Professional Summary

Decision-focused ML + Optimization for real-time industrial systems. I build long-running, portable, maintainable closed loops across prediction, optimization, control, and deployment. I enforce **hard-constraint safety** (feasible-set tightening, two-layer protections) and design modular, config-driven, decoupled, hot-updatable services with gray release, rollback, monitoring, and audit. My first-author work appears in *IEEE TSG* (Q1/TOP) and *ESWA* (Q1), with multiple DFL/PtO manuscripts under review.

Shunyu Wu

Decision-Focused ML • Optimization • Forecasting

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Research Highlights

- **Stability in DFL**: Characterized unstable training near piecewise-constant argmin maps; proposed variational free-energy regularization and proximal descent with inexact surrogate gradients for deployment-consistent training.
- **Constrained PtO**: Extended DFL to *learned constraints* via dual-gap regret and explored feasibility-preserving neural solvers ("projection-to-envelope") without labels.
- **Deployable pipelines**: Coupled graph/physics-informed surrogates with LP/MILP optimizers into end-to-end systems for power and water; emphasized feasible-set tightening, two-layer protections, config-driven services, auditability, and cross-site replication.

Power Plant Projects

China Coal Group —Intelligent Operation Optimization for Coal-Fired Units **Leader** 2024–Present

- Context & Objective： Fangchenggang Power Plant (Guangxi). Closed-loop optimization over setpoints (coal feed, primary/secondary air) under variable coal blends and frequent load swings to improve heat rate while respecting environmental and hardware limits.
- Key Metrics： Equivalent heat rate; constraint violations (rate/duration) on NOx, flue-gas temperature, tube-metal temperature; release success/rollback rates; operator adoption.
- Data & Signals： DCS/historian integration; anomaly handling and drift correction; features for load zoning, coal-quality profile, air distribution, combustion state, and equipment health.
- Modeling： Robust optimization with **hard constraints**; feasible-set tightening with condition-adaptive margins; local surrogate models to mitigate cross-domain shift; dual/implicit–prox routines for stable training and solving.
- Engineering & Release： Train–inference–optimization decoupling; YAML/Redis for parameters/templates; gray release with hot updates and rollback; offline replay before release; metrics dashboard, alerts, and audit trail.
- Results： Fuel-specific consumption **≈1.5%**↓; constraint violations **≈45%**↓; strategy switch latency **≈60%**↓; operator workload notably reduced.
- Role： Owned PRD and technical roadmap; coordinated cross-functional teams (data/control/O&M); defined A/B and boundary tests; delivered runbooks and training; drove templated replication.

TBEA —Closed-loop Efficiency Control across Multi-Units **Leader** 2024–Present

- Context & Objective：Cross-site (Zhunneng & washixia) deployment with tag/interface differences and model bias. Unified heat-rate improvement with strict NOx and tube-metal temperature limits; rapid cross-unit transferability.
- Key Metrics： Heat-rate ↑; specific coal consumption ↓; migration efficiency (deployment cadence/template reuse) ↑; rollbacks ↓.
- Data & Signals： Site-specific tag mapping and interface normalization; features for load zoning, fuel quality, airflow/temperature; cross-site parameter templates.
- Modeling： Load-zone parametric surrogates + online MILP; two-layer protections (hard-threshold immediate update; soft-threshold boundary tightening); wide-margin calibration during transfer with autoregressive drift checks.

- Engineering & Release： Decoupled inference/optimization/release/monitoring; YAML/Redis parameterization; versioned logs + hot updates; historical scenario bank for pre-release validation and continual learning.
- Results：Heat-rate **≈1.6%–2.0%**↑; coal consumption **≈1–3 g/kWh**↓; operator tuning workload **≈50%**↓; faster new-unit onboarding.
- Role： Led architecture and modeling; secured data integration and fallbacks; established SLOs/alerts and fault-tree logging; aligned contractual KPIs and review cadence.

TBEA —Intelligent Sootblowing **Co-Leader** 2024–Present

- Context & Objective：Fast load ramps cause soot deposition on heating surfaces. Built a physics-based cleanliness index and policies for timing and lance selection, coordinated with the efficiency loop.
- Key Metrics： Flue-gas temperature variance ↓; steam usage ↓; policy trigger rate and window-compliance ↑.
- Data & Signals： Sensor drift correction; features for surface regions, load transitions, and temperature recovery curves.
- Modeling：Benefit modeling with timing optimization under mutual-exclusion and min-gap constraints; state estimation and tiered priorities for intensity/order; risk-stratified triggering to avoid over-firing.
- Engineering & Release： Configurable windows and intensity; decoupled interface from efficiency loop for rapid integration and hot updates; offline replay validation.
- Results：Flue temperature variance **≈25%**↓; steam usage **≈10%**↓; improved transparency and operator trust.
- Role： Designed cleanliness index and thresholds; integrated with the efficiency loop; led on-site acceptance/operations; authored developer/deployment/communication manuals.

Water Utility Projects

Shanghai Chengtou Water —One-Plant–Two-Stations Optimization **Algorithm Leader** 2019–2022

- Context & Objective： Huangpu demo zone. Optimize pump on/off and outlet pressures to balance energy, pressure compliance, and equipment longevity; end-to-end SCADA integration with zero-interruption rollout.
- Key Metrics： Peak energy ↓; pump switches ↓; pressure compliance ↑; fault/false-alarm rate ↓.
- Data & Signals： SCADA integration and parameter identification; features for daily/weekly periodicity, demand series, and pressure–flow families.
- Modeling： Forecast–optimize pipeline: intra-day demand forecasting + mixed-integer optimization under node pressure/flow constraints; accuracy monitoring with self-updates.
- Engineering & Release：Modular interfaces for SCADA/EPANET/strategy engine; config-driven templates; hot updates/rollback and policy replay.
- Results： Peak energy **≈10%**↓; pump switches **≈20%**↓; pressure compliance **≈3%**↑; reduced operator workload.
- Role：Built the integrated model, designed strategies/thresholds, led deployment and acceptance, delivered training and manuals.

Shanghai Chengtou Water —Resilient Control for Urban Drainage **Co-Algorithm Leader** 2022–2024

- Context & Objective： Combined-sewer Phase I. Robust scheduling and anomaly handling for inflow shocks and sensing faults to maintain controllability under disturbances.
- Key Metrics： Overflow volume ↓; false-alarm rate ↓; response latency ↓.
- Data & Signals： Anomaly/missing-data detection and repair; redundant critical signals and voting features.
- Modeling： Anomaly-aware robust forecasting and optimization; redundant thresholds with voting on critical KPIs to reduce false alarms.
- Engineering & Release：Configurable scenario/policy template library; decoupled SCADA and strategy engine; audit logs and replay; weekly regression and post-mortems.
- Results： Under 1-in-5-year storms, overflow **≈21%**↓ vs. baseline; overall risk measurably reduced.
- Role：Designed policy/threshold systems; led integration and regression; curated anomaly knowledge base.

Publications

First-Author

- Wu, S., Wang, J., Xu, H., *et al.*. *End-to-End Stochastic Predict-then-Optimize for Cost-efficient Water–Energy Resource Scheduling*. *IEEE Transactions on Smart Grid*, accepted, 2025 **【Q1 / TOP / flagship】**
- Wu, S., Wang, J., Xu, H., *et al.*. *Knowledge-based Bi-correction Model for Lag-free Daily Urban Water Demand Forecasting*. *Expert Systems with Applications*, 2024, 255: 124508 **【Q1 / TOP】**
- Wu, S., Wang, J., Xu, H., Zhao, S., Xu, J.. *CritiCoder: End-to-End Uncertain Regression for Robust Macroscopic Pressure Models in WDN*. *IEEE Transactions on Computational Social Systems*, 2023, 11(2): 2222–2233 **【CAA A recommended】**

Under Review / In Preparation

- Wu, S., Wang, J., Geng, H.. *Crossing the Separation Point: Stabilizing Decision-Focused Learning with Variational Free-Energy*. *NeurIPS (Under Review)*, 2025 **【CCF A】**
- Wu, S., Wang, J., Rao, J., Xiao, X., Cai, H.. *Proximal Descent for Stable Decision-Focused Training with Inexact Surrogate Gradients*. *NeurIPS (Under Review)*, 2025 **【CCF A】**
- Wu, S., Wang, J., Rao, J., Wang, H., Xiao, X.. *Planning the Invisible: End-to-End Sensor Deployment Regret Minimization for Anomaly-Aware Water Networks*. *AAAI (Under Review)*, 2026 **【CCF A】**
- Wu, S., Wang, J.. *Beyond Objective Parameters: Parametric Dual-Gap Regret for Predict-then-Optimize under Unknown Constraint Parameters*. *ICLR (planned; in revision)*, 2026
- Wu, S.. *Projection-to-Envelopes Solver for Constrained Optimization*. *In preparation*, 2026

Collaborations (all Q1/TOP or IFAC)

- Xu, J., **Wu, S.**, *et al.*. *Reinforcement learning controller design for discrete-time-constrained nonlinear systems with weight initialization*. *IEEE Transactions on Systems, Man, and Cybernetics: Systems*, 2024, 54(4): 2368–2378 **【Q1 / TOP】**
- Zhong, Y., **Wu, S.**, *et al.*. *Prediction of energy consumption in hot rolling with TDADE*. *IEEE Transactions on Automation Science and Engineering*, 2023, 21(1): 555–568 **【Q1 / TOP】**
- Xu, J., **Wu, S.**, *et al.*. *Adaptive dynamic programming for optimal control of discrete-time nonlinear systems*. *IEEE TSMC: Systems*, 2023, 54(3): 1489–1501 **【Q1 / TOP】**
- Zhong, Y., **Wu, S.**, *et al.*. *Series-concatenation hybrid prediction for hot strip roughing with multi-step rolling*. *IEEE T-ASE*, 2023, 21(3): 4585–4598 **【Q1 / TOP】**
- Kan, T., Wang, J., **Wu, S.**. *The CEEMDAN-ps-gcGRU Model On Water Pressure Prediction With Strong Irregularity*. *IFAC-PapersOnLine*, 2023, 56(2): 7108–7113 **【IFAC World Congress / control top venue】**

Awards

2024	ABB Intelligent Technology Innovation Competition —**National 1st Prize**	1/194
2023	Shanghai Jiao Tong University —**Excellent Graduate Scholarship**	6/208
2023	Shanghai Jiao Tong University —**Merit Student**	Top 3%
2022	Shanghai Jiao Tong University —**Outstanding Graduate**	Top 15%
2019	Nanjing University of Science and Technology —**Outstanding Graduate**	Top 15%
2018	Jiangsu Province —**Advanced Class Collective**	Top 10%

Leadership & Service

2019–Present **Reviewer** ICLR, AAAI, CDC, IFAC; IEEE TSMC, TASE, TIV
Focus on PtO/DFL, optimization & control, industrial AI, time-series forecasting.

2020–Present **Mentoring** SJTU / Xi'an Tech Univ. / North Univ. of China
Assisted advisor in mentoring 1 Ph.D. and 13 M.Sc.; supported topic design, engineering application.

2022–2024 **Party Branch Secretary (PhD cohort)** Shanghai Jiao Tong University
Translating latest guidelines into actionable activities and measurable participation.

2015–2019 **Class President (Undergrad)** Nanjing University of Science and Technology
Coordinated student interests with school mandates; organized competition/volunteer tracks.

Education

Apr. 2022–Present **Ph.D.** in Control Science and Engineering Shanghai Jiao Tong University
Sep. 2019–Mar. 2022 **M.Sc.** in Control Engineering Shanghai Jiao Tong University
Sep. 2015–Jun. 2019 **B.Eng.** in Automation Nanjing University of Science and Technology

Skills

- **Languages**: Python, MATLAB, C
- **ML/Modeling (tools)**: PyTorch, TensorFlow/Keras, scikit-learn, XGBoost/LightGBM, NumPy/Pandas, PyTorch Geometric, DGL, NetworkX, DeepXDE
- **Optimization**: LP/MILP, robust/stochastic, bi-level/bi-parametric, setpoint optimization; Gurobi, Pyomo
- **Systems & Integration**: modular/config-driven services, decoupled pipelines, hot updates, gray release, audit/rollback; EPANET/Toolkit, SCADA, Redis, Docker, Git, Linux