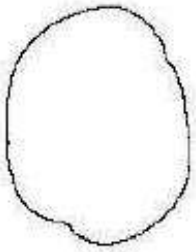
(a)

(b)



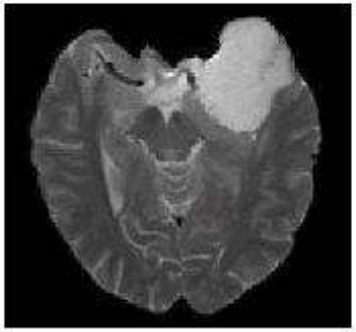
(c)

(d)

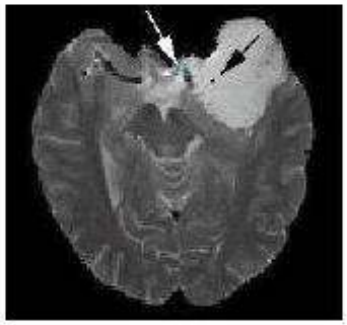


(e)

ESCOLHA DAS SEMENTES

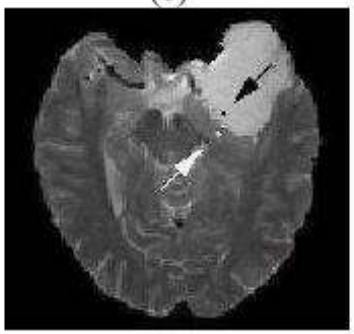


(a)

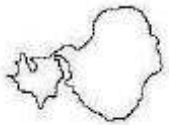


(b)

(c)

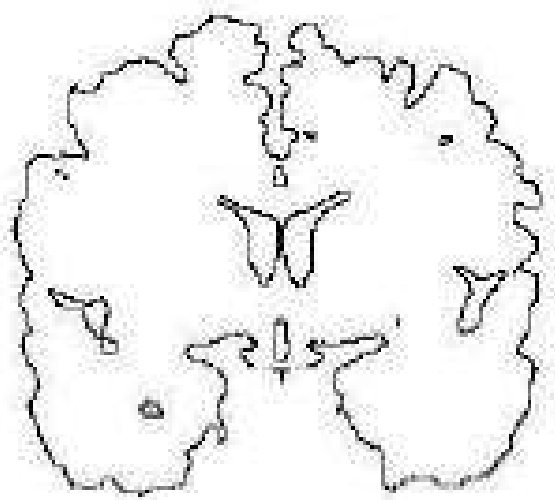


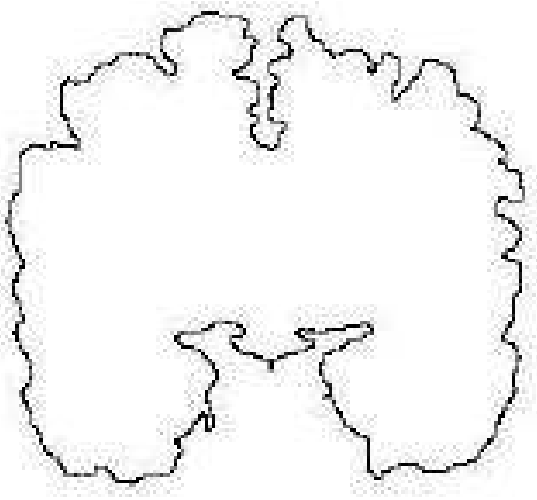
(d)



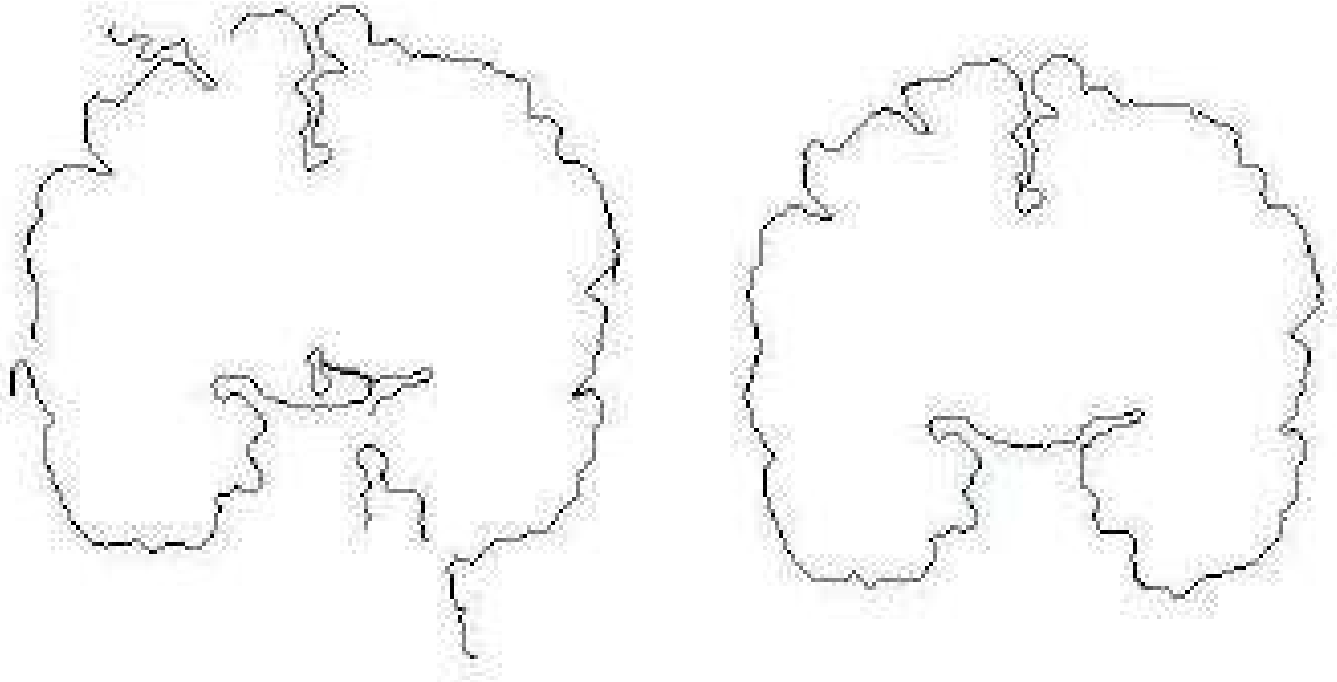
(e)

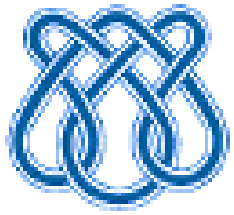
VANTAGEM DO CONTROLE TOPOLÓGICO





COMPARAÇÃO COM EDGE DETECTION





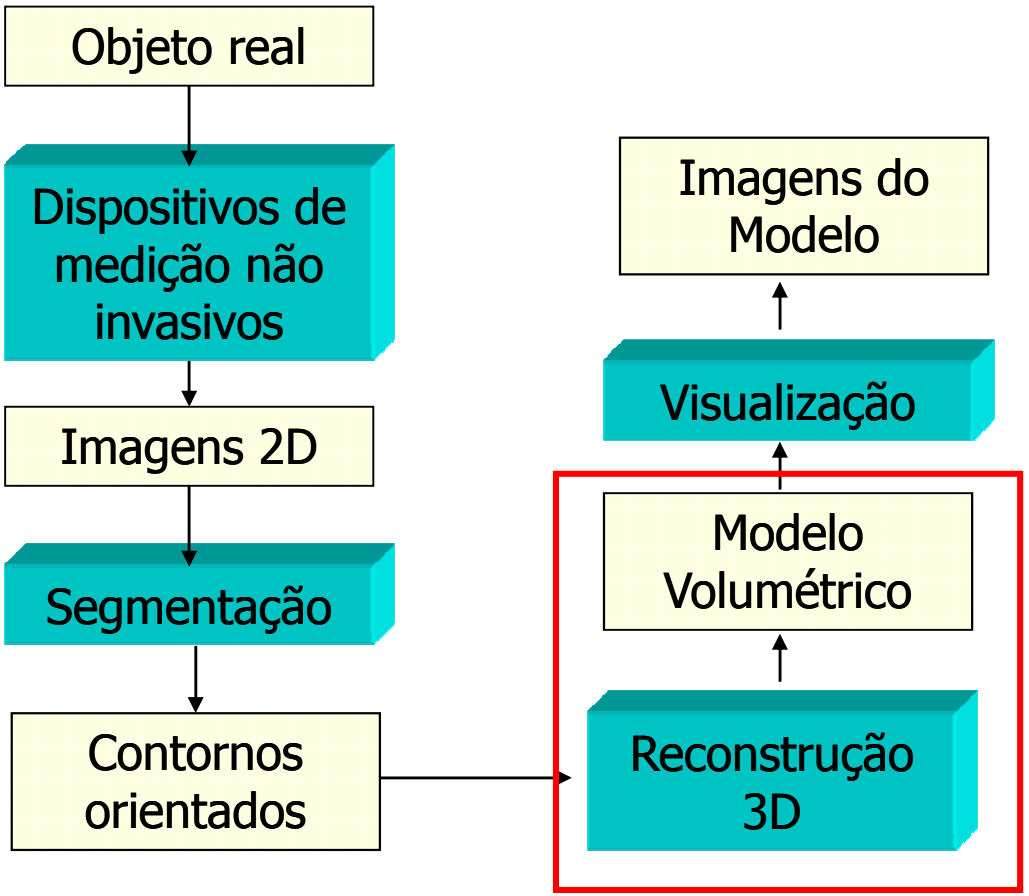
COMPARAÇÃO COM EDGE DETECTION

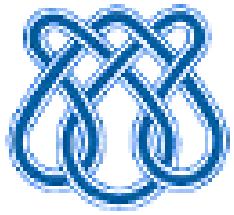
	Fig.	DPS	Edge-Detection	Clustering
Smoothing Time	22		16530ms	
	23		19950ms	
Number of Interactions	22	3	3	3
	23	2	13(4+9)	3
Time	22	520ms	20ms	2600ms
	23	520ms	62s	1700ms
Post Processing	22			870ms
	23			850ms
Total Time	22	520ms	16530ms	3470ms
	23	520ms	~1min22s	2550ms

TABLE I

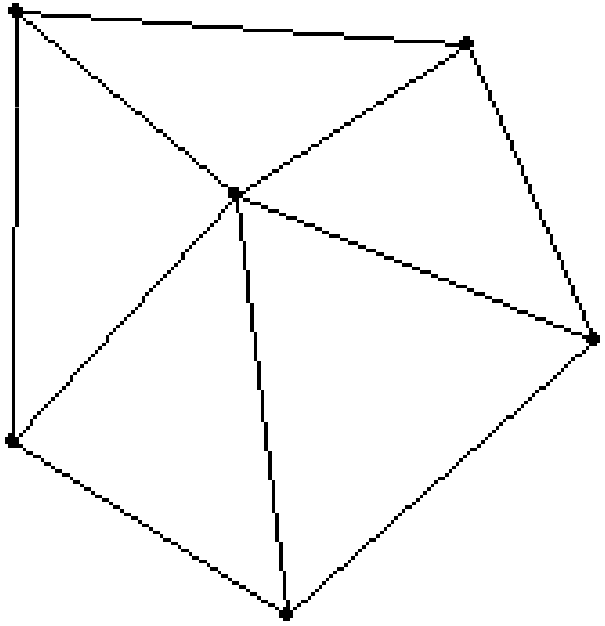
COMPARISON AMONG DPS, EDGE-DETECTION AND CLUSTERING SEGMENTATION METHODS

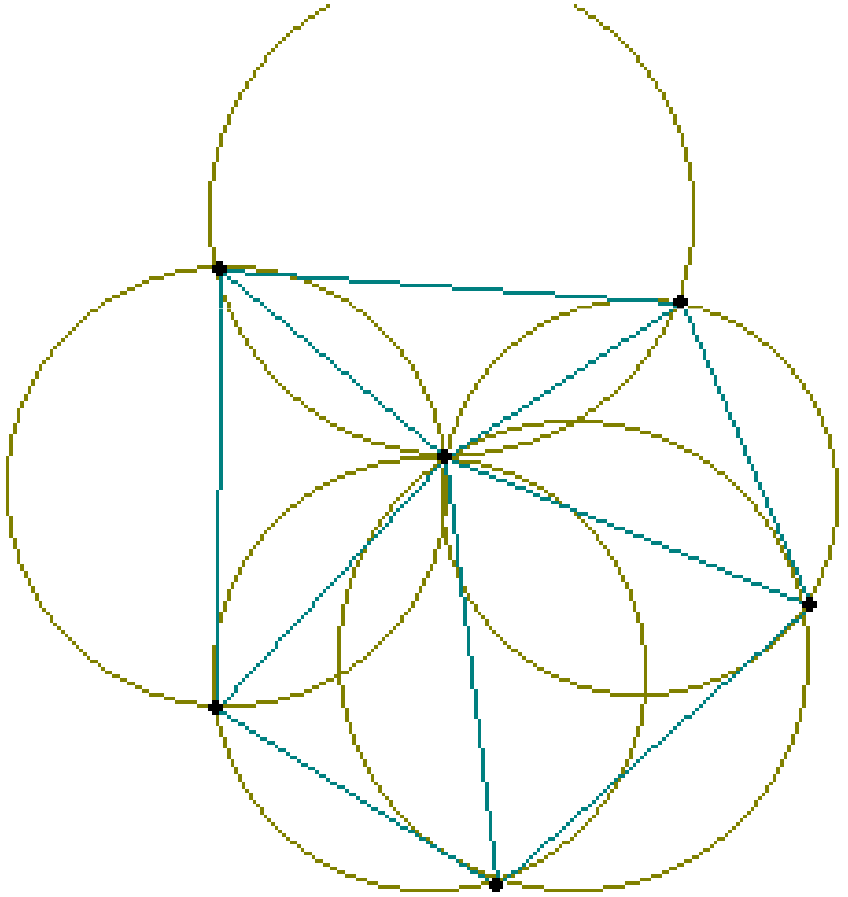
Reconstrução a partir de Seções Planares



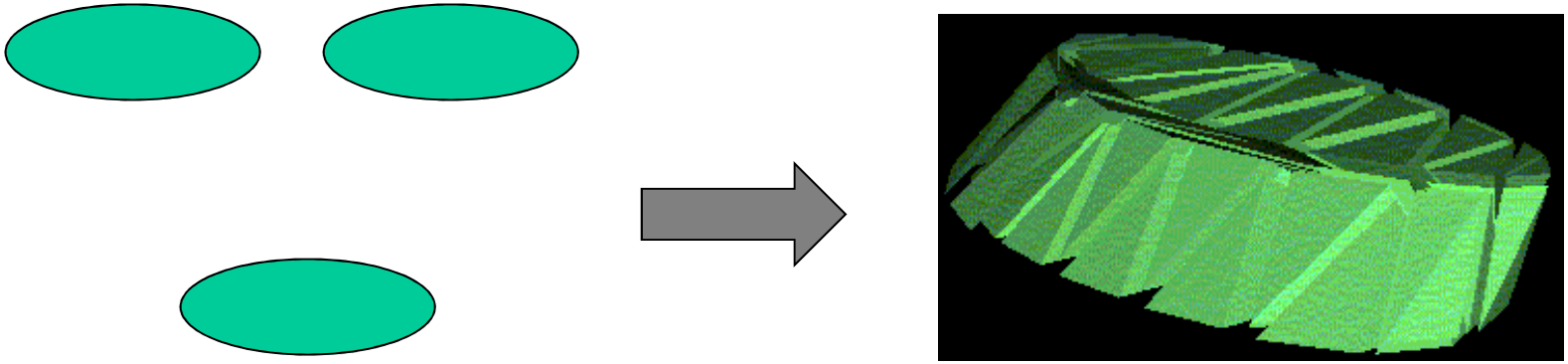


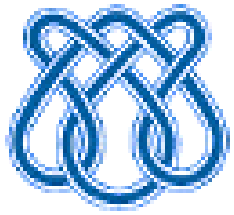
Reconstrução por Triangulação de Delaunay





Reconstrução por Triangulação de Delaunay





Reconstrução por Triangulação de Delaunay

Passos do Algoritmo após a construção da Triangulação 3D:

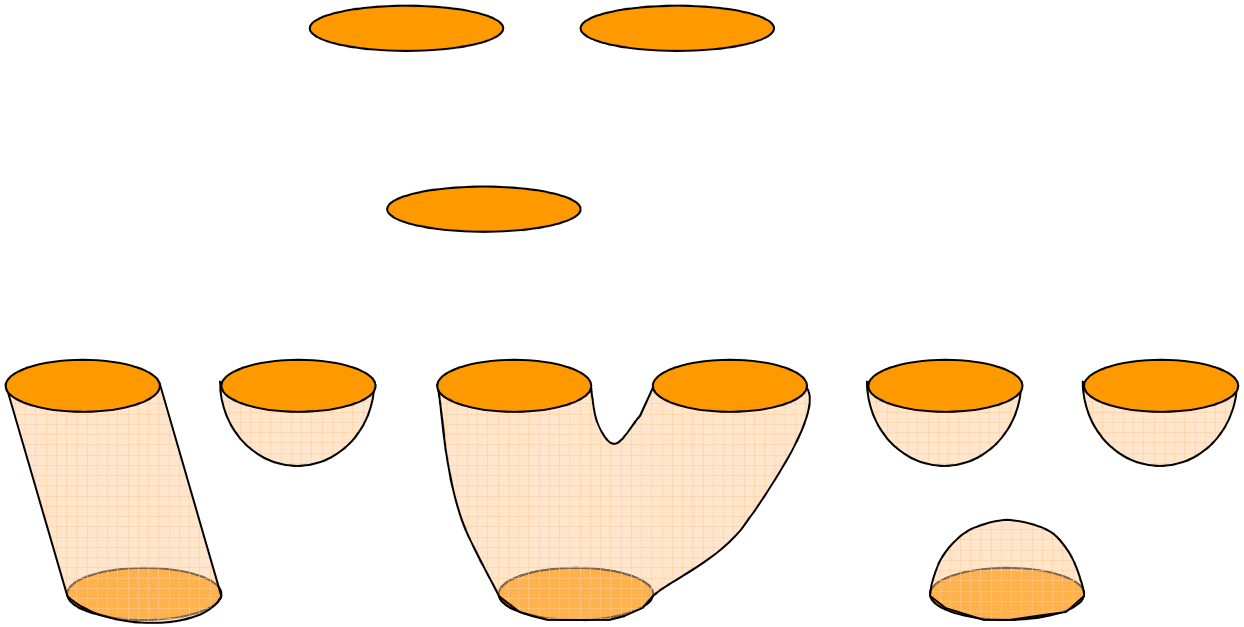
1. Decidir quais contornos devem ser conectados

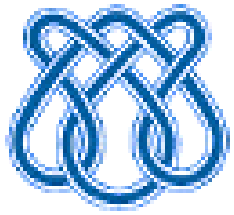
2. Eliminar tetraedros entre os contornos não conectados

3. Subdividir tetraedros a fim de garantir a re-exemplificação

Reconstrução por Triangulação de Delaunay

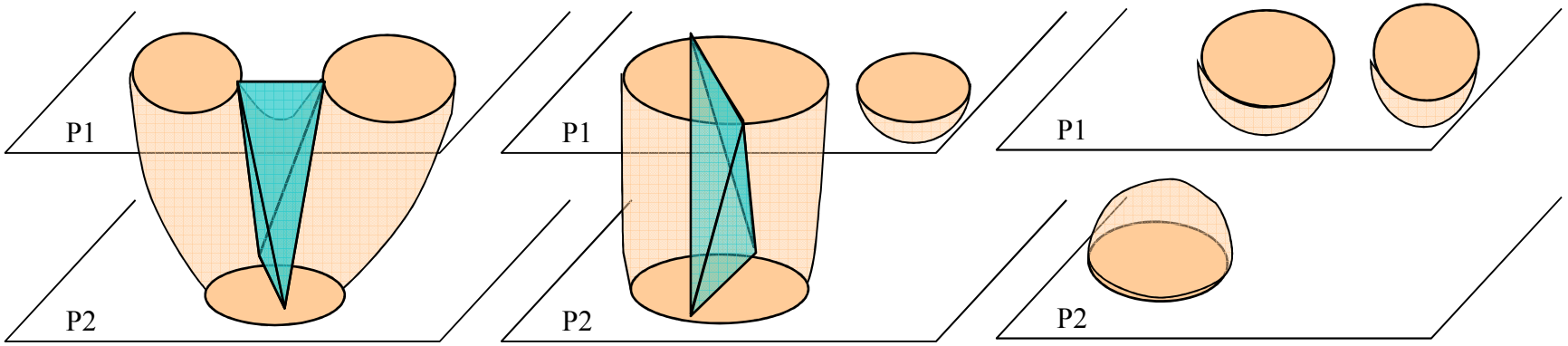
1. Decidir quais contornos devem ser conectados





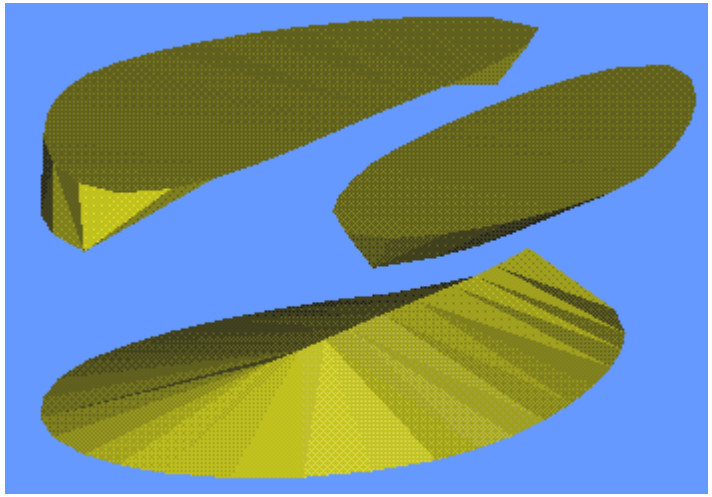
Reconstrução por Triangulação de Delaunay

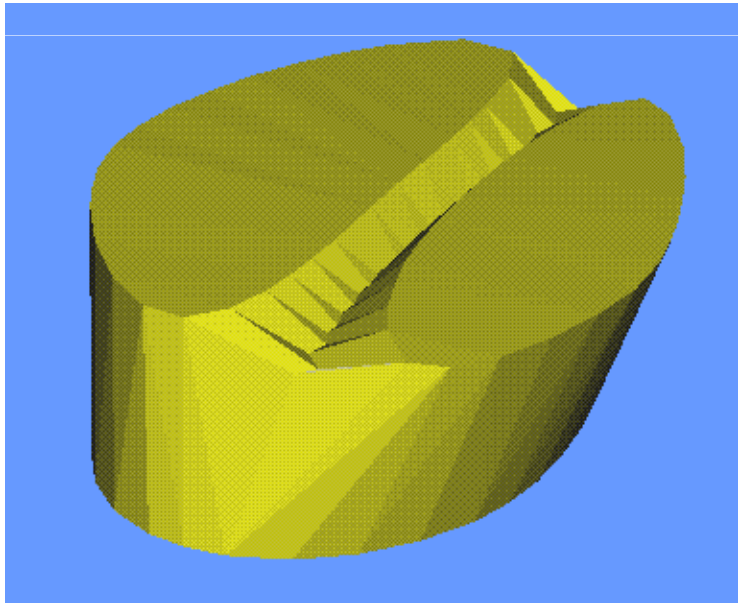
Proposição: *Dois contornos em planos adjacentes estão geometricamente bem posicionados se e somente se na triangulação de Delaunay 3D dos pontos dos contornos existe um tetraedro reverso conectando-os.*



Reconstrução por Triangulação de Delaunay

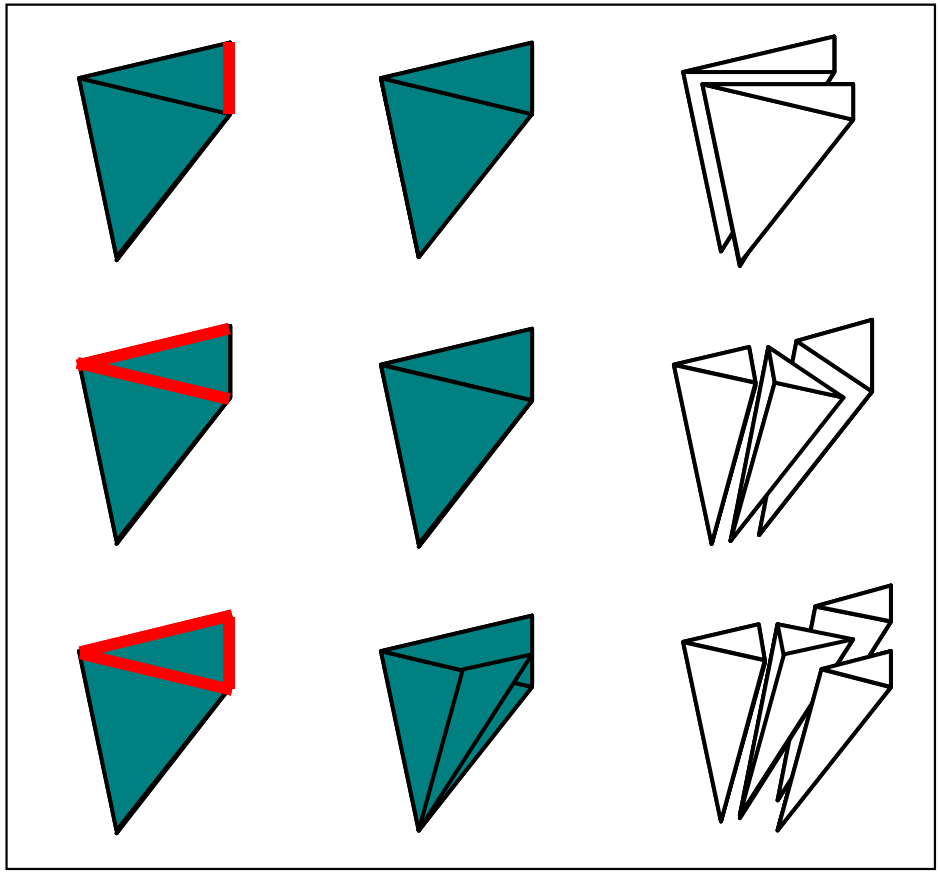
2. Eliminar tetraedros entre os contornos não conectados

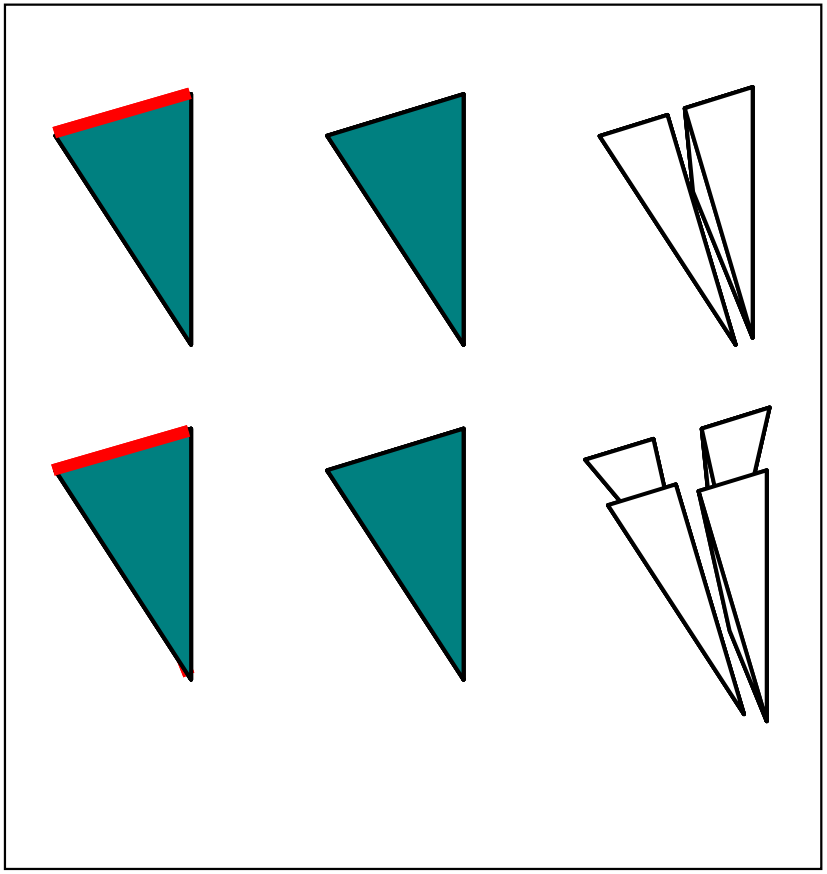


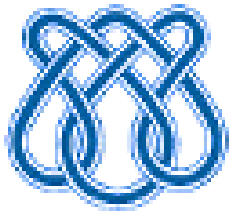


Reconstrução por Triangulação de Delaunay

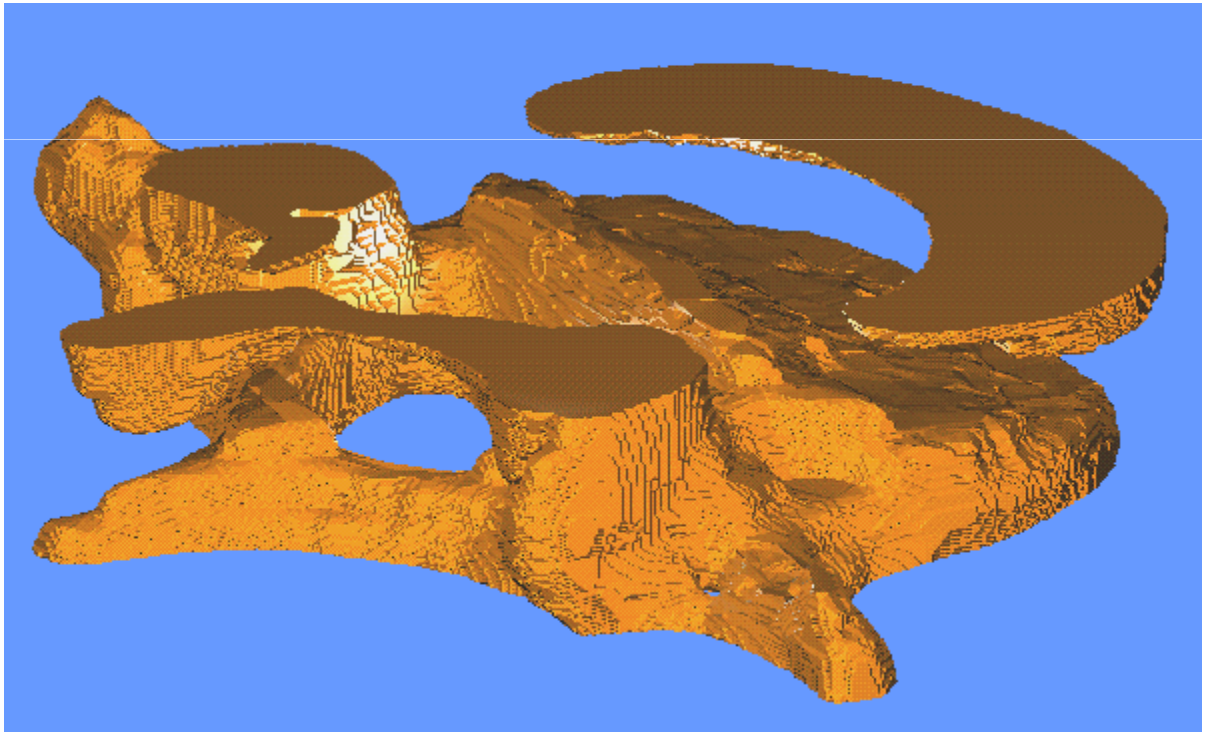
3. Subdividir tetraedros a fim de garantir a re-exemplificação



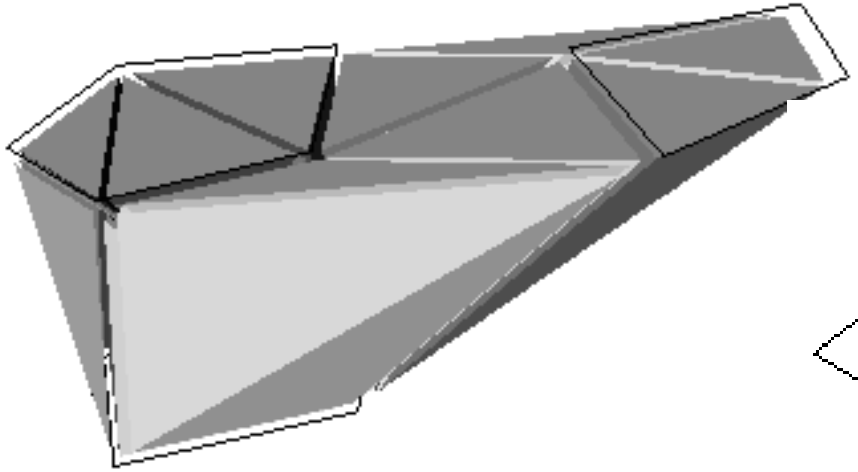


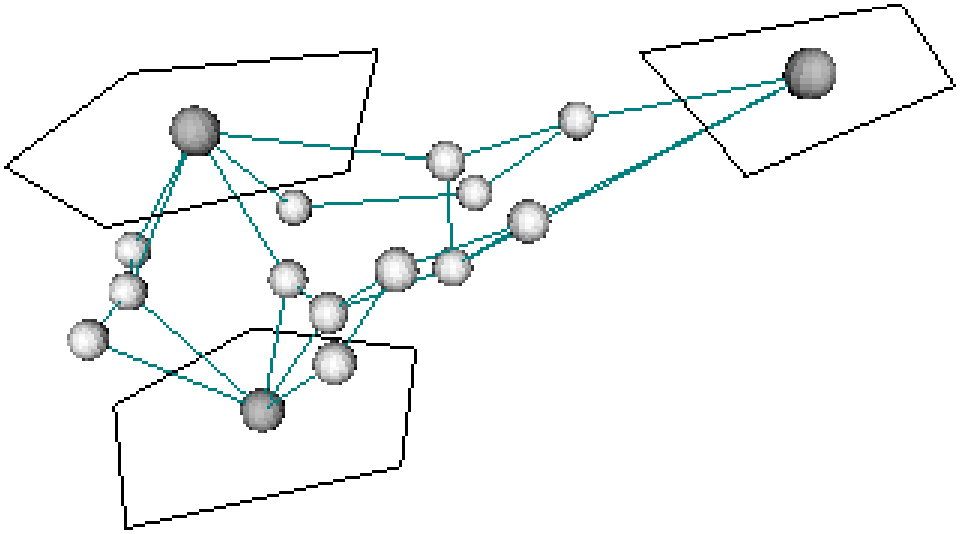


Reconstrução por Triangulação de Delaunay

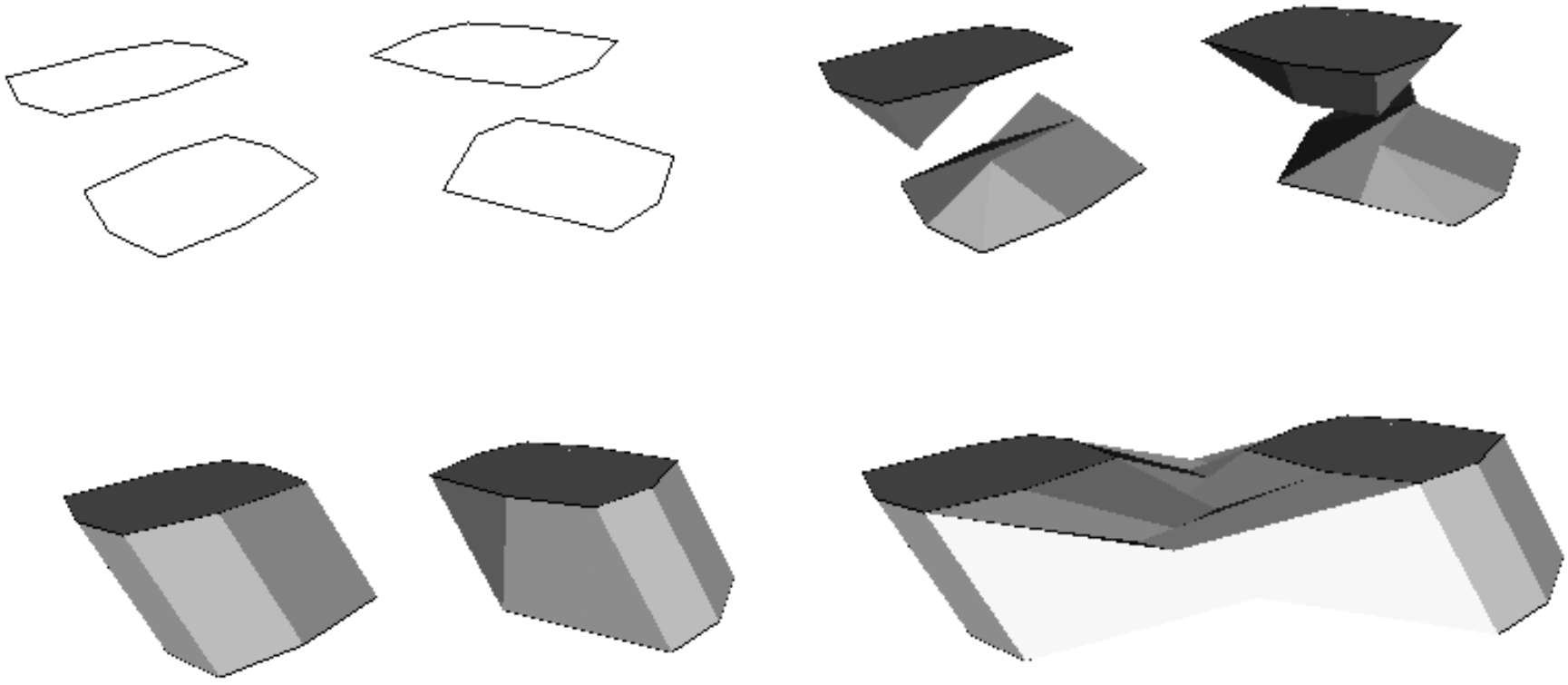


Beta-Conexão

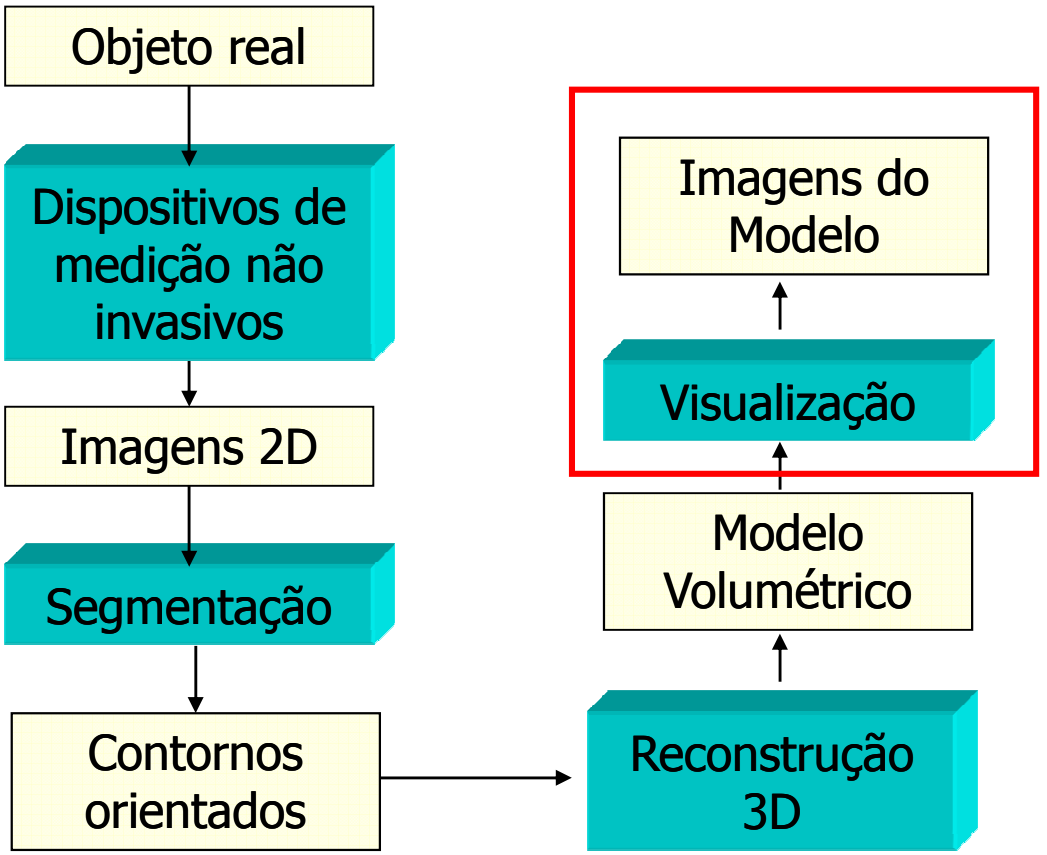


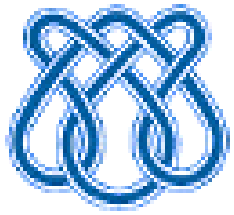


Beta-Conexão



Reconstrução a partir de Seções Planares



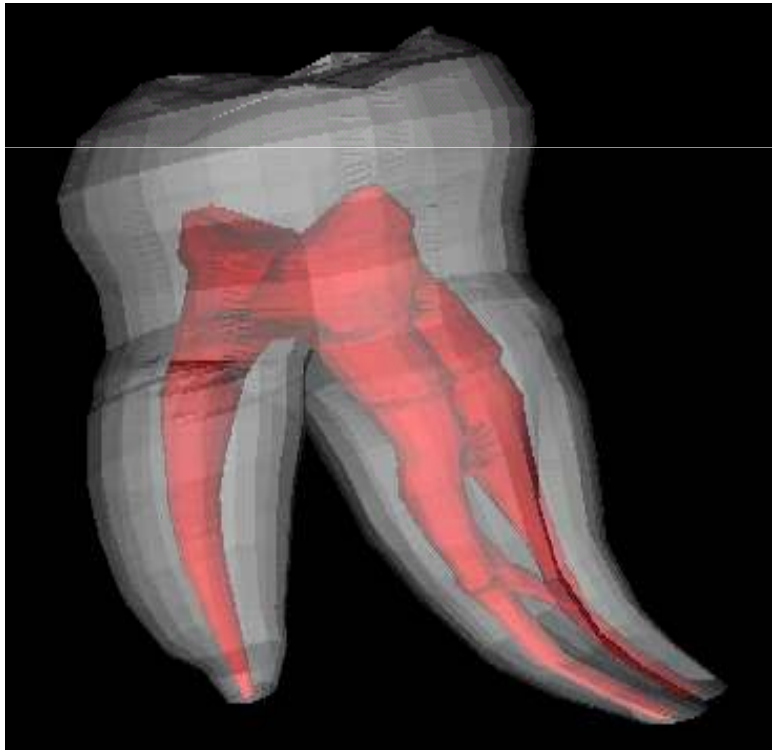


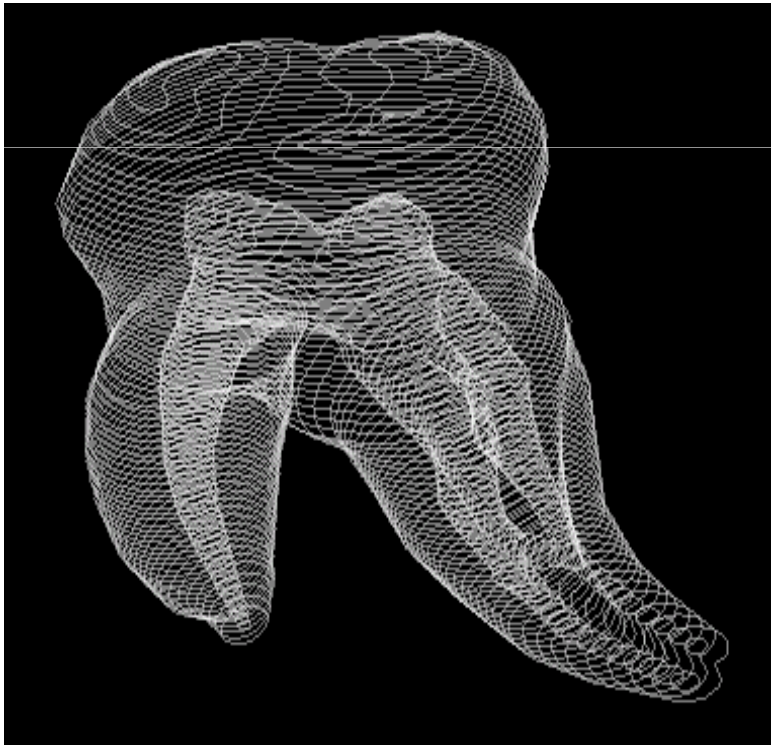
Visualização

Embora os modelos sejam volumétricos, apenas os bordos são visualizados.

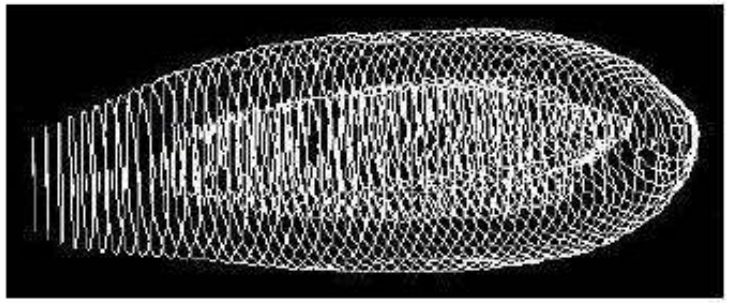
- Informações volumétricas podem ser perdidas
  - texturas internas
  - propriedades dos materiais

Visualização





Visualização



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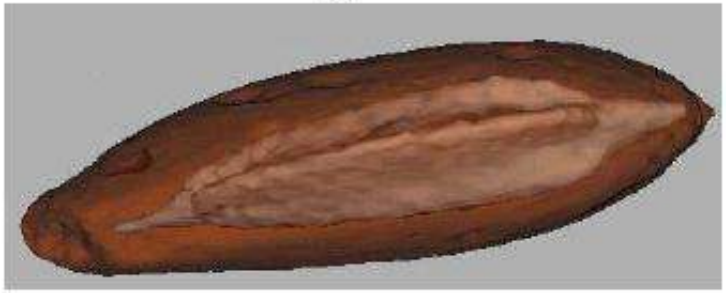

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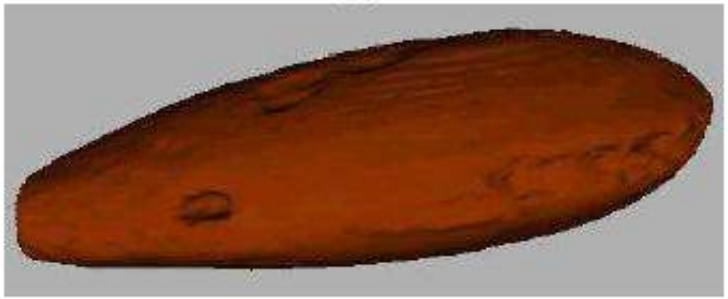
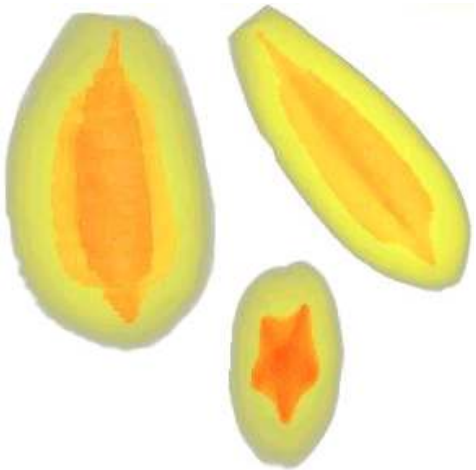


Tendências?

Visualização:

Rendering Híbrido = Superfície + Volume

Rendering Volumétrico



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Rendering Superfície