

# Yuen-Lam Voronin

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## RESEARCH INTERESTS

- Application of numerical optimization in biology, computer science, finance, quantum computing;
- Use of semidefinite optimization in solving NP hard problems;
- Algorithm design and implementation for numerical optimization problems;
- Mathematical modeling.

## EDUCATION

Ph.D. in Combinatorics and Optimization, September 2009 – December 2013  
University of Waterloo, Waterloo, Ontario, Canada.

Thesis topic:

**Preprocessing and Reduction for Semidefinite Programming via Facial Reduction: Theory and Practice.**

Thesis advisor: Prof. Henry Wolkowicz.

M.Math. in Continuous Optimization,  
University of Waterloo, Waterloo, Ontario, Canada.

September 2008 – August 2009

Research project topic:

**Portfolio Optimization via Downside-Risk Aversion Model.**

Advisor: Prof. Michael J. Best.

B.Sc. in Mathematics (minor in Economics, 2<sup>nd</sup> upper),  
Chinese University of Hong Kong, Hong Kong.

September 2003 – May 2007

## RESEARCH EXPERIENCE

*Use of semidefinite optimization in discovering long term behavior of stochastic systems*

(with Prof. Sriram Sankaranarayanan and Dr. Aleksandar Chakarov, University of Colorado)

- We use semidefinite optimization to establish persistence and recurrence properties in stochastic systems such as probabilistic computer programs and cyber-physical systems.
- Based on the proof rules that my colleagues established, I built an optimization framework that models the discovery of these long term properties in Markov systems.
- Using the optimization framework, I developed some numerical solution routines, and applied them on case studies from different areas, such as probabilistic computer programs and robotics.

*Optimization algorithm for constructing quantum channels*

(with Prof. Dmitry Drusvyatskiy, University of Washington; Prof. Chi-Kwong Li and Diane Christine Pelejo, College of William and Mary; Prof. Henry Wolkowicz, University of Waterloo)

- We proposed an empirically efficient algorithm for constructing quantum channels that transform a given set of quantum states to another set, a basic problem in quantum information science.
- I helped develop the algorithm and wrote part of the prototype code for quantum channel construction.

*Efficient use of semidefinite programming for the selection of rotamers in protein conformations*

(with Prof. Forbes Burkowski and Prof. Henry Wolkowicz, University of Waterloo)

- We study a semidefinite programming relaxation of the NP-hard sidechain positioning problem: given a list of components for building a protein molecule (e.g., designed to treat a certain disease), how do we pack those components together in a stable manner?
- I developed a cutting plane technique specialized for this application, and implemented an optimization procedure that configures a sidechain position in a reasonable amount of time.
- On 23 test instances involving proteins found in nature involving up to 900 rotamers, our numerical implementation successfully reconstructed the native sidechain configurations.

*Preprocessing and regularization of degenerate semidefinite programs*

(with Dr. Simon Schurr and Prof. Henry Wolkowicz, University of Waterloo)

- We developed a backward stable preprocessing procedure for regularizing semidefinite programs (SDP) that (nearly) fails strict feasibility.
- I performed numerical analysis on the preprocessing procedure and showed that it is backward stable.
- I implemented the preprocessing procedure as an add-on software to some existing SDP solvers.

*Portfolio optimization via downside-risk aversion model*

(with Prof. Michael J. Best, University of Waterloo)

- We explored the portfolio optimization problem via an expected-utility model that incorporates the notion of downside risk aversion via an S-shaped utility function.
- I studied several different algorithms for solving the nonsmooth optimization problems: active set method and interior point methods combined with smoothing and crossover techniques.

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## PUBLICATION

- D. Drusvyatskiy, N. Krislock, Y.-L. Voronin and H. Wolkowicz, Noisy sensor network localization: robust facial reduction and the Pareto frontier. *SIAM Journal on Optimization*, 27(4):2301–2331, 2017.
- P. Roux, Y.-L. Voronin, and S. Sankaranarayanan, Validating numerical semidefinite programming solvers for polynomial invariants. In *Static Analysis Symposium (SAS)*, Volume 9837 of *Lecture Notes in Computer Science* pp. 424-446 (2016).
- A. Chakarov, Y.-L. Voronin, and S. Sankaranarayanan, Deductive proofs of almost sure persistence and recurrence properties. In *Tools and Algorithms for Construction and Analysis of Systems (TACAS)*, Vol. 9636 of *Lecture Notes in Computer Science* pp. 260-279 (2016).
- Y.-L. Cheung, D. Drusvyatskiy, C.-K. Li, D.C. Pelejo, H. Wolkowicz, Projection methods for quantum channel construction. *Quantum Information Processing*, 14(8): 3075-3096, 2015.
- F. Burkowski, Y.-L. Cheung, H. Wolkowicz, Efficient use of semidefinite programming for selection of rotamers in protein conformations, *INFORMS Journal on Computing* 26(4): 748-766, 2014.
- Y.-L. Cheung, S. Schurr, H. Wolkowicz, Preprocessing and regularization of degenerate semidefinite programs. In *Computational and Analytical Mathematics*, Springer Proceedings in Mathematics & Statistics, Vol. 50. Springer, New York, 2013.

## WORK

### EXPERIENCE

- Quantitative Analyst at Tradewins Ltd.  
January 2017 – Present.
- Research Associate at Dept. of Computer Science, University of Colorado, USA.  
June 2014 – December 2016. Advisor: Prof. Sriram Sankaranarayanan
- Lecturer at Dept. of Computer Science, University of Colorado, USA.  
January 2015 – May 2015.  
Course: CSCI2824 **Discrete Structures** (undergrad.)
- Research Associate at Dept. of Combinatorics and Optimization, University of Waterloo, Canada.  
January 2014 – April 2014. Advisor: Prof. Henry Wolkowicz.
- Sessional lecturer at Dept. of Combinatorics and Optimization, University of Waterloo, Canada.  
January 2012 – April 2012.  
Course: CO466/666 **Continuous Optimization** (undergrad./grad.)
- Teaching assistant at Dept. of Combinatorics and Optimization, University of Waterloo, Canada.  
January 2009 – December 2012.  
Courses: ACTSC 973/CO372 **Portfolio Optimization** (grad., undergrad.),  
CO671 **Semidefinite Optimization** (grad.),  
CO250/CO350 **Linear Optimization** (undergrad.),  
CO355 **Mathematical Optimization** (undergrad.),  
CO365 **Nonlinear Optimization** (undergrad.)
- Program coordinator at Dept. of Mathematics, Chinese University of Hong Kong, Hong Kong.  
September 2007 – August 2008.

## CONFERENCE PRESENTATIONS

- *Degeneracy in SOS formulation of Lyapunov method for global asymptotic stability: why and how to exploit it.* Intl. Symposium on Mathematical Programming, Pittsburgh, PA, USA. July 2015.
- *On the sensitivity of semidefinite programs.* SIAM Conference on Optimization, San Diego, CA, USA. May 2014.
- *Efficient use of semidefinite programming for the selection of rotamers in protein conformations.* Retrospective Workshop on Discrete Geometry, Optimization, and Symmetry, Fields Institute, Toronto, ON, Canada. November 2013.
- *Facial reduction for semidefinite programming: theory and practice.* 15<sup>th</sup> Midwest Optimization Meeting, University of Western Ontario, London, ON, Canada. October 2013.
- *Sensitivity Analysis for Semidefinite Programs.* Optimization Days, HEC Montreal, Montreal, QC, Canada. May 2013.
- *Preprocessing and reduction for degenerate semidefinite programs.*
  - 7<sup>th</sup> Intl. Congress on Industrial and Applied Mathematics, Vancouver, BC, Canada. July 2011.
  - 13<sup>th</sup> Midwest Optimization Meeting, Fields Institute, Toronto, ON, Canada. October 2011.
  - INFORMS Annual meeting, Phoenix, AZ, USA. October 2012.
- *Structure based drug design problem: solving a class of quadratically constrained SDP problems.* Intl. Symposium on Mathematical Programming, Berlin, Germany. August 2012.
- *Strong duality in semidefinite programming and facial reduction with applications to sensor network localization and molecular conformation.* Computational and Analytical Mathematics Conference in honour of Jonathan Borwein's 60<sup>th</sup> Birthday, IRMACS Center, Simon Fraser University, Vancouver, BC, Canada. May 2011.
- *Robust optimization: applications in portfolio selection problems.* Research meeting at Tata Consultancy Services, Hyderabad, India. October 2009.

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## SCHOLARSHIPS AND AWARDS

- NSF Software & Hardware Foundation Award, Bilinear Constraint Solving and Optimization for Program Verification and Synthesis Problems, former co-principal investigator. Award number: 1527075.
- Cotton Family Women in Mathematics Graduate Scholarship
- AIMMS/MOPTA Modeling Competition 2010: Honorable mention (Competition theme: Tax-Aware Portfolio Optimization)

## ACTIVITIES

- Committee member of Women In Mathematics, University of Waterloo, Canada. September 2010 – December 2012.
- Organizer of Continuous Optimization Seminar, University of Waterloo, Canada. March 2009 – August 2012.
- Representative of Faculty of Mathematics, University of Waterloo visiting Tata Consultancy Services, India. October 2009.
- Editing the book Portfolio Optimization (by Michael J. Best. Taylor and Francis, May 2010). January 2009 – August 2009.

## COMPUTER SKILLS

Linux, Matlab, Python

*Last updated: April 13, 2018*