

Scientific Information and Data Visualization

Final Review
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CDS 301
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Outline

- CH1: Introduction
- CH2: From Graphics to Visualization
- CH3: Data Representation
- CH4: Visualization Pipeline

- CH5: Scalar Visualization
- CH6: Vector Visualization
- CH7: Tensor Visualization

- CH8: Domain-Modeling Techniques
- CH9: Image Visualization
- CH10: Volume Visualization

- CH11: Information Visualization
- Ch-12: Conclusion

CH2: From Graphics to Visualization

- Graphic Rendering
 - Lighting
 - Ambient, diffuse and specular coefficient
 - Shading: Flat; Gouraud
 - Transparency and Blending
- **Visualization Pipeline**
 1. Acquisition: produce discrete dataset
 2. Mapping: produce a 3-D geometric object
 3. Rendering: display the geometric object

CH3: Data Representation

•Dataset

•Sampling Points $D_s = (\{p_i\}, \{C_i\}, \{f_i\}, \{\Phi_i^k\})$

- Cell Types: line, triangle, quad, tetrahedron
- Attribute Types: scalar, vector, color, tensor
- Reconstruction Basis Function

•Reconstruction (mapping)

•Constant

•Linear

•e.g., 1-D line

•e.g., 2-D quad

$$\tilde{f} = \sum_{i=1}^N f_i \phi_i$$

Actual and reference cells

•Lexicographic order

•RGB color system and HSV color systems

CH5: Scalar Visualization

- Color Mapping
- Designing effective colormaps
 - Rainbow colormap
- Contouring

CH6: Vector Visualization

- Gradient, Divergence, Vorticity
- Vector Glyphs
- Vector Color Coding
- Stream Objects
 - Stream line; seed point
 - Stream tube; Stream ribbon
- Texture-based vector visualization

CH7: Tensor Visualization

- Principle Component Analysis
 - Tensor
 - Curvature
 - Eigenvalue
 - Eigenvector
 - Hessian matrix
- Tensor Glyphs
- Hyperstreamlines

CH8: Domain-Modeling Tech.

- Cutting: Slicing
- Selection: Contour, isosurface

- Grid Construction from Scattered Points
 - Delaunay triangulation method

- 3D surface reconstruction from a point cloud
 - Find Local Tangent Plane
 - Geometric center
 - Covariance matrix
 - Normal direction

- Grid-Processing Technique: Laplacian Smoothing

CH9: Image Visualization

- Image Data Representation
- Image Processing and visualization
 - Transfer functions
 - Contrast Enhancement; Histogram Equalization
- Basic Imaging Algorithms
 - Gaussian Smoothing (reducing noise)
 - Fourier Series and Transform
 - Low-pass filter, high-pass filter
 - Edge Detection (example)
 - Gradients: Roberts operator; Sobel operator
- Shape Representation and Analysis
 - Segmentation
 - Morphological Operations: dilation and erosion
 - Distance Transform
 - Skeletonization

CH10: Volume Visualization

- Volume Visualization Basics
 - Ray Function and Transfer function
 - Maximum Intensity Projection
 - Average Intensity Function
- Compositing function: a general ray function
 - Volumetric illumination model
 - opacity

$$\mathbf{C}(p) = \int_{t=0}^T c(t) e^{-\int_0^t \tau(x) dx} dt$$

CH11: Information Visualization

- What is Infovis?
- Infovis versus Scivis
- Table Visualization
- Visualization of Relations
 - Tree
 - Graph
- Multivariate Data Visualization

The End