16.410/413
Principles of Autonomy and Decision Making

Lecture 1: Introduction to the course

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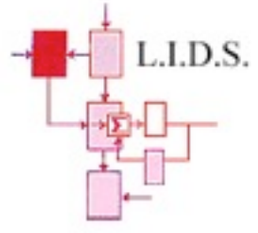

Outline

- Introduction
  - Examples of autonomy in aerospace systems and robotics
- Syllabus
  - Course Objectives
  - Course Staff
  - Logistics
  - Assignments and Grading
- Course Overview

Textbooks and programming languages

- Primary textbook:
  - **[AIMA]** “Artificial Intelligence: A Modern Approach,” by S. Russell and P. Norvig (Prentice Hall), 3nd Edition

- Other recommended textbooks:
  - **[PA]** “Planning Algorithms,” by S. LaValle (Cambridge Press), available at http://planning.cs.uiuc.edu/
  - **[IOR]** “Introduction to Operations Research,” by F. S. Hillier and G. J. Lieberman (McGraw-Hill).

- Programming:
  - All programming in this course will be done in Java.
  - A good Java reference is
    [JINS] “Java in a Nutshell” by D. Flanagan (O'Reilly).

Assignments and Grading

- Reading assignments
  - We highly recommend reading the assigned material before the lecture in which it will be covered

- Problem sets:
  - Problem sets are released weekly, and will include
    - modeling/analysis problems;
    - programming assignments;
  - Problem sets are due in class, or to the course administrator by 4:45pm of the due date, unless otherwise indicated, or arranged **in advance** with the instructors.

- Exams:
  - There will be a mid-term exam on Oct 20 (mark the date), and a final exam

Assignments and grading (cont'd)

- Term project:
  - Students in 16.413 will be required to complete a project (to be discussed)

- Grading schemes:
  - Your grade in 16.410 or 16.413 will be determined according to the following **approximate** weights (adjustments may be made based on factors such as, e.g., class participation):
  - 16.410: mid-term (25%), final (40%), and psets (35%)
  - 16.413: mid-term (20%), final (35%), project (20%), and psets (25%)

- Furthermore:
  - Must complete all assignments for a passing grade.
  - Late assignments lose 20% per day (or fraction) after the deadline.
  - Exams will be closed-book, with one sheet of handwritten notes allowed

Tentative Schedule

- **Introduction**:
  - 9/8,W: Course objectives, logistics, and overview

- **State-space search:**
  - 9/13,M: Formulating problem solving as state-space search
  - 9/15,W: Analysis of uninformed search

- **Global path planning:**
  - 9/21, M: Formulating Path Planning using Roadmaps.

- **Constraint Programming**
  - 9/22, W: Visual interpretation and scheduling
  - 9/27, M: Constraint satisfaction

Tentative schedule

- **Propositional Logic**
  - 9/29, W: Propositional Formulas, Models and Propositional Satisfiability, Propositional Inference and Entailment

- **Activity Planning and Execution**
  - 10/4, M: Operator-based Planning Problems and Plan Graphs, Plan Generation using Plan Graphs.
  - 10/6, W: Planning and Execution in a Changing World.

- **Autonomy architecture and case studies**
  - 10/13, W: Space probes, vehicles and human-robot coordination
  - 10/18, M: TBD

- ***10/20, W: Midterm Exam***

Tentative schedule

- **Constraint Optimization**
  - 10/25, M: Finite-domain constraint optimization, Conflict learning.
  - 10/27, W: Consistency-based diagnosis, Multiple-fault diagnosis, Mode estimation and active probing

- **Global Path Planning (cont'd)**
  - 11/1, M: Exploring Roadmaps using Informed Search. Weighted graphs; shortest path problems; DP, A*, B&B.
  - 11/3, W: Incremental sampling methods, PRM/RRT/RRT*

- **Mathematical Programming**
  - 11/8, M: Formulating planning, scheduling, and resource allocation problems as mathematical programs
  - 11/10, W: Linear Programs (LPs): The simplex algorithm.
  - 11/15, M: Mixed-Integer Linear Programs (MILPs)

Tentative schedule

- **Reasoning in an uncertain world**
  - 11/17, W: Probabilistic Inference, graphical models.

- **Sensing in an uncertain world**
  - 11/22, M: Hidden Markov Models (HMMs): robot localization and mapping
  - 11/24, W: HMMs: algorithms

- **Acting in an uncertain world**
  - 11/29, M: Dynamic programming and stochastic control, Markov Decision Processes (MDPs)

- **Acting in an adversarial world**
  - 12/6, M: Matrix and sequential games, alpha-beta pruning
  - 12/8, W: Mechanism design and auctions. Introduction to differential games, pursuit-evasion, and collision avoidance.

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