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RESEARCH INTEREST

- Quantitative Biology
- Computational Physics
- Bio-Informatics
- Data Science
- Machine Learning
- Mathematical Modeling

EDUCATION & PROFESSIONAL EXPERIENCE

❖ **4/2016 – present:** Postdoctoral Fellow **Supervisor:** Dr. Vipul Periwal

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

Research subject: *Causality Inference in Stochastic Processes*

• Developed a data-driven approach, namely Free Energy Minimization, for causality inference in stochastic processes that works well even in the limit of small sample sizes. Besides 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.

• 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%.

• Developed a data-driven inference of hidden variables in networks that can predict accurately the observed-to-observed, hidden-to-observed, observed-to-hidden, and hidden-to-hidden interactions, and the configurations of hidden variables in stochastic processes.

• 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.

• Developed a data-driven approach based on Expectation Maximization to infer the residue contacts in protein sequences, applied to predict tertiary and quaternary protein structures from multiple sequence alignments. The method provided a good inference accuracy for many protein families.

• Inferred a currency network from currency exchange rate fluctuations, suggested a currency trade strategy which produced an average profit of 150% over 14 years.

• Inferred a stock-market network using data of opening and closing stock prices of 25 American companies, suggested an investment strategy which produced an average profit of 350% over 10 years.

❖ **1/2013 – 3/2016:** Postdoctoral Fellow **Supervisor:** Prof. Junghyo Jo

Asia Pacific Center for Theoretical Physics, POSTECH, Pohang, South Korea.

Research subject: *Design principles of cellular networks*

• 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.

• 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.

❖ **9/2009 – 12/2012:** Graduate Student in theoretical physics **Supervisor:** Prof. H. T. Diep
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*

• Designed models for frustrated spin systems, molecular and liquid crystals.

• Performed Metropolis Monte Carlo simulation and advanced techniques such as Parallel Tempering and Wang-Landau sampling to study phase transition and spin transport.

SELECTED PUBLICATIONS (ISI JOURNALS)

20. Danh-Tai Hoang, Joseph McKenna, Chris Yang, and Vipul Periwal, *Data-driven approach for inferring residue contacts 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 (2018, under review).

18. Danh-Tai Hoang, Juyong Song, Vipul Periwal, and Junghyo Jo, *Causality inference in stochastic systems from neurons to currencies: Profiting from small sample size*, Physical Review E (2018, under review), arXiv:1705.06384.

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. *System inference with small sample size in stochastic systems* (keynote, presented by Dr. Vipul Periwal), NIST Workshop on Complex Systems Chemistry at the Nexus of Chaos, Emergence, and Information Theory, October 22-24, 2018, NIST, Maryland, USA.
15. *Causality inference in stochastic systems from neurons to currencies*: profiting from small sample size (invited talk, presented by Dr. Vipul Periwal), 2018 Quantitative Life Science Workshop, October 15-18, 2018, KIAS, Seoul, Korea.
14. *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. *Causality inference in stochastic systems: small sample sizes and hidden variables*, NIH BioInformatics Poster day, May 22, 2018, NIH, Bethesda, Maryland, USA.
12. *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. *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. *Cellular Organization and Controllable Synchronization of Pancreatic Islets*, APCTP 2015 Workshop on Frontiers of Physics, December 20-23, 2015, Yeosu, Korea.
9. *Cellular Organization and Controllable Synchronization of Pancreatic Islets* (invited talk), Korean Physical Society (KPS) Fall Meeting, October 21-23, 2015, Gyeongju, Korea.
8. *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. *Conserved Rule for Pancreatic Islet Organization*, XXVI IUPAP Conference on Computational Physics (CCP2014), August 11-14, 2014, Boston, Massachusetts, USA.

6. *Synchronization of conformist and contrarian oscillators under pinning force*, Korean Physical Society (KPS) Spring Meeting, April 23-25, 2014, Daejeon, Korea.
5. *Morphogenesis in Life: Pancreatic Islets*, Nurturing Connectivity: Physics and Biology, January 15-16, 2014, Pohang, Korea.
4. *Morphogenesis in Life: Pancreatic Islets* (invited talk), APCTP Workshop on Theoretical Physics, December 16, 2013, Pohang, Korea.
3. *Self-organization of Pancreatic Islets*, XXV IUPAP Conference on Statistical Physics (STATPHYS25), July 22-25, 2013, Seoul, Korea.
2. *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. *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.

COMPUTER SKILLS

❖ **O/S:**
- Linux/Unix OS (with bash script)
- Windows

❖ **Programming:**
- Python (with NumPy, SciPy, Scikit-learn, Pandas, Bio, etc.)
- Fortran 90
- Open MP
- F2PY (Calling Fortran from Python)
- CUDA (for GPU programming)
- High Performance Computing

❖ **Visualization tools:**
- Matplotlib
- Gnuplot
- Gephi
- RasMol
- Inkscape
- Pymol