

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 Summett <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/>

Canvas is the primary website you will be using for this course (<https://gatech.instructure.com/>). Lectures and problem sets will be delivered via Canvas. There is also a version of the course available for free on the Udacity website which you can find it at the direct URL:

<https://classroom.udacity.com/courses/cs373>

You must submit Projects & Problem Sets using the Gradescope tool in Canvas. Your grades will be returned using the Grades tool in Canvas. 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

Georgia Tech aims to cultivate a community based on trust, academic integrity, and honor. Students are expected to act according to the highest ethical standards. For information on Georgia Tech's Academic Honor Code, please visit <http://www.catalog.gatech.edu/policies/honor-code/> or <http://www.catalog.gatech.edu/rules/18/>.

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 or unauthorized collaboration.

Lecture Viewing Schedule

You are free to view the video lectures on Canvas 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, Aug 17th, 2020 First Day of Class
- Friday, Aug 21st Registration/Schedule change period ends (4pm ET)
- Monday, Aug 24th Midnight AOE* – **Syllabus Quiz Due**
(Problem set 0 is ungraded, but strongly encouraged as a way to practice a GradeScope submission, review python basics you will need to know, and ensure your local development environment is set up correctly.)
- Monday, Aug 31st Midnight AOE* - **Problem Set 1 Due**
- Monday, Sep 7th Midnight AOE* - **Problem Set 2 Due**
Note, Monday Sep 7th is Labor day in the US, so you may wish to submit PS2 early depending upon your plans.
- Monday, Sep 14th Midnight AOE* - **Kalman Filter Project Due**
- Monday, Sep 21st Midnight AOE* - **Problem Set 3 Due**
- Monday, Sep 28th Midnight AOE* - **Problem Set 4 Due**
- Monday, Oct 5th Midnight AOE* - **Particle Filter Project Due**
- Monday, Oct 12th Midnight AOE* - **Problem Set 5 Due**
- Monday, Oct 19th Midnight AOE* - **Mini-Project: PID Due**
- **Saturday Oct 24th** **Institute Withdrawal deadline, 4pm ET**
- Monday, Oct 26th Midnight AOE* - **Problem Set 6 Due**
- Monday, Nov 9th Midnight AOE* - **Search Project Due**
- Monday, Nov 30th Midnight AOE* - **SLAM Project Due**
- **Final Exam Period** Thursday Nov 3rd Midnight AOE **through**
Sunday Nov 6th Midnight AOE
(3 days, Friday/Saturday/Sunday)

* 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 well 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 (20% total)
(Problem set 0 is ungraded and for practice only.)
- PID mini-project (10%)
- Kalman Filter, Particle Filter, Search and SLAM Project (15% each, 60% total)
- Final Exam (10%)

- 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 & research 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. The maximum possible bump is 2% of your total course grade. Note that to achieve the maximum possible (2%) bump, you will need to do either all the hardware challenges OR all of the research challenges, as well as some Piazza Participation.

Assignments and Problem Sets are posted in Canvas using the Assignments tool, but you will submit all work using the Gradescope online-autograder tool (linked from Canvas). See the course guidelines document for more details. Note that you will receive *no credit or grade* for any work submitted to the free Udacity course.

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

If you are a student with learning needs that require special accommodation, contact the Office of Disability Services at (404) 894-2563 or <http://disabilityservices.gatech.edu/>, as soon as possible to make an appointment to discuss your special needs and to obtain an accommodations letter.

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.

Student-Faculty Expectations Agreement

At Georgia Tech we believe that it is important to strive for an atmosphere of mutual respect, acknowledgment, and responsibility between faculty members and the student body. See [this catalog page](#) for an articulation of some basic expectations that you can have of me and that I have of you. In the end, simple respect for knowledge, hard work, and cordial interactions will help build the environment we seek. Therefore, I encourage you to remain committed to the ideals of Georgia Tech while in this class.

Statement of Intent for Inclusivity

As a member of the Georgia Tech community, I am committed to creating a learning environment in which all of my students feel safe and included. Because we are individuals with varying needs, I am reliant on your feedback to achieve this goal. To that end, I invite you to enter into dialogue with me about the things I can stop, start, and continue doing to make my classroom an environment in which every student feels valued and can engage actively in our learning community.

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.