CSC 584/484 Course Syllabus

CSC 584/484 – Building Game AI

Section 001

SPRING 2016

3 Credit Hours

Course Description

The purpose of this course is to familiarize students with issues and techniques of Artificial Intelligence (AI) for computer games. For nearly 60 years, games have been a standard application area for artificial intelligence techniques. Indeed, some of the earliest AI techniques were designed to play games that humans excelled at: Checkers, Backgammon, Chess, and Go to name a few. While the more general AI goal of "human-level intelligence" has remained elusive, computer scientists have developed techniques that enable computers to play certain games at or beyond the level of the world's best human players. In fact, many game designers intentionally "dumb down" their AI opponents using techniques such as "artificial stupidity" or "intelligent mistakes" to create game experiences that human players find challenging and enjoyable, rather than impossible and frustrating.

In this course we will examine both traditional and modern AI techniques that are used in the design of computer games. We will look at techniques for game playing as well as the design of AI opponents tasked with creating "good experiences" for players. The course will begin with a discussion of AI in general, as well as common algorithms, data structures, and representations. From there, we will cover topics in character movement, pathfinding, decision making, strategy, tactics, and learning---all within the context of computer games.

Learning Outcomes

By the end of the course, students should be able to accomplish the following:

1. Evaluate the relative benefits and drawbacks of different artificial intelligence techniques that can be used to solve computer game problems, and identify the appropriateness of particular techniques for particular game problems.
2. Implement a range of artificial intelligence techniques for traditional and modern computer games, and characterize their performance on a range of tasks.

Course Structure

Students will be given three multi-week homework assignments, or mini-projects, related to the lecture material. These assignments will require students to implement and/or evaluate some of the algorithms or techniques we are covering during course lectures. All students will be evaluated with a midterm and a final
exam. In addition, students enrolled in CSC584 will conduct a semester-long project implementing an AI technique of their choosing in a game of their choosing.

Course Policies

Homework:

Students will submit homework individually unless otherwise specified in the assignment (see the section on "Academic Integrity"). The assignments will either be posted on the course webpage or distributed in class. If a student is unable to attend class, it is their responsibility to determine if an assignment was given.

Homework Grading:

Homework submissions will be graded according to the criteria outlined in the assignment. Missing components or lateness will be penalized accordingly.

Late Assignments:

Completed assignments should be turned in by the beginning of the class period on the date they are due. For assignments for which email or other electronic submission is requested, the submission should be completed before the start of the class period on the date they are due. Every student has four 24 hour periods which they may allocate to late assignments throughout the semester at a cost of five points per fraction of 24 hour period. Once the allotment of four days has been used, there will be no more late submissions accepted. For example, a student who submits the first assignment two days, three hours, and 27 minutes late (and receives 15 points off of their grade) only has one 24 hour period remaining for all subsequent assignments.

Valid excuses as determined by the university's attendance policy (http://policies.ncsu.edu/regulation/reg-02-20-03) such as illnesses with a note from a doctor or a death in the family (with documentation) will be granted extensions to deadlines, provided the documentation is presented to the instructor in a timely manner. Other extensions may be granted for other scholarly activities provided arrangements are made with the instructor well in advance of the deadline.

Exams:

This course will have two exams: a midterm and a final. The midterm will be given in class on (or about) 2/29/16. The final exam is scheduled from 1:00pm - 4:00pm on 5/2/16. Both exams will take place in EB2 1231. Both 484 and 584 students will take the same exam; however, 584 students will be graded out of 110 points whereas 484 students will be graded out of 100 points.

Course Project (for 584 students only):

Students will be evaluated using a semester-long group project on a topic of their choosing (approved by the instructor). Details about the project, grading desiderata, and deadlines can be found on the course webpage and will be distributed in class well in advance of any deadlines. Students are highly encouraged to work closely with the instructor on their project or to seek out a separate faculty mentor. Periodically throughout the semester, students will be asked to present updates on their progress to the instructor.
**Attendance:**

Attendance at class sessions is not required; however, unexcused absences that result in late assignments or missed announcements may negatively affect students' grades. Documented medical excuses or other excused absences will not adversely affect grades. Conference travel or other scholarly duties discussed well in advance of a missed session may be excused at the discretion of the instructor.

While regular attendance of lectures is not required, it is **STRONGLY** encouraged. In addition, attendance on 4/20/16 and 4/25/16 is required for all students. **Unexcused absences from class on those days will result in a 10 point reduction of your final grade for each session missed.**

**Final Grades and Extra Credit:**

At the discretion of the instructor, extra credit opportunities may be offered throughout the semester. The number and value of those opportunities will be solely up to the instructor and will be available to everyone in the course. No individual extra credit opportunities or makeup work will be allowed.

Final grades will be determined by a weighted average of all assignments including late penalties and extra credit. Final grades will not be rounded up or down.

**Instructors**

**Dr David L Roberts** (dlober4) - **Instructor**

Email: robertsd@csc.ncsu.edu  
Web Page: [http://www.csc.ncsu.edu/faculty/robertsd/](http://www.csc.ncsu.edu/faculty/robertsd/)  
Phone: 919-513-7182  
Office Location: Venture 2 Suite 530  
Office Hours: TBD, and by appointment. Note, the hallway to my office is generally locked, so please call for entry when coming to office hours or meetings. You are welcome to stop by my office at any time, but my presence does not indicate availability to meet.

**Mingyang Xu** (mxu5) - **Teaching Assistant**

Email: mxu5@ncsu.edu  
Phone: none  
Office Location: Engineering Building II (EB2)  
Office Hours: TBD

**Brian Patrick Clee** (bpclee) - **Teaching Assistant**

Email: bpclee@ncsu.edu  
Phone: none  
Office Location: Engineering Building II (EB2)  
Office Hours: TBD

**Course Meetings**

**Lecture**

Days: MW  
Time: 1:30pm - 2:45pm  
Campus: Centennial
Location: EB2 1231
This meeting is optional.

Meeting Notes
Note: lecture attendance on 4/20/16 and 4/25/16 is mandatory for all students. Attendance will be taken, and failure to attend will result in a 10 point reduction of your final grade.

Course Materials

Textbooks
Artificial Intelligence for Games, Second Edition - Ian Millington and John Funge
Edition: Second
ISBN: 0123747317
Cost: $57.61
This textbook is optional.

Expenses
None.

Materials
None.

Requisites and Restrictions

Prerequisites
For 484: CSC 316.

For 584: None.

Co-requisites
None.

Restrictions
For 484: None.

For 584: Open to MS or Ph.D. students in the CSC Department, or Senior CSC Undergraduates.

General Education Program (GEP) Information

GEP Category
This course does not fulfill a General Education Program category.

GEP Co-requisites
This course does not fulfill a General Education Program co-requisite.

Transportation
This course will not require students to provide their own transportation. Non-scheduled class time for field trips or out-of-class activities is NOT required for this class.
Safety & Risk Assumptions
None.

Grading

Grade Components

<table>
<thead>
<tr>
<th>Component</th>
<th>Weight</th>
<th>Details</th>
</tr>
</thead>
<tbody>
<tr>
<td>584 Homeworks</td>
<td>50</td>
<td>There will be three homework assignments.</td>
</tr>
<tr>
<td>584 Midterm Exam</td>
<td>10</td>
<td>The midterm exam will be given in class.</td>
</tr>
<tr>
<td>584 Final Exam</td>
<td>20</td>
<td>The final exam will be cumulative and given during the scheduled final exam period.</td>
</tr>
<tr>
<td>584 Course Project</td>
<td>20</td>
<td>Students will work on a semester-long project of their choosing. Note, all 584 students must complete the course project. Failure to complete the course project will result in a F in the course.</td>
</tr>
<tr>
<td>484 Homeworks</td>
<td>60</td>
<td>There will be three homework assignments.</td>
</tr>
<tr>
<td>484 Midterm Exam</td>
<td>15</td>
<td>The midterm exam will be given in class.</td>
</tr>
<tr>
<td>484 Final Exam</td>
<td>25</td>
<td>The final exam will be cumulative and given during the scheduled final exam period.</td>
</tr>
</tbody>
</table>

Letter Grades

This Course uses Standard NCSU Letter Grading:

<table>
<thead>
<tr>
<th>Grade</th>
<th>Score</th>
</tr>
</thead>
<tbody>
<tr>
<td>A+</td>
<td>97</td>
</tr>
<tr>
<td>A</td>
<td>93</td>
</tr>
<tr>
<td>A-</td>
<td>90</td>
</tr>
<tr>
<td>B+</td>
<td>87</td>
</tr>
<tr>
<td>B</td>
<td>83</td>
</tr>
<tr>
<td>B-</td>
<td>80</td>
</tr>
<tr>
<td>C+</td>
<td>77</td>
</tr>
<tr>
<td>C</td>
<td>73</td>
</tr>
<tr>
<td>C-</td>
<td>70</td>
</tr>
<tr>
<td>D+</td>
<td>67</td>
</tr>
<tr>
<td>D</td>
<td>63</td>
</tr>
<tr>
<td>D-</td>
<td>60</td>
</tr>
<tr>
<td>F</td>
<td>0</td>
</tr>
</tbody>
</table>

Requirements for Credit-Only (S/U) Grading

Performance in research, seminar and independent study types of courses (6xx and 8xx) is evaluated as either "S" (Satisfactory) or "U" (Unsatisfactory), and these grades are not used in computing the grade point average. For credit only courses (S/U) the requirements necessary to obtain the grade of "S" must be
clearly outlined.
In order to receive a grade of S, students are required to take all exams and quizzes, complete all assignments, and earn a grade of C- or better. Conversion from letter grading to credit only (S/U) grading is subject to university deadlines. Refer to the Registration and Records calendar for deadlines related to grading. For more details refer to http://policies.ncsu.edu/regulation/reg-02-20-15

Requirements for Auditors (AU)

Information about and requirements for auditing a course can be found at http://policies.ncsu.edu/regulation/reg-02-20-04.

There are no requirements for students wishing to audit CSC484.

Students wishing to audit CSC584 must complete the project. Auditing students will not be required to do the homework assignments or take the exams.

Policies on Incomplete Grades

If an extended deadline is not authorized by the Graduate School, an unfinished incomplete grade will automatically change to an F after either (a) the end of the next regular semester in which the student is enrolled (not including summer sessions), or (b) by the end of 12 months if the student is not enrolled, whichever is shorter. Incompletes that change to F will count as an attempted course on transcripts. The burden of fulfilling an incomplete grade is the responsibility of the student. The university policy on incomplete grades is located at http://policies.ncsu.edu/regulation/reg-02-50-03. Additional information relative to incomplete grades for graduate students can be found in the Graduate Administrative Handbook in Section 3.18.F at http://www.fis.ncsu.edu/grad_publicns/handbook/

For students enrolled in 484:

If an extended deadline is not authorized by the instructor or department, an unfinished incomplete grade will automatically change to an F after either (a) the end of the next regular semester in which the student is enrolled (not including summer sessions), or (b) the end of 12 months if the student is not enrolled, whichever is shorter. Incompletes that change to F will count as an attempted course on transcripts. The burden of fulfilling an incomplete grade is the responsibility of the student. The university policy on incomplete grades is located at http://policies.ncsu.edu/regulation/reg-02-50-03

Late Assignments

Completed assignments should be turned in by the beginning of the class period on the date they are due. For assignments for which email or other electronic submission is requested, the submission should be completed before the start of the class period on the date they are due. Every student has four 24 hour periods which they may allocate to late assignments throughout the semester at a cost of five points per fraction of 24 hour period. Once the allotment of four days has been used, there will be no more late submissions accepted. For example, a student who submits the first assignment two days, three hours, and 27 minutes late (and receives 15 points off of their grade) only has one 24 hour period remaining for all subsequent assignments.
Valid excuses as determined by the university's attendance policy (http://policies.ncsu.edu/regulation/reg-02-20-03) such as illnesses with a note from a doctor or a death in the family (with documentation) will be granted extensions to deadlines, provided the documentation is presented to the instructor in a timely manner. Other extensions may be granted for other scholarly activities provided arrangements are made with the instructor well in advance of the deadline.

**Attendance Policy**

For complete attendance and excused absence policies, please see http://policies.ncsu.edu/regulation/reg-02-20-03

**Attendance Policy**

Attendance at class sessions is not required; however, absences that are unexcused according to the university's excused absence policy (http://policies.ncsu.edu/regulation/reg-02-20-03) and that result in late assignments or missed announcements may negatively affect students' grades. Documented medical excuses or other excused absences will not adversely affect grades. Conference travel or other scholarly duties discussed well in advance of a missed session may be excused at the discretion of the instructor.

While regular attendance of lectures is not required, it is STRONGLY encouraged. In addition, attendance on 4/20/15 and 4/22/15 is required for all students. **Unexcused absences from class on those days will result in a 10 point reduction of your final grade for each session missed.**

**Absences Policy**

While attendance is not required at class sessions, the university's excused absense policy (http://policies.ncsu.edu/regulation/reg-02-20-03) will be used to determine when assignments are considered late or not.

**Makeup Work Policy**

No makeup work will be given.

**Additional Excuses Policy**

None.

**Academic Integrity**

**Academic Integrity**

Students are required to comply with the university policy on academic integrity found in the Code of Student Conduct found at http://policies.ncsu.edu/policy/pol-11-35-01

None.

**Academic Honesty**

See http://policies.ncsu.edu/policy/pol-11-35-01 for a detailed explanation of academic honesty.

None.

**Honor Pledge**
Your signature on any test or assignment indicates "I have neither given nor received unauthorized aid on this test or assignment." Additionally, by submitting an assignment via moodle you are certifying that you "have neither given nor received unauthorized aid on this test or assignment." It is your responsibility to safeguard your password and limit access to your moodle account.

**Electronically-Hosted Course Components**

Students may be required to disclose personally identifiable information to other students in the course, via electronic tools like email or web-postings, where relevant to the course. Examples include online discussions of class topics, and posting of student coursework. All students are expected to respect the privacy of each other by not sharing or using such information outside the course.

**Electronically-hosted Components:** Moodle will be used for supplementary course discussions and for assignment submissions.

**Accommodations for Disabilities**

Reasonable accommodations will be made for students with verifiable disabilities. In order to take advantage of available accommodations, student must register with the Disability Services Office ([http://www.ncsu.edu/dso](http://www.ncsu.edu/dso)), 919-515-7653. For more information on NC State's policy on working with students with disabilities, please see the Academic Accommodations for Students with Disabilities Regulation at [http://policies.ncsu.edu/regulation/reg-02-20-01](http://policies.ncsu.edu/regulation/reg-02-20-01).

**Non-Discrimination Policy**

NC State University provides equality of opportunity in education and employment for all students and employees. Accordingly, NC State affirms its commitment to maintain a work environment for all employees and an academic environment for all students that is free from all forms of discrimination. Discrimination based on race, color, religion, creed, sex, national origin, age, disability, veteran status, or sexual orientation is a violation of state and federal law and/or NC State University policy and will not be tolerated. Harassment of any person (either in the form of quid pro quo or creation of a hostile environment) based on race, color, religion, creed, sex, national origin, age, disability, veteran status, or sexual orientation also is a violation of state and federal law and/or NC State University policy and will not be tolerated. Retaliation against any person who complains about discrimination is also prohibited. NC State's policies and regulations covering discrimination, harassment, and retaliation may be accessed at [http://policies.ncsu.edu/policy/pol-04-25-05](http://policies.ncsu.edu/policy/pol-04-25-05) or [http://www.ncsu.edu/equal_op/](http://www.ncsu.edu/equal_op/). Any person who feels that he or she has been the subject of prohibited discrimination, harassment, or retaliation should contact the Office for Equal Opportunity (OEO) at 919-515-3148.

**Course Schedule**

**NOTE:** The course schedule is subject to change.

**Lecture MW 1:30pm - 2:45pm — Spring 2016 Semester — 01/06/2016 - 04/25/2016**

The schedule is subject to change pending student interests and background. The official schedule will be kept on the course webpage here: [http://www.csc.ncsu.edu/faculty/robertsd/csc584484s14/schedule.php](http://www.csc.ncsu.edu/faculty/robertsd/csc584484s14/schedule.php). The official schedule will be updated periodically to reflect changes as the semester progresses. It is the student's responsibility to check the schedule regularly for changes. The instructor will communicate any changes in deadlines to students in a timely manner via email and/or announcements in class. Note, it is the student's responsibility to check their official NCSU email address at least once daily and to come to class. Failure to do so does not excuse missed deadlines.
Lecture 1--2: Introduction, course overview, artificial stupidity, intelligent mistakes, models of game AI, data structures, representations, complexity, and constraints

Lecture 3--8: Movement: kinematics, steering behaviors, coordinated movement

Lecture 9--12: Pathfinding: pathfinding graphs, Dijkstra, A*, hierarchical pathfinding, motion planning

Lecture 13--17: Decision making: decision trees, state machines, behavior trees, fuzzy logic, goal-oriented behavior, scripting

Lecture 18--22: Learning: decision tree learning, naive bayes, reinforcement learning, artificial neural networks

Lecture 23--26: Game Playing: game theory, minimax, transposition tables, opening books and set plays, turn-based strategy games

Lecture 27--28: 584 Project Presentations