DANH-TAI HOANG, PhD

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CURRENT RESEARCH AREAS

- Statistical Physics
- Biological Physics
- Mathematical Modeling
- Data Science
- Machine Learning

EXPERIENCE & SKILLS

- 11 years in Linux OS (Centos and Ubuntu) with command line and bash scripting.
- 10 years in coding with multiple programming languages (Python, Fortran, CUDA).
- 10 years in High Performance Computing.
- 10 years in statistical and mathematical modeling.
- 10 years in optimizing methods such as Markov chain Monte Carlo, Free Energy Minimization, Likelihood Maximization, Expectation Maximization, and gradient descent.
- 7 years in quantitative analysis with large data sets in various areas (physics, biology, finance).
- 5 years in parameter estimations, predictive models, and Machine Learning algorithms (Linear Regression, Logistic Regression, K-means, Decision Tree, Random Forest, Naïve Bayes, etc.).
- 5 years in stochastic dynamical systems, time-series analysis.
- Published 19 papers in high profile journals. Delivered 16 presentations at scientific conferences.

SOFTWARE DEVELOPMENT

- Network inference in stochastics systems: https://danhtaihoang.github.io/network-inference/
- Network inference with hidden variables: https://danhtaihoang.github.io/hidden-variable/

Other codes are available at: https://github.com/danhtaihoang

EDUCATION & PROFESSIONAL EXPERIENCE

❖ **4/2016 – present:** Postdoctoral Researcher

Laboratory of Biological Modeling, NIDDK, NIH, Bethesda, MD, USA.

Research subject: *Causal Inference in Stochastic Processes*

Supervisor: Dr. Vipul Periwal

- Developed a data-driven approach, Free Energy Minimization, for causal inference in stochastic processes that works well even in the limit of small sample sizes. Besides the better performance than the present state-of-the-art methods, my approach is model-free, and does not assume any specific functional form for the interaction, allowing a systematic expansion to obtain higher-order interactions as warranted, 100 times faster than traditional methods using Maximum Likelihood Estimation (MLE) based on gradient ascent method, and generalizes to many data types (reference [18] in the list of publications).
- Inferred a currency network from currency exchange rate fluctuations, suggested a currency trading strategy which produced a profit of 150% over 14 years [18].
- Developed a data-driven inference of hidden nodes in networks, combining Free Energy Minimization and Expectation Maximization. This work was motivated by the fact that real-world data often contains only subsets of variables. For example, it is hopeless to obtain simultaneous spiking activity of every neuron in the brain, the transcription of every gene in the genome, every

fluctuating factor in a financial system. My method with hidden nodes outperforms other existing methods with or without hidden nodes [19].
• Inferred a stock-market network using data of opening and closing stock prices of 25 American companies, suggested an investment strategy which produced a profit of 350% over 10 years [19].
• Inferred a neuronal network from neuron activities in the salamander retina. Predicted activities of neurons from activities of input neurons with an accuracy of 80% [19].
• Developed a new algorithm for unsupervised data clustering, applied to classify successfully the MNIST hand-written digit images, and showed that there were about 60 clusters which are roughly equally distributed among the digits [19].
• Developed a data-driven approach, Expectation Reflection, to infer the residue interactions in protein sequences, applied to predict the tertiary structures of protein from multiple sequence alignments. The method provided a good inference accuracy for many protein domains [20].

❖ **1/2013 – 3/2016:** Postdoctoral Researcher
Asia Pacific Center for Theoretical Physics, POSTECH, Pohang, South Korea.
Research subject: *Design principles of cellular networks*
Supervisor: Prof. Junghyo Jo
• Studied the controllability of phase coordination between insulin and glucagon in pancreatic islets (the micro-organ for controlling glucose levels) and found that this controllability is based on the interaction motif of three cell types within an islet: alpha cells activate beta and delta cells; delta cells suppress alpha and beta cells; while beta cells suppress alpha cells but activate delta cells. This particular motif is unique for requiring minimal hormone secretion and reducing glucose fluctuations [16, 17].
• Inferred the relative attractions between the cell types and found that the attractions between homotypic cells are slightly, but significantly, stronger than the attractions between heterotypic cells [12].

❖ **9/2009 – 12/2012:** PhD Student in Statistical Physics
Laboratory for Theoretical Physics and Modeling, French National Center for Scientific Research (CNRS) – UMR 8089 and University of Cergy-Pontoise, France.
Research subject: *Phase transition and spin transport in complex systems*
Supervisor: Prof. H. T. Diep
• Designed models for frustrated spin systems [1-4], molecular [5-6], and liquid crystals [10].
• Performed Markov chain Monte Carlo (MCMC) simulation and advanced techniques such as Parallel Tempering and Wang-Landau sampling to study phase transition and spin transport [1-7, 9-10].

SELECTED PUBLICATIONS (ISI JOURNALS)

20. Danh-Tai Hoang, Joseph McKenna, Chris Yang, and Vipul Periwal, *Data-driven approach for inferring residue interactions in protein sequences*, Proc. Natl. Acad. Sci. U.S.A (PNAS), in preparation.

19. Danh-Tai Hoang, Junghyo Jo, and Vipul Periwal, *Data-driven inference of hidden nodes in networks*, Nature Physics (2019, under review), arXiv:1901.04122.

18. Danh-Tai Hoang, Juyong Song, Vipul Periwal, and Junghyo Jo, *Network inference in stochastic systems from neurons to currencies: Improved performance at small sample size*, Physical Review E, **99**, 023311 (2019).

17. Dong-Ho Park, Taegeun Song, Danh-Tai Hoang, Jin Xu, and Junghyo Jo, *A Local Counter-regulatory motif modulates the global phase of hormonal oscillations*, Nature - Scientific Reports, 7, 1602 (2017).

16. Danh-Tai Hoang, Manami Hara, Junghyo Jo, *Design principles of pancreatic islets: Glucose-dependent coordination of hormone pulses,* PLOS ONE, 11(4): e0152446 (2016).

15. Danh-Tai Hoang, B. Prasanna Venkatesh, Seungju Han, Junghyo Jo, Gentaro Watanabe, Mahn-Soo Choi, *Scaling law for irreversible entropy production in critical systems,* Nature -Scientific Reports, 6, 27603 (2016).

14. Marissa Pastor, Juyong Song, Danh-Tai Hoang, Junghyo Jo, *Minimal Perceptrons for Memorizing Binary Patterns*, Physica A, 462, 31-37 (2016).

13. Danh-Tai Hoang, Junghyo Jo, Hyunsuk Hong, *Traveling wave in a three-dimensional array of conformist and contrarian oscillators*, Physical Review E, 91, 032135 (2015).

12. Danh-Tai Hoang, Hitomi Matsunari, Masaki Nagaya, Hiroshi Nagashima, J. Michael Millis, Piotr Witkowski, Vipul Periwal, Manami Hara, Junghyo Jo, *A Conserved Rule for Pancreatic Islet Organization*, PLOS ONE, 9, 10, e110384 (2014).

11. Juyong Song, Danh-Tai Hoang, Jongwook Kim, and Junghyo Jo, *Population balancing with species switching*, J. Korean Phys. Soc., 61, 1, 111-116 (2014).

10. Danh-Tai Hoang and H. T. Diep, *Phase transition in dimer liquids*, J. Phys.: Condens. Matter., 26, 035103 (2014).

9. H. T. Diep, Virgile Bocchetti, Danh-Tai Hoang, and V. T. Ngo, *Theory and simulation of magnetic material: Physics at phase frontiers*, J. Phys.: Conference Series, 537, 01200 (2014).

8. Danh-Tai Hoang, Juyong Song, and Junghyo Jo, *Partial mixing phase of binary cells in finite systems*, Physical Review E. 88, 062725 (2013).

7. Maciej Kasperski, Henryk Puszkarsi, Danh-Tai Hoang, and H. T. Diep, *Magnetic properties of two-dimensional nanodots: Ground state and phase transition*, AIP Advances, 3, 122121 (2013).

6. Danh-Tai Hoang, Maciej Kasperski, Henryk Puszkarsi, and H. T. Diep, *Re-orientation transition in molecular thin films: Potts model with dipolar interaction*, J. Phys.: Condens. Matter., 25, 056006 (2013).

5. Danh-Tai Hoang and H. T. Diep, *Effect of dipolar interaction in molecular crystals*, J. Phys.: Condens. Matter., 24, 415402 (2012).

4. Danh-Tai Hoang and H. T. Diep, *Hexagonal-close-packed lattice: Ground state and phase transition*, Physical Review E, 85, 041107 (2012).

3. H. T. Diep, Yann Magnin and Danh-Tai Hoang, *Spin resistivity in magnetic materials*, Acta. Phys. Pol. A, 121, 985-991 (2012).

2. Danh-Tai Hoang, Yann Magnin and H. T. Diep, *Spin resistivity in the frustrated J_1-J_2 model*, Mod. Phys. Lett. B, 25, 937-945 (2011).

1. Yann Magnin, Danh-Tai Hoang and H. T. Diep, *Spin transport in magnetically ordered systems: Effect of the lattice relaxation time*, Mod. Phys. Lett. B, 25, 1029-1040 (2011).

SCIENTIFIC CONFERENCE PRESENTATIONS

16. Danh-Tai Hoang, Junghyo Jo, and Vipul Periwal, *System inference with small sample size in stochastic systems* (keynote), NIST Workshop on Complex Systems Chemistry at the Nexus of Chaos, Emergence, and Information Theory, October 22-24, 2018, NIST, Maryland, USA.

15. Danh-Tai Hoang, Juyong Song, Vipul Periwal, and Junghyo Jo, *Causality inference in stochastic systems from neurons to currencies*: profiting from small sample size (invited talk), 2018 Quantitative Life Science Workshop, October 15-18, 2018, KIAS, Seoul, Korea.

14. Danh-Tai Hoang, Junghyo Jo, and Vipul Periwal, *Causality inference in stochastic systems: small sample sizes and hidden variables*, 12th Annual q-bio Conference, June 26-29, 2018, Rice University in Houston, TX, USA.

13. Danh-Tai Hoang, Junghyo Jo, and Vipul Periwal, *Causality inference in stochastic systems: small sample sizes and hidden variables*, NIH BioInformatics Poster day, May 22, 2018, NIH, Bethesda, Maryland, USA.

12. Danh-Tai Hoang, Juyong Song, Vipul Periwal, and Junghyo Jo, *Maximizing weighted Shannon entropy for network inference with little data*, 11th Annual q-bio Conference, July 25-28, 2017, Rutgers University, New Jersey, USA.

11. Danh-Tai Hoang, Juyong Song, Vipul Periwal, and Junghyo Jo, *Non-equilibrium Network Reconstruction with Little Data* (invited talk), Workshop on Push the Envelope of Statistical Physics: Econo, Social, Bio and Beyond, December 12-15, 2016, Pohang, Korea.

10. Danh-Tai Hoang, Manami Hara, and Junghyo Jo, *Cellular Organization and Controllable Synchronization of Pancreatic Islets*, APCTP 2015 Workshop on Frontiers of Physics, December 20-23, 2015, Yeosu, Korea.

9. Danh-Tai Hoang, Manami Hara, and Junghyo Jo, *Cellular Organization and Controllable Synchronization of Pancreatic Islets* (invited talk), Korean Physical Society (KPS) Fall Meeting, October 21-23, 2015, Gyeongju, Korea.

8. Danh-Tai Hoang, Manami Hara, and Junghyo Jo, *Cellular Organization and Synchronization of Pancreatic Islets*, 3rd International Workshop on Theoretical and Computational Physics (IWTCP-3): Complex Systems and Interdisciplinary Physics, July 27-30, 2015, Dalat, Vietnam.

7. Danh-Tai Hoang and Junghyo Jo, *Conserved Rule for Pancreatic Islet Organization*, XXVI IUPAP Conference on Computational Physics (CCP2014), August 11-14, 2014, Boston, Massachusetts, USA.

6. Danh-Tai Hoang, Junghyo Jo, Hyunsuk Hong, *Synchronization of conformist and contrarian oscillators under pinning force*, Korean Physical Society (KPS) Spring Meeting, April 23-25, 2014, Daejeon, Korea.

5. Danh-Tai Hoang and Junghyo Jo, *Morphogenesis in Life: Pancreatic Islets*, Nurturing Connectivity: Physics and Biology, January 15-16, 2014, Pohang, Korea.

4. Danh-Tai Hoang and Junghyo Jo, *Morphogenesis in Life: Pancreatic Islets* (invited talk), APCTP Workshop on Theoretical Physics, December 16, 2013, Pohang, Korea.

3. Danh-Tai Hoang and Junghyo Jo, *Self-organization of Pancreatic Islets*, XXV IUPAP Conference on Statistical Physics (STATPHYS25), July 22-25, 2013, Seoul, Korea.

2. Yann Magnin, Danh-Tai Hoang, and H. T. Diep, *Spin Resistivity in Magnetic Materials* (invited talk, presented by Prof. H.T. Diep), European Conference "Physics of Magnetism 2011" (PM'11), June 27-July 1, 2011, Poznan, Poland.

1. Danh-Tai Hoang, Yann Magnin, and H. T. Diep, *Spin resistivity in a spin system with a strong first-order transition, International Conference on Frustrated Spin Systems*, Cold Atoms and Nanomaterials, July 14-16, 2010, Hanoi, Vietnam.