



ISP 2027

Project ideas

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The Pingry School

Browse the ideas. Reach out.

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An invitation to explore



Let me introduce myself: I'm Mike Andrews P'28, an ISP mentor. I love building systems and exploring ideas, and hope you'll join me.

My lifelong career connects mathematics, physics, computing, data, and algorithms. It has taken me from atomic, molecular, and optical physics at MIT to quantum and wireless physics at Bell Labs here in New Jersey, and into AI, cybersecurity, quantitative finance, and technology leadership. Across research and industry, I've enjoyed turning ideas into experiments, models, and working systems.

I'm offering mentorship, not an internship or externship. The focus is you: your interests, questions, and growth. We'll explore for the pleasure of learning and discovery. I'll offer guidance, feedback, and help along the way.

These ideas are starting points; bring your own, too. Together we'll shape a manageable, inquiry-based learning project that you design and lead.

Requirements

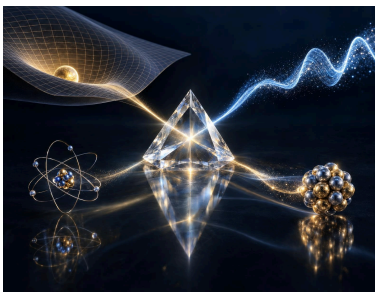
- Communicate: share progress, ask questions, and flag obstacles early.
- Take initiative: bring ideas, follow your curiosity, and try new approaches.
- Manage your time: set realistic goals and follow through on commitments.
- Be prepared and punctual: arrive ready to discuss your work and next steps.
- Collaborate: listen, welcome feedback, and contribute your own perspective.
- Be honest: show unfinished work, acknowledge uncertainty, and credit sources and help.

I'll bring the same reliability, curiosity, and openness to our work together. Ideally, we'll meet regularly at Pingry and stay in touch by email, text, phone, Zoom, FaceTime, Google Meet, or whatever else we decide works best.

Looking forward to working with you!

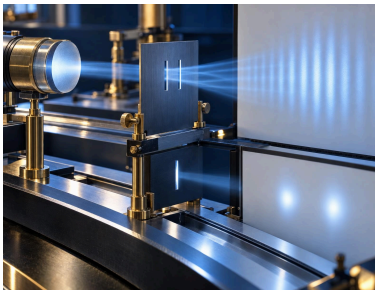
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Physics and the nature of reality



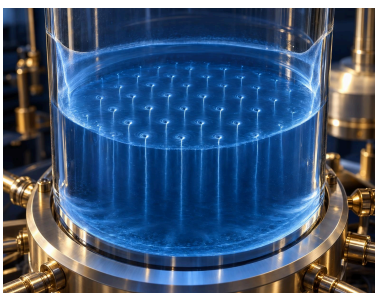
Theories of Everything

Can all the fundamental forces and laws of physics be unified into a single framework? Explore the competing approaches to a "theory of everything," the mathematical ideas behind them, and why reconciling quantum mechanics with general relativity remains so difficult.



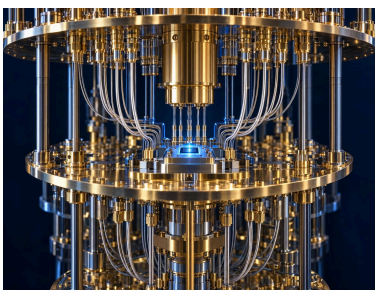
Where Do the Rules of Physics Come From?

Could familiar physical rules follow from a few requirements about how observations combine? Build a small rules laboratory comparing classical probability with a simple quantum-interference model. Vary assumptions about how alternative paths and successive steps combine, and explain which outcomes depend on which assumptions and how they might be checked experimentally.



Superfluidity and Superconductivity

What happens when quantum behavior becomes visible on a macroscopic scale? Explore superfluid helium, Bose-Einstein condensates, superconductors, and supersolids. Compare frictionless flow, zero electrical resistance, magnetic flux expulsion, and quantized vortices. Use mathematical models or simulations to investigate what these systems share and how they differ.



Quantum Computing

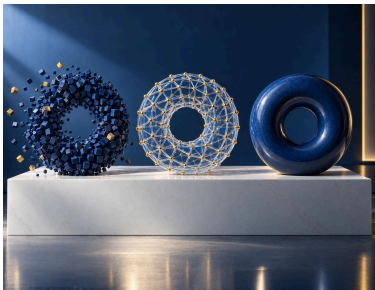
What makes quantum computation fundamentally different from classical computation, and what kinds of problems might it solve better? Build a quantum circuit simulator, experiment with quantum algorithms, or run small programs on an actual quantum computer.

AI, learning, and understanding



Compression, Prediction, and Understanding

What can a learning system safely forget? Compare simple predictors and compression methods on sequences with hidden patterns, then change the patterns or ask a different question about the same data. Investigate which summaries remain useful, what information has been lost, and whether good prediction alone is enough to support further learning.



What Makes a Good Representation?

Can changing how a problem is represented make it easier to learn and explain? Create a small shape-recognition task and compare the same simple learning model using raw pixels or features designed to capture geometric structure. Vary training data, noise, and orientation; test which representations improve predictions and whether the apparent structure actually matters when altered or removed.



Movie Recommender

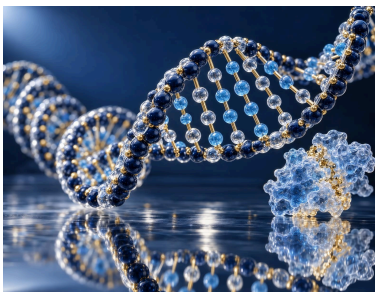
Build a movie recommendation engine that learns people's tastes and predicts what they'll enjoy. Explore collaborative filtering, machine learning, and the tradeoffs between recommending familiar favorites and helping people discover something unexpected.



Who Checks the AI?

How can a system verify work and coordinate decisions when producing answers is easy? Build a prototype in which AI-generated answers or code changes must pass explicit checks before acceptance. Use known-good and deliberately flawed submissions to compare self-checking, independent checking, and agreement among checkers. Measure errors and effort, including when the same participant both proposes and approves work.

Life, computation, and emergence



DNA: Language, Software, Memory, Intelligence, or What?

Is DNA best understood as software, an information storage medium, a language, a blueprint, or something fundamentally different? Investigate how DNA, RNA, and related biological molecules are encoded, interpreted, copied, and modified, and where familiar computational metaphors illuminate biology or break down.



Self-Reference and Paradox

What happens when a statement, program, or logical system refers to itself? Explore the liar paradox, Gödel's incompleteness theorems, Turing's halting problem, and self-replicating programs to uncover the surprising power and limitations of self-reference.



Digital Universe Simulations

Can remarkably simple computational rules give rise to worlds of extraordinary complexity? Create cellular automata, artificial-life systems, or simulated universes to investigate emergence, complexity, and the possibility that sophisticated behavior can arise from simple underlying laws.



Can a Program Keep Itself Alive?

Build a small artificial world in which simple agents must acquire energy, maintain themselves, and reproduce under resource limits. Compare strategies involving memory, cooperation, and resource sharing, then change the environment to see which persist. Explore what this model can reveal about survival and agency, and where the analogy with biological life breaks down.

Networks, privacy, and trust



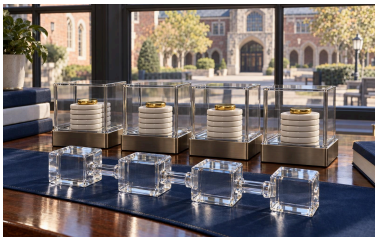
Wireless Networking from Scratch with Audio

Can two computers communicate using nothing but their speakers and microphones? Build a working acoustic modem that encodes digital information into sound, then explore modulation, error correction, synchronization, interference, and the fundamental limits of reliable communication.



Distributed Systems

How can many computers cooperate to behave like one reliable system, even when individual machines fail or disagree? Build a small distributed application and explore replication, consensus, synchronization, network failures, and the challenges of maintaining a shared view of reality.



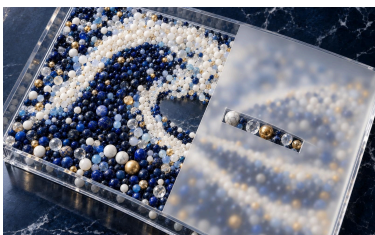
Blockchain for School

Could blockchain technology solve a real problem at Pingry, such as verifying credentials, maintaining club records, or tracking shared resources? Design and prototype a system, while critically examining when decentralization offers advantages over an ordinary database.



Cryptography

How can two people communicate securely when an adversary can observe everything they transmit? Explore the mathematics of encryption, public-key cryptography, digital signatures, and zero-knowledge proofs, perhaps building a secure messaging system or interactive demonstrations.



Anonymizing Data

How anonymous is "anonymous" data, and how much information can be recovered from supposedly private datasets? Experiment with re-identification attacks, k-anonymity, and differential privacy to explore the tension between privacy and usefulness.

Money, work, and social impact



From Clay Tablets to Bitcoin: The Technology of Money

What is money, and how have humans invented technologies to represent value, record obligations, and establish trust? Trace the evolution of money from ancient Mesopotamian accounting systems through coins, banking, paper currency, and cryptocurrencies, exploring how each innovation changed the way societies organize economic life.



Quantitative and Systematic Investing

Can a computer discover patterns in financial markets and turn them into a profitable investment strategy? Develop and backtest trading algorithms, investigate market efficiency, and confront the pitfalls of overfitting, transaction costs, and confusing luck with skill.



AI, Careers, and a Rapidly Changing World

How can seniors at Pingry make sense of rapid advances in AI and what they might mean for their careers and future jobs? Explore the anxiety around a changing world, how to evaluate predictions about work, and how young people can prepare for an uncertain future.



Technology and Not-for-Profits

How can technology help not-for-profits pursue their missions? Explore possibilities in fundraising, operations, and the people they serve. A current example is Crypto for Charity, which converts crypto donations to cash for designated charities. Consider Pingry or another local nonprofit as a case study: identify a practical need and explore how technology could help.

Evidence, uncertainty, and judgment



Can You Tell What Causes What?

When two things change together, how can you tell whether one causes the other? Build a small simulated world with hidden rules, then compare observing it with intervening in it. Design experiments to distinguish competing explanations within a limited budget. Investigate when more observations help and when you need a different experiment.



Seeing More by Measuring Less

How can a few measurements reveal an image or sound? Build a reconstruction laboratory with simple signals and simulated measurements. Vary the signal's structure, measurement count, and noise. Compare recovered signals with the originals, and find convincing reconstructions that are wrong. Explore which assumptions make recovery possible and when they fail.



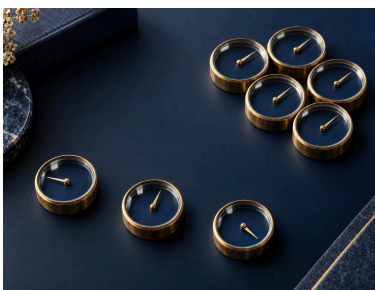
Can the Average Win While Most Players Lose?

Simulate a toy game in which each independent fair coin toss adds 50% to a player's token balance on heads or removes 40% on tails. Compare the predicted average, the simulated mean, the median, and individual histories over many rounds. Explore how rare outcomes, changing stakes, or sharing resources affect the results.

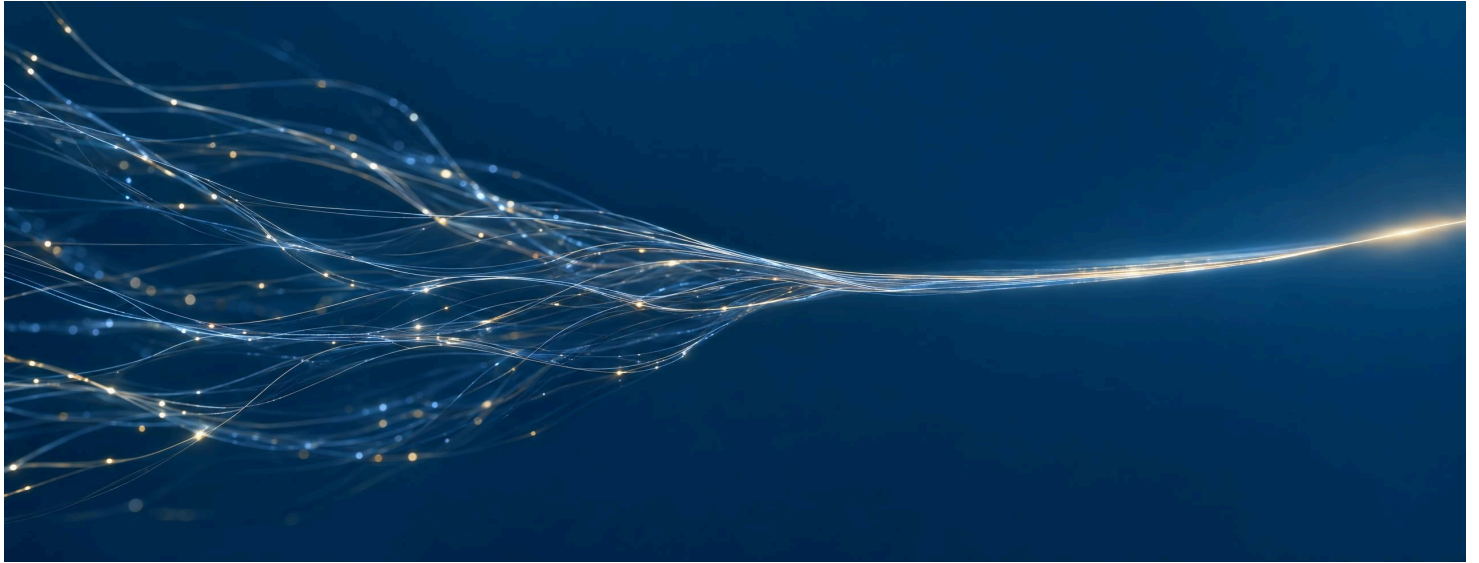


When Does a Crowd Become Wise?

When does listening to others improve judgment, and when does it produce an echo chamber? Create simulated decision-makers who receive incomplete clues and exchange opinions. Vary the communication network, dependence on others, and whether they can remain undecided. Measure accuracy and agreement separately, and examine how your model's assumptions limit what you can conclude about real groups.



25 ideas. What stayed with you?



A question. A surprise. A connection.



Make it concrete.

Choose one question. Imagine a small experiment or investigation.

Start a conversation.

Tell me what caught your attention, or bring your own idea. You don't need a finished proposal to get in touch.





Your next question starts here.

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