Geometric Representations of Graphs II

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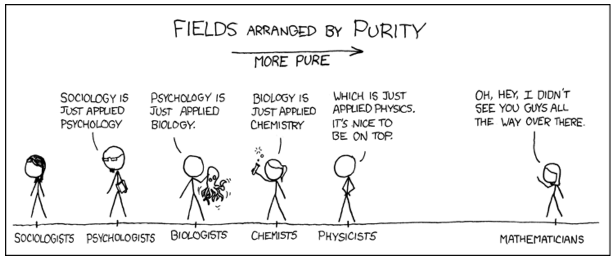
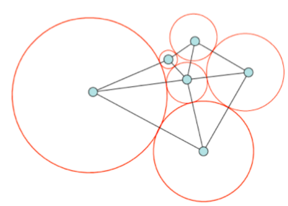


xkcd

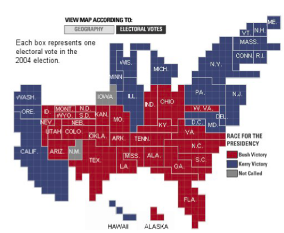
Description

Planar graphs play an important role in theory and practice: they naturally arise in modeling road and transportation networks, electronic circuit schematics, and hierarchical structures. From the early days of graph theory, planar graphs have received extra attention and a great deal is known about them. Fortunately, there are a great deal of beautiful open problems on visualizing planar graphs via contact representations. Unlike traditional node-link graph representation, in contact representations vertices are geometric objects (e.g., segments, circles, cubes) and edges are realized by contacts between the objects (e.g., kissing circles, rectangular duals). Motivation for these problems comes from classical information visualization techniques which are still active research topics today, such as cartograms. A cartogram is a value-by-area diagram in which the geographic areas of countries are modified in order to represent a given set of values, such as population, gross-domestic product, or other geo-referenced statistical data. The first rectangular cartograms date back to the 1930s and show states in the USA by rectangles, with areas proportional to population. The main challenge, and the reason why this continues to be an active research area, is that a "good cartogram" must optimize competing goals which cannot be simultaneously optimized, such as geographic accuracy (the cartogram should resemble the underlying geographic map) and statistical accuracy (the areas of each state should match the prescribed value for that state). Course topics include:

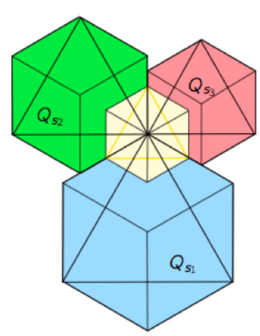
1. Planar Graphs Review
   - Kuratowski's theorem, Wagner's theorem, Fary's theorem
   - dual graphs, 3connectivity, 4-connectivity
   - outerplanar and series-parallel graphs, 2-trees, planar 3-trees



2. More Planar Graphs
   - planarity testing, planar graph drawing
   - Schnyder realizers
   - canonical order (and equivalence to Schnyder realizer)



3. Contact Representations
   - segments, triangles, rectangles, squares, pentagons, hexagons
   - proportional contact representations (value-by-area)
   - contact representation in 3D with boxes and cubes
   - proportional contact representation in 3D with boxes



4. 1-Planar Graphs
   - rotation systems, embedding
   - optimal 1-planar graphs, prime 1-planar graphs
   - generating 1-planar graphs (Suzuki operations)
   - contact representations