LANGCHEN LIU

📞 267-584-5004 ✉ langchen.liu@yale.edu 🔗 linkedin.com/in/langchen-liu/ ⬛ github.com/DecoderLiu

Education

Yale University   **Sep 2023 – May 2026(expected)**
Ph.D. in Statistics & Data Science   *New Haven, CT*
- Coursework: Theory of Statistics, Industrial AI Applications, LLMs, Advanced Optimization. All Honors Grade.

University of Pennsylvania   **Aug 2022 – Jul 2023**
Ph.D. in Applied Mathematics and Computational Science   *Philadelphia, PA*
- Coursework: Principles of Deep Learning, Analysis I, II, Algebra I, II, Probability, Stochastic Process, GPA: 4.0/4.0.

Duke University   **Aug 2018 – May 2022**
BS in Applied Mathematics   *Durham, NC*
- Major GPA 3.98/4.0 | Coursework: More than 10 graduate courses in mathematics, Data Structures, Algorithms, Machine Learning and Deep Learning | Dean's List (2019, 2020, 2021), Merit-based Scholarship, Summer Research Scholarship (2020, 2021).

Publication

Feasibility of Federated Learning in Scientific Machine Learning (FedSciML)   **Sep 2022 – Present**
Coordinator: Handi Zhang, Lu Lu   *New Haven, CT*
- **Experiment:** Implemented federated learning in **3** mainstream in SciML(Function Approximation, Deep Operator Network & Physics-Informed Neural Network) with **4,000+ lines** Python to learn **10+** functions and differential equations (e.g. Navier-stocks); Conducted **500+** experiments, achieving average **L-2 error within 5%**.
- **Theory Proof:** Constructed mathematical proofs to define the **upper bound** of weights divergence between federated model (distributed training with heterogeneous local data) and baseline model (global data) by **O(local epochs)**.
- **Methodology Innovation:** Invented the first **quantifiable** 1-d (sequential) and 2-d (block) data partition method with **measurable** data heterogeneity by recursive uniform partition.
- **Evaluation Benchmarks:** Set the **first academic benchmarks** for federated learning on major scientific machine learning tasks.

Multicultural Emotion in Multilingual Language Models   **Dec 2022 – Apr 2023**
Coordinator: Shreya Havaldar, Sunny Rai, Bhumika Singhal, Lyle Ungar   *Philadelphia, PA*
- **Data:** Reviewed **30+** psycho-linguistic literature to select **20+** representative emotions (e.g. happy, angry) in **15+** languages (e.g. Hindi, Mandarin), transformed into embeddings by **30+** models (English and Multilingual trained).
- **Methodology Innovation:** Labeled valence-arousal emotion plane's x-axis and y-axis using **average emotion embeddings** for the first time.
- **Experiments:** Projected **9000+** emotion embeddings by **cosine similarity** with axis embeddings; Identified non-English embeddings deviates from English benchmark by 3%, revealing the failure of LLM to capture cultural differences. Wrote **99%** of the codebase to build a formal architecture from scratch and open-sourced the repository.
- **Co-authored** the paper, pubslihed in **ACL WASSA 2023**, achieving **54** citations.

Foundation Models for Autoregressive PDE Discovery   **Jul 2024 – Present**
Research Lead   *Yale University*
- **Design:** Proposed the **first zero-shot transformer-based framework** to reconstruct analytical partial differential equation from numerical solution, with encoder to process solution and decoder to generate equations.
- **Methodology:** Represented PDEs in **tree structures** and **tokenized** PDEs as natural languages. Defined cross-entropy loss function to quantify the generator performance. Aggregated **derivative and Fourier features** of the data to the model. Innovated the **step-by-step method** to enable the model to zero-shot generalize on **unseen** PDEs.
- **Implementation and Training:** Built transformer with **PyTorch** and trained on **1M+** time-dependent PDEs (e.g. Heat Equations, Diffusion Reaction), achieving **90%**, surpassing academic benchmark (DISCOVER) by **20%+**.
- **Author of the research paper:** detailing methodology, results, and implications for AI-driven physics modeling.

Service

Teaching Assistant – Probability/Statistics   **2024 Fall & 2025 Spring**
Yale University   *New Haven, CT*

Teaching Assistant – Math 105 Calculus   **2021 Fall & 2022 Spring**
Duke Kunshan University   *Kunshan, China*

Peer Tutor, Academic Resource Center   **Sep 2018 – May 2022**
Duke Kunshan University   *Kunshan, China*

Publications

- Shreya Havaldar, Sunny Rai, Bhumika Singhal, **Langchen Liu**, Sharath Chandra Guntuku, & Lyle Ungar. Multilingual Language Models are not Multicultural: A Case Study in Emotion.

Skills and Interests

- **Programming:** Python, Java, Julia, SQL, R, MATLAB
- **ML:** TensorFlow, PyTorch, HuggingFace
- **Tools:** Git, Docker, Kubernetes, AWS
- **Interests:** Physics-ML, Federated Learning, AI4Science, Foundation Models, RL, LLMs.

Honors and Awards

- Fully-funded PhD Fellowship, Yale University (2023–2028).
- Benjamin Franklin Fellowship, University of Pennsylvania (2022–2023).
- Multiple national math competition awards, including two **First Prizes** in China's National Middle School Mathematics Contest.