Hyperbolic tree

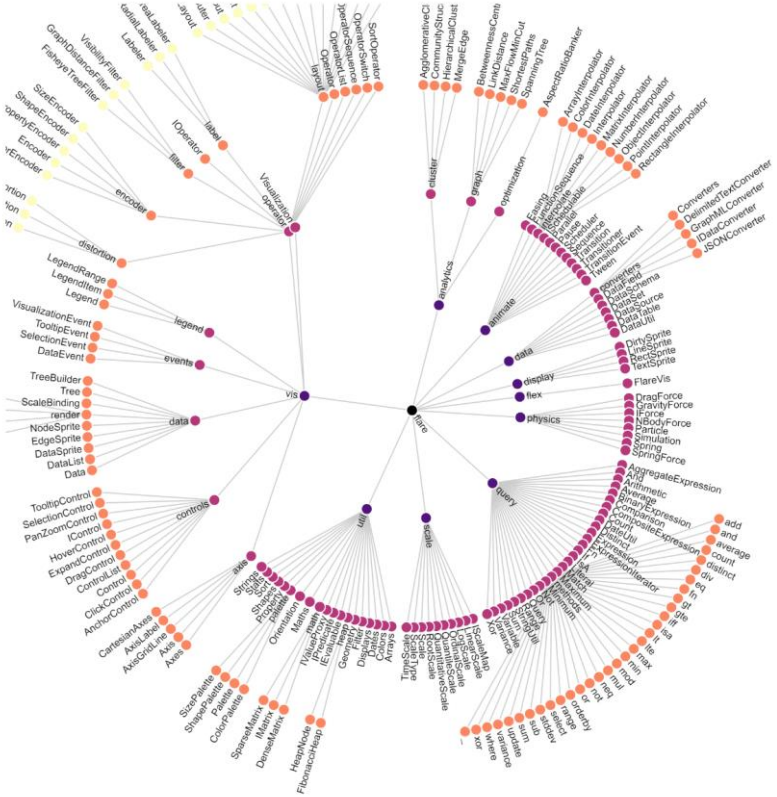
Visualizing hierarchical trees using hyperbolic space

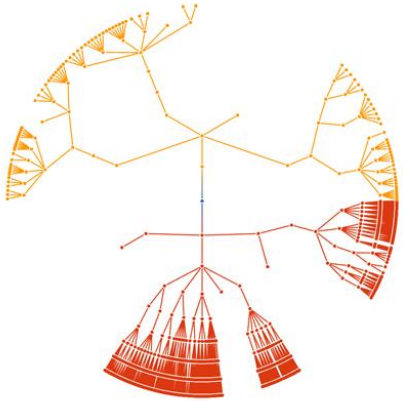
Hyperbolic tree

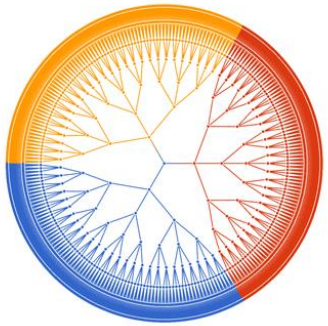
- “Hyperbolic graph layout uses a context + focus technique to represent and manipulate large tree hierarchies on limited screen size”.
- “The root is placed at the center while the children are placed at an outer ring to their parents”.
- “Hyperbolic layout uses a nonlinear (distortion) technique to accommodate focus and context for a large number of nodes”. (compare to radial trees)
- “To ensure that nodes do not overlap each other, hyperbolic layout algorithms assign an open angle for each node”.

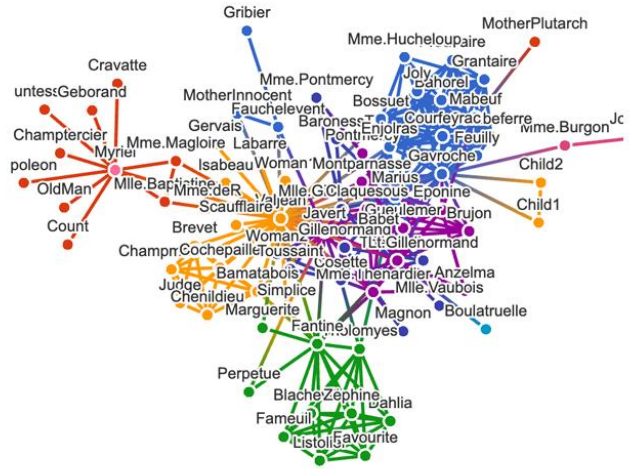
Ref: http://iv.slis.indiana.edu/sw/hyptree.html

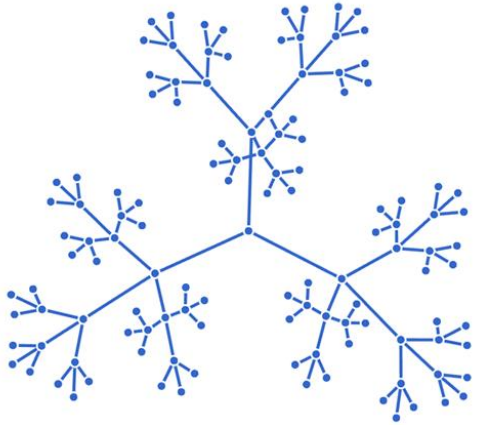
Graph visualizations: some examples







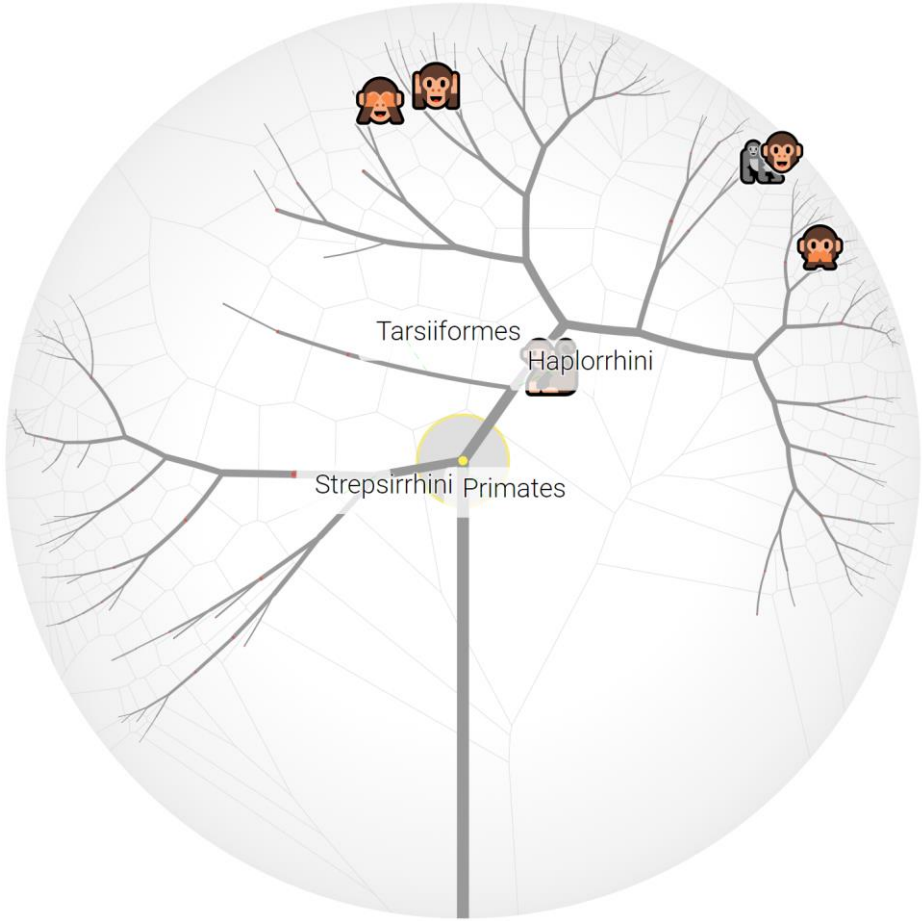




https://vega.github.io/vega/examples/radial-tree-layout/

https://www.elgrapho.com/

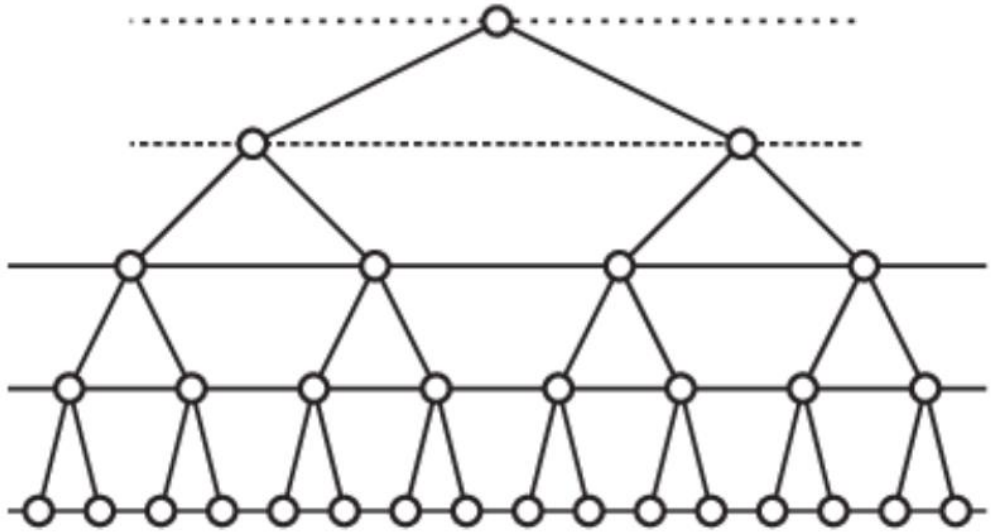
D3: Radial tree and Hypertree

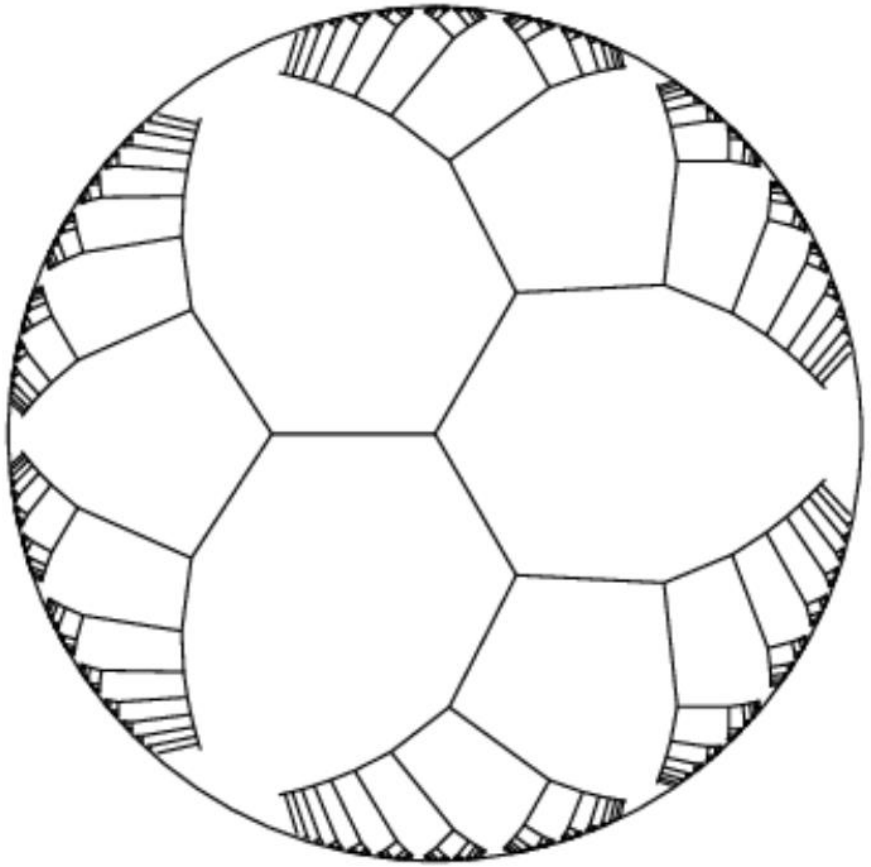


https://observablehq.com/@d3/radial-tidy-tree

https://glouwa.github.io/d3-hypertree/

Hierarchy -> Hyperbolic tree

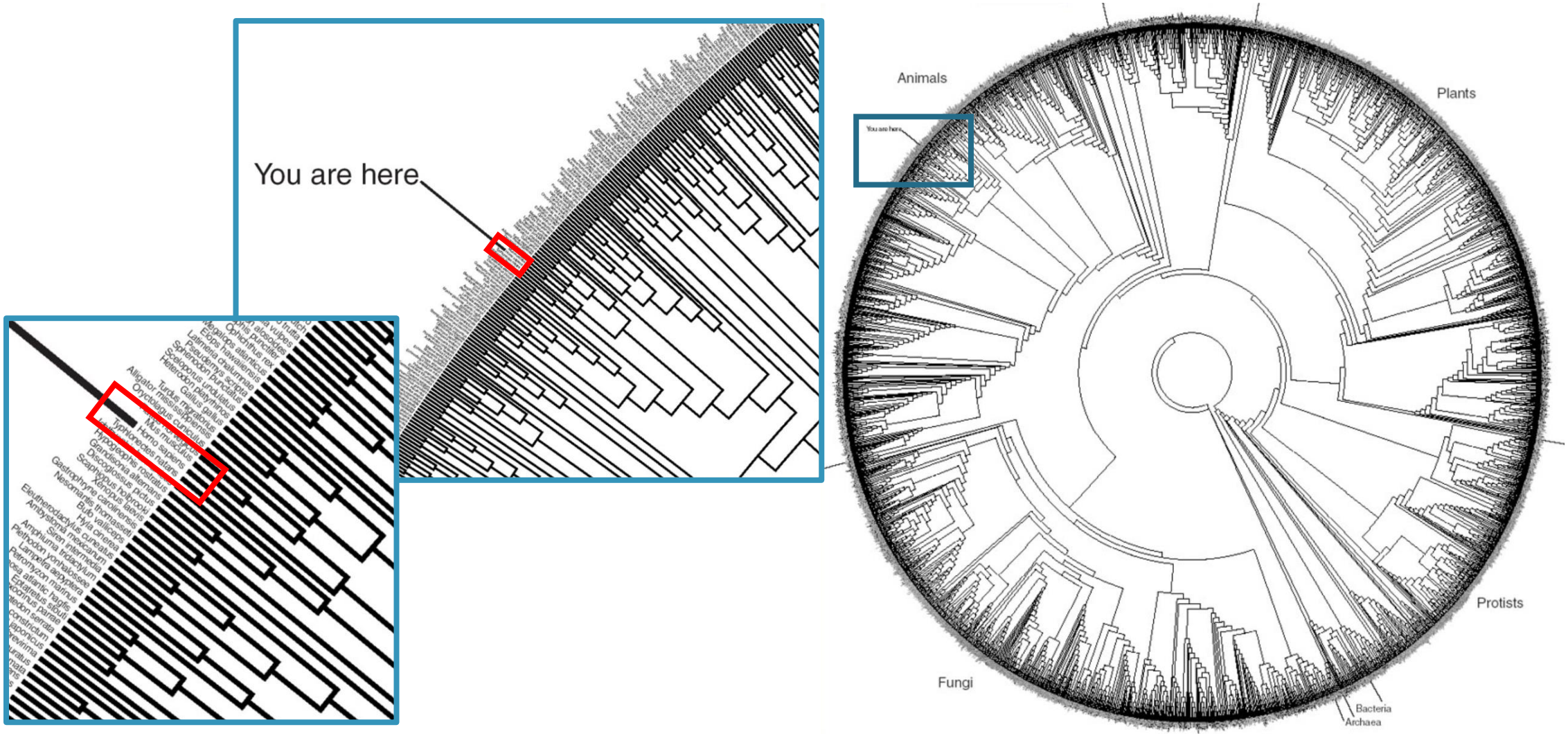




Baek, Seung Ki et al. “Ising model on a hyperbolic plane with a boundary.”

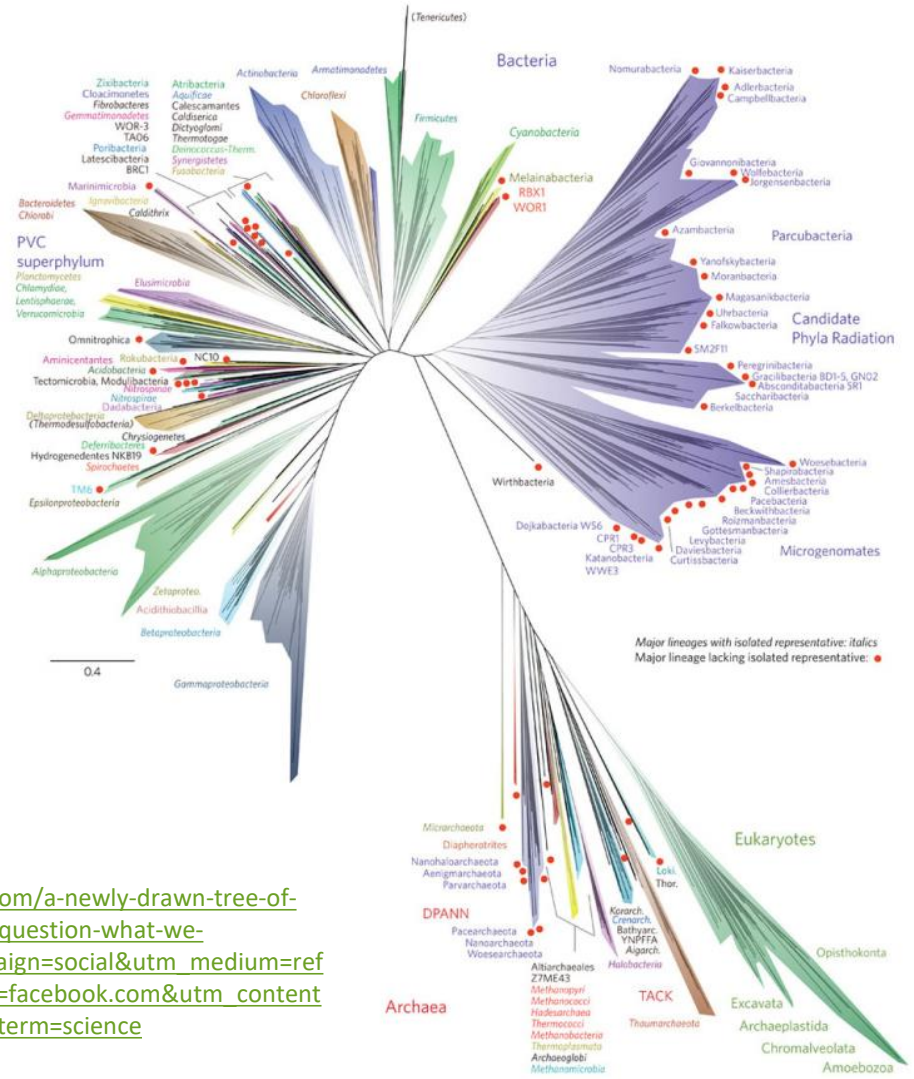
Physical review. E, Statistical, nonlinear, and soft matter physics 84 3 Pt 1 (2011): 032103 .

Phylogenetic tree (Radial Dendrogram)

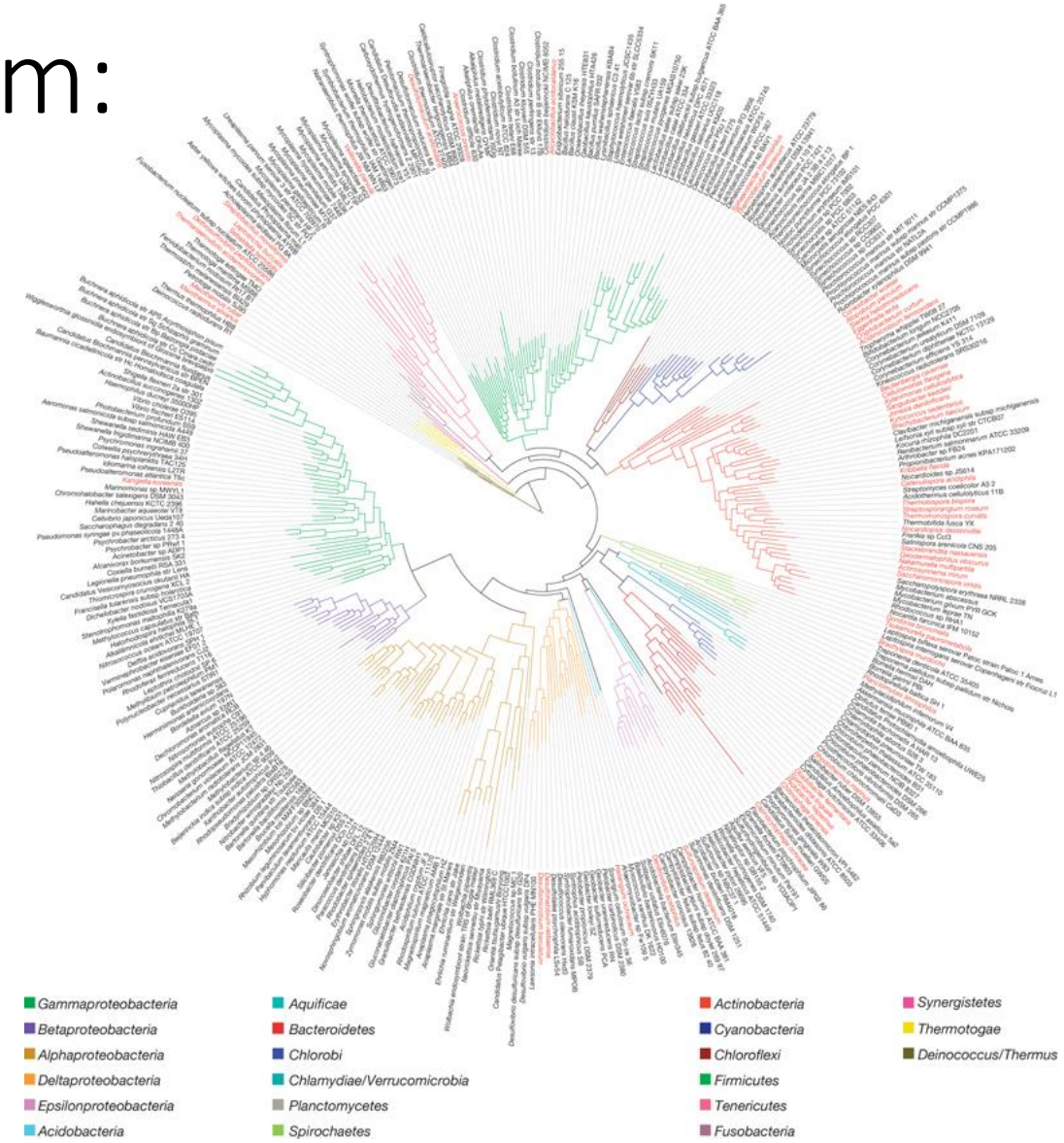


http://www.zo.utexas.edu/faculty/antisense/tree.pdf

Tree of life space problem:

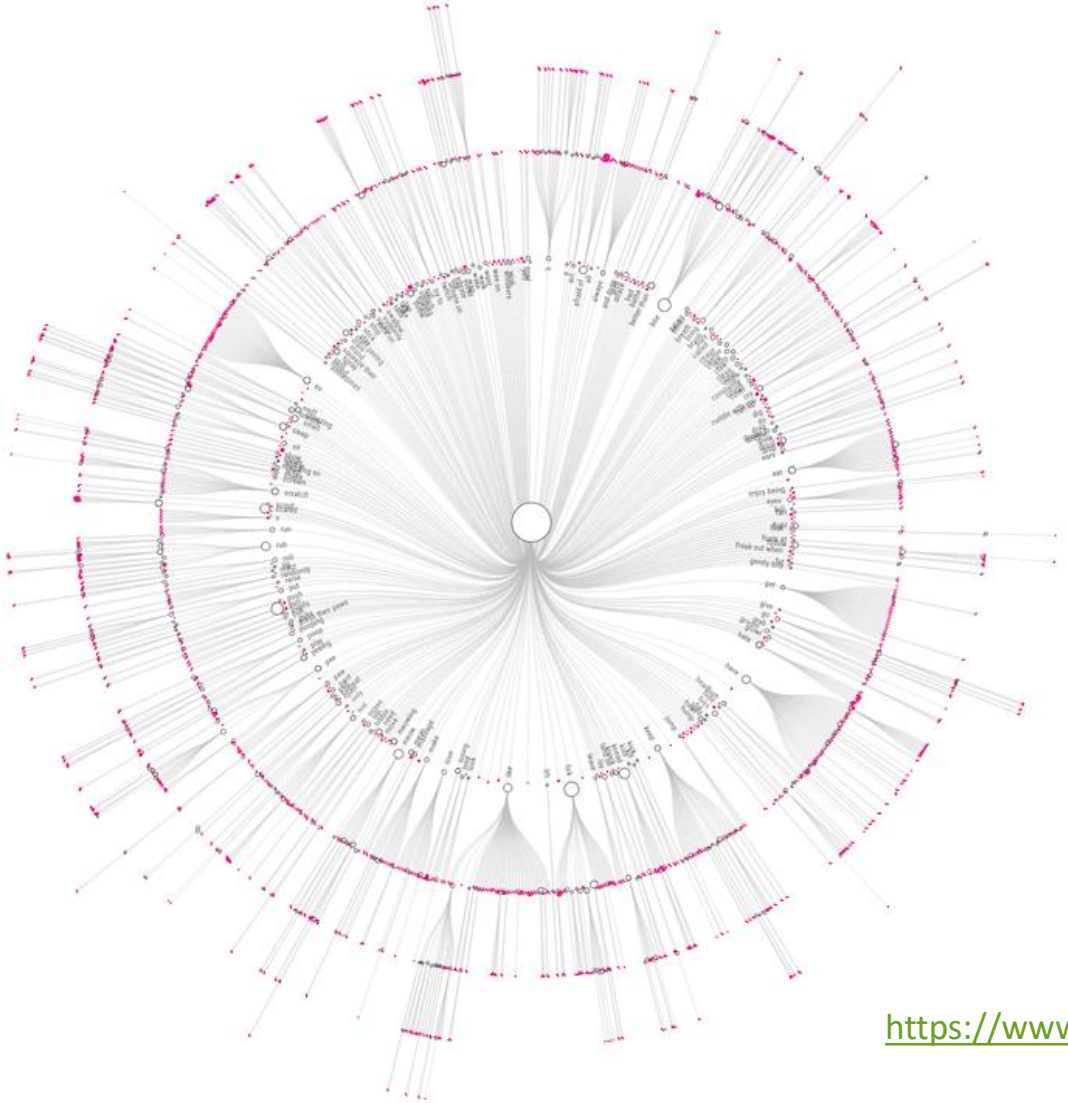


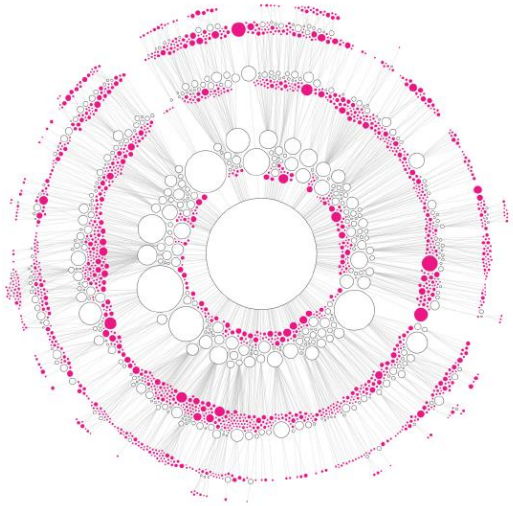
https://ideas.ted.com/a-newly-drawn-tree-of-life-reminds-us-to-question-what-we-know/?utm_campaign=social&utm_medium=referral&utm_source=facebook.com&utm_content=ideas-blog&utm_term=science

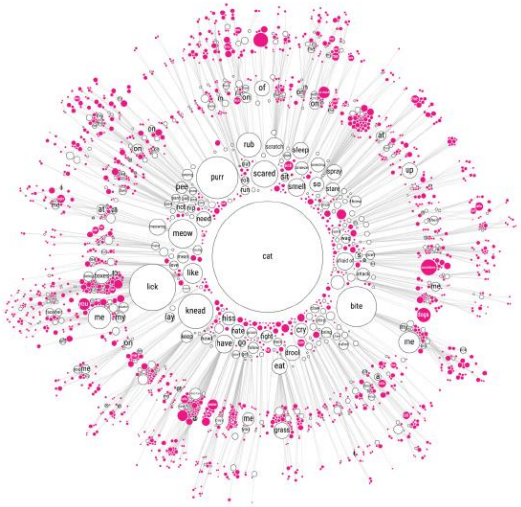


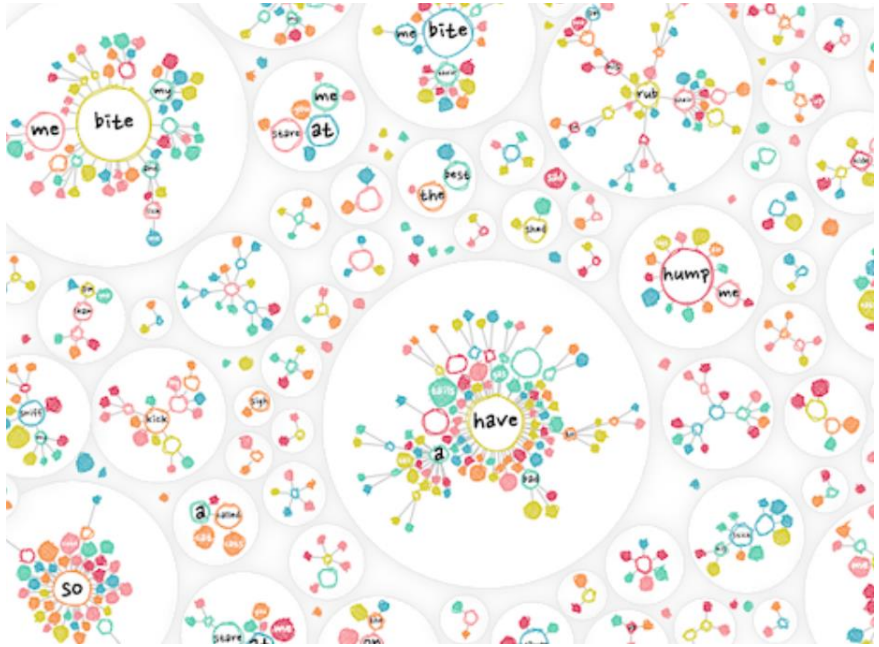
https://www.edwardtufte.com/bboard/q-and-a-fetch-msg?msg_id=0002QF

The problem of space:





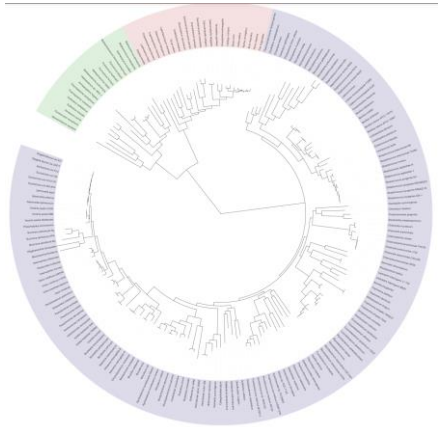




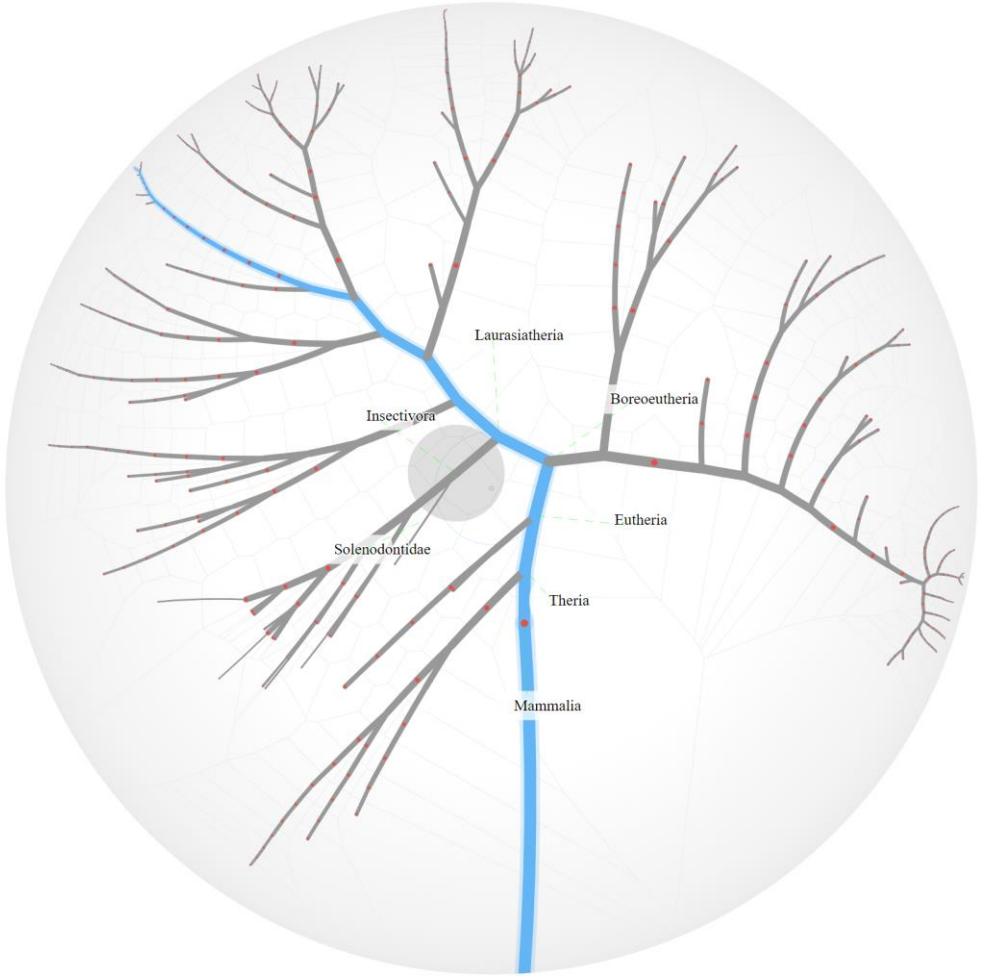
https://www.visualcinnamon.com/2019/04/designing-google-cats-and-dogs.html

Tree of life space problem solved?

http://tolweb.org/tree/phylogeny.html

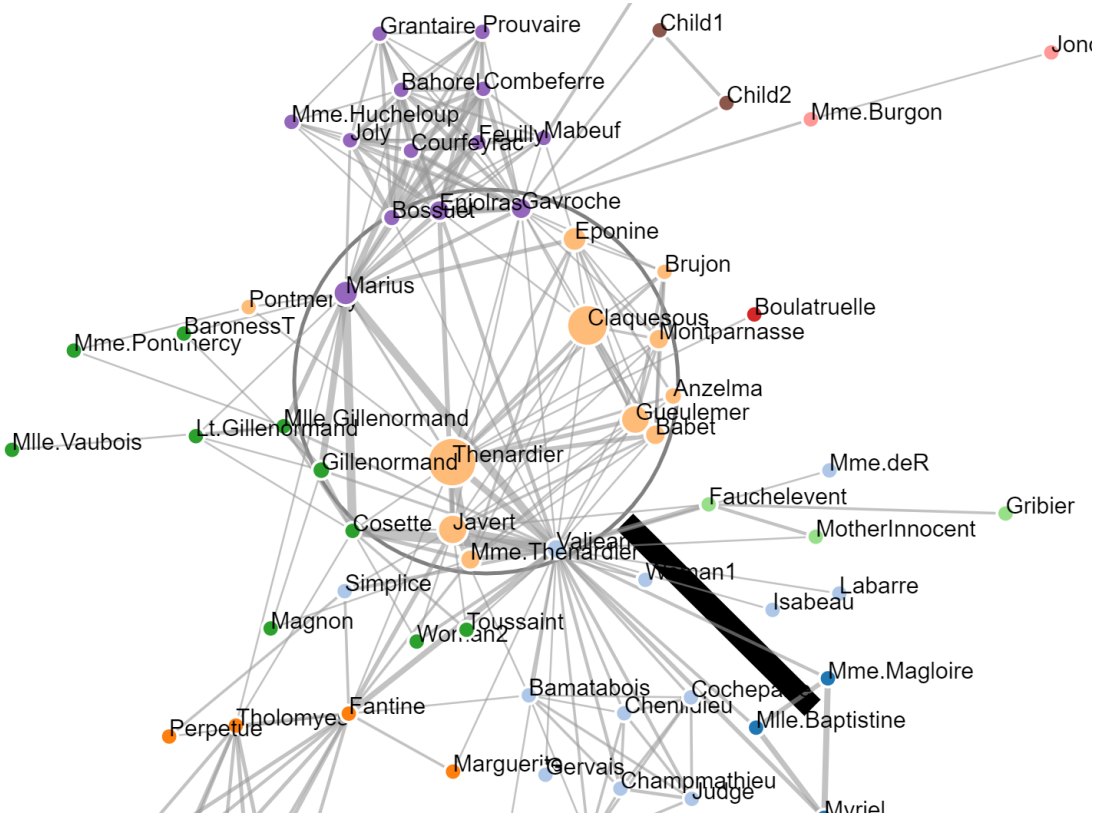


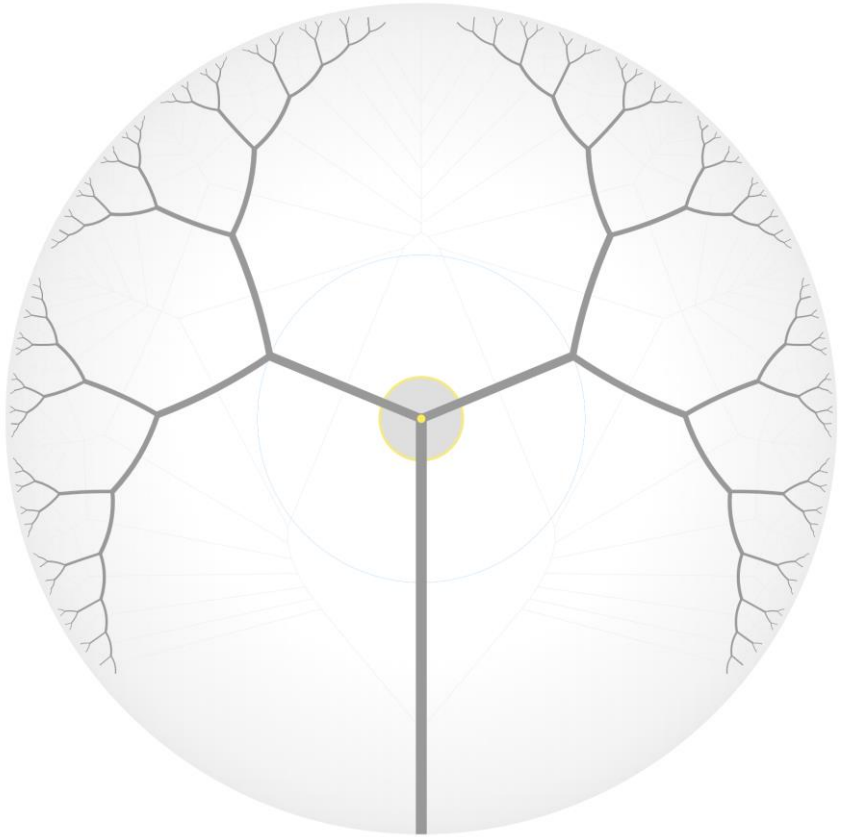
https://itol.embl.de/itol.cgi



https://glouwa.github.io/d3-hypertree-examples/examples-html/minimal-ajax/

Fish-eye?



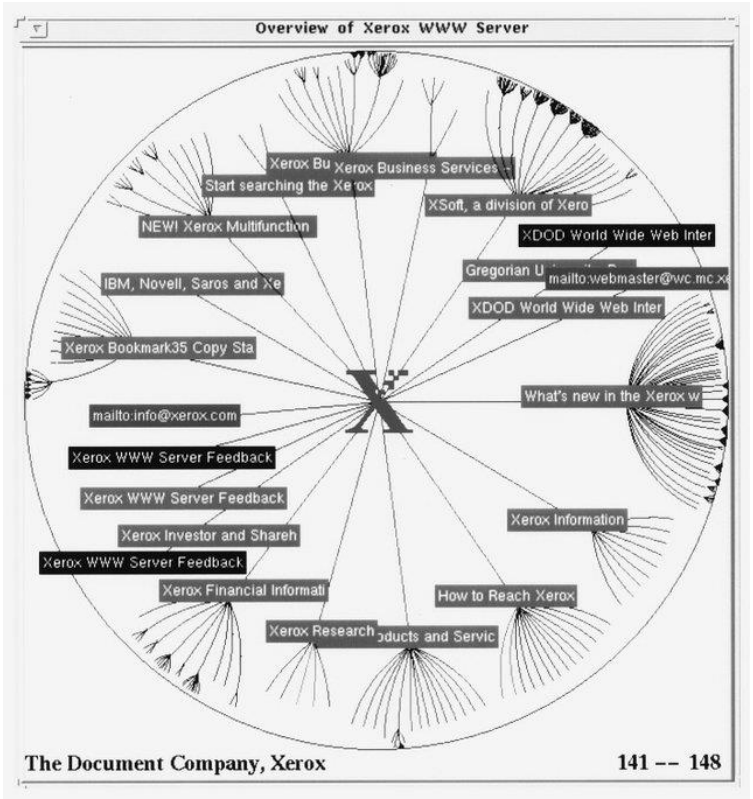


https://blockbuilder.org/fernoftheandes/8637581
http://bl.ocks.org/fernoftheandes/8637581

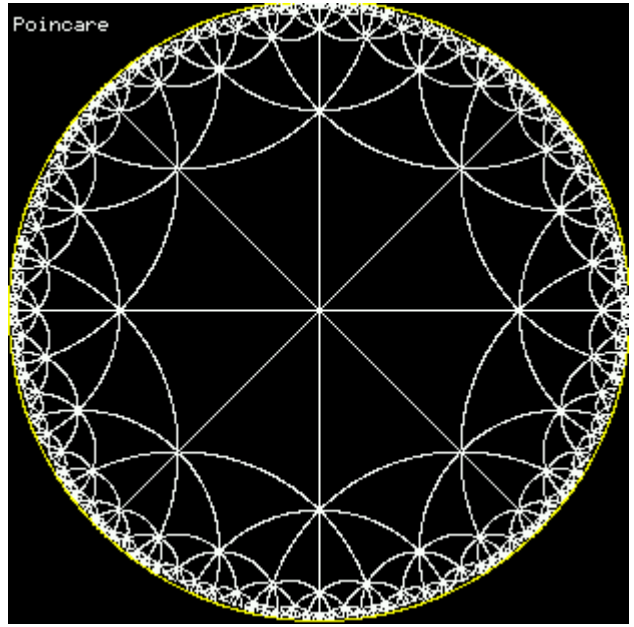
https://glouwa.github.io/d3-hypertree-examples/examples-html/minimal-generated/

The Xerox Browser (patent)

- https://www.youtube.com/watch?v=pwpze3RF55o

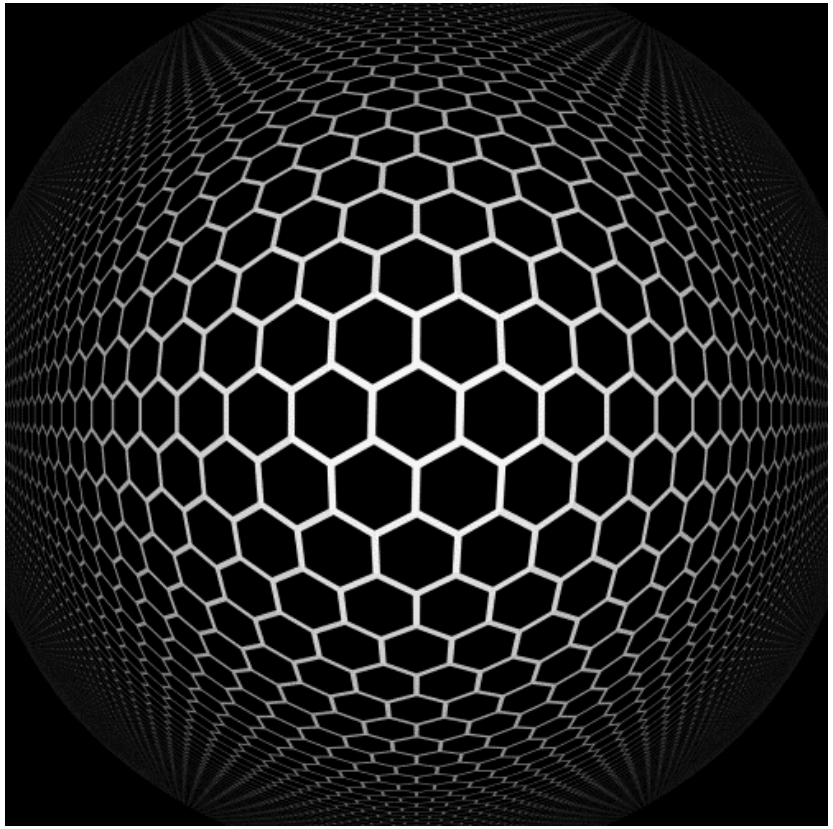


https://www.researchgate.net/publication/2358929_Visual_Information_Foraging_in_a_Focus_Context_Visualization

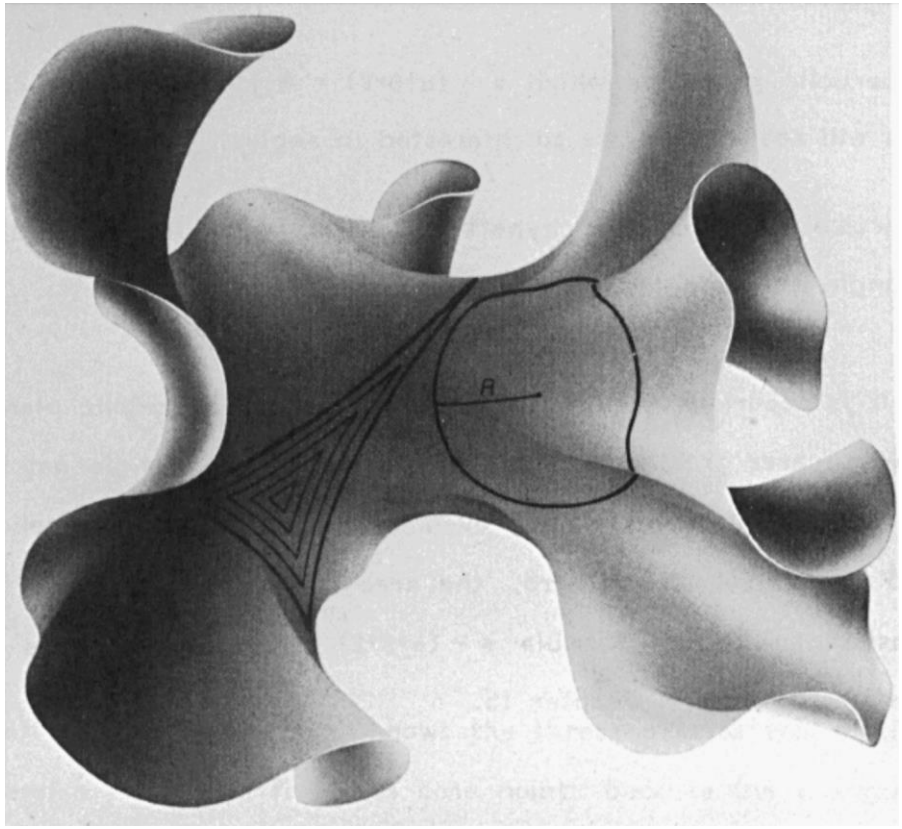


https://www.techfak.uni-bielefeld.de/~walter/h2vis/

Hyperbolic space



https://qualiacomputing.com/2016/12/12/the-hyperbolic-geometry-of-dmt-experiences/



http://graphics.stanford.edu/papers/munznerthesis/html/node8.html

hemisphere area

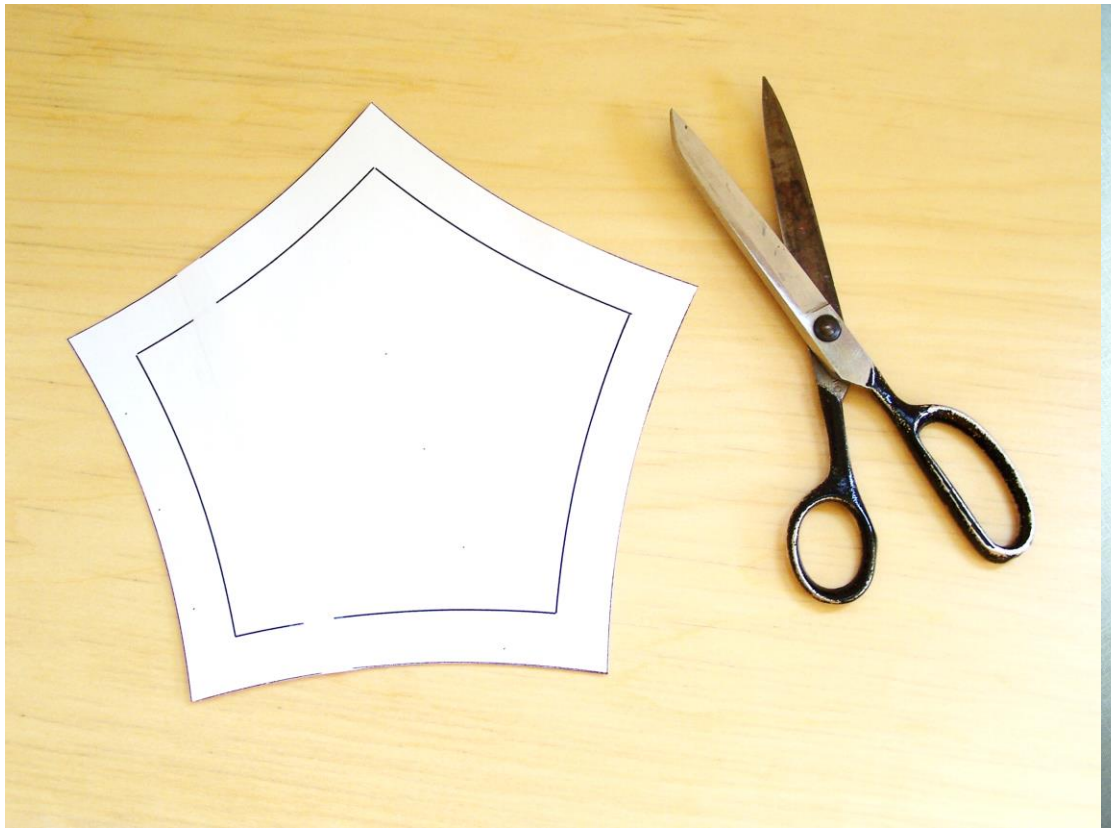
hyperbolic: exponential

$$2\pi \sinh^2(r)$$

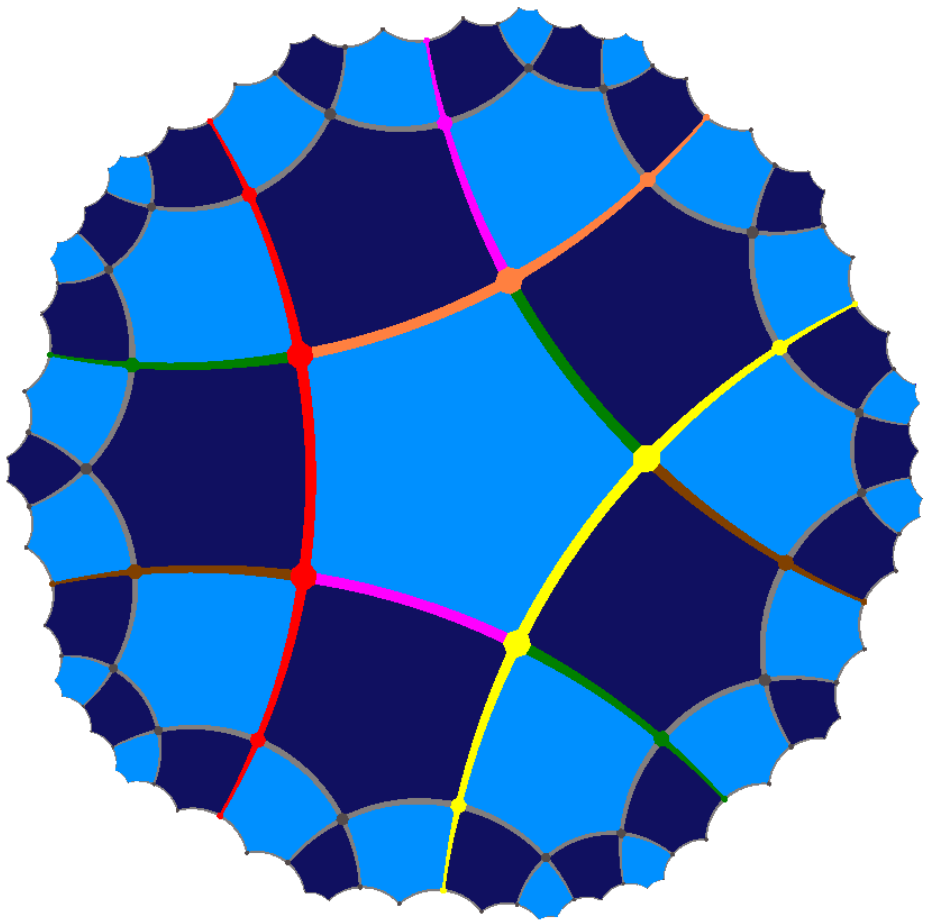
euclidean: polynomial

$$2\pi r^2$$

Hyperbolic space blanket

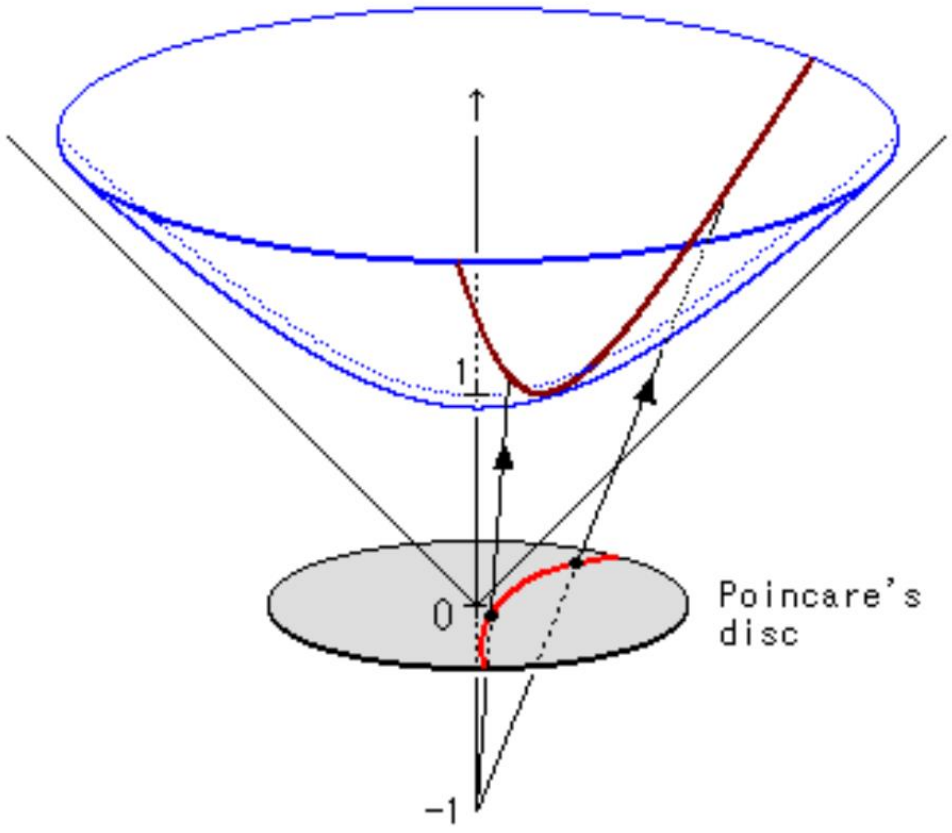


Hyperbolic space blanket

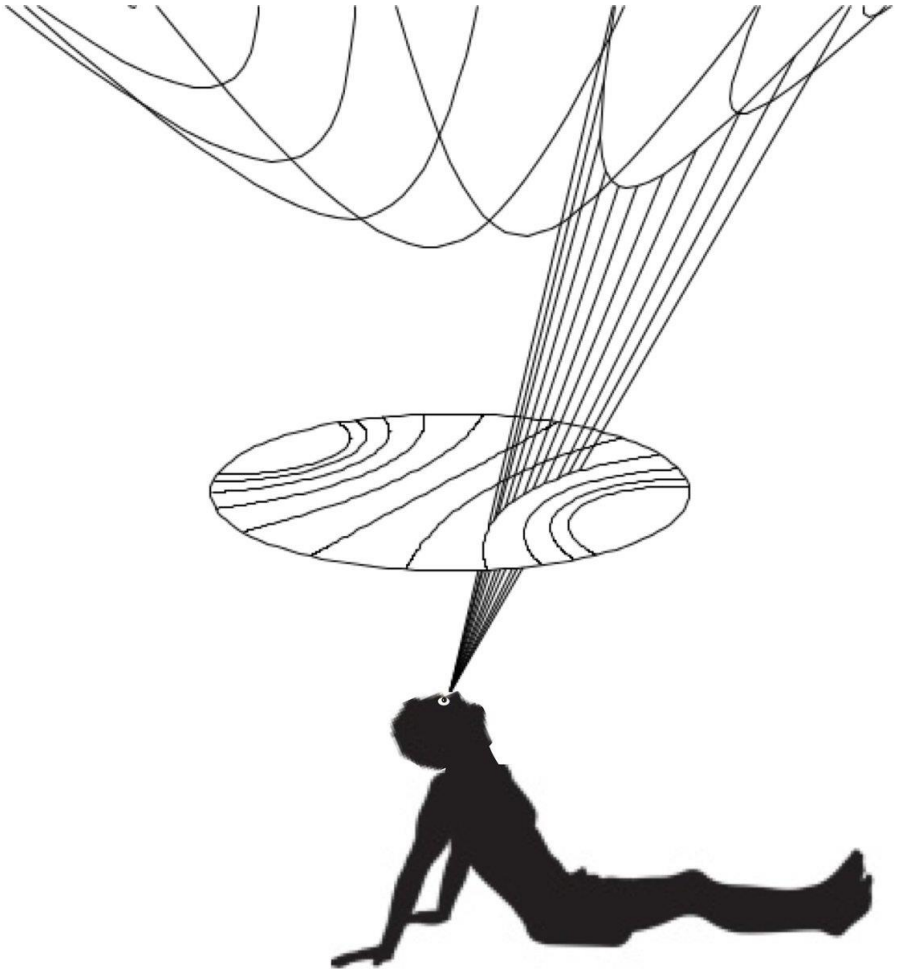


http://geometrygames.org/HyperbolicGames/index.html

The Poincare disc



http://web1.kcn.jp/hp28ah77/us3_poinc.htm

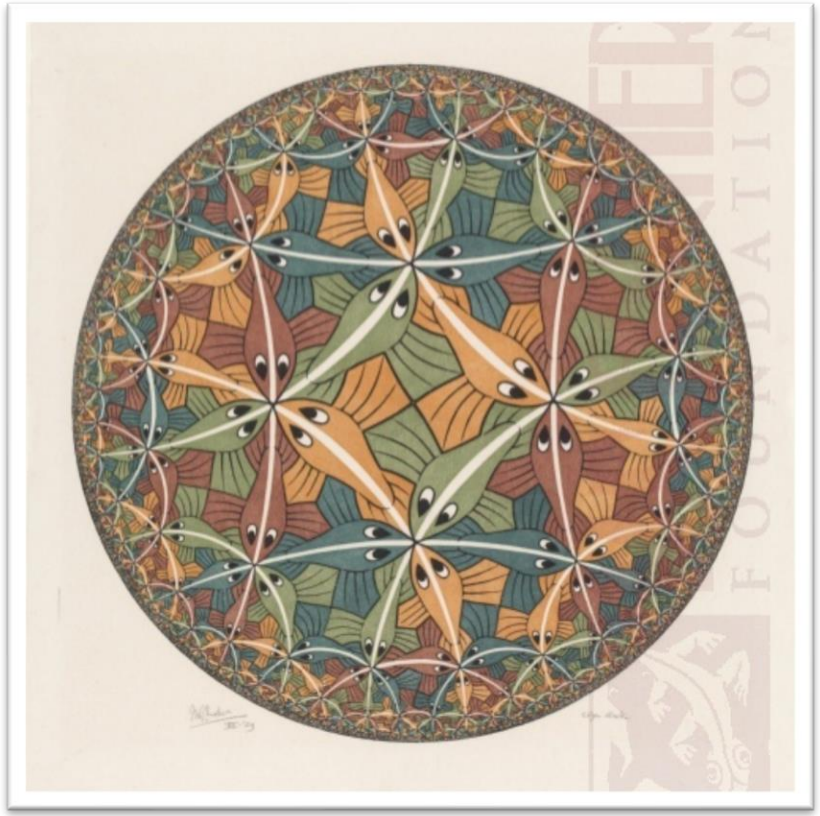


https://twitter.com/mathemaniac/status/753728363563331584

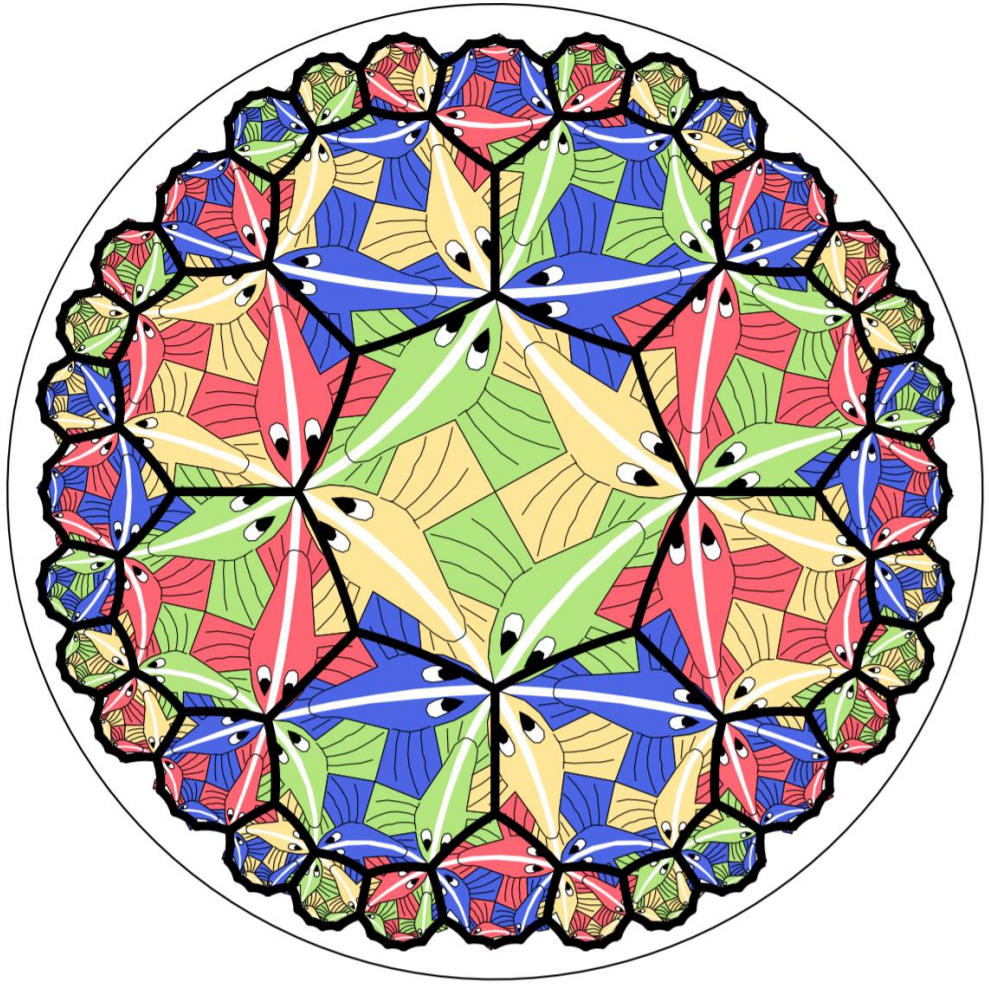
The Poincare disc

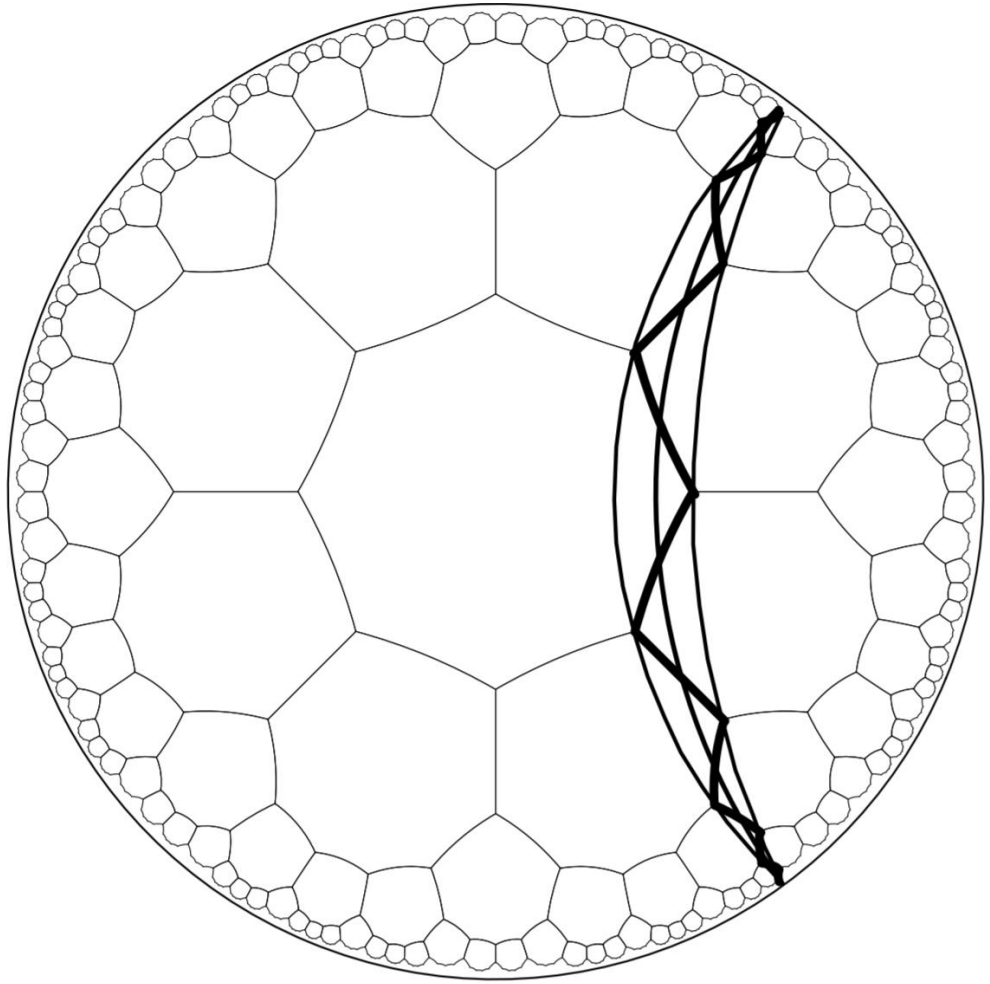
- Example: MC Escher

Ref: https://mcescher.com/gallery/mathematical/

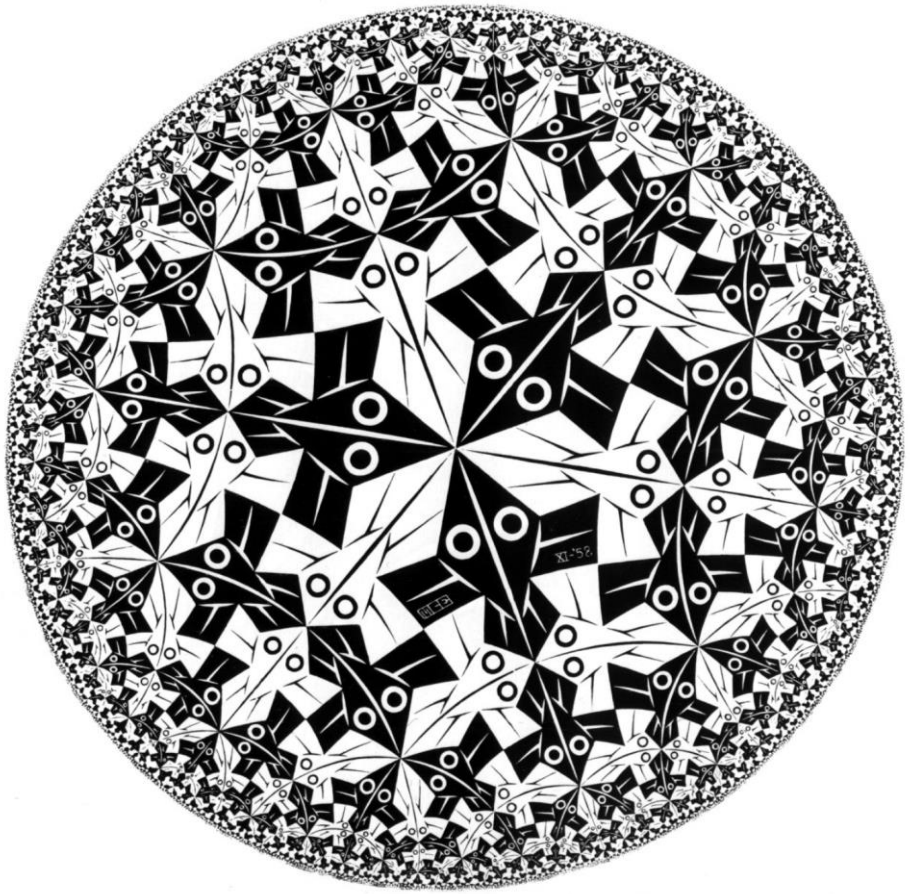


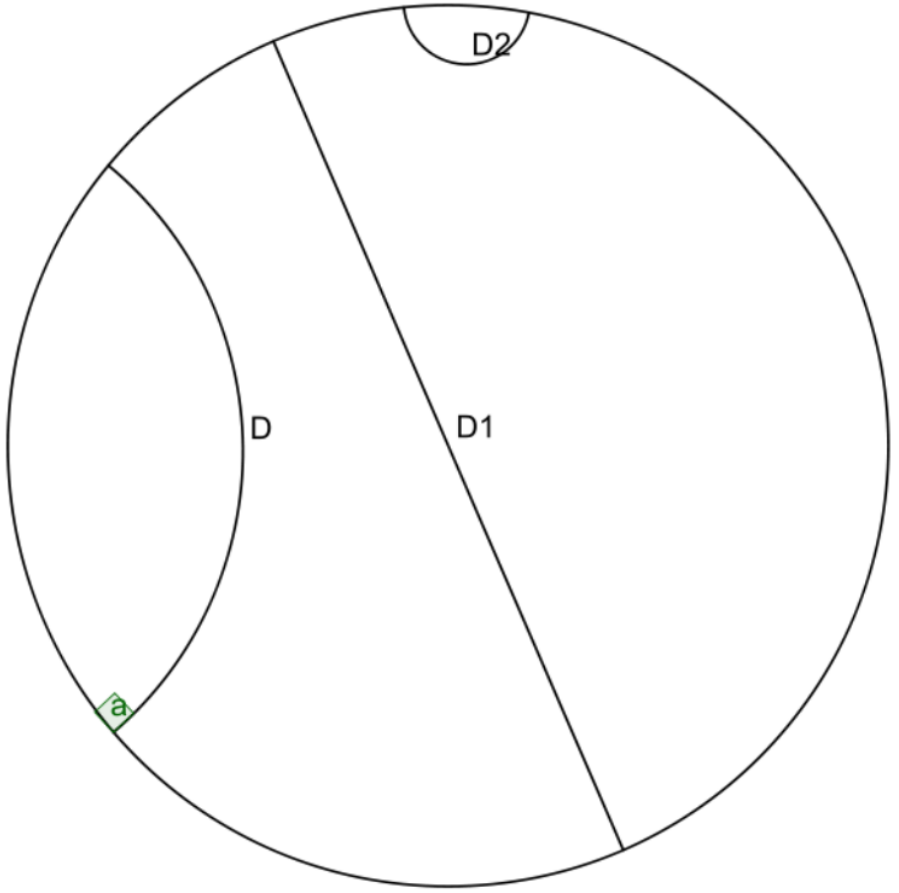
Escher and the Poincare disc





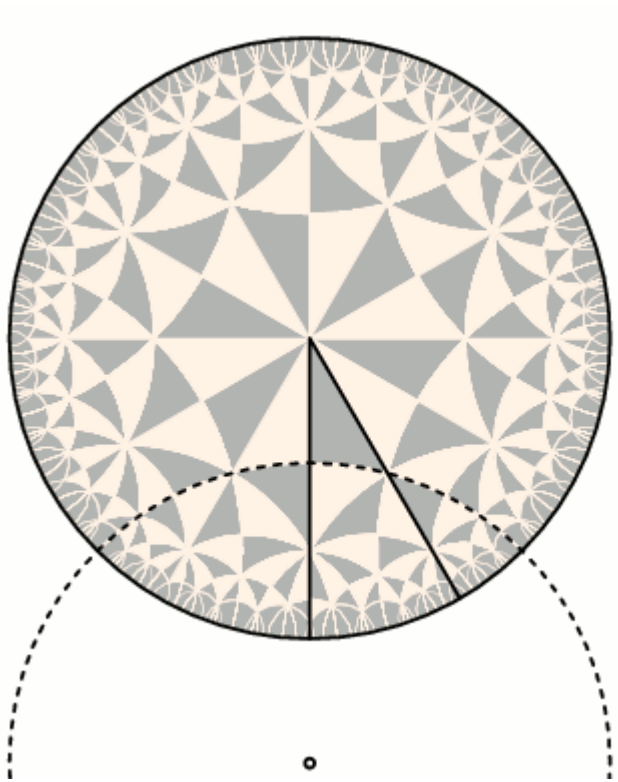
Escher and the Poincare disc

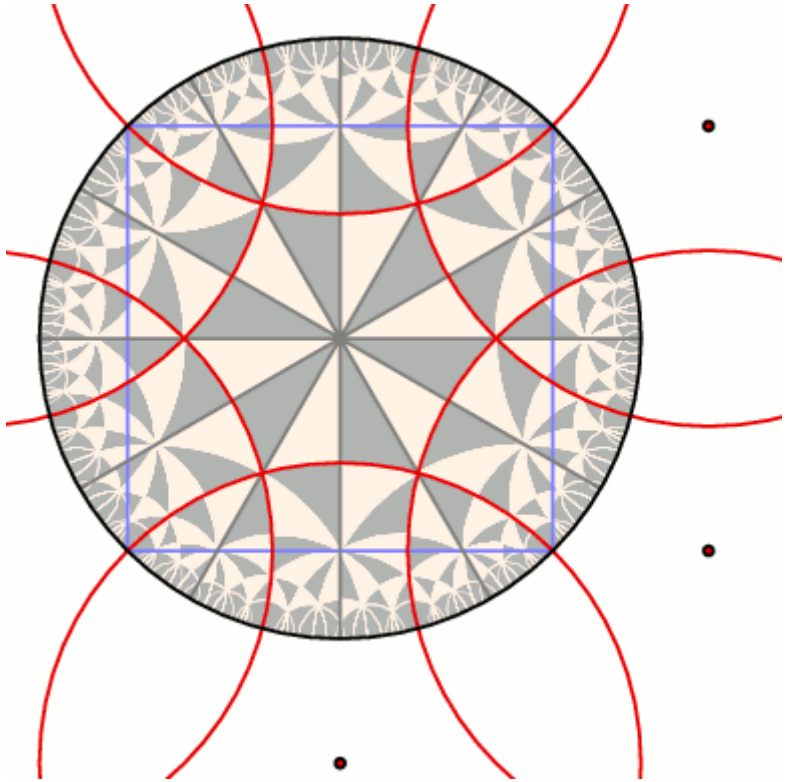


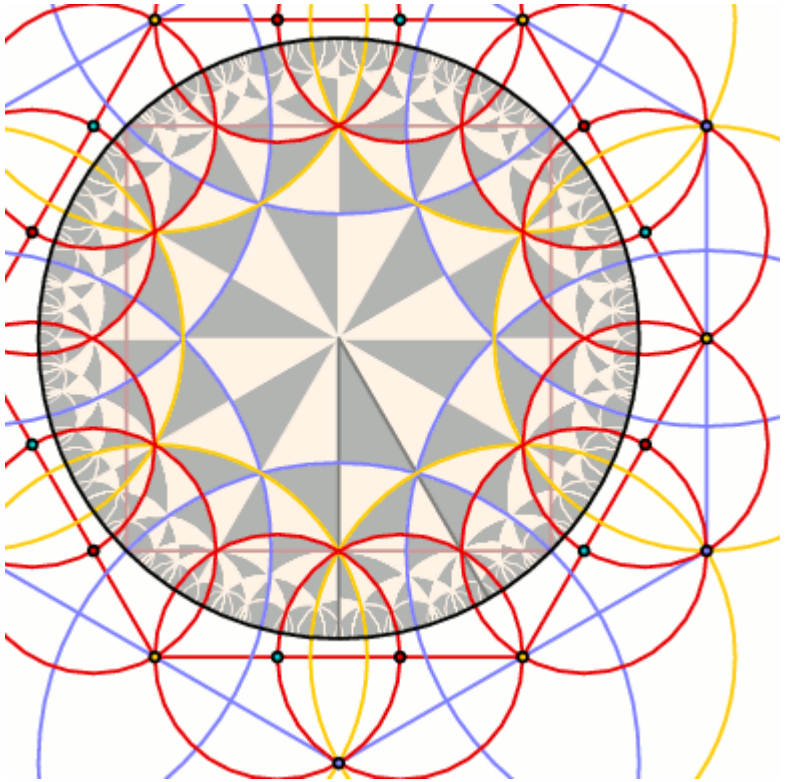


Circle Limit I M.C. Escher Date: 1958
https://www.wikiart.org/en/m-c-escher/circle-limit-i

The Poincare disc

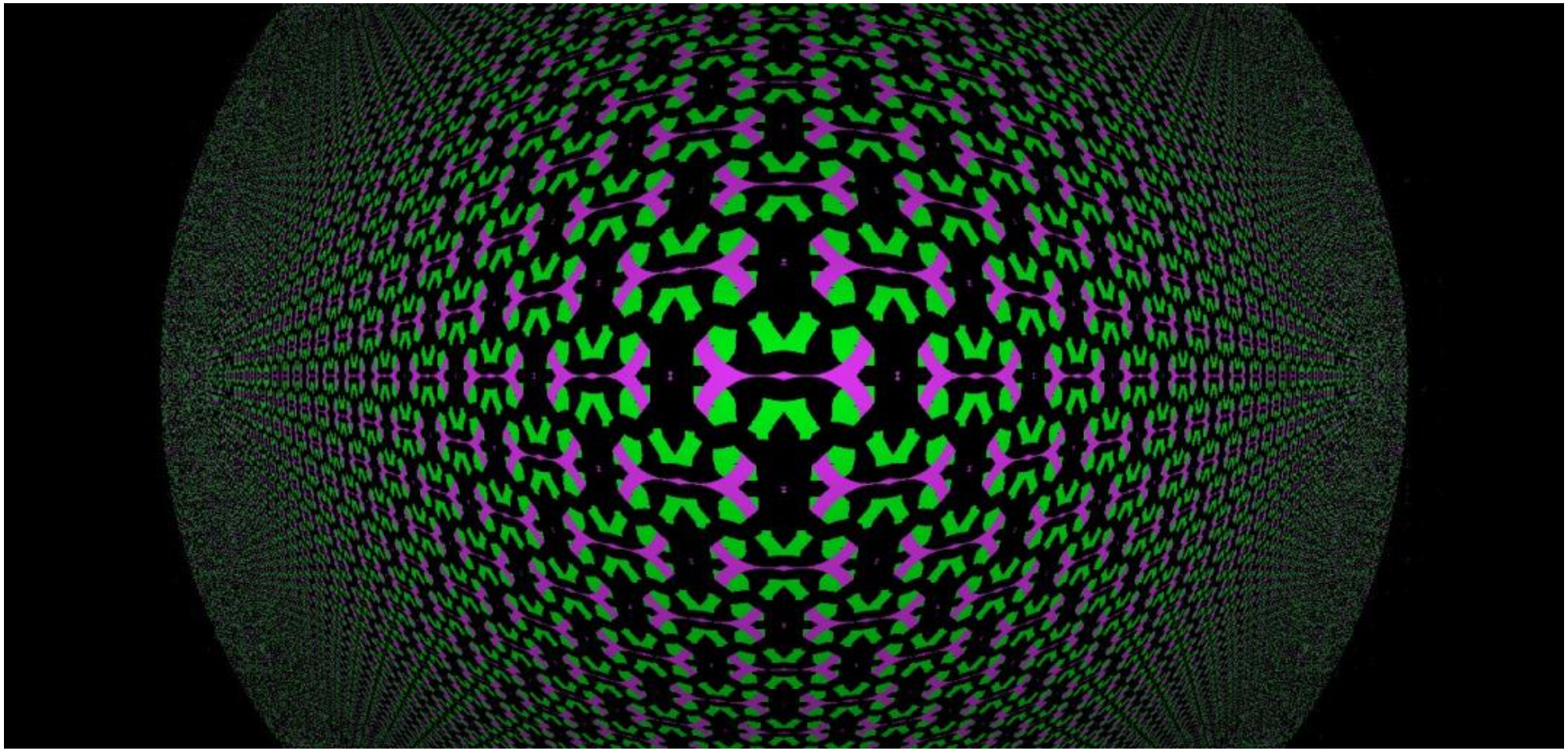






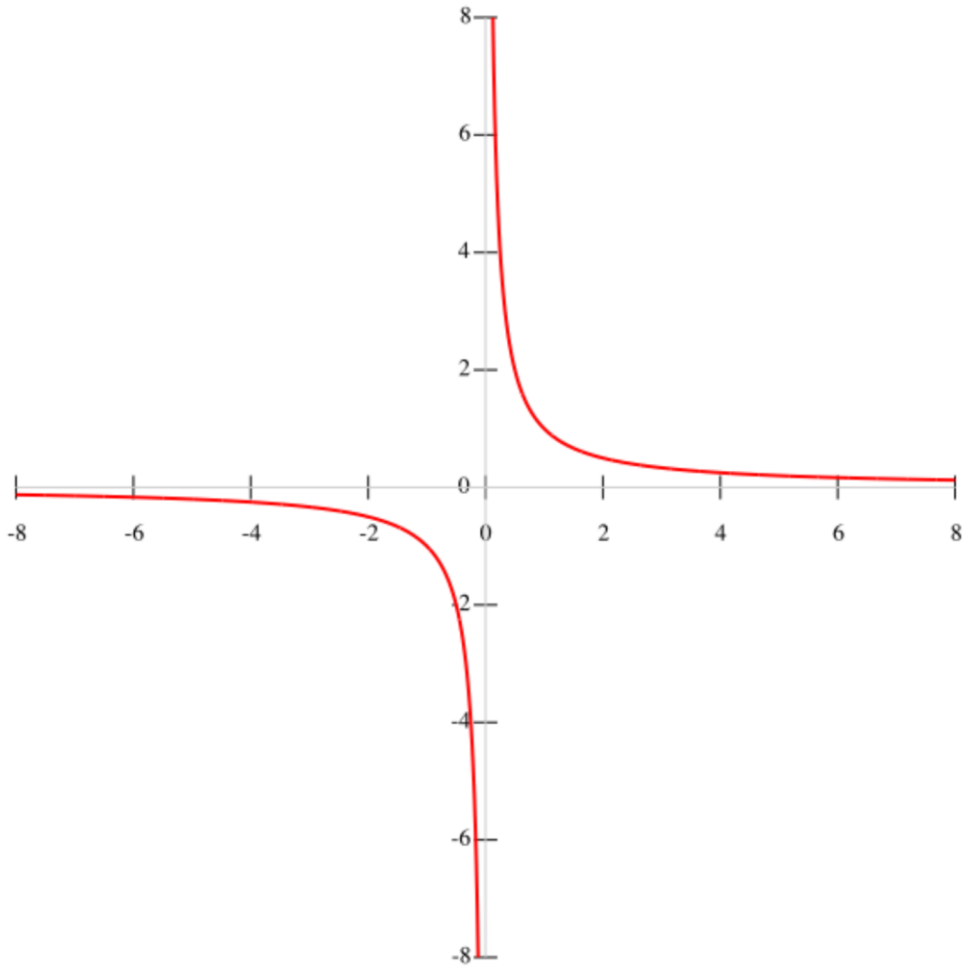
http://www.ams.org/publicoutreach/feature-column/fcarc-circle-limit

Hyperbolic space

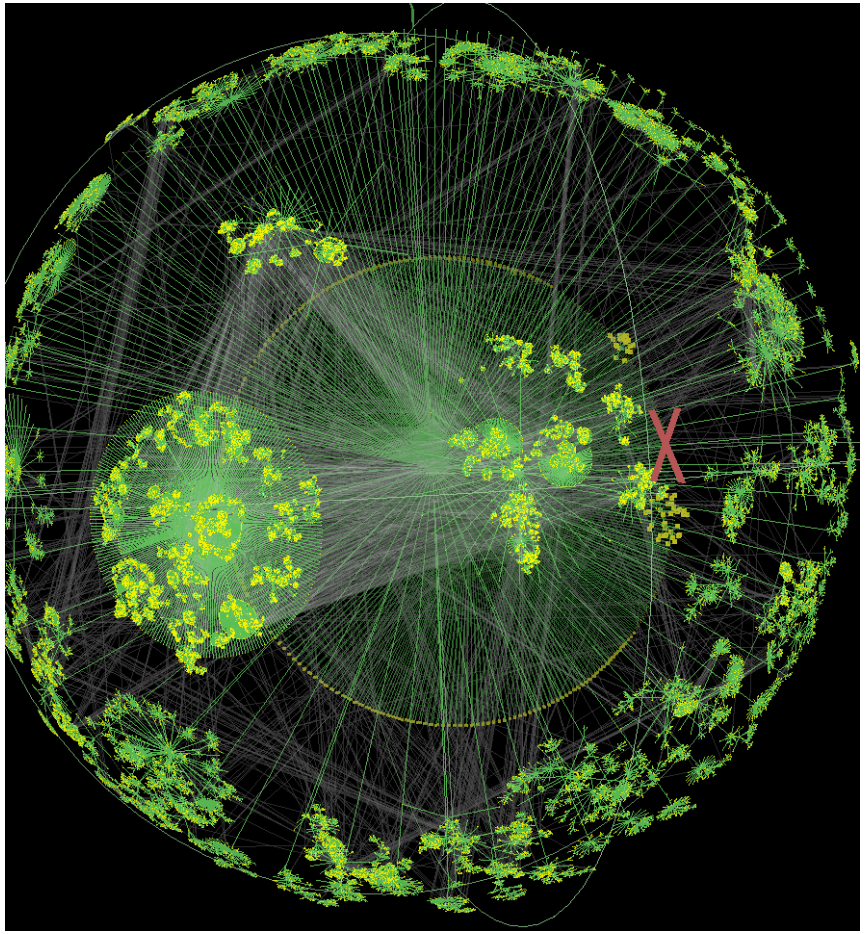


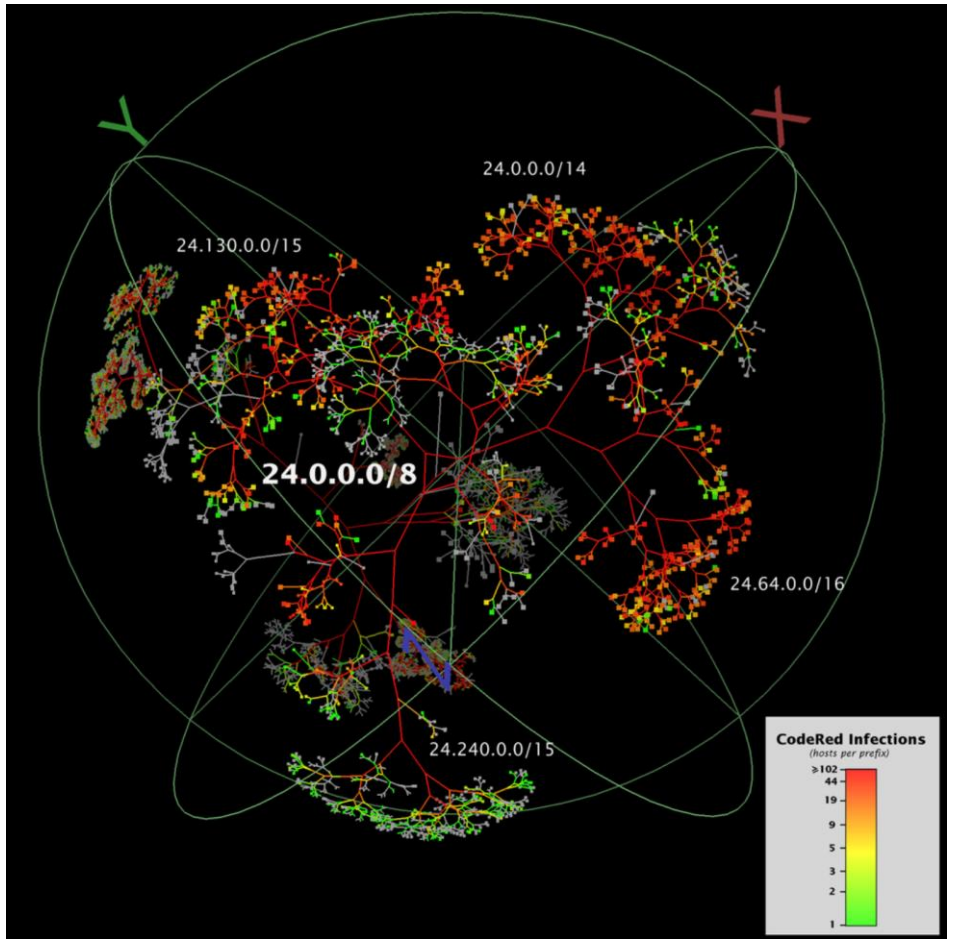
https://qualiacomputing.com/2016/12/12/the-hyperbolic-geometry-of-dmt-experiences/

Hyperbolic charts and “chartjunk”



Walrus: Hyperbolic Klein Projection

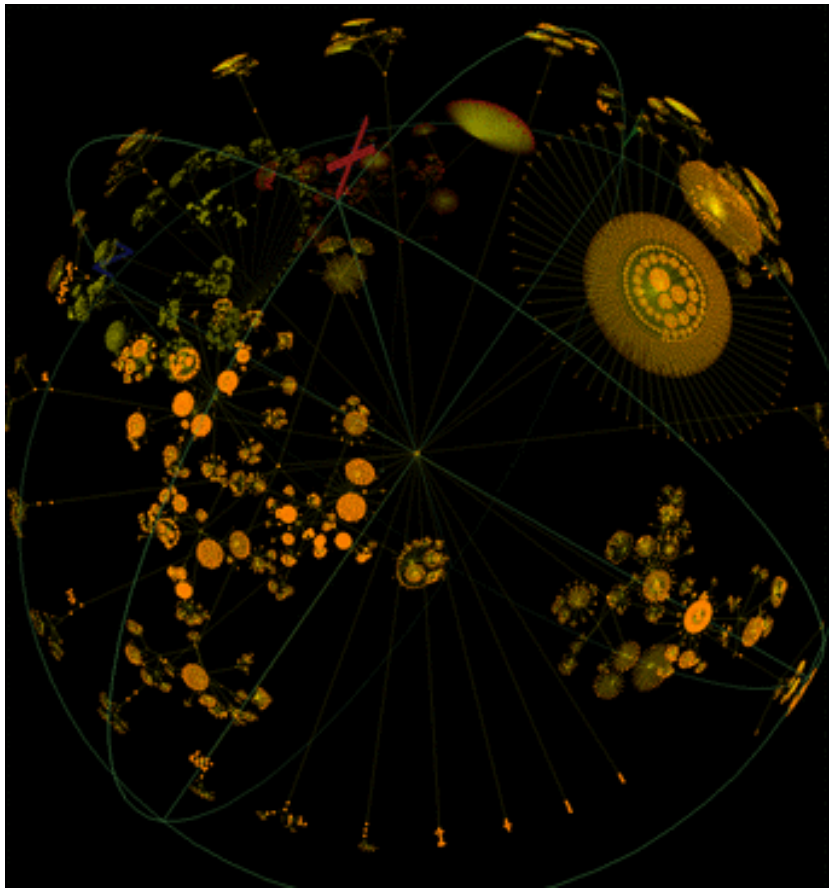




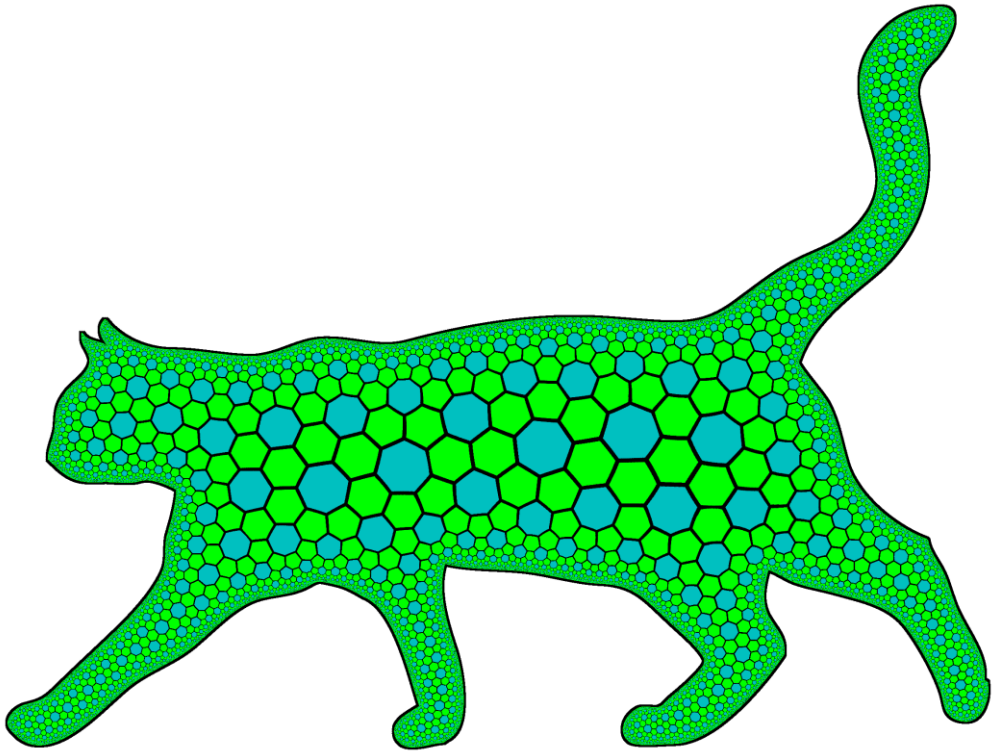
http://www.caida.org/tools/visualization/walrus/gallery1/

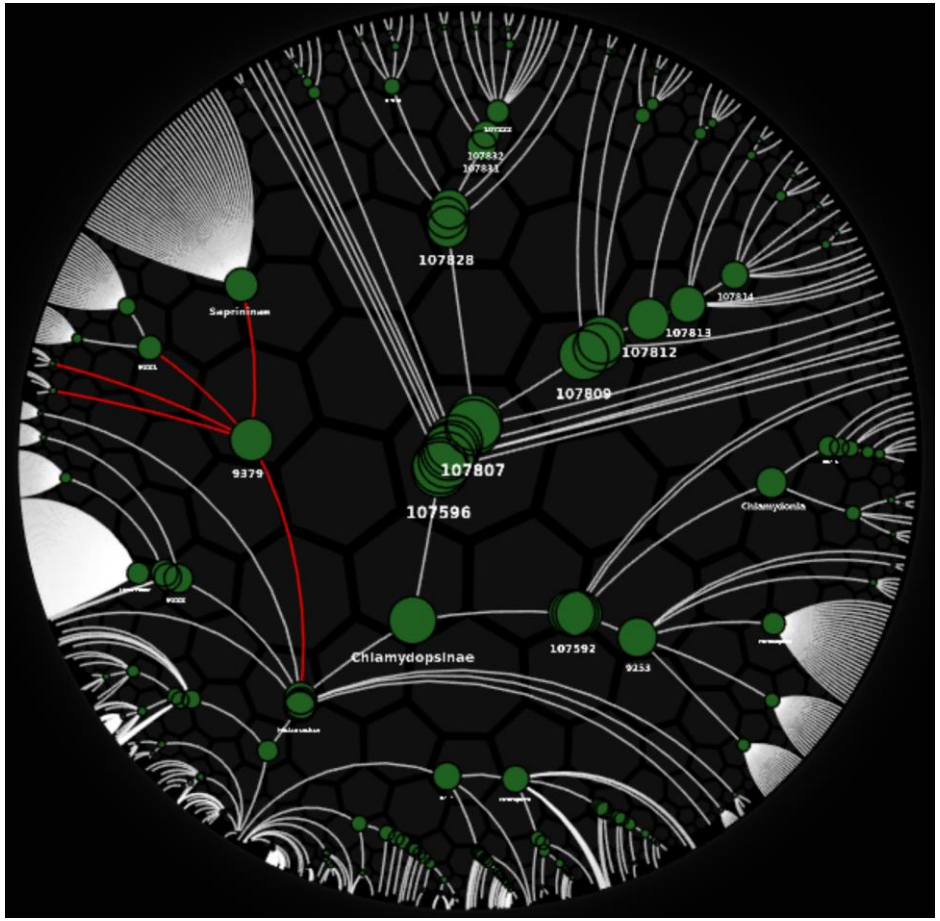
Walrus: 3D Hyperbolic Tree of life

- Tim Hughes has posted a nifty picture of "the whole NCBI taxonomy database which currently contains approx. 180,000 nodes (as close as one can get to a tree of life at the moment)."
- While this sphere visualization is nifty, I doubt that it would prove an effective visualization, either as static pictures or as an interactive object, for any of our audiences.



Other applications:

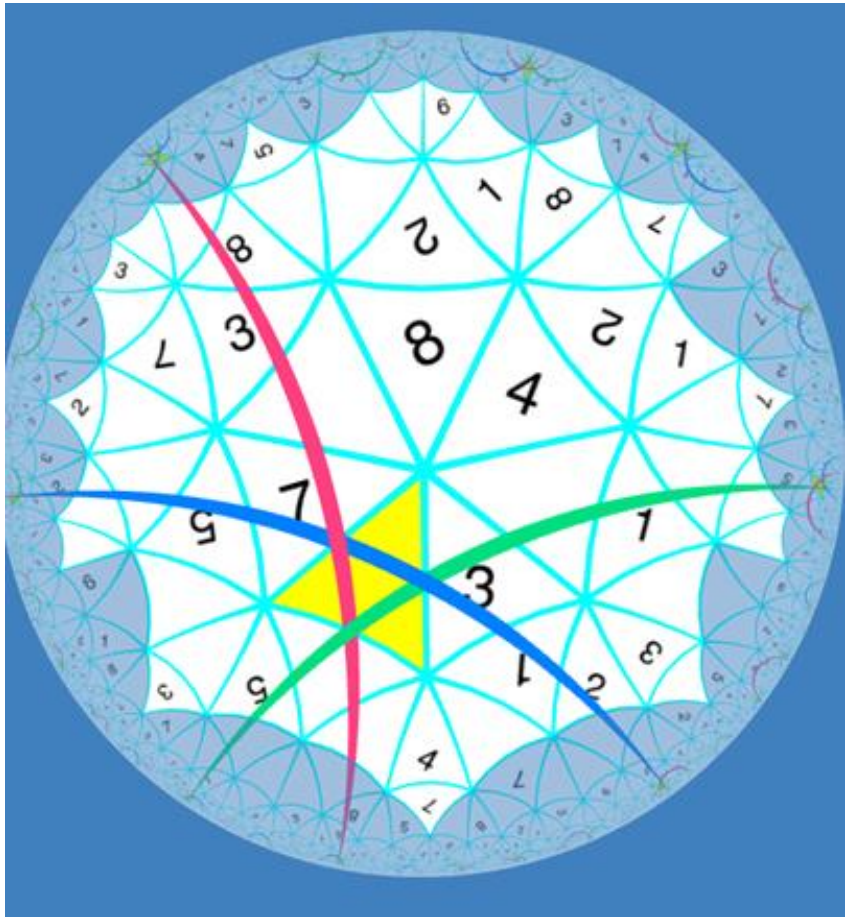




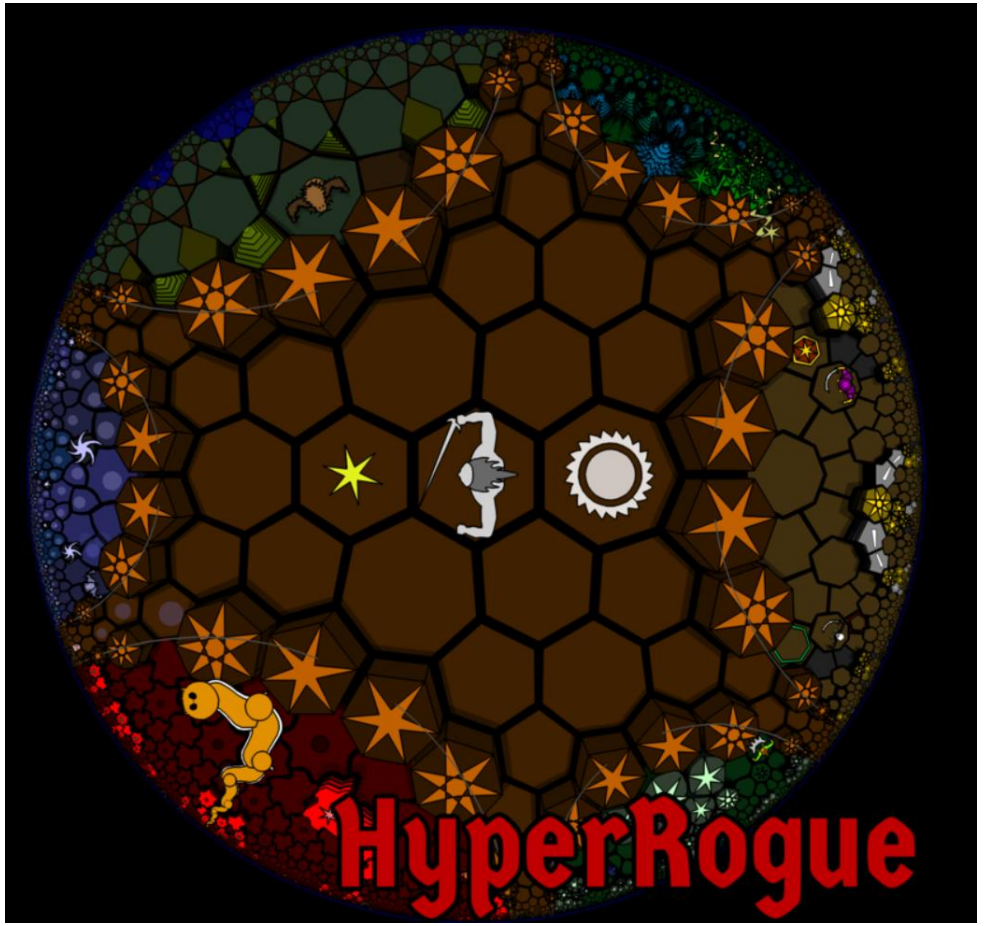
https://github.com/zenorogue/newconformist/blob/master/README.md

High density visualization

- Examples: Games



http://geometrygames.org/HyperbolicGames/index.html



http://www.roguetemple.com/z/

Discussion:

- How much should we change and combine different viz. methods to solve problems (e.g. Nadieh Bremer radial tree small multiple bubble chart).
- Should new viz. methods be patentable? (Xerox Hypertree)
- What are the best solutions to optimize screen surface area (without creating “chart junk”).