Chapter 8: Arrange Spatial Data
Paper: Flow Radar Glyphs

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http://www.cs.ubc.ca/~tmm/courses/547-14#chap8
Arrange spatial data

Use Given

Geometry
  - Geographic
  - Other Derived

Spatial Fields
  - Scalar Fields (one value per cell)
    - Isocontours
    - Direct Volume Rendering
  - Vector and Tensor Fields (many values per cell)
    - Flow Glyphs (local)
    - Geometric (sparse seeds)
    - Textures (dense seeds)
    - Features (globally derived)
Idiom: choropleth map

- **use** given spatial data
  - when central task is understanding spatial relationships

- **data**
  - geographic geometry
  - table with 1 quant attribute per region

- **encoding**
  - use given geometry for area mark boundaries
  - sequential segmented colormap

http://bl.ocks.org/mbostock/4060606
Idiom: **topographic map**

- **data**
  - geographic geometry
  - scalar spatial field
    - 1 quant attribute per grid cell

- **derived data**
  - isoline geometry
    - isocontours computed for specific levels of scalar values

*Land Information New Zealand Data Service*
Idiom: isosurfaces

• data
  – scalar spatial field
    • 1 quant attribute per grid cell

• derived data
  – isosurface geometry
    • isocontours computed for specific levels of scalar values

• task
  – spatial relationships

Idioms: **DVR, multidimensional transfer functions**

- **direct volume rendering**
  - **transfer function** maps scalar values to color, opacity
    - no derived geometry

- **multidimensional transfer functions**
  - derived data in joint 2D histogram
    - horiz axis: data values of scalar func
    - vert axis: gradient magnitude (direction of fastest change)
    - [more on cutting planes and histograms later]

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Vector and tensor fields

• data
  – many attribs per cell

• idiom families
  – flow glyphs
    • purely local
  – geometric flow
    • derived data from tracing particle trajectories
    • sparse set of seed points
  – texture flow
    • derived data, dense seeds
  – feature flow
    • global computation to detect features
      – encoded with one of methods above
Vector fields

• empirical study tasks
  – finding critical points, identifying their types
  – identifying what type of critical point is at a specific location
  – predicting where a particle starting at a specified point will end up (advection)


Idiom: similarity-clustered streamlines

• data
  – 3D vector field

• derived data (from field)
  – streamlines: trajectory particle will follow

• derived data (per streamline)
  – curvature, torsion, tortuosity
  – signature: complex weighted combination
  – compute cluster hierarchy across all signatures
  – encode: color and opacity by cluster

• tasks
  – find features, query shape

• scalability
  – millions of samples, hundreds of streamlines

Further reading

  – Chap 8: Arrange Spatial Data

• How Maps Work: Representation, Visualization, and Design. MacEachren.

• Overview of visualization. Schroeder and. Martin. In The Visualization Handbook,


• Overview of flow visualization. Weiskopf and Erlebacher. In The Visualization
Flow Radar Glyphs

• glyphs: complex combination of marks
  – more in Chapter 12!

• unsteady flow: changes over time
  – degenerate case: arrow glyph

• variations
  – magnitude scaled vs normalized
  – time ranges: normal, subset, inverted
  – uncertainty: filled, range min/max

• explicit guidance on when to use which variants!

Multiple scales

• all/overview
  – partitioned into regions w/ visual fusion

• some
  – compare neighboring regions

• one
  – finegrained structure inspection

• macro/micro readings common for glyphs
Comparison to previous work

• arrow glyphs
  – much more scalable
• path/streak lines
  – no clutter, avoids need for animation
Implementation & Validation

• GPU parallelism
  – both geometry and image-space (pixel-based) approaches

• validation
  – qualitative result image analysis
    • 3 application domains: CFD simulations
      – 2D air in closed room
      – 2D groundwater
      – 3D flow (cuboid)
    – expert feedback
Results

• qualitative result image analysis
• expert feedback
• 3 application domains
  – air in closed room
  – groundwater
  – 3D flow (cuboid)
2D air flow

- changing parameters
Results

- groundwater/wells simulation

- 3D flow