Peilun (Tommy) Li

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Biography

I am a senior undergraduate student pursuing double majors in Computer Science (Honors track) and Mathematics (Honors track) at Vanderbilt University. I am passionate about understanding and developing novel data-driven approaches to analyze Cyber-Physical Systems with reliability, generalizability, and interpretability. Some of my recent work focus on combining Bayesian learning with physics prior knowledge for modeling of physical systems.

Research Interests: Physics-Informed Learning, Uncertainty Quantification, Machine Learning, Robotics.

Education

Vanderbilt University   Aug 2021 – May 2025
B.S. in Computer Science (Hons) and Mathematics (Hons) (Double Majors)   *GPA:* 3.924/4.00

- **Research advisor**: Prof.Thomas Beckers

- **Major advisors**: Prof.Gautam Biswas, Prof.Glenn Webb

- **Selected coursework**: numerical linear algebra, numerical modeling with differential equations, real and complex analysis, (scientific) machine learning, statistical inference and probability, topology, discrete math.

Research Projects

Department of Computer Science, Vanderbilt University   May 2023 – Present
Research Assistant, VUSE Summer Fellowship '23 '24   *Nashville, TN*

- Topics: Physics-Informed Bayesian Modeling with Uncertainty Quantification on Cyber-Physical Systems
- Collaborator: Kaiyuan Tan (Ph.D. Student), Mentor/PI: Prof. Thomas Beckers

- Current projects involve developing uncertainty-aware Model-Predictive Control (MPC) and outlier dynamics detection algorithms based on conformal prediction. One of the projects resulted in a paper submitted to ICRA [1] under review.
- Designed, developed, and maintained PyGpPHs, a Python package based on GP-PHS (Gaussian Process port-Hamiltonian System), that shows high accuracy, efficiency, and generalizability in modeling non-linear dynamics. This project resulted in a publication [2] in an IFAC workshop and a public, well-maintained toolbox on Github.
- Studied and expanded Bayesian modeling approaches to distributed Port-Hamiltonian System (dPHS). Collaborated in implementing GP-dPHS models. This project culminated in a publication [3] in the L4DC conference.

Department of Mathematics, Vanderbilt University   Jan 2023 – May 2023, Aug 2024 – Present
Research Assistant   *Nashville, TN*

- Project: Mathematical Modeling of Disease Biology using Dynamical Systems of ODEs/PDEs
- Mentor/PI: Prof. Glenn Webb

- Currently exploring the models of vaccine hesitation and analyzing mathematical properties of such models.
- Studied mathematical theories of disease modeling with ordinary and partial differential equations (ODE and PDE). Developed theory and the construction of population age-structured, compartmentalized systems of ODE that considers social contacts. Presented my findings and system of ODEs at Shanks Workshop on mathematical biology.

Data Science Institute, Vanderbilt University   Jan 2023 – May 2023
Research Assistant   *Nashville, TN*

- Project: Dialogic Questioning AI Product Using GPT Models for Improving Reading Comprehension among Children
- PI: Prof. Jesse Spencer-Smith, Dr. Umang Chaudhry

- Utilized Chat-GPT API for building a interactive dialogic questioning AI product. Improved the performance through prompt engineering and fine-tuning techniques.

Vanderbilt University Medical Center   Aug 2022 – Feb 2023
Research Assistant   *Nashville, TN*

- Project: Identification of Geometry-Defining Protein sub-chains using Neural Network
- PI: Dr. Richard Stein, Prof. Hassane Mchaourab

- Studied basics of protein biology and neural networks, utilized tools like Omega-fold, protein library, and dimension reduction to engineer a learning framework for identifying and analyzing geometry-defining protein sub-chain.

Services

Department of Computer Science, Vanderbilt University Aug 2022 – Present
Teaching Assistant and Grader *Nashville, TN*

- CS4262/5262: Foundation of Machine Learning, Fall 2024
- CS3251/5251: Intermediate Software Design, Spring 2024
- CS3251/5251: Intermediate Software Design, Fall 2023
- CS/DS1100: Applied Programming and Problem Solving with Python, Fall 2022

Department of Mathematics, Vanderbilt University Aug 2024 – Present
Teaching Assistant and Grader *Nashville, TN*

- Math3620/5620: Intro to Numerical Math, Fall 2024

Presentations

16th World Congress on Computational Mechanics (WCCM) Jul 2024
Oral Presententation *Vancouver, British Columbia*
- Presented our paper on PyGpPHs toolbox for Bayesian Modeling of Port-Hamiltonian Systems
- Presented our paper on Physics-Constrained Learning for PDE Systems with Uncertainty Quantified PHS

ISIS 25th Anniversary Celebration Aug 2023
Poster Presenter *Nashville, TN*
- Presented our recent work on "Bayesian Physical-Informed Models for Soft Robotics."

Shanks Workshop on Advances in Theoretical Biology and Mathematical Biology Mar 2023
Poster Presenter *Nashville, TN*
- Presented my work on Age-Structured Systems of Ordinary Differential Equation Modeling on COVID-19.

Awards and Honors

Tennessee Beta Chapter of Tau Beta Pi at Vanderbilt University (Junior Class) Dec 2023
Vanderbilt University
- Award extended to undergraduate engineering majors who are in the top 1/8 of Junior Class.

School of Engineering Award Undergraduate May 2023
Vanderbilt University
- Scholarship award to 40 excelling undergraduate students in School of Engineering.

Dean's List Aug 2021 – Present
Vanderbilt University

American Mathematics Competition Honor Roll Feb 2021
AMC10, AMC12
- Achieved top 5% score in the AMC 12 competition and AMC 12 Honor Roll; qualified for AIME.

Publications

1. K.Tan, **P.Li**, J.Wang, and T.Beckers. "PnP-PIML: Physics-informed Learning of Outlier Dynamics using Uncertainty Quantified Port-Hamiltonian Models". IEEE International Conference on Robotics and Automation (**ICRA**), 2025. (**under review**)

2. **P.Li**, K.Tan, and T.Beckers. "PyGpPHs: A Python Package for Bayesian Modeling of Port-Hamiltonian Systems". In: Proceedings of the 8th IFAC Workshop on Lagrangian and Hamiltonian Methods for Nonlinear Control (**LHMNC**). 2024. (accepted, to appear)

3. K.Tan, **P.Li**, and T.Beckers. "Physics-Constrained Learning for PDE Systems with Uncertainty Quantified Port-Hamiltonian Models". In: Proceedings of the 6th Conference on Learning for Dynamics and Control (**L4DC**). 2024.

Technical Skills

Computational Programming: Ordinary, Partial Differential Equations, Numerical Methods, Probability, Linear Algebra
Technologies/Frameworks:Python{Numpy, SciPy, Pandas, CVXOPT, Scikit-Learn, Ctype, Matplotlib, Seaborn, Pytorch} C++{algorithms, Eigen}
Languages: Python, C/C++, R, MatLab, Mathematica, Java, LaTex