Welcome to CPSC 8810. This course is designed to introduce you to the state-of-the art in AI, motion planning and other technologies with a focus on robotics and computer graphics. There are many exciting topics in the field. I am happy to adjust what is covered based on the interests of those in the class. Please let me know if there is something in particular which interests you or you’d like us to cover.

Basic Information
Instructor: Ioannis Karamouzas
E-mail: ioannis@g.clemson.edu
Class: M/W 4pm - 5:15pm, McAdams 110E and ZFGEC 102
Office: ZFGEC 510
Office Hours: Tuesdays 3-4pm. I’m generally available if you have questions about the course, or just want to chat about new ideas. I will divide my time between the Clemson main campus, and the Charleston satellite campus.

Course Overview
Course Objective
The main goal of this course is to expose students to motion planning and AI techniques and to provide them experience with implementing these techniques in the context of robotics, and interactive computer graphics. A secondary goal for this course is that students develop and exercise the skills needed to to undertake independent work on the cutting edge of a discipline.

Outline
1. Local Navigation
   ○ Velocity Obstacles
   ○ Probabilistic crowd data analysis
   ○ Power law (aka TTC) model
   ○ Uncertainty TTC
2. Search Algorithms - Discrete Planning
   - A*, D*
   - Dynamic Programming
   - Stochastic search (Monte Carlo Tree Search)
3. Motion Planning
   - The Piano mover’s problem
   - Configuration space
   - Sampling-based planning (PRM, RRT, RRT*)
4. Sensors, Robot Localization and Mapping
   - Histogram Filtering
   - Particle Filtering
   - Graph SLAM
5. Numerical Optimization for PBA
   - Intro to numerical analysis
   - Equation solving and optimization
   - Time integration and implicit methods
   - Mass-spring systems

Course Materials
There is no textbook for the course. Selected articles and course notes will be made available as the course goes on. The following resources are likely to be useful:

- Steven LaValle’s book on Motion Planning
- Sebastian Thrun, Wolfram Burgard, and Dieter Fox’s book on Probabilistic Robotics
- Witkin and Baraff’s course notes on Physically Based Modeling
- Jason O’Kane’s Introduction to ROS

Prerequisites
I expect students to have some programming experience and mathematical fluency. The students should also have been exposed to at least some of the following topics at the undergraduate level: calculus, computer graphics, artificial intelligence, and statistics.

Evaluation
Course Work
This class will have about 3-4 programming assignments, a final programming project, and student presentations. The final project and student presentations can be completed in small groups. There will be no final exam, but students will be asked to give a presentation of their final project during exam time and turn in a brief write-up.

Homework Assignments
Programming assignments will be given bi-weekly during the first portion of the course; the last month and a half will be reserved for you to work on the final project. To be on time, work must be submitted before midnight of the due date. A late penalty of 1/2 point will be applied for each of the first seven days that a project is late. No project will be accepted beyond seven days from the due date. Homework problems will be graded using a 10 point scale. The final programming assignment average will be computed by averaging the student’s assignment scores.

The details of each assignment are subject to change, but here is a list of type of typical projects that will be assigned:

- **Sampling-Based Local Navigation**
- **PowerLaw Navigation under Uncertainty**
- **Discrete Planning of a Simple Car**
- **Particle Filtering Localization**

**Student Presentation**
Students will work in small groups to prepare a 10-minute lecture that presents a recent paper from the field. I will provide a list of suggested recent papers on the course webpage. The students are welcomed to suggest their own preferred papers.

**Final Project**
You must submit a proposal of the project you intend to do by 03/14. This written proposal should describe the proposed project in enough detail that both you and the instructor know fairly precisely what is to be done, and what principles from the course that will be emphasized. I will provide a list of suggested projects, but feel free to suggest anything that excites you. The project can be either simulation-based or involve implementation on an actual robot.

The final project will be graded on a 100 point scale, and will be based on the instructor’s judgement. A late penalty of 5 points will be applied for each of the first five days that a project is late. No project will be accepted beyond five days from the due date. At the end of the semester, you need to submit your code and a write up explaining what you did. Presentations of the final projects will take place during the exam week.

**Grading**
Students will be evaluated on in-class participation, programming assignments, and a final project. There is no final exam. The grade breakdown is as follows:

- Assignments: 40%
- Final Project: 40%
- Student Presentations: 10%
- Class Participation: 10%
Class Participation
The class participation grade is the instructor's subjective judgement of the student's contribution to a lively classroom atmosphere. He will consider mainly active, informed participation in classroom discussions, homework reviews, etc.

Disability Access
It is University policy to provide, on a flexible and individualized basis, reasonable accommodations to students who have disabilities. Students are encouraged to contact Student Disability Services to discuss their individual needs for accommodation.

Academic Integrity
As members of the Clemson University community, we have inherited Thomas Green Clemson's vision of this institution as a 'high seminary of learning.' Fundamental to this vision is a mutual commitment to truthfulness, honor, and responsibility, without which we cannot earn the trust and respect of others. Furthermore, we recognize that academic dishonesty detracts from the value of a Clemson degree. Therefore, we shall not tolerate lying, cheating, or stealing in any form. In instances where academic standards may have been compromised, Clemson University has a responsibility to respond appropriately and expeditiously to charges of violations of academic integrity.