MIGSAA Evolution Equations and Friends, 1 August 2016

Abstracts

Gissell Estrada-Rodriguez
Analysis of the blow-up solutions to a semilinear heat equation

The purpose of this talk is to provide rigorous numerical analysis of blow up solutions to a semilinear heat equation, considering sufficiently smooth initial and boundary data. The talk is organised in two parts. The first part is focus in a qualitative analysis of the blow up solutions such as, existence and uniqueness, a derivation of necessary and sufficient conditions for blow up in finite time, as well as a study of the asymptotic behaviour of the solution near the blow up point. The second part comprises a numerical study of blow up profiles and times. This is done by comparing the numeric and the analytic solutions, computing the error in the numeric for different number of time steps, and using a mesh refinement near the blow up point. Moreover, it is carried out a novel computation of error indicators in one and two dimensions, using non-polynomial basis functions. Finally, some conclusions are drawn that leads to possible direction for the future research.

Muhammad Iqbal
An a posteriori error estimate and local q-refinement for transient heat diffusion problems

An a posteriori error estimate is proposed for time dependent heat transfer problems using partition of unity finite element method. It is shown that a residual estimate provides reliable and practically useful upper bounds for the numerical errors, independent of the heuristically chosen enrichment functions. We present two numerical problems to test the proposed error estimate. 1st we consider a problem where the exact solution is known and it is shown that the error estimates capture the decrease in the error as the number of enrichment functions is increased or the time discretization refined. Second, the estimate is used to predict the behaviour of the error where no exact solution is available. It also reflects the errors incurred in the poorly conditioned systems typically encountered in generalised finite element methods. Finally we study local error indicators in individual time steps and elements of the mesh. Some results for local q-adaptive refinement are also presented.

Oluwaseun Lijoka
Approximation of linear wave problems using wave-like function spaces

Eleni Moraki
Mathematical modelling of corneal epithelium maintenance

Vision among with the other four traditionally recognised senses provides living organisms with data for understanding the world they live in. The process of vision begins when the light enters the eye through the cornea, which accounts for approximately two-thirds of the eye's total focusing power. The cornea in order to function properly is being protected by it's outermost layer, the epithelium. Several biological studies have shown that the corneal epithelium is maintained by stem cells which are located in the limbus according to the Limbal Epithelial Stem Cell (LESC) hypothesis. Although many mathematical models have been developed for the corneal epithelium wound healing, only a few exist to describe how a corneal epithelium can be maintained. In this talk I will describe the formulation of this complex biological process into two time-only-dependent mathematical models: a deterministic (system of coupled ODEs) and a stochastic (chemical master equation) model. The analysis of these two models gives us the parameter spaces which will provide biologists with those parameter constraints capable to maintain a corneal epithelium.

Aleksandra Plochocka
Aspects of mathematical biology

Modelling has been applied to various scales within Mathematical Biology. In this talk we explore two extreme cases of these scales: the cytoskeleton network of Drosophila and the homing of Green Sea Turtles over vast distances. With the use of appropriate techniques for both scales, including numerical simulations and a continuous PDE, we cover the motivation and the preliminary results for each topic.

David Stark
Time-domain boundary elements for wave propagation

This talk considers time-domain boundary element methods for wave propagation and scattering in $\mathbb{R}^3$, especially at high frequency. We discuss the background of these methods, relevant algorithmic aspects and applications to engineering problems like traffic noise. Numerical experiments consider high-frequency scattering, preconditioners and the use of non-polynomial approximation spaces defined by plane waves.

Jack Wiggins
Modelling of music instruments

We discuss the mathematical modelling for realistic strings and membranes, with the aim of describing music instruments like guitars, pianos or drums. We obtain wave equations with damping, which are solved numerically for realistic data that correspond to playing the instrument with a hammer or pluck.