AI/ML in Astrophysics Research (& AI/ML STIG)

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On behalf of the NASA AI/ML STIG

The University of Texas at Austin
Center for Gravitational Physics

What are different types of AI/ML tools?

1. Classical ML: Random forests, gradient boosting, and Gaussian processes, useful for tabular catalogs and small datasets

2. Deep learning: CNNs for images, transformers and RNNs for time series and spectra, graph neural networks for point clouds such as galaxies, particles.

3. Generative and probabilistic models: normalizing flows, diffusion models, which learn full distributions rather than single predictions.

4. Self-supervised and foundation models: representations learned from large unlabeled datasets and reused across tasks, such as multimodal models linking images and spectra.

5. LLMs and agents: literature search, coding assistance, and autonomous research workflows.

Where AI/ML shows up in astrophysics research

1. Instruments and data: real-time detection, denoising, and artifact rejection. Examples include spectral cleaning, glitch mitigation in LISA and interference flagging.

2. Signal discovery: transient classification in alert streams (Chandra, and Rubin), strong lens finding (Euclid, Roman), candidate vetting, and anomaly detection for the unexpected.

3. Inference: simulation-based inference and neural posterior estimation. Examples include rapid redshift estimation, cosmological parameter estimation, likelihood free inference

4. Emulator for simulations: emulators that replace expensive codes, super-resolution simulations, and learned baryonic physics.

5. Research acceleration: LLMs for literature synthesis and code, and agents that run analyses.

Best practices

1. Watch for domain shift from simulations to real data

2. Validate uncertainties with calibration and coverage tests, not just accuracy.

3. Start with simple baselines (don’t use a bulldozer to hit a nail)

4. Keep physics in the loop.

NASA AI/ML STIG

(Science & Tech Interest Group)

Official website

https://science.nasa.gov/astrophysics/programs/cosmic-origins/community/artificial-intelligence-machine-learning-science-technology-interest-group-ai-ml-stig/

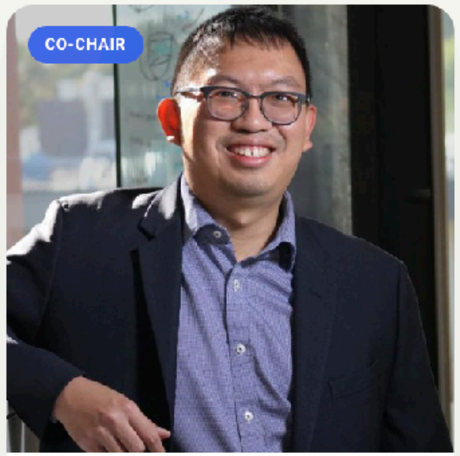
Community website

https://ai4astro.org/

NASA AI/ML Science & Tech. Interest Group

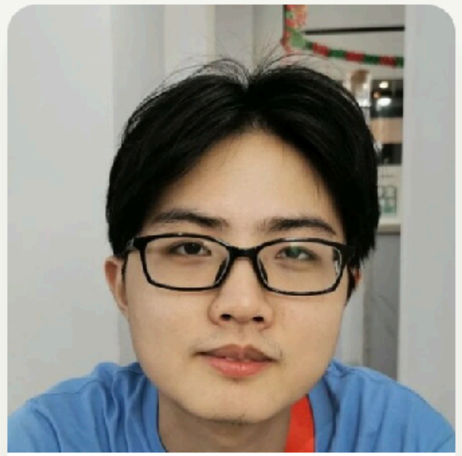
2026–2027 Leadership Council

Co-chairs and working council for the upcoming lecture year.



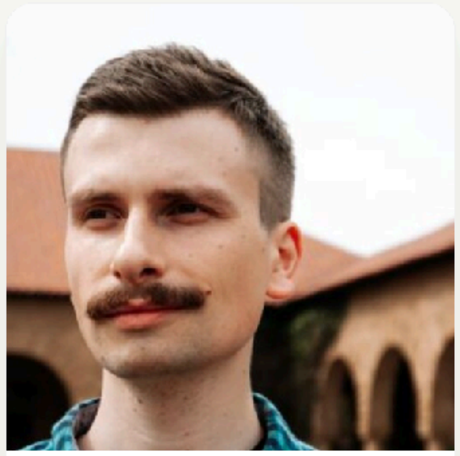
Yuan-Sen Ting
The Ohio State University

Jay Wadekar
University of Texas at Austin



Ce Sui
The Ohio State University

Tri Nguyen
Northwestern University



Artem Poliszczuk
Stanford University

Julie Rolla
NASA Jet Propulsion Laboratory

Advisory Council

Senior advisors supporting the direction and continuity of the program.

Moritz Münchmeyer
University of Wisconsin–Madison

Bhuvnesh Jain
University of Pennsylvania

Kelle Cruz
Hunter College, CUNY

AI for astronomy: gaps and opportunities

- AI/ML tools are widely available and becoming increasingly powerful, but adoption in astronomy lags

- The main barrier is training, not access to tools
(NSF white paper https://arxiv.org/pdf/2509.02661)

- The opportunity: a community that understands these tools can open new discovery space and boost the science return of NASA missions.

Year I activities

- 25 lectures by a range of ML+Astro researchers, 8 modules
- Most speakers gave talks based on curated pedagogical Jupyter Notebooks + companion slides
- Lecture content uploaded on our community website: https://ai4astro.org/
- Curated from the STIG's lecture series, we made a textbook at https://deeplearning4astro.com/ arXiv:2606.30855

Themes for year II

1. Agentic AI basics and applications

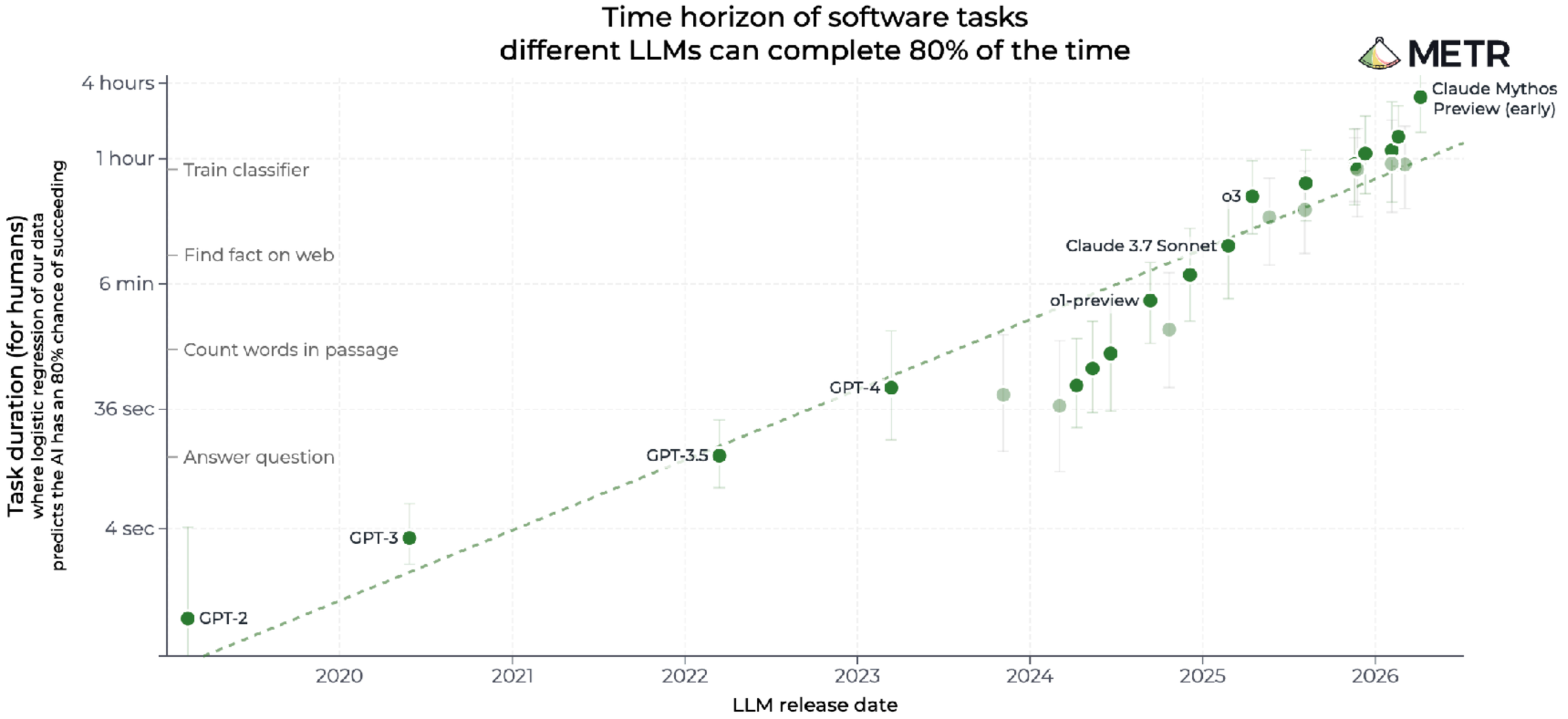
2. AI for scientific instrumentation

3. AI policy and collaboration opportunities

4. AI applications to upcoming astronomical survey data

5. Interactive sessions and town halls

Duration of tasks AI can do autonomously



Agentic AI discoveries in math

1. Olympiad to research-level in ~1 year
2. Multiple Erdos problems resovlved, including the unit-distance conjecture
3. Millennium-prize problem: Navier-Stokes

Applications to astrophysics

1. End-to-end multi-agent research assistant (e.g., Denario, 2510.26887)
2. CMBAgent wins FAIR Universe competition
3. Mephisto (Sun, Ting et al.): LLM agents for SED fitting to JWST Little Red Dots
3. gwAgent (Islam, DW et al. 2026): agents discovering interpretable analytic surrogates
4. Benchmarks: ReplicationBench (can agents replicate astro papers), Stargazer (model fitting), AstroMLab (Ting et al.), AstroVisBench, gwBenchmarks (Islam, DW et al.)

Our fall schedule

Date	Theme	Speakers
Sep 14 2026	Foundations of LLM agents and state of the art	Josh Speagle
Sep 21 2026	hands-on session on using agentic tools	Christopher Stubbs
Sep 28 2026	hands-on session II	Serat Saad
Oct 5 2026	Transformers, attention, and pre-training	Josh Nguyen
Oct 12 2026		NO MEETING
Oct 19 2026	Finetuning and reinforcement learning	Moritz Munchmeyer
Oct 26 2026	Retrieval and memory (RAG and beyond)	Kartheik Iyer
Nov 2 2026	Tool use, MCP	
Nov 9 2026	Skills for domains	Kelle Cruz
Nov 16 2026	Multi-agent systems and orchestration	Boris Bolliet
Nov 23 2026		NO MEETING
Nov 30 2026	Ethics and challenges of agentic AI	Paul Ginsparg
Dec 7 2026	Mechanistic interpretability	

Feedback on STIG is welcome

- Should the technical depth of the talks be adjusted?
- Any additional topics you'd like us to cover?
  More NASA specific applications?
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