Chapter 11: Manipulate
Paper: Myriahedral Projections

Tamara Munzner
Department of Computer Science
University of British Columbia

UBC CPSC 547: Information Visualization
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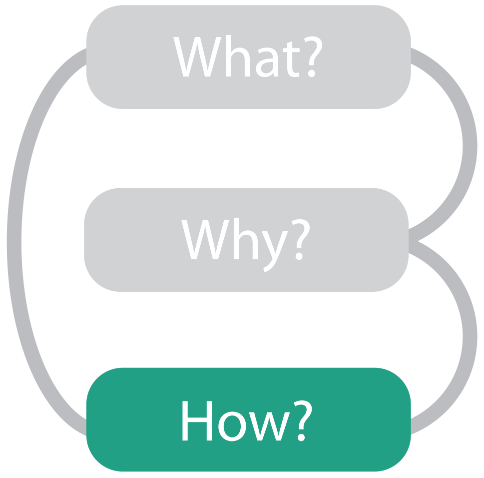
http://www.cs.ubc.ca/~tmm/course/547-14#chap11

Idiom design choices: Part 1

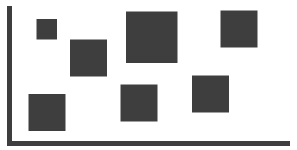


Encode

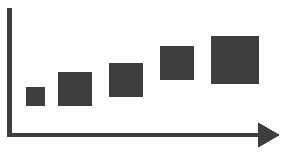
Arrange

- Express

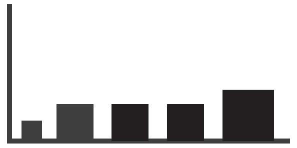
- Separate



- Order



- Align



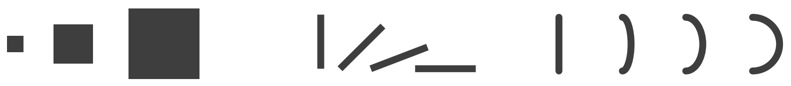
- Use

Map

from categorical and ordered attributes

- Color
  - *Hue*
  - *Saturation*
  - *Luminance*

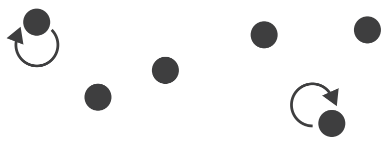
- Size, Angle, Curvature, ...



- Shape

- Motion

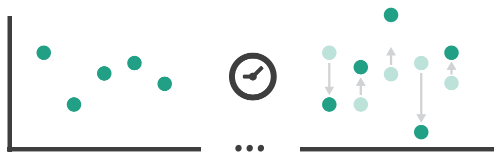
Direction, Rate, Frequency, ...



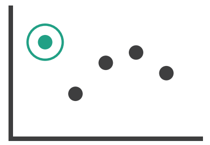
Idiom design choices: Part 2

Manipulate

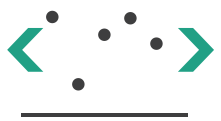
Change



Select

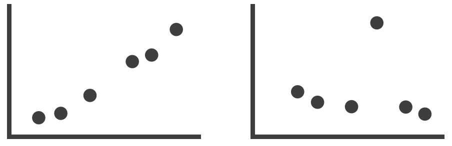


Navigate

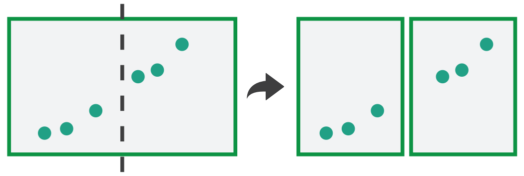


Facet

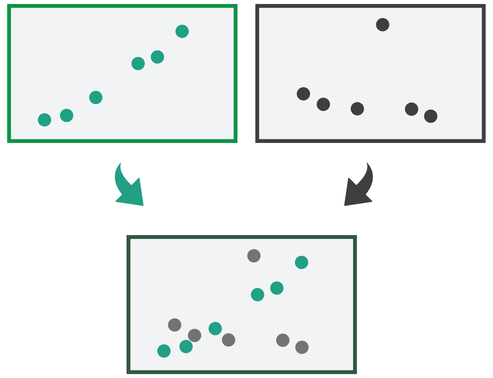
Juxtapose



Partition

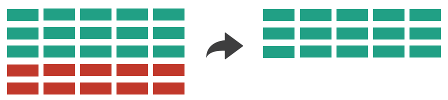


Superimpose

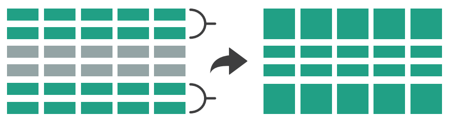


Reduce

Filter



Aggregate

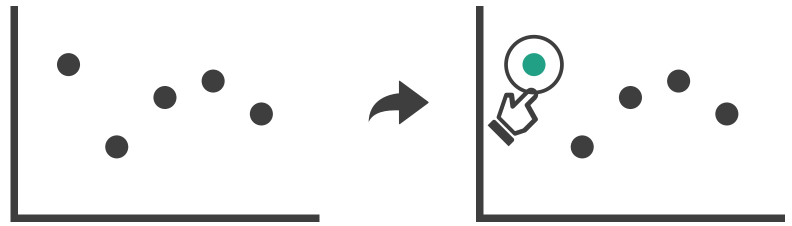


Embed

Manipulate

Change over Time

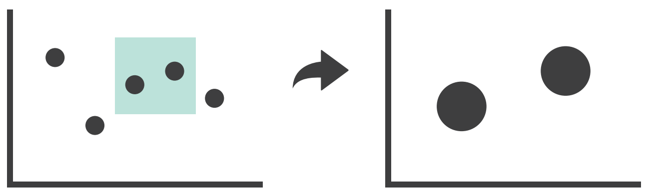
Select



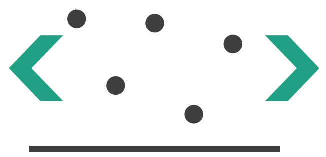
Navigate

Item Reduction

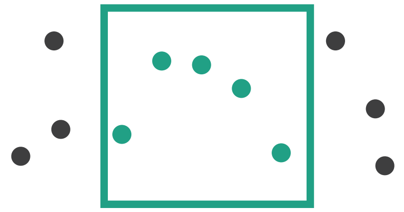
Zoom
Geometric or *Semantic*



Pan/Translate



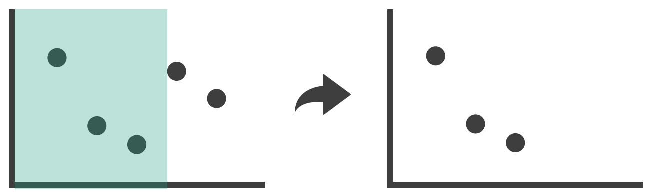
Constrained



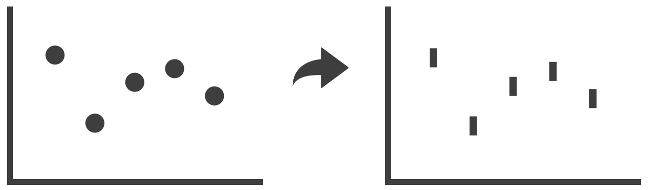
Attribute Reduction

Slice

Cut



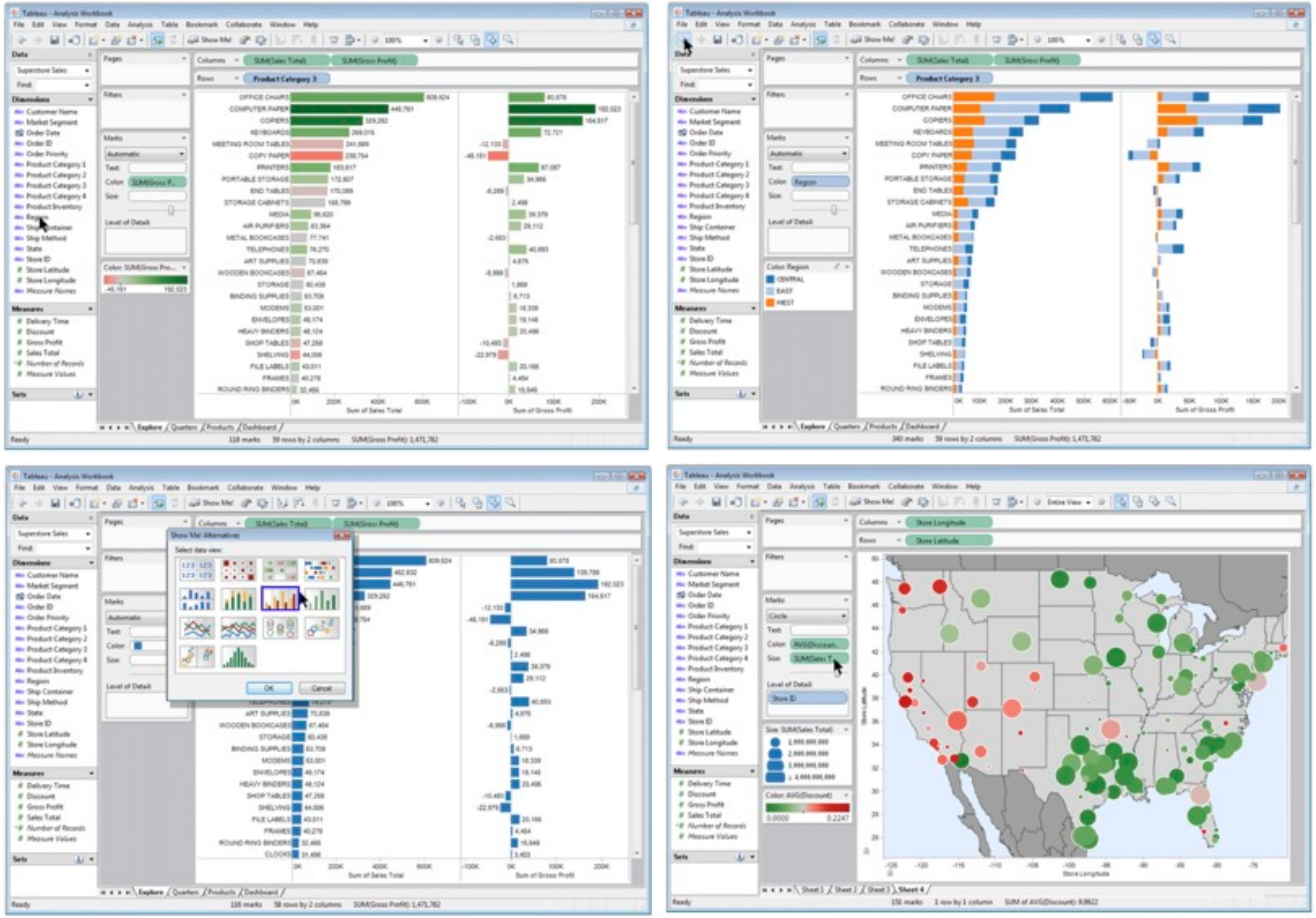
Project



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**

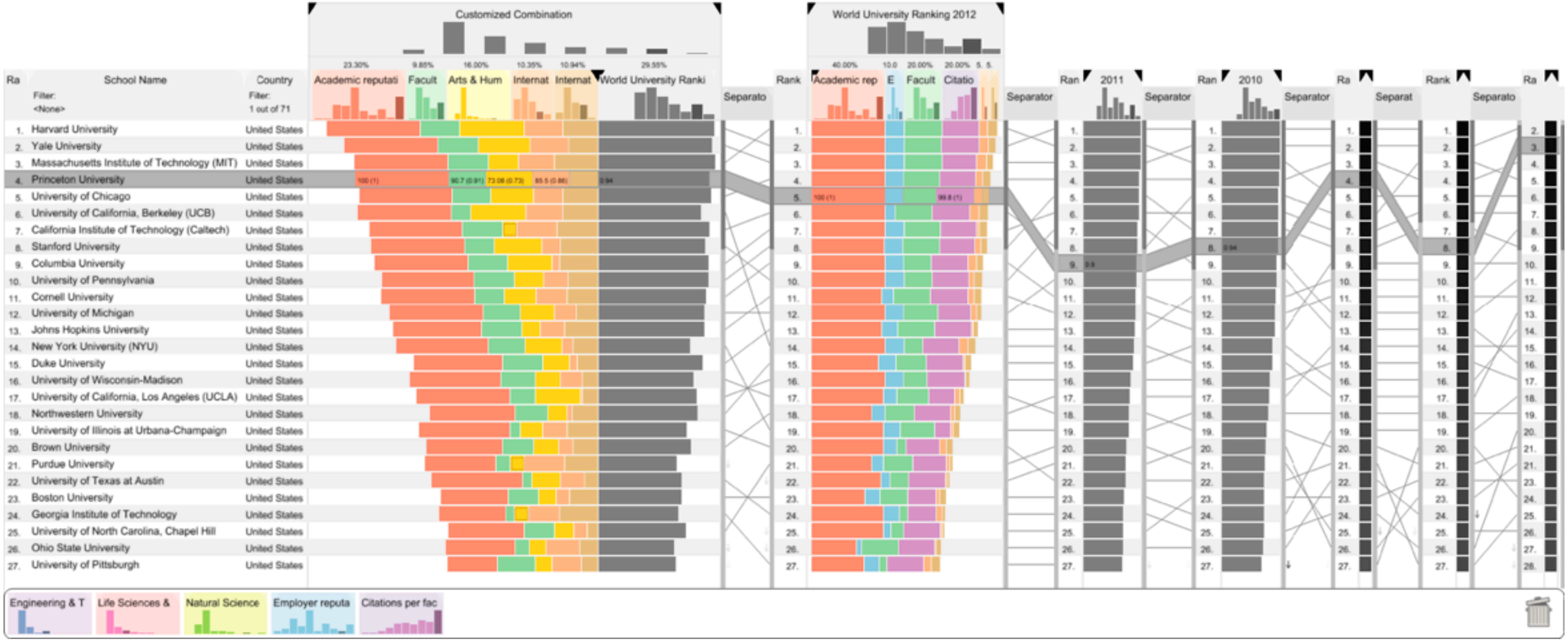


made using Tableau, <u>http://tableausoftware.com</u>

Idiom: **Reorder**

System: **LineUp**

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

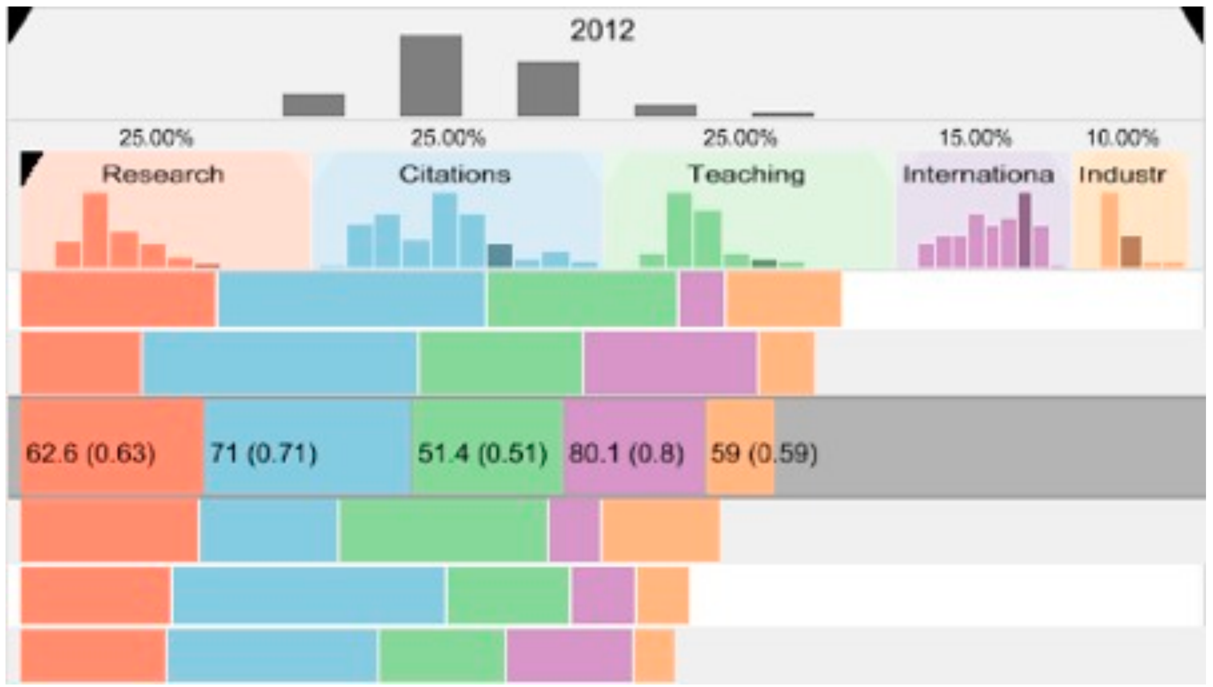


[LineUp: Visual Analysis of Multi-Attribute Rankings. Gratzl, Lex, Gehlenborg, Pfister, and Streit. IEEE Trans. Visualization and Computer Graphics (Proc. InfoVis 2013) 19:12 (2013), 2277–2286.]

Idiom: **Realign**

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

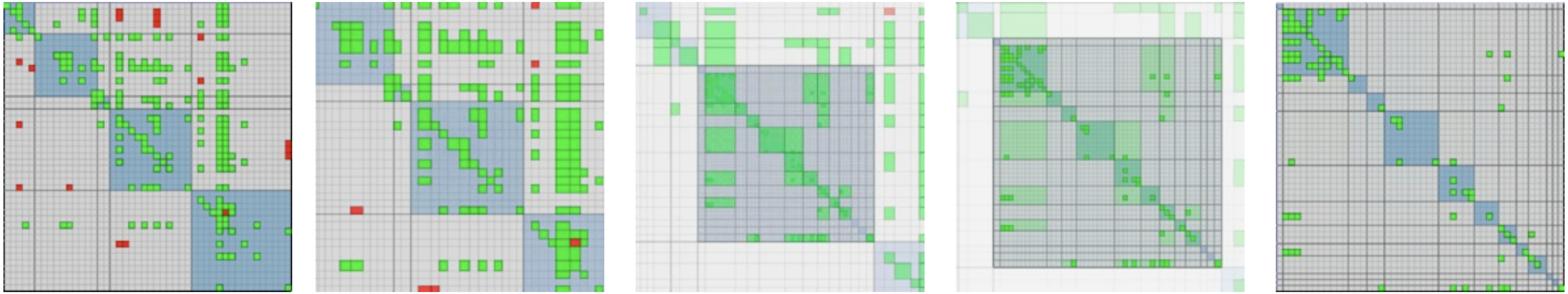
System: **LineUp**



[LineUp: Visual Analysis of Multi-Attribute Rankings. Gratzl, Lex, Gehlenborg, Pfister, and Streit. IEEE Trans. Visualization and Computer Graphics (Proc. InfoVis 2013) 19:12 (2013), 2277–2286.]

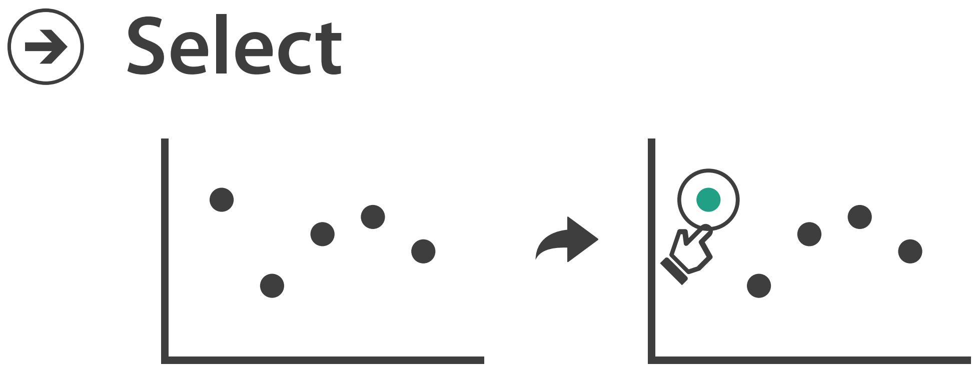
Idiom: **Animated transitions**

- 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



[Using Multilevel Call Matrices in Large Software Projects. van Ham. Proc. IEEE Symp. Information Visualization (InfoVis), pp. 227–232, 2003.]

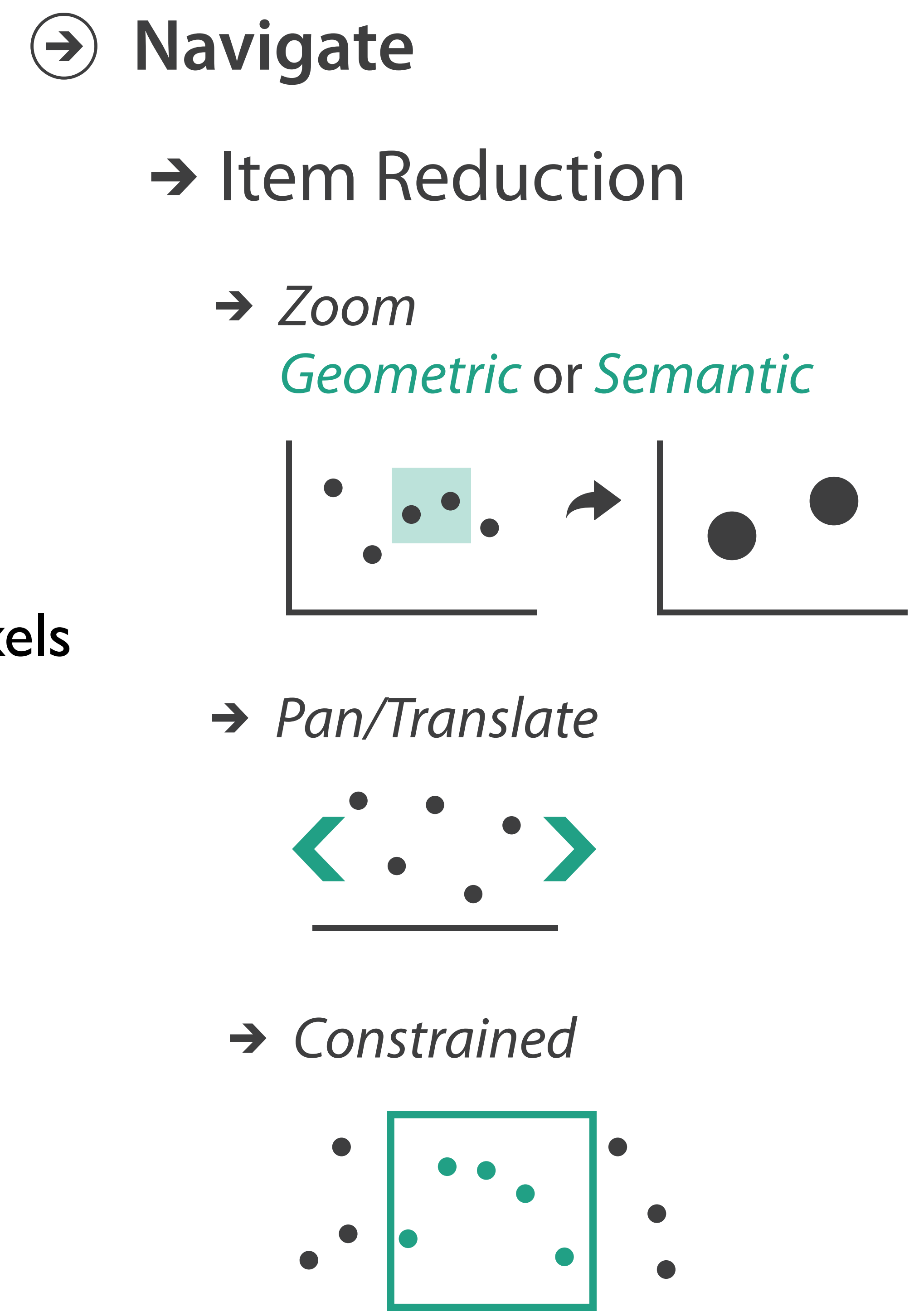
Select and highlight



- 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

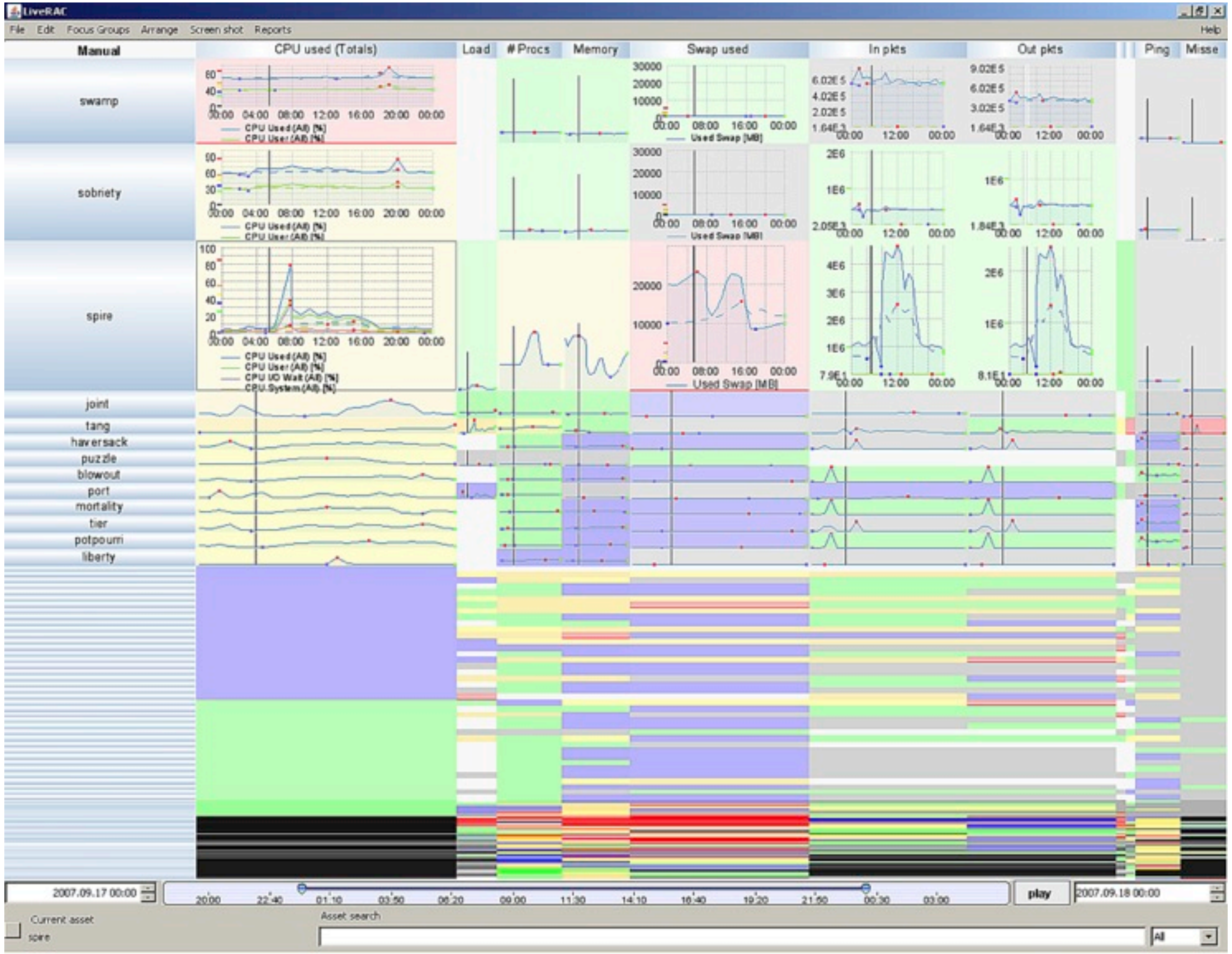
- change viewpoint
  - changes which items are visible within view
  - camera metaphor
    - zoom
      - geometric zoom: familiar semantics
      - semantic zoom: adapt object representation based on available pixels
        - » dramatic change, or more subtle one
    - pan/translate
    - rotate
 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



Idiom: **Semantic zooming**

System: **LiveRAC**

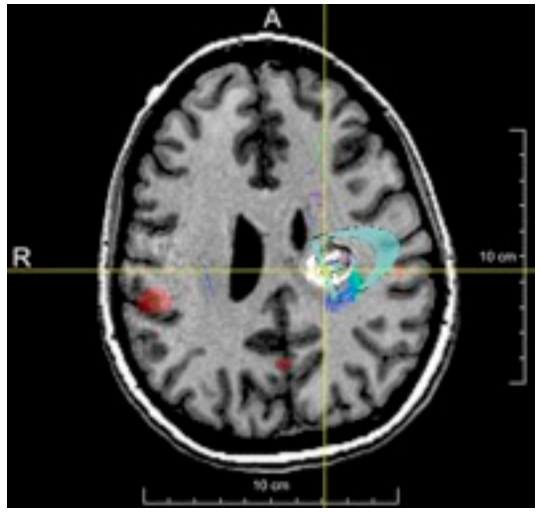
- visual encoding change
  - colored box
  - sparkline
  - simple line chart
  - full chart: axes and tickmarks

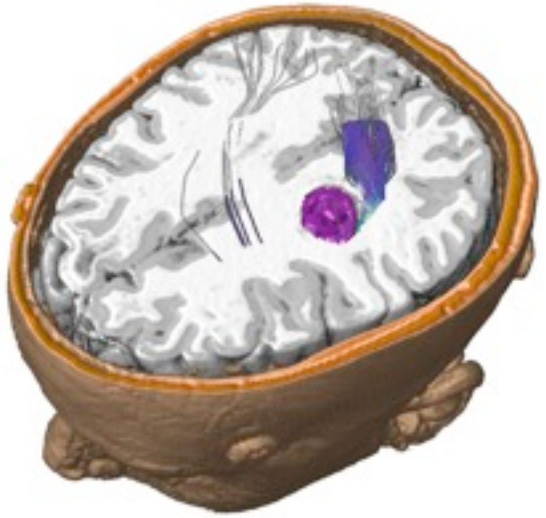


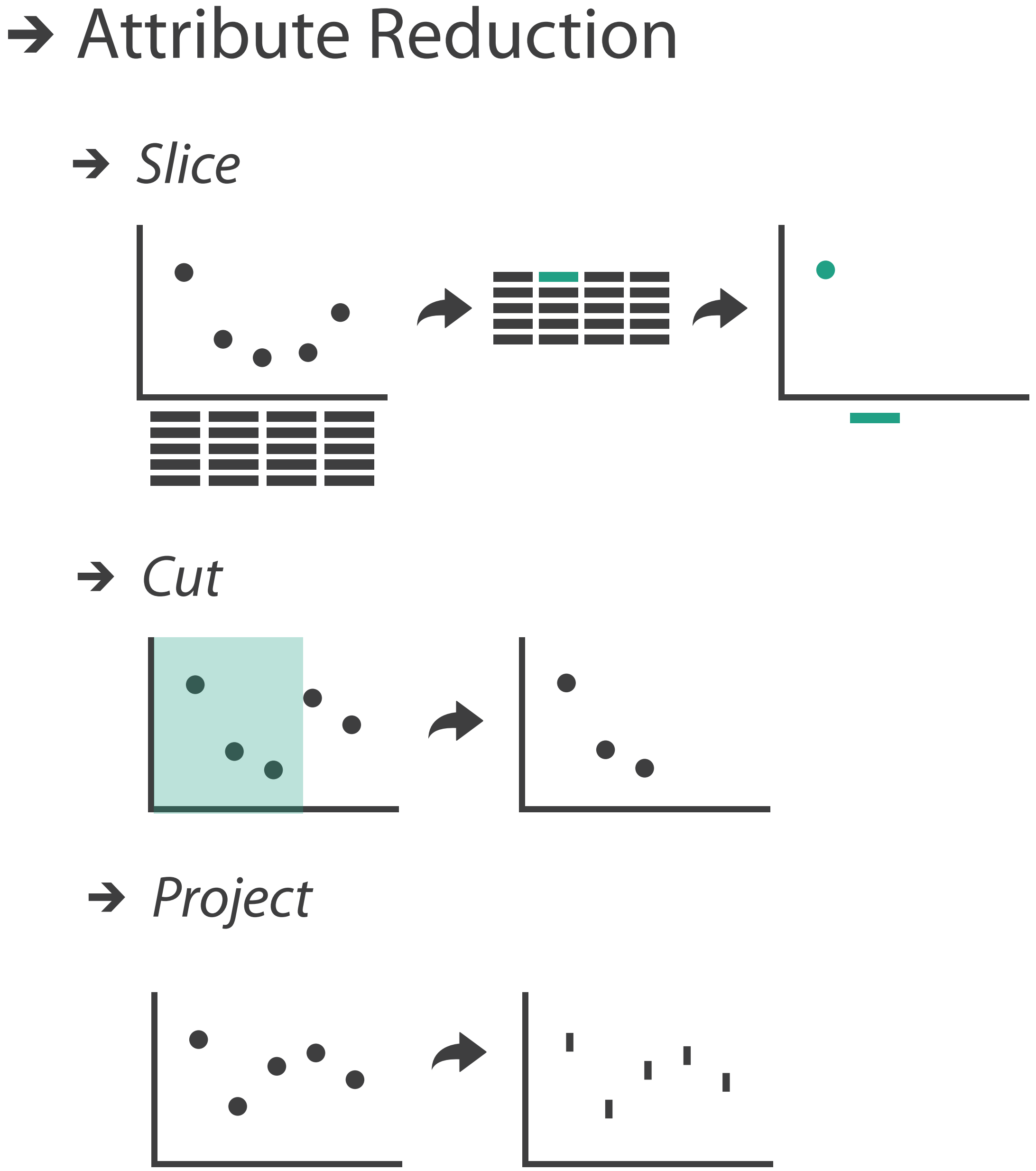
[LiveRAC - Interactive Visual Exploration of System Management Time-Series Data. McLachlan, Munzner, Koutsofios, and North. Proc. ACM Conf. Human Factors in Computing Systems (CHI), pp. 1483–1492, 2008.]

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, ...







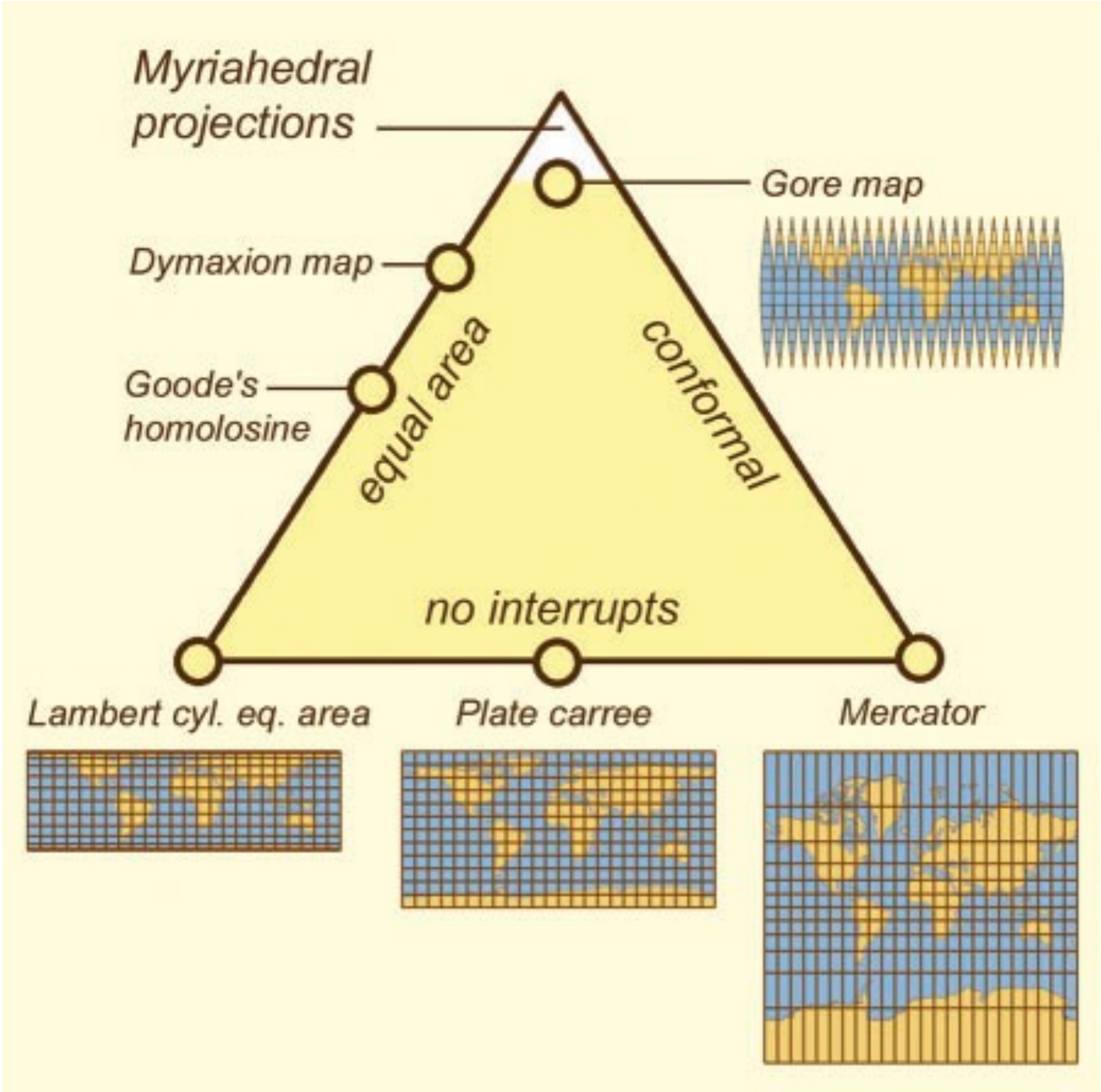
[Interactive Visualization of Multimodal Volume Data for Neurosurgical Tumor Treatment. Rieder, Ritter, Raspe, and Peitgen. Computer Graphics Forum (Proc. EuroVis 2008) 27:3 (2008), 1055–1062.]

Further reading

- Visualization Analysis and Design. Munzner. AK Peters / CRC Press, Oct 2014.
  - *Chap 11: Manipulate View*
- *Animated Transitions in Statistical Data Graphics*. Heer and Robertson. IEEE Trans. on Visualization and Computer Graphics (Proc. InfoVis07) 13:6 (2007), 1240–1247.
- *Selection: 524,288 Ways to Say "This is Interesting"*. Wills. Proc. IEEE Symp. Information Visualization (InfoVis), pp. 54–61, 1996.
- *Smooth and efficient zooming and panning*. van Wijk and Nuij. Proc. IEEE Symp. Information Visualization (InfoVis), pp. 15–22, 2003.
- *Starting Simple - adding value to static visualisation through simple interaction*. Dix and Ellis. Proc. Advanced Visual Interfaces (AVI), pp. 124–134, 1998.

Myriahedral Projection

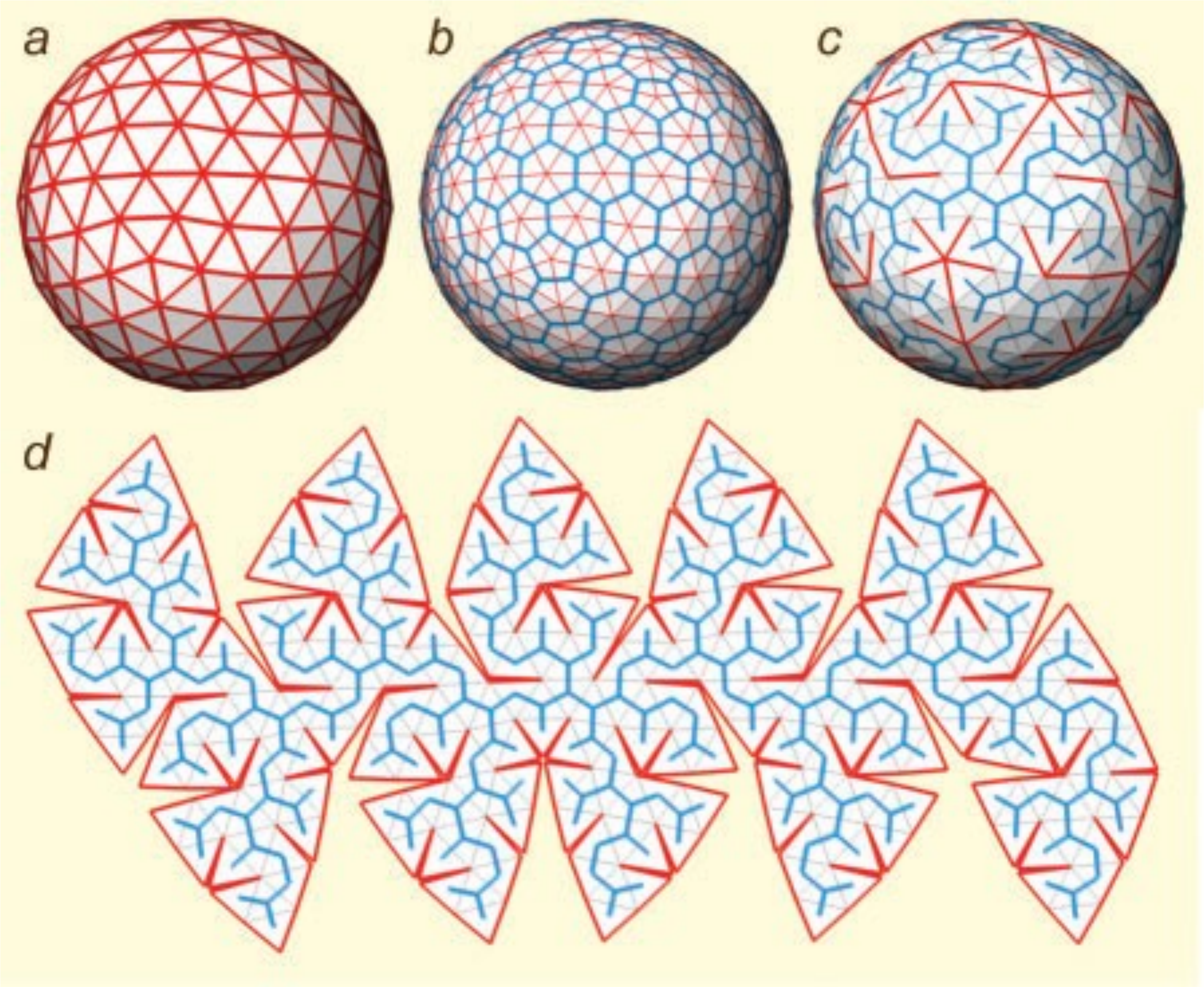
- cannot project from sphere to plane without distortion: something must give
  - equal area (preserve distances)
  - conformal (preserve angles)
  - interrupt-free
- what if embrace not avoid interrupts?
  - radial approach from computer graphics vs traditional cartography
- myriahedron: polyhedron with many faces
  - project surface onto myriahedron
  - label edges as folds/cuts
  - unfold into flat map



[Fig 1. Unfolding the Earth: Myriahedral Projections. van Wijk. The Cartographic Journal, Vol. 45, No. 1, pp.32-42, February 2008.]

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

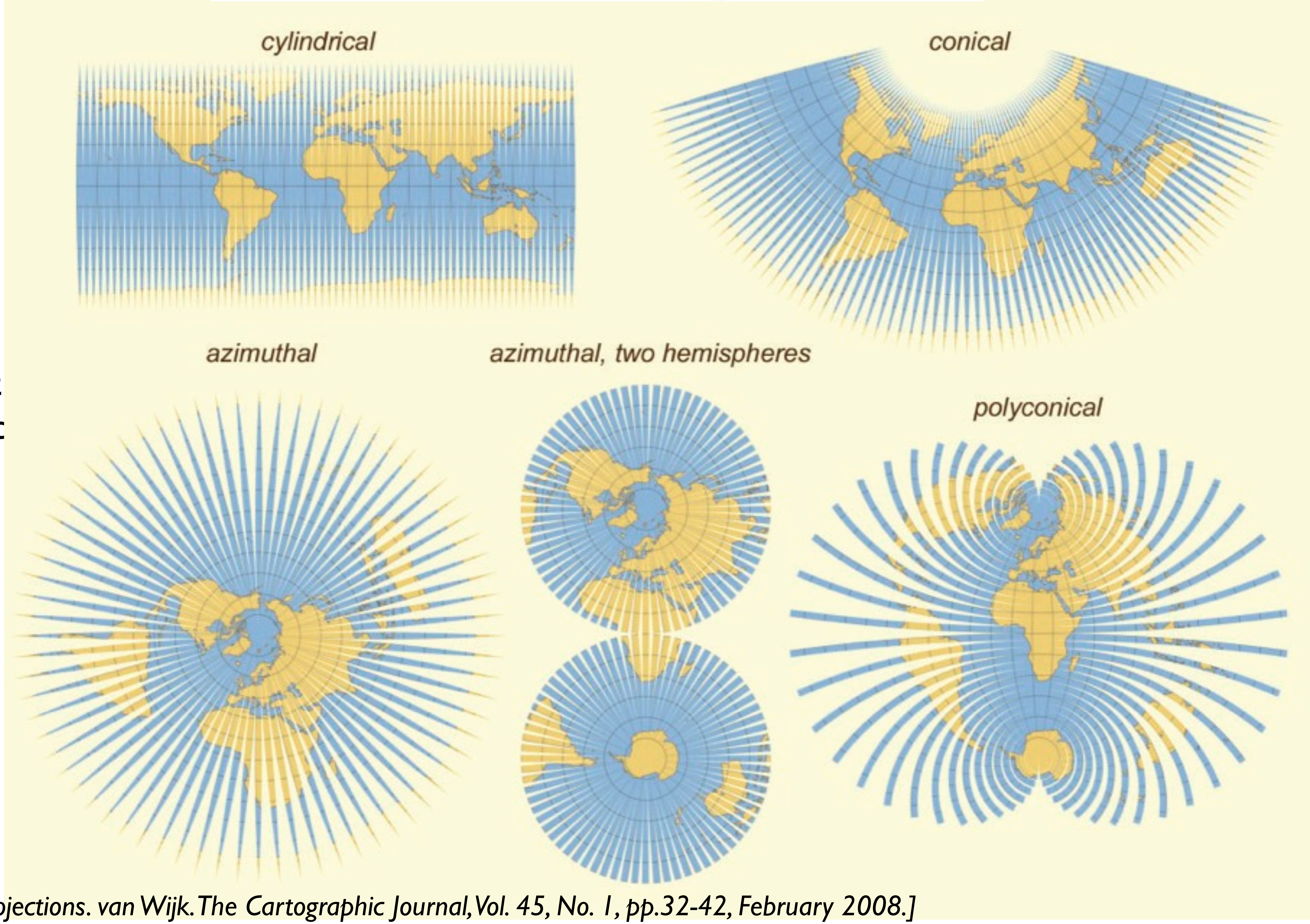


[Fig 2. Unfolding the Earth: Myriahedral Projections. van Wijk. The Cartographic Journal, Vol. 45, No. 1, pp. 32-42, February 2008.]

Graticular projections

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

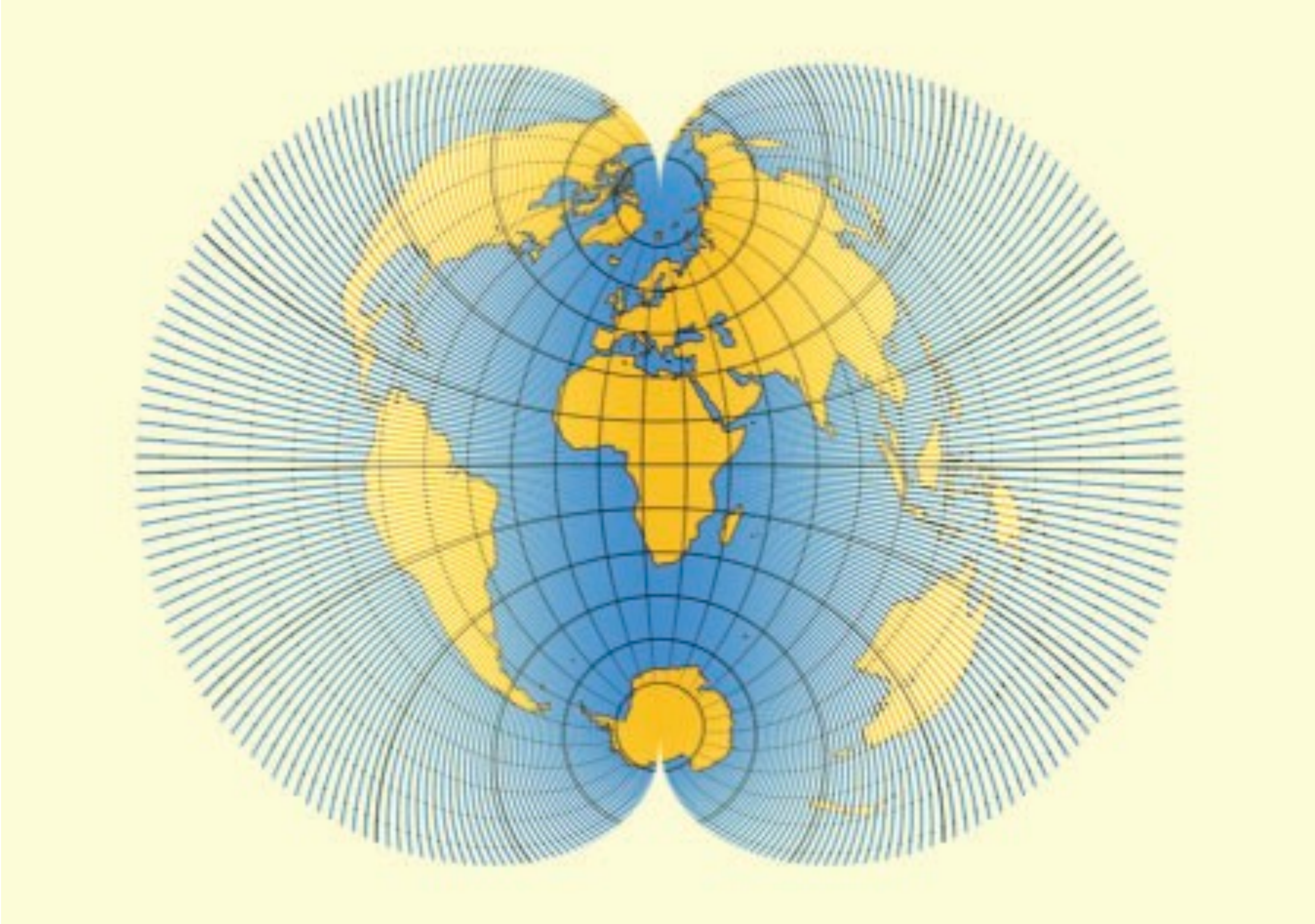
- meridian cuts: W_ϕ high
- ϕ_0 determines
  - cylindrical
  - conical
  - azimuthal
    - cut surface of globe at single point and projec to a circle
- two hemispheres: W_ϕ negative
- parallel cuts: W_λ high
  - polyconical



[Fig 3. Unfolding the Earth: Myriahedral Projections. van Wijk. The Cartographic Journal, Vol. 45, No. 1, pp.32-42, February 2008.]

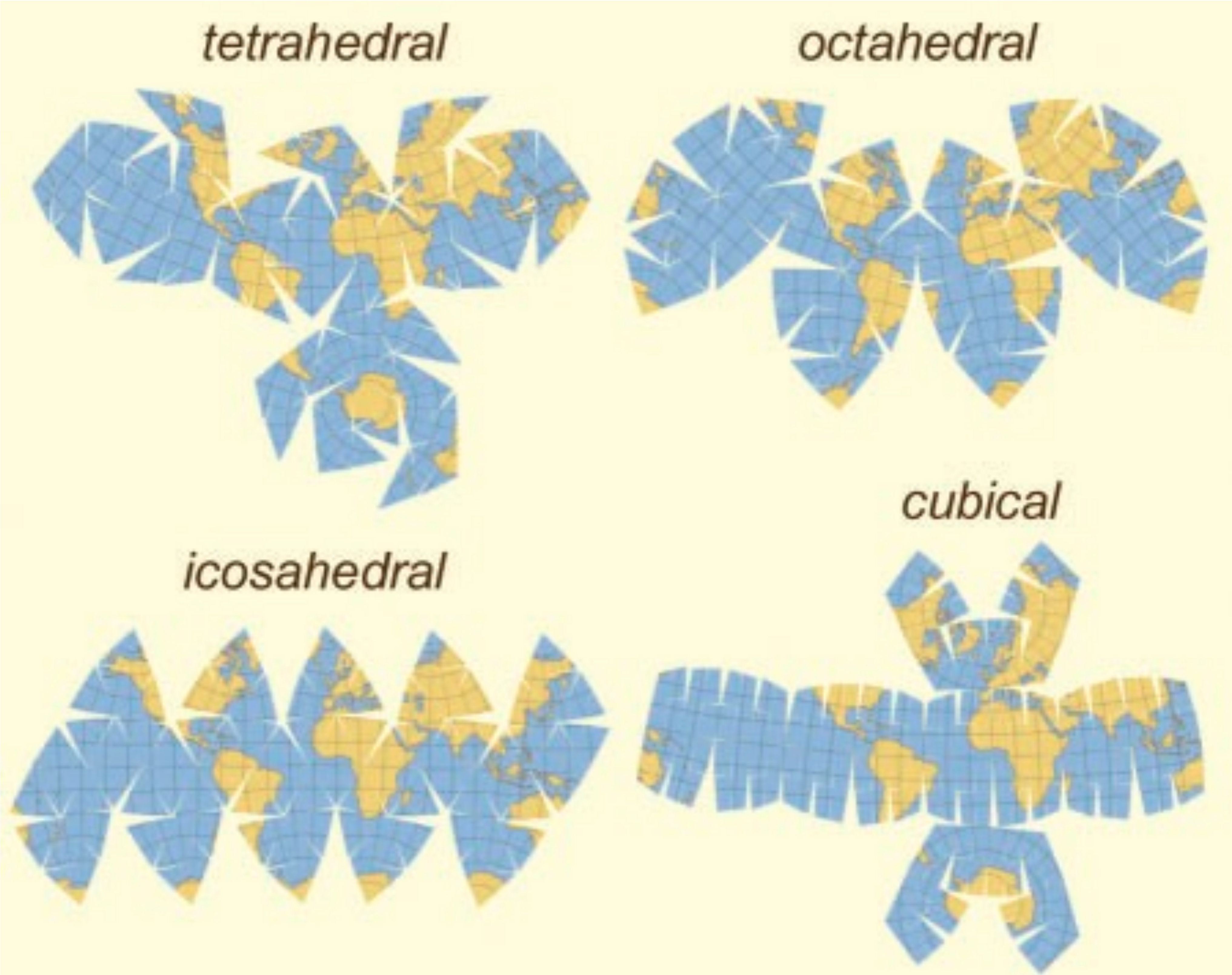
Gaps and strips

- 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

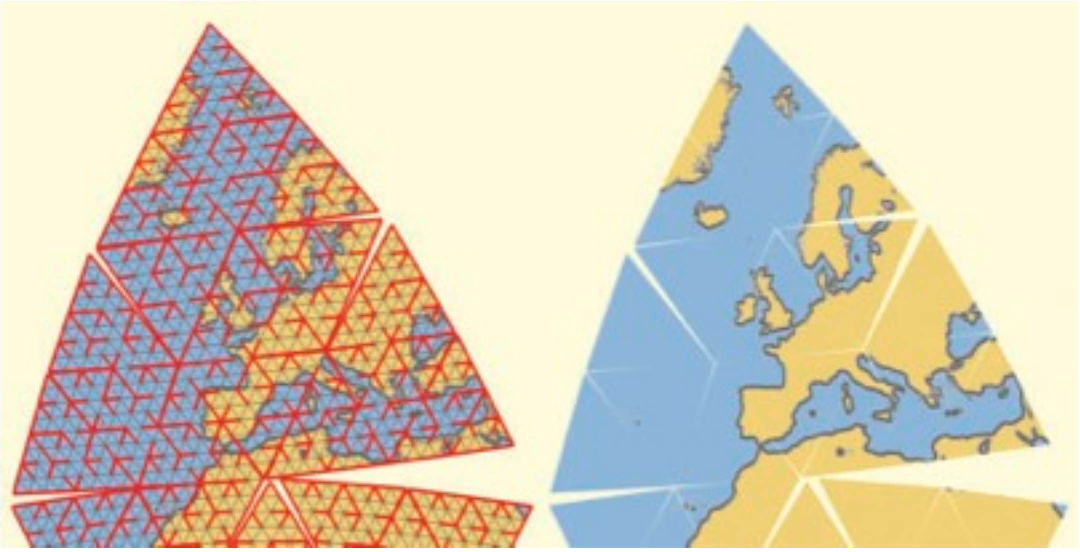


[Fig 4. Unfolding the Earth: Myriahedral Projections. van Wijk. The Cartographic Journal, Vol. 45, No. 1, pp.32-42, February 2008.]

Recursive subdivision of polygons



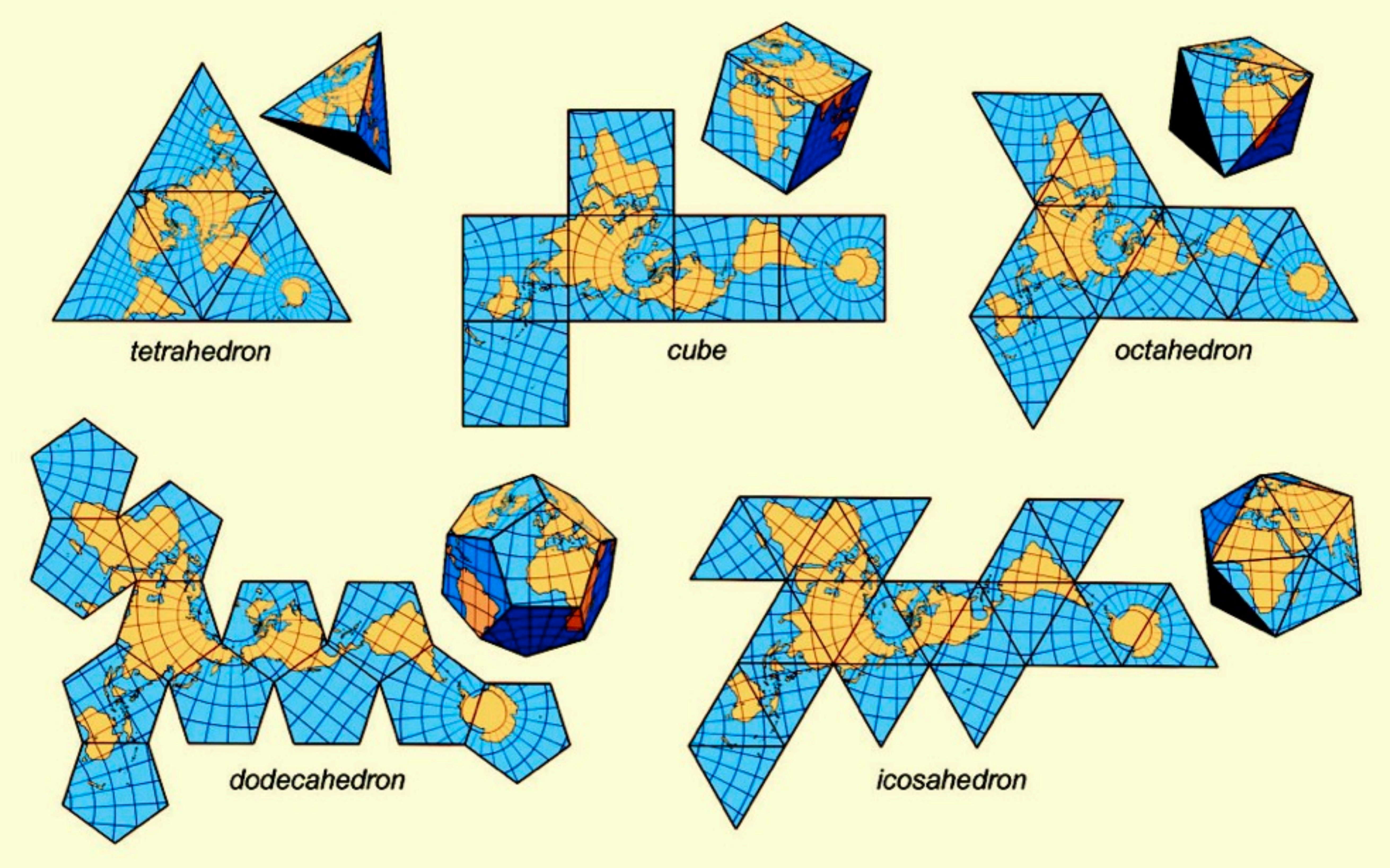
- ex: 5 levels of subdivision
- gaps quickly get small at lower subdivision levels
  - already by second level



[Fig 5, 6. Unfolding the Earth: Myriahedral Projections. van Wijk. The Cartographic Journal, Vol. 45, No. 1, pp.32-42, February 2008.]

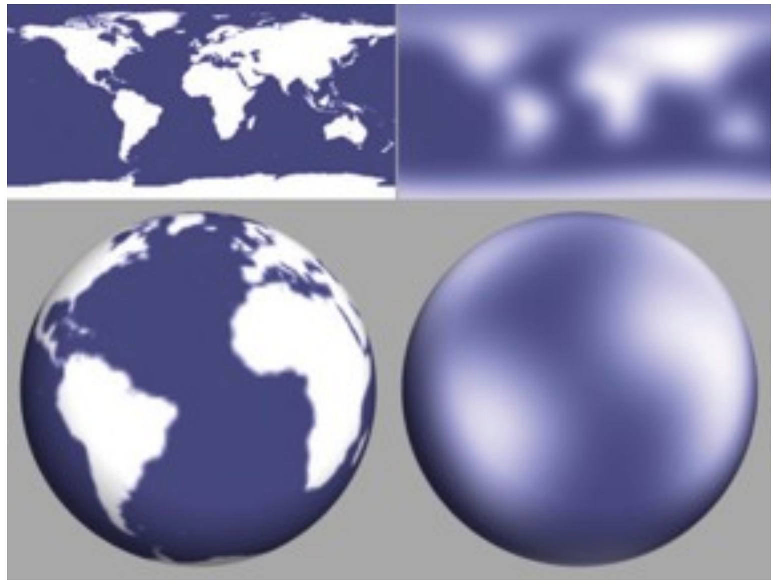
Optimal mappings

- 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



[Fig 7. Unfolding the Earth: Myriahedral Projections. van Wijk. The Cartographic Journal, Vol. 45, No. 1, pp.32-42, February 2008.]

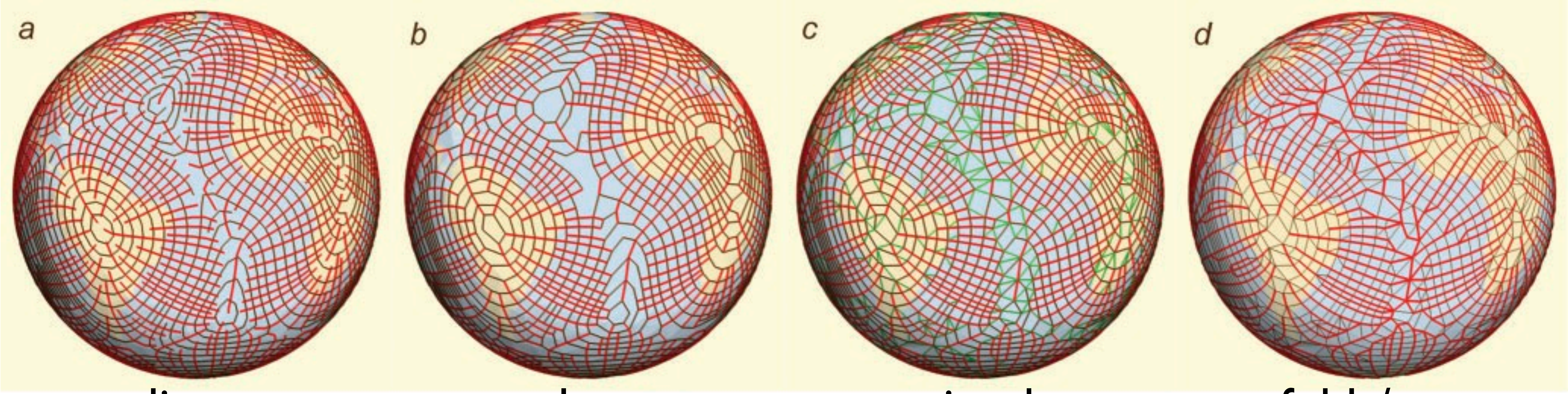
Geography aligned meshes



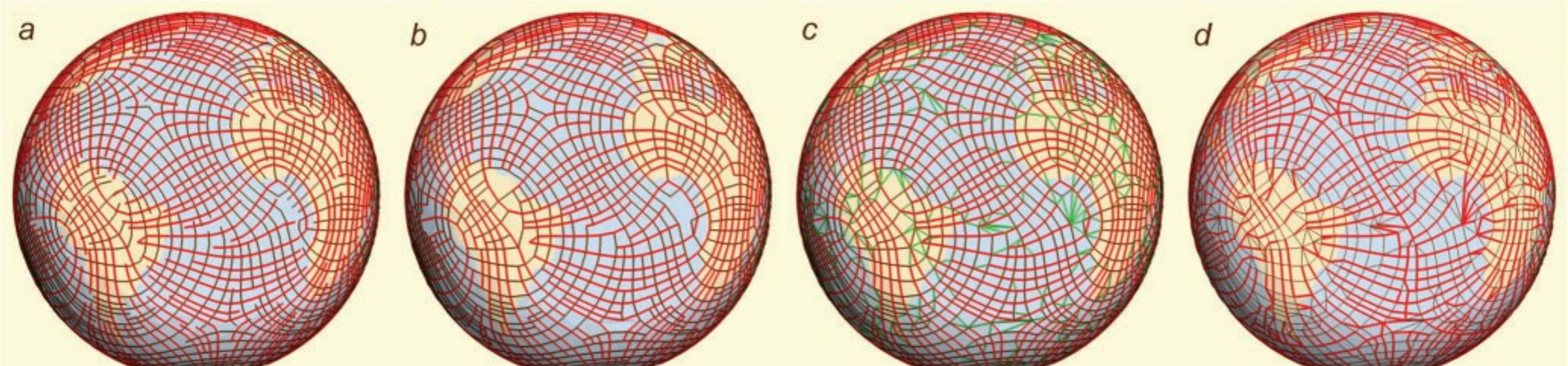
- f(ϕ, λ): high in continents, low in oceans
  - from image to matrix
- convolve (blur) with large mask
  - taking sphere curvature into account
- lines: generate from f contours
  - from flow vis alg: equally spaced streamlines in vector field
- polygons: from line intersections
- triangles: tesselate polys with > 4 edges
- folds/cuts: as before
- quality improvements hard to achieve, even with tensor vs vector field
  - so just leave boundaries fractured!

[Fig 9. Unfolding the Earth: Myriahedral Projections. van Wijk. The Cartographic Journal, Vol. 45, No. 1, pp.32-42, February 2008.]

Geography aligned meshes



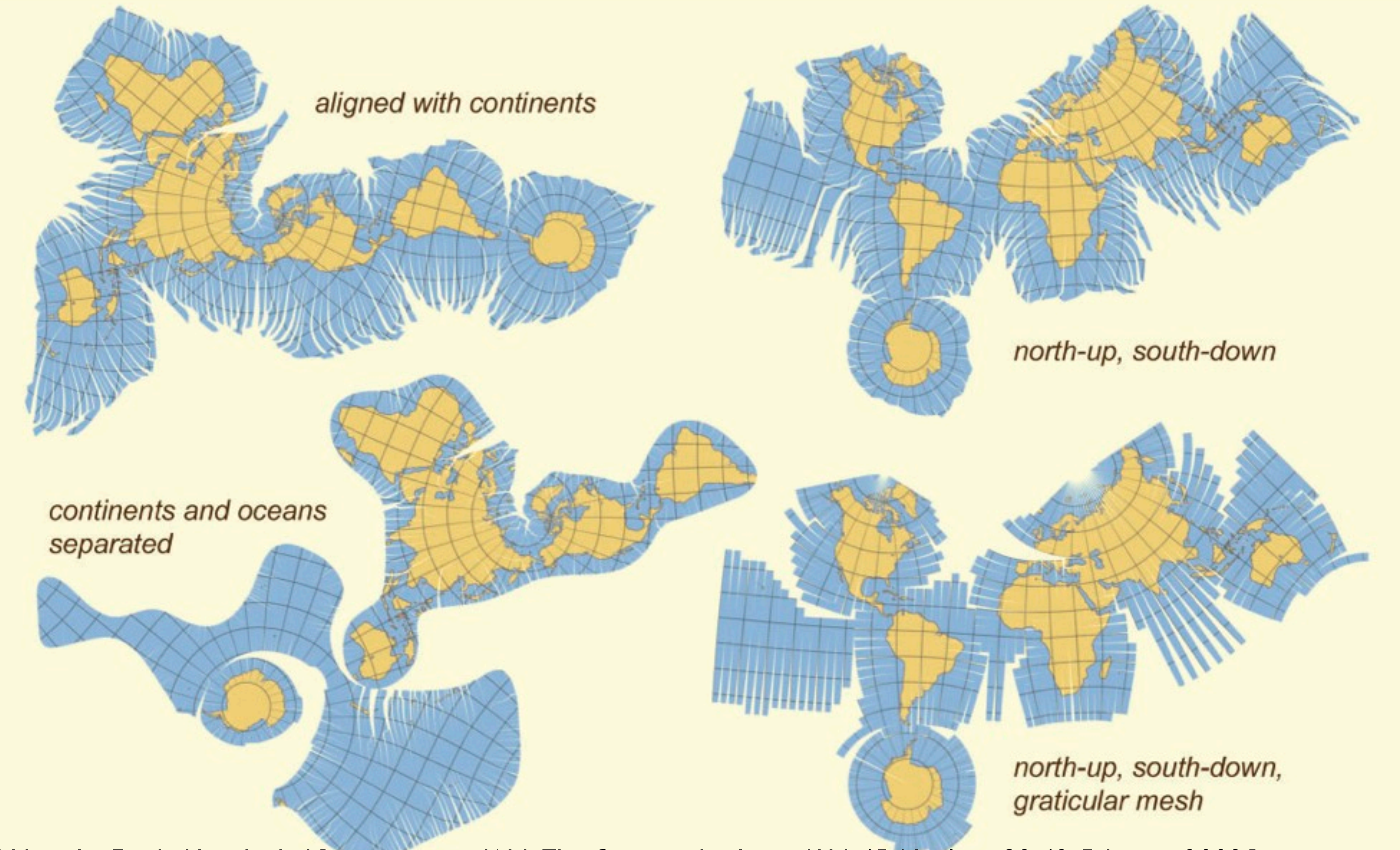
lines polygons triangles folds/cuts



tensor

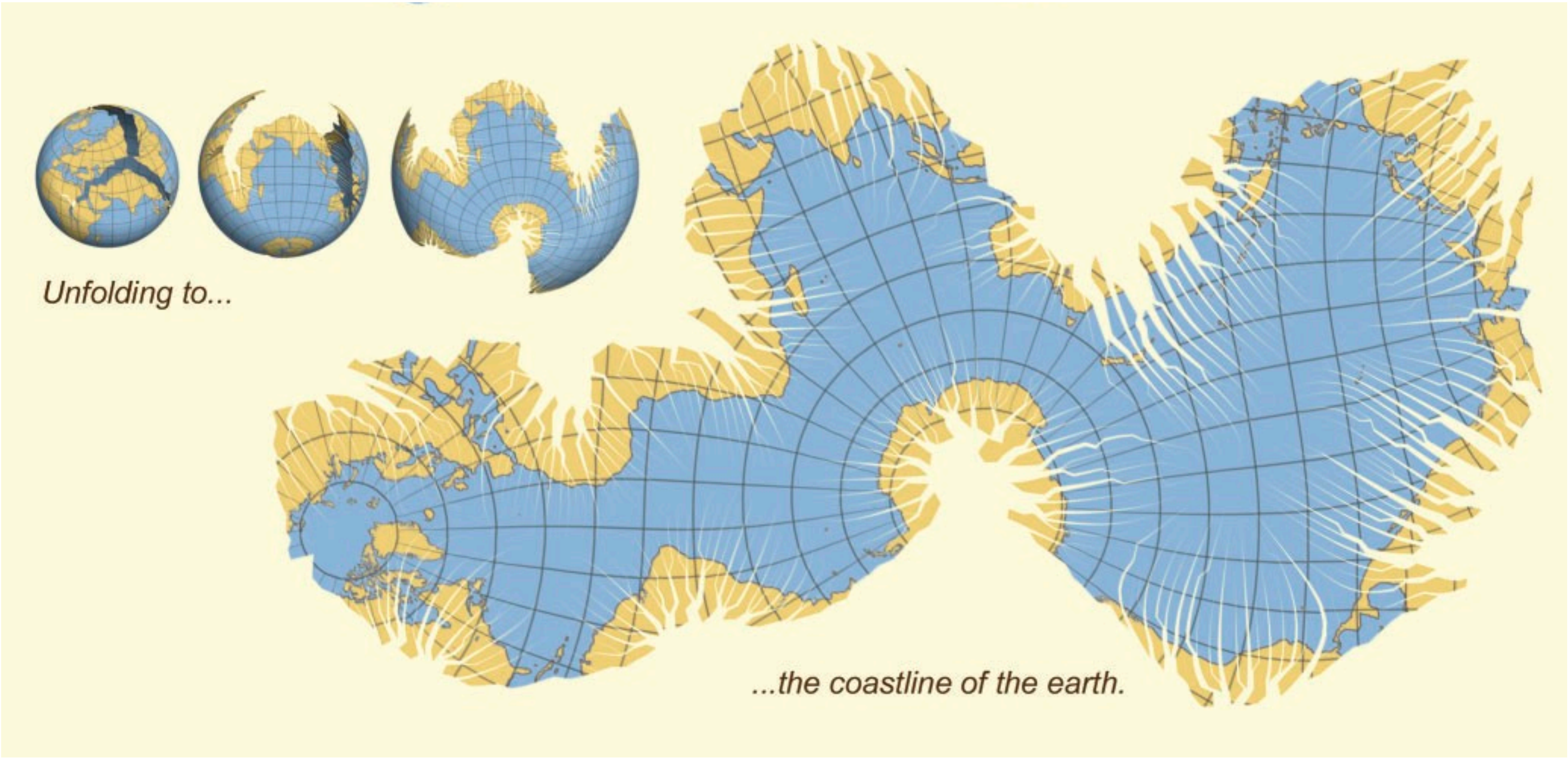
[Fig 10, 11. Unfolding the Earth: Myriahedral Projections. van Wijk. The Cartographic Journal, Vol. 45, No. 1, pp.32-42, February 2008.]

Geography aligned meshs, results



[Fig 12. Unfolding the Earth: Myriahedral Projections. van Wijk. The Cartographic Journal, Vol. 45, No. 1, pp.32-42, February 2008.]

Geography aligned meshs, results



[Fig 12. Unfolding the Earth: Myriahedral Projections. van Wijk. The Cartographic Journal, Vol. 45, No. 1, pp.32-42, February 2008.]

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