Basic Vector Techniques

Lecture 10

Vectors

- Vectors, like scalars have magnitude.
- We can represent magnitude as colour for example.
- Vectors also have direction.
- How can we represent this ?

Vector Sources

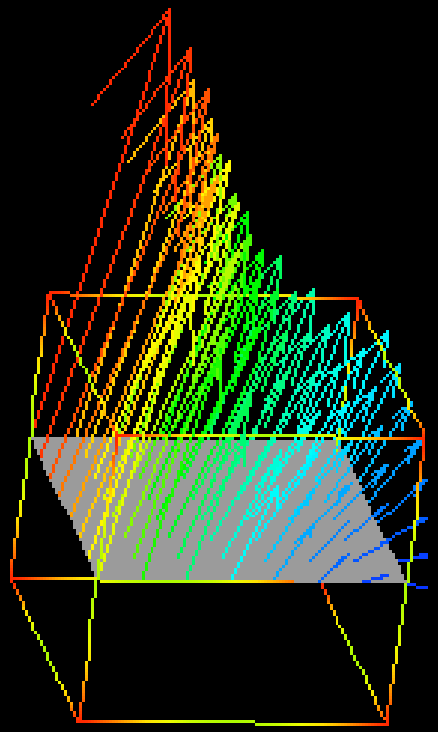
- Vectors come from a variety of data sources.
- Sources include raw vector information such as velocity and calculated values like curl and gradient.
- The type of data source may affect the visualization technique.
- In some cases a vector may be reduced to an angle which permits simpler visualization.

Basic Vector Techniques

- Hedgehog
- Streamlines
- Ribbons
- Particle Advection
- Surface Stretching

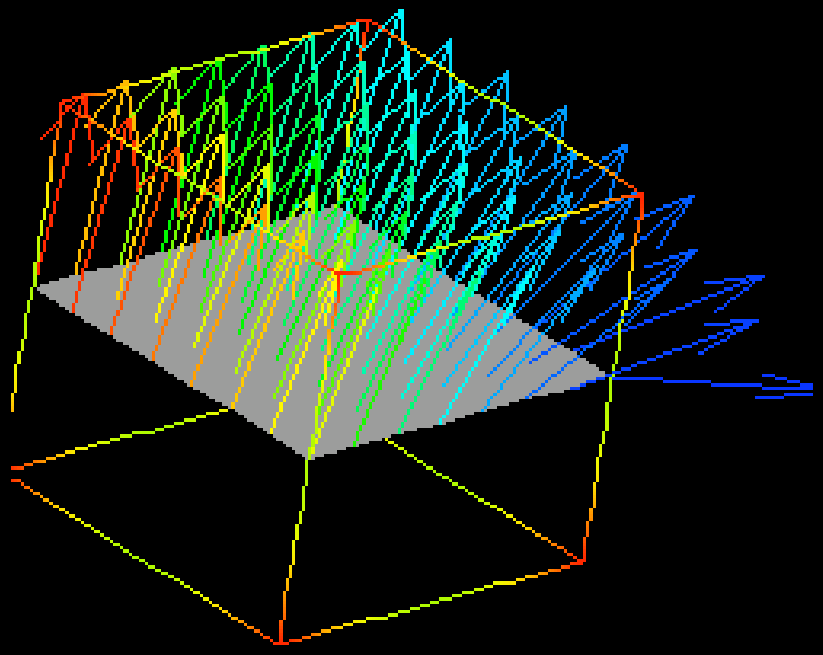
Hedgehog

- Use of directed lines (eg arrows) at sampled locations to display vector information.
- Due to visual complexity only part (eg slice) of data is shown.
- Vector length and colour indicate magnitude.



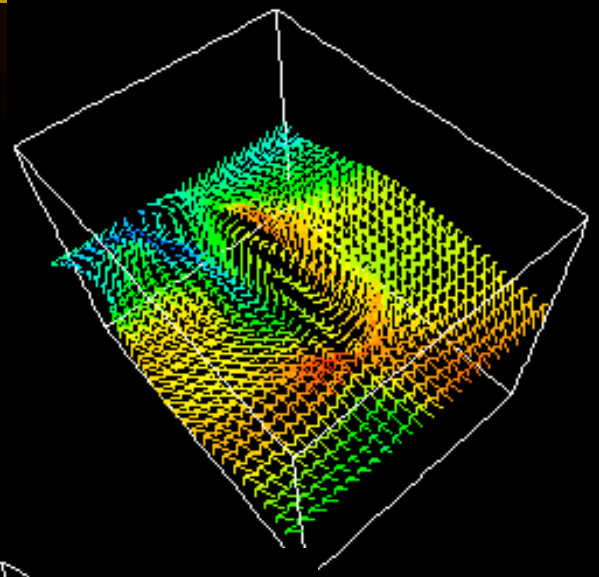
Unit Hedgehog

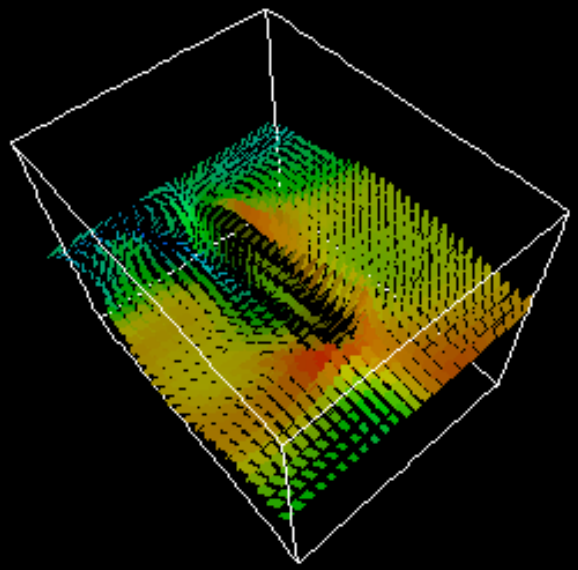
- All vectors have their lengths normalized .
- Colour still indicates magnitude.
- Data density may be increased.
- No loss of information,
- However loss of natural visual metaphor.



Hedgehog Glyphs

- Different glyphs and lighting give a different feel to the data.
- Viewing direction important
- Overlapping solid arrows may enhance or clutter interpretation.

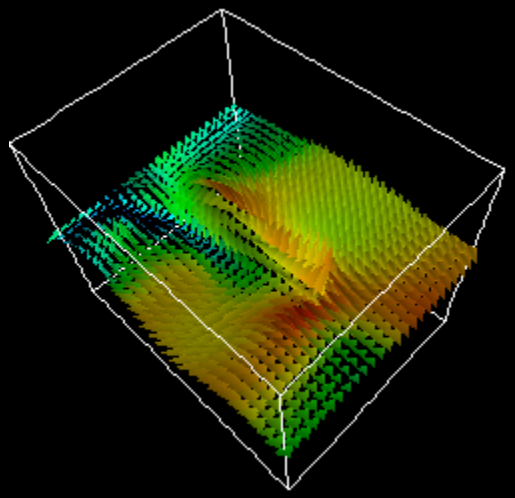




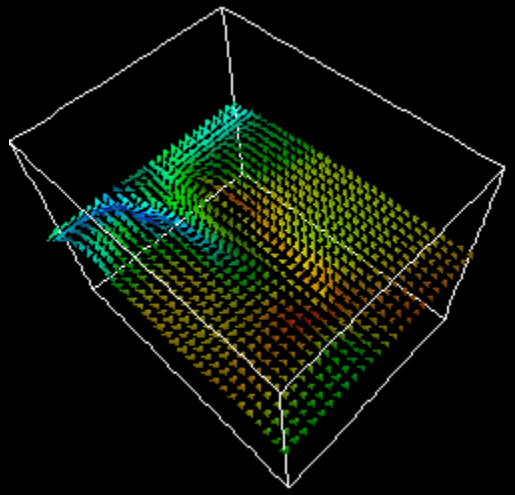
Glyph Variations

- Solid triangles

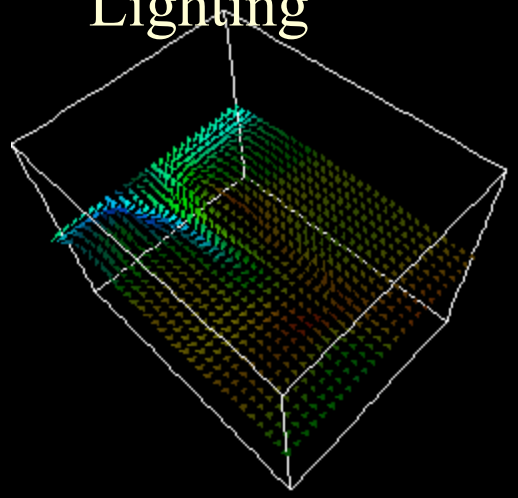
Size scaled to magnitude



Normalized

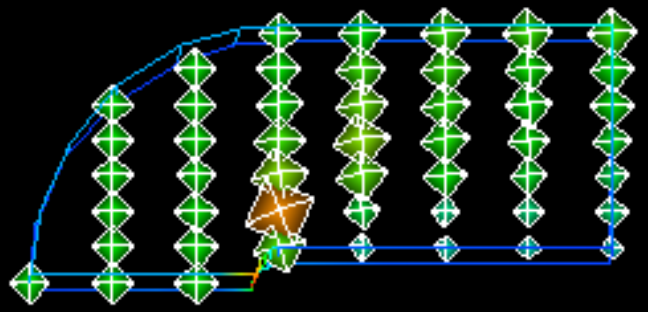


Normalized, Directional Lighting



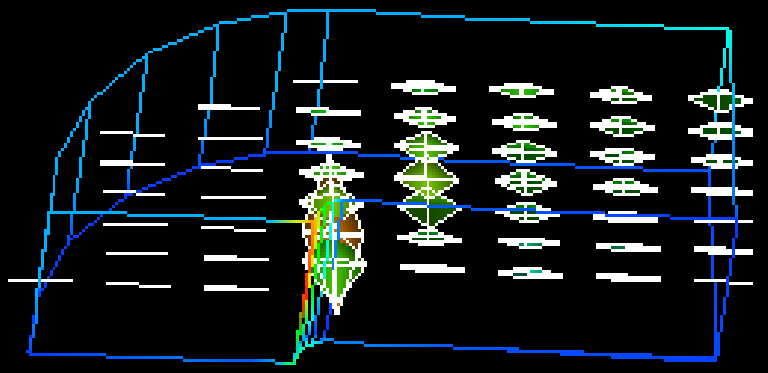
Glyph Variations…

- If vector orientation is limited (as with some angular data) then less directional glyphs may be used.
- Glyphs are scaled and coloured based on magnitude.
- Orientation is clearly discernible



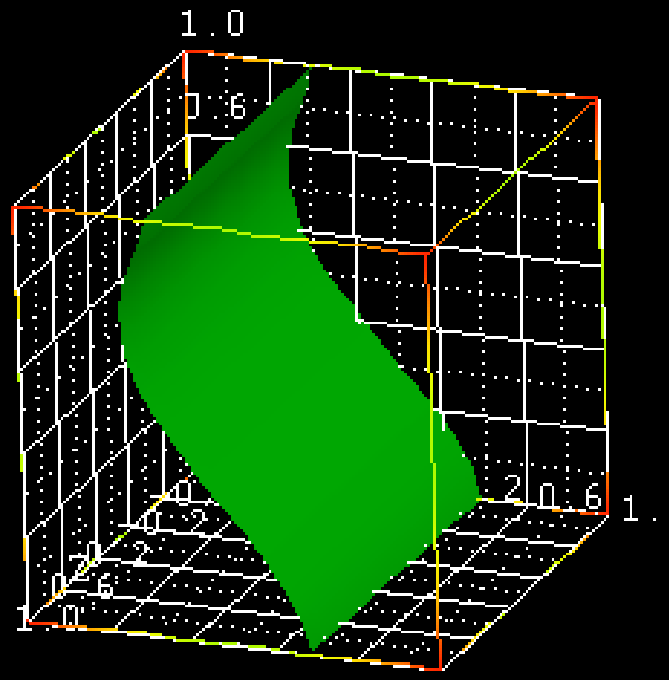
Glyph Variations…

- Each axis of a solid glyph is scaled based on vector component.
- Generally works best with low sampling density.
- Can be problematic if components have greatly different/ varying magnitudes



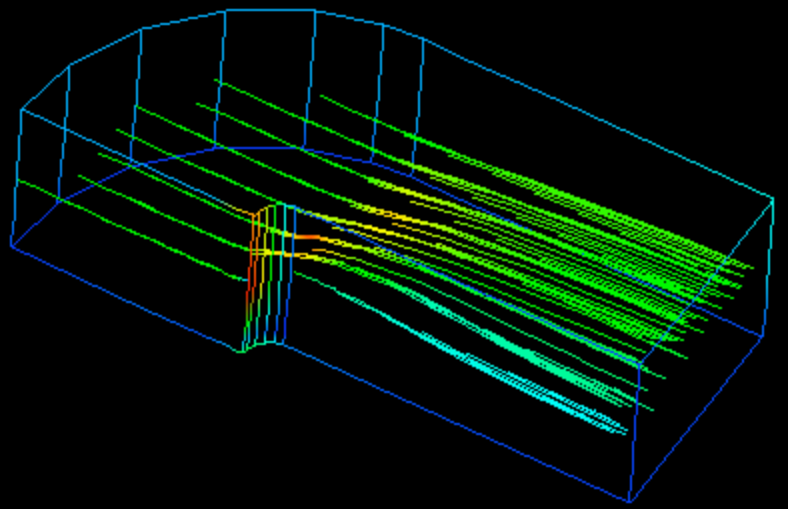
Divergence

- Although not strictly a vector technique, using an iso-surface to display vector divergence is a useful technique.



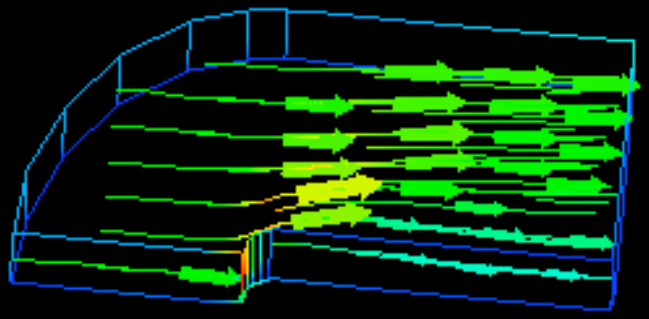
Streamlines

- Sample points may be selected and the vectors “followed” to create stream lines.
- Calculation based on massless particles in flow.
- These flow/flux lines are a powerful static visualisation technique.



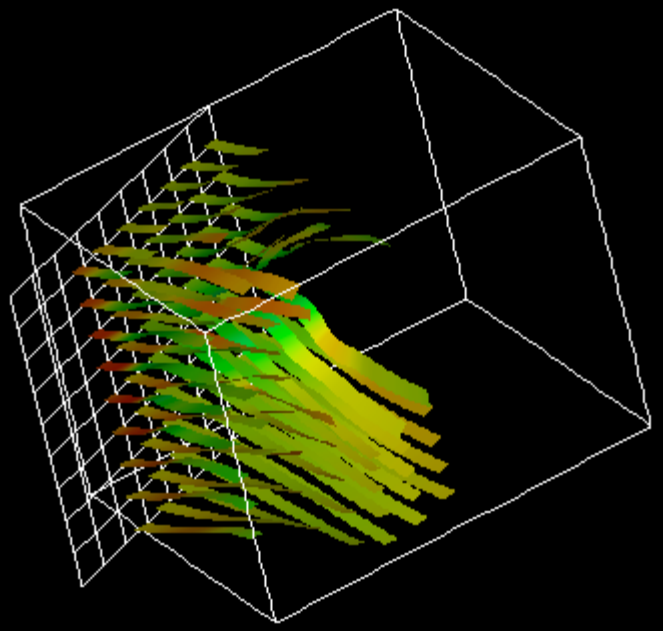
Streamlines…

- Individual points in a streamline may be highlighted with arrows.
- Streamlines indicate overall trends.
- Arrows indicate magnitude and direction of field at sample point.
- Especially useful in animation.



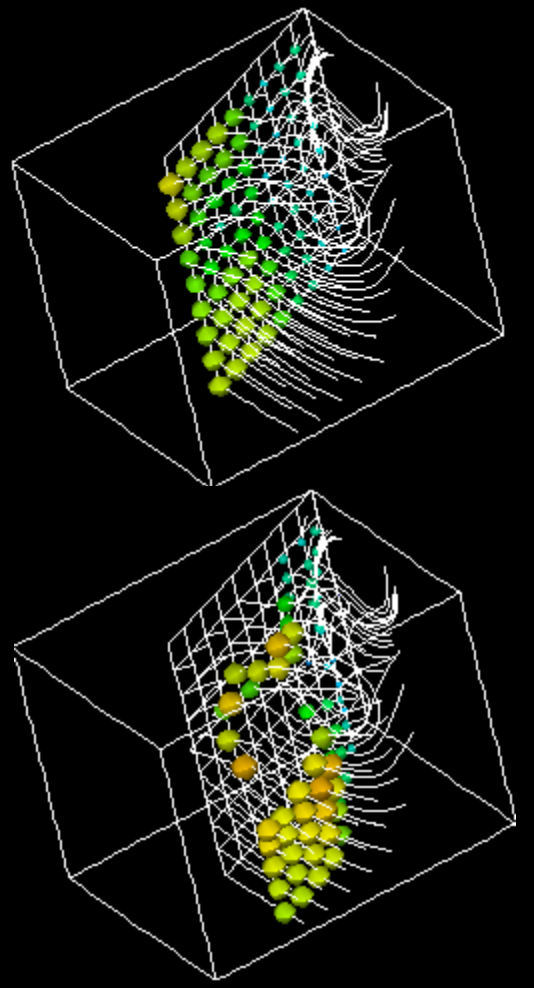
Ribbons

- Streamline ribbons generated from sample points (grid lines) take streamlines one step further.
- Ribbons can twist depending on gradient, curl or vorticity of vector stream at each point.



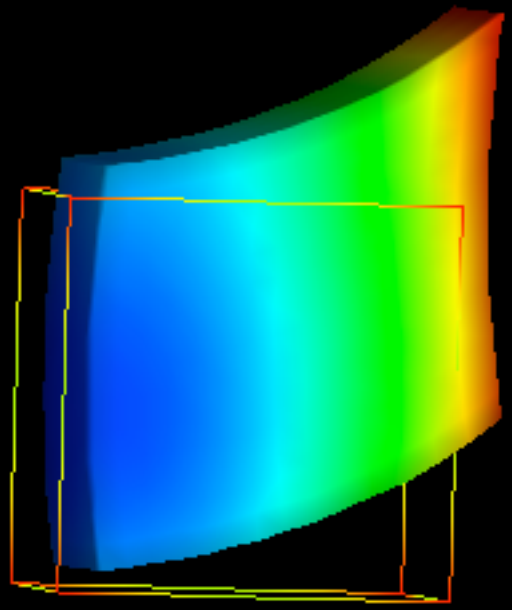
Particle Advection

- Another streamline variation.
- Streamlines are calculated (based on massless particles in flow)
- Time series animation shows particles following streamlines.



Surface Stretching

- Original (cube) surface has been displaced by vector information at each point.



Combining Techniques

- Convey different information with each technique
- Vectors in fixed colour to avoid visual overload