Data Visualization (CSCI 627/490)

Review

Dr. David Koop





Streamlines & Variants

- Steady vs. Unsteady The aracteristic Lines
 - In unsteady flows, the vector field changes over time
- Variants: Pathlines and Streaklines



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Streamlines & Variants

- Steady vs. Unsteady The aracteristic Lines
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Streamline Variants



Stream Tubes [Weiskopf/Machiraju/Möller]



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Stream Ribbons [Weiskopf/Machiraju/Möller]





3

Line Integral Convolution

- Goal: provide a global view of a steady vector field while avoiding issues with clutter, seeds, etc.
- Remember convolution?
- Start with random noise texture
- Smear according to the vector field $\int T(\mathbf{x}(t+s))k(s) ds$
- Need structured data



[Weiskopf/Machiraju/Möller]

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Line Integral Convolution









Topology: Find Critical Points











Topology: Find Critical Points











Scalar Field Topology



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Reeb Graph/Contour Tree/Merge Tree









Vector Field Topology

field, try to identify structure (topology) of the field



Figure 7.1

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Instead of "guessing" correct seed points for streamlines to understand the

A phase portrait.









Text Visualization: Tag Cloud

- Derived data: number of occurrences of words
- Channel: Font size



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Potential problem: Amount of ink may not be proportional to occurrences...











Word Tree



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Poetry Analysis

Fed Drapes	
Clark Coolidge	Rhy
	Idam
FELL FAR BUT THE BARN (came) up & smacked me Who're you, bleeding? Fled.	Iden
Blat in back of a Vistrola Car	Perf
is so red is such that sun	Som
tell in the rushes & pen bear appear	bem
the white wrong numeral on the wall	Sylla
can't take if off with the clock down with the clock it	Cons
way	
on the board - couch with brass, kindergarten clench joints	Vow
it hemmed & snowed	Para
the wrong way	Eve
remnant face	
the pucker	Allit
	Asso

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Comparing Corpora: Parallel Tag Clouds



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DC

NIU





Project

- Presentations on **Thursday**:

 - 5 minutes per presenter/group
 - Showcase the visualization (not slides)
 - Brief introduction to your data and questions
 - Discuss **design** decisions
 - **Demonstrate** the interactive features of your project
- For groups, one person should drive but both can help present
- Have until Dec. 6 to turn in final code and report Note two assignments on Blackboard (one for presentation, one for report)

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- Turn in code for the visualization to Blackboard by Dec. 2 at 11:59pm





Final Exam

- December 10, 2020, 10-11:50am

- Covers all topics but emphasizes second half of the course • Similar format as Midterm (multiple choice, free response) 627 Students will have a extra questions related to the research papers
- Questions?





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"Computer-based visualization systems provide visual representations of datasets designed to help people carry out tasks more effectively."

— T. Munzner







Dataset Types

→ Tables







 \rightarrow Multidimensional Table







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→ Geometry (Spatial)



+ Sets + Text









Tasks





How do we do visualization?



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How?







Visual Encoding







Visual Encoding

- How do we encode data visually?
 - Marks are the basic graphical elements in a visualization
 - Channels are ways to control the appearance of the marks
- Marks classified by dimensionality: → Points \rightarrow Lines

- Also can have surfaces, volumes

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• Think of marks as a mathematical definition, or if familiar with tools like Adobe







Channels by Effectiveness

Channels: Expressiveness Types and Effectiveness Ranks

•	Magnitude Channels: Ordered Attributes												
	Position on common scale												
	Position on unaligned scale												
	Length (1D size)												
	Tilt/angle	//											
	Area (2D size)												
	Depth (3D position)	$\longmapsto \bullet \longmapsto \bullet$											
	Color luminance												
	Color saturation												
	Curvature)))											
	Volume (3D size)	• • •											

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Effectiveness

Least

Same

Same

Identity Channels: Categorical Attributes











Design

Domain situation You misunderstood their needs

Data/task abstraction You're showing them the wrong thing



Wisual encoding/interaction idiom The way you show it doesn't work

Algorithm Your code is too slow

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Design Guidelines

- Tufte:
 - Show data variation, not design variation
 - Clear, detailed, and thorough labeling and appropriate scales
 - quantities ("lie factor")



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- Size of the graphic effect should be directly proportional to the numerical









Design Analysis: What is Wrong Here?



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3D Category Scatter

1)3

- http://d3js.org/
- Supports data as a core piece of Web elements
 - Correspondence between data and DOM elements
 - Dealing with changing data (joins, enter/update/exit)
 - Data drives the marks and channels
- Selections (similar to CSS) that allow greater manipulation
- Integrated layout algorithms, axes calculations, etc.
- Focus on interaction support
 - Straightforward support for transitions
 - Event handling support for user-initiated changes

Arrange Tables **Express Values** Separate, Order, Align Regions → Separate → Align → Order → 1 Key List (\rightarrow) **Axis Orientation** → Rectilinear → Parallel → Radial $\uparrow \uparrow \uparrow$

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Categorical Map

Map with Two Variables

Rectangular Cartogram

Arrange Networks and Trees

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Tree Visualizations

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Ireemaps

- Containment marks instead of connection marks
- Encodes some attribute of the items as the **size** of the rectangles
- Not as easy to see the intermediate rectangles
- Scalability: millions of leaf nodes and links possible
- Need a layout algorithm!
 - Slice-and-Dice vs. Squarify
- Viewing Hierarchy: Cushion Treemap

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Set Visualizations

• How to show the intersection of sets?

Human Color Perception

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[via M. Meyer]

Avoid Rainbow Colormaps!

(a) (b)

Colormaps

Interaction Overview

→ Attribute Reduction

→ Slice

→ Cut

→ Project

[Munzner (ill. Maguire), 2014]

Staged Animated Transitions

Staged Animated Transitions

Multiple Views

- Juxtapose and Coordinate Multiple Side-by-Side Views \bigcirc
 - → Share Encoding: Same/Different
 - → Linked Highlighting

→ Share Data: All/Subset/None

→ Share Navigation

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Partition into Side-by-Side Views (\rightarrow)

→ Superimpose Layers

Filtering and Aggregation

→ Filter

→ Attributes

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Focus+Content

→ Elide Data

→ Superimpose Layer

→ Distort Geometry

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[Munzner (ill. Maguire), 2014]

Fields in Visualization

Each point in space has an associated...

Vector Fields

Fields in Visualization

Scalar Fields (Order-0 Tensor Fields)

Each point in space has an associated...

 s_0

Scalar

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Vector Fields (Order-1 Tensor Fields)

 $\begin{bmatrix} v_0 \\ v_1 \\ v_2 \end{bmatrix}$ Vector

Isosurfacing

Volume Rendering

Vector Fießgreaklines in real life

NASA

http://www.dfrc.nasa.gov/gallery/photo/index.html NASA Photo: ECN-33298-03 Date: 1985

1/48-scale model of an F-18 aircraft in Flow Visualization Facility (FVF)

Streaklines [NASA]

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Mapping Methods Based on affere Tracing

Stream Tubes [Weiskopf/Machiraju/Möller]

The purpose of computing is about insight, not numbers

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– R. W. Hamming

The purpose of visualization is about **insight**, not pictures – Card, Mackinlay, Schneiderman

Projects Thursday

