1 Overview

The eleventh Prairie Discrete Math Workshop was held at BIRS on the weekend of August 7–9. There were 30 participants, including 5 graduate students, 3 post-doctoral fellows, 2 early-career researchers (within the first few years of employment after post-doctoral fellowships), and 20 more-senior faculty members. Eleven of the participants were women (including one of the students, one of the post-doctoral fellows, and one of the early-career researchers). We had broad representation from Manitoba (11 participants from 2 universities), Saskatchewan (7 participants from 2 universities), and Alberta (9 participants from 2 universities), as well as two participants from BC and one invited speaker who was visiting from Australia. Although these gatherings have been held almost annually since 2003, the 10th workshop had been held in 2013 at Thompson Rivers University in Kamloops. A combination of factors including low attendance from prairie provinces at that meeting led to no gathering being organised in 2014, so it was our hope that holding this workshop at BIRS would revitalise the gathering. Indeed, plans are already underway for the 2016 workshop to be held in Winnipeg, hosted by the University of Manitoba.

Discrete Mathematics is a broad field that covers a wide variety of research areas within departments of Mathematics and of Computer Science. The goal of this workshop was to gather researchers from the prairie provinces who specialise in Discrete Mathematics, for the purposes of facilitating collaboration, and introducing students and post-doctoral fellows to the expertise available within the region.

Specialties of researchers who work in the prairie provinces include cryptography; graph theory; optimisation; and design theory and finite geometries. Within each of these areas, we have researchers who bring tools from other mathematical fields to bear on problems in that area, including tools from number theory, linear algebra, and abstract algebra. The diversity is so broad that we are often only dimly aware of developments in other parts of discrete mathematics, and yet it is quite common to find that someone who has been working in one field of discrete mathematics is able to use ideas from their field to make significant progress on a question in some other field, once it has been brought to their attention.

In the program for the workshop, we included 4 invited talks of 50 minutes each, and 5 contributed talks of 25 minutes each. We tried to include quite a bit of free time for informal discussions, also. All of the lectures were videotaped and should be made available through BIRS.

2 Presentation Highlights

Michael Doob from the University of Manitoba gave the first invited talk. In addition to his expertise in discrete mathematics, he has considerable technological expertise, and it was here that he focussed his presentation. He talked about the use of technology to enhance research presentations. He concentrated on beamer (for creating slides), tikz (for creating graphics), and sage (for symbolic computation), and showed
tips and tricks that are useful for any mathematician who uses these tools, particularly for presenting results. He showed numerous examples of code and the corresponding output. His examples of animations related to algebraic graph theory [?]. Most participants learned from this talk and were excited to have these ideas for improving their use of these tools in the future.

Renate Scheidler’s invited talk came second on the schedule. She is an expert in number-theoretic cryptography, working at the University of Calgary. She introduced us to hyperelliptic curve arithmetic, and its applications to public key cryptography [?]. Her talk began by explaining the basics of public key cryptography. She then explained how the points on an elliptic curve (together with the point at infinity) form an abelian group that can be used to encrypt communications based on the difficulty of the discrete log problem. She noted that this form of encryption is being used. She went on to explain how these concepts can be generalised to hyperelliptic curves. She explained that even though the operation used to form the group for hyperelliptic curves is more complicated and harder to compute than for elliptic curves, this is offset by the fact that the base field involved can be half as large without compromising the level of security provided (as long as the hyperelliptic curve has genus 2). This form of encryption is also practical, and its use does not thus far require a licensing fee. This was an excellent introduction to this extremely practical and important branch of discrete mathematics that lies on the boundary with number theory.

Gabriel Verret gave an invited talk that related to the use of permutation groups in graph theory. He is a young researcher with an impressive research record, originally from the Ottawa area, who currently holds a post-doctoral fellowship at the University of Western Australia. The actions of permutation groups on graphs is an extremely active area of discrete mathematics, with permutation group-theoretic techniques often leading to advances in our understanding of graph theory, as well as graph-theoretic techniques leading to advances in our understanding of permutation group theory. This talk was an example of the latter. He spoke about some advances he had made (with a coauthor) [?] in understanding digraphs that have vertices with almost equal neighbourhoods, when a permutation group is acting primitively on the vertices. The techniques involved counting certain properties of the graphs, but led to some results about so-called “synchronising” permutation groups [?].

The final invited talk was given by Richard Brewster. He is an expert on graph homomorphisms, from Thompson Rivers University. He discussed the problem of recolouring a graph (moving from one colouring to another by successively recolouring one vertex at a time, ensuring that every colouring is proper) and other closely-related problems [?]. He focussed on the computational complexity of this problem, which is known to be polynomial for 3-colourings, but becomes PSPACE-complete for k-colourings when $k \geq 4$ [?]. He described the generalisation of this problem to circular ($p,q$)-colourings, and explained work of his (with coauthors) [?] showing that here, too, there is a complexity dichotomy, since the problem is polynomial when $p/q < 4$ and PSPACE-complete if $p/q \geq 4$.

Of the five contributed talks, three were given by a student, a post-doctoral fellow, and an early career researcher. The other two described work that had involved students or post-doctoral fellows. The contributed talks focussed on specific work by the researchers, often as part of a collaboration. Most of them related to graphs or hypergraphs. More specifically, topics touched on in contributed talks included random and self-avoiding walks (Nicholas Beaton, University of Saskatchewan) [?], the percolation time for certain cellular automata on graphs (Karen Gunderson, University of Manitoba) [?], recent developments on finding Erdős-Gallai type inequalities for degree sequences of hypergraphs and score sequences of hypertournaments (Muhammad Khan, University of Calgary) [?], polygons and discrete models for polymers and entangled DNA (Chris Soteros, University of Saskatchewan), and games played on graphs (Boting Yang, University of Regina) [?, ?].

3 Outcome of the Meeting

We received numerous appreciative comments from participants indicating that the eleventh Prairie Discrete Math Workshop was a success. It gathered discrete mathematicians from across the prairies, from senior researchers through students. It strengthened professional and personal bonds, and forged new connections and collaborations across the prairies. It made us all aware of expertise amongst our neighbours that we will be able to call upon, and of recent developments in a variety of fields. There were many informal discussions that may lead to collaborations, as well as work that went on between existing collaborators during breaks.
in the program. A specific example of a new collaboration that developed during the meeting was between researchers from the University of Regina and Thompson Rivers University, on a problem involving posets. As previously noted, this workshop did serve (as hoped) to revitalise these annual gatherings, and the next one is already being planned. Although it was a great pleasure to hold this workshop in Banff, and we hope to return from time to time, the limit of 30 participants is too small for us to use the BIRS facilities every year, as our target participants are quite numerous and we would not wish these workshops to become exclusive.

The organisers would like to thank BIRS and the Banff Centre for their hospitality and financial support in the form of accommodation for participants. We would particularly like to thank the staff who were extremely patient and helpful through the planning and preparation phases, as well as during the workshop itself. We would also like to acknowledge the generosity of PIMS, enabling us to provide breakfasts and lunches for participants, as well as some travel support. Finally, we would like to thank all of the participants, without whom no gathering can be successful, and in particular the speakers for their excellent presentations.

References


