Ch 13/14/15: Reduce, Embed, Case Studies
Paper: TopoFisheye
Example Present: Biomechanical Motion

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CPSC 547, Information Visualization
Week 8: 31 Oct 2017

http://www.cs.ubc.ca/~tmm/courses/547-17F
News

• presentation days assigned
  – next week papers

• today
  – catchup on Facet material
  – final three chapters
  – topo fisheye views paper
  – example presentation
  – (break in the middle somewhere)
Ch 13: Reduce
Reduce items and attributes

• reduce/increase: inverses
• filter
  – pro: straightforward and intuitive
    • to understand and compute
  – con: out of sight, out of mind
• aggregation
  – pro: inform about whole set
  – con: difficult to avoid losing signal
• not mutually exclusive
  – combine filter, aggregate
  – combine reduce, change, facet

Reducing Items and Attributes

Reduce
  ➔ Filter
    ➔ Items
      ➔ Attributes

Reduce
  ➔ Aggregate
    ➔ Items
      ➔ Attributes

Reduce
  ➔ Embed
Idiom: **cross filtering**

- item filtering
- coordinated views/controls combined
  - all scented histogram bisliders update when any ranges change

[http://square.github.io/crossfilter/]
Idiom: cross filtering

[https://www.nytimes.com/interactive/2014/upshot/buy-rent-calculator.html?_r=0]
Idiom: histogram

• static item aggregation
• task: find distribution
• data: table
• derived data
  – new table: keys are bins, values are counts
• bin size crucial
  – pattern can change dramatically depending on discretization
  – opportunity for interaction: control bin size on the fly
Idiom: **scented widgets**

- augmented widgets show information scent
  - cues to show whether value in drilling down further vs looking elsewhere
- concise use of space: histogram on slider


Scented histogram bisliders: detailed

Idiom: **Continuous scatterplot**

- static item aggregation
- data: table
- derived data: table
  - key attribs x,y for pixels
  - quant attrib: overplot density
- dense space-filling 2D matrix
- color: sequential categorical hue + ordered luminance colormap

Spatial aggregation

• MAUP: Modifiable Areal Unit Problem
  – gerrymandering (manipulating voting district boundaries) is only one example!
  – zone effects

[http://www.e-education.psu.edu/geog486/l4_p7.html, Fig 4.cg.6]

– scale effects

Idiom: **boxplot**

- static item aggregation
- task: find distribution
- data: table
- derived data
  - 5 quant attribs
    - median: central line
    - lower and upper quartile: boxes
    - lower upper fences: whiskers
      - values beyond which items are outliers
  - outliers beyond fence cutoffs explicitly shown

[40 years of boxplots. Wickham and Stryjewski. 2012. had.co.nz]
Idiom: **Hierarchical parallel coordinates**

- dynamic item aggregation
- derived data: *hierarchical clustering*
- encoding:
  - cluster band with variable transparency, line at mean, width by min/max values
  - color by proximity in hierarchy

Idiom: aggregation via hierarchical clustering (visible)

System: Hierarchical Clustering Explorer

[http://www.cs.umd.edu/hcil/hce/]
Dimensionality reduction

• attribute aggregation
  – derive low-dimensional target space from high-dimensional measured space
    • capture most of variance with minimal error
  – use when you can’t directly measure what you care about
    • true dimensionality of dataset conjectured to be smaller than dimensionality of measurements
    • latent factors, hidden variables

Tumor Measurement Data

data: 9D measured space

→ DR →

Malignant

Benign

derived data: 2D target space
Dimensionality vs attribute reduction

• vocab use in field not consistent
  – dimension/attribute

• attribute reduction: reduce set with filtering
  – includes orthographic projection

• dimensionality reduction: create smaller set of new dims/attrs
  – typically implies dimensional aggregation, not just filtering
  – vocab: projection/mapping
Dimensionality reduction & visualization

• why do people do DR?
  – improve performance of downstream algorithm
    • avoid curse of dimensionality
  – data analysis
    • if look at the output: visual data analysis

• abstract tasks when visualizing DR data
  – dimension-oriented tasks
    • naming synthesized dims, mapping synthesized dims to original dims
  – cluster-oriented tasks
    • verifying clusters, naming clusters, matching clusters and classes

Dimension-oriented tasks

- naming synthesized dims: inspect data represented by lowD points

Cluster-oriented tasks

- verifying, naming, matching to classes

Task 1

**In:** HD data

**Out:** 2D data

**What?**
- In High-dimensional data
- Out 2D data

**Why?**
- Produce
- Derive

Task 2

**In:** 2D data

**Out:** Scatterplot Clusters & points

**What?**
- In 2D data
- Out Scatterplot
- Out Clusters & points

**Why?**
- Discover
- Explore
- Identify

**How?**
- Encode
- Navigate
- Select

Task 3

**In:** Scatterplot Clusters & points

**Out:** Labels for clusters

**What?**
- In Scatterplot
- In Clusters & points
- Out Labels for clusters

**Why?**
- Produce
- Annotate
Interacting with dimensionally reduced data

[https://uclab.fh-potsdam.de/projects/probing-projections/]

Linear dimensionality reduction

• principal components analysis (PCA)
  – finding axes: first with most variance, second with next most, …
  – describe location of each point as linear combination of weights for each axis
  • mapping synthesized dims to original dims

Nonlinear dimensionality reduction

• pro: can handle curved rather than linear structure
• cons: lose all ties to original dims/attrs
  – new dimensions often cannot be easily related to originals
    – mapping synthesized dims to original dims task is difficult
• many techniques proposed
  – many literatures: visualization, machine learning, optimization, psychology, ...
  – techniques: t-SNE, MDS (multidimensional scaling), charting, isomap, LLE, ...
    – t-SNE: excellent for clusters
      – but some trickiness remains: http://distill.pub/2016/misread-tsne/
    – MDS: confusingly, entire family of techniques, both linear and nonlinear
      – minimize stress or strain metrics
      – early formulations equivalent to PCA
VDA with DR example: nonlinear vs linear

• DR for computer graphics reflectance model
  – goal: simulate how light bounces off materials to make realistic pictures
    • computer graphics: BRDF (reflectance)
  – idea: measure what light does with real materials

[Fig 2. Matusik, Pfister, Brand, and McMillan. A Data-Driven Reflectance Model. SIGGRAPH 2003]
Capturing & using material reflectance

• reflectance measurement: interaction of light with real materials (spheres)
• result: 104 high-res images of material
  – each image 4M pixels
• goal: image synthesis
  – simulate completely new materials
• need for more concise model
  – 104 materials \times 4M \text{ pixels} = 400M \text{ dims}
  – want concise model with meaningful knobs
    • how shiny/greasy/metallic
    • DR to the rescue!

[Fig 5/6. Matusik et al. A Data-Driven Reflectance Model. SIGGRAPH 2003]
Linear DR

• first try: PCA (linear)
• result: error falls off sharply after ~45 dimensions
  – scree plots: error vs number of dimensions in lowD projection
• problem: physically impossible intermediate points when simulating new materials
  – specular highlights cannot have holes!

[Fig 6/7. Matusik et al. A Data-Driven Reflectance Model. SIGGRAPH 2003]
Nonlinear DR

- second try: charting (nonlinear DR technique)
  - scree plot suggests 10-15 dims
  - note: dim estimate depends on technique used!

[Fig 10/11. Matusik et al. A Data-Driven Reflectance Model. SIGGRAPH 2003]
Finding semantics for synthetic dimensions

• look for meaning in scatterplots
  – synthetic dims created by algorithm but named by human analysts
  – points represent real-world images (spheres)
  – people inspect images corresponding to points to decide if axis could have meaningful name

• cross-check meaning
  – arrows show simulated images (teapots) made from model
  – check if those match dimension semantics

[Fig 12/16. Matusik et al. A Data-Driven Reflectance Model. SIGGRAPH 2003]
Understanding synthetic dimensions

Specular-Metallic

Diffuseness-Glossiness

[Fig 13/14/16. Matusik et al. A Data-Driven Reflectance Model. SIGGRAPH 2003]
Ch 14: Embed
Embed: Focus+Context

- combine information within single view
- elide
  - selectively filter and aggregate
- superimpose layer
  - local lens
- distortion design choices
  - region shape: radial, rectilinear, complex
  - how many regions: one, many
  - region extent: local, global
  - interaction metaphor

→ Embed
→ Elide Data
→ Superimpose Layer
→ Distort Geometry
Idiom: **DOITrees Revisited**

- elide
  - some items dynamically filtered out
  - some items dynamically aggregated together
  - some items shown in detail

Idiom: **Fisheye Lens**

- distort geometry
  - shape: radial
  - focus: single extent
  - extent: local
  - metaphor: draggable lens

http://tulip.labri.fr/TulipDrupal/?q=node/351
http://tulip.labri.fr/TulipDrupal/?q=node/371
Idiom: **Fisheye Lens**

System: **D3**

[D3 Fisheye Lens](https://bost.ocks.org/mike/fisheye/)
Idiom: Stretch and Squish Navigation

- distort geometry
  - shape: rectilinear
  - foci: multiple
  - impact: global
  - metaphor: stretch and squish, borders fixed

System: TreeJuxtaposer

Distortion costs and benefits

• benefits
  – combine focus and context information in single view

• costs
  – length comparisons impaired
    • network/tree topology comparisons unaffected: connection, containment
  – effects of distortion unclear if original structure unfamiliar
  – object constancy/tracking maybe impaired

Ch 15: Case Studies
Analysis Case Studies

- Scagnostics
- VisDB
- InterRing
- HCE
- PivotGraph
- Constellation
Graph-Theoretic Scagnostics

• scatterplot diagnostics
  – scagnostics SPLOM: each point is one original scatterplot

[Graph-Theoretic Scagnostics Wilkinson, Anand, and Grossman. Proc InfoVis 05.]
## Scagnostics analysis

<table>
<thead>
<tr>
<th>System</th>
<th>Scagnostics</th>
</tr>
</thead>
<tbody>
<tr>
<td>What: Data</td>
<td>Table.</td>
</tr>
<tr>
<td>What: Derived</td>
<td>Nine quantitative attributes per scatterplot (pairwise combination of original attributes).</td>
</tr>
<tr>
<td>Why: Tasks</td>
<td>Identify, compare, and summarize; distributions and correlation.</td>
</tr>
<tr>
<td>How: Encode</td>
<td>Scatterplot, scatterplot matrix.</td>
</tr>
<tr>
<td>How: Manipulate</td>
<td>Select.</td>
</tr>
<tr>
<td>How: Facet</td>
<td>Juxtaposed small-multiple views coordinated with linked highlighting, popup detail view.</td>
</tr>
<tr>
<td>Scale</td>
<td>Original attributes: dozens.</td>
</tr>
</tbody>
</table>
VisDB

- table: draw pixels sorted, colored by relevance
- group by attribute or partition by attribute into multiple views
VisDB Results

• partition into many small regions: dimensions grouped together

VisDB Results

• partition into small number of views
  – inspect each attribute

## VisDB Analysis

<table>
<thead>
<tr>
<th>System</th>
<th>VisDB</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>What: Data</strong></td>
<td>Table (database) with ( k ) attributes; query returning table subset (database query).</td>
</tr>
<tr>
<td><strong>What: Derived</strong></td>
<td>( k + 1 ) quantitative attributes per original item: query relevance for the ( k ) original attributes plus overall relevance.</td>
</tr>
<tr>
<td><strong>Why: Tasks</strong></td>
<td>Characterize distribution within attribute, find groups of similar values within attribute, find outliers within attribute, find correlation between attributes, find similar items.</td>
</tr>
<tr>
<td><strong>How: Encode</strong></td>
<td>Dense, space-filling; area marks in spiral layout; colormaps: categorical hues and ordered luminance.</td>
</tr>
<tr>
<td><strong>How: Facet</strong></td>
<td>Layout 1: partition by attribute into per-attribute views, small multiples. Layout 2: partition by items into per-item glyphs.</td>
</tr>
<tr>
<td><strong>How: Reduce</strong></td>
<td>Filtering</td>
</tr>
<tr>
<td><strong>Scale</strong></td>
<td>Attributes: one dozen. Total items: several million. Visible items (using multiple views, in total): one million. Visible items (using glyphs): 100,000</td>
</tr>
</tbody>
</table>
Hierarchical Clustering Explorer

- heatmap, dendrogram
- multiple views

[Interactively Exploring Hierarchical Clustering Results. Seo and Shneiderman, IEEE Computer 35(7): 80-86 (2002)]
<table>
<thead>
<tr>
<th>System</th>
<th>Hierarchical Clustering Explorer (HCE)</th>
</tr>
</thead>
<tbody>
<tr>
<td>What: Data</td>
<td>Multidimensional table: two categorical key attributes (genes, conditions); one quantitative value attribute (gene activity level in condition).</td>
</tr>
<tr>
<td>What: Derived</td>
<td>Hierarchical clustering of table rows and columns (for cluster heatmap); quantitative derived attributes for each attribute and pairwise attribute combination; quantitative derived attribute for each ranking criterion and original attribute combination.</td>
</tr>
<tr>
<td>Why: Tasks</td>
<td>Find correlation between attributes; find clusters, gaps, outliers, trends within items.</td>
</tr>
<tr>
<td>How: Encode</td>
<td>Cluster heatmap, scatterplots, histograms, boxplots. Rank-by-feature overviews: continuous diverging colormaps on area marks in reorderable 2D matrix or 1D list alignment.</td>
</tr>
<tr>
<td>How: Reduce</td>
<td>Dynamic filtering; dynamic aggregation.</td>
</tr>
<tr>
<td>How: Manipulate</td>
<td>Navigate with pan/scroll.</td>
</tr>
<tr>
<td>How: Facet</td>
<td>Multiform with linked highlighting and shared spatial position; overview-detail with selection in overview populating detail view.</td>
</tr>
<tr>
<td>Scale</td>
<td>Genes (key attribute): 20,000. Conditions (key attribute): 80. Gene activity in condition (quantitative value attribute): 20,000 × 80 = 1,600,000.</td>
</tr>
</tbody>
</table>
InterRing

# InterRing Analysis

<table>
<thead>
<tr>
<th>System</th>
<th><strong>InterRing</strong></th>
</tr>
</thead>
<tbody>
<tr>
<td>What: Data</td>
<td>Tree.</td>
</tr>
<tr>
<td>Why: Tasks</td>
<td>Selection, rollup/drilldown, hierarchy editing.</td>
</tr>
<tr>
<td>How: Facet</td>
<td>Linked coloring and highlighting.</td>
</tr>
<tr>
<td>How: Reduce</td>
<td>Embed: distort; multiple foci.</td>
</tr>
<tr>
<td>Scale</td>
<td>Nodes: hundreds if labeled, thousands if dense. Levels in tree: dozens.</td>
</tr>
</tbody>
</table>
PivotGraph

• derived rollup network

[Visual Exploration of Multivariate Graphs, Martin Wattenberg, CHI 2006.]
PivotGraph

## PivotGraph Analysis

<table>
<thead>
<tr>
<th>Idiom</th>
<th>PivotGraph</th>
</tr>
</thead>
<tbody>
<tr>
<td>What: Data</td>
<td>Network.</td>
</tr>
<tr>
<td>What: Derived</td>
<td>Derived network of aggregate nodes and links by roll-up into two chosen attributes.</td>
</tr>
<tr>
<td>Why: Tasks</td>
<td>Cross-attribute comparison of node groups.</td>
</tr>
<tr>
<td>How: Encode</td>
<td>Nodes linked with connection marks, size.</td>
</tr>
<tr>
<td>How: Reduce</td>
<td>Aggregation, filtering.</td>
</tr>
<tr>
<td>Scale</td>
<td>Nodes/links in original network: unlimited. Roll-up attributes: 2. Levels per roll-up attribute: several, up to one dozen.</td>
</tr>
</tbody>
</table>
Analysis example: Constellation

- data
  - multi-level network
    - node: word
    - link: words used in same dictionary definition
    - subgraph for each definition
      - not just hierarchical clustering
  - paths through network
    - query for high-weight paths between 2 nodes
      - quant attrib: plausibility


Using space: Constellation

- **Visual encoding**
  - link connection marks between words
  - link containment marks to indicate subgraphs
  - encode plausibility with horizontal spatial position
  - encode source/sink for query with vertical spatial position

- **Spatial layout**
  - curvilinear grid: more room for longer low-plausibility paths

Using space: Constellation

• edge crossings
  – cannot easily minimize instances, since position constrained by spatial encoding
  – instead: minimize perceptual impact

• views: superimposed layers
  – dynamic foreground/background layers on mouseover, using color
  – four kinds of constellations
    • definition, path, link type, word
      – not just 1-hop neighbors

https://youtu.be/7sJC3QVpSkQ

## Constellation Analysis

<table>
<thead>
<tr>
<th>System</th>
<th>Constellation</th>
</tr>
</thead>
<tbody>
<tr>
<td>What: Data</td>
<td>Three-level network of paths, subgraphs (definitions), and nodes (word senses).</td>
</tr>
<tr>
<td>Why: Tasks</td>
<td>Discover/verify: browse and locate types of paths, identify and compare.</td>
</tr>
<tr>
<td>How: Encode</td>
<td>Containment and connection link marks, horizontal spatial position for plausibility attribute, vertical spatial position for order within path, color links by type.</td>
</tr>
<tr>
<td>How: Reduce</td>
<td>Superimpose dynamic layers.</td>
</tr>
</tbody>
</table>
What-Why-How Analysis

• this approach is not the only way to analyze visualizations!
  – one specific framework intended to help you think
  – other frameworks support different ways of thinking
    • following: one interesting example
Algebraic Process for Visualization Design

- which mathematical structures in data are preserved and reflected in visualization—negation, permutation, symmetry, invariance

Algebraic process: Vocabulary

• **invariance** violation: single dataset, many visualizations
  – hallucinator

• **unambiguity** violation: many datasets, same vis
  – data change invisible to viewer
    • confuser

• **correspondence** violation:
  – can’t see change of data in vis
    • jumbler
  – salient change in vis not due to significant change in data
    • misleader
  – match mathematical structure in data with visual perception

• we can X the data; can we Y the image?
  – are important data changes well-matched with obvious visual changes?
Paper: TopoFisheye
Topological Fisheye Views

• derived data
  – input: laid-out network (spatial positions for nodes)
  – output: multilevel hierarchy from graph coarsening

• interaction
  – user changed selected focus point

• visual encoding
  – hybrid view made from cut through several hierarchy levels

[Fig 4,8. Topological Fisheye Views for Visualizing Large Graphs. Gansner, Koren and North, IEEE TVCG 11(4), p 457-468, 2005]
Coarsening requirements

- uniform cluster/metanode size
- match coarse and fine layout geometries
- scalable

Coarsening strategy

- must preserve graph-theoretic properties
- use both topology and geometry
  - topological distance (hops away)
  - geometric distance - but not just proximity alone!
    - just contracting nodes/edges could create new cycles
- derived data: proximity graph

[Fig 10, 12. Topological Fisheye Views for Visualizing Large Graphs. Gansner, Koren and North, IEEE TVCG 11(4), p 457-468, 2005]
Candidate pairs: neighbors in original and proximity graph

• proximity graph: compromise between larger DT and smaller RNG
  – better than original graph neighbors alone
    • slow for cases like star graph

• maximize weighted sum of
  – geometric proximity
    • goal: preserve geometry
  – cluster size
    • goal: keep uniform cluster size
  – normalized connection strength
    • goal: preserve topology
  – neighborhood similarity
    • goal: preserve topology
  – degree
    • goal: penalize high-degree nodes to avoid salient artifacts and computational problems
Hybrid graph creation

• cut through coarsening hierarchy to get active nodes
  —animated transitions between states

[Fig 10, 12. Topological Fisheye Views for Visualizing Large Graphs. Gansner, Koren and North, IEEE TVCG 11(4), p 457-468, 2005]
Final distortion

• geometric distortion for uniform density
• (colorcoded by hierarchy depth just to illustrate algorithm)
  – compare to original
  – compare to simple topologically unaware fisheye distortion

[Fig 2, 15. Topological Fisheye Views for Visualizing Large Graphs. Gansner, Koren and North, IEEE TVCG 11(4), p 457-468, 2005]
Example Presentation: Biomechanical Motion
Presentation expectations

• 20 minute time slots for presentations
  – aim for 18 min presenting and 2 min discussion

• slides required
  – if you’re using my laptop, send to me by 12pm
  – if you’re using your own, send to me by 6pm (right after class)

• three goals: up to you whether sequential or interleaved
  – explain core technical content to audience
  – analyze with doing what/why/how framework
    • do scale analysis of data for this system in specific, not for technique in general
  – critique strengths/weaknesses of technical paper

• marking criteria
  – Summary 40%, Analysis 15%, Critique 15%
  – Presentation Style 15%, Materials Preparation 15%
Analysis & critique

• paper type dependent
  – required for design studies and technique papers
  – some possible for algorithm papers
    • but more emphasis on presenting algorithm clearly
  – minimal for evaluation papers
    • but can discuss study design and statistical analysis methods

• please distinguish: their analysis (future work, limitations) from your own thoughts/critiques
  – good to present both
Beyond paper itself

• check for author paper page
  – may have video
  – may have talk slides you could borrow as a base
    • do acknowledge if so!
  – may have demo or supplemental material
  – include paper page URL in slides if it exists

• if using video, consider when it’s most useful to show
  – at very start for overview of everything
  – after you’ve explained some of background
  – after you’ve walked us through most of interface, to show interaction in specific
Slides

• do include both text and images

• text
  – font must be readable from back of room
    • 24 point as absolute minimum
    • use different type sizes to help guide eye, with larger title font
    • avoid micro text with macro whitespace
  – bullet style not sentences
    • sub-bullets for secondary points
    • Compare what it feels like to read an entire long sentence on a slide; while complex structure is a good thing to have for flow in writing, it’s more difficult to parse in the context of a slide where the speaker is speaking over it.

• legibility
  – remember luminance contrast requirements with colors!
Slide images

• figures from paper
  – good idea to use figures from paper, especially screenshots
    • judgement call about some/many/all

• new images
  – you might make new diagrams
  – you might grab other images, especially for background or if comparing to prev work
  – avoid random clip art

• images alone often hard to follow
  – images do not speak for themselves, you must walk us through them
    • text bullets to walk us through your highest-level points
      – hard to follow if they’re only made verbally
    • judgement call on text/image ratio, avoid extremes
Style

• face audience, not screen
  – pro tip: your screen left/right matches audience left/right in this configuration

• project voice so we can hear you
  – avoid muttered comments to self, volume drop-off at end of slide
  – avoid robot monotone, variable emphasis helps keep us engaged

• avoid reading exactly what the slide says
  – judgement call: how much detail to have in presenter notes

• use laser pointer judiciously
  – avoid constant distracting jiggle

• practice, practice, practice
  – for flow of words and for timing

• question handling: difficult to practice beforehand…
Technical talks advice

• **How To Give An Academic Talk**
  – Paul N. Edwards

• **How To Give a Great Research Talk**
  – Simon L Peyton Jones, John Hughes, and John Launchbury

• **How To Present A Paper**
  – Leslie Lamport

• **Things I Hope Not To See or Hear at SIGGRAPH**
  – Jim Blinn

• **Scientific Presentation Planning**
  – Jason Harrison
Interactive Coordinated Multiple-View Visualization of Biomechanical Motion Data


Biomechanical motion design study

• large DB of 3D motion data
  – pigs chewing: high-speed motion at joints, 500 FPS w/ sub-mm accuracy

• domain tasks
  – functional morphology: relationship between 3D shape of bones and their function
  – what is a typical chewing motion?
  – how does chewing change over time based on amount/type of food in mouth?

• abstract tasks
  – trends & anomalies across collection of time-varying spatial data
  – understanding complex spatial relationships

• pioneering design study integrating infovis+scivis techniques

• let’s start with video showing system in action

https://youtu.be/OUNezRNtE9M
Multiple linked spatial & non-spatial views

• data: 3D spatial, multiple attribs (cyclic)
• encode: 3D spatial, parallel coords, 2D line (xy) plots
• facet: few large multiform views, many small multiples (~100)
  – encode: color by trial for window background
  – view coordination:
    line in parcoord ==
    frame in small mult

3D+2D

• change
  – 3D navigation
    • rotate/translate/zoom

• filter
  – zoom to small subset of time

• facet
  – select for one large detail view
  – linked highlighting
  – linked navigation
    • between all views
    • driven by large detail view

Derived data: traces/streamers

- derived data: 3D motion tracers from interactively chosen spots
  - generates x/y/z data over time
  - streamers
  - shown in 3D views directly
  - populates 2D plots

Small multiples for overview

• facet: small multiples for overview
  – aggressive/ambitious, 100+ views

• encode: color code window bg by trial

• filter:
  – full/partial skull
  – streamers
    • simple enough to be useable at low information density

Derived data: surface interactions

- derived data
  - 3D surface interaction patterns

- facet
  - superimposed overlays in 3D view

- encoding
  - color coding

Side by side views demonstrating tooth slide

- facet: linked navigation w/ same 3D viewpoint for all
- encode: coloured by vertical distance separating teeth (derived surface interactions)
  – also 3D instantaneous helical axis showing motion of mandible relative to skull
Cluster detection

• identify clusters of motion cycles
  – from combo: 2D xy plots & parcoords
  – show motion itself in 3D view
• facet: superimposed layers
  – foreground/background layers in parcoord view itself

Analysis summary

• what: data
  – 3D spatial, multiple attrs (cyclic)

• what: derived
  – 3D motion traces
  – 3D surface interaction patterns

• how: encode
  – 3D spatial, parallel coords, 2D plots
  – color views by trial, surfaces by interaction patterns

• how: change
  – 3D navigation

• how: facet
  – few large multiform views
  – many small multiples (~100)
  – linked highlighting
  – linked navigation
  – layering

• how: reduce
  – filtering

Critique

• many strengths
  – carefully designed with well justified design choices
  – explicitly followed mantra “overview first, zoom and filter, then details-on-demand”
  – sophisticated view coordination
  – tradeoff between strengths of small multiples and overlays, use both
    – informed by difficulties of animation for trend analysis
    – derived data tracing paths

• weaknesses/limitations
  – (older paper feels less novel, but must consider context of what was new)
  – scale analysis: collection size of <=100, not thousands (understandably)
  – aggressive about multiple views, arguably pushing limits of understandability
Next time

• deadlines
  – meetings due by Thu Nov 2, 5pm
  • reminder that I’m not available Fri Nov 3 through Mon Nov 6
  – proposals due by Mon Nov 6, 10pm

• next week
  – presentations 1
  – guest lecture from Steve Franconeri