

# Peilin (Jack) Rao

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## EDUCATION

### University of California, Los Angeles (UCLA)

Los Angeles, CA

*Bachelor of Science, Mathematics of Computation & Bachelor of Arts, Economics*

*Sep 2022 – Jun 2026*

- **GPA: 3.98/4.00** (Major), 3.95/4.00 (Cumulative) · **GRE: 336** (V168, 99%; Q168, 81%; AW3.5, 43%)
- **Reader for Professor Randall R. Rojas's Econ 144 for Fall 2025**
- **Honors: Dean's Honors List (All eligible quarters)**
- **Selected Coursework:**
  - **Economics & Finance:** Micro/Macro Theory, Intro/Advanced Econometrics (+Lab), Data Science for Econ (+Lab), Economic Forecasting, Finance (+Lab), Financial Markets (+Lab), Investments (+Lab)
  - **Mathematics & Stats:** Real Analysis I & II, Linear Algebra, Probability Theory, Mathematical Statistics, Complex Analysis, Applied Numerical Methods, Optimization, Machine Learning
  - **Computer Science:** Data Structures, Computer Organization, Natural Language Processing (NLP)

### Nanjing Foreign Language School

Nanjing, China

*International Baccalaureate (IB) Diploma*

*Graduated Jun 2022*

- IB Score: 42/42 (Full Marks)

## RESEARCH EXPERIENCE

### A Principled Framework for Neural HJB Solver Selection (Working Paper)

UCLA

*Independent Research*

*Aug 2025 – Present*

- Initiated and led an independent project to establish a formal framework for selecting neural network architectures as numerical solvers for multi-agent Hamilton-Jacobi-Bellman (HJB) equations.
- Designed a three-stage empirical investigation using distinct economic games (e.g., Mean-Field, Sparse LQ) to reveal the trade-off between a model's approximation power and its structural bias.
- Proved theoretically that a GNN's graph convolution acts as a low-pass filter, providing implicit Lipschitz regularization essential for preventing numerical instability akin to the Runge phenomenon.
- Synthesized findings into a principled guide that links a problem's interaction structure and cost complexity to the optimal solver choice (SymmetricMLP, FFN, or GNN).

### Research Assistant, Computational Economics

Remote (CUHK)

*Advisor: Prof. Ji Huang*

*Jul 2025 – Present*

- Developing a high-performance JAX framework to solve a computationally intensive multi-agent network HJB equation, a class of problems often considered intractable.
- Architecting and implementing a fully JIT-compiled training loop using Graph Neural Networks ('jraph') to approximate the farsighted value function  $V(\mathbf{s}, \mathbf{G})$ .
- Leveraged advanced JAX primitives, including 'vmap' and vectorized broadcasting, to evaluate all counterfactual game states within a single, massively parallel forward pass, drastically reducing computation time.
- Engineered a numerically stable Bellman error loss function based on the "Division Form" of the HJB equation to ensure robust training and convergence.

### Predicting Market Troughs: A Machine Learning Approach with Causal Interpretation

*Under review at The Review of Financial Studies*

UCLA

*First Author, with Prof. Randall R. Rojas*

*Mar 2025 – Present*

- Authored a manuscript introducing a novel, comparative causal framework to demonstrate that conclusions about market through drivers are critically sensitive to econometric model specification.
- Developed a high-performance "nowcasting" model using a Support Vector Machine to resolve the data-leakage paradox in turning-point identification, achieving an out-of-sample ROC AUC of 0.89.
- Deployed a Double/Debiased Machine Learning (DML) pipeline to contrast a standard partially linear model with a flexible Average Partial Effect (APE) model, correcting economic interpretations.

- Identified the volatility of options-implied risk and market liquidity as robust causal drivers—a finding obscured by the simpler linear model—providing empirical support for intermediary asset pricing theories.

#### **Research Assistant, Labor & Trade Economics**

**Remote (Southeast University)**

*Advisor: Prof. Xin Gu*

*Jan 2024 – Present*

- Supported graduate-level research by compiling and synthesizing literature from over 20 academic papers weekly.
- Performed empirical analysis using Python, implementing multilinear regression and Difference-in-Differences (DiD) models to test economic hypotheses.
- Presented and led weekly discussions on recent research papers from top-tier economics journals.

#### **Research Mentorship on SPAC Viability**

**Remote (University of Auckland)**

*Advisor: Dr. Yequang Chi*

*Jul 2024 – Feb 2025*

- Investigated the viability of Special Purpose Acquisition Companies (SPACs) by collecting historical IPO and merger data from Capital IQ and formulating an initial microfoundational model for SPAC legitimacy.
- Concluded project after identifying critical limitations in data availability, honing ability to assess research feasibility and the importance of deep institutional knowledge.

### **ACADEMIC PROJECTS**

#### **AI Language Detector**

**UCLA**

*Course: Natural Language Processing*

*Spring 2025*

- Developed a deep learning model to differentiate between AI-generated and human-written text by engineering features using semantic embeddings (Sentence-BERT) and stylometric analysis.
- Implemented and trained a Transformer-based architecture in PyTorch, achieving 0.90 AUC and 85% accuracy on a held-out test set.

#### **Pet Image Segmentation**

**UCLA**

*Course: Machine Learning (Grade: A+)*

*Winter 2025*

- Led a team of four to build and train a U-Net, a convolutional neural network (CNN) architecture, for semantic segmentation of pets in images from the Oxford-IIIT Pet Dataset.
- Implemented the full model pipeline in PyTorch, including data preprocessing, augmentation, and training.

### **TECHNICAL SKILLS**

**Econometric & Causal Inference:** Double/Debiased Machine Learning (DML), Time Series Analysis (GARCH, State-Space Models, MiniRocket), Panel Data Methods (DiD), Bayesian Econometrics.

**Programming Languages:** Python (4 yrs; NumPy, Pandas, PyTorch, JAX), R (3 yrs), C++ (3 yrs), Matlab (1 yr).

**Data & Software:** Capital IQ, FRED, CBOE, Databento (Options & Futures), LaTeX.

**Languages:** Mandarin (Native), English (Fluent).

### **LEADERSHIP EXPERIENCE**

#### **Financial Investment and Technology (FIT)**

**UCLA**

*UCLA's student-run quantitative finance and investment group*

*Director of Data*

*Mar 2024 – Present*

- Pioneered a departmental restructuring by separating the Data and Fund teams to enhance operational specialization and manage member workload, improving project focus and output quality.
- Designed and launched a novel research workshop modeled after academic conferences to foster independent inquiry, where members pitch, develop, and present research posters on quantitative topics.
- Mentor a team of three student analysts in applying machine learning to finance; oversee all member projects to ensure methodological rigor, addressing pitfalls like data leakage and non-stationarity.
- Developed a quantitative trading model and a robust backtesting pipeline, demonstrating a 12.6% CAGR (vs. 6.01% benchmark) and validated through out-of-sample and sensitivity analysis.