Curriculum Vitae

Mark Skandera

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Citizenship: United States

Research interests:

Algebraic combinatorics: total nonnegativity, Schur nonnegativity, Kazhdan-Lusztig bases, polynomials with real zeros, f-vectors and h-vectors of simplicial complexes, partially ordered sets.

Education:

Massachusetts Institute of Technology — Cambridge, MA
September 1996-May 2000
Ph.D., Applied Mathematics, May 2000. Thesis *Chain Polynomials and Permutation Statistics* supervised by Richard Stanley.

University of California — Berkeley, CA
September 1991-May 1993
M.S., Operations Research, May 1992.

Brown University — Providence, RI
September 1987-May 1991
Sc.B., Applied Mathematics, May 1991.

Employment history:

Dartmouth College — Hanover, NH
August 2003-present
John Wesley Young instructor. Teaching undergraduate courses in calculus, combinatorics, differential equations, and probability. Teaching a graduate course in

combinatorics. Supervising undergraduate research. Coorganizing combinatorics seminar.

University of Michigan — Ann Arbor, MI
September 2000-July 2003
VIGRE Postdoctoral fellow. Taught undergraduate courses in calculus, linear algebra, probability. Designed and taught a graduate course in combinatorics. Supervised undergraduate research in the REU and UROP programs. Coorganized combinatorics seminar.

Massachusetts Institute of Technology — Cambridge, MA
September 1999-December 2000
Linear algebra teaching assistant for Professor Gilbert Strang.

Massachusetts Institute of Technology — Cambridge, MA
September 1998-January 1999
Coordinator of Mathematics Tutoring Room and undergraduate grading.

Boston Treasury Systems — Cambridge, MA; Madrid, Spain
January 1994-May 1996
Software engineer.

University of California — Berkeley, CA
June 1992-December 1992
Teaching assistant for graduate course in industrial engineering.

List of papers:

1. "Path tableaux and immanants related to representations of S_n", in progress, (2004). Lindström's combinatorial interpretation of determinants is generalized to define path tableaux for planar networks. This gives a formula for $\mathrm{Imm}_\lambda(A)$ when λ is a hook partition of n and A is an $n \times n$ matrix. When μ is any partition having at most two columns, the immanant $\mathrm{Imm}_\mu(x)$ is shown to be a nonnegative linear combination of Temperley-Lieb immanants.

2. "Kazhdan-Lusztig immanants", (with Brendon Rhoades), in progress, (2004). Functions generalizing the determinant are defined in terms of Kazhdan-Lusztig polynomials. These are shown to be totally nonnegative and Schur nonnegative, and to generalize the Temperley-Lieb immanants defined below. This implies the Schur nonnegativity of certain differences of products of skew Schur functions.

3. "Nonnegativity properties and the Bruhat order", (with Brian Drake, Sean Gerrish), in progress, (2004). A natural order concerning monomial nonnegativity is shown to be isomorphic to the Bruhat order.

4. "Temperley-Lieb immanants", (with Brendon Rhoades), *Ann. Comb.*, to appear (2005). Functions generalizing the determinant are defined in terms of the Temperley-Lieb algebra. These are shown to be totally nonnegative and to provide a characterization of totally nonnegative polynomials constructed from products of pairs of matrix minors.

5. "Two new criteria for comparison in the Bruhat order", (with Brian Drake, Sean Gerrish), *Elec. J. Combin.* **11** no. 1 (2004), #N6.
   Two natural orders concerning total nonnegativity and Schur nonnegativity are shown to be isomorphic to the Bruhat order.

6. "Doce lecciones en combinatoria algebraica", (with Federico Ardila, Mercedes Rosas), in progress, (2003).
   An expository article in Spanish about current problems in total nonnegativity, Schur nonnegativity, representations of the symmetric group, and hyperplane arrangements.

7. "Multicomplexes and polynomials with real zeros" (with Jason Bell), in progress, (2003).
   Each polynomial $a(z) = 1 + a_1 z + \cdots + a_d z^d$ in $\mathbb{N}[z]$ having only real zeros is shown to be the f-polynomial of a multicomplex. This implies that $a(z)$ is also the h-polynomial of a Cohen-Macaulay ring and the g-polynomial of a simplicial polytope. More results suggest that $a(z)$ is also the f-polynomial of a simplicial complex.

8. "Total nonnegativity and $(\mathbf{3}+\mathbf{1})$-free posets" (with Brian Reed), *J. Combin. Theory Ser. A.* **103** (2003), 237-256.
   The class of $(\mathbf{3}+\mathbf{1})$-free posets is related to the class of unit interval orders using totally nonnegative matrices. This relationship proves that the f-vector of a $(\mathbf{3}+\mathbf{1})$-free poset is also the f-vector of a unit interval order.

9. "Inequalities in minors of totally nonnegative matrices", *J. Alg. Combin.* **20** no. 2 (2004).
   All inequalities of the form $\Delta_{S,S'}\Delta_{T,T'} \leq \Delta_{U,U'}\Delta_{V,V'}$ which hold for totally nonnegative matrices are characterized. The proof provides a combinatorial interpretation for the difference of the two products.

10. "Interpretaciones del h-vector", *Bol. Asoc. Mat. Ven.* **2** (2001), 141-174.
    An expository article in Spanish about various interpretations of h-vectors, important results, and open problems.

11. "An Eulerian partner for inversions", *Sém. Loth. Combin.* **46** (2001), B46d.
A simple new Eulerian statistic "stc" is defined in order to be paired with the statistic INV in a result which asserts the equidistribution on S_n of (stc, INV) and (des, MAJ).

12. "Dumont's statistic on words", *Elec. J. Combin.* **8** no. 1 (2001), #R11.
Dumont's permutation statistic is generalized to words. The generalized statistic is shown to be equidistributed with the word statistic des on the rearrangement class of any word. This equidistribution is used to show that the h-vectors of certain distributive lattices are f-vectors of posets.

13. "A Characterization of $(\mathbf{3}+\mathbf{1})$-free posets", *J. Combin. Theory Ser. A.* **93** (2001), 231-241.
$(\mathbf{3}+\mathbf{1})$-free posets are characterized in terms of their antiadjacency matrices. This characterization relates $(\mathbf{3}+\mathbf{1})$-free posets to totally nonnegative matrices and gives an easy proof that the corresponding f-polynomials have only real zeros.

Other manuscripts and publications:

1. *Introduction to Combinatorics and Graph Theory.* (In preparation.) Unpublished lecture notes for a graduate course at the University of Michigan. (2002).

2. *User's Guide for the NIST Computer Security Bulletin Board.* (With Marianne Swanson.) Technical report NISTIR 4933. National Institute of Standards and Technology, Gaithersburg, MD. (1991).

Presentations:

AMS special session, Bard College. October, 2005.

Discrete Math Day, Worcester Polytechnic Institute. September 2005.

FPSAC Conference, Taormina, Italy. June, 2005.

Combinatorics Seminar, Brandeis University. March, 2005.

Combinatorics Seminar, University of Pennsylvania. March, 2005.

Mathematics Colloquium, Haverford College. March, 2005.

Combinatorics Seminar, Northeastern University. January, 2005.

Mathematics Colloquium, North Carolina State University. January, 2005.

Mathematics Colloquium, College of William and Mary. January, 2005.

CMS Winter Meeting, Montreal. December, 2004.

Combinatorics Seminar, Dartmouth. October, 2004.

Mathematics Colloquium, University of Texas at El Paso. September 2004.

FPSAC Conference, Vancouver. June, 2004.

R. Stanley Birthday Conference, Boston. June, 2004.

Mathematics Colloquium, University of Miami. March 2004.

Mathematics Seminar, Middlebury College. February, 2004.

Combinatorics Seminar, Dartmouth. October, 2003.

Combinatorics Seminar, LaCIM, Montreal. September, 2003.

Combinatorics Seminar, MIT. September, 2003.

FPSAC Conference, Vadstena, Sweden. June, 2003.

Lecture series, Universidad de los Andes, Bogotá. March, 2003.

Mathematics Colloquium, Iowa State University. February, 2003.

Applied Algebra Seminar, York University. October, 2002.

Commutative Algebra Seminar, University of Michigan. September, 2002.

FPSAC Conference, Melbourne. July, 2002.

Mathematics Colloquium, University of New South Wales, Sydney. July, 2002.

Mathematics Colloquium, Wesleyan University. March, 2002.

Combinatorics Seminar, Michigan State University. March, 2002.

Combinatorics Seminar, University of Michigan. February, 2002.

AMS Annual Meeting, San Diego. January, 2002.

Mathematics Colloquium, Dartmouth. October, 2001.

Combinatorics Seminar, University of Washington. August, 2001.

Lecture series, Universidad Simón Bolívar, Caracas. June, 2001.

Combinatorics Seminar, University of Minnesota. March, 2001.

Mathematical Challenges of the 21st Century, UCLA. August, 2000.

FPSAC Conference, Moscow. June, 2000.

Combinatorics Seminar, MIT. May, 2000.

Combinatorics Seminar, University of Michigan. February, 2000.

Combinatorics Seminar, Texas A&M. February, 2000.

Incontro Italiano di Combinatoria Algebrica. Maratea, Italy. October, 1999.

AMS special session, Providence. October, 1999.

CoNE Conference, Smith College. September, 1999.

Mathematics Colloquium, Universidad Rey Juan Carlos, Madrid. June, 1999.

FPSAC Conference, Barcelona. June, 1999.

Combinatorics Seminar, MIT. May, 1999.

Languages spoken:

English, Spanish, Italian, French, Portuguese.

Other activities:

DARTMOUTH COLLEGE — Hanover, NH
September 2003 - present
Participating in swimming, running, triathlon groups.
Participating in French, Italian clubs.
Playing piano, clarinet.
Mentoring community youth.
Organizing film discussion group.

UNIVERSITY OF MICHIGAN — Ann Arbor, MI
September 2000 - July 2003
Organized Mathematics Department French club.
Participated in university French, Spanish, Italian, Portuguese clubs.
Played clarinet in campus orchestras, organized clarinet quartet.
Participated in swimming, ultimate frisbee, stairclimbing groups.
Taught Cuban salsa dancing.

MIT — Cambridge, MA
January 1997 - August 2000
Organized and performed in Mathematics Department music recitals.
Organized a chamber ensemble.
Participated in swimming, running groups.
Participated in European Club.
Organized Mathematics Department French club.
Tutored Spanish and English.
Organized film discussions.