Invited Speakers

36th Southeastern International Conference on Combinatorics, Graph Theory, and Computing

Monday, March 7, 2005
9:30 AM and 2:00 PM

Alexander Rosa
MacMaster University

Ringel's Conjecture and Graceful Labellings; Forty Years Later and Colouring Designs: Some Recent Results and Trends

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Tuesday, March 8, 2005
9:30 AM and 2:00 PM

Charles. J. Colbourn

Arizona State University

Covering Arrays and the Power of Apathy

Abstract

A *covering array* of *size* N, *strength* t, having k *factors* with v *levels* each, is an $N \times k$ array whose entries are chosen from a v-set V, with the property that every $N \times t$ subarray has every one of the v^t t-tuples from V at least once as a row. To understand why these are important, imagine testing a device with k inputs each having v possible values; each factor is an input, and each level is a value for that input. Instead of exhaustively testing v^k possible input combinations, we can instead use the N rows of the covering array to prescribe tests. Each row is a test, each column is a factor, and the symbol in an entry gives the value for the factor in that test. Testing is not exhaustive, of course, but all possible interactions arising from t or fewer inputs will be revealed by at least one test. Moreover, when $t \ll k$, we typically find $N \ll v^k$. Such covering arrays have found extensive application recently in interaction software testing; while not well suited to all such problems, they are useful in many. When one considers that inadequate software testing costs the U.S. economy \$20-\$60 billion annually, tools for generating test suites (covering arrays) are sorely needed. To minimize testing costs, covering arrays with the fewest rows N for a given t, k, and v are of most interest.

While covering arrays evidently hold much practical interest, our focus in this talk is on mathematical reasons to like them. Most algebraic and combinatorial constructions are patterned on those for orthogonal arrays of index one (equivalently, covering arrays with $N = v^t$) and on recursive combinatorial constructions. We outline four main directions of combinatorial research on covering arrays: direct constructions, recursive (product) constructions, heuristic search, and probabilistic techniques.

We review each of these approaches briefly, focussing on the cut-and-paste constructions. We then weave the threads above to describe recent research on covering array construction using hybrid constructions. The idea is quite simple. The usual strategy for applying recursive methods for combinatorial designs is to first find many small ingredient designs, and then apply the recursive construction. In these cases, the ingredients do not interact and can be found independently of one another.

As we show, the cut-and-paste recursions for covering arrays are different. The ingredient designs can (and often do) overlap. So we propose a decomposition approach. The cut-and-paste recursions specify potential decompositions of large covering arrays into smaller arrays, and the specific decomposition determines precisely how these smaller arrays interact. Our idea, therefore, is to first choose the decomposition of the larger array, and only then to search for the smaller arrays needed. In this way, the interactions among these smaller arrays can be used both to simplify the search, and to permit the array to be "tailor-made" for the role that it plays. Once the properties of the small arrays and their interactions is determined by the decomposition, we can sometimes use direct constructions (from finite fields, designs, or finite geometries) to construct them; and when we cannot, we can employ heuristic search techniques to find them by computer. Of course, the benefit in the approach is that computational methods seem much more effective when the array to be found is small. We propose a particular approach for strength two arrays that exploits "don't care" positions, demonstrating the power of apathy. We close with a list of combinatorial questions on covering arrays.

Wednesday, March 9, 2005
11:00 AM and 2:00 PM

Mateja Sajna
University of Ottawa

An Invitation to Almost Self-complementary Graphs

A graph is called *almost self-complementary* (ASC) if it is isomorphic to the graph (called an *almost complement* of X) obtained from its complement by removing the edges of a 1-factor. The study of almost self-complementary graphs was first suggested by Alspach, and initiated by Dobson and Šajna in a 2004 paper on almost self-complementary circulant graphs. This paper revealed the complexity of the problem of ASC graphs: while every automorphism of a graph is also an automorphism of its complement, the same may not be true for an almost complement; and while an isomorphism from a self-complementary graph to its complement exchanges the two edge sets, an isomorphism from an ASC graph to an almost complement need not preserve the "missing" 1-factor and therefore need not exchange the edges of the graph with those of the almost complement. An isomorphism from an ASC graph to an almost complement, as well as an automorphism of an ASC graph, is called *fair* if it preserves the associated 1-factor. In this talk we shall present some recent results on various types almost self-complementary graphs.

Part I: Constructing Almost Self-complementary Graphs

Several construction techniques for ASC graphs will be introduced and used to prove existence results for some infinite families of ASC graphs, in particular, regular, vertex-transitive, and circulant ASC graphs, distinguishing those that admit fair isomorphisms into an almost complement.

Part II: Homogeneously Almost Self-complementary Graphs

We shall focus on a special class of vertex-transitive ASC graphs called *homogeneously almost self-complementary*; that is, ASC graphs possessing a vertex-transitive group of fair automorphisms and a fair isomorphism into the almost complement that normalizes it. It turns out these are precisely the graphs that occur as factors of symmetric index-2 homogeneous factorizations of the graphs $K_{2n} - nK_2$. We shall present several constructions and existence results, including the classification of all integers n of the form $n = p^r$ and $n = 2p$ with p prime for which there exists a homogeneously almost self-complementary graph on $2n$ vertices.

Keywords: almost self-complementary graph, regular graph, vertex-transitive graph, circulant graph, homogeneously almost self-complementary graph, homogeneous factorization.

Thursday, March 10, 2005
9:30 AM and 2:00 PM

John Wilson

University of Toronto

Axiomatic Circuit Theory

Friday, March 11, 2005
9:30 AM

Tran van Trung

University of Duisburg-Essen

Combinatorial Methods for Covering Arrays

We survey algebraic and combinatorial techniques for constructing covering arrays of strength $t \geq 3$. Some of these techniques are inspired from a recursive construction given in the 80's by Roux.

Friday, March 11, 2005
11:00 AM

Brief Session Dedicated to the Memory of Frank Harary

Organized by Gary Chartrand with John Gimbel and Jay Bagga
