CELEBRATING NEW APPOINTMENTS AT USW

<div align="center">TUESDAY 23RD JUNE</div>

Session 1: Combinatorics and cryptography

10:00 *On sudoku* by Siân K. Jones (USW)

Sudoku grids are a popular puzzle and well known throughout the world. In this talk I will give an introduction to some of the mathematics behind Sudoku, and discuss some of the problems that have recently been explored by our research group. These include the task of counting how many Sudoku grids there are, and whether a random allocation of numbers can be used to form a completable puzzle.

10:40 *Coding theory for DNA data storage* by Derek Smith (Professor Emeritus)

The feasibility of using DNA to store massive volumes of data for many thousands of years has been demonstrated in recent papers. In this talk the ways that coding theory can contribute to making this technique fully reliable are outlined. The relative merits of work at the University of South Wales with an alternative (2015) approach are considered.

11:20 *Information security spending: how much is enough?* by Hannah Davies (USW)

Current methods to evaluate financially the different Information Security solutions are very subjective, unpredictable and non repeatable. The methods are ad-hoc and are not standardised. The application of Multi Criteria Decision Making, namely Multi Attribute Utility Theory and fuzzy and grey theory can create a decision support system for assessing the suitability of an Information Security solution.

Session 2: Numerically modelling the atmosphere

13:30 *Energy conservation and enstrophy dissipation in numerical simulations of 2-d turbulence* by James Kent (USW)

Numerical methods designed for 2-d flows are often used in the development of weather and climate models. The dynamics of 2-d flow are such that energy is transferred upscale (from small to large scales), and enstrophy, the sum of vorticity squared, is transferred downscale (from large to small scales). This talk will discuss different numerical techniques to conserve energy and dissipate enstrophy in numerical simulations of 2-d turbulence.

14:10 *Geometry and atmospheric modelling* by John Thuburn (Exeter)

This talk will touch on some of the ways in which atmospheric modelling uses geometry. Geometry can inform us about the properties of quasi-uniform grids on the sphere, and provide tools, like conformal maps, for generating grids. Some common approximations to the governing equations are geometrical in nature and have interesting features. Some important properties of the governing equations, such as material conservation of potential vorticity, are related to properties of vector calculus, such as the vanishing of curl of grad. Understanding the geometrical origins of such properties can help in designing numerical methods.

14:50 *Lagrangian dispersion modelling* by Ayoe Buus Hansen (Met Office)

When numerically modelling the atmosphere several approaches can be used. Here Lagrangian modelling is presented, focusing on atmospheric dispersion and air quality modelling. The Met Office model for atmospheric dispersion is the Numerical Atmospheric-dispersion Modelling Environment (NAME). NAME is a Lagrangian model, developed for emergency response and applied for a wide range of topics including volcanic eruptions, radioactive releases, and industrial accidents. In the case of a larger fire, an Air Quality Cell is formed, in collaboration with Public Health England and the Environment Agency, to assess implications of the dispersion of the plume including impact on human health and the environment.

TUESDAY 30TH JUNE

Session 3: Operational research

10:00 *Combinatorial optimisation problems with applications in transport and health care* by Penny Holborn (USW)

The talk will mainly focus on a well know combinatorial optimisation problem, the Vehicle Routing Problem, in particular where each request has a pickup and delivery location and corresponding time windows. Heuristic and metaheuristic approaches to solve the dynamic variant of this problem will be introduced before recent work on a real-world application, the School Bus Routing Problem, is presented. Finally, a real-life application of a combinatorial optimisation problem in health care will be described. The problem involves rostering staff for continuing health care in the community.

10:40 *Applications of graph theory to real world combinatorial optimisation problems* by Rhyd Lewis (Cardiff)

In this talk, which is intended to be accessible to a wide audience, I will show how graph theoretical concepts can be used to help find approximate solutions to some important intractable combinatorial optimisation problems. We will consider three cases studies: The design of optimal bus networks through the use of evolutionary algorithms and shortest path algorithms; university and sports timetabling and their relationship to graph colouring; and an exact algorithm for the truss packing problem using Eulerian cycles.

11:20 *Operational Research techniques applied to health care* by Izabela Komenda (Aneurin Bevan University Health Board)

The talk will start with a description of my research involving modelling Critical Care Unit activities through queueing theory and game theory approaches. In the second part of the talk I will introduce the ABCi Modelling Unit, a collaboration between Cardiff University and Aneurin Bevan University Health Board, which involves applying a range of OR techniques to ongoing improvement projects. Research on a range of different developments will be illustrated.

Session 4: Group theory

13:30 *Growth in groups* by Nick Gill (USW)

Suppose that you have a set A inside a group G. We can define what it means to multiply the set by itself, thereby obtaining a new set that we call A^2. Similarly we have $A^3, A^4, \ldots$ The behaviour of the sequence $A, A^2, A^3, \ldots$ for different sets in different groups has a surprising array of applications to many areas of mathematics. We will discuss some classical results from the field of arithmetic combinatorics, as well as more recent developments in the context of non-abelian groups.

14:10 *Discrete semigroups of Möbius transformations* by Ian Short (Open University)

Motivated by a problem on continued fractions, we'll investigate semigroups of isometries of the hyperbolic plane. We'll see that a number of basic concepts from the theory of Fuchsian groups have counterparts in semigroup theory, often with a twist, and we'll relate these features of semigroups back to continued fractions. The talk will be accessible, with many pictures and few if any formal proofs.

14:50 *The probability that random group elements are conjugate* by John Britnell (Imperial)

The probability that two elements of a finite group G commute is well known to be $k(G)/|G|$, where $k(G)$ is the number of conjugacy classes of G. This statistic has been much studied. We will discuss a related, but relatively little-known statistic: the probability that two elements are conjugate. We shall see that the study of this statistic has much in common with that of the commuting probability. I shall survey what is known about it so far, and mention some open questions.