Focus+Context

Leung and Apperly taxonomy

Nonlinear Magnification Fields

2D Hyperbolic Trees

3D Hyperbolic Graphs

Intuition

Bifocal

Perspective Wall

Polyfocal: Continuous Mag
**Fisheye Views: Continuous Mag**

- Transformation
- Magnification

1D, 2D rect, polar, norm polar

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**Multiple Foci**

- Same params
- Diff params

Polyfocal magnification function dips allow this

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**Nonlinear Magnification Functions**

- Transformation
- Distortion
- Magnification
- Derivative of transformation

- Directionality
  - Easy: Compute transformation given magnification derivative
  - Hard: Compute magnification given transformation integration

- New mathematical framework
  - Approximation, integration, iterative refinement
  - Minimize "error mesh"

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**Expressiveness**

- Magnification is more intuitive control
- Allow expressiveness, data-driven expansion

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**2D Hyperbolic Trees**

- Fisheye effect from hyperbolic geometry

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**3D Hyperbolic Graphs: H3**

- Task
  - Browsing large quasi-hierarchical graphs

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[video]
Previous work: graph drawing
scalability bottleneck layout avoiding disorientation

Graph layout criteria
- minimize crossings, area, bends/curves
- maximize angular resolution, symmetry
- most criteria NP-hard
  - edge crossings (Carey and Johnson 83)
**Graph layout criteria**
- minimize: crossings, area, bends/curves
- maximize: angular resolution, symmetry

most criteria NP-hard
- edge crossings [Carey and Johnson 83]

incompatible
- Brandenburg 88

**Layout**
- problem: general problem is NP-hard

**Avoiding disorientation**
- problem: maintain user orientation when showing detail
  - hard for large datasets
  - exponential in depth: node count, space needed

**Overview and detail**
- two windows: add linked overview
  - cognitive load to correlate

**solution**
- merge overview, detail
  - "focus+context"
**Contribution: focus + context graphs**

- H3 [Munzer & Burchard 95]
- webviz [Munzer & Burchard 95]
- 3D Hip Trees [Camping et al. 96,99]
- Fuzzy Trees [Kolod & Wohlers 98]
- Cone Trees [Robertson et al. 91]

**3D hyperbolic space**

- 3-hyperboloid projects to solid ball

**H3 layout**

- circumference -> hemisphere

**Progressive rendering**

- want fast update during user interaction
  - fill in details when user is idle

- problem: dataset too big to draw in single frame

- solution: guaranteed frame rate algorithm

- progressive refinement: gradually improve image vs. standard Z-buffer
  - common in graphics [Bergman et al. 86]
  - far less attention in infographics

**H3Viewer algorithm**

- drawing queue for nodes
  - graph-theoretic
    - add parent, child nodes to queue
  - view-dependent
    - sort queue by screen area

**H3 video (excerpts)**
H3 results
scalability
  performance
    - layout
      110K edges, 12 seconds (1997: SGI IR2)
      300K edges, 16 seconds (2002: Intel P3)
    - drawing
      constant time; guaranteed frame rate
    - limited by main memory size

H3 results: scalability
information density: 10x better
H3

H3 discussion: scalability
focus + context layout
  success: large local neighborhood visible, 5-9 hops
cognitive limit: if graph diameter >> visible area

TreeJuxtaposer
extended cognitive limit
  move from local F+C to global F+C

Noneuclidean geometry
Euclid's 5th Postulate
  exactly 1 parallel line
spherical
  - geodesic = great circle
  - no parallels
hyperbolic
  - infinite parallels
Parallel vs. equidistant
euclidean: inseparable
hyperbolic: different

Exponential “amount of room”
good match for exponential node count of trees

2D hyperbolic plane embedded in 3D space
hemisphere area
hyperbolic: exponential
hyperbolic: $2 \pi \sinh^2(r)$
euclidean: polynomial
$2 \pi r^2$

Models, 2D
not just round!

Klein/projective
Poincare/conformal
Upper Half Space

Minkowski
1D
2D
the hyperboloid itself
embedded one dimension higher

1D Klein
hyperbola projects to line

2D Klein
hyperboloid projects to disk

[assets: Geometrize]
[assets: www.geomlab.com/~/ocelade/hyperboloid/hyp/shp/mibs/4hyp.mib]
[assets: graphics.com/fnd.com/papers/marzipheapers/html/node069.html]
**Klein vs Poincare**

- stereographic projection
  - transparent sphere
  - plane at south pole
  - light at north pole

  [demo: torus.math.uiuc.edu/jms/java/stereop/]

- transformation from Klein to Poincare
  - vertically project disc to hemisphere
  - stereographically project hemisphere to Poincare disc

  [video: www.geom.uiue.edu/~crabbs/hyperbolic/hyperbolic.mpg]

**graphics**

- Klein: 4x4 real matrix
- Poincare: 2x2 complex matrix

**Upper Half Space**

- "cut and unroll" Poincare
  - one point on circle goes to infinity

  [demo: www.geom.uiue.edu/~crabbs/hyperbolic/hyper/hypj2d/hypj2dapp.html]

**Models, 3D**

- Klein/projective
- Poincare/conformal
  - "inside"

  [http://graphics.stanford.edu/papers/newcon/]

  - Upper Half Space
  - Minkowski

**3D Insider**

- insider: camera also moves by hyperbolic rules
  - cool, but limited visibility

  [demo]

**3D Klein**

- 3-hyperboloid projects to solid ball

**3D Minkowski**

- 3-hyperboloid embedded in 4D space
  - light cone: special relativity
    - diagrams in 2D for clarity
  - timelike: inside cone, speed < c
  - lightlike: on cone, speed = c
  - spacelike: outside cone, speed > c
    - can’t affect