Course Title: ***Motion Planning***
Course Code:
Instructor: Aniket Bera
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Office:
Office Hours:

Course Description:
This course will provide students with an in-depth understanding of motion planning techniques applied to crowd simulation and robotics applications. Students will learn about various algorithms and approaches to handle complex, dynamic environments and will work on projects that tackle real-world challenges. The course will cover topics such as pathfinding, crowd modeling, multi-agent systems, and robot navigation in complex environments. Students will gain hands-on experience through lab sessions, individual assignments, and a final project.

Prerequisites:
- Introductory programming course (e.g., Python, C++)
- Basic knowledge of linear algebra and calculus
- Background in artificial intelligence, computer vision, or robotics is recommended but not required

Course Objectives:
Upon successful completion of this course, students will be able to:
1. Understand and analyze various motion planning techniques
2. Implement crowd simulation and robot navigation algorithms
3. Develop solutions for real-world challenges involving crowd simulation and robotics applications
4. Evaluate the performance of motion planning algorithms in complex, dynamic environments
5. Communicate technical concepts and project results effectively

Course Outline:
Week 1: Introduction to Motion Planning
- Overview of motion planning in crowd simulation and robotics
- Problem formulation and representation
- Basic concepts: configuration space, roadmap, graph search

Week 2: Pathfinding Algorithms
- Dijkstra's algorithm
- A* search
- Dynamic pathfinding

Week 3: Crowd Modeling and Simulation
- Agent-based modeling
- Cellular automata

- Social force models

Week 4: Multi-Agent Systems and Coordination
- Decentralized motion planning
- Coordination algorithms
- Swarm intelligence

Week 5: Sampling-based Motion Planning
- Probabilistic Roadmap (PRM)
- Rapidly-exploring Random Trees (RRT)

Week 6: Optimization-based Motion Planning
- Trajectory optimization
- Model predictive control
- Reinforcement learning

Week 7: Robot Navigation in Complex Environments
- Mapping and localization
- Sensor fusion
- Obstacle detection and avoidance

Week 8: Human-Robot Interaction and Collaboration
- Socially-aware motion planning
- Human-aware navigation
- Shared control and teleoperation

Week 9-11: Lab Sessions and Project Development
- Hands-on experience with motion planning tools and libraries
- Project proposal and development
- Intermediate project presentations

Week 12-13: Advanced Topics and Applications
- Scalability and real-time performance
- Machine learning for motion planning
- Applications in autonomous vehicles, drones, and more

Week 14: Final Project Presentations and Course Wrap-up
- Final project presentations
- Course review and future directions

Assessment and Grading:
- **Assignments (40%)**
- **Final project (50%)**
- **Participation and in-class activities (10%)**

Required Textbook:

There is no required textbook for this course. Lecture notes, research papers, and online resources will be provided throughout the course.

Course Policies:
- Late submissions will be penalized by a 10% reduction in grade for each day late.

- Academic dishonesty, including plagiarism and cheating, will not be tolerated and may result in a failing grade for the assignment or the entire course.
- Students are encouraged to actively participate in class discussions and ask questions to enhance their understanding of the course material.

*This syllabus is subject to change at the discretion of the instructor. Any changes will be communicated to the students in a timely manner.