Chapter 11: Manipulate
Paper: Myriahedral Projections

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http://www.cs.ubc.ca/~tmm/course/547-14#chap11
Idiom design choices: Part 1

Encode

Why?
How?
What?

Encode
Arrange
Express
Separate
Order
Align
Use

Map
from categorical and ordered attributes

Color

Hue

Saturation

Luminance

Size, Angle, Curvature, ...

Shape

Motion

Direction, Rate, Frequency, ...

Map
Color
Size, Angle, Curvature, ...
Shape
Motion

What?
Why?
How?
Idiom design choices: Part 2

- **Manipulate**
  - Change
  - Select
  - Navigate

- **Facet**
  - Juxtapose
  - Partition
  - Superimpose

- **Reduce**
  - Filter
  - Aggregate
  - Embed
Manipulate

- **Change over Time**

- **Select**

- **Navigate**
  - **Item Reduction**
    - Zoom
    - Geometric or Semantic
  - **Attribute Reduction**
    - Slice
    - Cut
    - Project
Change over time

• change any of the other choices
  – encoding itself
  – parameters
  – arrange: rearrange, reorder
  – aggregation level, what is filtered...

• why change?
  – one of four major strategies
    • change over time
    • facet data by partitioning into multiple views
    • reduce amount of data shown within view
      – embedding focus + context together
  – most obvious, powerful, flexible
  – interaction entails change
Idiom: **Re-encode**

System: **Tableau**

made using Tableau, [http://tableausoftware.com](http://tableausoftware.com)
Idiom: **Reorder**

- data: tables with many attributes
- task: compare rankings

**System:** **LineUp**

Idiom: **Realign**

- stacked bars
  - easy to compare
    - first segment
    - total bar
- align to different segment
  - supports flexible comparison

**System: LineUp**

Idiom: **Animated transitions**

- smooth transition from one state to another
  - alternative to jump cuts
  - support for item tracking when amount of change is limited

- example: multilevel matrix views
  - scope of what is shown narrows down
    - middle block stretches to fill space, additional structure appears within
    - other blocks squish down to increasingly aggregated representations

Select and highlight

• selection: basic operation for most interaction
• design choices
  – how many selection types?
    • click vs hover: heavyweight, lightweight
    • primary vs secondary: semantics (eg source/target)
• highlight: change visual encoding for selection targets
  – color
    • limitation: existing color coding hidden
  – other channels (eg motion)
  – add explicit connection marks between items
Navigate: Changing item visibility

• change viewpoint
  – changes which items are visible within view
  – camera metaphor
    • zoom
      – geometric zoom: familiar semantics
      – semantic zoom: adapt object representation based on available pixels
        » dramatic change, or more subtle one
    • pan/translate
    • rotate
      – especially in 3D
  – constrained navigation
    • often with animated transitions
    • often based on selection set
Idiom: **Semantic zooming**

- visual encoding change
  - colored box
  - sparkline
  - simple line chart
  - full chart: axes and tickmarks

**System: LiveRAC**

Navigate: Reducing attributes

• continuation of camera metaphor
  – slice
    • show only items matching specific value for given attribute: slicing plane
    • axis aligned, or arbitrary alignment
  – cut
    • show only items on far slide of plane from camera
  – project
    • change mathematics of image creation
      – orthographic
      – perspective
      – many others: Mercator, cabinet, ...

Further reading

  – Chap 11: Manipulate View


• Selection: 524,288 Ways to Say “This is Interesting”. Wills. Proc. IEEE Symp.
  Information Visualization (InfoVis), pp. 54–61, 1996.


• Starting Simple - adding value to static visualisation through simple interaction. Dix
Myriahedral Projection

• cannot project from sphere to plane without distortion: something must give
  – equal area (preserve distances)
  – conformal (preserve angles)
  – interrupt-free

• what if embrace not avoid interrupts?
  – radial approach from computer graphics vs traditional cartography

• myriahedron: polyhedron with many faces
  – project surface onto myriahedron
  – label edges as folds/cuts
  – unfold into flat map

Cuts and folds

• mesh G
• dual mesh H
• cuts and folds (edge labels)
• foldout
  – connected
  – flattenable (no cycles)
  – no foldovers
    • safe to ignore problem in practice
• maximal spanning tree $H_f$
  – minimal spanning tree $G_c$

Graticular projections

- meridian cuts: $W \phi$ high
- $\phi_0$ determines
  - cylindrical
  - conical
  - azimuthal
    - cut surface of globe at single point and project to a circle
- two hemispheres: $W \phi$ negative
- parallel cuts: $W \lambda$ high
  - polyconical

$$w(\phi, \lambda) = -\left( W_\phi |\phi - \phi_0| + W_\lambda \min_k |\lambda - \lambda_0 + 2\pi k| \right)$$

Gaps and strips

• folds: edges aligned with w contours
• cuts: edges aligned with w gradients
• gaps show where distortion would be
  – like Tissot indicatrix
• can’t do all three:
  – broaden strips to close gaps
  – shorten strips to maintain equal area
  – lengthen strips to maintain same aspect ratio
• many strips: gaps less visible

Recursive subdivision of polygons

- ex: 5 levels of subdivision
- gaps quickly get small at lower subdivision levels
  – already by second level

Optimal mappings

- so cuts don’t cross continents
- weight edges by land cut amounts
  – sampled at 25 positions
- try for many orientations
- take minimum
- dymaxion is usual result

Geography aligned meshes

• $f(\phi, \lambda)$: high in continents, low in oceans
  – from image to matrix

• convolve (blur) with large mask
  – taking sphere curvature into account

• lines: generate from $f$ contours
  – from flow vis alg: equally spaced streamlines in vector field

• polygons: from line intersections

• triangles: tesselate polys with > 4 edges

• folds/cuts: as before

• quality improvements hard to achieve, even with tensor vs vector field
  – so just leave boundaries fractured!

Geography aligned meshes

Geography aligned meshes, results

Geography aligned meshes, results

Discussion

• cons
  – unusual, computationally expensive

• pros
  – education: explain basics of map projection
  – entertainment
  – accuracy
    • inevitable distortions shown in natural and explicit way
    • left to reader to guess where and which distortion occurs with standard maps

• methods
  – CS approach: flow vis algorithms vs formulas
  – serendipitous discovery through parameter changes

• user feedback
  – reactions of 20 people: cartographers mixed, vs others more positive