Haotian MA

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Summary

AI/Algorithm Engineer focused on physics-informed learning and constraint-aware optimization, translating research ideas into robust training and evaluation pipelines for safety-critical systems. Developed hybrid physics–ML surrogate models for fast decision-making and performance forecasting, validated through large-scale scenario-based experiments. Core strengths include rigorous problem formulation, constraint-aware learning and safety guardrails, interpretable modelling, experiment-to-model data engineering, and reproducible, metrics-driven evaluation at scale.

Education

University College London London, United Kingdom
Ph.D. in Physics-Informed Multiscale Modelling 2023 – 2026

University of Warwick United Kingdom
MRes in Control Engineering 2021 – 2023

University of Nottingham United Kingdom
MSc in Electrical and Electronic Engineering 2019 – 2021

Southeast University Jiangsu, China
BEng in Energy and Power Engineering 2015 – 2019

Professional Experience

Huawei European Research Institute Nuremberg, Germany
Research Engineer (ML Algorithms) May 2023 – May 2025

- **Safety-Critical Algorithm Design and Problem Formulation**: Formulated AI-driven fast-charging control as a safety-critical constrained optimization and policy-search problem, defining objectives, hard safety constraints, offline evaluation protocols, and model interfaces aligned with existing R&D codebases.
- **Physics-Guided Data and Feature Engineering**:
  - Designed structured and versioned datasets integrating multi-source signals (electrochemical, thermal, temporal) with consistent schemas and provenance, enabling reproducible training and evaluation across platforms.
  - Implemented robust preprocessing and feature pipelines including outlier handling, temporal alignment, drift correction, and derived indicators for learning and constraint enforcement.
  - Built automated data integrity and regression checks based on monotonicity, stability, and derivative consistency to detect non-physical behaviours and prevent silent model or pipeline degradation.
- **Surrogate Modelling and Uncertainty-Aware Prediction**:
  - Developed hierarchical surrogate models combining physics-based simulators with machine learning approximations to enable fast inference and evaluation under uncertainty.
  - Achieved over 20× reduction in per-scenario inference time through surrogate coupling and structured reuse, supporting large-scale training and evaluation sweeps.
  - Applied attribution and sensitivity analysis (e.g., SHAP, gradient-based methods) to identify dominant risk drivers, translating insights into explicit safety guardrails used during evaluation.
- **Constraint-Aware Optimization and Policy Search**:
  - Designed constraint-aware Bayesian optimization and reinforcement learning workflows with explicit safety limits and experiment-ready evaluation hooks.
  - Enforced feasibility via a two-stage evaluation strategy combining fast surrogate screening with high-fidelity physics-based verification across held-out scenarios.
  - Identified reproducible multi-step control strategies meeting aggressive performance targets while maintaining safety margins under stress-test conditions.
- **ML Engineering and Evaluation Infrastructure**:
  - Built modular, reproducible training and evaluation pipelines integrating learning, optimization, and simulation to benchmark algorithms across more than 300 scenarios.

  - Developed diagnostic and visualization tools for analysing trajectories, uncertainty bounds, constraint margins, and failure cases to accelerate iteration and debugging.
  - Provided stable model and evaluation interfaces for downstream integration into validation workflows and existing project repositories.
- **Output**: Authored an internal research whitepaper, *AI-Augmented Modelling and Optimization of Fast-Charging Strategies for Composite SiC–Gr Batteries*, serving as a reference for algorithm design, evaluation methodology, and system-level validation.

Global Energy Interconnection Research Institute Berlin, Germany
Research Engineer (AI for Electrochemical Systems) Oct 2020 – Apr 2023

- **System-Level ML Modelling and Evaluation**: Developed AI-coupled modelling and optimization workflows for electrochemical energy systems, focusing on reproducible training, evaluation, and simulator-coupled experimentation under operational constraints.
- **ML Modelling, Surrogates, and Explainability**:
  - Developed predictive models including physics-informed neural networks, Gaussian process regressors, and gradient-boosted models to map fabrication parameters and operating conditions to voltage efficiency, loss components, and degradation-sensitive metrics.
  - Designed surrogate-assisted evaluation pipelines enabling rapid exploration of high-dimensional design spaces while preserving physical consistency through simulator validation.
  - Conducted SHAP-based global sensitivity and attribution analysis to identify dominant contributors to system performance, supporting model validation and design decision-making.
  - Implemented uncertainty-aware prediction and comparative evaluation to assess model robustness across operating regimes and data subsets.
- **Optimization and Experiment-Driven Evaluation**:
  - Applied Bayesian optimization within physics-constrained design spaces to recommend fabrication and operating parameter settings, achieving validated performance improvements in simulation-based studies.
  - Designed closed-loop experiment–model workflows where experimental results were iteratively incorporated into model retraining and evaluation.
  - Defined evaluation metrics, baselines, and ablation protocols to compare alternative modelling and optimization strategies in a controlled and reproducible manner.
- **Data Engineering and Training Pipelines**:
  - Built automated data acquisition, synchronization, and versioning pipelines linking electrochemical test benches with real-time logging systems, generating more than 10,000 high-resolution samples per experimental run.
  - Implemented signal processing workflows including impedance smoothing, baseline correction, feature normalization, and consistency checks to improve data quality and downstream model performance.
  - Established structured train/validation/test splits and regression checks to ensure repeatable training and evaluation across experiments and model iterations.
- **Simulation Integration and Scalable Evaluation**:
  - Integrated machine learning surrogates into dynamic electrochemical system simulators (Simulink-based), enabling fast evaluation loops and large-scale scenario sweeps.
  - Achieved over 15× computational speedup in evaluation while maintaining alignment with physics-based reference models.
  - Developed diagnostic visualizations and analysis tools to inspect prediction errors, uncertainty bounds, and failure cases across scenarios.
- **Output**: Delivered an integrated AI-enabled modelling, optimization, and evaluation workflow adopted as a reference methodology for electrochemical system design and performance analysis across GEIRI research units.

Publications

- **GAN-Augmented Data-Driven Performance Prediction of Membrane Electrode Assemblies in PEM Electrochemical Systems**: Haotian Ma, Jinman Zhao, Shangfeng Du, Leandro L. Minku, Georgios Nikiforidis. (2025). *IEEE International Conference on Environment and Electrical Engineering (EEEIC 2025)*. (Best Paper Nomination).
- **A Distribution Network State Estimation Method With Non-Gaussian Noise Based on Parallel Particle Filter**: Haotian Ma, Wen Sheng, Kai Liu. (2023). *IEEE Access*, 11, 133034–133048.
- **Multiscale Modeling and Electrochemical Validation of PEM Electrolyzer-Coupled Hybrid Energy Storage Systems**: Haotian Ma, Georgios Nikiforidis, Shangfeng Du. (2025). *IEEE Global Power, Energy and Communication Conference (GPECOM 2025) Proceedings.*
- **System Modelling and Sizing Optimization of PEM-Integrated Hybrid Energy Storage for Data Centre Resilience**: Haotian Ma, Georgios Nikiforidis, Catalina Spataru. (2025). *IET Conference on Energy Systems and Power Engineering (ESPE 2025)*, paper 56.

- **Technical and Economic Performance Assessment of Blue Hydrogen Production Using a New Configuration Through Modeling and Simulation**: Yiming Li, Jiayi Ren, Haotian Ma, A. N. Campbell. (2024). *International Journal of Greenhouse Gas Control*, 134, 104112. DOI: 10.1016/j.ijggc.2023.104112.

Manuscripts Under Review / In Preparation

- **Manuscript under review**: Haotian Ma, Co-authors. *AI-Augmented Modelling and Optimization of Fast-Charging Strategies for Composite SiC–Graphite Batteries*.
- **Manuscript in preparation**: Haotian Ma, Co-authors. *Physics-Informed Surrogate Modelling for Safety-Critical Battery Fast Charging under Distribution Shifts*.

Academic Service

- **Reviewer (ad hoc)**: IEEE Access; IET Energy Systems; related venues.
- **Research Mentoring**: Mentored junior researchers and interns on experimental data curation, model validation, and reproducible training/evaluation protocols.

Talks & Presentations

- **Conference & Professional Presentations**: Oral presentation: *Electrochemical Modelling and Experimental Validation of Proton Exchange Membrane Water Electrolysers for Loss Decomposition and Techno-Economic Assessment* (CIGRE-UK University Hub, Imperial College London). Poster presentation: ML-guided MEA performance prediction and optimization (Poster Award, CSCST–SCI Conference).
- **Invited / Internal Talks**: Internal technical seminars on physics-informed surrogate modelling, uncertainty-aware prediction, constraint-aware optimization, and large-scale evaluation workflows.

Patents

- **Patent application (in preparation)**: *Constraint-Aware Fast-Charging Protocol Optimization with Physics-Based Safety Guardrails*.

Awards & Certifications

- **MIT Professional Education — Applied Data Science & Machine Learning (2024)**: Professional certification covering statistical learning, time-series modelling, neural architectures, optimization, and end-to-end ML engineering.
- **European JESS Summer School — Fuel Cell, Electrolyser, and Battery Technology (2023)**: Advanced training in electrochemical systems and multiscale modelling used across EU R&D programmes.
- **Outstanding Graduate Award**: Outstanding Bachelor Graduate at Southeast University (2019).
- **International Competition — Second Prize**: Team leader, 2018 Schneider "Go Green" Global Innovation Challenge; national second prize among >2,000 teams.
- **Research Presentation Award**: Poster award at the 29th CSCST-SCI Conference on ML-guided MEA prediction and optimization.
- **National & University-Level Awards**: Recipient of 20+ awards, including Second Prize in the 2018 "Challenge Cup" Entrepreneurship Competition and Third Prize in the 11th National Energy Conservation & Emission Reduction Competition.