Braids, Knots and Applications

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My project was called braids, knots and applications. The aim was that I would read up on knot theory and braid theory and investigate in greater depth any areas that interested me, and also look at possible applications of braid and knot theory, particularly the application of knot theory to molecular biology.

A knot is essentially a loop in R^3, and two knots are considered equivalent if one knot can be "turned into" the other just by moving and stretching it, and without passing it through itself. A common example is to tie a knot in an extension cord and plug it into itself: in this case, any contortions of the resulting closed cord represent equivalent knots. This naturally raises the question of how to tell when two knots are equivalent, one of the motivating problems in much of knot theory. My project examined much of the work done in this field, from simplistic knot invariants, such as the minimum number of crossings required in any diagram of the knot, to the far more powerful and discriminating knot polynomials.

I further found that knot theory has applications in many of the physical sciences. In molecular biology, knot theory can be used to examine the knotting and unknotting of DNA by enzymes, and certain families of knot polynomials correspond to families of exactly solvable partition functions in statistical mechanics. In chemistry, spatial graphs (a slight generalisation of knots) can be used to analyse the structure of molecules.

This project has been a great learning experience for me. It has increased my interest in mathematics and given me more confidence and experience doing research, which will be invaluable in my upcoming honours year.

James received an AMSI Vacation Scholarship in December 2010 See: www.amsi.org.au/vs10.php