Suggested Final Year Project Topics for 2011-12 - R. Quinlan

1. **Matrices and Graphs**
   A *graph* G is a collection of vertices (dots), some pairs of which are joined by edges (lines). Various matrices can be associated to a graph, including the *adjacency matrix* $A(G)$, in which the rows and columns are labelled by the vertices, and the entry in position (i, j) is 0 or 1 according to whether the vertices labelled i and j are joined by an edge or not. An important theme in algebraic graph theory is the relationship between matrix-theoretic properties of $A(G)$ (such as rank, eigenvalues, etc.) and graph-theoretic properties of G (such as connectedness, path lengths etc.). A project on this topic could explore this relationship and other connections between matrix theory and graph theory.

2. **Literature Review : *Proofs and Refutations***
   The 1976 book "Proofs and Refutations" by Imre Lakatos is a major work in 20th Century Philosophy of Mathematics. Lakatos presents a particular view of how progress is made in Mathematics, using the Euler characteristic for polyhedra as an example. A central theme is the view that mathematical definitions are not fixed but negotiated and renegotiated in the light of new insights and new attempted (and partly failing) proofs. The book is written in the form of a dialogue that takes place in an idealized classroom. The work has been influential in mathematical philosophy and in mathematics education. A project on this topic would include a comprehensive discussion of the book itself, a review of some of the extensive literature that surrounds it, and maybe some original commentary.

   Other suggestions for literature reviews as final year projects are very welcome.

3. **Coxeter's 59 Icosahedra**
   A *stellation* of a polygon or polyhedron is obtained by extending the faces until they meet again. For example a five-pointed star is a stellation of a pentagon. A polygon or polyhedron may have more than one stellation. The stellations of the regular icosahedron were classified by Coxeter in the 1938; there are 59 of them. A new edition of Coxeter's 1938 book detailing this classification was published in 1999. A project on this topic could review the whole classification or focus on a few interesting examples.

4. **Difference Sets in Groups**
   If G is a group, then a subset $D = \{d_1, d_2, \ldots, d_k\}$ of G is called a *difference set* in G if amongst all the expressions of the form $d_i d_j^{-1}$ with $i \neq j$, every non-identity element of G occurs the same number of times. Difference sets are algebraically and combinatorially interesting objects as well as having various applications of practical use.

5. **A topic of mutual interest**
   For me this would probably mean something in abstract algebra, linear algebra, algebraic combinatorics, mathematics education at upper secondary or tertiary level, or a historical topic.

If you might be interested in any of these topics, please talk to me in my office or email me at `rachel.quinlan@nuigalway.ie`