

**CSCI 524 Networked Artificial Intelligence/
Procedural Content**

Units: 4-1

**Term—Day—Time: Spring – Tuesdays – 10am to 1pm,
Lab 1pm to 2pm.**

Location: EGG-108

Instructor: Michael Zyda

Office: EGG-209

Office Hours: Tuesdays 1pm

Contact Info: zyda@usc.edu

Instructor: Scott Easley

Office: EGG-207

Office Hours: Tuesdays 1- 4 pm

Contact Info: seasley@usc.edu

Teaching Assistant:

Office: EGG-205

Office Hours:

Contact Info:

IT Help: GamePipe Laboratory Manager

Hours of Service:

Contact Info:

Course Description

This course covers the design and implementation of artificial intelligence systems deployed as integral parts of networked games. This course also explores how machine learning and evolutionary algorithms can be used for complex game level generation for 2D and 3d games. The students will use open source game engines to create games where levels are constructed using rich data files and multiple inputs. The objective of the course is to prepare the student for research and development of AI technologies for interacting with and playing against large-scale, networked games as well as the new research of machine learning for level design.

Learning Objectives

Topics include networked game communication architectures, protocol development, architecting networked game AI clients and services, various AI techniques including character following, knowledge representation and reasoning, dynamic play strategies, search, learning, and utilizing evolutionary algorithm and machine learning for continued level creation.

Prerequisite(s): CSCI-420 or CSCI-580 or equivalent course/experience in computer graphics.

Required Readings and Supplementary Materials

Ian Millington and John Funge "Artificial Intelligence for Games," CRC Press, second edition, 2015.

Description and Assessment of Assignments

Week 1 -

AI Lecture:

- Class structure
- Final project expectations
- Networked Game Communication Architectures
- Select a networked game your group will use all semester as the object of AI client developments and explorations.

ML Lecture:

- Brief history
- Current uses
- Mari/o showcase
- Mid-term and final projects assignment review

Week 2 –

AI Lecture:

- Communications Protocol Interoperability & Design
- Examine the communications protocol developed for the selected networked game
- Plan on how to extend that protocol for the additional messages from semesters' AI clients.

ML Lecture:

- Genetic vs. Evolutionary
- Creating New Solutions Through Mutation
- Combining Solutions Through Crossover
- Survival of the Fittest
- Drawbacks of Evolutionary Algorithms

Week 3 –

AI Lecture:

- Initial Steps
- Character Following, Flocking, Formations & Coordinated Movement
- Develop simple AI client that selects a character in the game and begins to follow/taunt them.
- Add in a flock of characters that follow and taunt the live player.
- Reading: <http://www.aiwisdom.com>

ML Lecture:

- Supervised learning
- Unsupervised learning
- Reinforced learning
- Big Data

Week 4 –

AI Lecture:

- Knowledge Representation & Architectures
- Build an AI client that listens to game play for a networked game and have that client build an internal representation of the game world and game play.
- See if you can determine what is happening in the game purely from the packets, e.g. fighting is going on, character is hiding, character is laying in wait.
- Issue simple reports on game action.
- Reading: <http://www.aiwisdom.com>

ML Lecture:

- First Class Assignment
- Open Source Mario Brothers Level
- AI Competitions/Resources/Examples
- Marl/O review
- NeuroEvolution of Augmenting Topologies
- Learnfun and Playfun

Week 5 –

AI Lecture:

- Autonomous Game Play & Interaction
- Develop an AI client that fights/plays against the live players in the networked game using the internal representation of the state of the game built for project 4.
- Use a finite state machine architecture for this.
- Reading: <http://www.aiwisdom.com>

ML Lecture:

- Differences and Outcomes
- Subsets of each
- Example problems
- Opensource equivalents to Deepmind
- Tensorflow, Theano, GoLearn

Week 6 –

AI/ML Lecture

- Choosing use of Genetic Algorithms & Evolutionary Behaviors in your project
- Continue developing the fight/play behavior of your AI client.
- Consider how to develop clients that can dynamically evolve and develop new tactics and behaviors.

- Consider developing an entire evolving architecture of characters that fight/play against the live characters in the networked game with some aspect of ML.
- Reading: <http://www.aiwisdom.com>

Week 7 –

AI/ML lecture:

- Genetic Algorithms & Evolutionary Behaviors II
- Continue developing the fight/play behavior of your AI client system.

Week 8 –

AI/ML Lecture:

- Strategy/Tactical AI
- Pick one or more of the following and add into your AI client system - coordinated behavior, strategic decision-making
 - goal-directed behavior
 - pathfinding
 - engaging the enemy
 - terrain reasoning
 - level completion
- Reading: <http://www.aiwisdom.com>
- <http://www.aiwisdom.com>

Week 9 –

AI/ML Lecture:

- Strategy/Tactical AI II
- Continue working on your AI client project.

Week 10 –

AI/ML Lecture:

- Integrate machine learning into your networked game.
- Use the internal knowledge representation you constructed for the knowledge representation project.
- Reading: <http://www.aiwisdom.com>

Week 11 –

AI/ML Lecture:

- Knowledge Representation & Architectures II
- Further develop the internal representation of game play and issue better analyses/reports of game action.

Week 12 –

AI/ML Lecture:

- Strategy/Tactical AI III & Knowledge Representation & Architectures
- Modify your AI client to search for enemy/other players in your internal game representation and issues reports on their activities.

Week 13 –

AI/ML Lecture:

- Planning
- Build on your previous work and utilize the internal representation of state of the game gleaned from the network to plan attacks/actions against the live players in the networked game.
- Suggest plans and ask the live player of your AI clients if they should be launched.
- Reading: <http://www.aiwisdom.com>

Week 14 –

AI/ML Lecture:

- Sensors
- Modify your client to simulate various real-world sensors in your AI clients so that your AI system can reason using imperfect information rather than perfect, complete models of the world.

Week 15 –

AI/ML Lecture:

- Advanced Topics
- Highlights from recent papers on AI/ML and Networked Games
- Continue development of your AI clients.

Week 16 - Final Presentations

Final Project Demo & Writeup

Grading Breakdown

The lectures in this course will discuss AI techniques that can be deployed real-time in networked games. Each student is expected to develop AI clients/services that interact with a networked game chosen in consultation with the instructor. That project runs continuously all semester, the code testing the student's knowledge of the in-class lectures and reading material. The student's networked game AI client work will be presented in class weekly the entire semester.

Each project (projects 1 – 15) is worth 5% of the class grade. The grading of each project will be on whether the project fulfills the requirements for that project. The grading will be either "fulfills the goals" or "does not fulfill the goals". Students in this class will build and maintain a web site describing their group's work, and a personal web site describing their work in particular, and each project will be accompanied by a live in-class demo. That web site must be maintained weekly to advise the professor on group and individual status. The Final Project Demo & Writeup is 25% of the class grade. The student will demonstrate their final networked game and provide a short write-up on it. The final source code and write-up will be provided to the instructor. Daily class and lab attendance is required for full participation and for full credit for this course.

Statement on Academic Conduct and Support Systems

Academic Conduct

Plagiarism – presenting someone else’s ideas as your own, either verbatim or recast in your own words – is a serious academic offense with serious consequences. Please familiarize yourself with the discussion of plagiarism in *SCampus* in Section 11, *Behavior Violating University Standards* <https://scampus.usc.edu/1100-behavior-violating-university-standards-and-appropriate-sanctions>. Other forms of academic dishonesty are equally unacceptable. See additional information in *SCampus* and university policies on scientific misconduct, <http://policy.usc.edu/scientific-misconduct>.

Discrimination, sexual assault, and harassment are not tolerated by the university. You are encouraged to report any incidents to the *Office of Equity and Diversity* <http://equity.usc.edu> or to the *Department of Public Safety* <http://adminopsnet.usc.edu/department/department-public-safety>. This is important for the safety of the whole USC community. Another member of the university community – such as a friend, classmate, advisor, or faculty member – can help initiate the report, or can initiate the report on behalf of another person. *The Center for Women and Men* <http://www.usc.edu/student-affairs/cwm/> provides 24/7 confidential support, and the sexual assault resource center webpage <http://sarc.usc.edu> describes reporting options and other resources.

Support Systems

A number of USC’s schools provide support for students who need help with scholarly writing. Check with your advisor or program staff to find out more. Students whose primary language is not English should check with the *American Language Institute* <http://dornsife.usc.edu/ali>, which sponsors courses and workshops specifically for international graduate students. *The Office of Disability Services and Programs* http://sait.usc.edu/academicsupport/centerprograms/dsp/home_index.html provides certification for students with disabilities and helps arrange the relevant accommodations. If an officially declared emergency makes travel to campus infeasible, *USC Emergency Information* <http://emergency.usc.edu> will provide safety and other updates, including ways in which instruction will be continued by means of blackboard, teleconferencing, and other technology.