YILONG DAI

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RESEARCH INTERESTS

My research is in **AI for Science**: I build machine learning methods that make large-scale scientific simulation faster and more reliable, while respecting the physical laws that govern it. I am especially interested in learned solvers for partial differential equations and turbulence, and in how generative modeling can bring accuracy, physical consistency, and uncertainty awareness to scientific computing.

EDUCATION

University of Alabama (UA) — Tuscaloosa, AL
Ph.D. in Computer Science — Advisor: Prof. Runlong Yu — *Aug 2025 – Present*

University of Florida (UF) — Gainesville, FL
M.S. in Computer Science — *Aug 2022 – Dec 2024*

Xi'an Jiaotong University (XJTU) — Xi'an, China
B.E. in Software Engineering — *Sept 2018 – June 2022*

PUBLICATIONS

Physics-Preserving Latent Compression for Zero-Shot Resolution Transfer in 3D Turbulence — ***Y. Dai***, *Y. Sun, Y. Chen, Z. Wang, S. Chen, X. Jia, R. Yu* — ICDM 2026

- Compressed turbulence with a shared per-patch VAE rather than a whole-field model, so the learned representation is independent of grid size and transfers zero-shot from 256^3 training fields to 1024^3 without retraining.
- Kept physical diagnostics (dissipation, enstrophy, energy spectra, incompressibility) faithful under compression via exact mean preservation, an invertible Haar wavelet front-end, and shift-consistency regularization.

Flow Learners for PDEs: Toward a Physics-to-Physics Paradigm for Scientific Computing — ***Y. Dai***, *S. Chen, X. Jia, R. Yu* — KDD 2026

- Reframed learned PDE solving as modeling transport over physically admissible futures rather than regressing states, placing PINNs, neural operators, and diffusion solvers under one lens.
- Cast the solver as a transport vector field integrated over time, which yields continuous-time prediction and uncertainty quantification for free—properties a state-regression solver cannot offer.

Learning PDE Solvers with Physics and Data: A Unifying View of PINNs and Neural Operators — ***Y. Dai***, *S. Chen, Z. Wang, X. Jia, Y. Xie, V. Kumar, R. Yu* — IJCAI 2026

- Unified Physics-Informed Neural Networks and Neural Operators in a single design space along three axes: what is learned, how physics is integrated, and how computation is amortized across instances.
- Used this framing to expose the structural trade-offs and blind spots that distinguish the two paradigms and to identify where each is the right tool.

FlowRefiner: Flow Matching-Based Iterative Refinement for 3D Turbulent Flow Simulation — ***Y. Dai***, *Y. Sun, Y. Chen, S. Chen, X. Jia, R. Yu* — SDM 2026

- Swapped the stochastic denoising of diffusion refiners for deterministic ODE-based correction under one velocity-field objective shared across stages, removing sampling variance from the refinement loop.
- Decoupled the noise schedule from refinement depth so the correction stays in a stable small-noise regime no matter how many refinement steps are stacked.

TIDE: A Physically Diverse 3D Turbulence Benchmark Dataset for Advancing Scientific Machine Learning — ***Y. Dai***, *Y. Sun, Y. Chen, S. Chen, P. Givi, X. Jia, R. Yu* — KDD 2027

- Built a physically diverse, DNS-verified 3D turbulence corpus that varies the physical regime under a fixed solver and acceptance standard, so a model that learned the dynamics can be told apart from one that fit a single flow.
- Designed a benchmark that scores generalization along named physical axes with physical-fidelity metrics beside pointwise error, exposing a missing conditioning input in current neural operators.

*Additional publications in LLMs, vision-language models, and computer vision (**NeurIPS 2026 Oral**, EMNLP 2025, DIS 2026, NeurIPS 2025 Workshop, CEUS 2025, and others) available on Google Scholar.*

HONORS & AWARDS

- **NeurIPS 2026 Oral Presentation** — *Language-Conditioned World Modeling for Visual Navigation*
- **SDM 2026 Travel Award** — *FlowRefiner: Flow Matching-Based Iterative Refinement for 3D Turbulent Flow Simulation*

INDUSTRY EXPERIENCE

Bosch — Software Engineer Intern Shanghai, China
Vehicle-simulation models and web tooling (Python, JavaScript) *Apr 2023 – Aug 2023*

China UnionPay — Software Engineer Intern Shanghai, China
User-profile credit-scoring model; log-monitoring system migration (Java, Python) *Aug 2021 – Oct 2021*

TECHNICAL SKILLS

Programming: Python, C++
ML / Scientific: PyTorch, JAX, NumPy / SciPy; neural operators, diffusion / flow matching, PINNs, transformers
Compute / Tools: Linux, Git, HPC / SLURM, distributed & mixed-precision training, LaTeX