



# Colloquium



**MONDAY, APRIL 27, 2026**

**2:30 PM - 3:30 PM | 2048 CB**

**IMPROVING GRÖBNER BASIS  
ALGORITHMS THROUGH  
REINFORCEMENT LEARNING**

**Speaker: Yunus Zeytuncu**  
**Professor of Mathematics**  
**UM-Dearborn**

## Bio

Yunus Zeytuncu is a Professor of Mathematics and Associate Dean at the University of Michigan-Dearborn, specializing in several complex variables, operator theory, and complex geometry. Named the 2021 Michigan Professor of the Year, he is a recognized educator who directs the Center for Mathematics Education and coordinates NSF-funded undergraduate research programs.

## Abstract

Gröbner bases are a central tool in computational algebra for solving systems of polynomial equations. Their computation depends on two key choices: a monomial ordering and a polynomial pair selection strategy. Modern algorithms such as  $(F_4)$  use sparse linear algebra to reduce many pairs simultaneously, but performance remains highly sensitive to the choice of ordering. Despite decades of work, no general method has been found to identify optimal orderings, and standard heuristics such as graded reverse lexicographic (Grevlex) are typically used.

In this project, completed as part of the 2025 REU program, we use the Twin Delayed Deep Deterministic Policy Gradient (TD3) algorithm to dynamically select monomial orderings that minimize computational cost during  $(F_4)$  reductions. Focusing on zero-dimensional ideals arising in applications such as computer vision, economics, and cryptography, we leverage the FGLM algorithm to efficiently transition between orderings, allowing the agent to prioritize computational efficiency rather than elimination structure.

Experiments on benchmark problems show that our approach consistently outperforms standard heuristics such as Greedy Lexicographic Ordering and Graded Lexicographic Ordering, as measured by reduction matrix sizes and critical-pair degrees. We also explore how the agent's learned behavior can inform new heuristics for Gröbner basis computation. This talk will be accessible and will not assume prior background in reinforcement learning or algebraic geometry.

**Refreshments will be provided!**