

CS380: Artificial Intelligence for Games

Summer 2021

Prerequisites: CS225, CS280

General Information:

- Class schedule: Fri (a) 9:00am-12:20pm, (b) 1:30pm-4:50pm
- Classroom: (a) LT6D, (b) Edison
- Instructor: Dr. Vadim Surov

Contact:

- Email: vsurov@digipen.edu (Specify [CS380] in email subject field)
- Class web page: <https://distance3.sg.digipen.edu/2021sg-summer/course/view.php?id=265> is the online repository for CS380
- Office hours: Tue, Thu 1pm-3pm

Description:

The objective of this course is to introduce data structures and algorithms related to the artificial intelligence applicable in real time interactive applications. It will introduce students to a wide range of concepts and practical algorithms that are commonly used to solve game AI problems.

Course Objectives and Learning Outcomes:

Upon successful completion of this course, students will understand, implement, and be able to use several artificial intelligence strategies and their associated algorithms. The main AI topics that students will work with are graph generation, using implicit and explicit graphs, shortest paths, fuzzy logics, genetic algorithms, neural networks and more. Students will apply most of these techniques in their assignments where they implement core game AI algorithms with visual outputs projects.

Recommended Textbooks:

1. *Artificial Intelligence A Modern Approach*, third edition, by Stuart Russell and Peter Norvig.
2. *Artificial Intelligence For Games*, second edition, by Ian Millington and John Funge.
3. *Computational Geometry: Algorithms and Applications*, third edition, by Mark de Berg, et al.

Additional references:

AI for Game Developers, First edition, by David M. Bourg and Glenn Seemann, *AI Game Programming Wisdom 1, 2, 3 & 4*, Edited by Steve Rabin.

Grading Policy

- Quizzes: 10%
- Programming Assignments: 40%
- Midterm: 20%
- Final exam: 30%
- Final letter grade algorithm: A: 93 – 100%; A–: 90 – 92.99%; B+: 87 – 89.99%; B: 83 – 86.99%; B–: 80 – 82.99%; C+: 77 – 79.99%; C: 73 – 76.99%; C–: 70 – 72.99%; D: 60 – 69.99%; F: <60%

Outline

Please note that this is a tentative organization of the course and may be subject to change. Below is a list of topics that will be covered this semester.

Wk	Topic	Showcass
1	Introduction and review CS380 <ul style="list-style-type: none"> ● Introduction to the course <ul style="list-style-type: none"> ○ Milestones ○ Tools ○ Assignment projects ○ Codes and coding language on this page ● Fundamental data structures and algorithms <ul style="list-style-type: none"> ○ Arrays, Lists, Stacks, Queues, Graphs, Trees ○ Type of graphs: navigation (Euclidian, tile-based), dependency, state ○ Implementation: Adjacency list and matrix ○ Recursive vs iterative algorithms 	
2	Navigation graphs and uninformed search <ul style="list-style-type: none"> ● Blind search ● Brute-force search ● Flood-fill algorithm ● Search strategies: breadth-first vs depth-first 	Lines game
3	Cost-based graph search <ul style="list-style-type: none"> ● Graph with costs/weight ● Edge relaxation ● Shortest Path Tree ● Dijkstra's algorithm 	Lines game
4	Navigation graph: heuristics and negative costs <ul style="list-style-type: none"> ● Heuristics ● A* algorithm ● Navigation graph with positive and negative costs ● Bellman-Ford algorithm ● Floyd-Warshall algorithm 	Pathfinding, Pickup and delivery simulation
5	Navigation graph: combinatorial and local searches <ul style="list-style-type: none"> ● Combinatorial optimization ● Travelling salesman problem ● Local search, Hill climbing ● Best first, Greedy best-first, and Stochastic searches ● Local maximum, Plateau and Ridge problems 	Travelling salesman problem
6	Review and Midterm exam	
7	Trimester Break	
8	State graph search <ul style="list-style-type: none"> ● State graph. The Towers of Hanoi ● Sliding puzzle game. Search solution by using A* algorithm ● Constraint satisfaction problems ● Backtracking 	The Towers of Hanoi. Sliding puzzle. Sudoku
9	Adversarial Search <ul style="list-style-type: none"> ● Turn-based two-players game ● Game tree 	Tic-Tac-Toe

	<ul style="list-style-type: none"> Minimax algorithm 	
10	State Machines & Behavior Trees <ul style="list-style-type: none"> Decision Trees State Machines Behavior Trees 	Game Of Life. Battleship
11	Fuzzy Logic <ul style="list-style-type: none"> Fuzzy sets. Membership function Fuzzy variables Fuzzy operators Fuzzy rules and inference system Fuzzification and Defuzzification 	Weapon
12	Genetic Algorithm <ul style="list-style-type: none"> Evolutionary algorithm, fitness function, crossover, mutation Framework of Genetic Algorithm 	8-queens puzzle
13	Neural Network And Review <ul style="list-style-type: none"> Biological Neural Network, perceptrons, learning rule, gradient descent algorithm Stochastic approximation, using Neural Networks in games 	
14	Final Week 1	
15	Final Week 2	

Submission Requirement Policy

In order to properly grade works submitted, all source code and assets are required for assessment.

Detailed instructions and requirements will be listed in each assignment brief document.

You are expected to follow all instructions and meet all requirements stated in the brief.

Failure to comply with any requirement will be subject to penalties listed in the assignment brief document.

Grades will be given based only on what is submitted to the school's course management system (Moodle) and no exceptions will be allowed.

Late Submission Policy

Each assignment provided will be accompanied with a due date and time which will be clearly stated on the assignment submission page. A 100% penalty will be imposed on any submission deemed late by the course management system (Moodle). This will also be reflected on the assignment brief.

Students may request for extensions should they provide valid reasons with documented proof to justify their case. This will be handled on a case-by-case basis by the lecturer.

Request for extensions after the deadline will not be accepted except in excruciating cases. In those cases, it will be handled on a case-by-case basis by the school.

Classroom Policy

Students are expected to behave professionally at all times with regards to classroom conduct and timely delivery of all assignments. Specific guidelines will accompany each assignment, along with a completion date. Students are expected to retain all works done until after the end of the semester.

To maintain a conducive learning environment during class, it is expected for students to...

Be quiet during class while the lecturer is talking and to keep a low noise level at all times. This is to ensure that everyone is able to listen to the discussion and to not disturb others while doing class activities.

Turn off your mobile phones or put them on silent mode. This is to prevent unwanted interruptions due to phones ringing or vibrating.

Reduce use of mobile phones during class where possible. Also, playing games on any device is strictly prohibited during class time. This is to reduce distractions for everyone around including the student him/herself. Penalties may be imposed if students are caught doing so.

Keep the classrooms clean. Eating and/or drinking in class is strictly prohibited with the exception of bottled water. Do dispose of all wastes (such as used paper, eraser crumbs, empty bottles etc.) in the garbage bins located outside classrooms.

Do not mistreat school equipment (such as computers, keyboards, mice, monitors etc.). There will be penalties given for such abuse cases and having broken equipment will cause inconvenience for everyone in school.

Last Withdrawal Date

In order to withdraw from a course you are required to submit an official request that will be processed by the school in order to formally withdraw you from the class and the academic penalties associated.

As such, do note that it is not sufficient to simply stop attending class or to inform the instructor.

In accordance with policy, contact your advisor or the Registrar to begin the withdrawal process.

Do check the school's academic calendar and schedules to know the deadlines for withdrawal.

Academic Integrity Policy

Assignments in this module are NOT group projects. They must represent a student's own individual work. It is reasonable for students to consult or discuss general solutions to an assignment. However, it is prohibited for students to collaborate on detailed solutions, to copy code, or to give away code.

Cheating, or academic dishonesty in any form, will not be tolerated in this course. Penalties for cheating may include receiving a zero on an assignment, or a failing grade in the course, or even expulsion from DigiPen. It is permissible to discuss assignments (not solutions) with other students in the class, but the solutions must be recognizably your own. For further details, please consult the DigiPen Academic Integrity Policy.

With the internet as a readily accessible source of information and help, students may feel that plagiarism is ambiguous and thus be unable to determine what it constitutes. Here are some general guidelines to help make the distinction:

Do NOT copy-paste any works online (wholesale or otherwise). Using works that are not yours is plagiarism.

Do NOT ask online communities (such as stack overflow, unity forums etc.) to solve your bugs & code issues by providing your code segments. Asking others to solve your issues is work not done by you and thus is plagiarism.

You may learn from sources online, understand the workings and concepts, and implement them again via your own efforts. A good habit is to assume that you will be tested on the things you learn online and if you are unable to answer the questions then you should not use said works.

You may ask online communities general problems and use their insights to work on your problem.

This applies to all sources on any medium (be it the internet, textbooks, friends or social media etc.). It is the content that is important, not the medium they are on.

The bottom line test is to ask yourself "Did I work on this?" If you did not, then you should not use it. Learn from it and work it out yourself.

Attendance Policy

Attendance is mandatory. Students are expected to notify the lecturer if they are unable to attend class for any reason. A 1 week grace will be given before and after the class for the student to submit the notice. It is highly recommended for students to send the notice via email to keep a digital record of the notice.

Each absence case will be reviewed on a case-by-case basis and students may be required to provide document proof to back their reasons given.

Typical valid reasons are those that fall within the domain of medical (with valid medical certificate) and compassion (with document proof).

Any reasons that are deemed to be personal and/or due to negligence will be rejected. Examples are like oversleeping, working on another assignment/project/course, uncertain if class is being held, going on a family holiday... etc.

A 1% penalty from the course total will be given for each unexcused absence.

Workload

There will be two major exams during the semester – midterm and final and there will be four quizzes which help you keep track of the progress. There will be 10 programming assignments to work on outside the class. Most assignments are not large. You will have 1 week to complete them. Plan on spending 6 hours per week on these assignments. In addition to attending the lectures, you should plan to spend at least 7 hours per week reviewing, reading, and studying for this class.

External Preparation

It is expected that the students in this class spend (2 x module credits) hours on average per week for outside classroom activities through the semester, including, but not limited to, homework, reading assignments, project implementation, group discussions, preparation of examinations, etc.

Disability Support Service

Students who have special needs or medical conditions and require formal accommodations in order to fully participate or effectively demonstrate learning in this class should contact the Student Life & Advising Office (studentlife.sg@digipen.edu) at the beginning of each semester. A Student Life & Advising Officer will meet with the student privately to discuss how the accommodations will be implemented.