New course offered in Fall 2017 as part of CSCI-599

Heuristic Search in Artificial Intelligence. **4 units.**

Instructor: Prof. Ariel Felner

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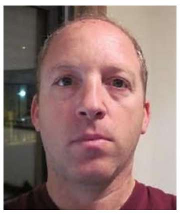
Phone: 310-4096965

Tuesday, 3:00pm-6:20pm.   Location: VKC111



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12	13	14	15

Description of the course

Many problems in Computer Science in general, and in Artificial Intelligence in particular can be described as search for a path in a state-space graph. Examples are path finding in maps (GPS), solving Rubik's cube and many other combinatorial problems. The field of *heuristic search in AI* studies such problems at all levels of scientific angles. It provides the scientific background for properly defining a search problem and the task to be solved. It also provides a large variety of algorithms that can solve search problems each with its own pros and cons in terms of solution quality, time complexity and memory complexity. This course will provide a deep coverage of the heuristic search field and introduce the different scientific achievements in all levels that have been achieved in this field. This course will also cover search in adversarial game trees for zero-sum games such as chess and checkers. The course lectures are summarized in slides and will be provided to the students on the fly.

Prerequisite(s): Knowledge on Data structures, Algorithms and basic complexity theory. Basic AI course is recommended but is not mandatory.

Learning Objectives

The students will be introduced to, and will experience all aspects of the field of heuristics search. A student taking the class will be able to use the acquired knowledge in many projects that he/she will be part of in the future either in or outside academia.

The instructor

Prof. Ariel Felner (http://felner.wix.com/home) is a visiting scholar in USC for 2017-2018. Prof. Felner is an expert in heuristic search and has experience in teaching this course for more almost 20 years, including in USC in 2007.

Assignments: The students will have three major assignments:

1) Exam. The exam will test the students on the different topics that were learned during the course. It will be a mid-term exam in the last week of class.

2) Research project. Each student, or pair of students, will need to perform a research project and submit a report by the end of the course. The research project should be picked individually by the students and include a small research topic learned during the course or a new topic that was spawned. The report should include a summary of theoretical and experimental treatment of the topic that was examined by the students.

3) Presentation. Each student or pair of students will be responsible to learn a given topic or to read a state-of-the-art scientific paper. Then, they will have to present it to the entire class. Time will be allocated for such presentations in the end of the semester.

Grading Breakdown: Final exam: 40%. Research project: 30%. Class presentation: 30%.

Course Schedule: A Weekly Breakdown

	Topics/Daily Activities
Week 1	Introduction and overview: state spaces, search basics and terminology.
Week 2	Uninformed search and its analysis: DFS, Breadth-first search., Iterative Deepening, Dijkstra's algorithm.
Week 3	Duplicate detection and pruning. Heuristics: definitions, basic attributes and requirements. A* algorithm: its definition and examples.
Week 4	A*: main features. Mathematical analysis of time and memory complexity.
Week 5	Time complexity of A*. Prediction systems.
Week 6	Linear space variants of A*: IDA*, RBFS, ILBFS, DFBnB.
Week 7	Suboptimal and bounded suboptimal algorithms: Anytime A*, WA*, EES, Potential search
Week 8	Heuristics: consistent vs inconsistent. Abstractions. Heuristics for exponential domains: Pattern-databases.
Week 9	Polynomial domains: true-distance heuristics. Pathfinding in grids. Relevant algorithms: JPS, Subgoal Search, contractions.
Week 10	Local Search: Hill climbing, Simulated annealing, Genetic Algorithms and more.
Week 11	Adversarial Search. Definitions. Game theory. Minimax algorithms.
Week 12	Alpha-beta pruning, best-first minimax. The convergence theorem.
Week 13	Multi-player games, MaxN vs Paranoid. Alpha-Beta pruning. Challenges.
Week 14	Student presentations: 4 groups of pairs.
Week 15 Dates	Mid term