2022 輔大分析方程會議議程

地點：耕莘樓 MA306 教室

Date ：MAY, 06, 2022

10:10-10:20 **開　場 ：邱文齡 教授**(輔仁大學數學系）

10:20-12:00 **第一場 主持人： 王振男 教授**

10:20-11:10 **Yi-Hsuan Lin** (林奕亘 教授，陽明交通大學應數系)

Title：Inverse problems for fractional equations with a minimal number of measurements

11:10-12:00 **Ching-Lung Lin** (林景隆教授，成功大學數學系)

Title：Classical unique continuation property for multi-term time-fractional evolution equations

12:00-14:40 Break Tea and Lunch

14:40-16:20 **第二場 主持人：林奕亘 教授**

14:40-15:30 **Jenn-Nan Wang** (王振男教授，台灣大學應用數學科學研究所)

Title：An inverse source problem for electromagnetic waves

15:30-16:20 **Yung-Ta Li** (李勇達 教授，輔仁大學數學系)

Title：Matrix decompositions in pseudospectral methods

16:20-16:40 Break Tea

16:40-17:30 **第三場 主持人：林景隆 教授**

16:40-17:30 **Ke-Shiuan Lynn** (林可軒教授，輔仁大學數學系)

Title：A Heart Rate Variability-Based Paroxysmal Atrial Fibrillation Prediction System

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Abstract

Ching-Lung Lin (林景隆教授，成功大學數學系)

Title：Classical unique continuation property for multi-term time-fractional evolution equations

Abstract：This talk concerns about the unique continuation property of solutions for a multi-terms time fractional evolution equation up to order $\alpha\,(0<\alpha<2)$ with general time dependent second order strongly elliptic operator for the diffusion. We have achieved this aim by first using the usual Holmgren transformation to derive the UCP in $(T_1,T_2)\times B_1$ for some $0<T_1<T_2<T$ and a ball $B_1\subset\Omega$. Then if u is the solution of the equation with $u=0$ in $(T_1,T_2)\times B_1$, we show $u=0$ also in $\left((0,T_1]\cup[T_2,T)\right)\times B_r$ for some $r<1$ by using the result and argument which uses two Holmgren type transformations different from the usual one. This together with spatial coordinates transformation, we can obtain the usual UCP which we call it the classical UCP given in the title of this talk for our time-fractional evolution equation.

Yi-Hsuan Lin (林奕亘 教授，陽明交通大學應數系)

Title： Inverse problems for fractional equations with a minimal number of measurements

Abstract：We study several inverse problems associated with a fractional differential

equation of the following form:

$$(-\Delta)^s u(x) + \sum_{k=0}^{N} a^{(k)}(x)[u(x)]^k = 0, 0 < s < 1, N \in \mathbb{N} \cup \{0\} \cup \{\infty\}$$

which is given in a bounded domain $\Omega \subset \mathbb{R}^n, n \geq 1$. For any finite N, we show that $a^{(k)}, k = 0,1,\cdots,N$, can be uniquely determined by $N + 1$ different pairs of Cauchy data in $\Omega_e := \mathbb{R}^n \backslash \bar{\Omega}$. If $N = \infty$, the uniqueness result is established by using infinitely many pairs of Cauchy data. The results are highly intriguing in that it generally does not hold true in the local case, namely $s = 1$, even for the simplest case when $N = 0$, a fortiori $N \geq 1$. The nonlocality plays a key role in establishing the uniqueness result. We also establish several other unique determination results by making use of a minimal number of measurements. Moreover, in the process we derive a novel comparison principle for nonlinear fractional differential equations as a significant byproduct.

Jenn-Nan Wang (王振男教授，台灣大學應用數學科學研究所)

Title：An inverse source problem for electromagnetic waves

Abstract：In this talk I would like to discuss the uniqueness and the increasing stability in the inverse source problem for electromagnetic waves in homogeneous and inhomogeneous media from boundary data at multiple wave numbers. For the unique determination of sources, we consider inhomogeneous media and use tangential components of the electric field and magnetic field at the boundary of the reference domain. The proof relies on the Fourier transform with respect to the wave numbers and the unique continuation theorems. To study the increasing stability in the source identification, we consider homogeneous media and measure the absorbing data or the tangential component of the electric field at the boundary of the reference domain as additional data. By using the Fourier transform with respect to the wave numbers, explicit bounds for analytic continuation, Huygens' principle and bounds for initial boundary value problems, increasing (with larger wave numbers intervals) stability estimate is obtained.

Yung-Ta Li (李勇達教授，輔仁大學數學系)

Title：Matrix decompositions in pseudospectral methods

Abstract：Matrix decompositions play essential roles in devising algorithms that solve problems in linear algebra. In this talk, we discuss linear systems arising from discretizing the Poisson equation using pseudospectral methods. We propose new

algorithms that solve the linear systems and illustrate the accuracy and efficiency of the algorithms from a matrix decomposition perspective.

Ke-Shiuan Lynn (林可軒教授，輔仁大學數學系)

Title：A Heart Rate Variability-Based Paroxysmal Atrial Fibrillation Prediction System

Abstract：Atrial fibrillation (AF) is characterized by totally disorganized atrial depolarizations without effective atrial contraction. It is the most common form of cardiac arrhythmia, affecting more than 46.3 million people worldwide and its incidence rate remains increasing. Although AF itself is not lifethreatening, its complications, such as strokes and heart failure, are lethal. About 25% of paroxysmal AF (PAF) patients become chronic for an observation period of more than one year. For long-term and real-time monitoring, a PAF prediction system was developed with four objectives: (1) high prediction accuracy, (2) fast computation, (3) small data storage, and (4) easy medical interpretations. The system takes a 400-point heart rate variability (HRV) sequence containing no AF episodes as the input and outputs whether the corresponding subject will experience AF episodes in the near future (i.e., 30 min). It first converts an input HRV sequence into four image matrices via extended Poincaré plots to capture inter- and intra-person features. Then, the system employs a convolutional neural network (CNN) to perform feature selection and classification based on the input image matrices. Some design issues of the system, including feature conversion and classifier structure, were formulated as a binary optimization problem, which was then solved via a genetic algorithm (GA). A numerical study involving 6085 400-point HRV sequences excerpted from three PhysioNet databases showed that the developed PAF prediction system achieved 87.9% and 87.2% accuracy on the validation and the testing datasets, respectively. The performance is competitive with that of the leading PAF prediction system in the literature, yet our system is much faster and more intensively tested. Furthermore, from the designed inter-person features, we found that PAF patients often possess lower (~60 beats/min) or higher (~100 beats/min) heart rates than non-PAF subjects. On the other hand, from the intra-person features, we observed that PAF patients often exhibit smaller variations (5 beats/min) in heart rate than non-PAF subjects, but they may experience short bursts of large heart rate changes sometimes, probably due to abnormal beats, such as premature atrial beats. The other findings warrant further investigations for their medical implications about the onset of PAF.