OMB No. 0925-0001 and 0925-0002 (Rev. 03/2020 Approved Through 02/28/2023)

BIOGRAPHICAL SKETCH

Provide the following information for the Senior/key personnel and other significant contributors.  
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NAME: Zachary M. Boyd

eRA COMMONS USER NAME (credential, e.g., agency login): ZACHARY\_MARK\_BOYD

POSITION TITLE: Postdoctoral research associate

EDUCATION/TRAINING (Begin with baccalaureate or other initial professional education, such as nursing, include postdoctoral training and residency training if applicable. Add/delete rows as necessary.)

| INSTITUTION AND LOCATION | DEGREE  (if applicable) | Completion Date  MM/YYYY | FIELD OF STUDY |
| --- | --- | --- | --- |
| Brigham Young University, Provo, UT | BS | 04/2013 | Mathematics |
| Brigham Young University, Provo, UT | MS | 08/2014 | Mathematics |
| University of California, Los Angeles, CA | PhD | 08/2018 | Mathematics |
| University of North Carolina, Chapel Hill, NC | Postdoctoral | 07/2021 | Mathematics |

**A. Personal Statement  
I have the analysis capabilities, modeling experience, literature knowledge, and motivation necessary to successfully support the proposed research project. I have a broad background in data science, network models, and mathematical analysis, with specific training and expertise in dynamical processes on networks, scalable computational solutions, and interpretation of algorithmic results. My research includes work with directed, time-varying, multi-layered networks of the type considered in this project. As NDSEG fellow at UCLA and now a postdoc at UNC, I have developed state-or-the-art data clustering and importance quantification approaches under a variety of different assumptions, which will be a key component in data interpretation for the present project. I also have experience applying these abilities in domains as diverse ad neuroscience, anti-terrorism, physics, and genealogy, to name a few. The communication skills required to work with scientists in such broad enterprises will be a key component to the rapid development of working tools, as required by the proposal, especially insofar as our team is multi-institutional. This work is a natural fit for my own research program, which involves applying my deep knowledge of network modeling to a variety of application domains in cooperation with domain experts, such as the PI, who will appreciate when and where these advanced tools will solve real, outstanding problems in their domains.**

1. Boyd, Z.M., Bae, E., Tai, X.C., & Bertozzi, A.L.. (2018). Simplified energy landscape for modularity using total variation. SIAM J. Appl. Math., 78, 2439-2464.
2. **Boyd, Z.M., Porter, M.A., & Bertozzi, A.L. (2019). Stochastic block models are a discrete surface tension. J. Nonlinear Sci.**
3. **Moorman, J.D., Chen, Q., Tu, T.K., Boyd, Z.B., & Bertozzi, A.L. (2018). Filtering methods for subgraph matching on multiplex networks. Proc. GTA2 Workshop, IEEE Conf. Big Data, Seattle, pp 3979-3984.**
4. **Boyd, Z.M, Marzuola, J., Osing, B., Fraiman, N., Mucha, P.J., & Weare, J. “A metric on the state space of Markov chains based on hitting probabilities.” In preparation.**

**B. Positions and Honors**

## *Positions and Employment*

2014 Contributor, Foundations of Applied Mathematics curriculum, Provo, UT

2015-2018 Graduate research assistant, Los Alamos National Laboratory, Los Alamos, NM

2017 Lecturer, Open Source Macroeconomics Laboratory at the University of Chicago, Chicago, IL

2017 Volunteer, FamilySearch Engineering, Salt Lake, UT

2018 Graduate mentor, UCLA Applied Mathematics Research Experience for Undegraduates, Los Angeles, CA

2019-2020 Consultant, Robinson Bradshaw law firm, Chapel Hill, NC

## *Honors*

2008-2013 Monson Presidential Scholar, Provo, Utah

2015-2018 National Defense Science and Engineering Graduate Fellow, Los Angeles, CA

**C. Contributions to Science**

1. My dissertation work presents analysis, algorithms, and applications of community detection, a fundamental tool of network analysis across application domains. For the popularity modularity approach to community detection, I proved fundamental limits on convexity-bases approach, connected the problem to total variation techniques, showed how non-convex approachs can improve on convex ones, and scaled up my codes to application networks involving millions of relationships. Performance on a variate of application domains were comparable with the state of the art but with better analytical underpinnings and guarantees. For the more complicated but more principled stochastic block model, I made similar contributions, eventually providing efficient codes that work on much larger networks than competing approaches.
   1. Boyd, Z.M., Bae, E., Tai, X.C., & Bertozzi, A.L.. (2018). Simplified energy landscape for modularity using total variation. SIAM J. Appl. Math., 78, 2439-2464.
   2. Boyd, Z.M., Porter, M.A., & Bertozzi, A.L. (2019). Stochastic block models are a discrete surface tension. J. Nonlinear Sci.
2. In addition to the contributions described above, with a UCLA REU team, I developed algorithms for detecting adversarial activities in transaction networks of interest to DARPA. The problems are normally combinatorially difficult, but we exploited special structure in the data to get efficient and accurate solutions. This work had a transformative effect on how DARPA viewed adversarial network detection and led to further expansions of these techniques after I left the project.
   1. Moorman, J.D., Chen, Q., Tu, T.K., Boyd, Z.B., & Bertozzi, A.L. (2018). Filtering methods for subgraph matching on multiplex networks. Proc. GTA2 Workshop, IEEE Conf. Big Data, Seattle, pp 3979-3984.
3. With a team of collaborator, I have developed a metric (distance) on the nodes of directed networks (that is, those with asymmetric links, as in supply chain networks, or Twitter follower networks) which uses notions of reachability to recover a symmetric distance despite the inherent asymmetry of directed network structures. We show that including the directed information in distance measurements enhances many procedures, such as community detection, visualization, data exploration, and chain discovery.
   1. Boyd, Z.M, Marzuola, J., Osing, B., Fraiman, N., Mucha, P.J., & Weare, J. “A metric on the state space of Markov chains based on hitting probabilities.” In preparation.

**D. Additional Information: Research Support and/or Scholastic Performance**