

CSE 5319-001/6319-001: Special Topics in Advanced Theory and Algorithms - Algorithmic Game Theory, Spring 2023

MW 1:00 - 2:20, Woolf Hall 208

- Instructor: Bob Weems, Associate Professor
Office: 627 ERB (weems@cse.uta.edu, <http://ranger.uta.edu/~weems>)
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.
- Outcomes:
1. Exposure to Game Theory concepts.
 2. Exposure to Price-of-Anarchy concepts.
 3. Exposure to Mechanism Design.
 4. Exposure to Adaptive Decision Making.
 5. Exposure to 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:
- M. Bichler, *Market Design: A Linear Programming Approach to Auctions and Matching*, Cambridge U. Press, 2018.
- 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/utar1/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:

<u>5319</u>	<u>6319</u>	
80%	60%	Homework (5-7 assignments)
	20%	20-Minute Presentation (Topic Due March 27)
20%	20%	Final Exam

Final exam is Friday, May 5 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 accommodation 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 & 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 (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			
16	MLK	18	Syllabus	1	1.D	1	3.A
23	1.A	25	1.B	6	1.E	8	3.C
30	1.C			13	2.A	15	2.B
				20	2.C	22	2.D
				27		27	
						6	3.B
						8	3.C
						13	SPRING
						15	BREAK
						20	3.D
						22	3.E
						29	3.F
April		May					
3	3.G	5	3.H	1	Students	5	Exam
10		12	4.A/B/C				
17	5.A/B	19	Students				
24	Students	26	Students				

March 31 is the last day to drop; submit requests to major advisor prior to 4:00 p.m.

Messages/disclaimers/fine print from our sponsor:

Face Covering Policy: *While the use of face coverings on campus is no longer mandatory, all students and instructional staff are strongly encouraged to wear face coverings while they are on campus. This is particularly true inside buildings and within classrooms and labs where social distancing is not possible due to limited space. If a student needs accommodations to ensure social distancing in the classroom due to being at high risk they are encouraged to work directly with the Student Access and Resource Center to assist in these accommodations. If students need masks, they may obtain them at the Central Library, the E.H. Hereford University Center's front desk or in their department.*

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.

Student Success Programs

UT Arlington provides a variety of resources and programs designed to help students develop academic skills, deal with personal situations, and better understand concepts and information related to their courses. Resources include [tutoring by appointment](#), [drop-in tutoring](#), [etutoring](#), [supplemental instruction](#), [mentoring](#) (time management, study skills, etc.), [success coaching](#), [TRIO Student Support Services](#), and [student success workshops](#). For additional information, please email resources@uta.edu, or view the [Maverick Resources](#) website.

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.

Institution 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 which includes the following policies:

- Drop Policy
- Disability Accommodations
- Title IX Policy
- Academic Integrity
- Student Feedback Survey
- Final Exam Schedule