Derek Hart, PhD

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Summary

Highly qualified scientist with advanced computational, analytical, statistical, and experimental skills. Recently led and completed a 2.5-year project combining molecular modeling & simulations with FRET microscopy experiments. Long-term experience communicating technical data to a variety of audiences in clearly written reports and engaging oral presentations.

Technical Skills

- **Programming**: Python, MATLAB, LaTeX, Bash, C++, SQL, Pandas, Scikit-learn, Keras, Matplotlib, Seaborn
- **Analytical**: Data Science, Data Cleaning, Data Visualization, Statistical Methods, Machine Learning, Deep Learning, Predictive Modeling, Image Processing, Signal Processing, Neural Networks, Decision Trees, Support Vector Machines
- **Scientific**: Single-molecule FRET, Molecular Dynamics, Monte Carlo Simulation, oxDNA, Rare Event Sampling, Hidden Markov Modeling, TIRF microscopy, DNA Assays, Molecular Biology Protocols, Biophysics

Education

Georgia Institute of Technology, Atlanta GA

- Doctorate of Philosophy in Physics (08/2016 – 09/2022)
- Master of Science in Physics (08/2016 – 05/2018)

Colorado School of Mines, Golden CO

- Bachelor of Science in Engineering Physics (08/2013 – 05/2016)

Relevant Experience

- **Harold Kim Lab,** Georgia Institute of Technology (01/2017 – Present)
  - Conducted Molecular Dynamics and Monte Carlo simulations of DNA in a remote, Linux-based, high performance computing environment
  - Used scripting languages (Python, Bash) to wrangle simulation data, perform statistical analyses, and visualize results
  - Implemented advanced statistical sampling techniques (forward flux sampling, umbrella sampling) to efficiently simulate rare events
  - Performed image and signal processing with statistical models (e.g. Hidden Markov) to extract DNA kinetics from FRET microscopy data
  - Designed DNA-based FRET assays with common molecular biology protocols
  - Developed C++ software to interact with scientific camera and optical instruments

- **Data Scientist**, Self-directed (01/2022 – Present)
  - Built machine learning pipelines, including data preprocessing, using big datasets from agriculture, economics, and healthcare

- Used a variety of predictive models, including neural networks, random forest, and XGBoost models
- Optimized model hyperparameters using Bayesian search cross-validation

Research Publications

- Hart, D.J., Jeong, J. Gumbart, J.C., and Kim, H.D. (2022) Weak hybridization accelerates hybridization and dehybridization of short oligonucleotides. bioRxiv (in peer review)

Conference Talks

- Hart, D.J. Jeong, J. Gumbart, J.C., and Kim, H.D. (2022). Weak tension accelerates hybridization of short oligonucleotides. By invitation at the *Annual Meeting of the International Physics of Living Systems Network*, Montpellier, France
- Hart, D.J., Kim, H.D. (2021). Nucleic acid melting under small tension. *Annual Meeting of the American Physical Society*, Virtual meeting
- Hart, D.J., Jeong, J. Gumbart, J.C., and Kim, H.D. (2021). Kinetics of DNA melting and hybridization under small tension. *Physics of Living Systems Seminar,* Atlanta, GA, USA.
- Hart, D.J. and Kim, H.D. (2019). How do DNA bending and twisting affect CRISPR-Cas12 binding and cleavage? *Physics of Living Systems Seminar,* Atlanta, GA, USA.
- Hart, D.J. Jeong, J. Gumbart, J.C., and Kim, H.D. (2018). Tracking polymer tangles. *Physics of Living Systems Seminar,* Atlanta, GA, USA.

Awards

- Georgia Tech Institute Fellowship, Georgia Institute of Technology (2022)
- Physics Faculty Distinguished Graduate, Colorado School of Mines (2016)