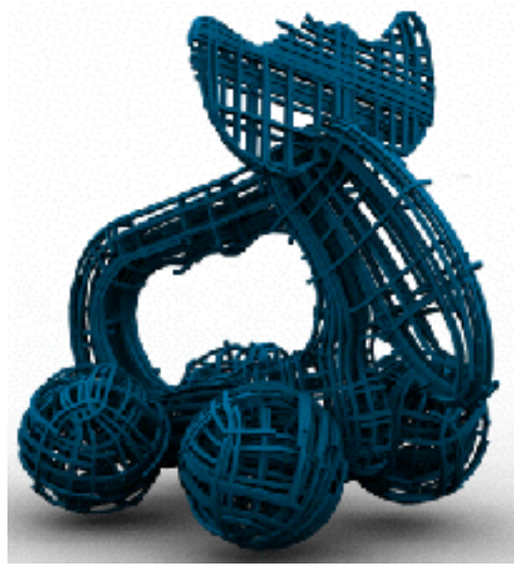

VISUALIZATION

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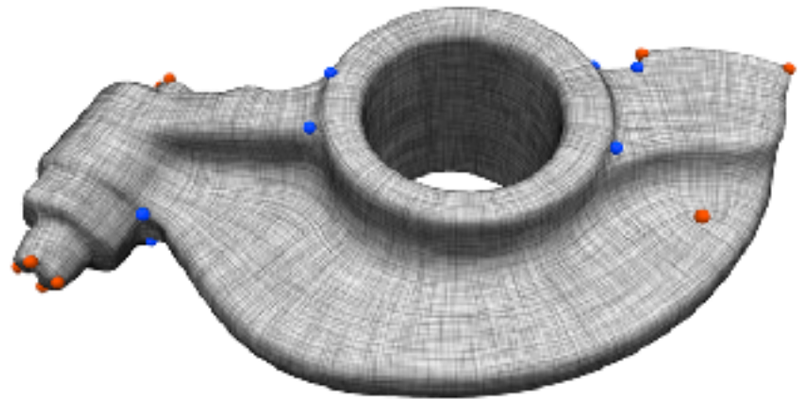
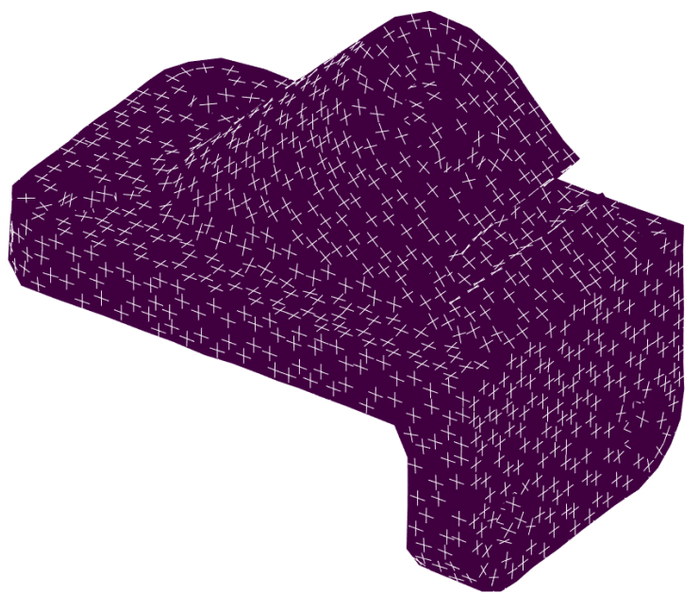
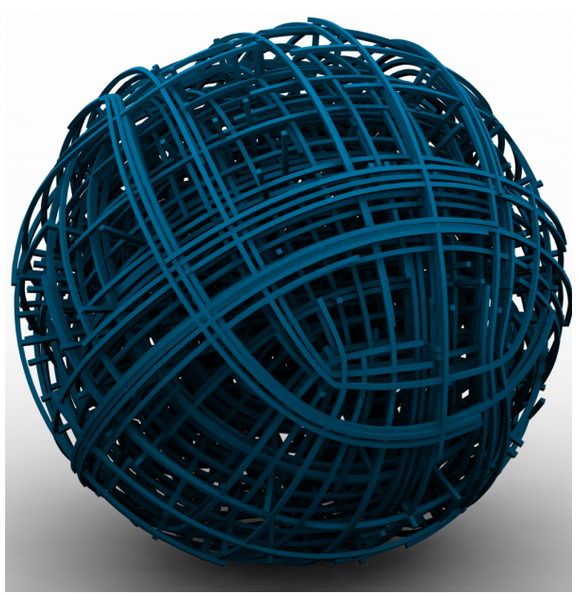
CHALLENGES

- Visualize directional fields in the most effective way.
- Important visual features:
  - Flow lines
  - Singularities
  - Avoid clutter/noise
- Optional: distinguish magnitude

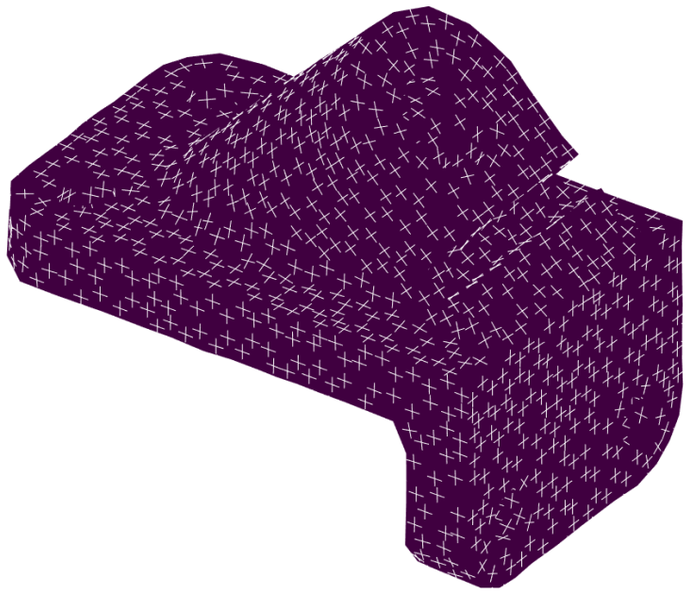


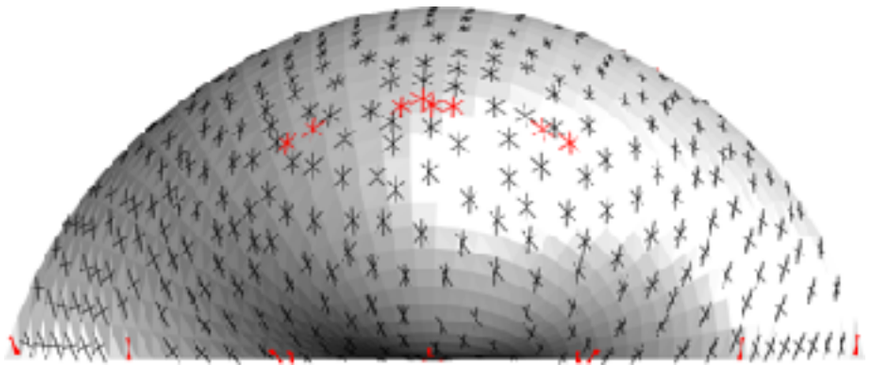




GLYPH RENDERING

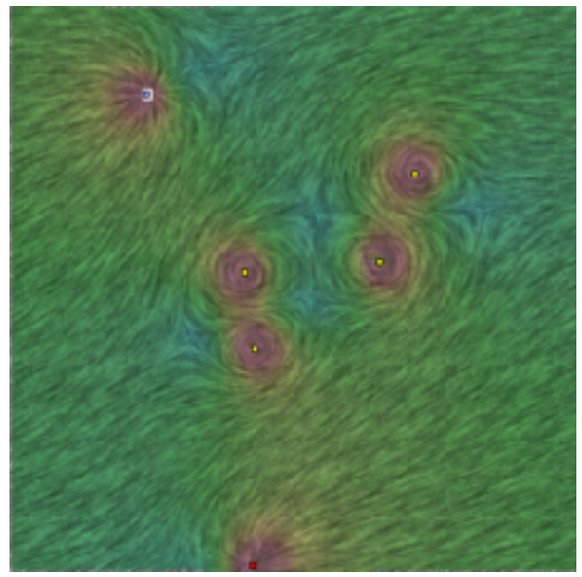
- “Arrows on tangent spaces”
  - Possibly: subset with importance sampling.
- Cluttered and unrevealing.
- Straightforward for non-symmetric configurations.





LINE-INTEGRAL CONVOLUTION – VECTOR FIELDS

- "Throwing paint in the river".
- Generate random image.
  - Typically white noise.
- Advect image with vector field.
  - Integrating value along the flow.
- Optional: map magnitude into color-coding.

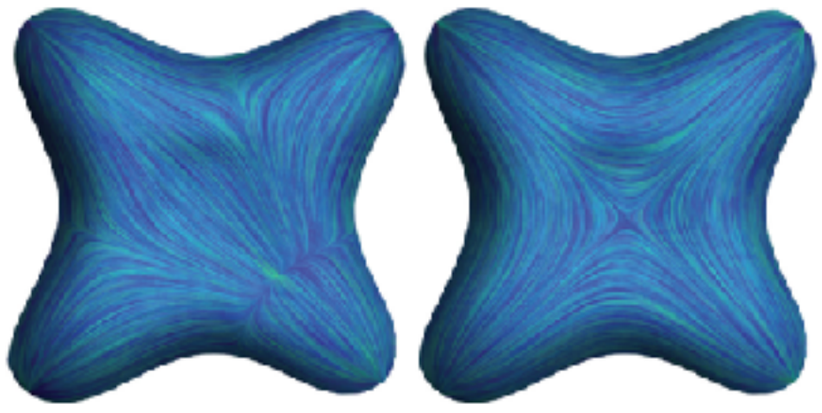


$$D(r) = \int_{-L/2}^{L/2} k(s) N(\sigma_r(s)) ds$$

Noise image

Convolution Kernel

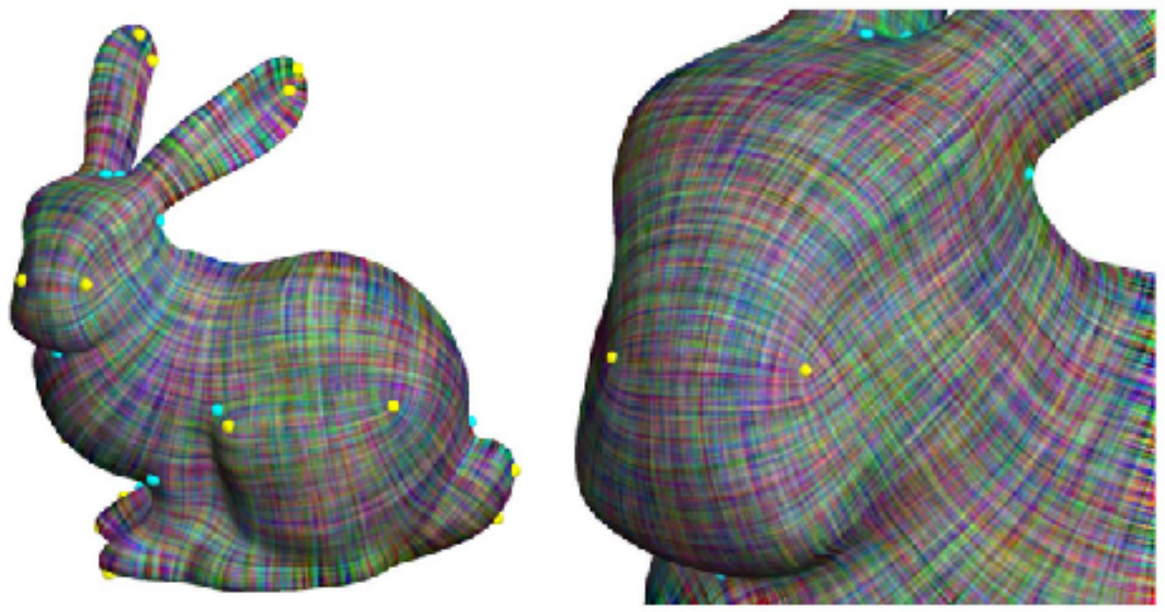
Flowline



[Azencot *et al.* 2015]

LIC – TENSOR & N-ROSY FIELDS

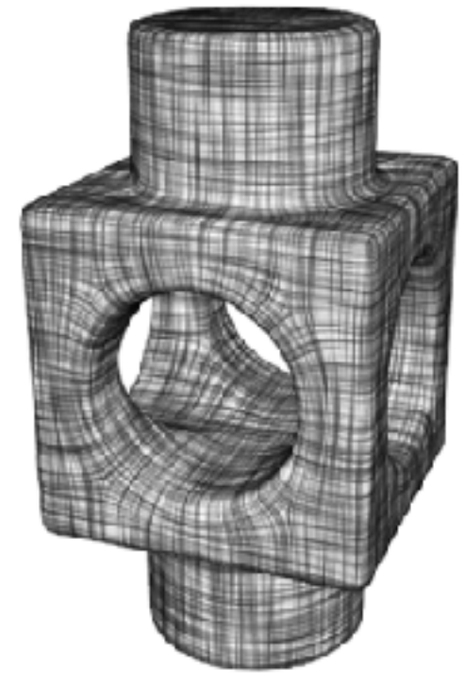
- Blending several single-vector LIC images.
- Optimizing for local contrast to avoid blur.



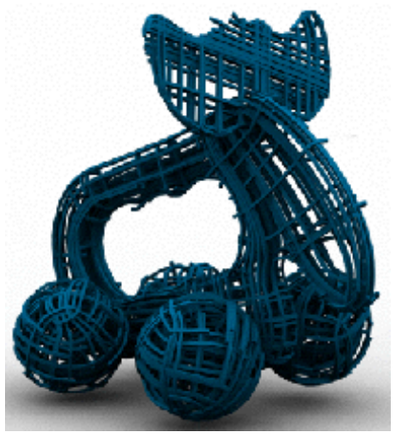
[Palacios and Zhang 2011]

STREAMLINE TRACING

- Tracing and integrating flow lines.
- Criteria:
  - Uniform
  - Not too dense/sparse
- Alternatives
  - Replace streamline by meshed brush strokes.



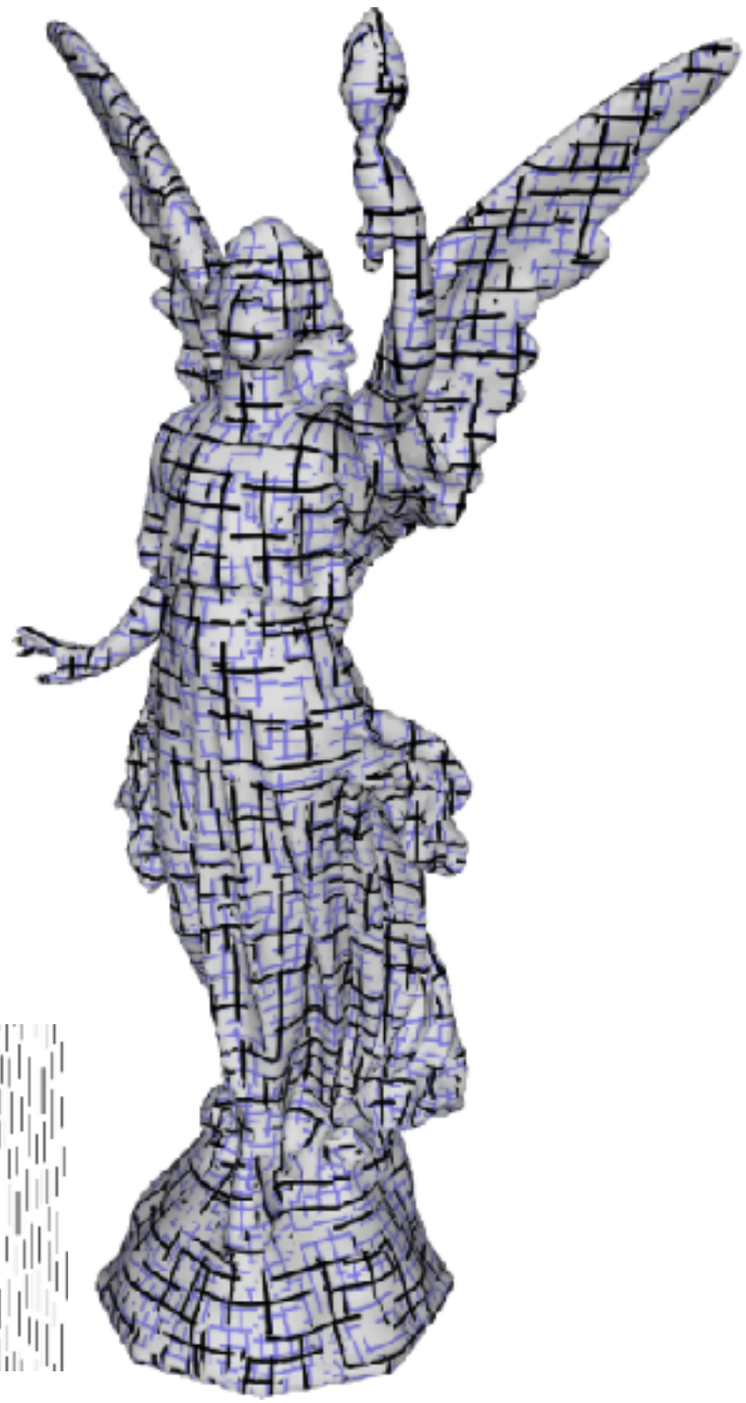
2D [Crane *et al.* 2010]

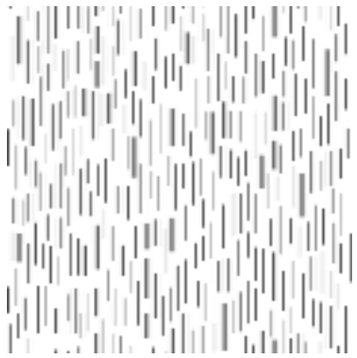


3D [Solomon *et al.* 2017]

TEXTURE-BASED RENDERING

- Specific for 2^2 -vector fields ("frame fields").
  - Can visualize anisotropy and scale.
- Two stochastic textures, UV-mapped to the surface.
  - Thick black & fine blue.
  - Grad(UV) $\sim=$ frame field.
- Seams are hidden by randomness and pattern combination.

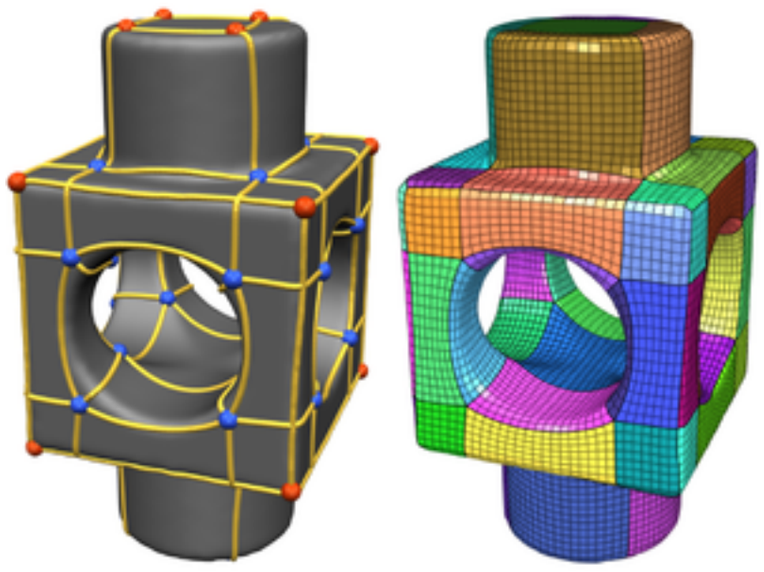




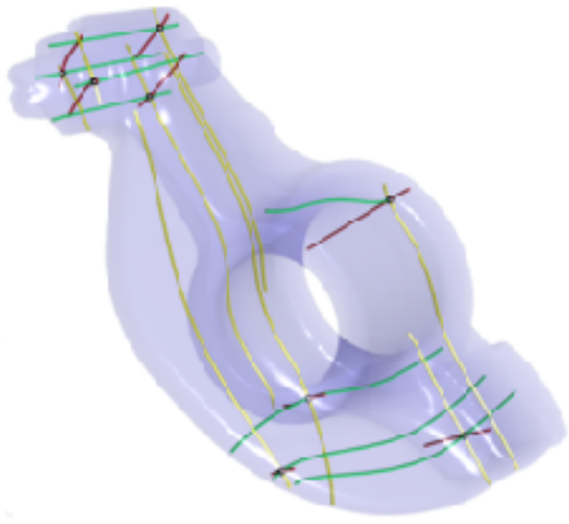
[Panozzo *et al.* 2014]

SINGULARITY GRAPHS

- The topological skeleton of the field.
- Good for very smooth fields.
  - Or mesh layouts.
- Readily extends to 3D.



2D [Campen *et al.* 2014]



3D [Huang *et al.* 2011]