

# Jason Swanson

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## Education

<b>Ph.D. in mathematics</b> Dissertation title: <i>Variations of Stochastic Processes: Alternative Approaches</i> Dissertation advisors: Krzysztof Burdzy and Zhen-Qing Chen	<b>University of Washington</b>	<b>2004</b>
<b>M.S. in mathematics</b>	<b>University of Washington</b>	<b>2003</b>
<b>B.S. in mathematics</b> Graduated with distinction in mathematics	<b>University of Washington</b>	<b>1998</b>

## Employment

<b>Assistant Professor</b>	<b>University of Central Florida</b>	<b>2007–present</b>
<b>VIGRE Van Vleck Assistant Professor</b> Faculty mentor: Thomas G. Kurtz	<b>University of Wisconsin-Madison</b>	<b>2004–2007</b>
<b>Teaching Assistant</b>	<b>University of Washington</b>	<b>1999–2004</b>

## Publications

1. Ivan Nourdin, Anthony Réveillac, and Jason Swanson. The weak Stratonovich integral with respect to fractional Brownian motion with Hurst parameter  $1/6$ . *Preprint*, 2010. [arXiv:1006.4238](https://arxiv.org/abs/1006.4238)

*Abstract:* Let  $B$  be a fractional Brownian motion with Hurst parameter  $H = 1/6$ . It is known that the symmetric Stratonovich-style Riemann sums for  $\int g(B(s)) dB(s)$  do not, in general, converge in probability. We show, however, that they do converge in law in the Skorohod space of càdlàg functions. Moreover, we show that the resulting stochastic integral satisfies a change of variable formula with a correction term that is an ordinary Itô integral with respect to a Brownian motion that is independent of  $B$ .

2. Jason Swanson. Game theory and poker. *Preprint*, 2010.

*Abstract:* Historically, games of chance involving cards, dice, or other simple instruments have been the canonical examples used to introduce the beginning student to the principles of elementary probability. It is not surprising, therefore, that the study of simplified versions of poker is a common tool for presenting ideas from game theory. In this article, we explicitly derive the game-theoretic optimal solutions for a simplified version of poker

which we call “One Card Poker.” We then compare the actual properties of the optimal solutions, as they relate to questions about bluffing, to various common heuristics that are often presented in the the popular poker literature.

3. Jason Swanson. Fluctuations of the empirical quantiles of independent Brownian motions. *Preprint*, 2009. [arXiv:0812.4102](https://arxiv.org/abs/0812.4102)

*Abstract:* We consider  $n$  independent, identically distributed one-dimensional Brownian motions,  $B_j(t)$ , where  $B_j(0)$  has a rapidly decreasing, smooth density function  $f$ . The empirical quantiles, or pointwise order statistics, are denoted by  $B_{j:n}(t)$ , and we are interested in a sequence of quantiles  $Q_n(t) = B_{j(n):n}(t)$ , where  $j(n)/n \rightarrow \alpha \in (0, 1)$ . This sequence converges in probability in  $C[0, \infty)$  to  $q(t)$ , the  $\alpha$ -quantile of the law of  $B_j(t)$ . Our main result establishes the convergence in law in  $C[0, \infty)$  of the fluctuation processes  $F_n = n^{1/2}(Q_n - q)$ . The limit process  $F$  is a centered Gaussian process and we derive an explicit formula for its covariance function. We also show that  $F$  has many of the same local properties as  $B^{1/4}$ , the fractional Brownian motion with Hurst parameter  $H = 1/4$ . For example, it is a quartic variation process, it has Hölder continuous paths with any exponent  $\gamma < 1/4$ , and (at least locally) it has increments whose correlation is negative and of the same order of magnitude as those of  $B^{1/4}$ .

4. Krzysztof Burdzy and Jason Swanson. A change of variable formula with Itô correction term. *Ann. Probab.*, 38(5):1817–1869, 2010. <http://dx.doi.org/10.1214/09-AOP523>, [arXiv:0802.3356](https://arxiv.org/abs/0802.3356)

*Abstract:* We consider the solution  $u(x, t)$  to a stochastic heat equation. For fixed  $x$ , the process  $F(t) = u(x, t)$  has a nontrivial quartic variation. It follows that  $F$  is not a semimartingale, so a stochastic integral with respect to  $F$  cannot be defined in the classical Itô sense. We show that for sufficiently differentiable functions  $g(x, t)$ , a stochastic integral  $\int g(F(t), t) dF(t)$  exists as a limit of discrete, midpoint style Riemann sums, where the limit is taken in distribution in the Skorohod space of cadlag functions. Moreover, we show that this integral satisfies a change of variables formula with a correction term that is an ordinary Itô integral with respect to a Brownian motion that is independent of  $F$ .

5. Krzysztof Burdzy, Soumik Pal, and Jason Swanson. Crowding of Brownian spheres. *ALEA Lat. Am. J. Probab. Math. Stat.*, 7:192–205, 2010. [http://alea.impa.br/english/index\\_v7.htm](http://alea.impa.br/english/index_v7.htm), [arXiv:1002.1057v1](https://arxiv.org/abs/1002.1057v1)

*Abstract:* We study two models consisting of reflecting one-dimensional Brownian “particles” of positive radius. We show that the stationary empirical distributions for the particle systems do not converge to the harmonic function for the generator of the individual particle process, unlike in the case when the particles are infinitely small.

6. Jason Swanson. Variations of the solution to a stochastic heat equation. *Ann. Probab.*, 35(6):2122–2159, 2007. <http://dx.doi.org/10.1214/009117907000000196>, [arXiv:math/0601007](https://arxiv.org/abs/math/0601007)

*Abstract:* We consider the solution to a stochastic heat equation. This solution is a random function of time and space. For a fixed point in space, the resulting random function of time,  $F(t)$ , has a nontrivial quartic variation. This process, therefore, has infinite quadratic variation and is not a semimartingale. It follows that the classical Itô calculus does not apply. Motivated by heuristic ideas about a possible new calculus for this process, we are led to study modifications of the quadratic variation. Namely, we modify each term in the sum of the squares of the increments so that it has mean zero. We then show that these sums, as functions of  $t$ , converge weakly to Brownian motion.

7. Teunis J. Ott and Jason Swanson. Asymptotic behavior of a generalized TCP congestion avoidance algorithm. *J. Appl. Probab.*, 44(3):618–635, 2007. <http://dx.doi.org/10.1239/jap/1189717533>, [arXiv:math/0608476](http://arxiv.org/abs/math/0608476)

*Abstract:* The Transmission Control Protocol (TCP) is a Transport Protocol used in the Internet. Ott has introduced a more general class of candidate Transport Protocols called “protocols in the TCP Paradigm”. The long run objective of studying this class is to find protocols with promising performance characteristics. This paper studies Markov chain models derived from protocols in the TCP Paradigm. Protocols in the TCP Paradigm, as TCP, protect the network from congestion by reducing the “Congestion Window” (the amount of data allowed to be sent but not yet acknowledged) when there is packet loss or packet marking, and increasing it when there is no loss. When loss of different packets are assumed to be independent events and the probability  $p$  of loss is assumed to be constant, the protocol gives rise to a Markov chain  $\{W_n\}$ , where  $W_n$  is the size of the congestion window after the transmission of the  $n$ -th packet. For a wide class of such Markov chains, we prove weak convergence results, after appropriate rescaling of time and space, as  $p \rightarrow 0$ . The limiting processes are defined by stochastic differential equations. Depending on certain parameter values, the stochastic differential equation can define an Ornstein-Uhlenbeck process or can be driven by a Poisson process.

8. Jason Swanson. Weak convergence of the scaled median of independent Brownian motions. *Probab. Theory Related Fields*, 138(1-2):269–304, 2007. <http://dx.doi.org/10.1007/s00440-006-0024-3>, [arXiv:math/0507524](http://arxiv.org/abs/math/0507524)

*Abstract:* We consider the median of  $n$  independent Brownian motions, denoted by  $M_n(t)$ , and show that  $\sqrt{n} M_n$  converges weakly to a centered Gaussian process. The chief difficulty is establishing tightness, which is proved through direct estimates on the increments of the median process. An explicit formula is given for the covariance function of the limit process. The limit process is also shown to be Hölder continuous with exponent  $\gamma$  for all  $\gamma < 1/4$ .

9. Teunis J. Ott and Jason Swanson. Stationarity of some processes in transport protocols. *SIGMET-RICS Perform. Eval. Rev.*, 34(3):30–32, 2006. <http://dx.doi.org/10.1145/1215956.1215969>

*Abstract:* This note establishes stationarity of a number of stochastic processes of interest in the study of Transport Protocols. For many of the processes studied in this note stationarity had been established before, but for one class the result is new. For that class, it was counterintuitive that stationarity was hard to prove. This note also explains why that class offered such stiff resistance.

## Invited Conference Presentations

1. “A change of variable formula with Itô correction term,” presented at the Stochastic Partial Differential Equations Programme, Isaac Newton Institute for Mathematical Sciences, Cambridge, UK, May 2010.
2. “Fluctuations of the empirical quantiles of independent Brownian motions,” presented at the Purdue Workshop on Stochastic Analysis, Purdue University, West Lafayette, IN, September 2009.
3. “Fluctuations of the empirical quantiles of independent Brownian motions,” presented at the 3rd International Conference on Stochastic Analysis and Its Applications, Beijing Institute of Technology, Beijing, China, July 2009.

4. “Fluctuations of the empirical quantiles of independent Brownian motions,” presented at AMS 2009 Spring Southeastern Sectional Meeting, Special Session on Stochastic Dynamics, North Carolina State University, Raleigh, NC, April 2009.
5. “A change of variable formula with Itô correction term,” presented at AMS 2008 Fall Southeastern Sectional Meeting, Special Session on Gaussian Analysis & Stochastic Partial Differential Equations, University of Alabama-Huntsville, Huntsville, AL, October 2008.
6. “A change of variable formula with Itô correction term,” presented at 2nd International Conference on Stochastic Analysis and Its Applications, Seoul National University, Seoul, Korea, May 2008.
7. “The median of independent Brownian motions and other colliding particle models”, presented at 32nd SIAM Southeastern-Atlantic Section Conference, Special session on Probability Theory and Applications, University of Central Florida, Orlando, FL, March 2008.
8. “Metastability and coupling of Markov processes,” presented at International Conference on Stochastic Analysis and its Applications, University of Washington, Seattle, WA, August 2006.

## Contributed Conference Presentations

1. “An application of the Markov mapping theorem to the study of metastability,” presented at Markov Processes and Related Topics, University of Wisconsin-Madison, Madison, WI, July 2006.
2. “Weak convergence of the median of independent Brownian motions,” presented at 30th Conference on Stochastic Processes and their Applications, University of California, Santa Barbara, CA, June 2005.
3. “The  $p$ -th variation of a Brownian martingale with an application to mathematical finance,” presented at Summer Internship in Probability and Stochastic Processes, University of Wisconsin-Madison, Madison, WI, June 2003.

## Other Conferences Attended

<b>Seminar on Stochastic Processes 2010</b> University of Central Florida, Orlando, FL	<b>Mar 2010</b>
<b>Seminar on Stochastic Processes 2009</b> Stanford University, Stanford, CA	<b>Mar 2009</b>
<b>Seminar on Stochastic Processes 2008</b> University of Delaware, Newark, DE	<b>Apr 2008</b>
<b>29th Midwest Probability Colloquium</b> Northwestern University, Evanston, IL	<b>Oct 2007</b>
<b>32nd Conference on Stochastic Processes and their Applications</b> University of Illinois at Urbana-Champaign, Urbana, IL	<b>Aug 2007</b>

<b>Conference on Stochastic Partial Differential Equations</b> Cornell University, Ithaca, NY	<b>Apr 2007</b>
<b>28th Midwest Probability Colloquium</b> Northwestern University, Evanston, IL	<b>Oct 2006</b>
<b>Seminar on Stochastic Processes 2006</b> Princeton University, Princeton, NJ	<b>Mar 2006</b>
<b>27th Midwest Probability Colloquium</b> Northwestern University, Evanston, IL	<b>Oct 2005</b>
<b>Conference on Stochastic Control and Numerics</b> University of Wisconsin-Milwaukee, Milwaukee, WI	<b>Sep 2005</b>
<b>New Directions in Probability Theory</b> University of Minnesota, Minneapolis, MN	<b>Aug 2005</b>
<b>26th Midwest Probability Colloquium</b> Northwestern University, Evanston, IL	<b>Oct 2004</b>
<b>Seminar on Stochastic Processes 2004</b> University of British Columbia, Vancouver, BC	<b>May 2004</b>
<b>5-day Workshop on Stochastic Partial Differential Equations</b> Banff International Research Station, Banff, AB	<b>Sep 2003</b>
<b>Seminar on Stochastic Processes 2003</b> University of Washington, Seattle, WA	<b>Mar 2003</b>
<b>Conference on Probability and Conformal Mappings</b> Institut Mittag-Leffler, Djursholm, Sweden	<b>Fall 2001</b>

## University Seminars/Colloquia

<b>University of Central Florida</b>	<b>Oct 2009</b>
<b>University of Wisconsin-Madison</b>	<b>Oct 2008</b>
<b>University of Central Florida</b>	<b>Mar 2008</b>
<b>University of Washington</b>	<b>Apr 2007</b>
<b>Purdue University</b>	<b>Mar 2007</b>
<b>University of Kansas</b>	<b>Feb 2007</b>
<b>Tufts University</b>	<b>Feb 2007</b>

Iowa State University	Feb 2007
University of Central Florida	Feb 2007
University of Wisconsin-Milwaukee	Feb 2007
University of Illinois at Chicago	Dec 2006
University of Wisconsin-Madison	Apr 2006
University of Illinois at Urbana-Champaign	Apr 2006
University of Washington	Jan 2006
University of Washington	Mar 2005
University of Wisconsin-Madison	Dec 2004
University of Wisconsin-Madison	Jul 2004
University of Washington	Apr 2004
University of California, San Diego	Jan 2004
University of Washington	Feb 2003

## Courses Taught

### University of Central Florida

*MAA 5228: Analysis I* (Fall 2010)

This is the first semester in a year-long, core qualifying course for incoming graduate students. Topics include real numbers, limits, differentiation, Riemann integrals, Riemann-Stieltjes integrals, calculus in  $\mathbb{R}^n$ , metric and normed spaces, contraction mapping theorem, inverse and implicit functions, Lebesgue measure and integration, topological spaces, Banach spaces, Hilbert spaces, bounded linear operators, distribution theory and the Fourier transform, general measure theory, and  $L^p$  spaces.

*MAA 4906: Directed Independent Study* (Fall 2010)

Supervised an undergraduate student in the study of probability theory, with emphasis on applications to problems in actuarial science.

*MAC 2311: Calculus with Analytic Geometry I* (Fall 2010, Fall 2009, Fall 2007)

The differential and integral calculus of algebraic and elementary transcendental functions with geometric and physical applications. Topics from analytic geometry include coordinate systems, vectors, lines, conic sections, transformations of coordinates, and polar coordinates. During the 2nd and 3rd semesters the topics also include sequences and series, Taylor series, and the differential and integral calculus for functions of several variables.

*MAC 2312: Calculus with Analytic Geometry II* (Spring 2010, Spring 2008)  
Continuation of MAC 2311.

*MAA 6306: Real Analysis* (Spring 2010)

Sets, function spaces, Lebesgue measure, Lebesgue-Stieltjes measure, measurable functions, convergence notions, general measure and integration, Radon-Nikodym theorem.

*MAA 6238: Measure and Probability* (Spring 2009)

A first graduate course on measure theoretic probability theory. Topics include measure and integration, probability measures, random variables, distribution functions, characteristic functions, and the standard modes of convergence: in  $L^p$ , in probability, in distribution, and almost surely.

*MAC 2311H: Calculus with Analytic Geometry I, Honors* (Fall 2008)

Differential and integral calculus, emphasizing understanding basic concepts and their applications. Students will complete projects on their own. For honors students from all disciplines.

*MAC 2313: Calculus with Analytic Geometry III* (Fall 2008)

Continuation of MAC 2312.

## University of Wisconsin-Madison

*Introduction to Probability Theory* (Spring 2007)

A first course in probability at the undergraduate level, with topics including probability in discrete sample spaces, methods of enumeration (combinatorics), conditional probability, random variables, properties of expectations, the Weak Law of Large Numbers, and the Central Limit Theorem.

*Introduction to Stochastic Processes* (Fall 2006)

This course gives an introduction to Markov chains and Markov processes with discrete state spaces and their applications. Particular models studied include birth-death chains, queuing models, random walks and branching processes. Selected topics from renewal theory and Brownian motion are also included.

*Basic Concepts of Mathematics* (Spring 2006)

This course teaches the writing of rigorous mathematical proofs, by first covering some basic concepts of logic needed for mathematical proofs, and then working with those concepts on many examples from different areas of mathematics. The course also introduces the student to some of the abstract concepts of mathematics used in higher level math courses, such as equivalence relations, orderings, and a rigorous treatment of mathematical induction and the real numbers.

*Directed Study* (Fall 2005)

Supervised a senior undergraduate student in the study of Brownian motion and stochastic calculus.

*Stochastic Analysis* (Fall 2005)

A graduate course covering the foundations of continuous time stochastic processes, semimartingales and the semimartingale integral, Itô's formula, stochastic differential equations, stochastic equations for Markov processes, and applications in finance, filtering, and control.

*An Introduction to Brownian Motion and Stochastic Calculus* (Spring 2005)

An advanced undergraduate introduction to Brownian motion and stochastic calculus that does not require knowledge of measure theory.

*The Theory of Single Variable Calculus* (Fall 2004)

This course covers material in first and second semester calculus but it is intended to teach math majors to write and understand proofs in mathematics in general and in calculus in particular.

## University of Washington

*Introduction to ordinary differential equations*

*Linear Analysis and Introduction to Partial Differential Equations*

*Advanced Multivariable Calculus*

*Algebra in business and economics* (teaching assistant)

*First-year calculus* (teaching assistant)

*Undergraduate abstract algebra* (teaching assistant)

*Graduate complex analysis* (teaching assistant)

## Grants, Awards, and Academic Achievements

<b>NSF Conference Grant 0957479</b>	<b>2010</b>
<b>NSA Grant H98230-09-1-0079</b>	<b>2009–2011</b>
<b>VIGRE Van Vleck Assistant Professorship</b> Department of Mathematics, University of Wisconsin-Madison	<b>2004–2007</b>
<b>VIGRE Graduate Fellowship</b> Department of Mathematics, University of Washington	<b>2002–2004</b>
<b>Academic Excellence Award</b> Department of Mathematics, University of Washington	<b>2000</b>
<b>ARCS (Achievement Rewards for College Scientists) Fellowship</b> Department of Mathematics, University of Washington	<b>1999–2002</b>
<b>Gullickson Memorial Scholarship for outstanding achievement in math</b> Department of Mathematics, University of Washington	<b>1995</b>

## Seminars and Conferences Organized

Seminar on Stochastic Processes 2010	Mar 2010
Probability and Statistics Seminar, University of Central Florida	2008–present
Probability Seminar, University of Wisconsin-Madison	2005–2007

## Referee Work

Bernoulli Journal	May 2010
Annales Inst H Poincare	Jul 2009
NSERC (grant)	Dec 2008
Probability Theory and Related Fields	Jul 2008
Oxford University Press (book)	Apr 2008

Journal of Theoretical Probability	Mar 2008
Springer US (book)	Jan 2008
Journal of Franklin Institute	Jan 2008
Annals of Applied Probability	Aug 2007
Annals of Applied Probability	Apr 2007
Annales Inst H Poincare	Mar 2007
Oxford University Press (book)	Mar 2006
Annals of Probability	May 2005

## Math Reviews

MR2521408	Feb 2010
MR2518544	Feb 2010
MR2447835	Aug 2009
MR2445506	Aug 2009
MR2396060	May 2008
MR2386739	May 2008
MR2386925	May 2008
MR2354393	May 2008
MR2353457	Mar 2008
MR2326530	Jan 2008
MR2316287	Aug 2007
MR2277867	Aug 2007

## Students Mentored

Taylor Chapman, National Merit Scholar	2009–2010
Christopher James, National Achievement Scholar	2009–2010
Kyle Trainor, National Merit Scholar	2008–2009

## Thesis/Dissertation Committee Service

Haimei Shao (served as committee member)	2010–present
Justin Davis (served as committee member)	2010–present

## Other Committee Service

Student Affairs Committee	2007–present
Newsletter Committee	Spring 2008
Undergraduate Committee	Fall 2007

## Other Service

Faculty Advisor to the Math Club

2007–present

Faculty Advisor for Pi Mu Epsilon (National Mathematics Honor Society)

2010–present

## Other Professional Activities

Provided probability/statistics consulting services to  
Schroeder Measurement Technologies, Inc.

Feb 2010