Faculty of Science
Department of Mathematics

MA4198 PROJECT PROPOSAL (PROJECT CUM SEMINAR GROUP)

SUPERVISOR'S INFO

Name:	WONG Tin Lok
Email:	matwong@nus.edu.sg
Tel number:	66013668
Office location:	S17-05-18

PROJECT ID: PS2610-06

TITLE

AI-assisted Mathematical Discovery: Physical Models of Computation

BRIEF DESCRIPTION OF PROJECT

This project explores the power of large language models (LLMs) in the context of undergraduate mathematics research, on the specific topic of physical models of computation.

Classical notions of computability, e.g., via Turing machines or (un)bound search, are all based on discrete computations. These notions are robust, in the sense that all of them turn out to be equivalent. In the physical world, computations are arguably continuous. What physical machines are able to compute seems to depend on what tools they have available to them. Conceivably, they give whole new families of computability and complexity notions. Or do they?

EXPECTATION/S

Investigate a particular physical model of computation, and compare it with the classical notion with respect to computability and/or complexity. Experiment with advanced LLMs in the process to establish new, insightful mathematical results. Distill from the experience best practices in using LLMs in undergraduate mathematics research.

PREREQUISITE/S (at level 3000 or below, with at most one course at level 3000)

MA1100(T)/CS1231(S), CHS Digital Literacy, and CHS Artificial Intelligence

READING REFERENCE/S

Michael Friedman. *A History of Folding in Mathematics*. Birkhäuser Cham, 2018.

George E. Martin. *Geometric Constructions*. Springer New York, NY, 1998.

Mark Levi. *The mathematical mechanic: using physical reasoning to solve problems*. Princeton University Press, Princeton, 2009.

V. A. Uspenskii. *Some Applications Of Mechanics To Mathematics*. Blaisdell Publishing Company, New York/London, 1961. Translated from the Russian by Halina Moss.

Olivier Bournez, Michel Cosnard. "On the computational power of dynamical systems and hybrid systems". *Theoretical Computer Science*, Volume 168, Issue 2, 20 November 1996, Pages 417–459.

Damien Woods, Thomas J. Naughton. "An optical model of computation". *Theoretical Computer Science*, Volume 334, Issues 1–3, 15 April 2005, Pages 227–258.

Prasun Dutta, S. Pratik Khastgir, Anushree Roy. "Steiner trees and spanning trees in six-pin soap films". *Am. J. Phys.* 1 February 2010; 78(2): 215–221.

Edwin J. Beggs, José Félix Costa and John V. Tucker. "Axiomatizing physical experiments as oracles to algorithms". *Philosophical Transactions: Mathematical, Physical and Engineering Sciences*, 28 July 2012, Vol. 370, No. 1971, The foundations of computation, physics and mentality: the Turing legacy (28 July 2012), pp. 3359–3384.