

# Visualização de Informação Parte IV

## Multi-dimensional Visualization: Detalhamento Ávores de Similaridade e Desenvolvimento Atual/Futuro

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# Use Cases: Exploration of Image collections

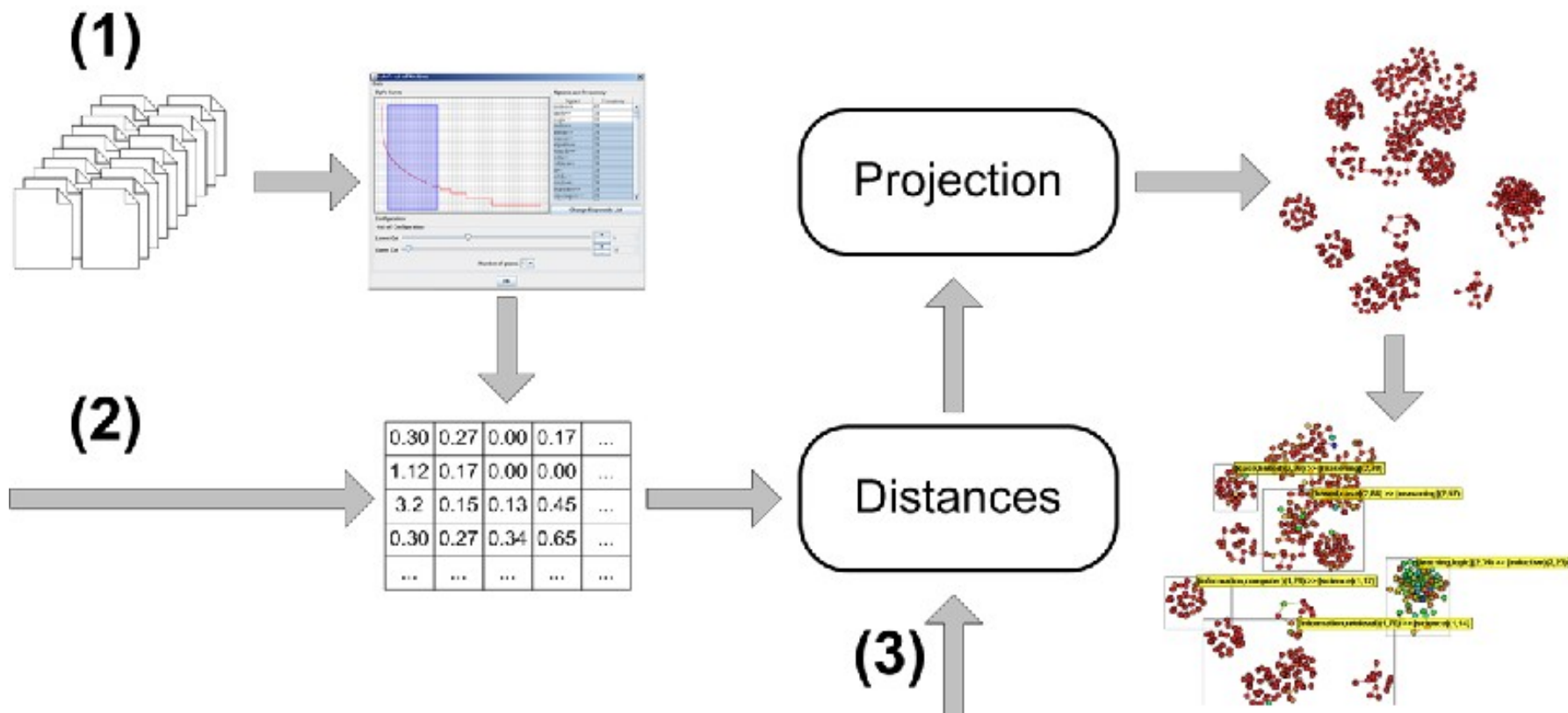
- ▶ Applications
  - Visual Exploration of Image Retrieval results
  - Photograph Visual exploration
  - Support for development of Image Analysis algorithms
  
- ▶ Projection Explorer (PEX) for Images

Eler et. al 2009 – The Visual Computer

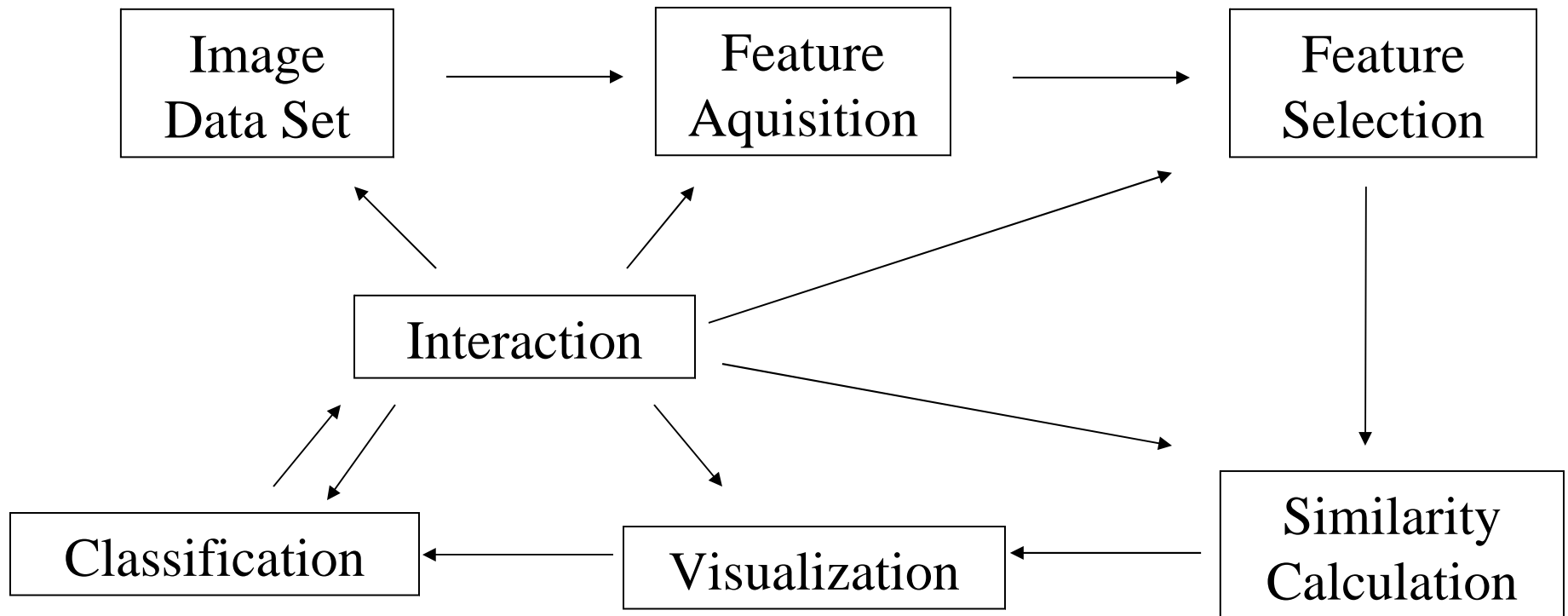
# Recall: Projection Explorer (PEX) Framework



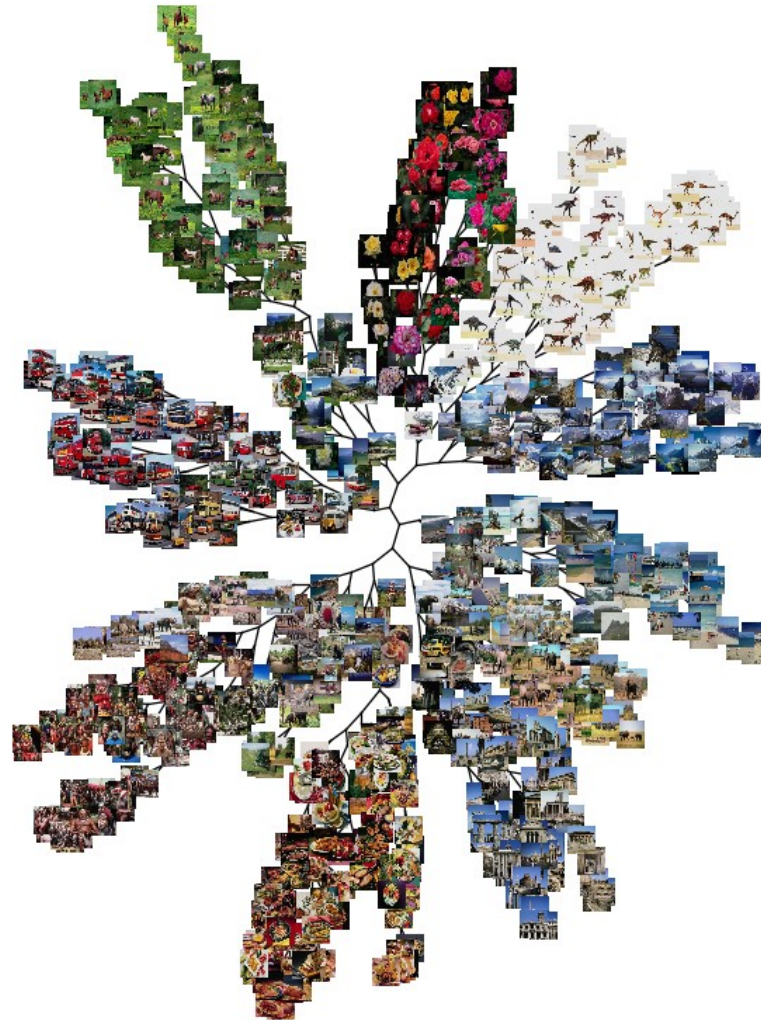
Paulovich, Oliveira, Minghim 2008



# Pipeline for Mapping Images



# Example for a set of photos



# Coordination between Image and Text



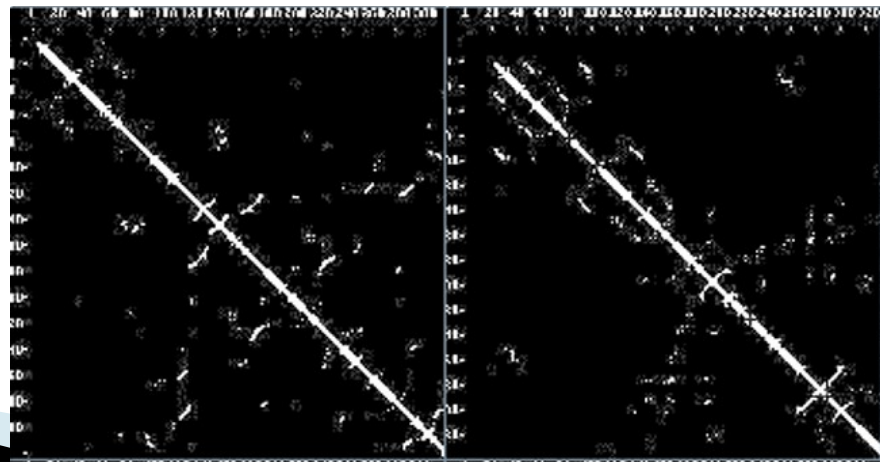
- ▶ Simultaneous analysis of text and image
- ▶ Protein sequences
  - Textual input

1AAM:A|PDBID|CHAIN|SEQUENCE

MFENITAAPADPILGLADLFRADERPGKINLGIGVYKDETGKTPVLTSVKKAEQYLLENETTKNYLGIDGIPEFGRCTQE

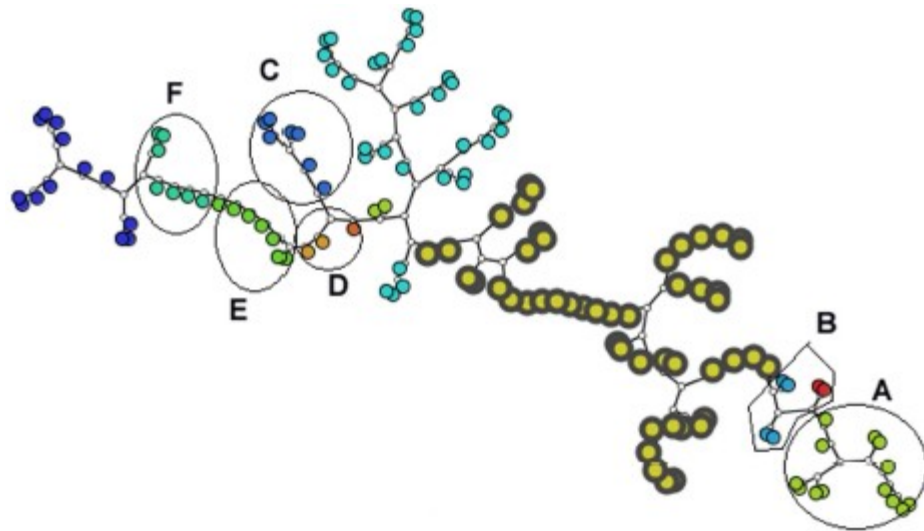
LLFGKGSALINDKRARTAQTPGGTGALRVAADFLAKNTSVKRVVWSNPSPVNHKSVFNSAGLEVREYAYYDAENHTLDFDALI  
NSLNEAQAGDVVLFHGCCHNPTGIDPTLEQWQTLAQLSVEKGWLPLDFAYQGFARGLEEDAEGLRFAAMHKELIVASS  
YSKNFGLYNERVGACTLVAADSETVDRAFSQMKAIDANYSNPPAHGASVVATILSNDALRAIWEQELTDMRQRIQMRQL  
FVNTLQEKGANRDFSFIKQNGMFSFGLTKEQVLRLEEFVYAVASGRVNVAGMTPDNMAPLCEAIVAVL

- *Contact Maps* (images)

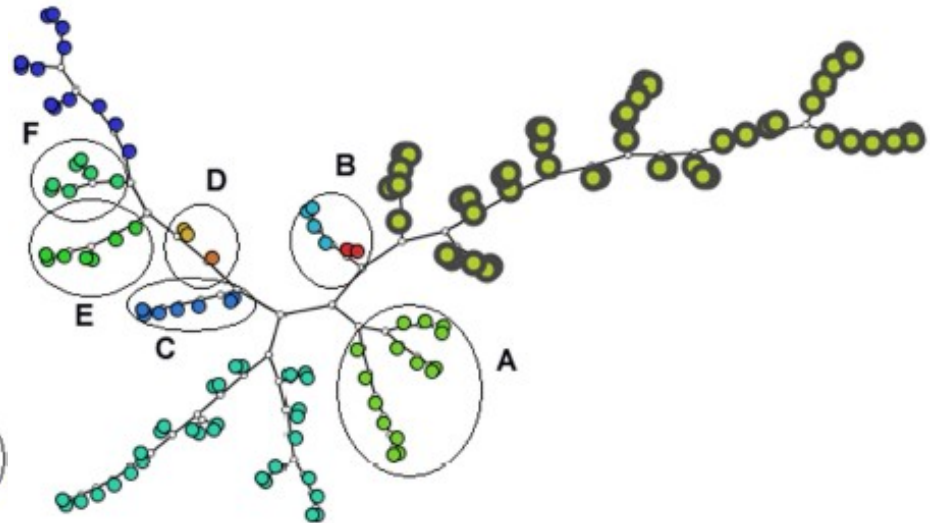


# Coordination between Image and Text

Contact Maps

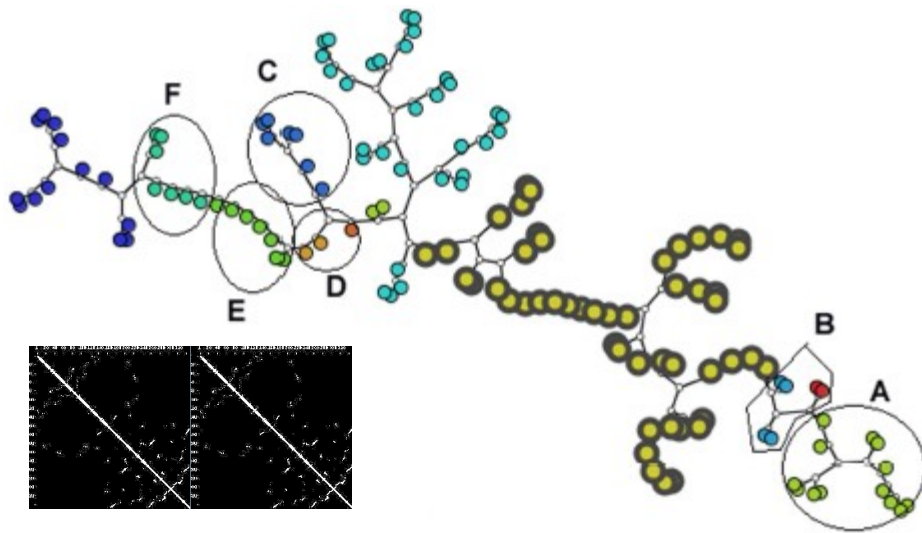


Amino-acid sequences

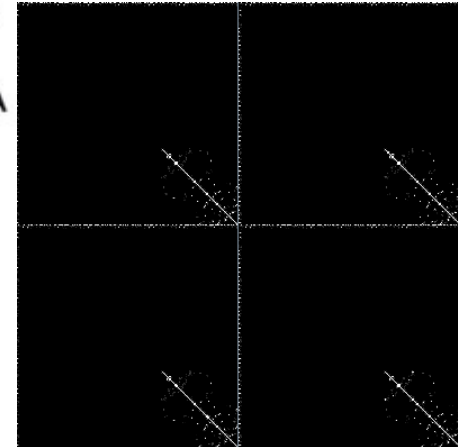
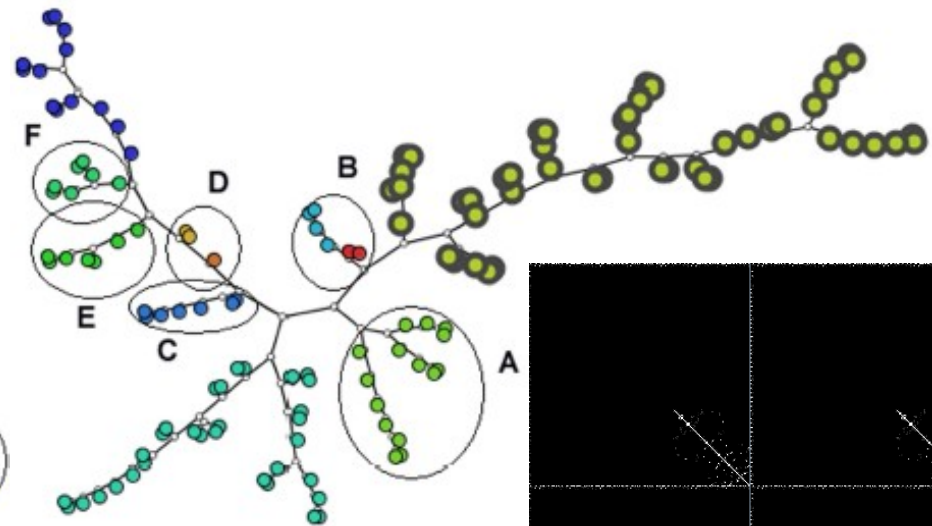


# Coordination between Image and Text

Contact Maps



Aminoacid sequences



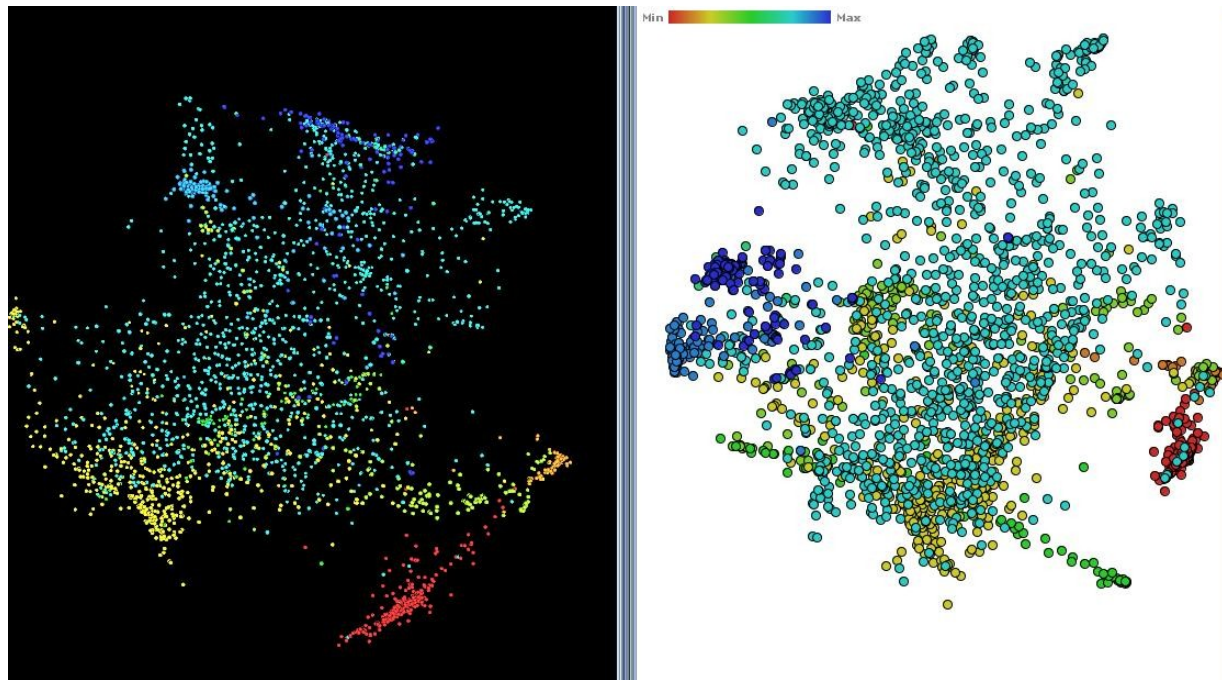


# Conclusions on Imaging Applications

- ▶ *PEx-Image*: a set of tools and a novel approach to
  - map an image data set onto 2D space
  - make data analysis and exploration more effective
- ▶ Provide evaluation of
  - similarity measures
  - feature vectors
  - feature selection strategies
- ▶ Coordination between image and text
  - Finding patterns and discrepancies
  - Coordination of other data sets

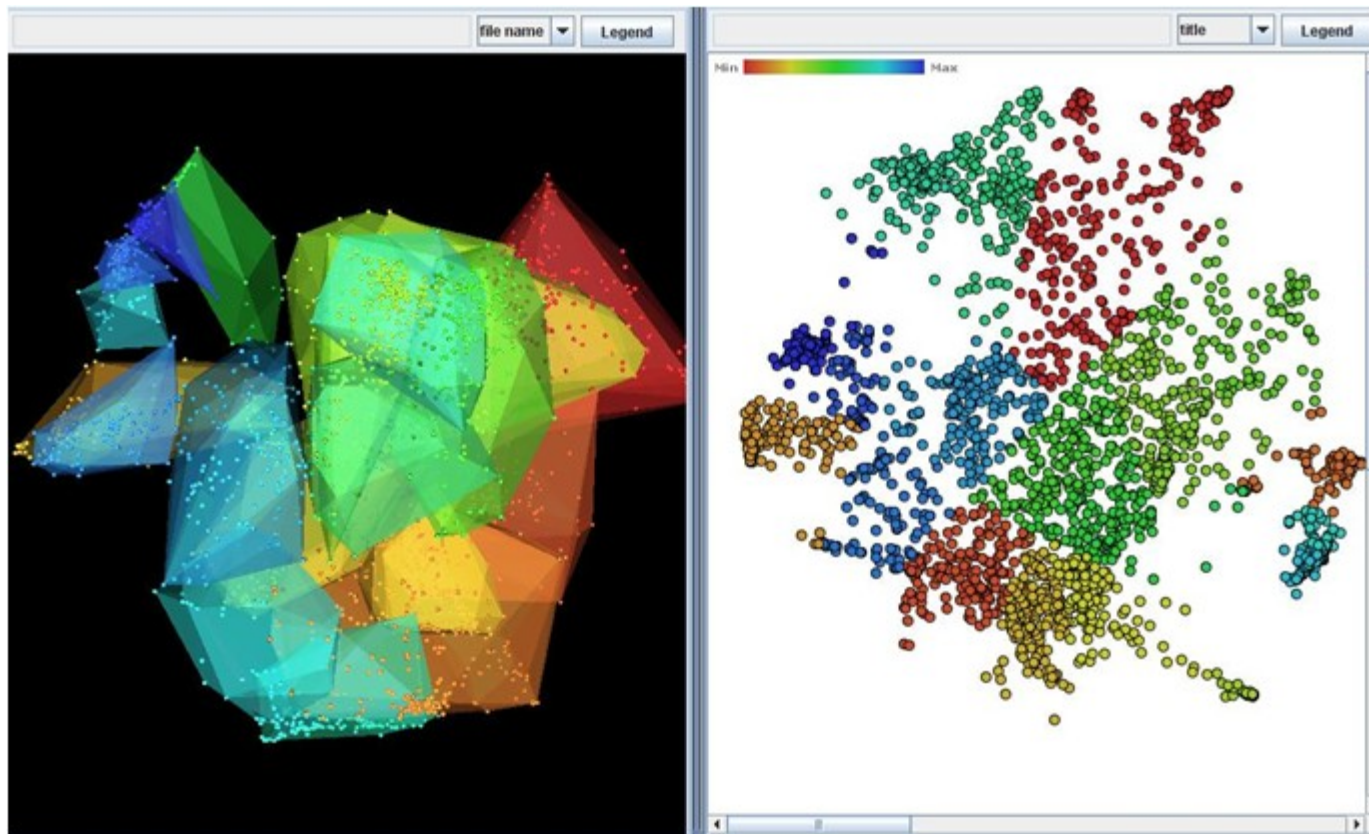
# 3D Projections, Interaction, Hierarchical Models

LSP 3D e piecewise LSP



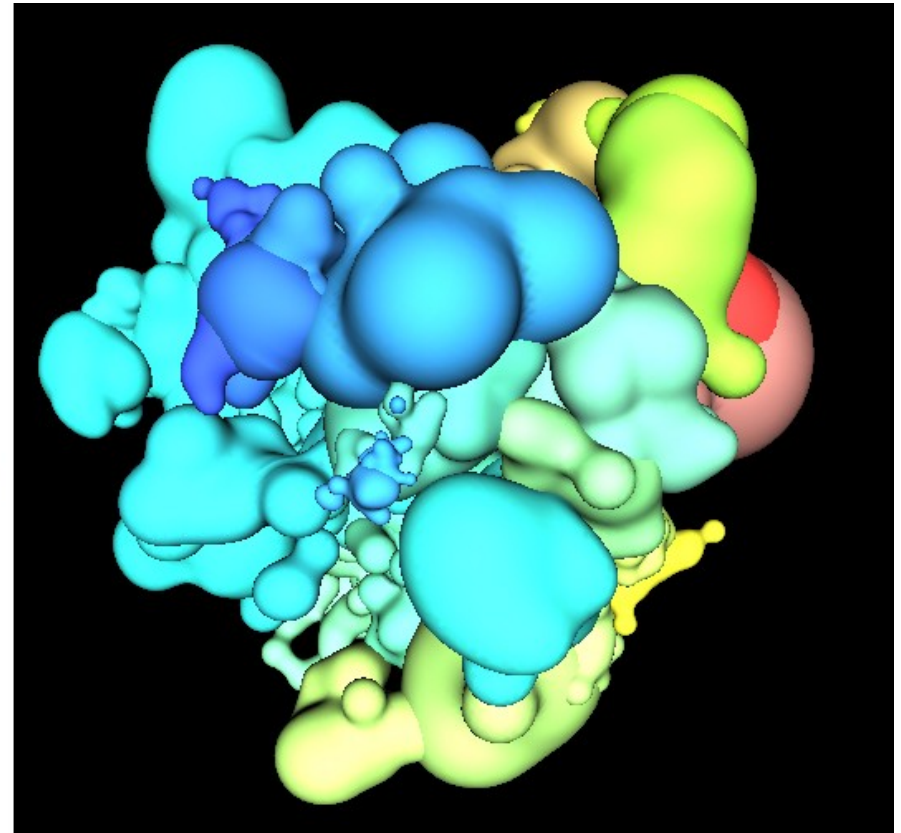
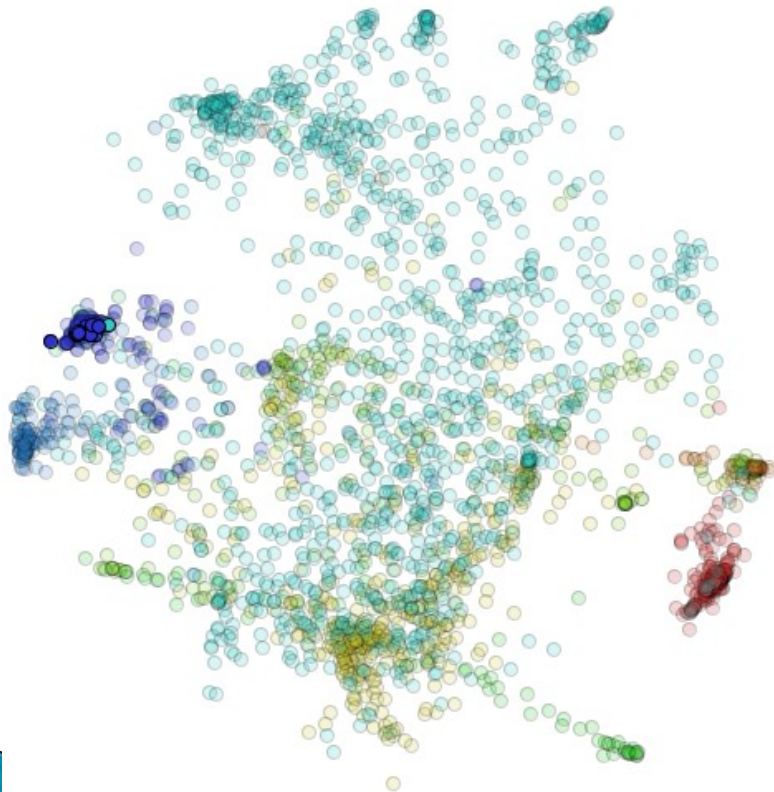
# 3D Projections and their exploration

Convex Hull of post-processed clustering

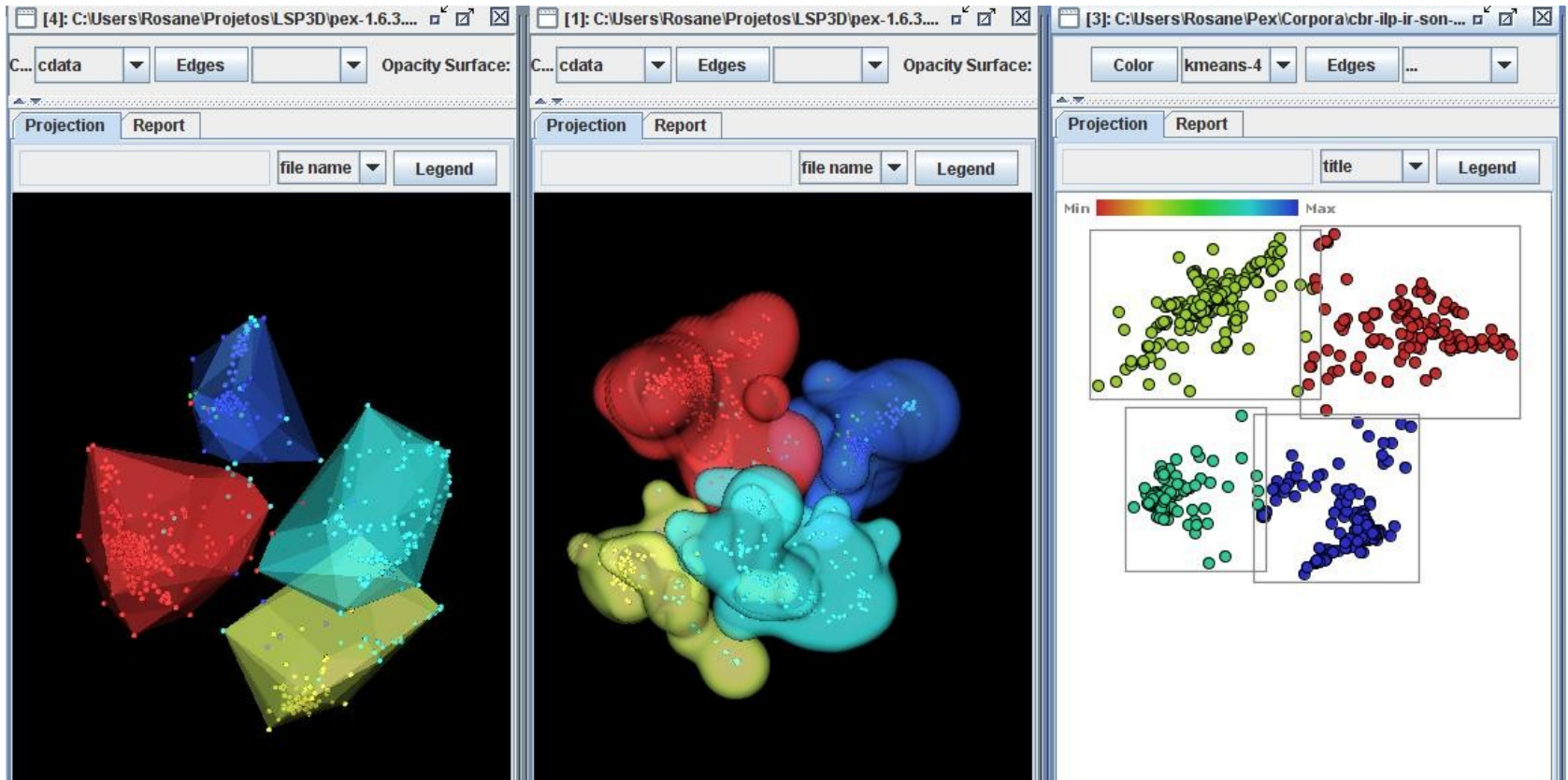


# 3D Projections and their exploration

Density Surface for Group Selection

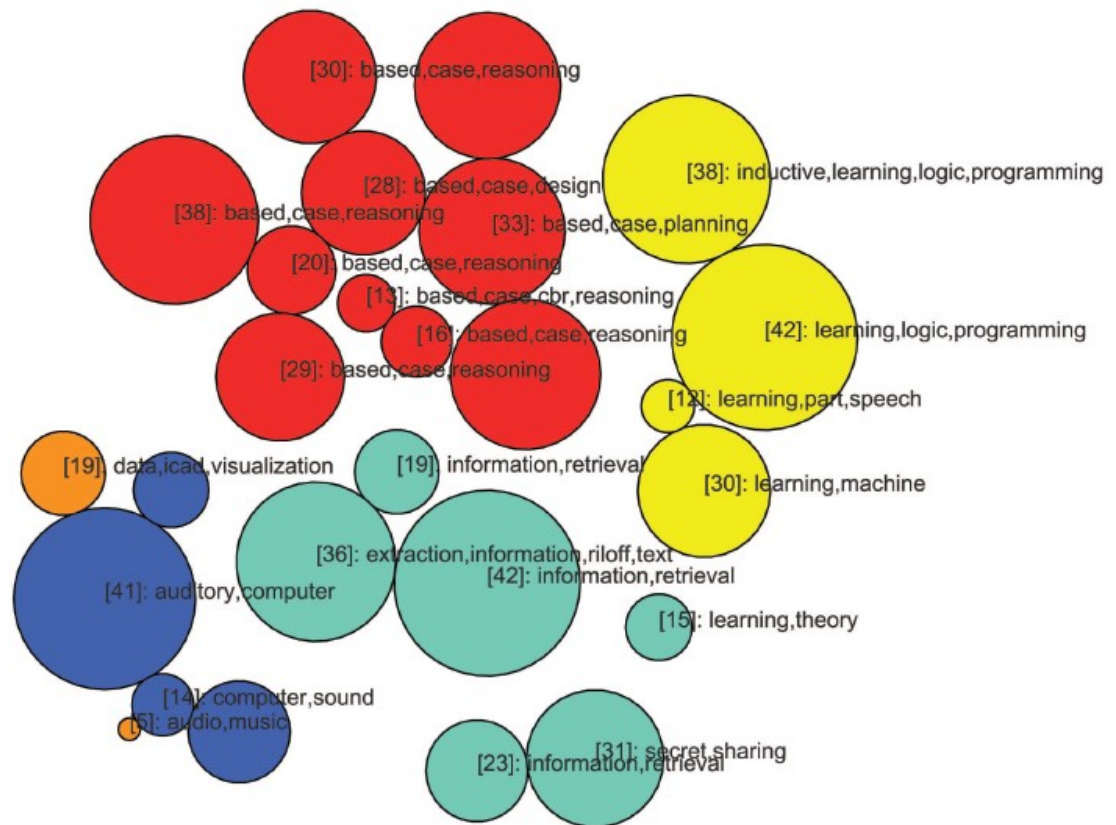


# 2D/3D Exploration



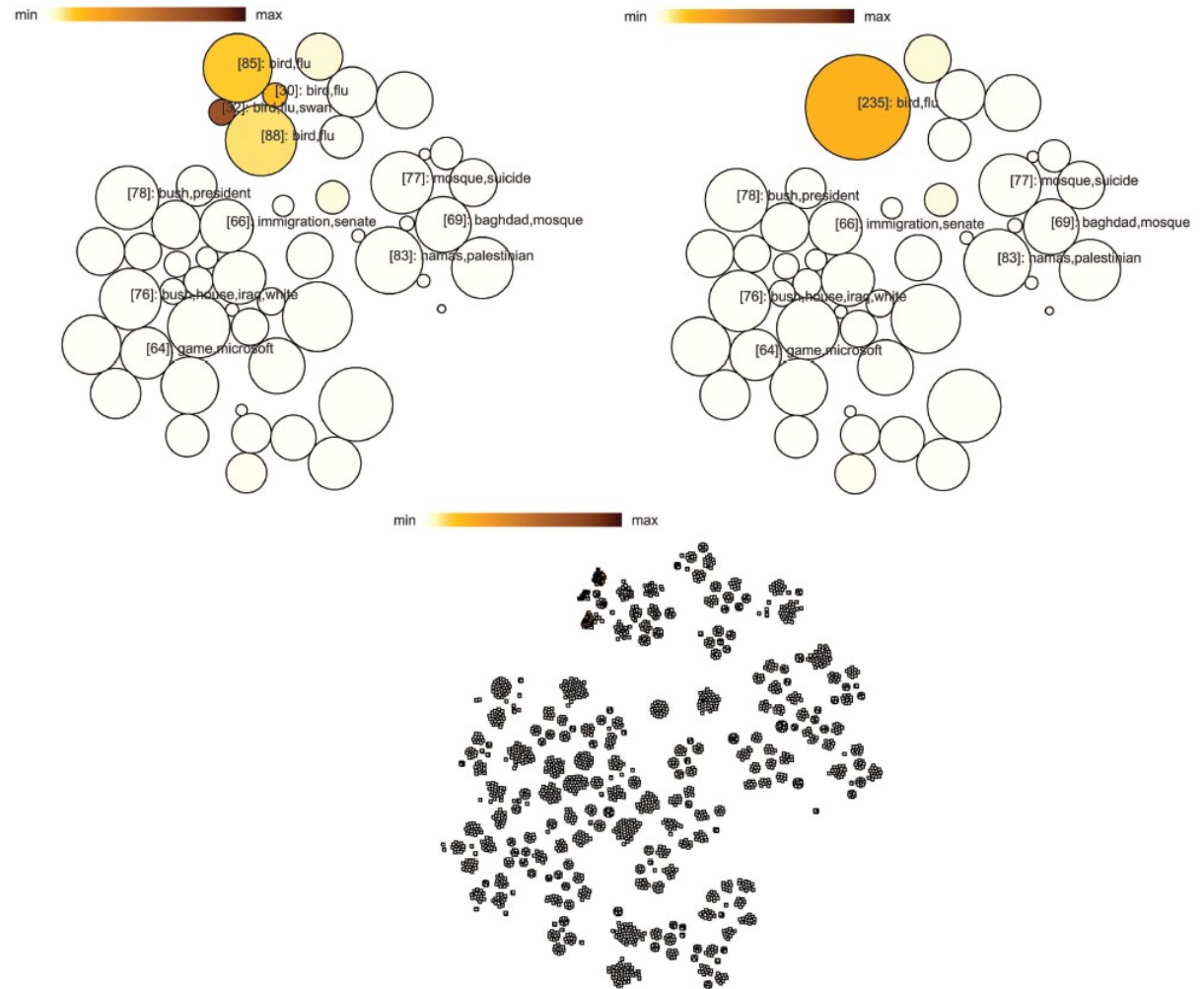
# Hierarchical Models

## Hipp - Hierarchical Point Placement



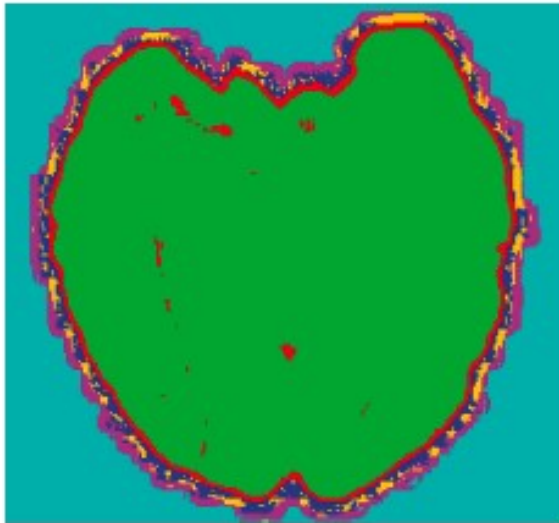
# Hierarchical Models

Regrouping and detailing



# Projections for Volume Exploration based on Feature Spaces

- ▶ What if the 'points' are the pixels?





# Projections for Volume Exploration based on Feature Spaces

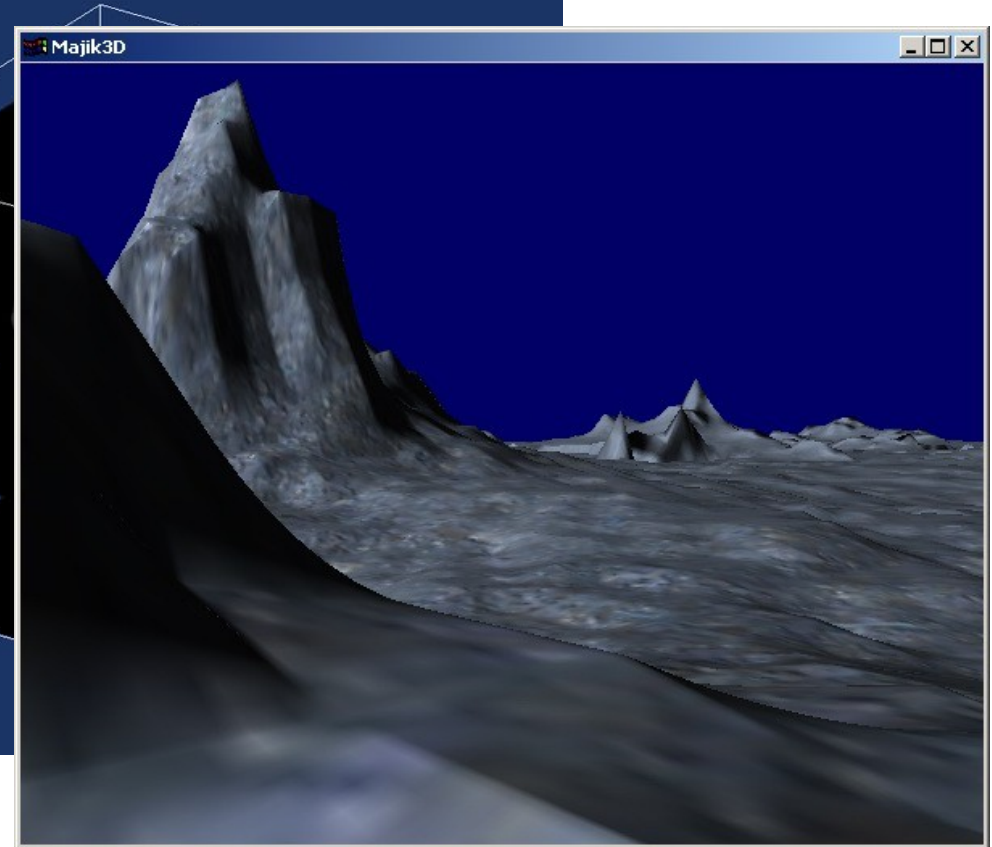
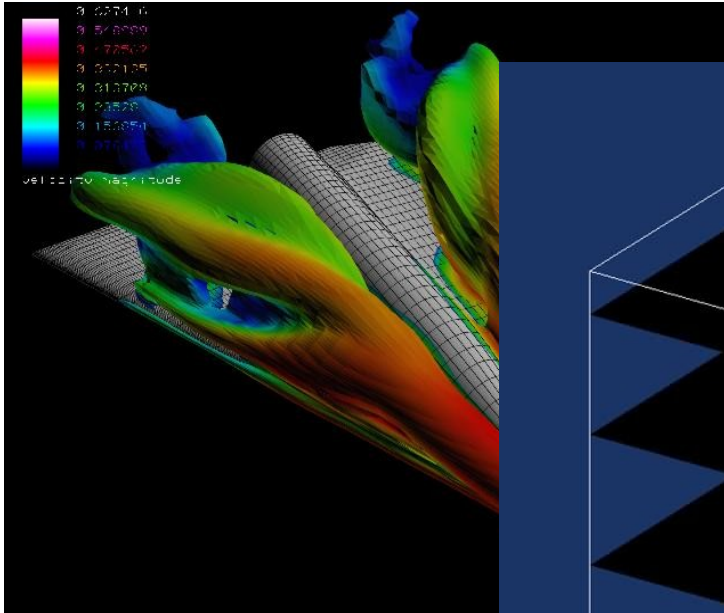
- ▶ What if the points are voxels?
- ▶ Back to Scientific Visualization Techniques
  - InfoVis
  - SoftVis
  - SciVis
    - Geometrical representation

# Applications

Numerical Simulations

Medical Imaging

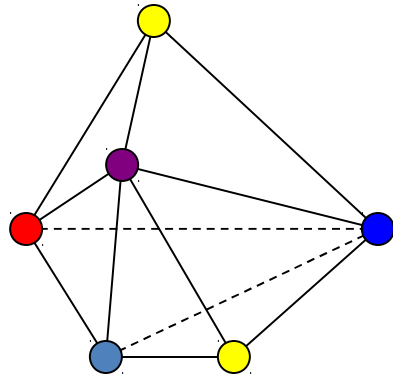
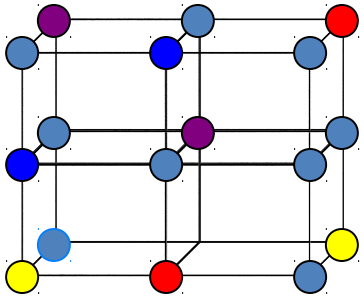
Terrain Modeling



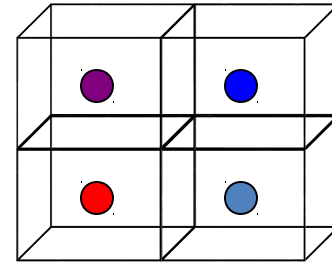
# SciVis

- ▶ Data Representation

Cells

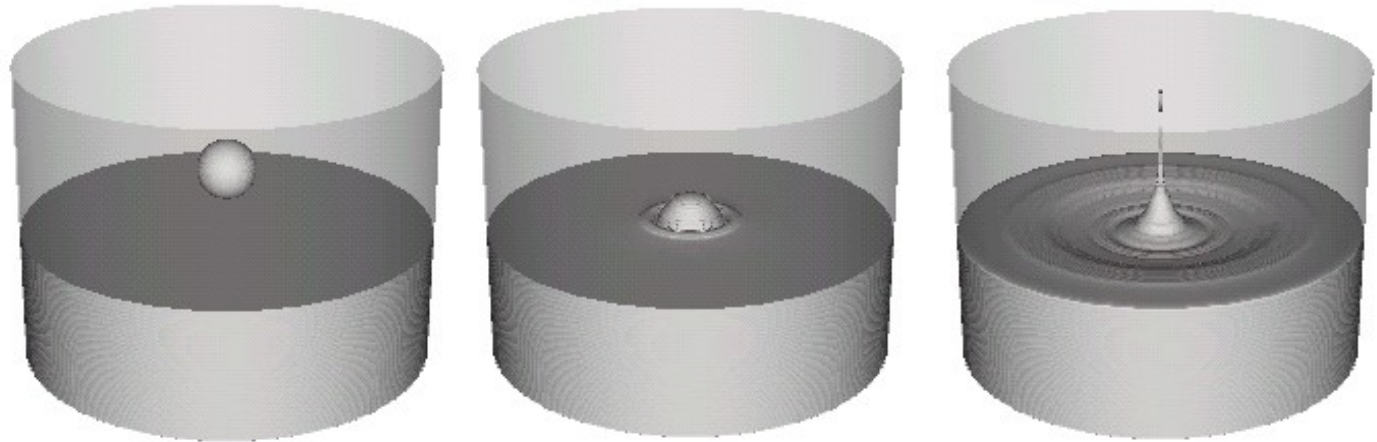


Voxels



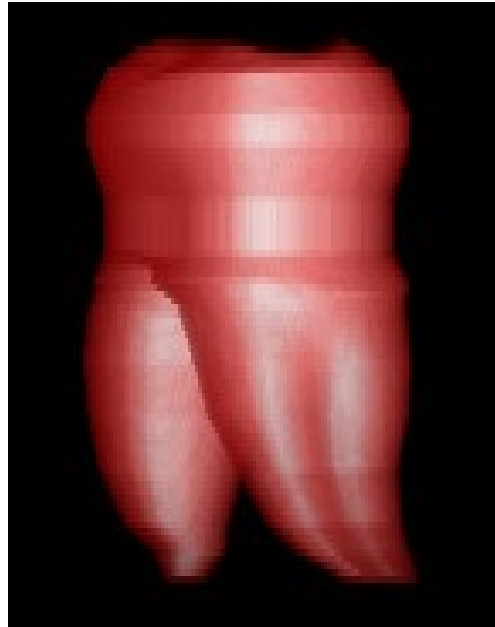
# SciVis Visualization Techniques

- ▶ Surface fitting (reconstruction)
  - ▶ Choice of scalar value
    - ▶ Problem: large loss



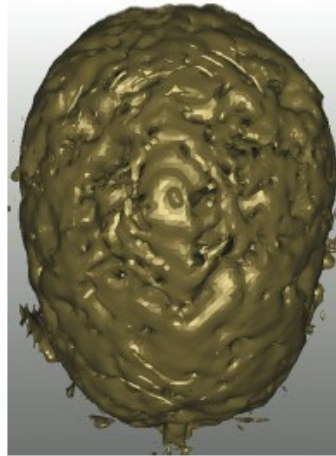
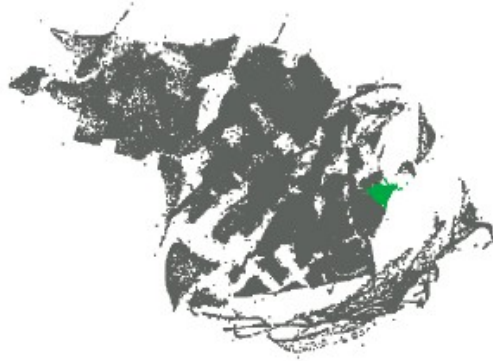
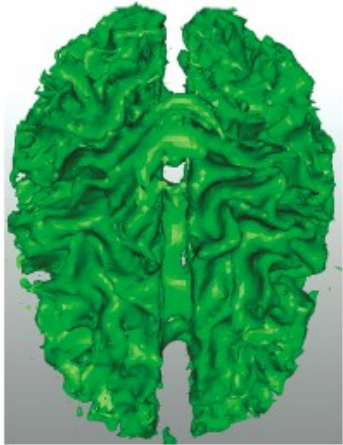
# SciVis

- ▶ Direct Volume Rendering
  - ▶ Look-up tables, transfer functions



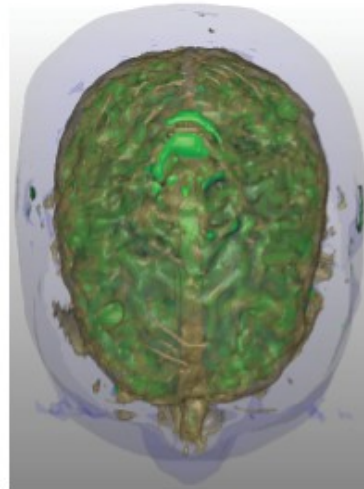
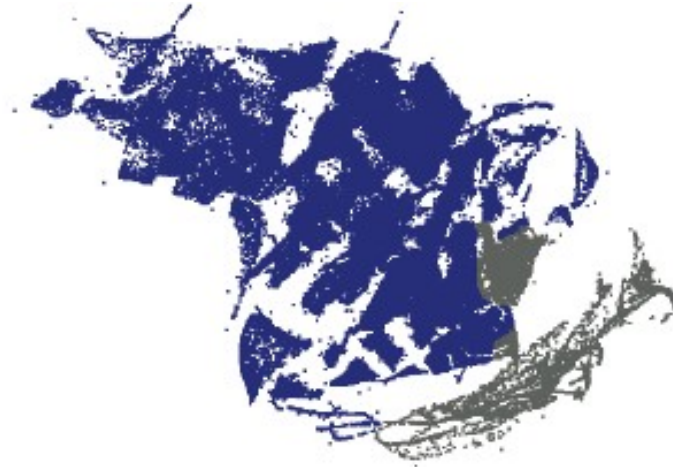
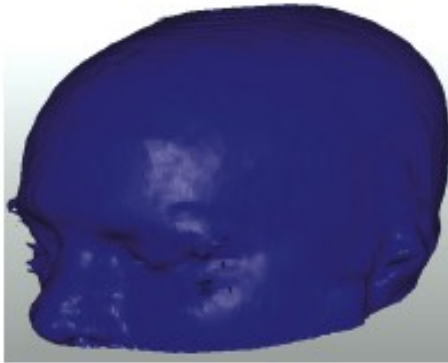
# Projections for Volume Exploration based on Feature Spaces

- ▶ If the 'points' are voxels



# Projections for Volume Exploration based on Feature Spaces

- ▶ If the 'points' are voxels



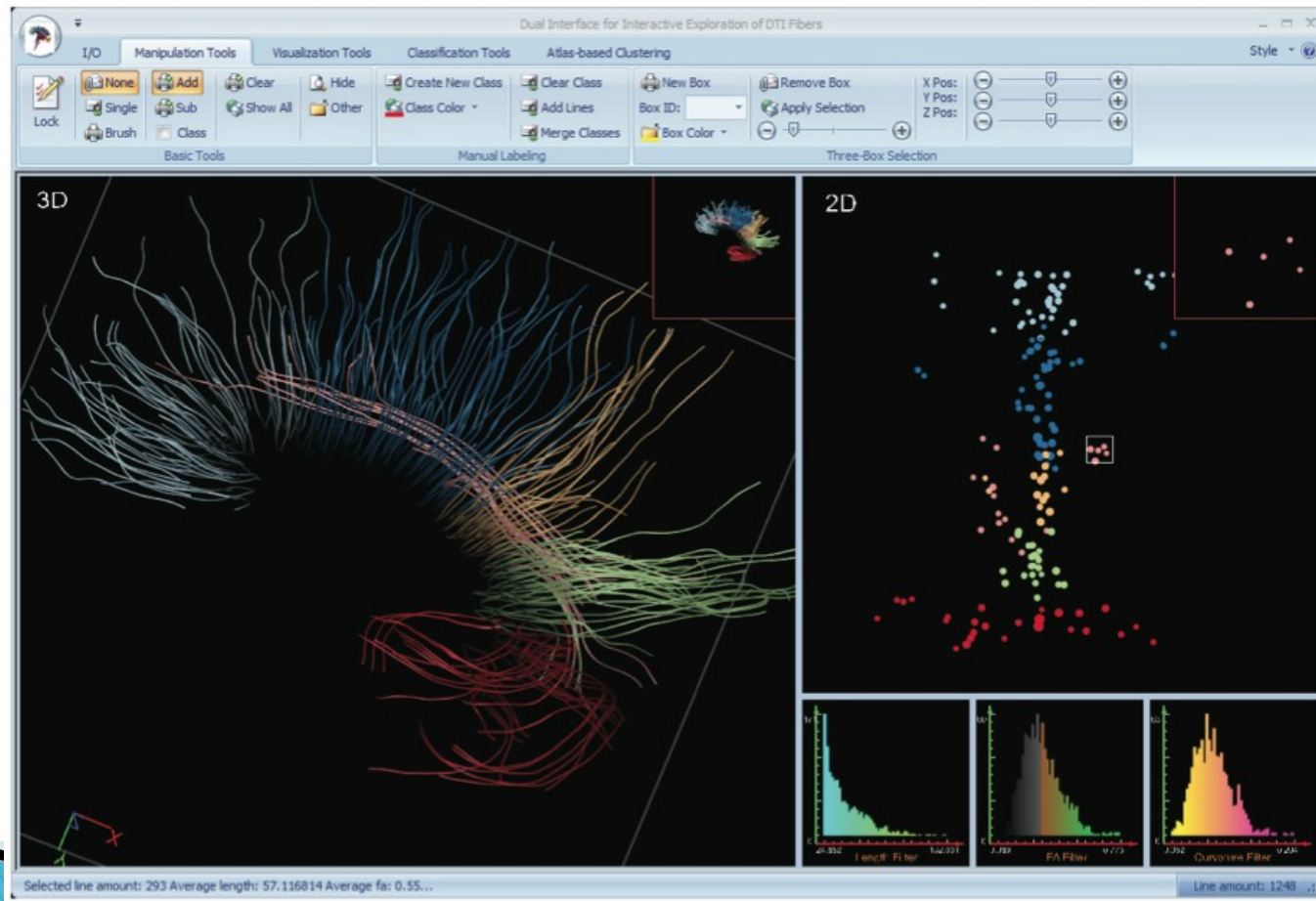
# Projections for Volume Exploration based on Feature Spaces

- ▶ What if the 'points' are brain fibers?
  - DTI (Diffusion Tensor Imaging)
  - Tensor Data
  - Fibers
    - ▢ Extracted
    - ▢ Classified (bundled)

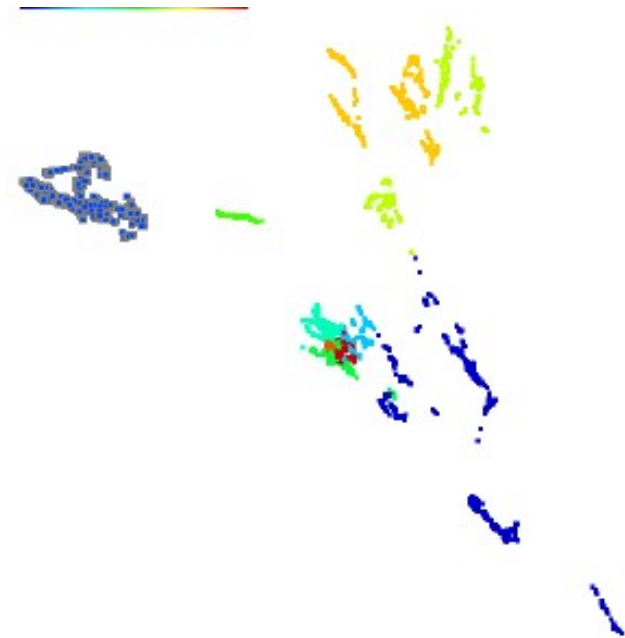
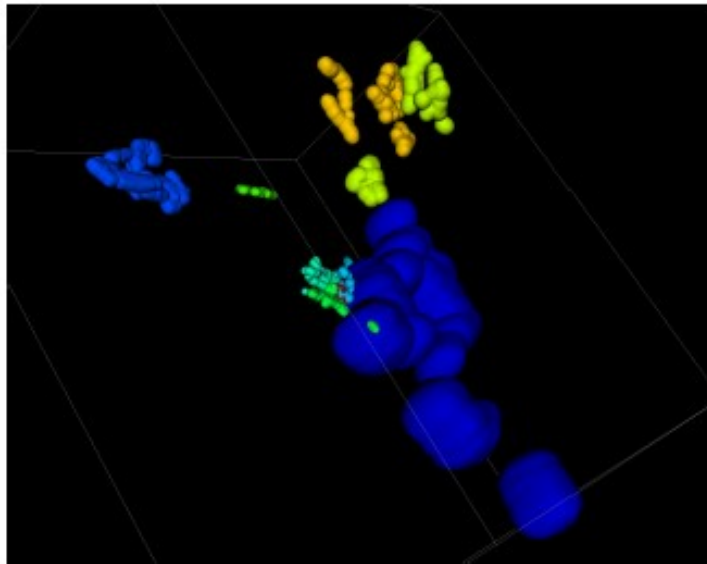


# Projections for Volume Exploration based on Feature Spaces

- ▶ Chen et. AI 2009

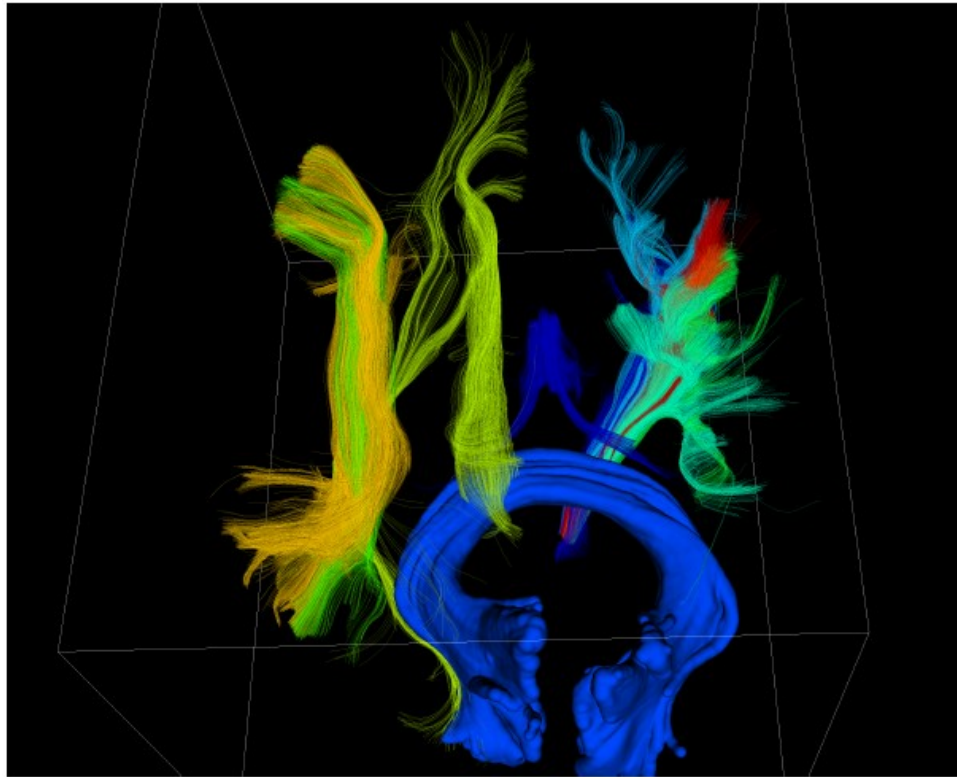


# Projections for Volume Exploration based on Feature Spaces



# Projections for Volume Exploration based on Feature Spaces

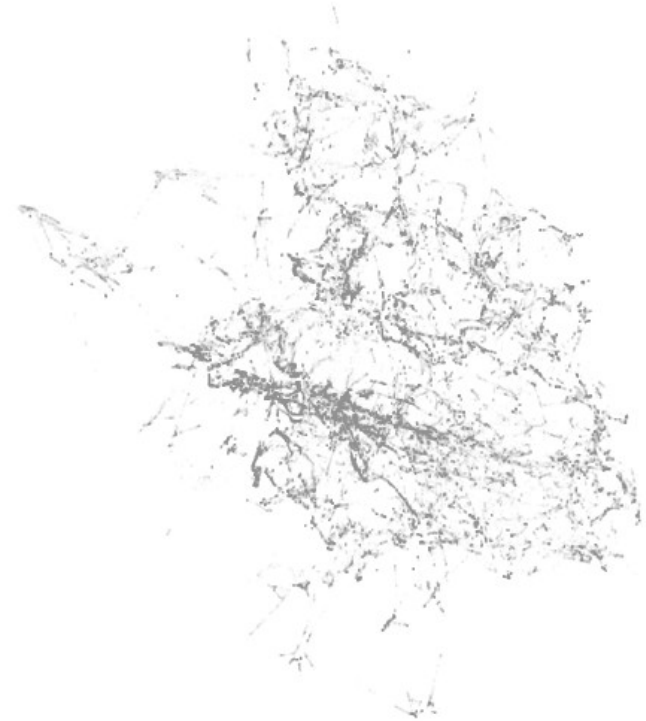
- ▶ Better separation using an extension of LSP



# Projections for Volume Exploration based on Feature Spaces

250 K fibers

P-LSP



# Collaborators – Course Part I

- ▶ Professors, Lecturers, and other professionals
  - Fernando V. Paulovich – ICMC – USP, São Carlos
  - Osvaldo Novaes de Oliveira Jr. – IFSC – USP , São Carlos
  - Alneu de Andrade Lopes – ICMC – USP, São Carlos
  - Luis Gustavo Nonato – ICMC – USP, São Carlos
  - Guilherme P. Telles – IC – UNICAMP
  - João E. S. Batista – ICMC - USP
  
  - Haim Levkowitz – UMASS Lowell, USA
  - Charl Botha & team, TU Delft, The Netherlands
  - Anton Heijs - Treparel Inc., The Netherlands
  - Lars Linsen & team, Jacobs University, Bremen, Germany

# Collaborators – Course Part I

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- Jorge Poco
- Bruno Brandoli
- Roberto Pinho, Brasilia
- Renato Oliveira
- Aretha Alencar
- Marcel Yugo Nakazaki, São Paulo
- Gabriel Andery

# Sponsors – Course Part I

- ▶ CNPq
- ▶ CAPES
- ▶ FAPESP
- ▶ Fulbright

## Link

- ▶ [infoserver.lcad.icmc.usp.br](http://infoserver.lcad.icmc.usp.br) (Pex, Pex-WEB, Pex-Temporal, Pex-Image).

# Research Results (1 / 2)



- ▶ Eler, D. M. ; Nakazaki, M. Y. ; Andery, G. F.; Paulovich, F. V. ; Santos, D. P. ; Oliveira, M. C. F.; Batista, J. ; Minghim, R. . Visual Analysis of Image Collections, *The Visual Computer, Springer*, 25(10), 23-937, 2009.
- ▶ Paulovich, F. V. ; Nonato, L. G. ; MINGHIM, R. ; Levkowitz, H. . Least Square Projection: a fast high precision multidimensional projection technique and its application to document mapping. *IEEE Transactions on Visualization and Computer Graphics*, 2008, IEEE CS Press, 14(3), 564-575, 2008.
- ▶ Cuadros, A. M, Paulovich, F. V., Minghim, R., Telles, G. P - Point Placement by Phylogenetic Trees and its Application to Visual Analysis of Document Collections *IEEE VAST 2007*, Sacramento, CA, USA, IEEE CS Press, pp.99-106.
- ▶ Paulovich, F. V., Oliveira, M.C.F., Minghim, R. - The Projection Explorer: A Flexible Tool for Projection-based Multidimensional Visualization, *Proceedings of Sibgrapi 2007*, IEEE CS Press, Belo Horizonte, Brazil, pp. 27-34,2007.
- ▶ Lopes, A. A., Pinho, R., Paulovich, F. V., Minghim, R. Visual Text Mining Using Association Rules. *Computers & Graphics*, 31(3):316-326, Elsevier, 2007.



# Research Results (2 / 2)



- ▶ Pinho, R. D. ; Oliveira, M. C. F. ; Minghim, R. ; Andrade, M. G. . Voromap: A Voronoi-based Tool for Visual Exploration of Multidimensional Data. In: **10th International Conference on Information Visualization**, 2006, Londres. Proceedings of Information Visualisation 2006, 2006. v. 1. p. 39-44
- ▶ Paulovich, F. V. ; Minghim, R. . Text Map Explorer: a Tool to Create and Explore Document Maps. In: Information Visualisation 2006 (IV06) **10th International Conference on Information Visualisation**, 2006, Londres. Proceedings of Information Visualisation 2006, 2006. v. 1. p. 245-251.
- ▶ Minghim, R. ; Levkowitz, H. ; Nonato, L. G. ; Watanabe, L. S. ; Salvador, V. C. L. ; Lopes, H. ; Pesco, S. ; Tavares, G. . Spider Cursor: A simple versatile interaction tool for data visualization and exploration. In: **ACM GRAPHITE'05** - 3rd International Conference on Computer Graphics and Interactive Techniques in Australasia and Southeast Asia, 2005, Dunedin. Proceedings of Graphite 2005, 2005. p. 307-314.
- ▶ Paulovich, F.V.; Minghim, R.; HiPP: A Novel Hierarchical Point Placement Strategy and its Application to the Exploration of Document Collections. *IEEE Transactions on Visualization and Computer Graphics, Special Issue: Proceedings of IEEE Visualization 2008 and IEEE Information Visualization 2008*, 14(6):1229-1236, IEEE CS Press, 2008.

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- [1] K. Andrews, W. Kienreich, V. Sabol, J. Becker, G. Droschl, F. Kappe, M. Granitzer, P. Auer, and K. Tochtermann. The infosky visual explorer: exploiting hierarchical structure and document similarities. *Information Visualization*, 1(3/4):166–181, 2002.
- [2] C. Bachmaier, U. Brandes, and B. Schlieper. Drawing phylogenetic trees. In X. Deng and D. Du, editors, *Proc. Intl. Symp. on Alg. And Comp. , ISAAC 2005*, volume 3827, pages 1110–1121, 2005.
- [3] T. F. Cox and M. A. A. Cox. *Multidimensional Scaling*. Chapman & Hall/CRC, second edition, 2000.
- [4] T. M. J. Fruchterman and E. M. Reingold. Graph drawing by force-directed placement. *Software - Practice and Experience*, 21(11):1129–1164, 1991.
- [5] I. T. Jolliffe. *Principal Component Analysis*. Springer-Verlag, 2 edition, 2002.
- [6] F. V. Paulovich and R. Minghim. Text map explorer: a tool to create and explore document maps. In *IV '06: Proc. of the conf. on Information Visualization*, pages 245–251, Washington, DC, USA, 2006. IEEE Computer Society Press.

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- [8] G. Telles, R. Minghim, and F. Paulovich. Normalized compression distances for visual analysis of document collections. *Computer & Graphics, Special Issue on Visual Analytics*, 2007.
- [9] J. Wise, J. Thomas, K. Pennock, D. Lantrip, M. Pottier, A. Schur, and V. Crow. Visualizing the non-visual: spatial analysis and interaction with information for text documents. In *Readings in information visualization: using vision to think*, pages 442–450, San Francisco, CA - USA, 1995. Morgan Kaufmann Publishers Inc.
- [10] M. Salemi, A. Vandamme. The phylogenetic handbook. A practical approach to DNA and protein phylogeny. Cambridge University Press, 2003.
- [11] F. V. Paulovich and L. G. Nonato and R. Minghim and Haim Levkowitz. Least Square Projections; A Fast High-precision multidimensional projection technique and its application to document mapping. *IEEE TVCG* (to appear), 2008.