CSCE 631: Algorithmic Game Theory Meets LLMs

Syllabus — Summer I 2026

Department of Computer Science and Engineering
Texas A&M University — College Station

1 Course Information

Course: CSCE 631 — Algorithmic Game Theory Meets LLMs
Section: Online / Asynchronous
Term: TAMU Summer I 2026 (May 26 – June 29)
Credit Hours: 3
Delivery: Fully online, asynchronous — no synchronous meetings

Instructor Details

Instructor: Dr. Alan Kuhnle
Office: 421 Peterson Building (PETR)
E-Mail: kuhnle@tamu.edu
Office Hours: By appointment (via Canvas messaging or email)

2 Course Description

This is a five-week asynchronous graduate course covering the theory and practice of algorithmic game theory, from classical foundations through modern applications in large language model (LLM) agents. The arc runs from normal-form games and Nash equilibria, through regret minimization and counterfactual regret minimization (CFR), to extensive-form games, game abstraction, poker AI case studies, and finally to LLM-based autonomous agents, multi-agent debate, and adversarial red-teaming.

All lectures are pre-recorded videos hosted on the course website. Students watch at their own pace within each week and complete programming assignments and a course project. Prior experience with machine learning is helpful but not required; mathematical maturity (proofs, probability, optimization) is expected.

Prerequisites

CSCE 420 or CSCE 625, or instructor approval.

3 Course Learning Outcomes

Upon completion of this course, students should be able to:

1. Formalize strategic interactions as normal-form and extensive-form games, and identify appropriate solution concepts (Nash equilibrium, correlated equilibrium, maxmin strategies).
2. Compute equilibria using algorithms such as support enumeration, Lemke–Howson, and linear programming for zero-sum games.
3. Analyze regret minimization algorithms (Regret Matching, RM+) and explain their convergence to equilibrium in repeated games.
4. Implement and evaluate counterfactual regret minimization (CFR) and its variants (MCCFR, Deep CFR) for extensive-form games.
5. Apply game abstraction techniques to reduce large games to tractable representations.
6. Design and evaluate LLM-based agents using game-theoretic principles, including multi-agent debate, coordination, and red-teaming as a zero-sum game.

4 Course Structure

- **Lectures:** Approximately 4.5 hours of pre-recorded video per week, hosted on the course website. Watch at your own pace within each week. Closed captions are provided.
- **Programming Assignments:** Two assignments (PA1 and PA2) in Python/NumPy, distributed as Jupyter notebooks via the course website.
  - **PA1** covers normal-form game fundamentals: utilities, best responses, equilibrium verification, and dominated strategy detection.
  - **PA2** involves building multi-agent LLM debate systems using the TAMU API.
- **Course Project:** An individual research or implementation project. Choose from 10 curated topics (or propose your own with instructor approval). Deliverables: 1-page proposal + code/notebook + 4-page written report.
- **Communication:** All announcements are posted on Canvas. Use Canvas messaging or email for questions. Discussion boards are available for peer interaction.

5 Required Materials

No textbook required. All materials — lecture videos, slides, module notes, and programming assignment notebooks — are provided on the course website.

Software requirements:

- Python 3.x with NumPy, Jupyter
- The `openai` Python library (for PA2 and the course project)
- TAMU API access — see the TAMU API Guide for setup instructions

GPU access is not required.

Recommended reference: Shoham & Leyton-Brown, *Multiagent Systems: Algorithmic, Game-Theoretic, and Logical Foundations* (freely available online).

6 Grading Policy

Component	Weight
PA1 — Normal-form games	20%
PA2 — Multi-agent debate with LLM agents	30%
Course project (proposal 5% + final report 45%)	50%

No midterm. No final exam. No quizzes. Assessment is through programming assignments and a creative research application project.

Grading scale: A $\geq$ 90% > B $\geq$ 80% > C $\geq$ 70% > D $\geq$ 60% > F.

7 Key Dates

Date	Event
May 25 (Mon)	Memorial Day — university holiday, no classes
May 26 (Tue)	**First day of classes**
May 29 (Fri)	Last day to add/drop; official census date
June 6 (Fri)	**PA1 due**; project proposal due (1 page)
June 15 (Mon)	PA2 released
June 15 (Mon)	Last day to Q-drop with no academic penalty
June 19 (Fri)	Juneteenth — university holiday, no classes
June 29 (Mon)	**PA2 due**
June 29 (Mon)	**Course project due** (last day of classes)
June 30 (Tue)	Final examinations period (no exam for this course)

8 Course Schedule

Week	Dates	Topics	Video Hours
1	May 26–30	Foundations of Game Theory: normal-form games, Nash equilibria, maxmin, correlated equilibria, dominated strategies	∼3.4 hr
2	Jun 2–6	Computing Equilibria & Regret Minimization: support enumeration, Lemke–Howson, LP for zero-sum, RM, RM+, no-regret learning	∼5.7 hr
3	Jun 9–13	Extensive-Form Games & CFR: game trees, information sets, subgame perfection, CFR, MCTS, sampling-based CFR	∼5.8 hr
4	Jun 16–20	Game Abstraction & Poker Case Studies: information/action abstraction, lossy bounds, Libratus, Pluribus	∼3.4 hr
5	Jun 23–29	Advanced Topics & Autonomous Agents: Deep CFR, LLM agent architectures, multi-agent debate, red-teaming as a zero-sum game	∼3.4 hr

Total: 21 lectures, ∼21.7 hours of video across 5 weeks. The detailed lecture-by-lecture schedule with individual durations is available at: course schedule (PDF).

9 Assignments and Due Dates

Week	Date	Milestone
1	May 26	PA1 released; project topics released
2	June 6	**PA1 due**; project proposal due (1 page)
4	June 15	PA2 released
5	June 29	**PA2 due** (postponed after delayed release)
5	June 29	**Course project due** (code/notebook + 4-page report)

10 Late Work Policy

You have **3 slip days** total for programming assignments, usable in 24-hour increments (maximum 2 per assignment). After slip days are used, late submissions are penalized 10% per day, up to 3 days. Submissions more than 3 days late (after slip days) will not be accepted. The course project deadline (June 29) is firm and does not accept slip days.

11 Course Project

Apply a game-theoretic concept from this course to a multi-agent or human–agent interaction involving LLMs. Choose from 10 curated topics or propose your own with instructor approval. This is an individual project.

Deliverables:

- **Project Proposal** (1 page) — due June 6. Submit your top 3 topic choices and a brief description of your planned approach.
- **Final Submission** — due June 29. Code/notebook + 4-page written report.

See the course project description for the full topic list, rubric, and guidelines.

12 Course Links

- Course website — lecture videos, slides, module notes, and all course materials
- Course schedule (PDF)
- Course project description and topics
- TAMU API Guide
- PA1 notebook
- PA2 notebook

13 University Policies

Attendance Policy

The university views class attendance and participation as an individual student responsibility. Students are expected to attend class and to complete all assignments. Please refer to Student Rule 7 in its entirety for information about excused absences, including definitions, documentation, and related timelines.

Note: This is an asynchronous online course with no synchronous meetings. "Attendance" in this context means engaging with lecture videos and course materials each week.

Makeup Work Policy

Students will be excused from attending class on the day of a graded activity or when attendance contributes to a student's grade, for the reasons stated in Student Rule 7, or other reason deemed appropriate by the instructor. Please refer to Student Rule 7 in its entirety for information about makeup work, including definitions, and related documentation and timelines.

Academic Integrity Statement and Policy

"An Aggie does not lie, cheat or steal, or tolerate those who do."

Texas A&M University students are responsible for authenticating all work submitted to an instructor. If asked, students must be able to produce proof that the item submitted is indeed the work of that student. Students must keep appropriate records at all times. The inability to authenticate one's work, should the instructor request it, may be sufficient grounds to initiate an academic misconduct case (Student Rule 20.1.2.3).

You may use LLM tools (ChatGPT, Claude, Copilot, etc.) for programming assignments. However, you must understand and be able to explain all code you submit. The analysis and write-up portions of each PA must be your own original work. You can learn more about the Aggie Honor System Office Rules and Procedures, academic integrity, and your rights and responsibilities at aggiehonor.tamu.edu.

Americans with Disabilities Act (ADA) Policy

Texas A&M University is committed to providing equitable access to learning opportunities for all students. Students who experience barriers to their education due to a disability or who think they may have a disability should contact Disability Resources as early as possible. For College Station and most system locations, Disability Resources can be reached at (979) 845-1637 or disability@tamu.edu. Disabilities may include, but are not limited to, attentional, learning, mental health, sensory, physical, or chronic health conditions. All students are encouraged to discuss their disability-related needs with Disability Resources and their instructors as soon as possible.

Notice of Nondiscrimination

Texas A&M University is committed to providing safe and non-discriminatory learning, living, and work environments for all members of the University community. The University provides equal opportunity to all employees, students, applicants for employment or admission, and the public, regardless of race, color, sex (including pregnancy and related conditions), religion, national origin, age, disability, genetic information, or veteran status.

For more information on civil rights and Title IX, see civilrights.tamu.edu.

Pregnancy Accommodations

Texas A&M provides reasonable accommodations to students due to pregnancy and related conditions, such as childbirth, recovery, and lactation. Students should contact the University's Pregnancy Coordinator as soon as they become aware of the need for accommodation.

Mental Health and Wellness

Texas A&M University recognizes that mental health and wellness are critical factors influencing academic success and overall wellbeing. Students are encouraged to utilize University Health Services and other campus resources as needed. If you or someone you know is experiencing mental health concerns, please contact Counseling & Psychological Services (CAPS) at (979) 845-4427 or visit caps.tamu.edu.

In an emergency or life-threatening situation, call 911 or go to the nearest emergency room. The 988 Suicide & Crisis Lifeline is available 24/7 by calling or texting 988 or via 988lifeline.org.

Family Educational Rights and Privacy Act (FERPA)

FERPA is a federal law designed to protect the privacy of educational records. For more information about student rights under FERPA at Texas A&M, see the university's FERPA resources.