Justin Sirignano

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Appointments

Assistant Professor, University of Illinois at Urbana-Champaign   Aug. 2016-
Department of Industrial & Enterprise Systems Engineering

Chapman Fellow, Imperial College London   2015-2016
Department of Mathematics

Education

Stanford University, PhD   2010-2015
Management Science & Engineering
PhD Advisor: Kay Giesecke

Princeton University, B.S.E.   2006-2010
Major: Operations Research & Financial Engineering
Graduated *summa cum laude*
Elected to Phi Beta Kappa, Tau Beta Pi, and Sigma Xi

Research Interests

Machine learning, applied probability, stochastic analysis, engineering and mathematical finance applications.

Research Publications

1. "DGM: A Deep Learning Algorithm for solving Partial Differential Equations" (with K. Spiliopoulos).
   Journal of Computational Physics, 375, 1339–1364, 2018.

2. "Stochastic Gradient Descent in Continuous Time" (with K. Spiliopoulos).
   SIAM Journal on Financial Mathematics, 8(1), 933-961, 2017.

3. "Risk Analysis for Large Pools of Loans" (with K. Giesecke). **Winner of the inaugural SIAM Financial Mathematics & Engineering Conference Paper Prize.**
   Management Science, 2018.

4. "Large-scale Loan Portfolio Selection" (with K. Giesecke and G. Tsoukalas).
   Operations Research, 64(6), 1239-1255, 2016.

5. "Large Portfolio Asymptotics for Loss from Default" (with K. Giesecke, K. Spiliopoulos, and R. Sowers).
   Mathematical Finance, 25(1), 77-114, 2015.

6. "Fluctuation Analysis for the Loss from Default" (with K. Giesecke and K. Spiliopoulos).
   Stochastic Processes and their Applications, 124(7), 2322-2362, 2014.

7. "Optimization of Secondary-Air Addition in a Continuous One-Dimensional Spray Combustor" (with L. Rodriquez, A. Siders, and W. Sirignano).
   Journal of Propulsion and Power, 26(2), 288-294, 2010.

8. "Deep Learning for Limit Order Books."
   Quantitative Finance, in press 2018. arXiv:1601.01987

9. "Inference for Large Financial Systems" (with G. Schwenkler and K. Giesecke).
   Mathematical Finance, forthcoming 2019. SSRN: 3012751

10. "Mean Field Analysis of Neural Networks: A Law of Large Numbers" (with K. Spiliopoulos).
    Invited Revision at *SIAM Journal on Applied Mathematics*. arXiv:1805.01053

11. "Universal Price Formation in Financial Markets: Insights from Deep Learning" (with Rama Cont).
    Invited Revision at *Quantitative Finance*. arXiv: 1803.06917

12. "Deep Learning for Mortgage Risk" (with K. Giesecke and A. Sadhwani), arXiv:1607.02470.
    Invited submission for Special Issue at *Journal of Financial Econometrics*.

13. "Mean Field Analysis of Neural Networks: A Central Limit Theorem" (with K. Spiliopoulos).
    Invited Revision at *Stochastic Processes and their Applications*. arXiv:1805.01053

14. "Stochastic Gradient Descent in Continuous Time: A Central Limit Theorem" (with K. Spiliopoulos).
    In Review at *Stochastic Systems*. arXiv:1710.04273

Other Publications

1. "Deep Learning: Theory and Computation." In preparation and invited to be published by *Cambridge University Press*. Book proposal was peer-reviewed.

2. "Deep Learning Models in Finance."
   SIAM News, June 2017.

3. Book review of "Deep Learning" by Goodfellow, Bengio, and Courville.
   SIAM Review, 2018.

4. "A Forward-Backward Algorithm for Stochastic Control Problems" (with S. Ludwig, R. Huang, and G. Papanicolaou).
   Proceedings of the First International Conference on Operations Research and Enterprise Systems, February 2012.

Awards and Honors

1. Chapman Fellowship at Imperial College London

2. Winner of the inaugural SIAM Financial Mathematics & Engineering Conference Paper Prize.

3. Rose Hills Foundation Engineering Fellowship at Stanford University.

4. Lore von Jaskowsky Memorial Prize, School of Engineering and Applied Sciences at Princeton University, for senior thesis research "Utility Pricing of Collateralized Debt Obligations".

Computational Grants on the Blue Waters national supercomputer

1. Blue Waters Director's allocation (75,000 node hours, 2019)

2. Blue Waters general allocation (58,000 node hours, 2019)

3. Blue Waters general allocation (115,000 node hours, 2017-2018)

4. Blue Waters general allocation (111,000 node hours, 2016-2017)

5. Blue Waters startup allocation "Deep Learning: Modeling Financial Data and Reinforcement Learning" (25,000 node hours, 2016)

6. Blue Waters education allocation (50,000 node hours, 2018)

7. Blue Waters education allocation (50,000 node hours, 2017)

8. Blue Waters education allocation (25,000 node hours, 2016)

Teaching

1. "Deep Learning" (Fall 2016, 2017, 2018). Graduate course, cross-listed between Industrial Engineering and Computer Science.

2. "Deep Learning" (Spring 2018). Undergraduate course.

3. "Deep Learning II" (Spring 2018). Graduate course.

4. "Analysis of Data" (Spring 2017, Spring 2018). Undergraduate course.

5. "Machine Learning" (Spring 2016, Imperial College London, Dept. of Mathematics). Graduate course.

Current Students

1. Xiaobo Dong (ISE, 2022). PhD Thesis: "Deep Learning Models of High Frequency Financial Data".

2. Lei Fan (ISE, 2022). PhD Thesis: "Machine Learning Methods in Quantitative Finance".

3. Rachneet Kaur (ISE): PhD student collaborating on a deep learning project.

4. Abhinav (CS, 2019). Masters Thesis: "Modeling High Frequency Data at Nanosecond Scale".

Submitted Grant Proposals (currently under review)

1. NSF Applied Math (PIs: J. Sirignano and K. Spiliopoulos).

2. DoE/NNSA PSAAP III center (approximately $18 million, I am a co-PI). This would replace the current PSAAP II center at UIUC. Pre-proposal has been reviewed, and we have been encouraged to submit a full proposal (in early 2019). I am leading the machine learning part of this proposal.

Grant proposals in preparation

1. MURI, NSF EAGER, NSF Career, Air Force, Bloomberg Data Science Grant.

Patents

1. US Patent Application 15/331,825
   Title: Apparatus for Analyzing the Risk of a Large Loan Pool and Method of Using
   Inventors: K. Giesecke and J. Sirignano

2. US Patent Application 15/613,256
   Title: Apparatus for Optimizing a Loan Pool and Method of Using
   Inventors: K. Giesecke and J. Sirignano

Professional Activities

1. Associate Editor, *Journal of Dynamics and Games* (an AIMS journal).

2. Associate Editor, Special Issue of *Management Science* on Data-Driven Prescriptive Analytics.

3. Invited Participant for NSF/American Institute of Mathematics Workshop on "Deep Learning and Partial Differential Equations", 2019. Travel costs fully funded by NSF/AIMS.

4. Organized Minisymposiums and Sessions

   (i) *Machine learning* minisymposium at SIAM Financial Math Meeting, Toronto, June 2018. 12 speakers.

   (ii) *Machine learning in finance* session at INFORMS Annual Meeting, Houston, October 2017.

   (iii) *Financial engineering* session at INFORMS Applied Probability Meeting, Northwestern University, July 2017.

(iv) *Machine learning for finance* minisymposium at SIAM Financial Mathematics Conference, Austin, November 2016.

(v) *Machine learning for finance* session at INFORMS Annual Meeting, Nashville, November 2016.

(vi) *Large-scale portfolio risk* session at INFORMS Annual Meeting, Philadelphia, November 2015.

5. Referee for *SIAM Journal on Financial Mathematics*, *Journal of Machine Learning Research*, *Journal of Computational Physics*, *Quantitative Finance*, *Operations Research*, *Management Science*, and other journals.

6. Member of committee for the Masters of Financial Engineering program.

7. Campus collaborator for the Deep Learning Major Research Instrument Project (approx. $2 million), which is developing a high-performance cluster specifically designed for deep learning and will provide unprecedented computational performance for deep learning applications.

Selected Presentations

1. Seminar at Oxford University, Dept. of Mathematics, Spring 2019.

2. Seminar at University of Michigan, Dept. of Mathematics, 2019.

3. Seminar at University of Washington in St. Louis, Dept. of Mathematics, 2019.

4. Seminar at Carnegie Mellon University, Dept. of Statistics, 2019.

5. Seminar at Columbia University, Dept. of Industrial Engineering & Operations Research, 2019.

6. Seminar at Stanford University, Dept. of Management Science & Engineering, 2019.

7. Seminar at Purdue University, Dept. of Statistics, 2019.

8. Seminar at Carnegie Mellon University, Dept. of Statistics, 2019.

9. SIAM Financial Mathematics conference, June 2019.

10. SIAM Annual Meeting, July 2018.

11. London Quantitative Finance Seminar, May 2018.

12. Deep Learning Workshop, National Center for Supercomputing Applications, UIUC, October 2017.

13. Seminar at Princeton University, Dept. of Operations Research and Financial Engineering, 2017.

14. INFORMS Applied Probability Society Conference, Northwestern University, July 2017. Invited.

15. Seminar at Northwestern University, April 2017.

16. J.P. Morgan, New York City, August 2017. Invited seminar.

17. Seminar at UIUC Business School, February 2017.

18. SIAM Financial Mathematics Conference, Austin, Texas, November 2016. Co-organized minisymposium on machine learning in finance.

19. Bank of England, London, May 2016. Invited seminar.

20. INFORMS Annual Meeting, Nashville, November 2016. Invited.

21. Seminar at London Business School, London, June 2016.

22. Seminar at Oxford University, May 2016.

23. London-Paris Bachelier Workshop on Mathematical Finance, London, September 2015. Invited.

24. Lending Club, San Francisco, June 2015.

25. IPAM Workshop on Systemic Risk and Financial Networks, Los Angeles, 2015.

26. SIAM Financial Mathematics and Engineering Meeting, Chicago, 2014. Invited.

27. INFORMS Annual Meeting, San Francisco, 2014. Invited.

28. Joint Mathematics Meeting, Baltimore, 2014. Invited.

29. INFORMS Annual Meeting, Phoenix, October, 2012. Invited.

30. SIAM Financial Mathematics and Engineering Meeting, Minneapolis, 2012. Chair of the *Credit Risk* session.

31. Annual Meeting of the Canadian Applied and Industrial Mathematics Society, Toronto, 2012. Invited.

32. 5th Financial Risks International Forum, Paris, France, 2012.

Other work experience

British Petroleum, Natural Gas & Power (NAGP), Summer 2013. Machine learning model for electric power market.

Citizenship

United States of America