Glyph-based Visualization: Design Considerations and Challenges

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How to design a successful Glyph?

- Some visual channels are more dominant
  - position
  - length
  - slope

- Some can be compared more accurately
  - angle
  - area
  - volume
  - saturation

[Cleveland & McGill 84]

[Ware 04]
Challenges in Glyph Design

integral pairs

red-green   yellow-blue
width   height
size   orientation
color   shape
color   motion
color   location

separable pairs

[Ware 04]
## Design Considerations

[Ward 02/08, Ware 04, Ropinski et al. 08/11, Lie et al. 09, Maguire et al. 12]

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Visualization Space

2D
- Star glyphs
- Stick figures

3D
- Chernoff faces
- Profile glyphs
- [Kindlmann&Westin 06]

Surface glyphs
- [Meyer-Spradow et al. 08]
Complexity vs. Density

dense & simple  sparse & complex

Stick figures  Glyph packing  Helix glyphs  Local flow probe
[Pickett&Grinstein 88]  [Kindlmann&Westin 06]  [Tominski et al. 05]  [de Leeuw&van Wijk 93]
Complexity vs. Density

- dense & simple
- sparse & complex

- attributes mapped to angles
- texture patterns

Stick figures
[Pickett&Grinstein 88]
Complexity vs. Density

dense & simple

sparse & complex

- represent multiple flow properties
- sparsely placed

Local flow probe
[de Leeuw & van Wijk 93]
Hybrid Visualizations

Layering [Kirby et al. 99]

Arrow glyphs [Treinish 99]
Data Enhancement

- Data range $\rightarrow [0, 1]$
- Exponentiation
- Inverse mapping

[Johannes Kehrer 10
Lie et al. 09]
Gestalt principles: Simple & symmetric shapes facilitate perception of patterns [Ward 08, Peng et al. 04]

Random ordering

Complexity and symmetry-driven ordering
Perceptually Uniform Channels

- **Colors**
  - Rainbow colormap
  - Black-body radiation
  - Green-red isoluminant

- **Symbol size**

  ![Symbol size example]

  power law transformation [Li et al. 10]

[Borland&Taylor II 07]
**Glyph Shapes** [Ropinski et al. 11]

- **Basic glyph shapes**
  - box, spere, torus, ellipsoid, etc.
  - pre-attentive processing

- **Composite shapes**
  - combine basic shapes

Customized glyphs [Kraus&Ertl 01]
**Orthogonality & Normalization**

- Perceive each visual channel independently

- Account for distortions (e.g., shape→size)

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[Lie et al. 09]
Ellipsoid glyphs
8 tensors
different viewpoint

Superquadric glyphs
8 tensors
different viewpoint

View-point Independence

Johannes Kehrer

[Kindlmann 04]
Intuitive Mapping based on Semantics

- **Diverging data**
  - 100°C
  - 0°C
  - -100°C
  - bad
  - neutral
  - good

- **Sequential data**
  - high
  - low

- **Direction**
  
  Arrow glyphs [Crawfis&Max 93]

[Brewer 99, Stolte et al. 02]
Importance-based Mapping

- Emphasize important variables
- Guide the user’s focus of attention (e.g., color, size)

PET activity $\rightarrow$ thickness

[Ropinski et al. 08]
Enhance Depth Perception

- Halos/contours
  [Lie et al. 09]

- Chroma depth
  [Toutin 97]
Summary

- Just combining visual channels is not enough
- Design considerations (e.g., orthogonality, perceptually uniform channels, semantics)
- Glyph design restricted by perceptual limits