# Abstracts and Schedule
# Discrete Mathematics Day of the Northeast
# September 15, 2012
# Bread Loaf Campus, Middlebury College
# Ripton, VT

**Friday, September 14th, 6pm–10pm** Guest-room check-in in Bread Loaf Inn Lobby. Building assignments are Birch and Cherry.

**9:00–10:00am** Registration in Bread Loaf Inn Lobby. Coffee and light refreshments served.

*All lectures will take place in the Little Theatre at the Bread Loaf Campus.*

**10:00–11:00am**
**Speaker:** Paul Horn, Harvard University
**Title:** 3D floorplanning and tree representations


**Abstract**

A (2D) mosaic floorplan is a partitioning of a square into $n$ rectangles. Schemes which can be used to represent and count these floorplans, under a suitable topological equivalence, have applications in chip design. A 3D mosaic floorplan is a partitioning of a box into $n$ smaller boxes. Modern chip construction techniques, allowing chips with multiple layers, have fueled the desire to understand the number of 3D mosaic floorplans and how to represent them. For the 2D case, the number of unlabeled floorplans with $n$ rectangles, up to topological equivalence, is exponential in $n$. For many classes of 3D floorplans the number of floorplans is also exponential. Notable among these are 'slicing' floorplans, where to obtain an $n$ box floorplan one starts with an $n-1$ box floorplans, and divides a box in two. In this talk, we discuss some of the difficulties with more general 3D floorplans, even with only two layers. In particular, if $F_n$ denotes the number of 3D floorplans with two levels, we show that $\log F_n \sim \frac{1}{3} n \log n$, and hence $F_n$ grows superexponentially in $n$. The upper bound comes from a representation scheme using trees, while the lower bound comes from a random construction.

**11:00am–12:00pm**

**Speaker:** Ileana Streinu, Smith College
**Title:** Rigidity and origami


**Abstract**

Around 1995, Robert Lang, a well-known origamist, proposed a computational method for designing a crease pattern on a flat piece of paper such that it has an isometric flat-folded realization with an underlying, predetermined metric tree structure. Important mathematical properties of this algorithm remain elusive to this day.

In this talk I will show that Lang's beautiful method leads, most often, to a crease pattern that cannot be continuously deformed to the desired flat-folded shape if its faces are to be kept rigid. Most surprisingly, sometimes the initial crease pattern is simply rigid: the (real) configuration space of such a structure may be disconnected, with one of the components being an isolated point. Along the way, we uncover other structural properties of Lang's Universal Molecule algorithm.

This is joint work with my PhD student John Bowers, who also implemented a very nice program to visualize what is going on.


**12:15–1:15pm** Lunch in Bread Loaf Inn dining room.

**1:15pm–1:30pm** Conference photo

**1:30–2:30pm**
**Speaker:** Bruce Shepherd, McGill University

**Title:** Maximum Throughput versus Minimum Congestion in Disjoint Path Problems in Planar Graphs


**Abstract**

Garg, Vazarani, and Yannakakis showed that the integrality gap for (the natural LP relaxation of) maximum disjoint paths (MEDP) in planar graphs is $\Omega(\sqrt{n})$. Noting that their gap example (a grid minor) all but disappears if edge congestion 2 is allowed, Kleinberg and Tardos asked if MEDP in planar graphs behaves better when one admits constant congestion. A sequence of results ultimately showed that with constant (in fact 2) congestion, the integrality gap is indeed $O(1)$. (In addition, recent work of Chuzhoy shows a polylog(n) gap in general graphs with constant congestion.) There are strong connections to a parallel stream of work on routing all demands with minimum congestion. This latter work is on "flow-cut gaps" which amounts to embedding a finite metric in $L_1$. We discuss the connections and distinctions between the max throughput and min congestion problems, with an emphasis on highlighting some of the open problems.

**2:30–3:30pm**

**Speaker:** Elizabeth Beazley, Haverford College
**Title:** Projections on Parabolic Quotients of Affine Weyl Groups

**Abstract**

Affine Weyl groups and their parabolic quotients are used extensively as indexing sets for objects in representation theory, algebraic geometry, and number theory. Moreover, we can conveniently realize the elements of certain quotients via intuitive geometric and combinatorial models such as abaci, alcoves, root lattice points, and core partitions. Berg, Jones, and Vazirani have described a bijection between $n$-cores with first part equal to $k$ and $(n-1)$-cores with first part less than or equal to $k$. This bijection also has an interpretation in terms of the correspondence of Lapointe and Morse between n-cores and $(n-1)$-bounded partitions. This correspondence played a crucial role in the development of $k$-Schur functions, which are known to represent the Schubert basis in the homology of the affine Grassmannian. In this talk we discuss how to generalize this bijection of Berg, Jones, and Vazirani to parabolic quotients of affine Weyl groups in other classical Lie types. We have developed not only combinatorial techniques to describe this map, but also a visually explicit method utilizing the geometric properties of the alcove model coming from the root system associated to the affine Weyl group.

**3:30–4pm** Coffee break on patio of Little Theatre.

**4:00–5:00pm**
**Speaker:** Mel Nathanson, City University of New York
**Title:**Problems and results in combinatorial number theory

**Abstract**

This will be a survey of recent results and open problems in additive problems concerning the growth of finite sets of integers and lattice points, and of finite subsets subsets of arbitrary abelian and nonabelian groups. There are also new results about the Calkin-Wilf tree for enumerating the positive rational numbers.

**5:15–6:15pm** Walk on campus trails led by local discrete mathematician and ornithologist Professor Emeritus Bruce Peterson, Middlebury College.

**6:15pm** Cocktail Reception on Porch of Bread Loaf Inn.

**7pm–9pm** Dinner in Bread Loaf Inn dining room.

**Sunday, September 16th, 7:00–9:00am** Continental breakfast available in Inn Lobby