Course Syllabus

Introduction

In this course, you will learn how to program all the major systems of a robotic car based on lectures from the former leader of Google's and Stanford's autonomous driving teams, Sebastian Thrun. You will learn some of the basic techniques in artificial intelligence, including probabilistic inference, planning and search algorithms, localization, tracking, and PID control, all with a focus on robotics. Extensive programming examples and assignments in Python will apply these methods in the context of autonomous vehicles.

Learning objectives

Upon successfully completing this course, you will be able to:

- Implement filters (including Kalman and particle filters) in order to localize moving objects whose locations are subject to noise.
- Implement search algorithms (including A*) to plan the shortest path from one point to another subject to costs on different types of movement.
- Implement PID controls to smoothly correct an autonomous robot's course.
- Implement a SLAM algorithm for a robot moving in at least two dimensions.

Prerequisites

Success in this course requires programming experience and some mathematical fluency. **Programming in this course is done in Python 3**. We will use some basic object-oriented concepts to model robot motion and perception. If you don't know Python but have experience with another language, you should be able to pick up the syntax fairly quickly but *must budget extra time for learning a new programming language*. If you are NOT fluent in some programming language already, learning python and coding the projects will be extremely time consuming. The math used will primarily be probability and linear algebra. You need not be an expert in either, but some familiarity with concepts in probability (e.g., that probabilities must add up to one, the definition of conditional probability, and Bayes' rule) will be extremely helpful and reduce the amount of time you will need to spend (re)learning the mathematical underpinnings.

Dramatis personæ

Course Creator: Dr. Sebastian Thrun
Instructor of Record: Dr. Jay Summet <summetj@gatech.edu>

Materials & Websites

There are no required texts for this course; however, a supplementary reading you may find very helpful is Probabilistic Robotics by Wolfram Burgard, Dieter Fox, and Sebastian Thrun. The book provides much of the math and the derivations omitted in Sebastian's lectures.
http://probabilistic-robotics.org/

Lectures and problem sets will be delivered via the Udacity website. The course is a "free" offering, so you can find it at the direct URL: https://classroom.udacity.com/courses/cs373

Once registration is complete, the course will automatically be added to your Georgia Tech Udacity account. (Choose "Sign in with your organization" at the bottom and then the "Sign in with Georgia Tech" option from the Udacity sign-in page.)

The small quizzes throughout the Udacity lectures are not graded, but you must submit Problem Sets using the Gradescope tool in Canvas.

Your grades will be returned and assignment submission (Problem Sets & Projects) will be handled using Canvas. (https://gatech.instructure.com/) Please refer to the course policy guidelines document for further details. Official course announcements will be sent via the "Announcements" tool in Canvas, and will be archived there for viewing. (Replies to announcements and assignments may not be seen, please use Piazza for communication purposes.)

All course communication including public questions about content and private questions about individual grades will be handled via the Piazza website. You will be automatically enrolled in Piazza using your GaTech Official email address. Clarifications to course policies and project specifications may also be discussed on Piazza so it is vital that you maintain awareness of the question & answer content. See the "Using Piazza" in the course policy guidelines document posted on Canvas for more details.

Note that because we use automated tools to download/grade your assignments, *comments posted to assignments in Canvas or Gradescope are not seen*. **All regrade requests must be handled via a private post on Piazza.**

Office Hours

We will hold online office hour sessions throughout the semester using the BlueJeans video conference tool. We will post the office hours schedule on Piazza. The sessions can be viewed live, or you may watch the recordings after the fact. Please submit your questions in advance by posting them in the designated Piazza thread beforehand, or you may ask questions "live" after we answer the pre-posted questions. Dr. Sebastian Thurn may also make guest appearances at office hours to discuss robotics and the course content from an industry standpoint.

Privacy Notice: If you join the live office hour video chat, your voice, image and username will be visible to all other students in the course. You may choose to not export video when asking your (audio only) question, but if you do not wish your voice to be heard, you should ask your questions via the Piazza thread before the video office hour or via the BlueJeans chat feature. We may read aloud the first names of students who choose to ask questions via Piazza. If this is unappealing to you, please feel free to ask your question anonymously on Piazza.

Academic Integrity Policy

All Georgia Tech students, including students in the OMSCS program, must read and uphold the Georgia Tech Academic Honor Code. (http://osi.gatech.edu/content/honor-code)
Georgia Tech expects honest and ethical behavior of you at all times. We will report all incidents of suspected dishonesty to the Office of Student Integrity (OSI). Please refer to the course guidelines document for further details. We actively scan project submissions with automated means to detect cases of plagiarism.

Lecture Viewing Schedule

You are free to view the video lectures on Udacity at any time. We recommend that you view each video lesson before you complete the associated problem set (PS). The due dates for the six PS are designed so that if you have viewed the associated video lessons for each PS by its due date, you will have all of the material needed for each of the projects that are due after the PS. (For example, the Kalman filter project will require material from Lessons 1 and 2, while the Particle Filter project will require material from Lesson 3 – Particle Filters.) We have set up the PS deadlines so that you will complete the video lectures in the first two thirds of the course, leaving time to complete the last two projects at the end of the semester. Note that unlike the problem sets, the projects may be extremely time consuming, so you should start them as soon as they are posted. In some cases you may be working on more than one project or problem set simultaneously.

Important Dates & Deadlines

- Monday, May 11th, 2020 First Day of Class
- Friday, May 15th Registration/Schedule change period ends (4pm ET)
- Monday, May 18th Midnight AOE* – **Problem Set 1 & Syllabus Quiz Due**
- Monday, May 25th Midnight AOE* - **Problem Set 2 Due**
  ** Note: In the USA, Monday May 25th is Memorial Day, so you may wish to submit this problem set early depending upon your plans.**
- Monday, June 1st Midnight AOE* - **Problem Set 3 AND Kalman Filter Project**
- Monday, June 8th Midnight AOE* - **Problem Set 4 Due**
- Monday, June 15th Midnight AOE* - **Particle Filter Project Due**
- Monday, June 22nd Midnight AOE* - **Problem Set 5 Due**
- ***June 27nd*** ***Institute Withdrawal deadline***
- Monday, June 29th Midnight AOE* **- *Mini-Project: PID Due***

  ** Note: School Break occurs July 2nd & 3rd (USA Independence day) **
- Monday, July 6th *Midnight AOE** - **Problem Set 6 Due**
- Monday, July 13th Midnight AOE* - **Search Project Due**
- Monday, July 27th Midnight AOE* - **SLAM Project Due**

Note: As this is a project based course, we have no final exam. The deadline for our final project is during the final exam period and takes the place of a final. We DO NOT recommend you take this course with any other courses in the compressed summer semester, so that you are not trying to balance the final project with studying for another final exam. [OMSCS guidelines is that you take only one course in the summer semester.]

* Midnight AOE = Midnight Anywhere On Earth – You may read this as 8am ET on the following day, but we recommend that you always plan to submit before Midnight your local time to ensure you meet the deadline. You may need to change your Canvas “timezone” settings to your local timezone to avoid timezone confusion.

Grading Policy

Your overall course grade will be calculated from your weighted scores on the following deliverable items:

- 6 problem sets and a Syllabus Quiz (26% total)
- PID mini-project (10%)
- Kalman Filter, Particle Filter, Search and SLAM Project (16% each, 64% total)

- Extra Credit Opportunities: Worried you might end up right below a grade cutoff line? You can earn a small amount of extra credit in several ways, including:
  - Participating in optional hardware challenge assignments (details of which we will announce on Piazza).
  - Exceptional participation and helpfulness on Piazza throughout the semester.

  We will not add extra credit for the challenge assignments or Piazza participation to your overall score. Instead, we will take it into consideration at the end of the semester if you are within two points of the threshold for the next higher letter grade. Note that to achieve the maximum possible (2%) bump, you will need to do all hardware challenges as well as some Piazza Participation.

You will submit all assignments and Problem Sets using the Gradescope online-autograder tool in Canvas, which will tie into the Assignments tool. (See the course guidelines document for more details.) Note that the problem set descriptions are hosted on Udacity, but you will receive no credit/grade for any work submitted to Udacity.

We will post grades using the Gradebook tool in Canvas. We will do our best to return grades to you as quickly as possible. We ask that if you have a concern about a grade received to please notify us via a private post on Piazza within one week of receipt.

The minimum required percentage scores (we do NOT round up) for course letter grades are:

- A: 90.00%
- B: 80.00%
- C: 70.00%
- D: 60.00%

If circumstances warrant, the instructor may lower these grade cutoffs (that is, make them more favorable to your grade) at the end of the semester, although we have not had to do this in the past few semesters.

Disability Services

Georgia Tech is an ADA-compliant educational institution. If you have a disability that requires accommodations, contact Disability Services. To receive accommodations, ask Disability Services to forward the instructor a letter specifying the accommodations you should receive. Do this as soon as possible, as it can take up to 15 business days for the office to process your initial application. http://disabilityservices.gatech.edu/

Online Grading

Using the GradeScope autograder you may submit your work “on-line” at any time before the deadline to have them automatically graded before the due date.

The grade you receive via the “online” autograder is a good indication of the performance of your code, but we reserve the right to re-grade all student code submitted after the deadline using a modified or different set of test cases, *which may increase or decrease* your final grade on that project. [All student projects will be graded using the same set of test cases.] If you fail to submit to GradeScope/Canvas before the deadline it is very likely you will receive a zero.