Seminar descriptions for SUMSRI 2012

Statistics.
Spatial statistics concerns data that are correlated by location, and relies upon the assumption that objects closer together in space (e.g. geographical location) will most likely have similar responses. In medical research and epidemiological studies, it is important to understand the spatial heterogeneity (clustering) cross the study regions. If global or local clustering patterns among the responses exist, it is essential to consider the spatial association of the individuals in a statistical model to evaluate the association between the response (e.g., cancer death and incidence) and the risk factors. The statistics seminar group will be introduced to graphical and quantitative methods for the analysis of spatial data using GIS software. Emphasis is on lattice data (also known as areal data or aggregated data.) The statistics seminar group will focus on the application of spatial statistics to the study of noninfectious diseases, such as cancer. We will simulate spatially correlated data that mimic global clustering patterns and outliers for noninfectious diseases in order to develop spatial methods that improve upon current methods that exist to evaluate spatial inhomogeneity.

Algebra.
The notion of a group figures prominently in any undergraduate abstract algebra course; a group is a set together with an associative binary operation which has an identity, and such that each element has an inverse. Starting from this definition, it is not too difficult to prove that the multiplication table for this operation is a Latin square; that is, each group element appears exactly once in each row and exactly once in each column. One may then define a quasigroup to be a set together with a binary operation whose multiplication table is a Latin square. Certainly groups are examples of quasigroups, but there are many other examples which are easy to define, yet structurally very complex. This seminar will explore some tractable but challenging questions about quasigroups, and will involve both theoretical and computational work.

Discrete Mathematics.
We study tournaments and bipartite tournaments. A tournament on n vertices can be viewed as the results of a round robin tournament between n teams, indicating who won and who lost between each pair of teams in head-to-head competition. Abstractly, a tournament is a complete graph in which each edge has been given an orientation

from one end to the other. Likewise, a bipartite tournament with n vertices in each part can be viewed as the results of a tournament between two n-team leagues, each team competing only against those teams in the other league.

One potential research project is as follows. As a consequence of the 'Marriage Theorem' in graph theory, one can arbitrarily schedule the first so-many rounds of a bipartite tournament (no two teams playing each other more than once so far) with assurance that there will be at least one way to complete the bipartite tournament schedule in the minimum n rounds possible. The research question: how can one take advantage of this fact, so as to tend to leave the more 'interesting' matchups to be scheduled in the later rounds? So, one bases the opponent pairings round by round upon the results of the rounds already completed. One might, in particular, rate the interest in a matchup according to the difference between the win/loss records of the two teams competing. One can study much the same problem for round robin tournaments, but without the benefit of the Marriage Theorem.

Another possibility is to choose a less 'applied' topic, based on the contents of John Moon's book *Topic on Tournaments*.