Comprehensive Professional Vitae

4 February 2008

Konstantin Rybnikov
Department: Mathematical Sciences
College: Arts and Sciences
Rank: Assistant Professor
Appointed: July 2002

Fields: Graph Theory, Geometry of Numbers, Computational Geometry and Topology, Discrete Geometry, Convexity, Statistics

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A. EDUCATION AND ACADEMIC QUALIFICATIONS

Degrees:

2000 Ph.D. in Mathematics Queen's University, Kingston, Ontario. Dissertation: Polyhedral Partitions and Stresses (1999). *Honor:* best thesis of the year in Division of Sciences, ranked second in the competition for the Governor General Gold Medal.

1993 Diploma (M.Sc.) with Honors in Mathematics and Applied Mathematics Moscow State University, Moscow, Russia. Major: Discrete Mathematics.

Education:

07/1988 - 06/1993 Moscow State University, Faculty of Mechanics Mathematics.
Area: *Mathematics and Applied Mathematics*
Major: *Discrete Mathematics.*

11/1993 – 09/1995 Moscow State University, Graduate School of the Faculty of Mechanics and Mathematics. Program: Ph.D. in *Mathematics*
Major: *Discrete Mathematics and Theoretical Computer Science*
Minor: *Geometry and Topology.*

01/1998 – 05/1998 Fields Institute for Research in Mathematical Sciences and University of Toronto. Visiting Ph.D. student in the program *Complexity Theory*

01/1999 – 06/1999 Fields Institute for Research in Mathematical Sciences. Visiting Ph.D. student in the program *Probability and its Applications*

09/1995 – 10/1999 Queen's University, Department of Mathematics and Statistics.
Program: Ph.D. in *Mathematics and Statistics.*

Postdoctoral Experience:

12/1999 – 12/2001 National Science and Engineering Research Council of Canada Postdoctoral Fellowship in Mathematics. Cornell University.

Professional Academic Appointments:

07/2002 – present Assistant Professor (tenure-track), UMASS Lowell

08/2003 – 12/2003 Visiting Researcher on a Discrete and Computational Geometry Fellowship, Mathematical Sciences Research Institute, Berkeley.

01/2000 – 09/2002 Assistant Professor, Cornell University, Ithaca, NY

B. PROFESSIONAL ACTIVITIES:

- Referee for journals: "Algorithmica", "Discrete and Computational Geometry", "European Journal of Combinatorics", "Discrete Mathematics", "Journal of London Mathematical Society".
- Referee for conferences: Formal Power Series and Algebraic Combinatorics, ACM Symposium on Computational Geometry.
- Member of the American Mathematical Society
- Member of the Association for Computing Machinery
- Delivered 17 invited talks at research meetings on mathematics, computational biology, and computer science in the period of July 2002 - January 2008
- Member of the Hausdorff Research Institute for Mathematics, Bonn University, March 14–29, 2008

C. RESEARCH:

Prior and Current Federal Support:

- 2008-2009 Personal National Security Agency grant, *Algorithmic Issues in Geometric and Topological Graph Theory,* **$30000**
- 2004-2006 Personal National Science Foundation grant, *Studies in Geometry: Convexity, Polyhedra, Rigidity, and Point Lattices.* **$35000.**
- 2003-2005 Co-PI on NSF/DAPRA grant, *CARGO: Verification of Properties of Geometric Structures and Reconstruction of Geometric Objects from Partial Information* (joint with K. Daniels and D. Klain). **$100000.**

Internal Grants:

- 2003-2004 Grant for professor-student collaboration from the Learning Center and the Dean of Sciences **$2000**
- 2005-2006 Grant for professor-student collaboration from the Learning Center and the Dean of Sciences **$2000**
- 2005-2006 Grant for introducing technology into the classroom from the Learning Center **$2000**

Pending Grant Applications:

- *Interactive High-Dimensional Analysis for Clustering Massive Datasets (joint with G. Grinstein and K. Daniels),* submitted to NSF in November of 2007
- *Individualized Predictions for Cancer Patients (joint with L. Jones, A. Kheifets, and Aik Choon Tan (Johns Hopkins),* grant proposal to the Exploratory Innovations in Biomedical Computational Science and Technology Program of the National Institute of Health (NIH), being prepared for submission to NIH.

Papers in refereed journals, books, and conference proceedings since at UML:

K. A. Rybnikov, *Efficient Local Approach to Verification of Convexity of Piecewise-Linear Hypersurfaces without Boundary,* 44 pp. Accepted and will appear in *Computational Geometry: Theory and Applications,* 2008. Available on-line at `http://faculty.uml.edu/krybnikov/PDF/ConvAlg_2_Oct_2007.pdf`

R. M. Erdahl, A. Ordine, K. Rybnikov, Perfect Delaunay Polytopes and Perfect Quadratic Functions on Lattices, 22 pp., *Contemporary Mathematics,* **vol. 452,** 2008.

M. Dutour, K. Rybnikov, A New Algorithm in Geometry of Numbers, In *Proceedings of ISVD-07, the IEEE International Symposium on Voronoi Diagrams in Science and Engineering,* Pontypridd, Wales, July 2007. IEEE Publishing Services, Los Angeles, USA, 2007.

M. Dutour, R. Erdahl, K. Rybnikov, Perfect Delaunay Polytopes in Low Dimensions, 49 pp., *Integers: Electronic Journal Of Combinatorial Number Theory* **7** (2007), #A39. `http://www.westga.edu/~integers/cgi-bin/get.cgi`

W. Li, K. Daniels, K. A. Rybnikov, A Study of Conway's Thrackle Conjecture, in *Proceedings of 18th Canadian Conference on Computational Geometry,* August 14-16, 2006 Queen's University.

K. A. Rybnikov, T. Zaslavsky, Cycle and Circle Tests of Balance in Gain Graphs: Forbidden Minors and Their Groups *J. Graph Theory* **51**, No. 1, (2006), 1-21.

K. A. Rybnikov, T. Zaslavsky, Cycle Criteria for Balance in Abelian Gain Graphs with Application to Piecewise-Linear Geometry, *Discrete Comp. Geom.* **34**, No. 2, (2005), 251-268.

R. M. Erdahl, A. Ordine, and K. Rybnikov, Perfect Delaunay polytopes, *Voronoi's Impact on Modern Science, Book 3. Proc. Inst. Math. Nat. Acad. Sci. Ukraine* , Vol. **55**, (2005), pp. 126–136.

R. M. Erdahl, K. Rybnikov, Voronoi's Hypothesis on Perfect Forms and L-types. *Rendiconti del Circolo Matematiko di Palermo*, Serie II, Tomo LII, part I, (2002), 279-296.

R. M. Erdahl, K. Rybnikov, New Infinite Series of Perfect Quadratic Forms and Big Delaunay Simplexes in $\mathbb{Z}^n$. *Proc. of Steklov Institute of Math.*, **239**, no. 4, (2002), 159-167.

M. Menshikov, K. Rybnikov, and S. Volkov, Loss of Tension in an Infinite Membrane with Holes Distributed by Poisson Law. *Advances in Applied Probability,* **34** , No. 2 (2002), 292-312.

Invited Conference Paper:

L. Jones, K. Rybnikov, Local Minimax Learning of Approximately Polynomial Functions, 14 pp., in *Proceeding of Dagstuhl Seminar 06201 "Combinatorial and Algorithmic Foundations of Pattern and Association Discovery",* held in May of 2006 in the International Conference and Research Center (IBFI), Schloss Dagstuhl. Published online at `http://drops.dagstuhl.de/opus/volltexte/2007/891/` .

Refereed Conference Contribution:

Numerical Integration with Respect to Euler Characteristic, Paper presented at *Computational Topology Workshop,* Denison University, Granville, Ohio, July 2005.

Submitted:

K. Rybnikov, *Convexity of Hypersurfaces in Spherical Spaces,* On-line at `http://arxiv.org` as arXiv:0708.3149v2 [math.MG]

D. Klain, K. Daniels, K. Rybnikov, B. Jones, C. Durante, *Statistical Estimation of Euler Characteristic from Volumetric Data,* being submitted in February 2008.

Preprints:

R. M. Erdahl, K. Rybnikov, *Supertopes*, online at `http://arxiv.org` as arXiv:math/0501245v1 [math.NT].

D. Klain, K. Rybnikov, K. Daniels, B. Jones, C. Neacsu, *Estimation of Euler Characteristic from Point Data,* Technical Report and Open Source Software, UMASS Lowell Department of Computer Science, `http://teaching.cs.uml.edu/~heines/techrpts/details.jsp?Year=2005&SeqNo=006`

K. Rybnikov, *Packing Density as a Function on the Voronoi Graph of Perfect Forms.* On-line at `http://faculty.uml.edu/krybnikov/PDF/Lattice_Packings.pdf`

Manuscripts in preparation [copies available upon request]:

R. Erdahl, K. Rybnikov, *Linear Reduction Theories and Corresponding Tilings of the Cone of Positive Quadratic Forms in Six Variables*, manuscript in preparation.

K. Rybnikov, *Locally Convex Hypersurfaces in Hyperbolic Space*, manuscript in preparation.

L. Jones, K. Rybnikov, D. Berry, *Individualized Minimax Estimation of Posterior Probability with Applications to Cancer Gene Expression Array Data: Quadratic Programming Approach*, manuscript in preparation.

Software:

FORMAMENTUM: Open Source C++ Library for Analyzing First-Order Rigidity of Structures, by K. Rybnikov and K. Ramanathan. Available from `http://faculty.uml.edu/krybnikov/research.thm`

Software for patient-dependant minimax estimation of posterior probability with interface to BPMPD quadratic optimization package, by D. Berry and K. Rybnikov. Available upon request.

Matlab library for conversion, analysis, and visualization of volumetric CAT-scan data, By V. Durante and K. Rybnikov. Available upon request.

Conference Talks since UML Appointment (invited or accepted upon refereeing):

Sphere Packings and Integral Matrices of Determinant 1, *Geometry, Algebra, Singularities, Combinatorics Seminar,* Northeastern University. January 28, 2008. New Algorithm in

Geometry of Numbers, *4-th International Symposium on Voronoi Diagrams in Science and Engineering,* Pontypridd, Wales, July 2007.

Convex Surfaces in Hyperbolic Space, Workshop *Discrete Geometry and Topology in Low Dimensions,* Banff International Research Station, Alberta, April 1–6, 2007.

Perfect Delaunay Polytopes and Perfect Quadratic Functions on Lattices, Lattice Polytopes, International Conference on *"Integer Points in Polyhedra – Geometry, Number Theory, Representation Theory, Algebra, Optimization, Statistics"*, Snowbird, Utah, June 11-15, 2006.

Local Minimax Learning of Approximately Polynomial Functions, Dagstuhl Seminar 06201 *"Combinatorial and Algorithmic Foundations of Pattern and Association Discovery",* held in the International Conference and Research Center (IBFI), Schloss Dagstuhl, May 21-26, 2006.

Statistical Estimation of Topological and Integral-Geometric Invariants of Non-Convex Bodies in 3D: Mathematical Challenges, *Special Session on Discrete and Convex Geometry, Spring Eastern Section Meeting (#1017) of AMS,* Durham, NH, April 22-23, 2006.

Locally-Convex Spaces. *Second Joint Meeting of American and German Mathematical Societies* Mainz, Germany, June 2005.

Local Convexity of PL-surfaces. *Convex and Abstract Polytopes.* Banff International Research Station, Banff, Alberta. May 19-21, 2005.

General Convexity Theory. Invited talk at the *2004 Winter Meeting of Canadian Mathematical Society.* Montreal. Dec. 11-13, 2004.

Rigidity of Proteins and Probabilistic Approach to Graph Rigidity; Computational Difficulties in Rigorous Verification of Rigidity. Talks at *NSF-sponsored Workshop on Rigidity and Flexibility of Proteins* BIRS, Banff, Alberta. July 2004.

Verification of Properties of Geometric Structures and Reconstruction of Geometric Objects from Partial Information (joint with K. Daniels). *CARGO meeting organized by NSF and DARPA.* Monona Terrace, Madison, WI, May 12, 2004.

Testing for Convexity. *MIT Combinatorics Seminar.* Apr. 2, 2004.

Verification of Properties of Geometric Structures and Reconstruction of Geometric Objects from Partial Information. *CARGO meeting organized by NSF and DARPA.* Santa Rosa, CA, May 2003.
When is a locally convex surface convex? Theorems and algorithms for PL-manifolds. *Geometry, Algebra, Singularities, Combinatorics Seminar*, *Northeastern University*, Jan. 26, 2004.

Local Convexity: Is it Strong Enough to Guarantee Global Convexity? *Geometry Seminar, Penn State.* 25 Feb. 2003

Local vs. Global Convexity of PL-surfaces in Classical Geometries. *Conference on Discrete and Combinatorial Geometry*, Mathematical Sciences Research Institute, Nov. 17, 2003. (this invited talk was given right after the conference, due to a health problem)

On Locally Convex PL-manifolds and Fast Verification of Convexity. *Kolmogorov Centennial Conference, Moscow,* June 18, 2003. Page 236 in the abstracts of talks.

On the State of Voronoi's Conjecture on Parallelohedra. Invited Talk at the Convex Geometry Session, *AMS meeting in Northeastern University*, Boston, October 6, 2002.

Voronoi's Conjecture and Local-to-Global Constructions in Discrete Geometry. Invited Talk at the *Janos Bolyai Bicentennial Symposium, Budapest,* July 2002.

Publications prior to arriving at UML:

R. Connelly, K. Rybnikov, and S. Volkov, Percolation of the Loss of Tension in an Infinite Triangular Lattice, *Journal of Statistical Physics,* **105**, No. 1/2, (2001), 145-173.

R. M. Erdahl, K. A. Rybnikov, and S. S. Ryshkov, On traces of d-stresses in the skeletons of lower dimensions of homology d-manifolds, *Europ. J. Combin.* **22**, No. 6, (2001), 801-820.

K. A. Rybnikov (1999b), *Polyhedral Partitions and Stresses,* Ph.D. Thesis, Queen's University, Kingston, Canada. `http://faculty.uml.edu/krybnikov/PDF/disser.pdf.gz`

K. A. Rybnikov, Stresses and liftings of cell-complexes, *Discrete Comp. Geom.* **21**, No. 4, (1999), 481-517.

S. S. Ryshkov, K. A. Rybnikov Jr., The theory of quality translation with applications to tilings. *European J. Combin.* vol. **18**, No. 4, (1997), 431-445.

S. S. Ryshkov, K. A. Rybnikov Jr. (1996), Generatrix: the Problems of Maxwell and Voronoi. *Doklady Mathematics* Vol. **54**, No. 1, 614-617

K. A. Rybnikov Jr., On the density of three-dimensional compacta. *Doklady Mathematics*, vol. **48**, No. 1, (1994), 110-113.

D. INSTRUCTION RELATED ACTIVITY:

Courses Taught while at UML:

GRADUATE: Abstract Algebra I, Abstract Algebra II, Linear Algebra, Numerical Methods, Numerical Algebra, Computational Mathematics II, Directed Studies in Computational Geometry, Directed Studies in Rigidity and Flexibility of Graphs, Directed Studies in Algebraic and Computational Topology.

UNDERGRADUATE: Calculus I honors, Calculus II, Calculus III, Differential Equations and Computer Methods, Differential Equations, Discrete Structures II, Algebraic Structures

Present Teaching and Mentoring Activities:

Alan Barlett, UMASS Lowell Mathematics major, studying theory of sheaves and categorical foundations of mathematics

Vincent Durante, UMASS Lowell Applied Mathematics Masters student, working on volumetric image analysis.

Damon Berry (D.Sc. Computer Science), quadratic optimization, implementation of minimax algorithms for local learning.

Past Teaching and Mentoring Activities:

K. Ramanathan (M.Sc. Computer Science): algorithms for checking rigidity of structures, implementation. Research resulted in 1) creation of open software library, 2) talk at a student research conference, and 3) my invited talk at a meeting on computational methods for proteins analysis.

C. Neacsu (M.Sc. Computer Science): implementation of algorithms for shape recognition and analysis. Funded by the National Science Foundation grant of Daniels, Klain, Rybnikov.

K. Bhat (B.Sc., M.Sc. Mathematics): computational topology, geometry of numbers. funded by the National Science Foundation ISET grant of Thompson, Chandra, Daniels.

A. Elhajjaj (joint Sc.D. program in Computer Science and Mathematics) geometry of numbers

B. Jones (B.Sc. Computer Science, UMASS Amherst) computational geometry and topology, implementation of geometric algorithms. Funded by the National Science Foundation grant of Daniels, Klain, Rybnikov.

N. Laflin, (B.Sc. Mathematics and B.Eng. Plastics Engineering) algebra, computational topology. Funded by the National Science Foundation ISET grant of Thompson, Chandra, Daniels.

Z. Opalka, (M.Sc. Mathematics) combinatorics, algorithms in groups

Wei Li, (Sc.D. Computer Science) working on topological graph theory (Conway's thrackle conjecture). Research resulted in a joint paper published in refereed conference proceedings.

W. Brown (B.Sc. Computer Science), graph rigidity and implementation of combinatorial algorithms.

G. Kanter (B.Sc. Computer Science), quantifier elimination with REDLOG library of REDUCE computer algebra system.

Paul Meixler (UML alumnus): topological graph theory, diagrammatic reasoning, topos theory.

B. Intoccia (B.Sc. Mathematics), graph rigidity and implementation of combinatorial algorithms. Funded by professor-student research collaboration grant from Learning Center. I advised his senior project which got a grade of A.

A. DErico (B.Sc. Mathematics), combinatorial analysis of sparse systems of linear equations arising in geometric graph theory.

E. SERVICE:

- Fall 2002 Member of the Bioinformatics Initiative. Co-PI on the university-wide NIH grant application.
- Fall 2002 – present Department's Library Liaison and mathematical books purchase coordinator for UMASS Lowell Libraries
- Spring 2004 – present member of interdepartmental Committee on Computational Mathematics Sc.D. Program.
- 2004 – 2006 Member of Department of Mathematical Sciences Hiring Committee
- Fall 2004 Member of the UMASS Lowell Research Task Force representing the Department.
- Fall 2006 Member of the UMASS Lowell Task Force on Facilities and Resources.
- Fall 2007 Volunteered for the Partnership for College Success between Lowell High School and UMASS Lowell