Self-Statement for Merit Action, Effective 7/1/20
Mason A. Porter, 8/29/19

This document covers scholarship, teaching, etc. since 1 December 2017, when I submitted my documents for promotion from Step 3 to Step 4 of the professorial ladder. The current submission is for a one-year acceleration to advance to Step 5.

In addition to the Department of Mathematics, I am also affiliated with UCLA's Bhaumik Institute for Theoretical Physics.

Scholarship

I continue to conduct research in network analysis, data science, complex systems, and nonlinear systems — including contributions to theory, algorithms, data analysis, and applications. A defining feature of my work continues to be its interdisciplinary nature, including recent publications in mathematics, physics, biology, social science, and multidisciplinary journals.

Papers:

New peer-reviewed papers accepted in final form and/or published: **26**, including ones in *PNAS*, *SIAM Journal on Mathematics of Data Science*, *Nature Neuroscience*, *Nature Communications*, and *Chaos*

New papers (i.e., completed since 1 December 2017) that are currently undergoing peer review or revision based on referee reports: **17**

My work is being cited at an ever-increasing rate, with (according to Google Scholar) now about 15000 citations overall, including more than 2700 citations in 2018. This includes one paper from 2018 with more than 30 citations and three papers from 2017 with more than 100 citations. I work in a large variety of areas in network analysis, complex systems, and nonlinear systems; I will highlight three themes here.

One major theme of my research the past two years has been theory, methods, data analysis, and applications of multilayer networks, a concept I helped originate (with our 2014 review article [A121] getting more than 400 citations in 2018 and about 300 so far in 2019). Highlights since 1 December 2017 include perspectives and reviews on multilayer network analysis in animal behavior [A173, A186]; derivation of a relationship between multilayer modularity maximization and stochastic block models (which, jointly with Andrea Bertozzi and her former Ph.D. student Zach Boyd, I have also related to discrete surface tension [A187]), two of the most prominent ways of detecting communities in multilayer networks [A191]; development of new generalizations of centrality analysis for multilayer networks [C63, C66]; analysis of edge correlations in multilayer networks [C72]; and new multilayer stochastic blocks models, with an application to urban bicycle-sharing networks [C51]. Additionally, I was recently awarded grants from the National Science Foundation to examine multilayer social networks in how real-world networks shape and are shaped by neural processing (joint with Carolyn Parkinson, Department of Psychology, UCLA) and to analyze information and opinion spreading in multilayer networks (modeling multichannel communication networks). My upcoming research on multilayer networks will explore these and other topics, such as multimodal transportation networks.

A second major theme is opinion models on networks. Recent work on this topic includes generalizing social-contagion models (such as the Watts Threshold Model) to include synergistic effects [A177], timers [A168], and hipsters [A184]; analysis of bounded-confidence models [A174], which have continuous opinions, and using them (jointly with my postdoc Heather Brooks) to study the influence of media on opinions [C62]; a dynamical-systems model for forecasting elections [C61] that performed just as well as those of experts such as FiveThirtyEight; and voter models that coevolve with network structure (joint with my Ph.D. student Yacoub Kureh) [C70]. I am currently collaborating with Jeff Brantingham of the Department of Anthropology to study opinion models in various types of crime and police networks. Additionally, with my recently awarded grant on opinion models on multichannel communication networks, my group and I are starting to analyze generalize of bounded-confidence models (both multilayer and simplicial generalizations) and analysis and models of media influence on social networks. Heather Brooks and I are also collaborating with Andrew Stuart and Franca Hoffmann of Caltech on a project that crosses over between bounded-confidence models and aggregation equations, strengthening connections between the two.

A third of my major themes in the last two years has been topological data analysis (TDA), especially persistent homology (PH). These papers have especially explored situations that are embedded in space, including two-dimensional percolation with disks [A175], contagions on spatially-embedded networks [C57], and (jointly with my Ph.D. student Michelle Feng) analysis of PH on geospatial data, including the construction of new types of filtrations and a case study with voting data from California from the 2016 presidential election [C59]. My work on TDA in spatially-embedded systems is also related to my active research program on spatial networks, which includes recent work on granular and particulate networks [A190, C71] (on which I have also coauthored a review article [A172]), spatiotemporal Hawkes processes [A188], the aforementioned bicycle-sharing networks [C51], and customer mobility and congestion in supermarkets [C65]. Active work on TDA and spatial networks more generally include a paper on generative network models for spatial networks that is almost ready for submission and an application-oriented follow-up to [C59] in which we are applying our new methods for geospatial PH to urban road networks, spider webs, and other data. I am also collaborating with the Los Angeles Unified School District (LAUSD) on a project to improve their bus routes.

I'll illustrate the impact of my recent work on the work of others with three examples:

(1) Martínez et al. [A178] was published in *Philosophical Transactions of the Royal Society* (and was the source of the picture on the cover) in 2018. It is a paper on strongly nonlinear Anderson localization in quasiperiodic chains of particles. An important contrast from prior work on such localization is that it uses quasiperiodic configurations, instead of random ones. This makes it feasible to use one configuration experimentally, instead of relying on an ensemble average (which is difficult experimentally). Our paper also proposed three distinct experimental setups. This paper has been cited 4 times by other research groups thus far, and one of them (which was published in June 2019 in the top journal *Nature Communications*) reported experimental observations of phenomena that we proposed.

(2) Meng et al. [A174], published in 2018 in *Physical Review E*, is a systematic study of bounded-confidence models on several types of networks to examine how the dynamics of such models — these are opinion models with continuous-valued opinions, such that two agents, when chosen to interact, compromise by some amount on their opinion states if and only if their current opinions are sufficiently close — depend on the structure of a social network of people. We demonstrated numerically that both network structure and opinion-update parameters have important effects on whether there is convergence to a consensus opinion state, as

well as how long such convergence takes when it exists. We also found studied transitions between qualitatively different types of behavior. Thus far, [17] has been cited 11 times, with 10 of these citations by other groups, including well-known researchers such as Harry Dankowicz (UIUC) in physics, computer science, and control-theory venues.

(3) Papadopoulos et al. [A172], published in 2018 in *Journal of Complex Networks*, is a review article on granular and particulate networks. It has become the "go to" review article in this subject, which is increasingly prominent throughout soft-matter physics, applied mathematics, engineering, and other fields. Employed methods for such systems include both network analysis and topological data analysis. Thus far, this article has been published 32 times, including by prominent researchers such as Robert Ghrist (Penn), Ginestra Bianconi (QMUL), Robert Ziff (Michigan), Steve Strogatz (Cornell), Alex Arenas (URV), Andrea Liu (Penn), and Konstantin Mischaikow (Rutgers)

Editorial activities: I recently co-edited (with Andrea Bertozzi) a special issue of *Journal of Nonlinear Science* on data science and network analysis. In 2018, I joined the inaugural editorial board of *SIAM Journal on Mathematics of Data Science (SIMODS)*. At *SIMODS*, I am the only editorial-board member in the area of complex systems. I continue to serve on the editorial boards of *IMA Transactions in Mathematics and Applications* (inaugural board), *SIAM Review*, *IEEE Transactions on Network Science and Engineering* (inaugural board), *European Journal of Applied Mathematics*, *IMA Journal of Applied Mathematics*, and *Network Neuroscience* (inaugural board).

Selected invited lectures (since 1 December 2017): Southern California Applied Mathematics Symposium (SOCAMS) 2018, UCSB, Santa Barbara, CA, USA [April 2018]; Keynote ("Springer Complexity Lecture"), NetSci2018, Paris, France [June 2018]; University of Sydney, Department of Mathematics [September 2018]; California Institute of Technology, Department of Computing and Mathematical Sciences, Computational Mathematics + X Seminar [October 2018]; The Ohio State University, Translational Data Analytics Institute colloquium [November 2018]; Centro de Investigación en Matemática Pura y Aplicada, Universidad de Costa Rica [January 2019]; CompleNet International Conference on Complex Networks (COMPLENET '19), Tarragona, Spain [March 2019]; USC, Keck School of Medicine, Center for Applied Network Analysis [November 2019]

Organization of conferences, workshops, and summer schools:

I was the lead or co-lead organizer for the SIAM Conference on Applications of Dynamical Systems 2019 [DS19] (with E. Spiller), Snowbird, UT, USA (May 2019); NetSciEd2019 (with C. Cramer, R. Gera, E. Panagakou, H. Sayama, L. Sheetz, M. Stella, and S. Uzzo), Satellite Symposium on Network Science in Education, NetSci 2019 [May 19]; NetSciEd2018 (with C. Cramer, R. Gera, E. Panagakou, H. Sayama, L. Sheetz, M. Stella, and S. Uzzo), Satellite Symposium on Network Science in Education, NetSci 2018 [June 18]; Workshop on Threshold Networks (with S. Coombes, Y. M. Lai, and R. Thul), Nottingham, UK [July 2019]; Workshop on Granular and Particulate Networks [PARNET19] (with D. S. Bassett and K. E. Daniels), Max Planck Institute for the Physics of Complex Systems, Dresden, Germany [July 2019]. I am also on the Board of Experts of the Lake Como School on Complex Networks (with summer schools every May since 2014).

Hosting visiting scholars: I have had hosted several visiting scholars—both short-term and long-term, and both domestic and international—since 1 December 2017. This includes Paul C.

Bressloff (Professor of Mathematics, University of Utah, Sept–Dec 2018)

Teaching

Design of new Data Theory major and a new course: I was part of the committee to design our new Data Theory major, including designing and teaching (Spring 2019) our new capstone lower-division course in it: **Math 42: Introduction to Data-Driven Mathematical Modeling: Life, The Universe, and Everything**.

Courses taught:

Since the fall 2017 quarter, I have taught the following courses: Math 266a (Fall 17, 18, 19); Math 276 (Winter 18, 19); Math 168 (Spring 18); and Math 42 (Spring 19). I have also offered a Math 290J seminar in all quarters since fall 2017. I am convening Math 296J (the applied-mathematics colloquium) in fall 2019. Math 266a is our core graduate ODE course. I developed the courses Math 168 (introduction to networks), Math 276 (topics in network science), and Math 42.

My course evaluation scores and feedback have been strong. A highlight is Math 168 in Spring 2018. In it, my teaching effectiveness (from 12 responses) had a mean of 7.92 and a median of 8, my availability and helpfulness had a mean of 8.75 and a median of 9, and the rating of the course had a mean of 8.33 and a median of 9.

A few quotes from student evaluations from my various courses convey my students' experiences:

"Awesome class. The HWs were really time-consuming, but in general learned a lot."

"I want to thank Professor Porter for what he had done for us throughout the quarter. He has been kind and helpful. He is both funny and so knowledgeable. His T-shirt is really cool, by the way. This class literally made me want to apply for a graduate school in the area of network science."

"Professor Porter makes his class challenging yet also intriguing. He has been very helpful during office hours and he'd always be willing to discuss topics outside the scope of our class. Looking back, I have learned so much from this class and much of the knowledge is applicable to many other areas of my study."

"The course materials were perfectly fit to an advanced course in network theory and the instructor was capable of presenting them quite well."

"Professor Porter is very knowledgeable and cares about his students. He is always very helpful during his office hours. The topics that we discussed are difficult but also very interesting. The homework assignments sometimes require a lot of work, but I get to learn a lot during the process. Overall I really enjoyed this class."

Student and Postdoc Supervision:

I am currently supervising **four UCLA Ph.D. students**: Michelle Feng, Yacoub Kureh, Will Oakley, and David Spencer. Feng, Kureh, and Oakley all passed their ATC exams in June 2018; and they are all slated to defend their dissertations in time to graduate in June 2020. Spencer is slated to have his ATC exam in winter or spring of 2020. (I also have 3 remaining doctoral students at University of Oxford.) I am contacted frequently by Ph.D. students who are interested in my work, and I plan to continue to grow my research group.

From 1 December 2017, I am or have been on the dissertation committees of the following Ph.D. students in mathematics: Dr. Zach Boyd (Fall 2017–Summer 2018; earned Ph.D. in 2018), Shyr-Shea Chang (Winter 2017–present; earned Ph.D. in August 2019), Hao Li (Spring 2018–present), Cassidy Mentus (Fall 2016–present; defended dissertation in June 2019), Jacob Moorman (Spring 2019–present), Thomas Tu (Spring 2019–present), and Baichuan Yuan (Spring 2017–present)

I am or have been on the dissertation committees of the following Ph.D. students from other departments: Duncan Clark (Statistics; Spring 2019–present), Jalil Kazemitabar (Statistics; Summer 2018–present), Tianyun Lin (Biostatistics; Summer 2018–present), and Dr. Fiona Yeung (Statistics; Fall 2017–Spring 2019; earned Ph.D. in 2019)

I currently mentor **three postdoctoral scholars**: Elisa Baek (July 2019–present; joint with Carolyn Parkinson, Department of Psychology), Heather Brooks (July 2018–present), and Nina Otter (January 2019–present; joint with Guido Montufar). Baek sits in psychology, and the other two are in the Department of Mathematics.

I have mentored two Masters students: Cu Hauw Hung (Department of Computer Science; Winter 2019–present) and Dimitri Lozeve (Mathematical Institute, University Oxford; Spring–Summer 2018; joint with Oxford faculty).

Since 1 December 2017, I have mentored **17** undergraduate students (including 8 women) on research projects.

Major Awards and Recognition

In 2019, I was named a Fellow of the Society for Industrial and Applied Mathematics (SIAM).

(I am now a Fellow of all three of the American Mathematical Society, the American Physical Society, and SIAM.)

Service

UCLA: I have been active in departmental service. For the 2019–20 academic year, I am Chair of the Colloquium Committee, a member of the Distinguished Lecture Series Committee, a member of the Putnam Exam and Mathematical Contest in Modeling (MCM) Committee, and a member of the Ad Hoc Search Committee for a new faculty member in "Data Theory" (joint between the Departments of Mathematics and Statistics). I am also convening the Applied Mathematics Colloquium (Math 296J) in fall 2019 during Andrea Bertozzi's sabbatical leave. I was Chair of the ADE Qualifying Exam Committee in fall 2019 and fall 2018, and I was a member of the committee in spring 2018. My other committees for the 2018–19 academic year were the Graduate Advisors Committee, Staff Search (for which I was particularly active, including with the financial math position), and Distinguished Lecture Series. My other committees for the 2017–18 academic year were the CFM Postdoc Hiring Committee, Distinguished Lecture Series, and Graduate Admissions Committee. In both the 2017–18 and 2018–19 academic years, I was a member of the Working Group to establish our new Data Theory major, jointly with the Department of Statistics. I was very active in this working group, and I designed the major's capstone lower-division course: Math 42: Introduction to Data-Driven Mathematical Modeling: Life, The Universe, and Everything.

National and international: In addition to the previously mentioned (in other categories) organizational and scientific committee work with conferences and summer schools (and membership of journal editorial boards), I have held several other service positions. I am Program Director of the Society for Industrial and Applied Mathematics (SIAM) Activity Group on Dynamical Systems [1/1/18–12/31/19], after finishing my two-year term as Secretary at the end of December 2017. I am the longest-serving member of SIAM's Education Committee [3 terms; 1/1/13–12/31/21]. I have refereed the usual variety of books, papers, grant proposals, and workshop proposals; and I have been an External Evaluator for several promotion cases (for mid-term review, tenure, and full professorship), including in mathematics, information science, and mechanical engineering departments.

Research Grants

Since 1 December 2017, I have been awarded three grants (and an additional supplement to one of the grants).

1. Co-Principal Investigator, "NCS-FO: How Real-World Interaction Networks Shape and are Shaped by Neural Information Processing", National Science Foundation, Integrative Strategies for Understanding Neural and Cognitive Systems (NSF-NCS) (PI: Carolyn Parkinson), $976,747 [4/1/19–3/31/22]

2. Principal Investigator, "Dynamic Optimization and Network Analysis for Bus Transportation for the Los Angeles Unified School District", funded as a 2018 UCLA Institute of Transportation Studies (IST) research proposal (co-PI: Mario Gerla), $101,447 [10/01/18–03/31/20]

3a. Principal Investigator (sole PI), "ATD: Models of Spreading Dynamics in Multilayer Networks", National Science Foundation, ATD-Algorithms for Threat Detection (NSF 19-504), Division of Mathematical Sciences, $500,000 [10/01/19–09/30/22].

3b. Supplement (to Grant 3a) of $15,999 to work on Challenge Problems awarded on 7/31/19