CSE 5319-001/6319-001: Special Topics in Advanced Theory and Algorithms - Algorithmic Game Theory, Spring 2025

MW 1:00 - 2:20, ERB 129

Instructor:	Bob Weems, Associate Professor
Office:	ERB 627 (`weems@cse.uta.edu`, `http://ranger.uta.edu/~weems`, `https://ranger.uta.edu/~weems/NOTES6319/cse6319.html`)
Hours:	MW 2:30 - 3:30 p.m.
Prerequisite:	Advanced Algorithms (CSE 5311, `https://ranger.uta.edu/~weems/NOTES5311/cse5311.html`)
Objectives:	Introduction to topics of interest to Computer Scientists, Game Theorists, and Economists. Exposure to:

Outcomes:
1. Game Theory concepts.
2. Price-of-Anarchy concepts.
3. Mechanism Design.
4. Adaptive Decision Making.
5. Complexity Issues for Equilibria.

Textbooks:

T. Roughgarden, *Twenty Lectures on Algorithmic Game Theory*, Cambridge U. Press, 2016. (Henceforth known as R)

A. Karlin and Y. Peres, *Game Theory, Alive*, Amer. Math. Society, 2016. (Link to PDF on webpage. Henceforth known as KP)

N. Nisan et. al. *Algorithmic Game Theory*, Cambridge U. Press, 2007. (Link to PDF on webpage. Henceforth known as N)

References:

E.R. Berlekamp, J.H. Conway, and R.K. Guy, *Winning Ways for Your Mathematical Plays*, A.K. Peters, four volumes downloadable from UTA Library, `https://doi-org.ezproxy.uta.edu/10.1201/9780429487330`

M.R. Garey and D.S. Johnson, *Computers and Intractability: A Guide to the Theory of NP-Completeness*, Freeman, 1979.

D. Gusfield and R. Irving, *The Stable Marriage Problem: Structure and Algorithms*, MIT Press, 1989.

D. Manlove, *Algorithmics of Matching Under Preferences*, World Scientific, 2013, `https://ebookcentral-proquest-com.ezproxy.uta.edu/lib/utarl/detail.action?docID=1168176`

J. Matousek and B. Gartner, *Understanding and Using Linear Programming*, Springer, 2007, `https://link-springer-com.ezproxy.uta.edu/content/pdf/10.1007/978-3-540-30717-4.pdf`

Y. Shoham and K. Leyton-Brown, *Multiagent Systems: Algorithmic, Game-Theoretic, and Logical Foundations*, 2009, `http://www.masfoundations.org/download.html`

K. Steiglitz, *Snipers, Shills, & Sharks: eBay and Human Behavior*, Princeton U. Press, 2007, `https://doi-org.ezproxy.uta.edu/10.1515/9780691233864`

Grade: Based on the following weights:

5319	6319	
80%	60%	Homework (5-7 assignments)
	20%	20-Minute Presentation (Final Topic Due March 26)
20%	20%	Final Exam

Final exam is Friday, May 2 from 11:00 a.m. - 1:30 p.m.

Policies:

1. Regular attendance is expected. The lectures are being recorded and will have a link from Canvas, but no availability guarantee is made (e.g. this is not a "distance" course).

2. CHEATING - YOU ARE EXPECTED TO KNOW UNIVERSITY POLICIES. All cases of plagiarism/collusion will be processed through University channels outside the CSE department.
   `http://www.uta.edu/student-affairs/community-standards`

3. Any request for special consideration must be appropriately documented **in advance**. (Special consideration does not include giving a higher grade than has been earned.)

4. If you require a reasonable accomodation for a disability, please contact me no later than the second week of this semester. Further details are available at `http://www.uta.edu/disability/`

5. Occasional class-wide email messages (e.g. weather situations, clarifications) may be sent to the addresses recorded by MyMav.

Course Outline

1. Game Theory Concepts - KP 1/2/3/4/5/7; N 1/2
   Selfish Behavior
       Classic Games & Strategic Situations
       Two-Person/Zero-Sum
   Equilibrium Concepts
   Potential Games
   Utility Functions, Risk Aversion, St. Petersburg Paradox
   Bayesian Games & Bayes-Nash Equilibrium
   Correlated Equilibria
   Optimal Basket of Goods via Network Flow (N 1.8.1)
   Linear Programming (KP appendix A, Matousek/Gartner, `https://www.gnu.org/software/glpk/`)
2. Price of Anarchy - KP 8; N 17/18/19/20; R 1/11/12/13/14/15
   Relating Equilibria and Optimality
   Selfish Routing (infinitesimal, non-atomic)
   Network Formation Games
   Makespan Scheduling
   Potential Games - Location Games
   Atomic Selfish Routing

Smooth Games
Best-Case and Strong Nash Equilibria/Price of Stability
3. Mechanism Design - KP 10/11/12/13/14/15/16/17; N 9/10/11/12/13/15/28; R 2/3/4/5/6/7/8/9/10
   Single-Peaked Preferences Over Policies (N 10.2)
   Stable Matching – Marriages, Roommates (a little bit) & House Allocation
   Fair Division - Cake Cutting & Bankruptcy
   Cooperative Games
   Social Choice - Condorcet Paradox/Arrow's Properties & Impossibility Theorem
   Analysis of Specific Voting Rules
   Auction Concepts - KP 14; N 9/11/13; R 2/3/4
       Single Item Auctions - English/Second-Price/Myerson's Lemma
       Knapsack Auctions
       Characterization of Bayes-Nash Equilibrium/POA in Auctions/Revelation Principle
       Myerson's Optimal Auction/Revenue Maximization
       Approximately (Near-) Optimal Auctions - Prophet Inequality/Bulow-Klemperer
   Multi-Unit Auctions - R 9; Nisan survey (. . . /PAPERSONE/nisanAmd.pdf)
       Uniform-Price
       Clinching (Dobzinski, Ausubel)
       Nisan survey - Emphasizes concepts rather than generality of combinatorial auctions
   Truthful Auctions in Win/Lose Settings (KP 15)
       Win/Lose Allocation Settings
       Social Surplus and the VCG Mechanism
       Applications of VCG
       Sponsored Search Auctions - KP 15.5; N 28; R 2.6/3.5/5.3
   VCG and Scoring Rules - KP 16; N 9; R 7
   Combinatorial Auctions - N 11; R 8
   Matching Markets - KP 17; N 11.7/28.3
4. Adaptive Decision Making - R 16/17/18; KP 18; N 4
   Best-response dynamics - Approx. PNE in Selfish Routing Games/Fast convergence for
       smooth potential games
   No-regret dynamics - On-line decision making/Multiplicative weights/Coarse correlated equil.
   Swap regret and the minimax theorem
5. Complexity of Equilibria - R 19/20; N 2/3/19.3.4
   Tractability Issues/PLS-completeness/Pure Nash Equilibria of Congestion Games
   Pure Nash Equilibria of Bimatrix Games/Total NP Search Problems/PPAD

Calendar - with subject numbers from course content

January				February				March			
13	Syllabus	15	1.A	3	1.E	5		3	3.B	5	3.C
20	MLK	22	1.B	10	2.A	12	2.B	10	SPRING	12	BREAK
27	1.C	29	1.D	17	2.C	19	2.D	17	3.D	19	3.E
				24		26	3.A	24		26	3.F
								31	3.G		

April				May	
		2	3.H	2	Exam
7		9	4.A/B/C		
14	5.A/B	16			
21		23	Students	March 28 is the last day to drop.	
28		30	---	Submit requests to major advisor prior to 4:00 p.m.	

Messages/disclaimers/fine print from our sponsor:

Attendance: At The University of Texas at Arlington, taking attendance is not required but attendance is a critical indicator in student success. Each faculty member is free to develop his or her own methods of evaluating students' academic performance, which includes establishing course-specific policies on attendance. As the instructor of this section, I expect regular attendance. However, while UT Arlington does not require instructors to take attendance in their courses, the U.S. Department of Education requires that the University have a mechanism in place to mark when Federal Student Aid recipients "begin attendance in a course." UT Arlington instructors will report when students begin attendance in a course as part of the final grading process. Specifically, when assigning a student a grade of F, faculty report the last date a student attended their class based on evidence such as a test, participation in a class project or presentation, or an engagement online via Canvas. This date is reported to the Department of Education for federal financial aid recipients.

Emergency Exit Procedures: Should we experience an emergency event that requires us to vacate the building, students should exit the room and move toward the nearest exit. When exiting the building during an emergency, one should never take an elevator but should use the stairwells. Faculty members and instructional staff will assist students in selecting the safest route for evacuation and will make arrangements to assist individuals with disabilities.

Academic Success Center
The Academic Success Center (ASC) includes a variety of resources and services to help you maximize your learning and succeed as a student at the University of Texas at Arlington. ASC services include supplemental instruction, peer-led team learning, tutoring, mentoring and TRIO SSS. Academic Success Center services are provided at no additional cost to UTA students. For additional information visit: Academic Success Center (https://www.uta.edu/student-success/course-assistance). To request disability accommodations for tutoring, please complete this tutoring request form (https://www.uta.edu/student-success/course-assistance/tutoring/request).

The IDEAS Center (https://www.uta.edu/ideas/) (2nd Floor of Central Library) offers **FREE** tutoring and mentoring to all students with a focus on transfer students, sophomores, veterans and others undergoing a transition to UT Arlington. Students can drop in or check the schedule of available peer tutors at www.uta.edu/IDEAS, or call (817) 272-6593.

Institutional Information
UTA students are encouraged to review the below institutional policies and informational sections and reach out to the specific office with any questions. To view this institutional information, please visit the Institutional Information page (https://resources.uta.edu/provost/course-related-info/institutional-policies.php) which includes the following policies among others:
- Drop Policy
- Disability Accommodations
- Title IX Policy
- Academic Integrity
- Student Feedback Survey
- Final Exam Schedule