12TH NORDIC COMBINATORIAL CONFERENCE

Levi, Kittilä, Finland

June 13–15, 2016

https://research.comnet.aalto.fi/norcom2016

We gratefully acknowledge support from the following sponsors:
Welcome to NORCOM 2016!

The Nordic Combinatorial Conference (NORCOM) is a triennial scientific meeting covering the fields of combinatorics and discrete mathematics, interpreted broadly, with the arrangement rotated among the five Nordic countries. The conference is a venue for Nordic as well as foreign combinatorialists to get together and interact in a relaxed atmosphere. This time the participants will also be able to experience the midnight sun.

Steering committee:

- Lars Døvling Andersen (University of Aalborg)
- Petter Brändén (KTH Royal Institute of Technology)
- Trygve Johnsen (UiT The Arctic University of Norway)
- Patric Östergård (Aalto University)
- Einar Steingrímsson (University of Strathclyde)

Organizers:

- Janne Kokkala
- Antti Laaksonen
- Ferenc Szöllősi
- Patric Östergård (Chair)

Future conferences

The 13th NORCOM conference is scheduled to take place in 2019 in Denmark. Stay updated at http://www.nordiccombinatorics.org/.
List of plenary speakers:

- Gunnar Brinkmann, Universiteit Gent, Belgium
- Charles J. Colbourn, Arizona State University, United States
- Ilias S. Kotsireas, Wilfrid Laurier University, Canada
- Klas Markström, Umeå University, Sweden

List of speakers:

- Andrea Burgess, University of New Brunswick, Canada
- Dean Crnković, University of Rijeka, Croatia
- Ragnar Freij-Hollanti, Aalto University, Finland
- Oliver W. Gnilke, Aalto University, Finland
- Antonio González, University of Sevilla, Spain
- Rosalind Hoyte, Monash University, Australia
- Trygve Johnsen, UiT The Arctic University of Norway, Norway
- Petteri Kaski, Aalto University, Finland
- Janne Kokkala, Aalto University, Finland
- Daniel Koltar, Tel-Hai College, Israel
- Antti Laaksonen, Aalto University, Finland
- Pekka H. J. Lampio, Aalto University, Finland
- Joel Larsson, Umeå University, Sweden
- Anders Martinsson, Chalmers University of Technology, Sweden
- Giuseppe Mazzuoccolo, University of Verona, Italy
- Padraig Ó Catháin, Aalto University, Finland
- Salim El Rouayheb, Illinois Institute of Technology, United States
- Sanja Rukavina, University of Rijeka, Croatia
- Rinovia Simanjuntak, Institut Teknologi Bandung, Indonesia
- Ferenc Szöllösi, Aalto University, Finland
- Kristijan Tabak, Rochester Institute of Technology (Zagreb), Croatia
- Ulrich Tamm, University of Bielefeld, Germany
- Bjarne Toft, University of Southern Denmark, Denmark
- Edvin Wedin, University of Gothenburg, Sweden
- Thomas Westerbäck, Aalto University, Finland
Program

Participants can register on Sunday between 18:00–21:00.

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| 10:00–10:25  | **Mazzuoccolo**  
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| 10:25–11:00  | *Coffee break*                                                                                                                             |
| 11:00–11:25  | **Toft**  
               2-factors in graphs – history, solution, problems                                                                                     |
| 11:25–11:50  | **Burgess**  
               Decompositions of complete graphs into bipartite 2-regular subgraphs                                                                   |
| 11:50–12:15  | **Wedin**  
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| 12:15–12:25  | *Group photo*                                                                                                                              |
| 12:25–13:30  | *Lunch break*                                                                                                                              |
| 14:00–18:00  | *Excursion*                                                                                                                                |
| 19:00–22:00  | *Banquet*                                                                                                                                   |

**Excursion**

Participants should choose either of the following two activities. The decision should be made at the conference venue at the time of registration.

- **Hike to a nearby fell**: Those interested in hiking will visit the Kätkä fell. Starting from the conference venue we will walk along the shores of Lake Immel towards the fell. We will have a leisurely walk towards the peak, enjoying the beautiful surrounding scenery. Some simple refreshment might be provided at the top.

- **Bus tour to neighboring villages**: Those interested in the stories of Lapland will visit the sights of Levi and genuine Lappish villages close by. The guide enlivens the journey with stories of life in the villages. Old Lappish building culture will be shown, and a local village shop will be visited where some refreshments could be purchased.

**Banquet**

In the evening after the excursion there is a banquet, where participants are served Lappish cuisine. The banquet takes place in a ballroom at the conference site, starting at 19:00. Dresscode is mainstream casual (there is no need for a top hat or a ball gown).
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Hamiltonian cycles in polyhedra

Gunnar Brinkmann

Universiteit Gent

Abstract

A classical result in graph theory is Whitney’s theorem from 1931 that each 4-connected triangulation has a Hamiltonian cycle. This result was generalized in several directions: Tutte proved that the result also holds for 4-connected polyhedra that are no triangulations, Thomassen and Schmeichel proved that a 4-connected triangulation with $n$ vertices has at least $n/\log n$ Hamiltonian cycles and not just one and Jackson and Yu proved that the condition of 4-connectedness can be weakened for triangulations and that up to three 3-cuts can be allowed (and even more in case they have certain relative positions described in terms of a decomposition tree).

In this talk we will extend and improve some of these results and show directions of further research. Among others we will prove a linear bound for the number of Hamiltonian cycles in 4-connected triangulations and triangulations with one 3-cut and show that Jackson and Yu’s result that up to three 3-cuts can be allowed can be extended to the class of polyhedra.

This is joint work with Jasper Souffriau, Nico Van Cleemput and Carol Zamfirescu.

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Covering arrays: asymptotics and construction algorithms

Charles J. Colbourn

Arizona State University

Abstract

Covering arrays have important applications in interaction testing. In a testing application, $k$ factors each taking on $v$ levels are identified; interactions of every $t$ (factor, level) combinations are to be tested. Rows correspond to tests to be executed. One wants not just to bound from above the minimum number of rows, $\text{CAN}(t,k,v)$, in a covering array for given $t,k$ and $v$, but also to construct a covering array with “close to” $\text{CAN}(t,k,v)$ rows. For fixed $t \geq 3$ and $v \geq 2$, as $k \to \infty$, the best known bounds on $\text{CAN}(t,k,v)$ arise from the Stein–Lovász–Johnson (SLJ) strategy and the Lovász local lemma (LLL). In this talk, we first improve upon the best known asymptotic bounds. Improvements on the SLJ bound are obtained by analyzing a randomized construction algorithm, whereas improvements on the LLL bound are obtained by sample space reduction. Both lead to algorithms for covering array construction. Previous construction methods based on the SLJ strategy suffer storage requirements that are prohibitive when $t$ and $k$ are large. We employ ideas from the improvements to both strategies to develop construction algorithms that guarantee to meet the (improved) bounds in polynomial expected running time. Perhaps more importantly, the algorithms derived have modest storage requirements and prove effective at generating best known covering arrays for a variety of parameters.

This is joint work with Kaushik Sarkar (ASU).
Periodic autocorrelation and compression

Ilias S. Kotsireas
Wilfrid Laurier University

Abstract

Compression of collections of sequences with constant total periodic autocorrelation has been introduced recently by Đoković and Kotsireas and has been used successfully in a series of papers to discover dozens of new such objects. Some of the advantages of compression are that it naturally lends itself to a systematic treatment of the symmetries of these objects and that it is easily amenable to parallelization. Combining these two features of compression, led us to the discovery of new D-optimal matrices, periodic Golay pairs, symmetric Hadamard matrices, skew-Hadamard matrices, good matrices, best matrices and G-matrices. Compression can also be used to furnish non-existence results, regarding circulant weighing matrices for instance. We will discuss theoretical and experimental results as well as implementation challenges that arise in the realm of compression. We will also discuss related future work and potential improvements of our compression method.

This is joint work with Dragomir Z. Đoković (University of Waterloo).

Turán densities for graphs and 3-graphs

Klas Markström
Umeå University

Abstract

The Turán problem for an ordinary graph $H$ ask how many edges a graph $G$ on $n$ vertices can have if it does not have $H$ as a subgraph. The asymptotics of this problem is well understood as long as the graph $H$ is not bipartite. The leading order asymptotics of the maximum number of edges in $G$ is determined by the chromatic number of $H$, and there is a simple explicit family of $H$-free graphs which have that number of edges.

We can ask the same question for 3-graphs, i.e. hypergraphs where each edge consists of three vertices. Here the situation is much more complicated and we only know the full answer for a small collection of choices of $H$.

In this talk I will describe some of the known results for 3-graphs, describe some connections of the Turán problem for 3-graphs with algebraic geometry and convex optimization, and present some new results and conjectures based on extensive use of computational methods.
Decompositions of complete graphs into bipartite 2-regular subgraphs

Andrea Burgess
University of New Brunswick

Abstract

Let $K_n^*$ denote the complete graph $K_n$ if $n$ is odd, and $K_n - I$ (the complete graph with the edges of a 1-factor removed) if $n$ is even. The Oberwolfach problem, posed by Ringel in the 1960s, asks whether $K_n^*$ admits an $F$-decomposition, where $F$ is a 2-regular graph of order $n$. In this talk, we consider a generalization of the Oberwolfach problem, where $F$ has order $k \leq n$. We show that if $F$ is a bipartite 2-regular graph of order at most $n/2$ or at least $n - 2$, then the obvious necessary conditions for the existence of an $F$-decomposition of $K_n - I$ are sufficient.

This is joint work with Darryn Bryant and Peter Danziger.

Regular Hadamard matrices

Dean Crnković
University of Rijeka

Abstract

A Hadamard matrix of order $m$ is an $m \times m$ matrix $H = (h_{i,j})$, $h_{i,j} \in \{-1, 1\}$, satisfying $HH^T = H^TH = mI_m$, where $I_m$ is the identity matrix. A Hadamard matrix is called regular if the row and column sums are constant. It is conjectured that a regular Hadamard matrix of order $4k^2$ exists for every positive integer $k$. In this talk we give some method of construction of regular Hadamard matrices.
Hierarchical repairability and their weight enumerators

Ragnar Freij-Hollanti
Aalto University

Abstract
In this talk, we will survey certain coding-theoretic notions of special importance for distributed storage systems for large data. In particular, we consider the notion of local repairability, from the perspective of the matroids associated to the storage codes. We generalize the notion of local repairability to a hierarchical definition, allowing data items to be recoverable on several different scales. Moreover, we present a family of Singleton-type bounds for such storage codes, and characterize storage codes that are close to meeting these bounds, in terms of field size and weight enumerators.

This is joint work with Camilla Hollanti, Antti Pöllänen, and Thomas Westerbäck.

Mosaics of combinatorial designs

Oliver W. Gnilke
Aalto University

Abstract
We will motivate the definition of a new combinatorial object called mosaics. A mosaic is a collection of $c$ $t$-designs of equal sizes (points and blocks) together with an ordering of their blocks such that the blocks partition the point set. A small example stemming from the Fano plane can be described by the following incidence matrix:

\[
\begin{bmatrix}
0 & 1 & 1 & 2 & 1 & 2 & 2 \\
2 & 0 & 1 & 1 & 2 & 1 & 2 \\
2 & 2 & 0 & 1 & 1 & 2 & 1 \\
1 & 2 & 2 & 0 & 1 & 1 & 2 \\
2 & 1 & 2 & 2 & 0 & 1 & 1 \\
1 & 2 & 1 & 2 & 2 & 0 & 1 \\
1 & 1 & 2 & 1 & 2 & 2 & 0 \\
\end{bmatrix}
\]

Each of the “colors” 0, 1, 2 represents a $t$-design on 7 points with 7 blocks.

After presenting a handful of examples and constructions we will outline a few general properties and open questions. The appropriate generalization to the $q$-analogue case will be presented along with an almost trivial example. We conclude with a version of the famous $S_2(2, 3, 13)$ Steiner Systems by Braun et al., and show that it gives rise to a $q$-mosaic.

This is joint work with Marcus Greferath and Mario Osvin Pavčević.
Computing shortcut sets for plane Euclidean networks

Antonio González
University of Seville

Abstract
In this work, we deal with the problem of augmenting the locus $N_\ell$ of a plane Euclidean network $N$ by adding iteratively a finite set of segments, called shortcut set, in order to reduce the diameter of the locus of the resulting network. Our principal contribution is to provide the first approach on the problem for general plane Euclidean Networks since all the previous results are restricted to specific families of graphs (namely, paths and cycles). Indeed, one of our main results states that it is always possible to determine in polynomial time whether inserting only one segment to $N_\ell$ suffices to reduce the diameter; actually, we can find such a segment (if it exists) by means of a number of nice tools based on certain arrangements of curves and regions. Furthermore, we characterize the networks $N$ whose locus $N_\ell$ admits a shortcut set. It is worth mentioning that we also initiate a study of two hard problems: to minimize the size of shortcut sets and to study optimal shortcut sets for general plane Euclidean networks (i.e., shortcut sets that minimize the diameter among all shortcuts). We thus consider shortcut sets for non-connected networks, which is fundamental for proving another main result of this work: to minimize the size of a shortcut set is an NP-hard problem. Preprint available at arXiv:1604.03878.

This is joint work with J. Cáceres, D. Garijo, A. Marquez, M. L. Puertas and P. Ribeiro.

Cycle decompositions of the complete graph with a hole

Rosalind Hoyte
Monash University

Abstract
The complete graph of order $v$ with a hole of size $u$, denoted $K_v - K_u$, is the graph obtained from a complete graph of order $v$ by removing the edges of a complete subgraph of order $u$. In 2014 Bryant, Horsley and Pettersson proved that the complete graph can be decomposed into cycles of arbitrary lengths, provided that the obvious necessary conditions hold. In this talk we present some results for cycle decompositions of $K_v - K_u$.

Our main result gives necessary and sufficient conditions for decomposing the complete graph with a hole $K_v - K_u$ into cycles of uniform length $m$, provided that $m \leq \min(u, v-u)$. We also discuss some results on decomposing $K_v - K_u$ into cycles of arbitrary lengths, and outline the necessary conditions for these decompositions.

This is joint work with Daniel Horsley.
Hamming weights of almost affine codes and matroids

Trygve Johnsen
UiT The Arctic University of Norway

Abstract
Let $A$ be a finite alphabet. An almost affine code $C \subset A^n$ is a block code such that for every subset $X \subseteq \{1, \ldots, n\}$, the projection $C_X$ of $C$ into $A^X$ has cardinality a power of $|A|$. These codes were first defined by Simonis and Ashikhmin (1998). Linear codes are examples of almost affine codes, but the class of almost affine codes up to equivalence is strictly bigger. To an almost affine code $C$, one can associate a matroid $M$, defined by its rank function

$$r(X) = \log_{|A|}|C_X|$$

for all $X \subseteq \{1, \ldots, n\}$. We will recall definitions of Hamming weights of matroids, and define Hamming weights of almost affine codes accordingly, and show how these weights can be expressed as cardinalities of support weights of subcodes, in analogy with the situation for the smaller class of linear codes. We will discuss Wei duality, in particular for the intermediate class of multilinear codes. Preprint available at arXiv:1601.01504.

This is joint work with Hugues Verdure.

How proofs are prepared at Camelot

Petteri Kaski
Aalto University

Abstract
We discuss a design framework for robust, independently verifiable, and workload-balanced distributed algorithms working on a common input. The framework builds on recent Merlin–Arthur proofs of batch evaluation of Williams (2016) with the basic observation that Merlin’s magic is not needed for batch evaluation – mere Knights can prepare the independently verifiable proof, in parallel, and with intrinsic error-correction. As our main technical result, we show that the $k$-cliques in an $n$-vertex graph can be counted and verified in per-node $O(n^{(\omega+\epsilon)k/6})$ time and space on $O(n^{(\omega+\epsilon)k/6})$ compute nodes, for any constant $\epsilon > 0$ and positive integer $k$ divisible by 6, where $2 \leq \omega < 2.3728639$ is the exponent of square matrix multiplication over the integers. This matches in total running time the best known sequential algorithm, due to Nešetřil and Poljak (1985), and considerably improves its space usage and parallelizability. Preprint available at arXiv:1602.01295.

This is joint work with Andreas Björklund (Lund University).
The chromatic number of the square of the 8-cube

Janne Kokkala
Aalto University

Abstract

The $k$th power of the $n$-cube, $Q_8^n$, is the graph over $Z_2^n$ that has edges between two vertices if their Hamming distance is at most $k$. An independent set in $Q_8^n$ corresponds to a binary code of length $n$ and minimum distance $k + 1$. The chromatic number $\chi(Q_8^n)$ is thus the number of such codes needed to partition the $n$-dimensional Hamming space.

The problem of determining the chromatic number of $Q_8^n$ has attracted interest in coding theory and combinatorics. In this case, the independent sets in the graph correspond to one-error-correcting binary codes. It is known that asymptotically $\chi(Q_8^n) \sim n$, but for small $n$, exact values of $\chi(Q_8^n)$ have been known only for $n \leq 7$.

The maximum size of a one-error-correcting binary code of length 8 is 20, which gives a lower bound $\chi(Q_8^n) \geq \lceil 2^8 / 20 \rceil = 13$. On the other hand, colorings of $\chi(Q_8^n)$ with 14 colors were found independently by Hougardy in 1991 and Royle in 1993. We discuss a computer search that was used to find 13-colorings of $Q_8^n$, thus proving that $\chi(Q_8^n) = 13$.

This is joint work with Patric R. J. Östergård.

Rainbow matchings for sets of large matchings in bipartite graphs

Daniel Kotlar
Tel-Hai College

Abstract

Given sets $F_1, F_2, \ldots, F_n$ of edges in a graph, a (partial) rainbow matching is a choice of disjoint edges from some of the $F_i$s. In other words, it is a partial choice function whose range is a matching. If the rainbow matching represents all $F_i$s then we say that it is full. Let $f(n)$ be the smallest number such that every collection of $n$ matchings, each of size at least $f(n)$, in a bipartite graph, has a full rainbow matching. For an arbitrary $1 \leq k \leq n$ the matchings $F_1, \ldots, F_k$ which are all equal to the perfect matching in the cycle $C_{2n}$ consisting of the odd edges, along with $F_{k+1}, \ldots, F_n$ which are all equal to the perfect matching in $C_{2n}$ consisting of the even edges have no full rainbow matching. This shows that $f(n) \geq n + 1$ for all $n > 1$.

Generalizing famous conjectures of Ryser, Brualdi and Stein, Aharoni and Berger (2009) conjectured that $f(n) = n + 1$ for every $n > 1$. A greedy choice of representatives shows that $f(n) \leq 2n - 1$. Successive improvements on this trivial bound were $f(n) \leq \lfloor \frac{5}{2}n \rfloor$ (Aharoni, Charbit and Howard), $f(n) \leq \lfloor \frac{3}{2}n \rfloor$ (Kotlar and Ziv) and most recently, $f(n) \leq \lfloor \frac{3}{2}n \rfloor + o(n)$ (Clemens and Ehrenmüller). In this work we show that the $o(n)$ term can be reduced to a constant, namely $f(n) \leq \lfloor \frac{3}{2}n \rfloor + 1$.

This is joint work with Ron Aharoni and Ran Ziv.
Constructing error-correcting binary codes using transitive permutation groups

Antti Laaksonen
Aalto University

Abstract

An error-correcting binary code of length $n$ and minimum distance $d$ is a set of binary vectors of length $n$ where the Hamming distance between any two vectors is at least $d$. The size of a code is the number of vectors that it contains, and for many parameters $n$ and $d$ it is an open problem what is the maximum size of such a code. We approach the problem by focusing on codes that can be derived from transitive permutation groups.

This is joint work with Patric R. J. Östergård.

On the classification of Butson-type Hadamard matrices

Pekka H. J. Lampio
Aalto University

Abstract

Butson-type Hadamard matrices are a generalization of Hadamard matrices. They are $n \times n$ complex matrices where the entries are $q$th roots of unity (complex numbers that are solutions to the equation $x^q = 1$), and the rows and columns are pairwise orthogonal, that is,

$$HH^T = nI.$$ 

This computer-aided work is motivated partly by the existence of some small matrices with surprising properties. For example, there exists a $7 \times 7$ matrix where the entries are sixth roots of unity. Why should it be possible to construct a $7 \times 7$ Butson-type Hadamard matrix with only six distinct entries? Are there any other small matrices like that?
Speed and concentration of the covering time for structured coupon collectors

Joel Larsson
Umeå University

Abstract
Let $V$ be an $n$-set, and let $X$ be a random variable taking values in the powerset of $V$. Suppose we are given a sequence of random coupons $X_1, X_2, \ldots$, where the $X_i$ are independent random variables with distribution given by $X$. The covering time $T$ is the smallest integer $t \geq 0$ such that $\bigcup_{i=1}^t X_i = V$. The distribution of $T$ is important for many applications in discrete probability and has been extensively studied. However, the literature has focused almost exclusively on the case where $X$ is assumed to be symmetric and/or uniform in some way.

In this paper we study the covering time for general random variables $X$; we give general criteria for $T$ being sharply concentrated around its mean, precise tools to estimate that mean, as well as examples where $T$ fails to be concentrated and when structural properties in the distribution of $X$ allow for a very different behaviour of $T$ relative to the symmetric/uniform case.

By considering more general or structured distribution for the random set $X$, we can give a unified treatment of a number of important problems, such as random $k$-SAT and the connectivity threshold of random graphs, and we are able to obtain sharp results for some general classes of distributions, e.g. when $X$ is negatively correlated.

This is joint work with Victor Falgas-Ravry and Klas Markström.

Most edge-orderings of $K_n$ contain monotone Hamiltonian paths

Anders Martinsson
Chalmers University of Technology and University of Gothenburg

Abstract
The altitude of a graph $G$ is defined as the largest integer $k$ such that any edge-ordering of $G$ contains a (self-avoiding) path of length $k$ that is increasing in the ordering. In 1971, Chvátal and Komlós asked for the altitude of the complete graph on $n$ vertices. While there have been some results to this end, progress on this problem has been slow.

Inspired Chvátal's and Komlós’ question, in a recent paper, Lavrov and Loh (2016) considered the length of the longest increasing path in a random edge-ordering of the complete graph. They proved that a.a.s. this length is at least $0.85n$, and with probability at least $1/e - o(1)$ it is the maximally possible $n - 1$, i.e. there exists an increasing Hamiltonian path. They consequently conjectured that increasing Hamiltonian paths exist a.a.s. In my talk, I will present my own work on this problem, proving this conjecture.

The basic proof idea is to relate $X$, the number of increasing Hamiltonian paths, to $Y$, the conditional number of such paths given that some fixed Hamiltonian path is increasing. By coupling $X$ to $Y$ in a natural way, one can show that $Y \approx cX$ for large $n$. The proof of this essentially reduces to estimating the third moment of $X$, hence this argument may be considered one of the rare applications of a “third moment method”.
Flows and bisections in cubic graphs

Giuseppe Mazzuoccolo
University of Verona

Abstract
We study the relations between circular nowhere-zero $r$-flows in a cubic graph $G = (V, E)$ and the existence of certain bisections (partitions into two subsets of the same cardinality) of the vertex set $V$. In particular, a circular nowhere-zero $r$-flow in $G$ implies a bisection, where every connected subgraph on $r - 1$ vertices intersects both parts of the bisection. This is related to a recent conjecture of Ban and Linial, stating that any bridgeless cubic graph, other than the Petersen graph, admits a bisection, where the graph induced by each part of the bisection consists of connected components on at most two vertices. In particular, we show that any cubic graph admits a bisection where the graph induced by each part consists of connected components on at most three vertices.

This is joint work with L. Esperet and M. Tarsi.

Uncertainty principles and trades in Hadamard matrices

Padraig Ó Catháin
Aalto University

Abstract
Arising originally from the analysis of a family of compressed sensing matrices, Ian Wanless and I recently investigated a number of linear algebra problems involving complex Hadamard matrices. I will discuss our main result, which relates rank-one submatrices of Hadamard matrices, simultaneous representations of a fixed vector with respect to two unbiased bases of a finite dimensional vector space and trades in Hadamard matrices. Only a basic knowledge of linear algebra will be assumed.

This is joint work with Prof. Ian Wanless.
Private information retrieval from coded data

Salim El Rouayheb
Illinois Institute of Technology

Abstract

An information theoretic Private Information Retrieval (PIR) scheme ensures that a user can retrieve records in a database or files in a distributed storage system (DSS) while revealing no information on which record or file is being retrieved. A user can achieve PIR by downloading all the data in the DSS. However, this is not a feasible solution due to its high communication cost. I will present constructions of PIR schemes with low download communication cost when the data is stored on the DSS using Maximum Distance Separable (MDS) codes. I will also discuss open questions in this area.

This is joint work with Razan Tajeddine.

Self-dual codes from quotient matrices of symmetric divisible designs with the dual property

Sanja Rukavina
University of Rijeka

Abstract

We study codes spanned by the rows of the quotient matrices of symmetric (group) divisible designs (SGDD) with the dual property. We define an extended quotient matrix and show that under certain conditions the rows of the extended quotient matrix span a self-dual code with respect to a certain scalar product. We also show that sometimes a chain of codes can be used to associate a self-dual code to a quotient matrix of an SGDD with the dual property.

This is joint work with Dean Crnković and Nina Mostarac.
Strong oriented graphs with largest directed metric dimension

Rinovia Simanjuntak
Institut Teknologi Bandung

Abstract
Let $D$ be a strongly connected oriented graph with vertex set $V$ and edge set $E$. The distance from a vertex $u$ to another vertex $v$, $d(u,v)$ is the minimum length of oriented paths from $u$ to $v$. Suppose $B = \{b_1, b_2, b_3, \ldots, b_k\}$ is a nonempty ordered subset of $V$. The representation of a vertex $v$ with respect to $B$, $r(v|B)$, is defined as a vector $(d(v,b_1), d(v,b_2), \ldots, d(v,b_k))$. If any two distinct vertices $u, v$ satisfy $r(u|B) \neq r(v|B)$, then $B$ is said to be a resolving set of $D$. If the cardinality of $B$ is minimum then $B$ is said to be a basis of $D$ and the cardinality of $B$ is called the directed metric dimension of $D$, $\dim(D)$.

In this talk we shall prove that if $D$ is a strongly connected oriented graph of order $n \geq 4$, then $\dim(D) \leq n - 3$. Furthermore, we shall characterize strongly connected oriented graphs attaining the upper bound, i.e., strongly connected oriented graphs of order $n$ and metric dimension $n - 3$.

This is joint work with Jozef G. Tjandra.

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Enumeration of cospectral Seidel matrices

Ferenc Szöllősi
Aalto University

Abstract
We report on computational results regarding two-graphs on 13 vertices. Amongst other things, we determine all Seidel matrices with exactly 3 distinct eigenvalues on fewer than 20 vertices, and prove that there does not exist 21 equiangular lines in the 12 dimensional Euclidean space with common angle $1/5$.

This is joint work with Patric R. J. Östergård.
Normalized difference sets tiling in $\mathbb{Z}_p$

Kristijan Tabak
Rochester Institute of Technology, Zagreb campus

Abstract
We use normalized difference set tiling with parameters $(31, 6, 1)$ in $\mathbb{Z}_{31}$ as a motivation to develop applicable description of possible tiling in bigger groups $\mathbb{Z}_p$. Using multipliers and basic character theory we manage to prove NTC (normalized tiling conjecture), stating that products of all elements from difference set in tiling should be $1$. Proof was developed based upon assumption that we don't know anything about putative tiling in $\mathbb{Z}_{31}$.

With this approach we are in position to generalize it in order to determine the status of NTC for bigger abelian groups.

Information complexity and communication complexity

Ulrich Tamm
University of Bielefeld

Abstract
Is it significantly easier to compute several instances of a problem simultaneously than sequentially? An affirmative answer to this question for communication complexity (the so-called direct-sum conjecture) would have deep impact in circuit complexity. Recently, for probabilistic protocols the amortized (= simultaneous) communication complexity could be characterized as an information expression. For deterministic protocols we shall demonstrate via Kraft's inequality from data compression for some functions related to set intersection that an improvement is possible — but that this improvement is not significant.
2-factors in graphs – history, solution, problems

Bjarne Toft
University of Southern Denmark

Abstract
The 2-factor problem is to decide which graphs have a vertex-covering with disjoint cycles. It is one of the earliest problems studied in graph theory (by J. Petersen and J.J. Sylvester in 1889). It was solved by A.B. Belck (1949), T. Gallai (1950) and W.T. Tutte (1951). But there are still interesting unsolved problems.

The freezing time of the Hegselmann–Krause model

Edvin Wedin
University of Gothenburg and Chalmers University of Technology

Abstract
The Hegselmann–Krause model is a naïve discrete time multi-agent model in opinion dynamics. In its simplest form, opinions are taken to be real numbers, and, at each time-step, each agent updates its opinion to the average of those that lie within a prescribed distance of its own. This definition is simple enough to allow for precise mathematical analysis, and it turns out to give rise to remarkably rich interactions with many challenging open problems and several non-trivial rigorous results to date. As for the problems that have been solved, the proofs have employed tools as diverse as Markov chains, optimisation and mean field theory of stochastic differential equations. An early result was that, for opinions in \( \mathbb{R} \), or even \( \mathbb{R}^d \), for all initial conditions the system must freeze after a finite number of updates. One of the questions that has received the most attention is that of bounding this freezing time for general configurations. The current state of the art for real-valued opinions is that the longest possible freezing time for a system of \( n \) agents is at most \( O(n^3) \) and at least \( \Omega(n^2) \), the latter bound found by us by means of Markov chain theory. In this talk I will briefly introduce the model, along with some of its properties. I will then discuss the freezing time problem and, if time permits, other interesting questions.

This is joint work with Peter Hegarty.
Combinatorial coding theory

Thomas Westerbäck
Aalto University

Abstract

Matroid theory can be used to analyze many interesting properties of linear codes over finite fields. Recent research has proven matroid theory to be a valuable tool in several areas in coding theory, e.g., in distributed storage, index coding and network coding. In this talk I will present how polymatroid theory can be used to analyze properties of codes that are not necessarily field-linear. New results on codes will be given in the setting of polymatroids. These results can therefore also be applied to non-code objects that are associated with polymatroids.
Area map (downtown Sirkka)