

# Miaomiao Dai

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## ACADEMIC HISTORY

University of Michigan at Ann Arbor

August 2024 — present

B.E. in Computer Science

GPA: 3.97/4.00

Major course: Data Structures and Algorithms (A), Introduction to Machine Learning (A), Introduction to Algorithmic Robotics (A), Robot Learning (A+), Computer Vision (A) Foundations of Computer Science (A), Computer Organization (A)

Shanghai Jiao Tong University, Shanghai

September 2022 — August 2026 (expected)

B.E. in Mechanical Engineering

GPA: 3.56/4.00

## RESEARCH EXPERIENCE

Fast Differential Dynamic Programming for Time-Optimal Trajectory Planning

July 2025 — Present

Advisor: Professor Zhongqiang Ren, Shanghai Jiao Tong University

- Developed a novel control framework that **automatically determines the optimal time horizon  $T^*$**  to solve the long-standing limitation of manual tuning in standard algorithms.
- Invented an **efficient evaluation method** capable of computing **all possible horizons in a single pass**, reducing computational complexity from  $O(N^2n^3)$  to  $O(Nn^3)$
- Outperformed prior SOTA methods, which only estimate time and are prone to failure in nonlinear cases, by returning the **exact optimal  $T^*$**  with comparable runtime.

Scalable Simulation Infrastructure for Autonomous Driving

May 2025 — August 2025

Advisor: Professor Henry Liu, Haowei Sun (Postdoc) University of Michigan, Ann Arbor

- Engineered a **scalable simulation pipeline** on the Terasim platform to generate **adversarial construction zone scenarios**, addressing the data scarcity of long-tail corner cases in urban driving.
- Developed an automated algorithm to **procedurally generate diverse construction sites** across the Ann Arbor digital map, incorporating realistic road topology and constraints.
- Implemented a robust data conversion module to standardize simulation outputs into the **Waymo Open Dataset format**.

## SELECTED PROJECTS

Deep Learning for Visual Classification & Representation | Course Project: Computer Vision

- **Built a Vision Transformer (ViT)** in PyTorch by manually implementing **patch embeddings, learnable CLS tokens, and Multi-head Self-Attention** to capture global dependencies within image data.
- Executed a **Transfer Learning** pipeline by pre-training an eight-class CNN on source domain data and fine-tuning the feature extractor for use on a binary target task, addressing data scarcity effectively.
- Optimized model generalization through **data augmentation** and rigorous **hyperparameter tuning**, such as learning rate scheduling, and weight decay, ultimately achieving a test **AUROC of 0.87**.

Neural ODE (Ordinary Differential Equation) for Planar Pushing Dynamics | Course Project: Robot Learning

- Developed a **continuous-time dynamics model** using **Neural ODEs** to capture the complex physics of robot pushing, resolving discretization errors identified in traditional Residual Networks.
- Achieved a **38% decrease in prediction errors** as compared to baseline models by designing a physics-aware **SE (2) loss function** and finetuning differential equation solvers such as DoPri5.
- Validated the model's practicality by integrating it with a **Model Predictive Path Integral (MPPI) controller**, empowering a Franka Panda robot to execute precise pushing tasks during simulation.

Large Language Model Implementation & Training (GPT) | Course Project: Natural Language Processing

- **Built a modern decoder-only Transformer** in PyTorch, incorporating state-of-the-art components including **Rotary Position Embeddings (RoPE)**, **SwiGLU activation**, and **RMSNorm** to replicate LLaMA-style architecture.
- **Pre-trained the model on 1B tokens** of the FineWeb-Edu dataset using **Mixed Precision (BF16)**, **Gradient Accumulation**, and **torch.compile** which ultimately optimized training throughput and memory efficiency.
- **Implemented Supervised Fine-Tuning (SFT)** pipeline with **selective loss masking** on the SmolTalk corpus.

## SKILLS

- **Programming Languages:** Python, C++, C, MATLAB, SQL, LaTeX
- **Deep Learning and AI:** PyTorch, OpenAI Gym, NumPy, SciPy, Pandas, OpenCV, Transformers
- **Robotics and Simulation:** PyBullet, Gazebo, SUMO, Terasim, SolidWorks, ROS
- **Tools and Platforms:** Git, Linux (Ubuntu), Docker, Waymo Open Dataset

## HONORS & AWARDS

Honorable Mention in Interdisciplinary Contest in Modeling, May 2023; **First Prize** in the 13<sup>th</sup> SJTU Liming Cup Mechanical Innovation Competition for Freshmen, May 2023; 2022-2023 **Outstanding Volunteer** of Miyuan Volunteer Team, March 2023