COL864: Special Topics in AI

Semester II, 2020-21

Course Organization

Rohan Paul

Course Information

- Name
  - COL864: Special Topics in AI
  - Topic: Planning and Estimation for Autonomous Systems
  - Credits: 3
  - LTP: 3-0-0
- Timing
  - Slot AD
  - Tuesday and Friday. 3:30pm – 5:00pm.

Course Information

- Instructor
  - Rohan Paul
  - Email: rohanp@csail.mit.edu
  - Website: https://www.cse.iitd.ac.in/~rohanpaul/teaching

- Teaching Assistant
  - Mr. Vikas Upadhyay
  - Email: anz188059@iitd.ac.in

Teaching Mode

- Lectures
  - Microsoft Teams account created by the institute as per registration.
  - Combination of live sessions and asynchronous recorded material.
  - Class recordings will be made available on Impartus.
  - Any slide material will be made available.
  - Extra teaching days may be utilized (discretionary and with prior notification).

- Communication
  - Class mailing lists: col864@cse.iitd.ac.in.

Who should take this course?

- Relevant Background
  - Introduction to Artificial Intelligence (COL333-671) or Introduction to Machine Learning (COL774 or equivalent).
  - Programming proficiency (Python and ability to install/work with external libraries on your own).
  - Knowledge of probabilistic models, basic deep learning, basic search algorithms, Markov Processes.

Evaluation Scheme

- Examination component: 60%
  - Minor 20% and Major 40%
- Practical component: 40%
  - Assignments (1-2)
  - Independent investigation & presentation (details will follow)
- Margin: 5%-10% (discretionary)

Other Guidelines

- Audit Pass (NP) Criteria
  - Options: (i) 40% of the total score (with 30% in theory and 30% in practical) or (ii) C grade overall.
- Pass Requirement for Credit
  - 30% of the total score.
- Attendance
  - Class attendance and interaction is encouraged.
  - Clarifications will be provided only in class. The student is requested to track announcements and clarifications given in class.

Assignments

- Detailed instructions will be provided for each assignment submission.
- Assignments can be done individually or in pairs (choice is left to the students).
- Python/C++ and ability to install/work with external libraries if required for an assignment on your own.
- Submissions only on Moodle or any other modality specified by the TA (not over email).
- The submission time will be 5pm.
- Any delays beyond the submission time will result in late penalty of 10% per day (from the submission day and time).
- There will be no deadline extensions.
- Any changes to the code after submission is not permitted.

Exams

- Proctored online exam on MS Teams.
- Hand-written responses that are to be scanned and uploaded.
- Submission on Gradescope (or any other method communicated by the TA).
- Any changes in exam logistics (if any) will be communicated to the class prior to the examination.
- Only hand-written class notes are permitted in the exam. No digital material is allowed. A non-programmable scientific calculator is permitted.

Other Emergencies

- Requests for late submission on the grounds of medical emergencies must be accompanied with a medical certificate from a qualified doctor indicating that you were unwell in the period of submission and a proof of prescription. Provided to the TA before the submission deadline not afterwards.
- Any other requests on other grounds such as law and order, basic infrastructure must be accompanied with written proof.
  - Formal proof and verification is necessary for consideration of any such requests.
  - Any decision will be taken on those as per institute guidelines and consideration of the documents. The documents may be submitted in the Department as per institute guidelines.
- Any request to appear in the re-minor will require formal proof that you were unwell or exceptional circumstances prevailed during the minor due to which you could not appear. The proof will be used by the Department and the Dean to decide if a re-minor will be permitted on not.

Honor Code Violations

- Please listen to your conscience. Please do not cheat.
  - Please write code or other written submissions from scratch independently. Sharing of code or parts of it or posting it online will constitute a violation of the honor code.
  - We are duty bound to follow the disciplinary procedures of the Department and the Institute in this regard.
  - Code similarity s/w e.g., MOSS may be used check plagiarism in code and results may be released.
  - Only submit work from your own efforts. Do not look at or refer to code written by anyone else. You may discuss the problem, however the code implementation must be original. Discussion will not be grounds to justify software plagiarism.
  - Submission of code written by some one else or form internet sources will be excluded from any evaluation.

Honor Code Violations

- Plagiarism Policy
  - Plagiarism in assignment/exam will result in zero in the assignment/exam and an additional penalty on an absolute scale (at least -10). Department and institute procedures such as DISCO and an F-grade will follow.
  - Copying or cheating in even a sub-part of an assignment or an exam will be counted as plagiarism in the whole assignment/exam. The whole assignment and exam will be made void with additional penalties and Dept. procedures.
  - Note that the entire assignment and the exam is considered as one unit.
  - Names will be released/forwarded to the Dept. and the institute as per guidelines.

Focus

- Autonomous Systems
  - Systems capable of sensing, decision making and interacting with the physical world.
  - Intelligent Robotic Systems
  - Modern take: Embodied Artificial Intelligence (EAI).
- Core
  - Planning and decision-making
  - Estimation or Inference.
  - Uncertainty.
- Relation with AI and Learning
  - From an AI perspective, it is an intelligent agent operating in domains that are imperfect and uncertain.
  - Requires models and algorithm to enable intelligent behavior
- This course will cover the foundation tools required to understand modern day intelligent robotic systems.

Topics

- Introduction
- State Estimation
- Task Planning
- Planning under Uncertainty
- Reinforcement learning (relevant applications)
- POMDPs
- Information Gathering, Human-robot interaction, applications of neural models, scene understanding etc. (if time permits).
- The topic list is tentative and will be updated as the lectures are presented.

Books and References

- Primary resource is the **lecture material**.
- Books
  - Material is derived from various sources. The relevant sections will be indicated on the course webpage.
    - **Artificial Intelligence: A Modern Approach (3rd Edition). Russell, Stuart J., and Peter Norvig. Link.**
    - Sebastian Thrun, Wolfram Burgard and Dieter Fox. Probabilistic Robotics. MIT Press, 2005.
    - Reinforcement Learning (Second Edition). Richard Sutton and Andrew Barto. MIT Press. 2018. Online.
    - Deep Learning. Ian Goodfellow, Yoshua Bengio and Aaron Courville. Online.
    - Mykel Kochenderfer, Decision Making Under Uncertainty
    - Steven LaValle. Planning Algorithms. Cambridge University Press, 2006.
- Paper references
  - Any paper references mentioned will be provided on the course webpage.

Learning Objectives

- At the end of the course students will model a robotic system (e.g., a ground robot or manipulator) as a decision-making AI and Learning agent.
- Students will be able to formulate/solve relevant planning and estimation problems in this domain.
- Understand how to incorporate recent learning-based methods decision-making algorithms.
- Undertake independent project work in this area.

Other Information

- This course will focus on AI aspects of autonomous systems.
- A robotic system (ground/air vehicle or manipulator) will be modeled as an AI agent capable of sensing and taking simple actions in the environment.
- The detail control and physical aspects of the system will be abstracted to a certain degree for the models discussed in the course.
- In future offerings experimental component with a real system is likely to be added but is beyond scope in the current offering.

Next Time

- This Class
  - Course Organization
- Next Class
  - Introduction