CS148
Building Intelligent Robots

Introductory Missive *6 Sep 2005*

CS148 will meet Tuesdays and Thursdays from 9–10:20am. Lecture sessions for CS148 will meet in CIT 368. For lab sessions, the class format will be more informal, with labs and demonstrations of students work in the MSLab (CIT 167). Throughout the semester there will also be FIVE mandatory project demonstrations for the LEGO track.

CS148 will consist of two tracks:

- Lego track: Students in the lego track will be using the LEGO Mindstorms kits throughout the course. As these resources are limited, this track will be limited to 30 students, with one kit to each pair of students. Lego track enrollment will be determined by a lottery weighted towards seniors and concentrators; to be eligible to enter the lottery you must attend the first class and fill out the lottery form you will receive there.
- Advanced track: Students in the advanced track will use the Player/Stage/Gazebo (PSG) robot interface and simulation package for their projects. Because PSG is simulation software, enrollment in the advanced track limited only by the discretion of the instructor. The advanced track will place greater emphasis on project design and implementation.

The current syllabus is available on the course web page, `www.cs.brown.edu/courses/cs148`. Labs and projects will be posted there as they are assigned. Check the web page and course newsgroup, `brown.cs.cs148`, often. Any important announcements posted on the newsgroup will also be posted on the MOTD page.

Course Staff (`cs148tas@cs.brown.edu`)

Professor	Chad Jenkins (`cjenkins`)
Head TA (`cs148headtas@cs.brown.edu`)	Adrienne Trudeau (`atrudeau`)
Teaching Assistants	Dan Hartmann (`dhartman`) Ethan Leland (`eleland`) Adam Chmielewski (`chmielea`)

Class Format

As stated above, CS148 will have both lecture and lab sessions. Lab sessions will be devoted to hands-on learning of general robotics concepts covered in lecture and concepts necessary for assigned projects.

Prerequisites

CS 4 or CS 15/16 or CS 17/18.

Labs and Projects

Labs and projects for CS148 will begin during the second week of the semester.

0.0.1 Lego Track

The lego track will consist of:

- 1 preparatory homework assignment
- 6 laboratory assignments
- 3 project assignments
- 1 midterm project (Robotag)
- 1 open-ended final project

Labs will be posted the Tuesday before the lab. The lab handout will describe the requirements for the lab in addition to what you should do to prepare. Labs should be finished by the end of the session, or checked off by a TA during office hours.

Projects for the lego track will involve an implementation and project writeup to be submitted via the handin script. Each project will have a demonstration period and a project writeup, which will be due two days after the demo. Refer to the Writeups and Handins sections for information about project writeup specifications and electronic submission.

The midterm project will be assigned in late October and last three weeks.

The final will go out in early November and be due at the end of the semester. It is an open-ended project designed by a student team and approved by the course staff.

0.0.2 Advanced Track

The advanced track will consist of:

- 1 preparatory laboratory assignment
- 4 project assignments
- 1 project proposal and reviewing assignment
- 1 open-ended final project

Each project will involve an implementation and project writeup to be submitted via the handin script. Refer to the Writeups and Handins sections for information about project writeup specifications and electronic submission.

The advanced track includes a single longer-term project, consisting of a design, a proposal, and an implementation of a substantial robotics project. Additionally, advanced track students will be required to peer-review other advanced track project proposals, which will be due in mid-October followed by peer reviews due in late October. An advanced track proposal must be approved, or "greenlit", by the instructor. There will be two required intermediate project demonstrations during November. The project will conclude with a final demonstration and submission of a conference-style paper at the end of the semester.

Writeups

The project report is meant to be a scientific reporting on your project, the methods underlying your work, and its basis in the science of robotics. As such, the paper should follow the scientific method: observation, hypothesis, experiment, analysis, and conclusion. It should be objective and scientific in tone (avoid informal writing and use the first person sparingly). Also, the paper should have a central thesis and everything in the report should contribute toward the validity or invalidity of the thesis. The paper should include the following sections:

- Abstract: A short 3-7 sentence description of your work. This should include a high-level version of your central thesis.
- Introduction: The introduction should briefly state the problem and why it is relevant, state the thesis, and give a brief overview of how the paper will validate/invalidate the thesis.
- Approach: The approach describes the technical details of your work. This section includes the underlying design and methodology and relevant details of the technical components. Save comments about future extensions and the quality of the results for the discussion section. Code snippets are acceptable in this section, however, you should not copy your entire program into the report.
- Evaluation: In this section you should present the specific criteria that was used to gauge how the project validates/invalidates your thesis. Presenting the results from multiple runs of your system is encouraged.
- Discussion: This section includes analyses of challenges and problems encountered, the strengths and shortcomings of the project, and potential future extensions. This is also the section where you should discuss why you made certain decisions regarding the methods and implementation of your project. For final projects, this section will also contain brief comparisons to existing work.
- Conclusion: A brief 1-2 paragraph summary of the central thesis, its validity/invalidity, and what was learned from the project.

A final note: illustrations with good captions and labeling are extremely useful. The instructor is a sucker for pretty pictures.

If you do not hand in a writeup, you will receive no credit for the entire project. If you hand in a late writeup, you will receive credit for the physical part of the project, but not the writeup part. (Your maximum grade for the project in this situation is 50%.)

Handins

In order to use the handin script correctly, electronic submissions need to follow a specific format and execute from a Linux machine in the CS department. The submission directory handed in should be a directory with your login as the name. Your login directory should contain your project writeup in PDF format, and another directory labeled "code". The code directory should contain all the source code for the project and a README detailing how to use the code. For the lego track, this readme should detail how to use your code if the TAs were to recreate your project. For the advanced track, the readme should explain how to run your simulation code. The project handouts will provide specific instructions as to how to run the handin script. Typically, the handin script is executed with a command in the format:

```
% cs148_handin <project_id> <submission_directory>
```

Collaboration Policy

Students in the lego track will work in pairs for all of the labs and projects. Unless there are exceptional circumstances, you will work with the same person all semester. For the final, your team may choose to work with another team if you want to do an especially extensive project requiring two RCX bricks. There will be more details about this as the final approaches.

Students in the advanced track will work as individuals for projects. You will be allowed to team with other advanced track students for proposing a final project. The size of such collaborations can vary based on the scope of a proposed project. A single proposal will be submitted for a collaborating group with specific mention to each individual's contribution. Each student within a project collaboration, however, must submit their own paper at the conclusion of the project.

No collaboration is allowed on the project writeups—not even with your partner. You are encouraged to take notes and make diagrams while you're building and programming your robots, but each partner's writeup must contain their own thoughts and ideas and is to be done individually.

While working on a project, collaboration with other groups is allowed up to but not including sharing of code or written design documentation.

Any usage of material, ideas, or concepts other than your own must be explicitly cited in your submission and will not count as central to your submission.

Grading

The lego track grade distribution is as follows:

6 Lab Assignments	10%
Project: Subsumption	15%
Project: Monte Carlo Localization	15%
Project: Path Planning	15%
Midterm: Robotag	15%
Final project	30%

The advanced track grade distribution is as follows:

Project: Monte Carlo Localization	12.5%
Project: Path Planning	12.5%
Project: Exploration and Coverage	12.5%
Project: Articulated PD Servo/RoboCup	12.5%
project proposal and peer-reviewing	10%
final presentation	20%
project paper	20%

Grading of all assignments will be interactive. You will not want to take your robot apart for the next assignment before it has been graded. Therefore, it is important that you finish your projects on time. Projects will be graded during the project demonstrations (see the syllabus for dates and times). Grading for the midterm and final will be covered in the handouts.

Late Policy

Labs should be completed during lab time, but if you are unable to do so, you may finish up during your own time and show it to a TA on hours. Any requests for extensions on projects (demos or write-ups) should be made to the HTA. Extensions will be given at the HTA's discretion.

Late final projects will not be accepted.

Demo Days

You are required to attend in their entirety the Midterm Competition and the Final Project Demo Day on 11/17 and 12/9[1] respectively. Attendance is mandatory on both of these days, and will be factored into your midterm and final grades. If you have a conflict on one of these days, you must let the course staff know well in advance. As previously mentioned, there will be three other demos (one for each project). Attendance is mandatory at these events as well, as that is where the TAs will be grading the projects.

[1] Dates subject to change.

brickOS

The LEGO Mindstorms kits come with a visual programming tool called RIS. You are welcome to play around with this if you would like, but for the course we will be using a more traditional C-based programming language: brickOS. The prepatory homework for the first lab provides instructions on how to use brickOS. There are also other languages that may be used, such as not quite c and lejos (a java version). You are welcome to experiment with these, however, the TAs may not know these languages and are only required to support brickOS.

LEGOs

On 9/8, lego track students will be given a LEGO kit which includes:

- RCX brick
- two motors
- two light sensors
- two touch sensors
- two rotation sensors
- infrared port and cable
- four short wires
- a plastic container for storing your robot

You will not receive a grade for the course until you return your kit at the end of the semester.

Hours

See the website for the individual TA's hours and locations.

LEGOs will be available for use at anytime. Students may use the nodes in the Lego Lab.

The schedule is available the course web page. Please let us know if the current times don't work. We don't want to be holding hours when no one can take advantage of them, so feedback (sent to `cs148tas@cs.brown.edu`) would be appreciated.

The TAs will answer questions related to lectures, labs, and course-related material. However, if you have not completed the labs and/or preporatory assignments the TAs will answer your questions at their discretion.

Lego Lab (CIT 472)

You will be able to get a key to the Lego Lab early in September. We will notify you in class and on the web site when the keys are available. You will be required to pay a refundable $25 deposit to the CS Department to get a key. **You will not receive a grade for the course until you return your key at the end of the semester.**

Everybody will have access to the Lego Lab so its in everyone's best interest to keep the lab neat and clean. This includes returning the legos you don't use to their correct bin after you are done building your robot. The bins have been painstakingly organized by your TAs, so please do not place pieces in the wrong drawers. At the beginning of the semester groups will be randomly assigned a week to clean the lego lab.

Do not keep more pieces than you need in your kit. Some parts are heavily used, and when these parts run out, it is very frustrating to those who need them. Please clean out your kit after each project.

Final Note: The lego lab should never be left unlocked or unattended. Also, everyone needs to work to keep the lego lab clean and the lego pieces sorted. These points will be strictly enforced as the class will not run smoothly otherwise.

Required Books

- Martin: *Robotic Explorations: A Hands-On Introduction to Engineering*, Prentice-Hall, 2001.
- Craig: *Introduction to Robotics: Mechanics and Control (3rd Edition)*, Addison-Wesley, 1989.

Recommended Books

- Bekey: *Autonomous Robots: From Biological Inspiration to Implementation and Control*, The MIT Press, 2005.
- Thrun, Burgard, Fox: *Probabilistic Robotics*, The MIT Press, 2005.
- Matarić: *The Robotics Primer*, pending publication, 2004.