Scientific software.
Evidence you can inspect.

SELECTED PROJECTS / MD ASHRAFUL ISLAM

A selection of public scientific software for research and engineering teams. These educational prototypes make assumptions, reference checks and limitations visible. They provide a practical starting point for collaborative work in scientific computing and empirical AI evaluation.

maiphysics.com/portfolio

01 / Heat diffusion

WORKING NUMERICAL DEMONSTRATION

Question. Does a numerical solution approach a known analytical answer as the grid is refined?

Method. An explicit forward-time, centred-space scheme solves a one-dimensional heat equation on 0 ≤ x ≤ 1. Endpoints remain zero. The initial profile is sin(πx); diffusivity is 0.4 and the stability ratio r is 0.4. All quantities are nondimensional.

$$u_t = 0.4\, u_{xx}; \quad u(x,t) = \exp(-0.4\pi^2 t)\sin(\pi x)$$

Reference check at t = 0.2

Grid intervals N	Time steps	Maximum absolute error
20	80	0.00103579537746
40	320	0.000258232570795
80	1,280	0.0000645135652161

Halving grid spacing reduces the maximum error by approximately four each time in this case. The comparison checks numerical convergence against an independent analytical expression.

LIMIT

This is a finite-difference solver. It contains no trained neural network and is not calibrated to a particular material or experimental apparatus.

Reproduce. Run the public model with N = 20, 40 and 80 and the step counts above. Maximum errors were recomputed from the current model on 5 November 2026.

Demo: maiphysics.com/#synthetic-lab
Source: maiphysics.com/heat-solver.js

02 / Synthetic sensing

WORKING SIMULATION / KNOWN GROUND TRUTH

Question. When can correcting a known bias make an individual prediction less accurate?

Method. A simulated rectangular object moves at constant speed. Partial visibility shifts its visible centroid; latency shifts its observation time. A deterministic sinusoidal disturbance is added. The model corrects the known visibility and timing offsets, then compares its prediction with the object's position 0.2 seconds into the future.

Check. By construction, corrected signed error equals the imposed disturbance, up to floating-point rounding. This is an algebraic identity within the simulation; it does not establish sensor accuracy.

A counterexample to "correction always helps"

Use zero latency and no occlusion. At the time below, the disturbance reaches +12 mm. The raw estimate benefits from cancellation between that disturbance and a -8 mm timing offset.

Parameter	Value
Speed	40 mm/s
Latency / occlusion	0 seconds / 0%
Disturbance amplitude	12 mm
Observation time	Approximately 0.288934 seconds
Prediction horizon	0.2 seconds

Quantity	Signed prediction error
Raw estimate	+4 mm
After known-bias correction	+12 mm

The correction removes the -8 mm timing offset and exposes the full +12 mm disturbance. The absolute error therefore increases from 4 to 12 mm in this example. A credible evaluation must retain such cases.

LIMIT

This demonstration has no physical sensor, trained vision model or robot controller. Motion, geometry and disturbance are supplied by the simulation. The behaviour is educational, not a measured deployment result.

Counterexample recomputed from the public model on 5 November 2026.

Demo: maiphysics.com/robotics-sensing
Source: maiphysics.com/robotics-model.js

03 / Search and verification

WORKING EDUCATIONAL SAT LAB

Question. How does checking a proposed answer differ from searching for one?

Method. The browser lab enumerates Boolean assignments for finite satisfiability examples. Step controls expose the search, while counters record assignments, clauses and literal inspections. A proposed assignment can be checked separately and the run exported as JSON.

Check. In a deliberately structured six-variable example, enumeration reaches 64 candidate assignments and 384 literal inspections. The unit-clause structure also permits an immediate shortcut. That contrast shows why a count for one chosen algorithm is not an algorithm-independent lower bound.

> **LIMIT**
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> The examples are small and intentionally constructed. They illustrate search, certificates and algorithm choice; they do not resolve P versus NP or establish general scaling.

Demo: maiphysics.com/p-vs-np
Source: maiphysics.com/complexity-model.js

Proposed next study

Independent checks for AI-generated physical simulations

Build a bounded task set with independently checkable physical answers. Compare direct generation, explicit assumption recording and independent verification. Vary units, boundary conditions and initial conditions; measure numerical correctness, false acceptance and failure detection on held-out cases. Publish task definitions, prompts, model versions, all outcomes and the analysis.

This AI evaluation study is proposed. The existing numerical demonstrations provide starting examples; no model-improvement or AI-safety result is claimed.

Contribution and working practice

Ash defines questions, model assumptions and validation plans; directs AI-assisted implementation; reviews outputs; and develops the scientific explanation. The portfolio and its presentation were prepared with AI assistance. The examples distinguish executable behaviour, measured checks and future research plans.

Contact. projects@maiphysics.com
Full portfolio. maiphysics.com/portfolio