Abstracts

The following is a list of abstracts ordered chronologically according to the schedule and room numbers. Reminder that all plenary, workshops and discussion panel talks are in SCRF 100 and that all coffee breaks are in ANGU 037 except the first coffee break which is in MATH 125.

Monday

SCRF 100

Sampling Designs for Interventions in Dynamic Networks (Plenary Talk)
Steve Thompson, SFU

Sampling designs are procedures for selecting units to include in a sample. In network settings sampling designs include link-tracing procedures. These are especially useful for finding members of hidden populations by following social links from one person to another. Sampling designs can be used for inference about population characteristics, for setting experiments in populations, and for making interventions to benefit a population. In the HIV epidemic, the virus itself uses a link-tracing design, spreading from one person to the next through sexual or drug injection links. Interventions to slow down or stop the spread include behavioural changes such as reductions in partner uptake or change rates, use of condoms, antiretroviral drugs, and potential treatments not yet available such as vaccines and cures. Some of these interventions can be distributed adaptively through link-tracing designs as well as random distribution to a population. In this talk I will illustrate a way to model and simulate the dynamic network and interacting designs to evaluate the effectiveness of intervention strategies.

Room ANGU 354

Resonance in the Nonlinear Schrödinger Equation.
Matthew Coles- University of British Columbia, Vancouver

I will first talk generally about quantum mechanics and the nonlinear Schrdinger equation. I will then turn my attention to the focusing nonlinear Schrödinger equation which exhibits solitary wave solutions (solitons) the stability of which can be understood by studying the appropriate linearization operator. I will say something about the interesting resonance eigenvalue that appears on the edge of the essential spectrum and how it bifurcates.

Quantum Entanglement and Positive Maps
Mark Girard - University of Calgary

For nearly a century, quantum entanglement has been investigated as interesting facet of quantum mechanics. Only recently has the usefulness of entanglement in quantum systems led the the burgeoning field of Quantum Information Theory, where entanglement has limitless applications for use in, for example, quantum cryptography and quantum computation schemes. Yet a complete mathematical understanding of entanglement continues to elude us. One way to understand entangled states of quantum systems is through the study of positive maps on Banach algebras that are not completely positive. In this talk, I will introduce the idea of quantum entanglement using mathematical formalism and present some of the mathematical tools needed to solve the problem of characterizing entanglement in quantum systems.

Room ANGU 434

On Almost Prime Solutions to Diophantine Equations
Tatchai Titichetrakun- University of British Columbia, Vancouver

Let $p = (p_1, ...p_r)$ be a system of r polynomials with integer coefficients of degree d in n variables $x = (x_1, ..., x_n)$: The classical result of Birch and Schmidt gives the asymptotic formula of the number of solutions of the system $p(x) = s$ for $s \in \mathbb{Z}^n$ as long as the system depends essentially on a sufficiently large numbers of variables with respect to the degree d. Our aim is to combine the classical Hardy-Littlewood method with Goldston-Yildirim sieve to extend Birch-Schmidt's results to give an asymptotic of number of solutions with bounded numbers of prime factors (the number of factors depends just on the degree d). The condition on polynomials would be the same as of Birch-Schmidt.

Valuations of Net Polynomials
Jeff Bleaney - University of Lethbridge

An *elliptic net* is a map $W : A \to R$ from a finite rank free Abelian group into an integral domain which satisfies $W(0) = 0$ and

$$W(p+q+s)W(p-q)W(r+s)W(r) \\ + W(q+r+s)W(q-r)W(p+s)W(p) \\ + W(r+p+s)W(r-p)W(q+s)W(q) = 0,$$

for all $p, q, r, s \in A$. We explain the connection between elliptic nets, and linear combinations of points on elliptic curves.

Room ANGU 435

Lattice Symmetry Breaking Perturbation for Spiral Waves
Laurent Charette - University of British Columbia, Vancouver

The spiral wave is a pattern on a surface occurring in several natural phenomena, such as in chemical reactions or in cardiac pathologies. The motion of spiral waves can be described by a reaction-diffusion system, which can be further reduced to a simple three-dimensional ordinary differential equation. This system has full Euclidian symmetry, that is any translations and rotations maps a solution to another. In physical experiments, this symmetry is never present due to bounded domains, inhomogeneities or anisotropy. To observe the effect of these imperfections we add symmetry breaking perturbation terms in the system. In this talk we will discuss on the effect of square lattice symmetric perturbations on spiral waves through some stability analysis and numerical simulations.

A Mathematical Model for the Interaction Between Tumor Cells and Macrophages at the Tumor Invasion Front
Andreas Buttenschoen-University of Alberta

The interactions between cancer cells and the immune system have recently been added to the list of hallmarks of cancer. In this presentation we apply mathematical modeling to the interactions between macrophages and tumor cells at the tumor boundary (invasion front). For that purpose we chose the individual based Glazier-Graner-Hogeweg model (cellular Potts model) modeling approach in 2D. At this point we observe the formation of small clusters of 1-2 macrophages and 1-2 tumor cells. These clusters invade into the surrounding environment. This research has been supported by NSERC.

SCRF 100

The Belief Propagation Community Detection Conjecture (Plenary Talk)
Elchanan Mossel, UC Berkeley

Questions of clustering graphs generated by the block model / planted partition / inhomogeneous random graphs have been widely studied in statistics, computer science, the random graph community and statistical physics. A beautiful conjecture from statistical physics predicated the threshold for this problem in sparse graphs. This conjecture was recently proved. In the talk I will give an overview of the conjecture and its resolution as well as connections to Belief Propagation, Reconstruction on Trees, Random Matrices, Zeta Functions of Graphs and Non Back Tracking Random Walks.

Room ANGU 354

On the CQ algorithm: Then and Now
Yipin Guo - University of British Columbia, Okanagan

The CQ algorithm is used to solve the split feasibility problem(SFP). The algorithm has many its applications, such as in signal processing and image reconstruction. In this talk, I will present CQ algorithms for convex functions and recent extensions in nonconvex case.

Well-Approximable Numbers
Kyle Hambrook

I will discuss the size of the set of real numbers that can be "well-approximated" by rational numbers using tools from number theory, harmonic analysis, and probability theory. No familiarity with any of these topics will be assumed. The only prerequisite is curiosity.

Room ANGU 434

Friendly Walks, Sticky Walls and Counting Problems.
Thomas Wong - University of British Columbia, Vancouver

The study of lattice walks has been a subject of continued interest for their ability to model and predict the physical behaviours of polymers in a good solvent. In this introductory talk, I will focus on the use of generating functions as a tool for constructing and encoding lattice walk models in the presence of a sticky wall. I will also discuss the problems we can pose using this model and some results we were able to obtain.

What is the Riemann Hypothesis and Why Do We Care?
Justin Scarfy - University of British Columbia, Vancouver

We shall survey the basic complex-analytic properties of the Riemann ζ-function, its application in prime number theory, to introduce one of the most important unsolved problem in mathematics, the Riemann Hypothesis. If time permits, we shall also discuss its generalizations in a greater setting.

Room ANGU 435

Quantifying the Effect of Open-Mindedness in Group Opinion Dynamics and Advertisement Optimization
Clinton Innes - Simon Fraser University

Group opinion dynamics shape our world in innumerable ways. Societal aspects ranging from the political parties we support to the economic decisions we make in our daily lives are all directly effected in some way by group opinion dynamics. This makes understanding and potentially being able to predict the complex inter-relationships between individual's opinions and group opinion dynamics invaluable both scientifically and economically. We propose an aggregation model incorporating in group out group dynamics, as well as media influence to establish potential causal relationships between various types of social interaction and social phenomenon such as the occurrence of group consensus and the hostile media effect. We further apply our model to simplified industrial applications relating to advertisement optimization to determine the optimal portion of a population to target with advertisement in order to maximize opinion shift while holding cost constant.

Application of Sign Patterns that Allow $\mathbb{H}_n$
Garrett Culos - University of Victoria

A *sign pattern* is a matrix with entries $\in \{+, -, 0\}$. These sign patterns are very useful when the magnitudes of the entries of a real matrix are unknown or varied. The *refined inertia* of an n-by-n real matrix A, denoted $\mathrm{ri}(A) = (n_+, n_-, n_z, 2n_p)$, is an ordered 4-tuple where n_+, n_- are the number of eigenvalues with positive, negative real parts, n_z is the number of zero eigenvalues, and $2n_p$ is the number of nonzero pure imaginary eigenvalues. We are interested in sign patterns that allow refined inertias in the specific set $\mathbb{H}_n = \{(0, n, 0, 0), (2, n-2, 0, 0), (0, n-2, 0, 2)\}$. For a system of differential equations to undergo a Hopf bifurcation, the linearized system must allow the above set of refined inertias. The goal is to use sign patterns as a tool for analyzing dynamical systems thought to undergo a Hopf bifurcation. The methods are illustrated with examples from biochemical reaction networks and predator-prey models.

SCRF 100

Words to the Wise-Workshop
Fok-Shuen Leung

As a graduate student, you have at least three opportunities to give a presentation on mathematics: you might give a talk as part of a research seminar, a lecture as part of a course, or a thesis presentation as part of your candidacy exam or defense. How are these different, and how should they be different? In this session we'll come up with some practical tips and maybe make a broader philosophical point.

Tuesday

SCRF 100

Asymptotic error analysis (Plenary Talk)
Brian Wetton, UBC

When computing numerical approximations to problems with smooth solutions using regular grids, the error can have additional structure. The historical example of the Euler-Maclaurin formula for the approximation of integrals with the trapezoidal rule is shown. This expansion can be used to justify Richardson extrapolation of the approximations leading to the Romberg integration formula. For approximation of differential equations, similar error expansions can be derived. These expansions justify the higher order discrete regularity that is sometimes called super-convergence in the finite element literature. The expansion can also be used as an analytical tool in the convergence analysis of methods used to compute nonlinear problems. For standard methods, an expansion for the error can be constructed that is regular in the grid spacing. For some other methods, numerical artifacts (boundary layers and errors that alternate in sign between adjacent grid points) can also be present. Identifying the types of errors that are generated by a given scheme and the order at which they occur is called Asymptotic Error Analysis. Several examples are shown, including the error analysis of cubic spline interpolation which is shown to have numerical boundary layers. A new result of a numerical artifact from an idealized adaptive grid with hanging nodes used to approximate a simple elliptic problem is presented.

Room ANGU 354

Triangulation of Real Projective Spaces with Few Vertices.
Soumen Sarkar - University of Regina

P. Arnoux and A. Marin showed that any triangulation of $\mathbb{RP}^n$ contains more than $(n+1)(n+2)/2$ vertices if $n > 2$. We construct some natural triangulations of $\mathbb{RP}^n$ with $n(n+5)/2+1$ vertices for all $n > 2$.

The Double Exponential Sinc-Collocation Method for Computing Eigenvalues of Sturm-Liouville Problems and Applications to Anharmonic Oscillators
Philippe Gaudreau - University of Alberta

A quantum anharmonic oscillator is defined by the Hamiltonian $\mathcal{H} = -\frac{\mathrm{d}^2}{\mathrm{d}x^2} + V(x)$, where the potential $V(x) = \sum_{i=1}^{m} c_i x^{2i}$ with $c_m > 0$. Using the double exponential Sinc-collocation method (DESCM), we develop a highly accurate and efficient algorithm for computing energy eigenvalues of this Hamiltonian for anharmonic potentials. We establish the theoretical convergence of our algorithm. We also introduce a method for finding the optimal mesh size given the number of collocation points $2N+1$. This method is based on optimizing the derivative of the trace of a matrix obtained through the DESCM. We finish our paper with a systematic numerical study. We begin by testing our algorithm on test potentials for which the eigenvalues are known. We continue by testing our algorithm on potentials of the form of $V(x)$ with $m = 2, 3, 4, 5$. We also apply our method to a potential with multiple wells and finish our numerical study with a multiple precision result.

Room ANGU 434

The Many Variants of Hadwiger's Conjecture
Ross Churchley - Simon Fraser University

Hadwiger's conjecture, a famous generalization of the Four-Colour Theorem, suggests that every graph with chromatic number k contains a minor isomorphic to the complete graph on k vertices. This introductory talk will define graph minors, subdivisions, and immersions; review the status of several variants of Hadwiger's conjecture; and present a partial result on the odd immersion version of the conjecture.

Elliptic Curves with Complex Multiplication: Obtaining a Relation to Their Quadratic Twist.
Marie-Andrée B.Langlois - University of Calgary

The first thing that will be explained is complex multiplication of elliptic curves, the property that very few of them have. Then quadratic twist of elliptic curves will be introduced and we will consider the following question: when is an elliptic curve isogenous to one of its quadratic twists? This happens for the curves that have complex multiplication and this will be explained for the remainder of the talk.

Room ANGU 435

An Asymptotic Analysis on Histone H1 Rapid Interactions in Living cells
Carlos Contreras Castillo - University of Alberta

The histone H1 is protein responsible for the mobility of DNA and the highly structure it acquires when forming the chromosomes. The understanding of the histone H1 dynamics is important when a less or more compact chromatin structure (DNA and associated proteins) is required in transcription. It is accepted that the histone H1 interacts with the chromatin structure dynamically rapid in a intermediate regulation. A set of tree-population models (consisting of free to diffuse, weakly bound and strongly bound population) describe well the histone H1 dynamics. A simpler model consisting of two-population (free to diffuse and bound) provides more flexible framework, but inconsistent parameters estimation. We analyze the connection between the three-population models and the two-population model using regular perturbation theory. We are able to compute the effective diffusion and other effective parameters present in the two-population model, allowing the recovery of the real parameters using the simpler model.

Modelling How Honeybees Stay Warm
Jeremy Chiu - Simon Fraser University

We describe the notion of math modeling by looking over a few examples. We emphasize our research in modeling how a hiveless honeybee cluster can regulate their temperatures to survive ambient temperatures lower than -15 degrees Celsius.

SCRF 100

From mathematician to data scientist: my experiences in moving from academia to industry (Plenary Talk)
Matthew Folz-Yammer Inc.

I'm a recent math Ph.D from UBC who is now working as a data scientist for Yammer (Microsoft) in San Francisco. I'll give a brief overview of what data science is and what the day-to-day life of a data scientist at Yammer looks like. As well, I'll talk about why I chose industry over a postdoc, the major differences between academia and industry, and what skills and talents tech companies (and my team) are looking for.

Room ANGU 354

On the Finite Convergence of a Projected Cutter Method
Jia Xu - University of British Columbia, Okanagan

The subgradient projection iteration is a classical method for solving a convex inequality. Motivated by works of Polyak and of Crombez, we present and analyze a more general method for finding a fixed point of a cutter, provided that the fixed point set has nonempty interior. Our assumptions on the parameters are more flexible. Various limiting examples and comparisons are provided.

Thresholds of Prox-Boundedness of PLQ functions
Chayne Planiden - University of British Columbia, Okanagan

A function f is said to be prox-bounded if there exists a point x and a parameter r such that the Moreau envelope $e_r f(x) > -\infty$. The infimum of all such r is called the threshold of prox-boundedness of f, denoted $\bar{r}$. These thresholds can be classified into three useful categories, depending on the behavior of $e_{\bar{r}} f$. The categories are proper, improper and strongly improper. This presentation defines the categories, and provides examples of each type. The thresholds for single-variable linear and quadratic functions are categorized, then that result is generalized to the multivariate case. The main result is a theorem describing the threshold behavior of piecewise linear-quadratic functions on $\mathbb{R}^n$.

Room ANGU 434

On a Generalization of the de Bruijn-Erdős Theorem
Cathryn Supko - Concordia University

Abstract: The de Bruijn-Erdös Theorem from combinatorial geometry states that every set of n non-collinear points in the plane determine at least n distinct lines. Chen and Chvátal conjecture that this theorem can be generalized from the Euclidean metric to all metric spaces with appropriately defined lines. This talk will survey the evidence given thus far in support of the Chen-Chvátal Conjecture. In particular, I will discuss recent work which provides an $\Omega(\sqrt{n})$ lower bound on the number of distinct lines in all metric spaces without a universal line and an $\Omega(n/k)$ lower bound on the number of distinct lines in metric spaces with at most k distance values. This is based on joint work with Pierre Aboulker, Xiaomin Chen, Guangda Huzhang, and Rohan Kapadia.

Differential Geometry of the Kähler Cones
Atsushi Kanazawa - Harvard University

Let X be a Kähler manifold. Then the possible Kähler forms on X form an open cone in the cohomology group $H^{1,1}(X, R)$, called the Kähler cone. Although the topology of the Kähler cone is trivial, it comes equipped with a natural metric, given by the product of its cohomology ring, and the differential geometry the Kähler cone is interesting. In fact, it has an application in string theory. In this talk, I will give an overview of the subject.

Room ANGU 435

How Does Tumour Cell Kinetics Change After Treatment: A Mathematical Model.
Wafa Veljee - University of Alberta

Glioblastoma Multiforme (GBM) is an aggressive brain malignancy. Prognosis is poor and the median survival, with a treatment involving both radioactivity and chemotherapy, is 14.6 months! This tumour is mainly non-curable due to tumour stem cells which are not only radio-resistant but also capable of repopulating the tumour after treatment. In fact, ionizing radiation can induce tumour stem cell growth. This is because fractionated treatment activates signaling pathways for stem cell division. Sometimes, a phenomenon called tumour growth paradox arises, in which treated tumours end up becoming larger and more invasive than untreated ones. We propose an ODE system that models this behaviour.

Mesoscale dynamics: A comparison of the Hydrostatic and Non-Hydrostatic Models and Stability Analysis of the Governing Equations
Muhammad Awais-University of Victoria

Mesoscale dynamics, which includes a study of the atmospheric processes with horizontal scales ranging from 20 to 2000 kilometres, covers a wide range of weather phenomena happening in the atmosphere. Studies available for such type of atmospheric processes make a very vital assumption of hydrostatic balance (vertical accelerations are negligible). I will present a comparison of the hydrostatic and non-hydrostatic Mesoscale processes in the presence of a singular forcing. I will give the comparison in the case of both constant and shear dependent background profiles and under different types of boundary conditions. Regarding the stability analysis: I will present a stability study for two different types of background profiles. I will show the instability for a smooth background by using a the method of continued fractions and the instability for a discontinuous background using the dispersion relation.

SCRF 100

Panel Discussion on Gender and Diversity in Mathematics
Priscilla (Cindy) E. Greenwood, Izabella Laba, Malabika Pramanik

Why is diversity important? How far have we come as academics and where is the end of the pursuit of diversity? How do we strike a balance between fairness and equity? How do we, as individuals, support all genders toward career success? A panel of high achieving female researchers from three eras gather to tell story of the evolution in academia.

Wednesday

SCRF 100

An Introduction to Python and Reproducible Research-Workshop
Bernhard Konrad

Python is a very popular programming language. It is designed to encourage readable and reusable code that is also usually shorter than in most other common languages. Python is open source and cultivates a creative, vibrant, and inviting community for developers, users, and newcomers. Many tools are and have been developed to facilitate sharing your work with the scientific community in a reusable and reproducible way. I will highlight the IPython Notebook, an interactive programming environment which lets you combine regular python code with Latex explanation, plots and interactive media, that can easily be shared even with people who don't know Python. Basic programming knowledge is helpful for this workshop, but no Python is assumed - or it would miss the point of demonstrating readable and shareable code.

Room ANGU 354

Laplace-Beltrami Spectra as "Shape-DNA" of Surfaces Using the Closest Point Method
Reynaldo Arteaga-Simon Fraser University

A wide range of applications necessitates a fast and accurate method to compare two separate manifolds. The eigenvalues of the Laplace-Beltrami operator are used to create a numerical signature representing an individual object. The spectrum is an isometry invariant which is independent of the manifolds representation such as parametrization or spatial positioning. Moreover, geometric data can be obtained via the spectrum in order to obtain an interpretation of the manifold. We solve the Laplace-Beltrami operator using the closest point method on the manifold. In 3D we illustrate the process using a triangulated mesh for the surface of objects and subsequently apply the method where the surface is given as a point cloud. Convergence studies are carried through leading to corresponding rates based on classical finite difference results. Multidimensional scaling is used to give a 2D visualization based on the level of similarity of individual objects from a given data set.

On Modeling Time Series of Counts
Boyko Zlatev - University of Alberta

In the talk are compared different statistical models for time series of counts describing individual creative productivity, historical events per unit of time (usually year or decade), etc. Poisson, autoregressive Poisson and Hawkes process are among the considered, together with application of different strategies to handle trend and missing data. Advantages and disadvantages of the models in terms of interpretation, forecasting, diagnostic are briefly discussed.

Room ANGU 434

New bounds for ψ(x;q,a)
Allysa Lumley - University of Lethbridge

In 1837, Dirichlet proved there exists infinitely many primes, p, such that $p = nq + a$

whenever a and q are relatively prime to one another. Consider the prime counting function

$$\psi(x;q,a) = \sum_{\substack{n \le x \\ n = lq+a}} \Lambda(n)$$

where $\Lambda(n) = \log p$ whenever $n = p^k$ for p a prime and $k \geq 1$ an integer and 0 otherwise. The Prime Number Theorem in Arithmetic Progressions states that as $x \to \infty$

$$\psi(x;q,a) = \frac{x}{\varphi(q)} + o(x).$$

We give a quantitative version of this theorem. Estimates of this type are used for measuring the irrationality of algebraic numbers, solving families of Thue equations, and previous results were used to prove the Schmutz Schaller conjecture for dimension 2.

Unlikely intersections and a variation of heights
Niki-Myrto Mavraki - University of British Columbia, Vancouver

In this talk we will introduce the theme of unlikely intersections. We will talk about some number-theoretic questions in which this theme occurs. In doing so, we will motivate proving a variation of heights for a family of rational maps. This is joint work with Dragos Ghioca.

Room ANGU 435

Direction-Dependent Communication Mechanisms Enrich Pattern Formation in an Individual-Based Model of Animal Movement
Cole Zmurchok - University of Alberta

In this presentation, direction-dependent communication mechanisms will be incorporated into a one-dimensional individual-based model of collective behaviour. Previously, direction-dependent communication mechanisms were incorporated into a non-local hyperbolic PDE model for collective behaviour, recreating numerous spatial patterns observed in nature. Like the PDE model, the IBM is formulated in terms of the three social interaction forces: repulsion, alignment, and attraction, and includes information regarding conspecifics' direction of travel. The IBM produces a variety of complex spatial patterns such as stationary groups, traveling groups, zigzagging aggregations, feathers, and ripple-like patterns, matching the rich behaviour of the PDE model. This not only demonstrates that the complex spatial patterns formed are not unique to the PDE model, but also suggests the importance of direction-dependent communication in collective behaviour.

Modeling Brain Tumor Spread Using an Anisotropic PDE Model
Amanda Swan - University of Alberta

Current treatment of glioblastoma brain tumors offers lots of room for improvement, with the current expected survival being about a year with treatment. A model which describes the distribution of cancer cells within the brain tissue would offer potential for improved treatment regions, and subsequently improved survival and quality of life. I will present a model which makes use of brain architecture to predict the patterns of invasion. This is done by assuming that the cancer cells migrate preferentially along the white matter tracts of the brain, and adjusting the diffusion coefficient both spatially and directionally. We refer to this as anisotropic diffusion. We make use of Diffusion Tensor Imaging (DTI) to measure the diffusion tensors at each location within the brain and show simulations using real patient data.

SCRF 100

Angels vs. Devils (Plenary Talk)

Dale Rolfsen, UBC

Hermann Weyl said (in 1939) "In these days the angel of topology and the devil of abstract algebra fight for the soul of each individual mathematical domain. " The same may be said today, perhaps with tongue in cheek. More seriously, we mathematicians (both young and old) do struggle with questions such as: What's the best way to do mathematical research? Should I narrow my focus, in order to go ever more deeply into a particular topic? Or should I strive to keep a broad perspective, perhaps to make new connections between diverse areas of mathematics? How do I choose a direction for research? How do I deal with "allergies" to certain subjects? I'll touch on these questions with stories from my own experience, trying to understand things and finding surprises and new directions along the way – motivated by angels, but sometimes turning to the dark side. At the end, I would like to open discussion with the audience on the questions raised above.