CWiMAC 2021 Student and Post-Doc Talks

Schedule

1:00 - 1:15	Hermie Monterde Perfect State Transfer and Generalizations
1:20 - 1:35	Avleen Kaur A space-time spectral method for the Stokes problem
1:40 - 1:55	Nadia Lafrenière Combinatorial study of the convergence to stationary for card shuffling
2:00 - 2:15	Mahsa N. Shriazi The Erdős-Ko-Rado theorem for set-wise 2 and 3-intersecting perfect matchings
2:20 - 2:35	Neha Joshi Fusion primitivity for Multiplicity-free subgroups of Symmetric groups

Titles and Abstracts

Presenter: Hermie Monterde (monterdh@myumanitoba.ca)
University of Manitoba, Winnipeg, Manitoba, Canada

Title: Perfect State Transfer and Generalizations

Abstract:

Undirected graphs are used in quantum information theory to model quantum spin networks, with the vertices and edges representing the qubits and their interactions, respectively. One of the main interests involving quantum spin networks is determining a time t such that the state at a given vertex is transmitted to another vertex with a given probability. The matrix $U(t) = e^{itM}$ governs the evolution of the system at any time t, and it is known that its entries give information about the probability of state transfer between any two vertices of G at time t. In particular, if the (j, k) entry of $U(\tau)$ is a unit complex number, then we say that perfect state transfer occurs from vertex j to vertex k at time τ. In this talk, we look at the properties perfect state transfer, and consider its generalizations.

Presenter: Avleen Kaur (kaura349@myumanitoba.ca)
University of Manitoba, Winnipeg, Manitoba, Canada

Title: A space-time spectral method for the Stokes problem

Abstract:
In this work, we consider the Stokes equations in steady and unsteady states, along with Dirichlet boundary conditions and an initial condition in the latter case. We impose the $\mathbb{P}_N - \mathbb{P}_{N-1}$ spectral Galerkin scheme in space by using a recombined Legendre polynomial basis resulting in exponential convergence in space. For the unsteady state, we implement spectral collocation in time, thus giving exponential convergence in both space and time. The global spectral operator for both schemes is a saddle point matrix. We prove the 2norm estimates for every block of the two operator matrices, and proceed to show that the condition number for the global spectral operator for the steady-state scheme is $\mathcal{O}(N^4)$, where N is the number of spectral modes in each direction. We also have results

on the condition number of the unsteady-state scheme. Numerical results of this scheme applied to the unsteady Navier-Stokes problem will also be shown.

This is joint work with S.H. Lui.

Presenter: Nadia Lafrenière (nadia.lafreniere@dartmouth.edu)
Dartmouth College, Hanover, New Hampshire, United States.

Title: Combinatorial study of the convergence to stationary for card shuffling

Abstract:
Imagine we are playing a cards game. It is the end of a round, and we need to shuffle for the next round to be fair, and to erase traces of how the deck was placed. How, and how long, should we shuffle so the deck is random?

From our experience playing cards, we might have noticed that some techniques seem to be more efficient than others. Mathematically, we can formalize this intuition by determining the number of times one should repeat a shuffling procedure. This short talk is meant to be an introduction to the study of randomness in a deck of cards, and to how combinatorics and linear algebra could help solve this long-standing problem.

Presenter: Mahsa N. Shriazi, (Mahsa.NasrollahiShirazi@uregina.ca)
University of Regina, Regina, Saskatchewan, Canada

Title: The Erdős-Ko-Rado theorem for set-wise 2 and 3-intersecting perfect matchings

Abstract:
A perfect matching $\mathcal{PM}$ in the complete graph K_{2k} is a set of edges in which every vertex is covered exactly once. Two $\mathcal{PM}$s P and Q of a graph on $2k$ vertices are said to be set-wise t-intersecting if there exist edges $P_1, \ldots, P_t$ in P and $Q_1, \ldots, Q_t$ in Q whose unions of edges have the same set of vertices. In this talk we show an extension of the famous Erdős-Ko-Rado theorem to set-wise t-intersecting $\mathcal{PM}$ for $t = 2$ and $t = 3$.

Presenter: Neha Joshi (njp008@uregina.ca)
University of Regina, Regina, Saskatchewan, Canada

Title: Fusion primitivity for Multiplicity-free subgroups of Symmetric groups

Abstract:
Suppose ϕ is a representation of the group G, with irreducible decomposition

$$\phi = \sum_{i=1}^{n} m_i \phi_i$$

The representation is called multiplicity-free if each m_i is equal to 1. If G and H are groups with $H \leq G$ such that $ind_G(1_H)$ is a multiplicity-free representation of G, then the adjacency matrices of the orbitals of G on the cosets G/H form a commutative association scheme.

An association scheme is known as fusion-primitive if its only fusions are the trivial ones. In the early 1990s, Muzychuk and Uchida proved the fusion-primitivity of the Johnson scheme $J(n, k)$ with $k \geq 7$ for all n except $2k + 1 < n < 3k + 1$.

In this presentation, I will talk about the techniques for checking fusionprimitivity of multiplicity-free subgroups of the symmetric group S_n .