CS16: Introduction to Algorithms and Data Structures

Summer 2021

In addition to Brown University's rules, CS16 has its own policy on student collaboration. If you have *any* questions about this policy, ask a TA or Doug.

Time & Place: TTh 1:00-2:20 on **Zoom** (password: browncs16)

Instructor: Doug Woos (`dwoos`)

Head TAs: Amy Pu (`apu1`), Lionel Han (`lhan8`), Lisa Yang (`lyang51`), Lucy Qu (`lqu2`),

Undergraduate TAs: Damian Wasilewicz (`dwasilew`), Daniel Segel (`dsegel`), Gaurav Sharma (`gsharma6`), Geireann Lindfield Roberts (`glindfie`), Henry Sowerby (`hsowerby`), Ian Gurland (`igurland`), Kenya Kimata (`kkimata`), Maia Mongado (`mmongado`), Megan Lu (`mlu39`), Prashanth Ramireddy (`pramired`), Samantha Hong (`shong41`), Simran Shankardass (`sshanka8`), Tyler Zickmund (`tzickmun`), Virak Pond-Tor (`vpondtor`), Xinru Li (`xli115`), Zackary Entwistle (`zentwist`)

Socially Responsible Computing TAs: Lucas Gelfond (`lgelfond`), Ishaani Khatri (`ikhatri`)

Contact: Professor: `doug_woos@brown.edu`,
HTAs: `cs0160headtas@lists.brown.edu`,
TAs: `cs0160tas@lists.brown.edu`

Overview

CS16 introduces fundamental techniques for problem solving that are relevant to most areas of computer science, ranging from theoretical to applied. Algorithms and data structures for sorting, searching, graph problems, and geometric problems are covered. Programming assignments conform with the object-oriented methodology introduced in CS15.

You will learn a number of algorithms and how to analyze them during class, practice analyzing and using them in homeworks, projects, and sections, and demonstrate your abilities in a midterm and a final exam.

Aims

At the end of CS16 students should be:

- familiar with a set of fundamental algorithms and data structures;

- able to analyze, reason about, communicate about, and decide among algorithms and data structures theoretically and practically;

- comfortable implementing algorithms and data structures and using them in projects;

- prepared to take subsequent CS classes.

Course Prerequisites

The prerequisite for this course is CS15. If you did not take CS15, contact Doug and the HTAs `cs0160headtas@lists.brown.edu` to explore the possibility of a special arrangement. The following background is assumed: programming experience in Java and a basic understanding of polynomials, logarithms, and exponentials.

Reading Material

All the required information will be presented in the lecture slides. However, the following textbooks are strongly recommended (but optional) for this course:

Sanjoy Dasgupta, Christos Papadimitriou, and Umesh Vazirani; *Algorithms* (1st Edition). McGraw-Hill Higher Education, (2008). Available free online at `http://algorithmics.lsi.upc.edu/docs/Dasgupta-Papadimitriou-Vazirani.pdf`

Tim Roughgarden; *Algorithms Illuminated*. `http://www.algorithmsilluminated.org`

Dasgupta is awesome, free, and a great reference for homeworks.

Topics

Fundamentals: mathematical induction

Algorithm Approaches: greedy algorithms, divide and conquer, dynamic programming, recursion

Analysis of Algorithms: time complexity, asymptotic notation, amortization, recurrence relations, probabilistic algorithm analysis

Elementary Data Structures: stacks, queues, trees, hash tables, binary search trees, heaps, graphs

Sorting: insertion sort, selection sort, heap sort, merge sort, quicksort, radix sort

Machine Learning: decision trees

Graph Algorithms: depth-first search, breadth-first search, shortest path, minimum spanning tree, topological sort, PageRank

Functional Programming: higher-order functions, map, reduce

Content

Assignment breakdowns:

- Homeworks (due weekly), which include programming in Python (30%)
- Four Java programming projects (35%)
  - Seamcarve (7%)
  - Heap (10%)
  - Decision Tree (9%)x
  - Graph (9%)
- Section participation (10%)
- Midterm (12.5%)
- Final (12.5%)

There are no fixed cutoffs for final letter grades. **You must turn in every homework and every project to pass this class. You must also attend weekly sections (more than 3 unexcused absences will result in a failing grade).**

Course Information

You are responsible for knowing what goes on in class and in section, and for any information that is emailed to the course list or posted to the website. There will be important announcements - make sure you're informed. You should also read this document, the **collaboration policy**, and the **hours policy**, all in full. You are responsible for knowing all information in these three documents.

The CS16 website (`http://www.cs.brown.edu/courses/cs016`) is the home of assignments, project handouts, and other course documents. If you have questions about course material from lecture or assignments in progress, feel free to come to TA hours. If you have administrative questions, please email the TAs `cs0160tas@lists.brown.edu`.

Ed Discussion is the place to post comments, questions, or any CS16 related discussions on homeworks, projects, exams, and lectures. We will often post clarifications on homeworks and projects there, so make sure to enroll and actively participate. Keep in mind that the collaboration policy still applies to Ed Discussion.

Handins

You must submit your homework in the form of a PDF (and a PDF only!) through Gradescope. No identifying information (name, login, Banner ID, etc.) should be included in any handin for CS16. Handins containing identifying information will be subject to a grade letter deduction. For help with producing PDFs for your homework write-ups, please refer to the **PDF guide on the website**. You may write out solutions by hand and scan them to make a PDF, but all written solutions must be neat, fully legibile, and organized. Please avoid taking pictures of your work with a camera. If your written handin is messy, we will issue you a warning and may deduct points if we cannot read your solution. If it's messy again you will be required to type your homework solutions for the rest of the semester.

We recommend you use a typsetting program, such as LaTeX(we recommend **Overleaf**), that can produce attractive-looking code or pseudocode in a fixed-width font, and can typeset mathematics beautifully. For those who have never used LaTeX, we have created a lovely guide available at
`http://cs.brown.edu/courses/cs016/static/files/docs/LatexHandout.pdf`.

Homeworks and Projects should also be submitted through Gradescope using your anonymous Gradescope account.

Be sure to pay careful attention to the due dates and times on the assignments page of the course website.

Discussion Sections

CS16 will have weekly TA-led discussion sections. Broadly, there are two main goals for these sections: to teach students how to critically analyze an algorithm, program, or proof, and to foster group work and collaboration on assignments.

Each section is graded on participation and preparedness (being up to date with lectures and completion of pre-section mini-assignments). If you have an unexcused absence, you will receive no credit for that section. If you absolutely cannot make your section one week, please pick another section to go to for that week and inform both sections' TAs of this switch **before** both your usual section and the section you're switching into have happened. If the email is not received before both sections, you will receive an unexcused absence for that week's section. If you need to permanently change your section, email the HTAs at cs0160headtas@lists.brown.edu. **Section attendance is mandatory, you cannot miss more than 3 sections and still pass the course without a dean's or doctor's note**. If you believe that you qualify for an excused section absence a certain week that you will not be able to make it to *any* of the section times, please send the HTA list a health services or dean's note so that we can take that into account.

Mentorship

CS16 will have mentorship program, where students will be paired up with a TA and be able to ask questions about the class, CS in the department, and related topics. The goals of the program are to foster a more inclusive environment for students with all backgrounds and to provide a mechanism for students to bring up any concerns they have. There will be mentor check-ins that occur throughout the semester. Attendance at these check-ins will be accounted as part of the section grades.

Late Policy

The following outlines our general policy for late handins:

Homeworks: We do not give credit for late homework submissions, unless a late credit is applied (see late credit policy for homeworks below). Note that the handin deadline applies to the Python programming parts of the homework as well.

Projects: All projects handed in after the deadline are considered late, unless a late credit is applied. For every day late, you will lose 10% from your grade (i.e. a grade of 92% two days late comes out a 72%). Projects will not receive any credit if they are turned in more than 5 days after the deadline, even if a late credit is used.

To account for unforeseen events or heavy workload, you will be granted six "late credits," which enable you to submit an assignment (homework or project) up to 48 hours late with no penalty. In other words, if a late credit is used on a homework assignment, you will be given an extended 48-hour period to submit the assignment for full credit, after which you will receive no credit. Alternatively, applying a late credit to a project will grant you immunity from the 10% penalty for the first two days after the deadline (i.e. a grade of 92% three days late comes out to an 82%, as opposed to a 62%).

Please note that you may not use multiple late credits on a single assignment. Late credits will be applied automatically to your submissions at the end of the semester. If you have an extension on an assignment, you cannot use a late credit in addition to your extension.

Lastly, please note that if you miss the final deadline for a homework or project, you are required to hand it in before the end of the semester to pass the course, even though you will not receive credit for it. You may not use late days on the midterm or final.

Extensions

Only in exceptional circumstances will extensions be granted. **All such extensions require supporting communication from a dean.** We urge you to reach out to the deans, they're very kind people and here to advocate for you! If you believe you have an exceptional circumstance warranting an extension and a note from a dean, please fill out **this Google form** as early as possible and we will evaluate requests on a case-by-case basis. Please do NOT email the HTAs and/or the UTAs. Most often the Office of Student Life (x33145, osl@brown.edu) will be the right place to go for these exceptional circumstances. After hours in any emergency situation, the Department of Public Safety (x34111) can reach an Administrator on Call. If you're suffering from an injury or illness that warrants an extension - please send us a note from health services or a dean's note with a proposed timeframe for the extension. You may submit the notes through the Google form or email Professor Woos directly. Decisions will be made on a case-by-case basis. If you are granted an extension but realize the extension is not long enough, please email the HTA list **before** your extension ends. Finally, you cannot use a late credit on top of an extension. If an assignment is handed in after the late deadline and after the agreed upon extension deadline, your assignment will receive no credit. To hand in an assignment with an extension past the late deadline, please email the **cs0160headtas@lists.brown.edu** your assignment files, your github link, and your anonymous Gradescope ID.

Credit Hours

The general estimated time commitment for this course is 180 hours. Keep in mind that this is an approximation, and we expect there to be some natural variation from this number. Below is a breakdown of the time estimate:

- Homeworks: 54 hours

- Projects: 75 hours

- Exams: 6 hours

- Lecture: 35 hours

- Section: 10 hours

Diversity, Inclusion and Professionalism

CS16 aims to create a diverse and inclusive environment so it is important that everyone feels welcome. This is our collective responsibility: the course staff and yours as well. Towards achieving this goal, please be mindful of how you interact with your fellow students and TAs. Make sure to treat others with consideration and respect. Do not diminish their accomplishments, do not make assumptions about their background or proficiency in computer science and do not belittle them.

Harassment is any behavior that intimidates and/or makes others feel uncomfortable. This includes unwelcomed advances, innappropriate touching and offensive comments about someone's sexual orientation, gender, race, religion, disability, and appearance. No harassment of any kind will be tolerated in this course.

If you you would like to report an instance of harassment, you can reach out to Doug (`doug_woos@brown.edu`), Laura Dobler (`laura_dobler@brown.edu`) or to the Chair of the CS Department, Ugur Cetintemel (`ugur_cetintemel@brown.edu`). To report instances of gender or sexual harassement you can also reach out to the Title IX office. [1]

Accommodations

Brown University is committed to full inclusion of all students. Please inform me early in the term if you have a disability or other conditions that might require accommodations or modification of any of these course procedures by filling out **this Google form**. You may speak with me after class or during office hours. Please do not email the HTAs or the TA list. For more information, please contact Student and Employee Accessibility Services at 401-863-9588 or SEAS@brown.edu.

Undergraduate students in need of short-term academic advice or support can contact one of the deans in the Dean of the College office. Graduate students can contact one of the deans in the Dean of the Graduate School office.

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[1]See `https://www.brown.edu/about/administration/title-ix/get-help/i-am-student`