Fun Problems for Planar Graphs

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A *planar graph* is a graph that can be drawn on the plane with no crossing edges. This talk describes several fun research problems that consider planar graphs.

The *combinatorial curvature* of a vertex v is equal to $1 - \frac{deg(v)}{2} + \sum_{f \sim v} \frac{1}{size(f)}$ (where the summation is over all faces f incident with v). Prisms and anti-prisms are planar graphs that can be arbitrarily large that have strictly positive curvature at every vertex. A *PCC-graph* is a planar graph that is not a prism or an anti-prism that has strictly positive curvature at every vertex. One open question is to determine the maximum size of a PCC-graph. The talk will include some new results for this problem.

Simple Venn diagrams can be represented by 4-regular planar graphs. We first describe how we generated all the simple 6-Venn diagrams. Mining the resulting collection of Venn diagrams revealed a counterexample to a conjecture of Winkler (he conjectured that every simple Venn diagram with k curves could be extended to a simple Venn diagram with $k+1$ curves with the addition of one curve).

The talk will conclude with some examples of families of planar graphs and their properties that are of interest to chemists.

The research on graphs with positive curvature is joint work with Patrick Fowler and Paul Oldridge. The work on Venn diagrams has been done in collaboration with Frank Ruskey, Bette Bultena, Khalegh Mamakani, Ben Kimmett, Jagjit Singh and Tom Arjanikov. The work on chemical graph theory has involved several students and has been with the guidance of Patrick Fowler (a chemist).