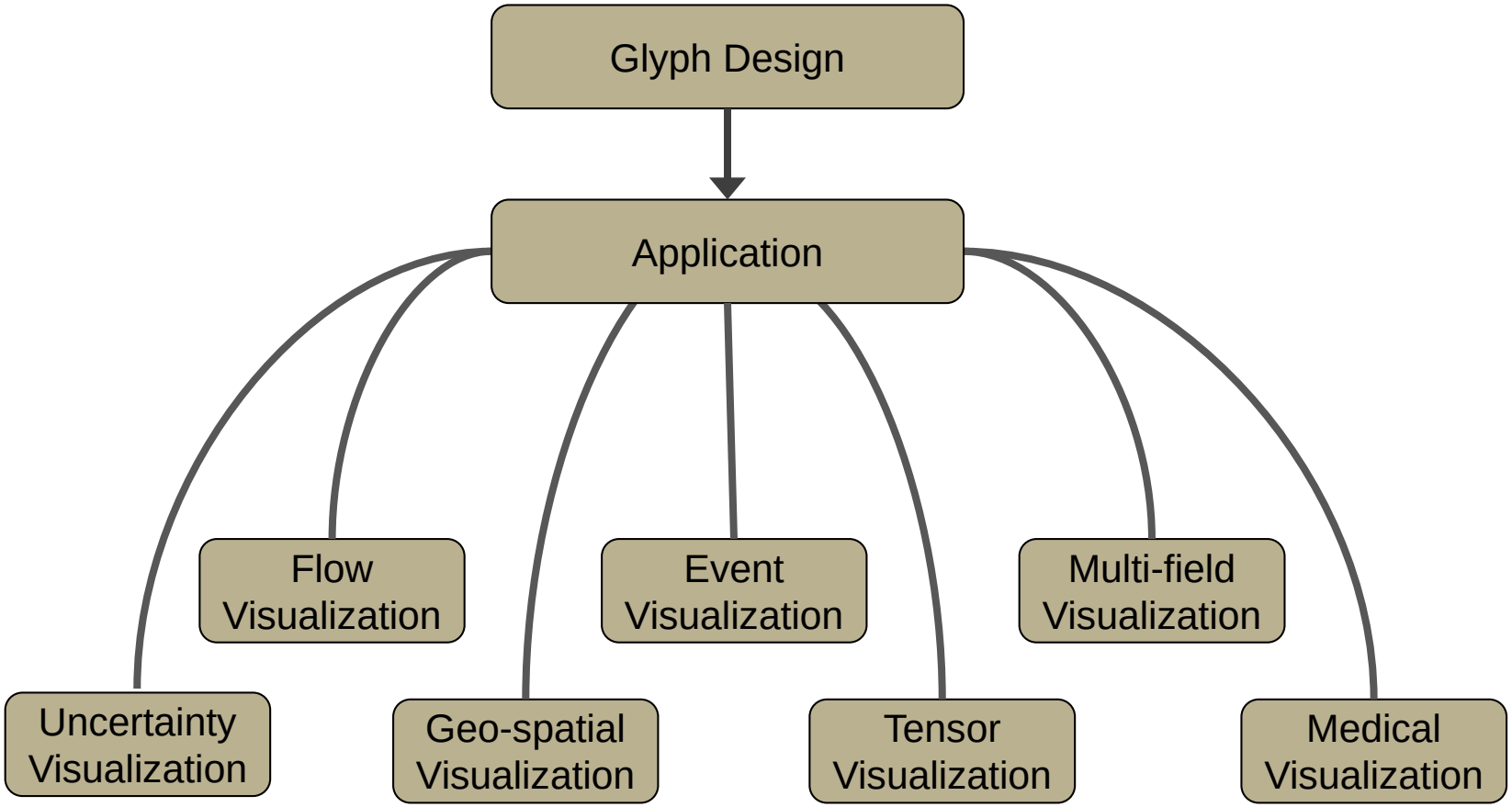
Eurographics 2013
May 6-10, Girona (Spain)

Glyph-based Visualization

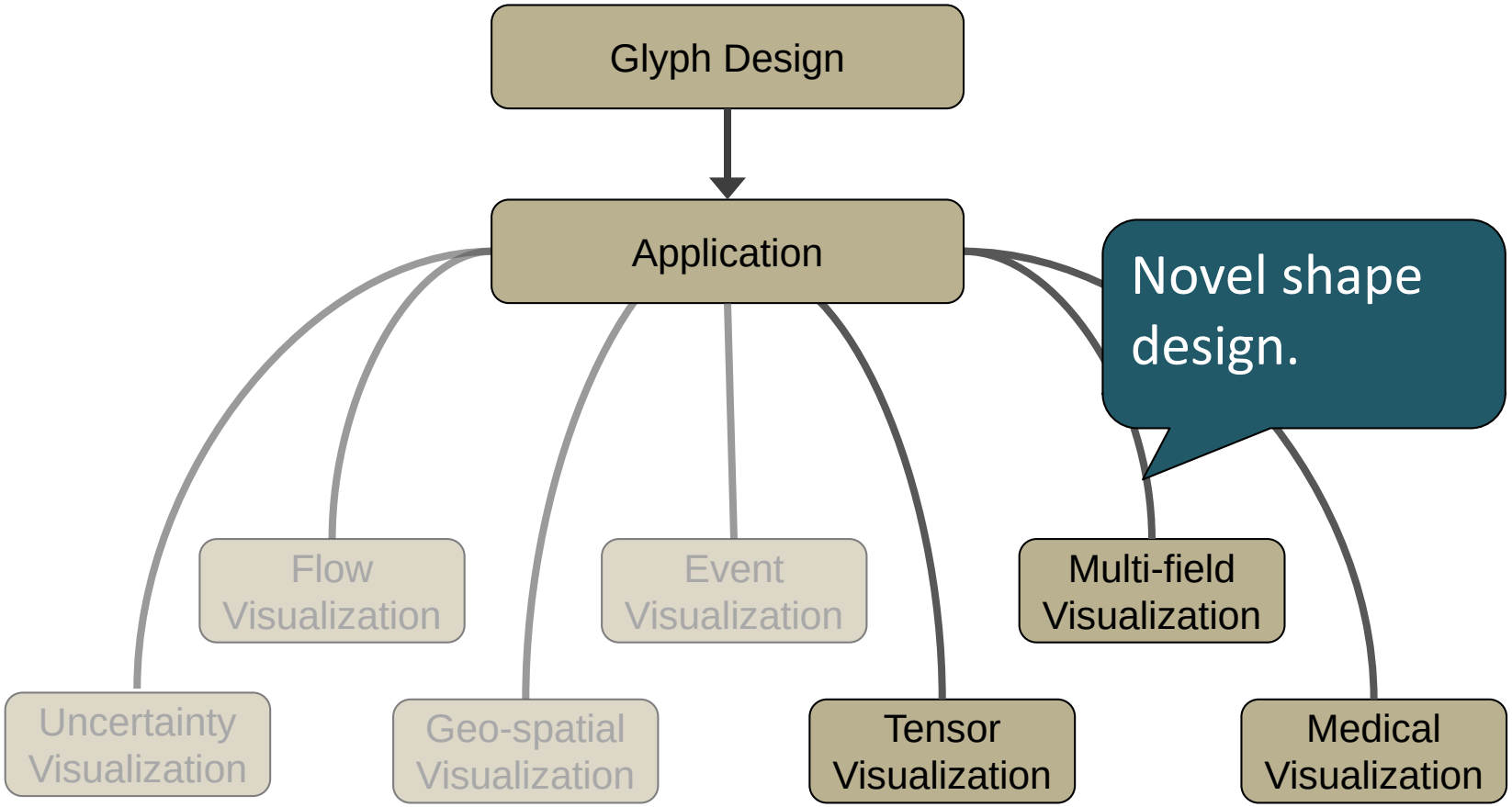
Applications

David H. S. Chung
Swansea University

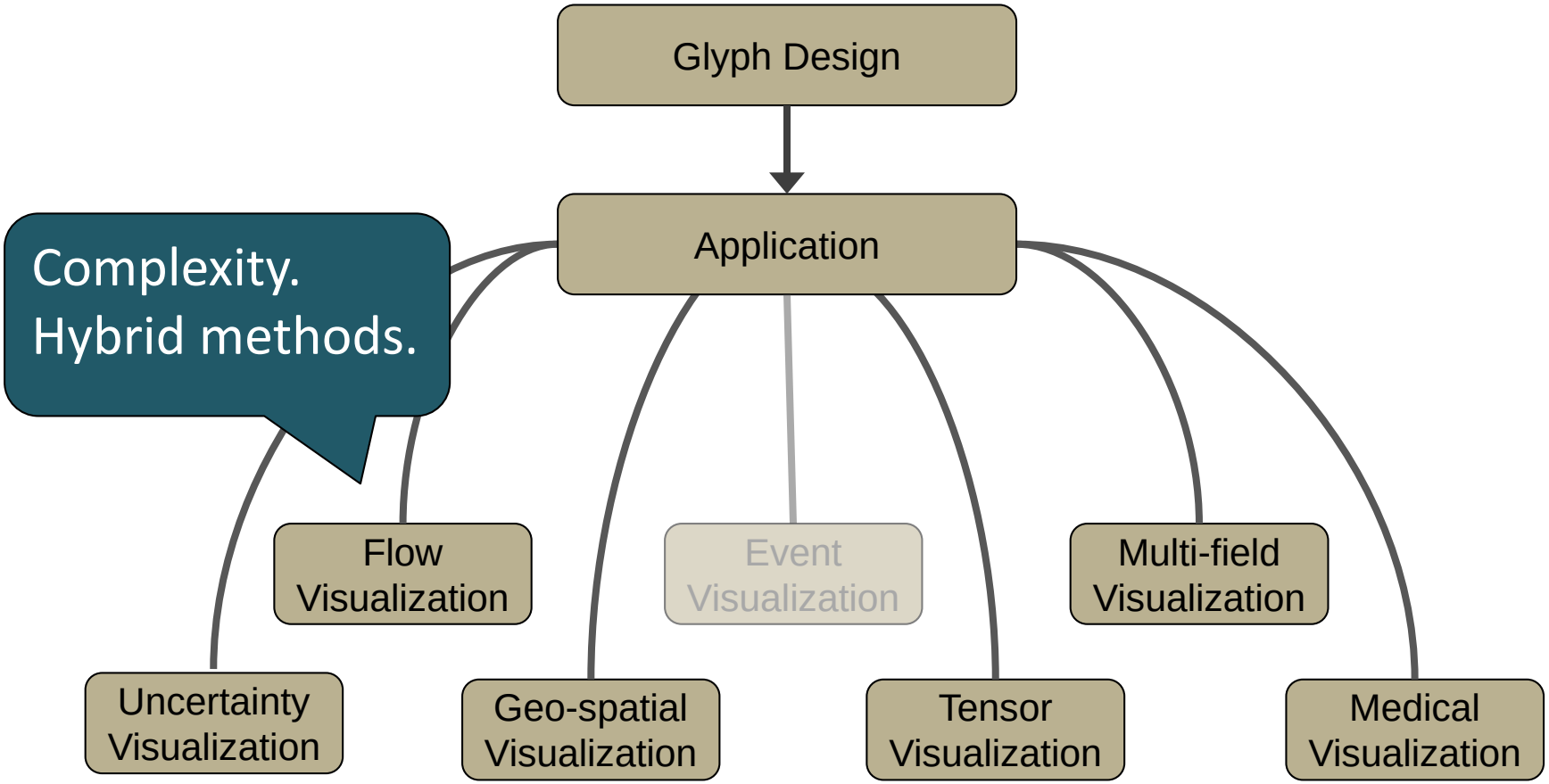
Outline


Glyph Design
Application
Flow Visualization
Event Visualization
Multi-field Visualization
Uncertainty Visualization
Geo-spatial Visualization
Tensor Visualization
Medical Visualization

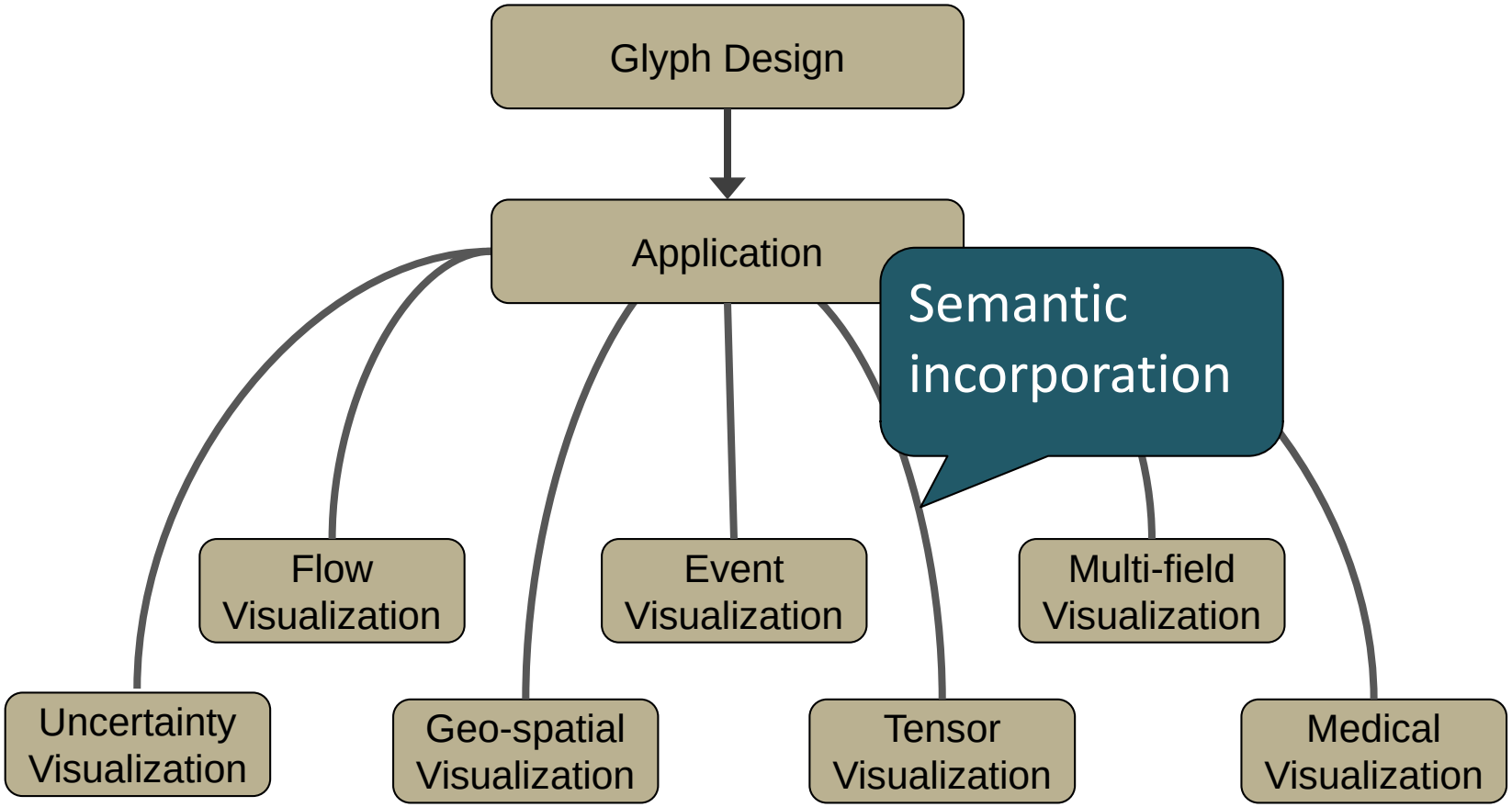
Outline


Glyph Design
Application
Novel shape design.
Flow Visualization
Event Visualization
Multi-field Visualization
Uncertainty Visualization
Geo-spatial Visualization
Tensor Visualization
Medical Visualization

Outline


Glyph Design
Application
Complexity.
Hybrid methods.
Flow Visualization
Event Visualization
Multi-field Visualization
Uncertainty Visualization
Geo-spatial Visualization
Tensor Visualization
Medical Visualization

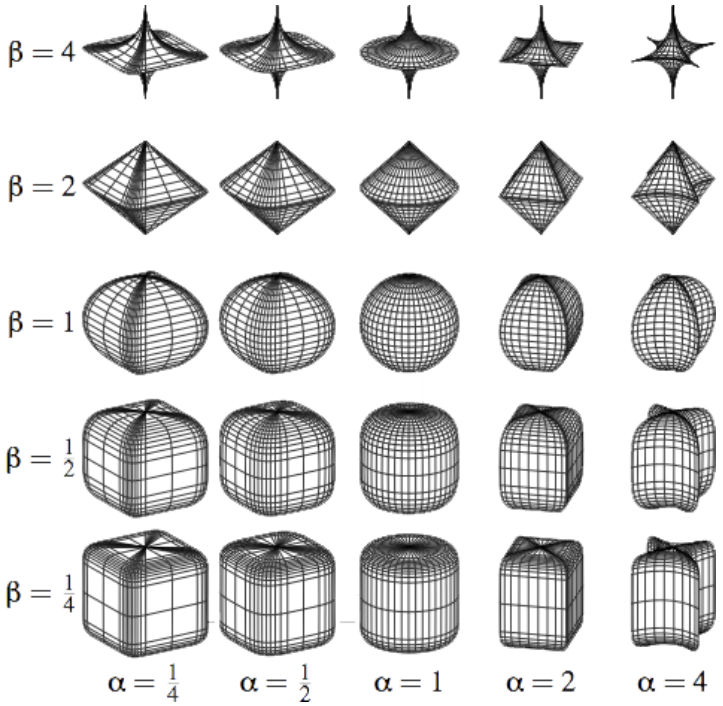
Outline


Glyph Design
Application
Semantic incorporation
Flow Visualization
Event Visualization
Multi-field Visualization
Uncertainty Visualization
Geo-spatial Visualization
Tensor Visualization
Medical Visualization

Multi-field Visualization

Superquadric glyphs and Angle-preserving Transformation by Barr (1981)

- Shape design is one of the most prominent visual channels.
- Adjusting the exponents **β** and **α** controls the superquadric shape.
- These are referred to as squareness parameters.



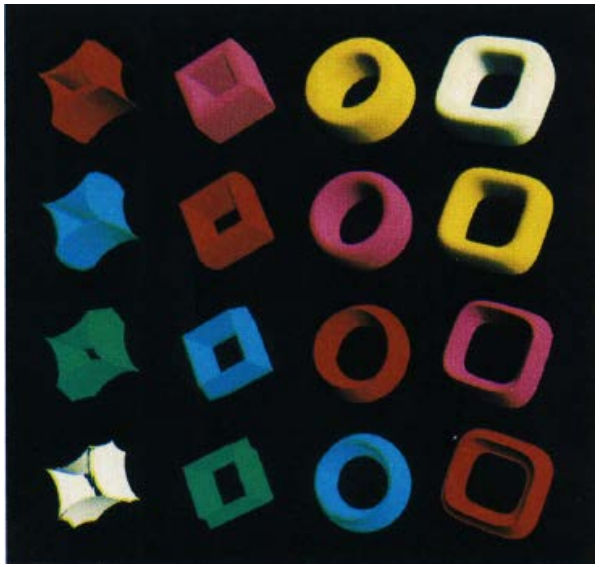
[Kindlmann 2004]

Multi-field Visualization

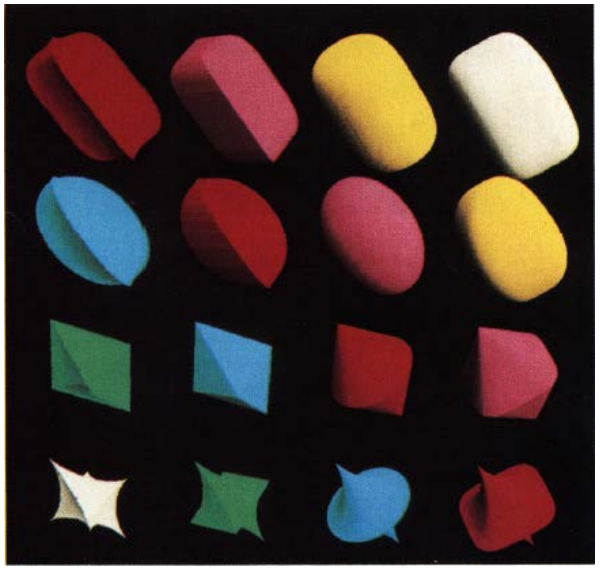
Superquadric glyphs and Angle-preserving Transformation by Barr (1981)

- The position, size, and surface curvature of the glyph can be mapped to multiple data attributes.

Superhyperboloids



Supertoroids

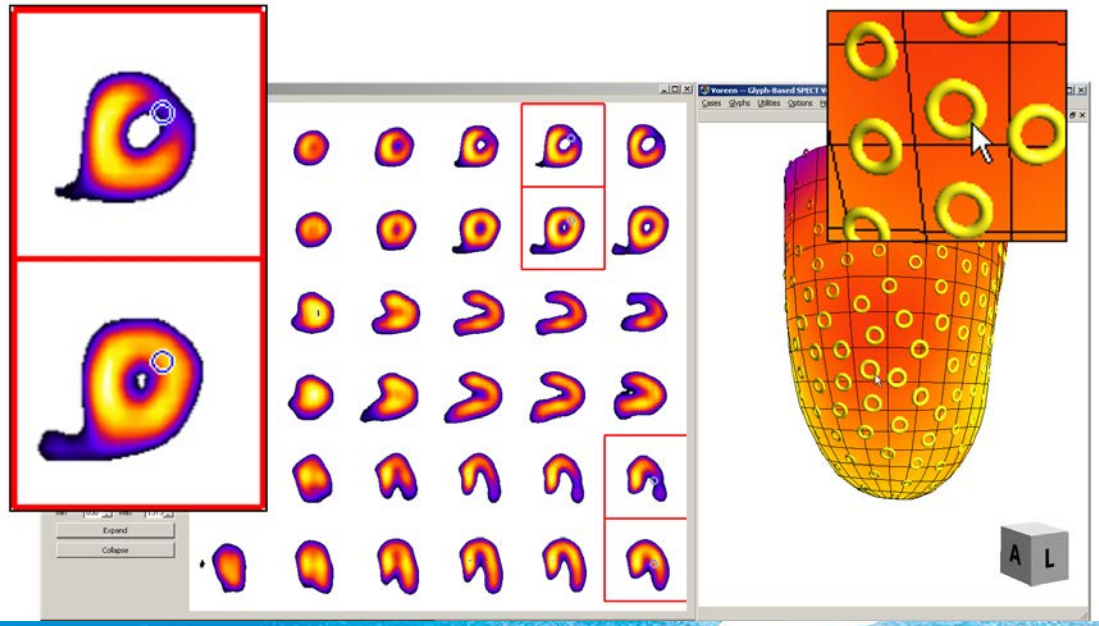


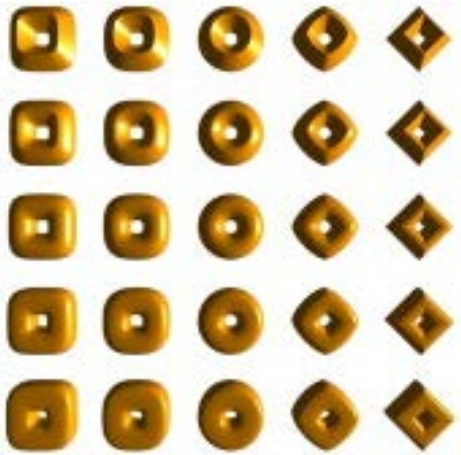
Superellipsoids

Medical Visualization

Glyph-Based SPECT Visualization for the Diagnosis of Coronary Artery Disease by Meyer-Spradow et al. (2008)

- Perfusion parameters are mapped to a **supertorus** glyph.
- Blood supply at resting condition, the difference between resting and under stress, and the wall thickening.
  - Colour, Size and Roundness.



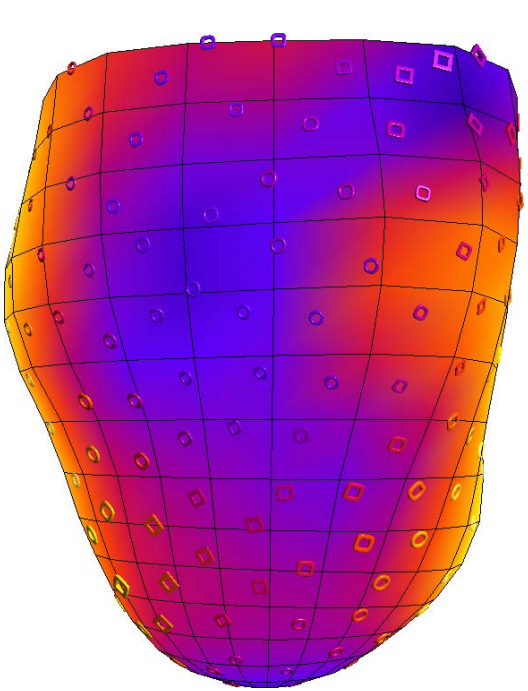


[Ropinski et al. 2011]

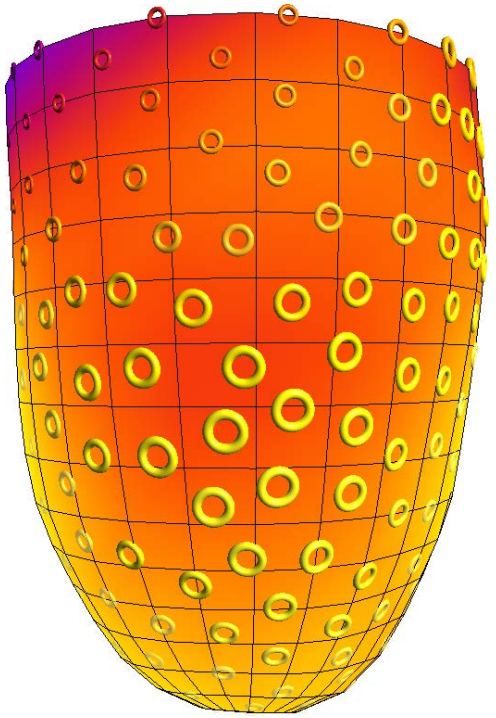
Medical Visualization

Glyph-Based SPECT Visualization for the Diagnosis of Coronary Artery Disease by Meyer-Spradow et al. (2008)

- Semi-transparency used to emphasise glyphs that are important for diagnosis.
- Glyphs describe the state of the underlying tissue on the myocardium.



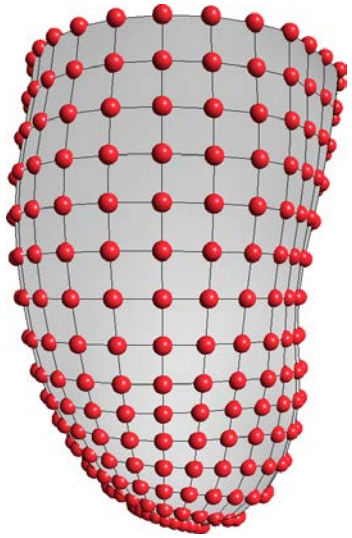
scar



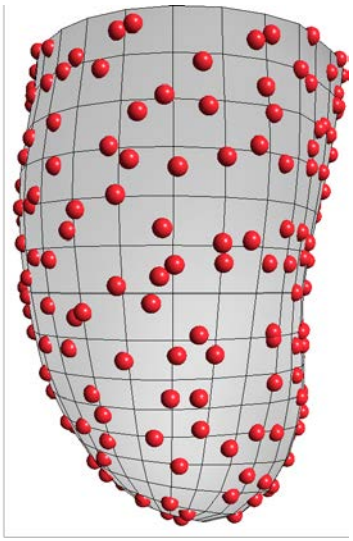
ischemia

Medical Visualization

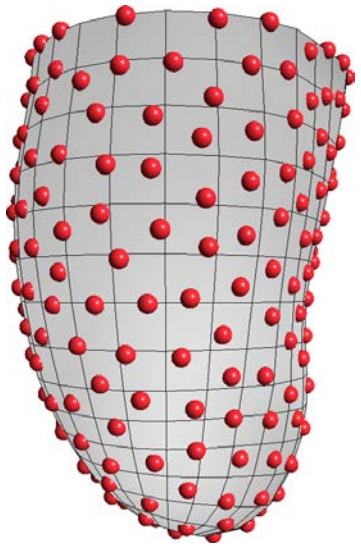
Glyph-Based SPECT Visualization for the Diagnosis of Coronary Artery Disease by Meyer-Spradow et al. (2008)



Uniform seeding



Random distribution



Random distribution with relaxation

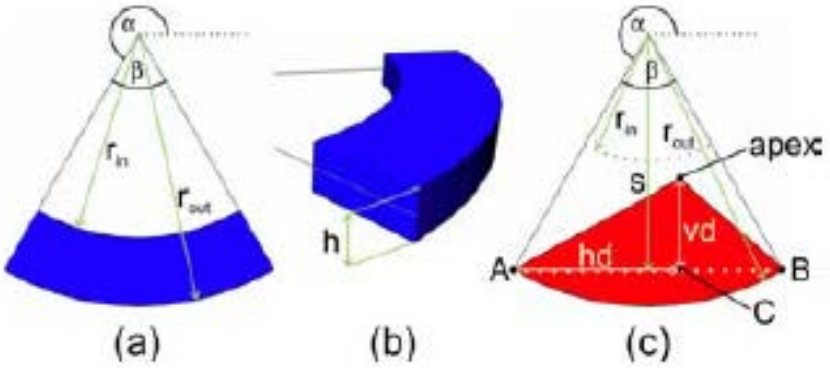
- Random distribution with relaxation gives a balanced glyph placement strategy for unstructured surfaces.

Medical Visualization

Glyph-based Visualization of Myocardial Perfusion Data and Enhancement with Contractility and Viability Information by Oeltze et al. (2008)

- Introduce two glyph-based methods:
  1. 3D Bull's Eye Plot (**BEP**) segments.
  2. Time Intensity Curve (**TIC**) Miniatures.

- Perfusion parameters:
  - Peak Enhancement (PE),
  - Time to peak (TTP),
  - Integral and Up-slope

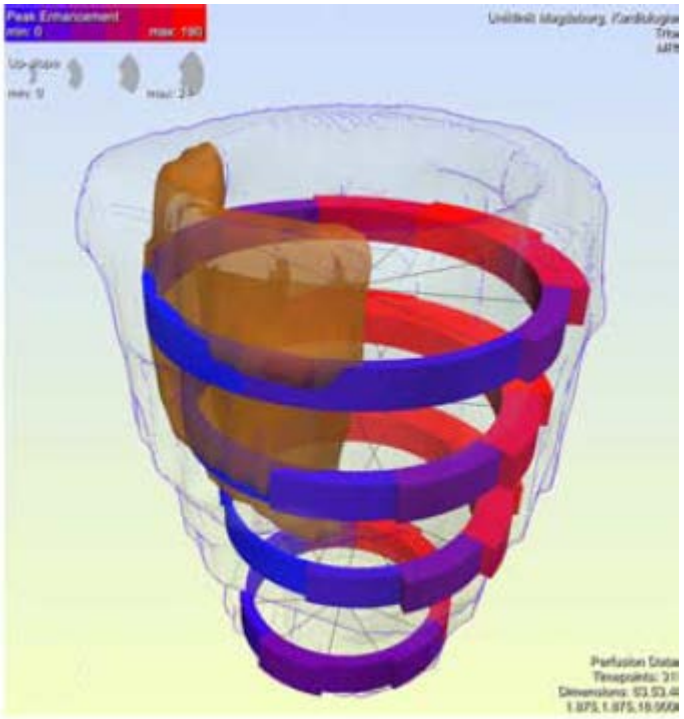


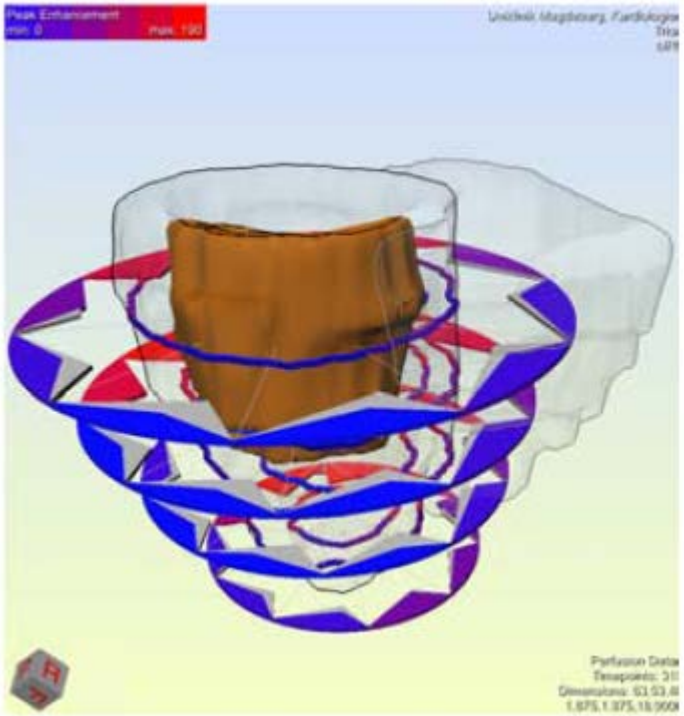
Glyph legend for (a) – (b) 3D **BEP** segment and (c) **TIC** glyph

Medical Visualization

Glyph-based Visualization of Myocardial Perfusion Data and Enhancement with Contractility and Viability Information by Oeltze et al. (2008)

- Glyph visualizations developed to support the analysis of cardiac MR data.

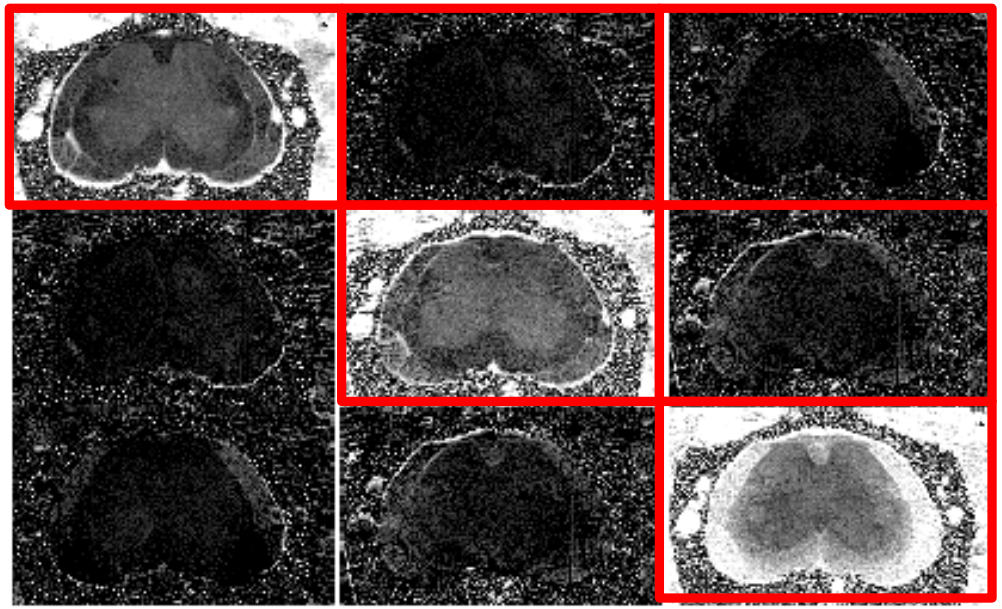




Tensor Visualization

Visualizing Diffusion Tensor Images of the Mouse Spinal Cord by Laidlaw et al. (1998)

- 2D diffusion tensor image (DTI) and associated anatomical scalar field define seven values at each spatial location.
- Difficult to integrate data using multiple scalar visualizations.

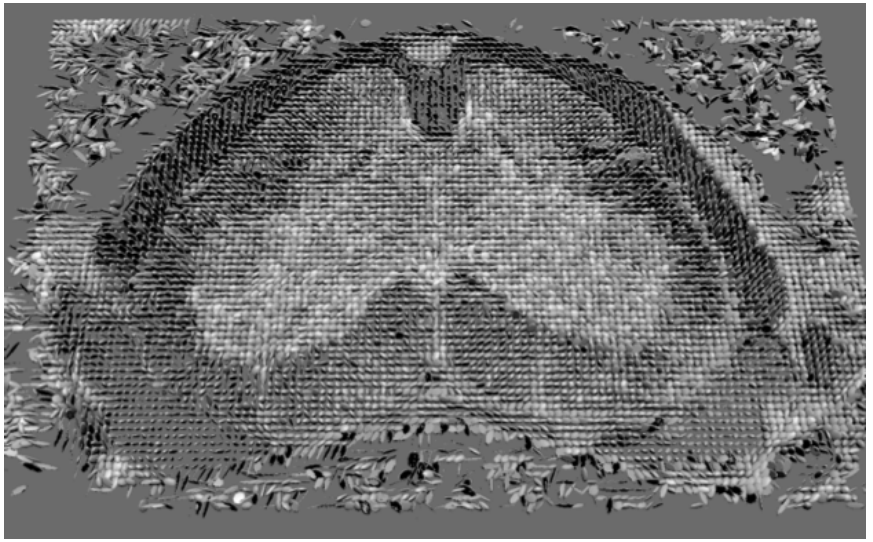


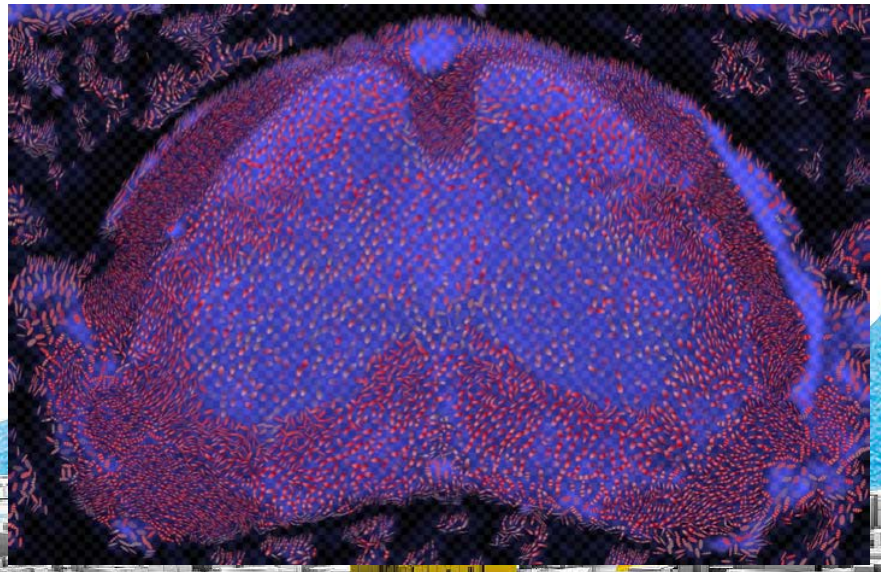
Tensor Visualization

Visualizing Diffusion Tensor Images of the Mouse Spinal Cord by Laidlaw et al. (1998)

- Normalized Ellipsoids.
  - Simultaneous display in one image.
  - Partial representation of the tensor properties.

- Concepts from oil painting.
  - Multiple layers of brush strokes.
  - Displays all seven data values.

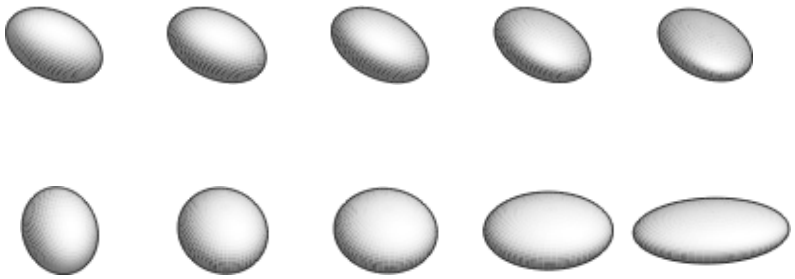




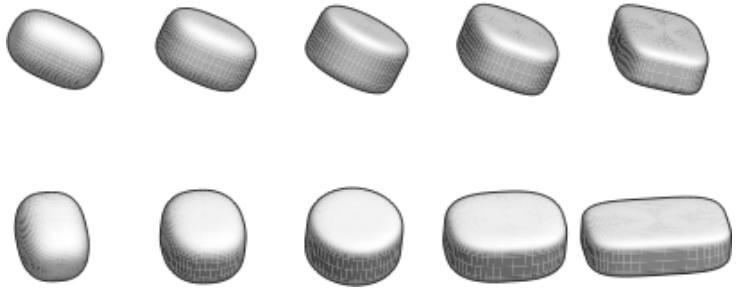
Tensor Visualization

Superquadric Tensor glyphs by Gordon Kindlmann (2004)

- Symmetrical properties of ellipsoids can cause visual ambiguity depending on the user's viewing angle.
- Superquadrics overcome view point dependence.



Ellipsoids

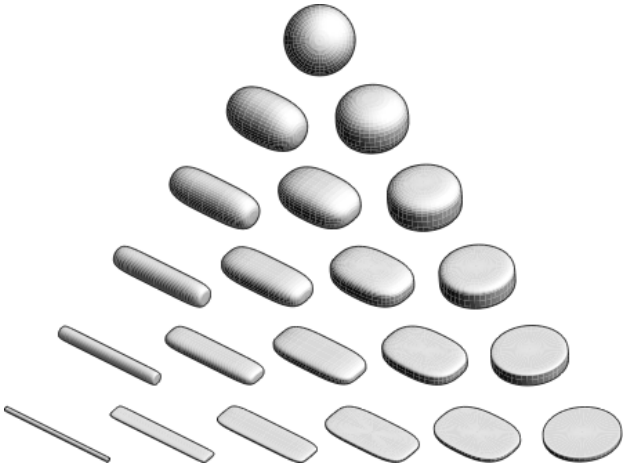


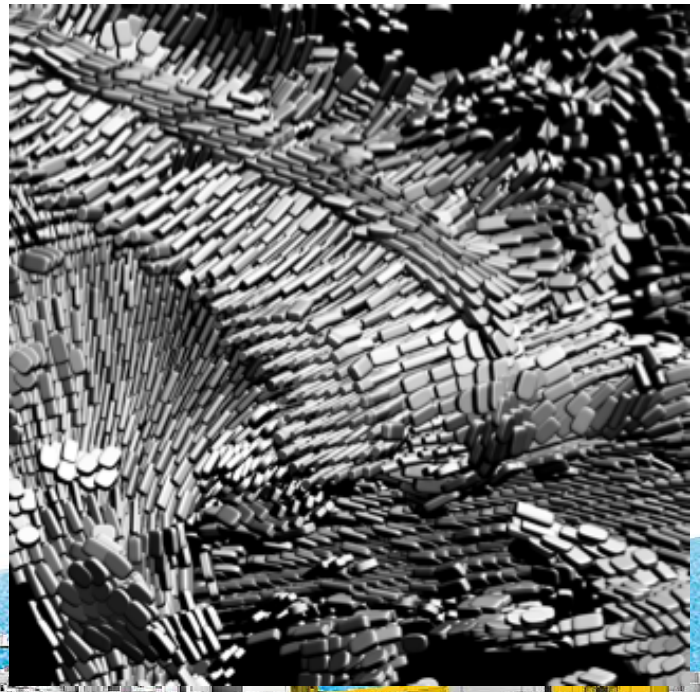
Superquadrics

Tensor Visualization

Superquadric Tensor glyphs by Gordon Kindlmann (2004)

- Barycentric of shapes that change in length, flatness and roundness based on anisotropic tensor metrics.
- Visualization of DT-MRI tensor field.

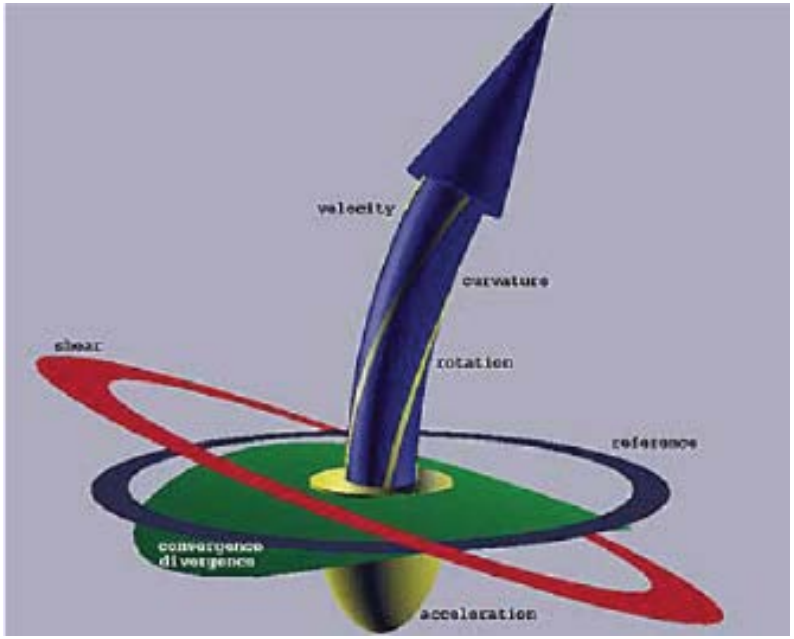




Flow Visualization

A probe for local flow field visualization by de Leeuw and van Wijk (1993)

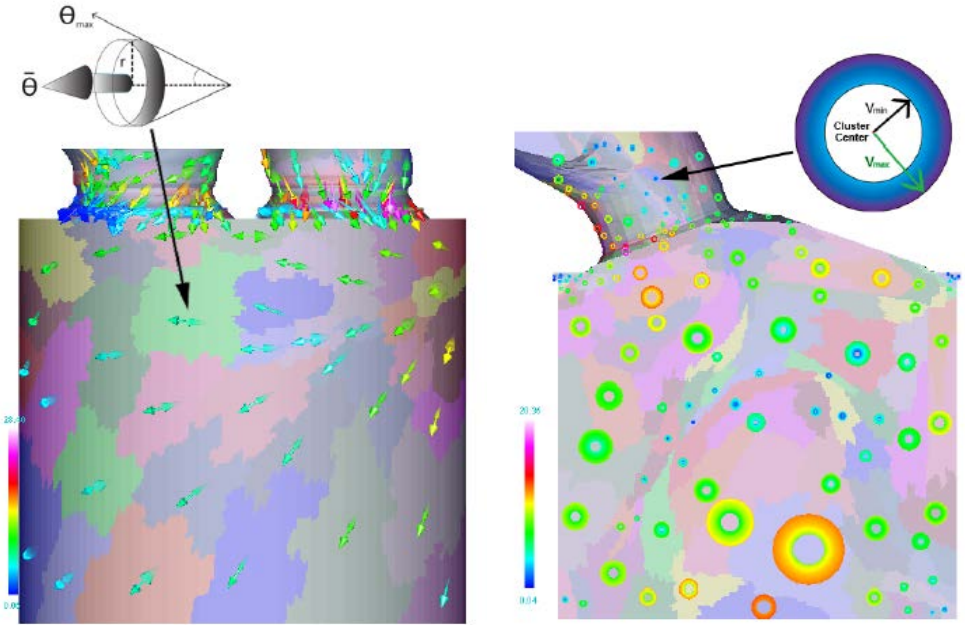
- **Probe glyphs** are interactively placed within a 3D flow field to depict flow characteristics such as velocity, acceleration and convergence.
- Large complex glyphs need to be sparsely placed to avoid occlusion.



Flow Visualization

Mesh-driven Vector Field Clustering and Visualization by Peng et al. (2011)

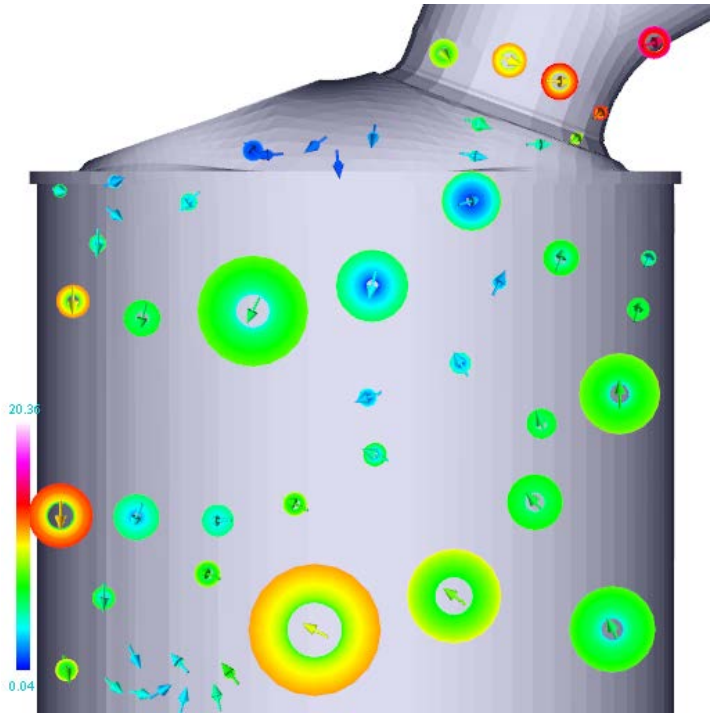
- Automatic vector field clustering algorithm.
- Visualizing statistical information of each vector cluster.
  - **Θ-Angle** range glyphs illustrate the variance in vector field direction.
  - **|v|-Magnitude** range Discs depict the minimum and maximum vector.

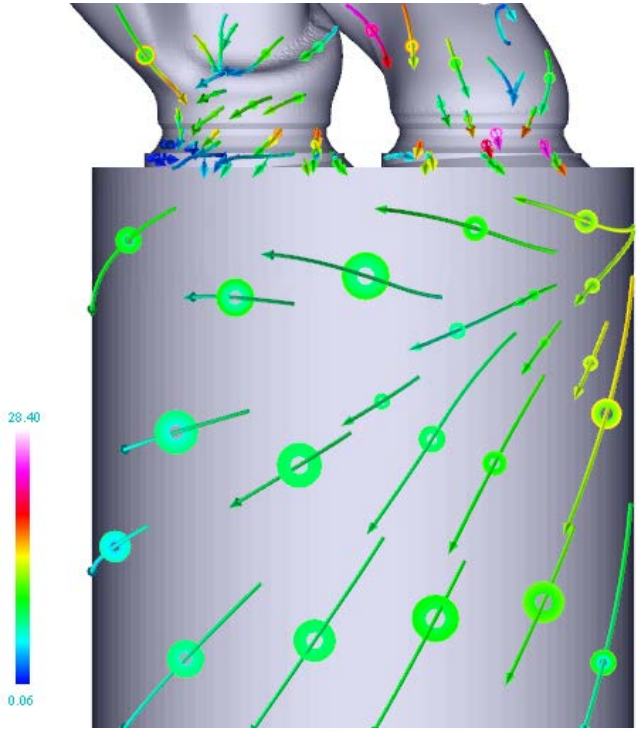


Flow Visualization

Mesh-driven Vector Field Clustering and Visualization by Peng et al. (2011)

- Combining glyph-based techniques for more informative visualization of vector fields.



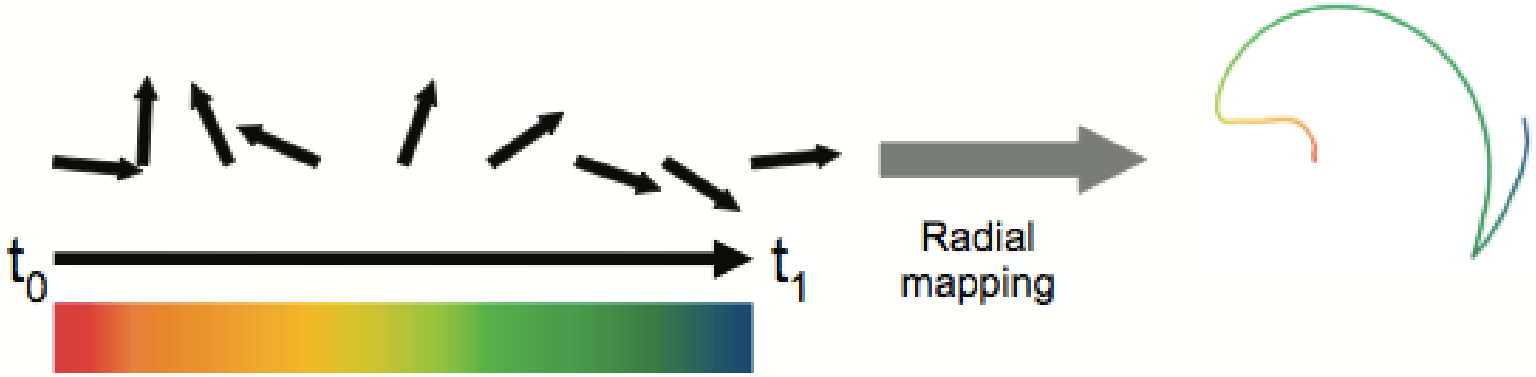


Flow Visualization

Flow Radar Glyphs: Static Visualization of Unsteady Flow with Uncertainty, Hlawatsch et al. (2011)

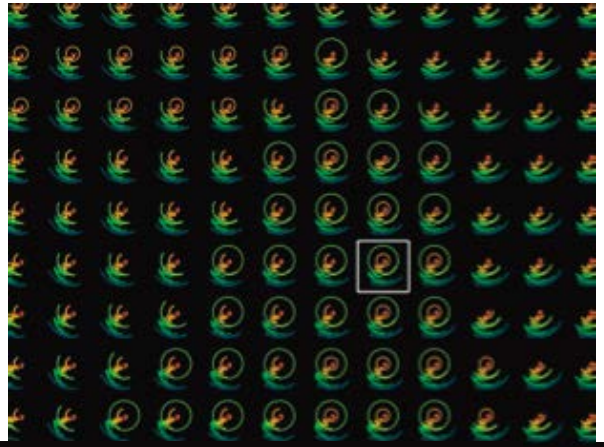
- Visualizing time-dependant vector data without using animation.

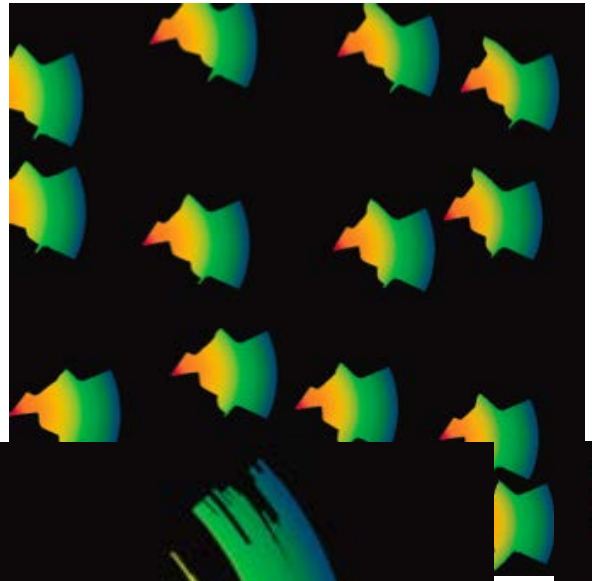
- **Flow radar glyphs:**
  - Map vector quantities into polar coordinates.

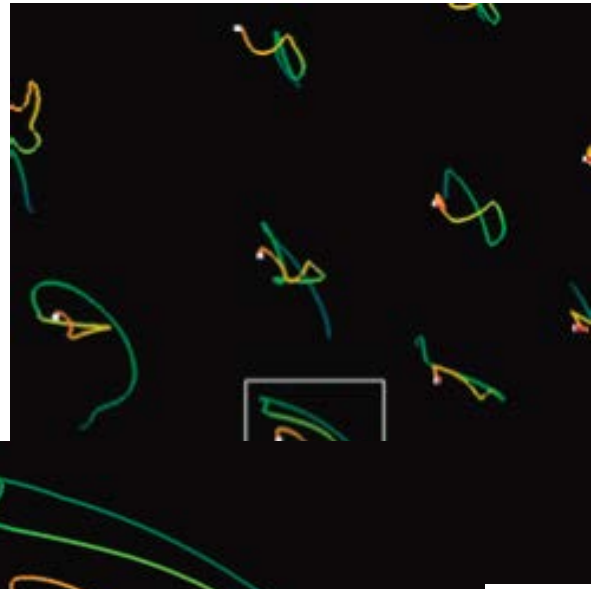


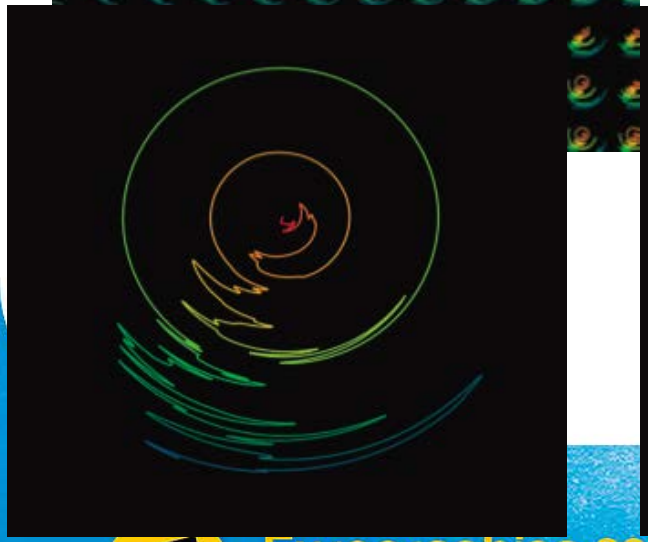
Flow Visualization

Flow Radar Glyphs: Static Visualization of Unsteady Flow with Uncertainty, Hlawatsch et al. (2011)





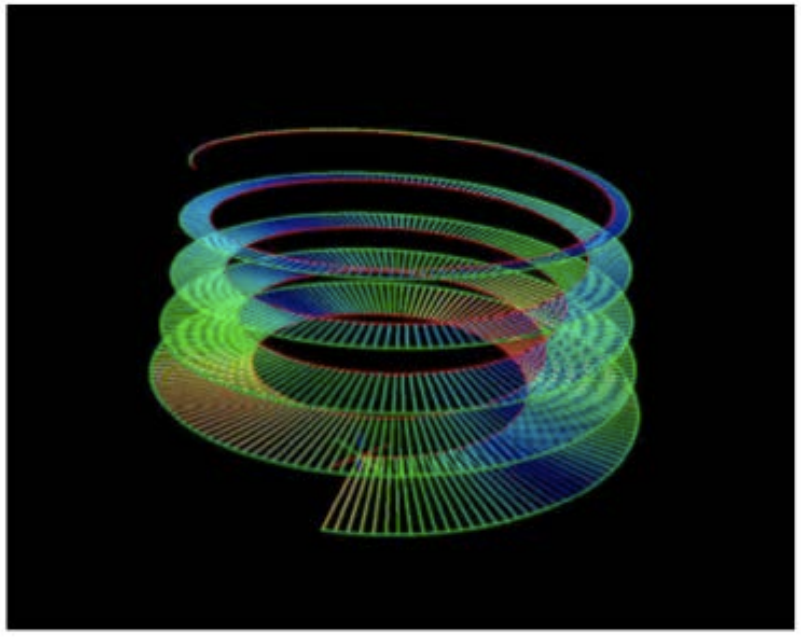


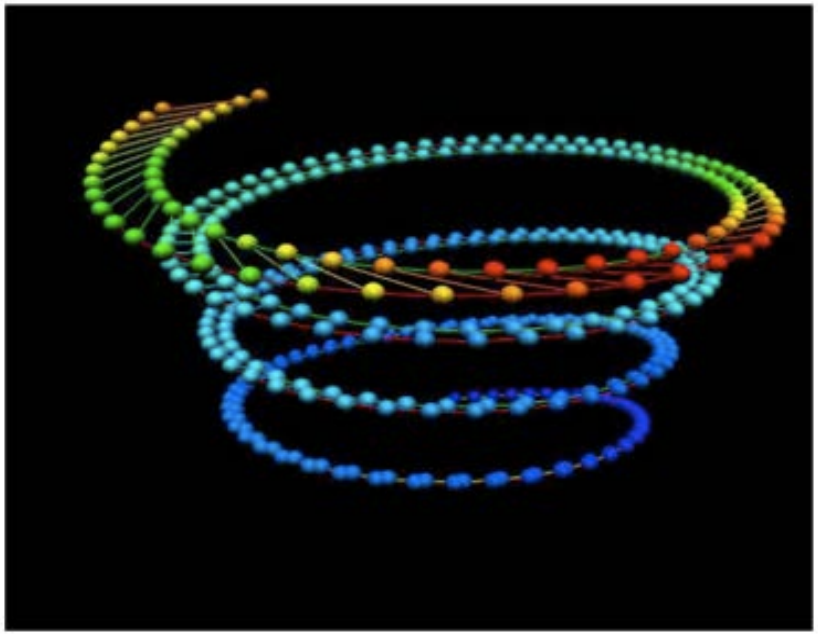


Uncertainty Visualization

UFLOW: Visualizing Uncertainty in Fluid Flow by Lodha et al. (1996)

- Visualize uncertainty arising from different numerical algorithms for tracing a particle.
- Difference between two streamlines.
- **Line segment** and **Bar bell** glyphs
  - Colour mapped to uncertainty.

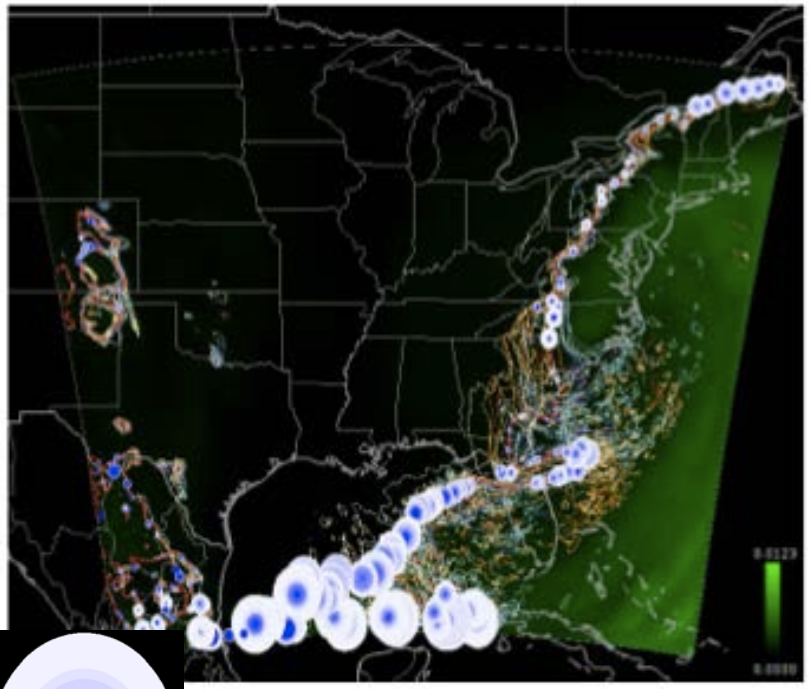


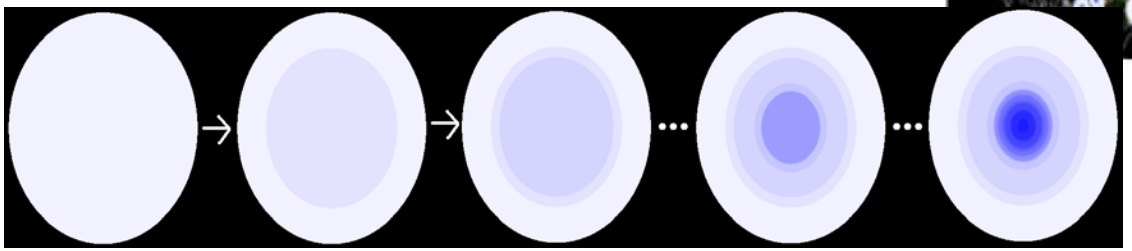


Geo-spatial Visualization

Noodles: A Tool for Visualization of Numerical Weather Model Ensemble Uncertainty, Sanyal et al. (2010)

- Visualizing an ensemble of simulations to show uncertainty using **concentric circular glyphs.**
- Glyphs are positioned over a map for spatial and context information.

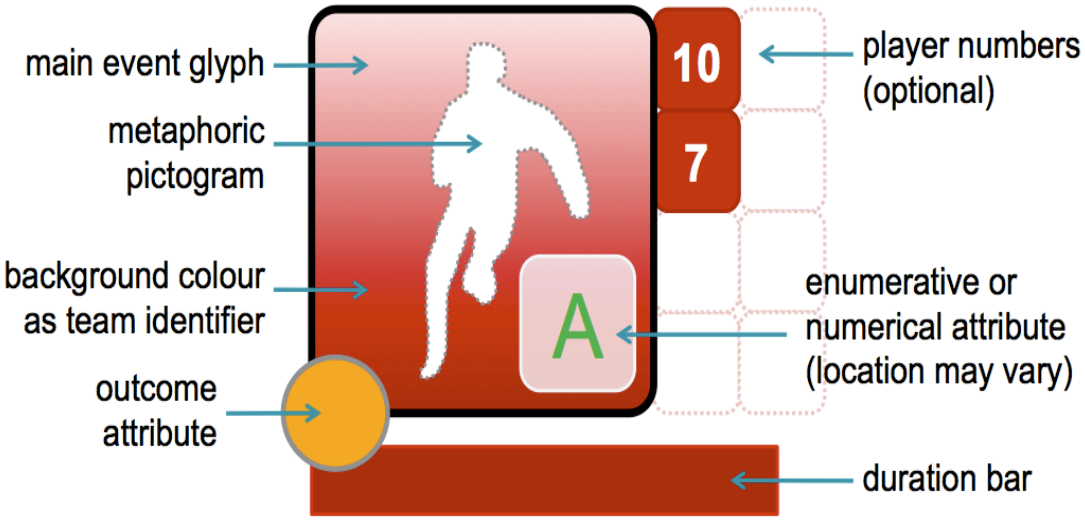




Event Visualization

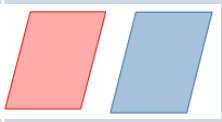
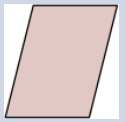
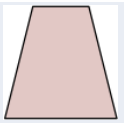
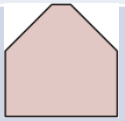
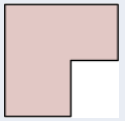
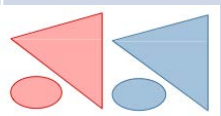
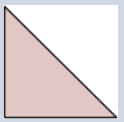
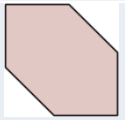
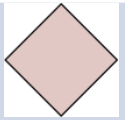
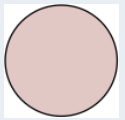
MatchPad: Interactive Glyph-Based Visualization for Real-Time Sports Performance Analysis, Legg et al. (2012)

– Notational Analysis is used to collect data on the match.
  - Events, players involved, outcomes, techniques, etc…
– A large range of categorical data values.
– Results in “information overload” – difficult to quickly review.



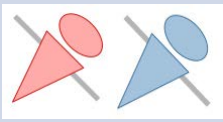
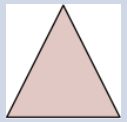
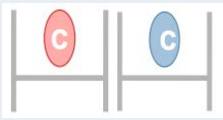
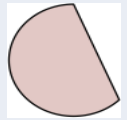
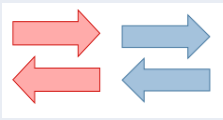
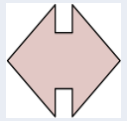
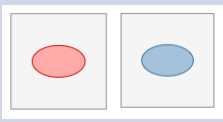
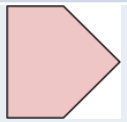
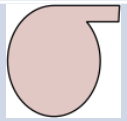
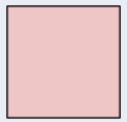
Event Visualization

MatchPad: Interactive Glyph-Based Visualization for Real-Time Sports Performance Analysis, Legg et al. (2012)

	Match	Team	Player	Outcome	Values	Metaphoric Glyph	Abstract Icon	Shape	Colour
Restart		○		Occurrence					
Drop Kick		○	○	Occurrence					
Scrum		○		Won/Lost					
Lineout		○		Won/Lost					
Ruck		○		Won/Lost					
Maul		○		Won/Lost					
Tackle		○	○	Won/Lost					
Pass		○	○	Won/Lost					

Event Visualization

MatchPad: Interactive Glyph-Based Visualization for Real-Time Sports Performance Analysis, Legg et al. (2012)

	Match	Team	Player	Outcome	Values	Metaphoric Glyph	Abstract Icon	Shape	Colour
Try	○	○	○	Occurrence					
Goal Kick	○	○	○	Score/Miss	C, P, D				
Injury	○	○	○	Occurrence					
Substitute	○	○	○	Occurrence					
Phase Ball	○	○		Occurrence	1 - 10				
Territory	○	○		Occurrence	A - D				
Referee	○			Occurrence	N, Y, R				
Ball in Play	○			Occurrence					

Event Visualization

MatchPad: Interactive Glyph-Based Visualization for Real-Time Sports Performance Analysis, Legg et al. (2012)

- Four design options to represent events:
  - Metaphoric Glyph, Abstract Icon, Shape and Colour.
- Shape and Colour fail due to the large number of events.
- The requirement for event depiction should be easy to learn, memorise and recognise.
- Abstract Icon although better, still requires some learning.
- Metaphoric Glyph is easy to recognise, especially for a domain expert, and requires no learning.

Event Visualization

MatchPad: Interactive Glyph-Based Visualization for Real-Time Sports Performance Analysis, Legg et al. (2012)

- Metaphoric Glyphs can come in different forms, ranging from abstract representation to photographic icons.
  - Abstract representation – requires learning.
  - Photographic icon – would restrict use of colour channel, distracting, and possibly confusing
- Choosing metaphoric designs that lie between these two schemes.

Summary

- We have shown how glyph-based techniques can be used effectively to enhance data visualization.
- Glyph designs vary from small to large, simple or complex to facilitate the requirement of data mapping.
- We presented examples of how glyphs are used in many multi-disciplinary applications.

Thank you for listening.