CSC 286/486: Computational Complexity
Course Information Handout/Syllabus

Version 4.02.0.0 (any substantially updated versions of this document will be announced as the course goes on via BB and made available on the course home page)

Fall 2019 Semester
2019/8/28 (last updated: 2019/8/26/1239pm-814pm)

Location/Time: The course meets in Room B&L 315, M/W 2:00PM-3:15PM, in Room WEG 2506.

Instructor: Lane A. Hemaspaandra, WEG 2317, csc486staff “at” cs.rochester.edu. Office hours: Wednesdays 3:30PM–4:30PM (but from 3:45PM onward I’ll stay only if there are people at my office hours, so please do arrive safely earlier that 3:45PM for sure) in WEG 2317 (and you usually can also chat with me right before and right after one of our class sessions, in our classroom) starting 8/28 and through and including December 11th (but not 9/25 or 11/27).

TA: Jason Brar, csc486staff “at” cs.rochester.edu. Office hours: Mondays 6:30-7:20 in the Wegmans Hall 2nd Floor Atrium (i.e., the wood-floored open hallway/sitting area at the southeast edge of the second floor) and Thursdays 4:50PM-5:40PM in WEG 2215 starting 9/5 and through and including December 9th (but not 11/28).

Address for Course-Related Email: Please use csc486staff “at” cs.rochester.edu for all course-related email. (This address will be automatically forked by the system to go to both me and the TA. Please make sure to always use it so that either of us is left out of the process of being on top of any questions and discussion. The only exception is if you are for example trying to set up a one-on-one appointment time with Jason, then you might want to write him directly at his individual email address of jbrar “at” u.rochester.edu.)

Overview: This course studies the difference between computable and uncomputable problems and between feasible and infeasible problems. Regarding the latter, what properties of a problem make it computationally simple? What properties of a problem may preclude its having efficient algorithms? How computationally hard are problems? Topics often covered include: Complete sets and low information content; P=NP?; unambiguous computation and one-way functions; reductions relating the complexity of problems; complexity classes and hierarchies.

The course is discovery-driven. Rather than me just pushing theorems and proofs at you, we will—after a prefix\(^1\) of the course that indeed will be of that flavor—be having you work on discovering for yourself the proofs to many of the important results of the field (often in class or over a few class sessions, often starting individually or in a small group, and then working in increasingly large groups on the given problem, often until at the end the entire class as a group of the whole presents its approach to a problem). The goal of this approach is to help you improve your skills at discovering, formalizing, and proving, which are core skills for researchers (and more generally, for problem-solvers).

Prerequisites: CSC 280 (prereq). You should also have taken (or know equivalently well) discrete mathematics (MTH 150), which is a prerequisite of CSC 280.

\(^1\)However, see Footnote 5.
Collaboration and Class Participation: You may discuss and work with other (current) CSC286/486 students on the reading, studying, and problems; the goal of the course is not to compete with each other, and, indeed, in real research, collaborative work is very common. However, it is cheating to solicit help from anyone other than your classmates—this includes (as cheating) using electronic forums such as StackOverflow/wikis/Piazza-or-so-on/Facebook-or-Google-etc.-groups (or even mailing lists that function as electronic discussion forums) and also includes (as cheating) using solutions from previous years’ CSC286/486.

If there are take-home exercises (which from now on I’ll often more tersely refer to as “home exercises), often in groups, those will as to collaboration follow whatever rules are attached to them if specific rules are, but by default, if those are by groups, you may speak freely to your groupmates but should not speak with anyone else, not even people in the class’s other groups (as typically the groups will work more on—or compare, or seek to negotiate and merge—their solutions at a coming class session, and the between-class time is for each group to work as a team).

In some cases the groups will be graded on the home exercises (e.g., they will, as on in-class exercises, put solutions on the board and I’ll assign grades to the solutions, though quite often the groups will be asked to create, during class, a group-of-the-whole solution, which in that case would typically be what is graded). These same two grading patterns also hold for graded in-class group exercises.

On home exercises that are done without groups, you (unless when assigning it I set other rules) may may speak about the problems with your classmates within the frameworks and rules mentioned above and below (so talking to your classmates is ok, and talking to anyone else—even CSC 286/486 students from previous years or writing to web forums or etc.—is cheating). Individual home exercises usually are not graded (so your plan should not be to maximize the quality of the solution via drawing on others so early or so much that you don’t understand the solution or gain the learning from the task of trying to move toward it, but rather should be to immerse yourself in the learning/solving process, using the allowed ability to talk with your classmates wisely and in such a way as to help the learning rather than to weaken it). If a given home exercise done without groups will be graded, I’ll let you clearly know that as it is assigned.

More broadly speaking, as to what can be used, it is cheating to get or use, during this course, course quiz or homework or home exercise or exam materials (quizzes or their answers, homework sets or their answers, home exercises or their answers, exams or their answers, etc.) from any previous offering of CSC286/CSC486. Further, when doing home exercises, you indeed may use the library and the internet to search for information and examples on techniques and so on. But you should not attempt to find/look up a solution to a given in-progress home exercise; doing so is cheating. If you by accident stumble on a web page that happens to solve an in-progress home exercise, that in itself is not cheating. But you should, immediately the moment you realize that this has happened, not read or copy the solution. The experience and skills you’ll build by working on solving problems are an important part of doing this course; this is not a course about web-searching for answers.

Also, on the (rare, or quite likely none at all unless working in groups seems not to be working well; plus quite a bit of the exercise work will be done purely within the class sessions) home exercises that are done without groups and that will be graded and on which I ask for a written turn-in, the answers must be your own work/words, even if you discussed the problem(s) with others; you may in no case copy all or part of anyone else’s write-up. (A very wise way to achieve this is as follows: Even if you have discussed the problem with others, as you do your final write-up have nothing in front of you but rather write just from the knowledge/images of the solution you have in your head.)

As to in-class exercises and what can be used during them, you cannot use computers/the web/etc./slides/printouts/etc., but if you have notes taken by you by hand, I sometimes will let you use those (but often, what you may bring in will be your own knowledge).
I strongly encourage the undergrads and grads not to act as if they have no connections and cannot interact, but, rather, I’d encourage you to treat each other as what you are: fellow learners who are interested in complexity and may be able to help each other better learn this important, fun, difficult area.

Anything that has a due date must be done/submitted on time; late items get no credit (and will not be graded or marked up with comments; although you always can stop by the TA’s or my office hours to, after solutions have been gone over in class, make sure you understand those solutions or to discuss an alternate approach). (No late turn-ins means no late turn-ins; even if one of my faculty colleagues—even if he or she is the chair—tells you that he or she thinks it will be ok to hand in late an item in this course, even for some very good reason such as there being a research paper deadline or there being a fellowship deadline, you nonetheless must hand in your work on time in this course if you wish to get credit for it; similarly, none of my faculty colleagues can excuse you from this course’s other items/material.)

The TA and I generally won’t answer questions about home exercise questions that are currently in progress (my typical answer to such questions is to point to this sentence itself (let us label this sentence “β1” as a convenient reference string ), or “no comment,” or “understanding the question is part of solving the question” or if it was asked by email simply not to reply); of course, if you have questions about the underlying material (that a question might be related to), you can and should use the office hours to ask questions about or better learn about that material (but not to ask for answers to or explanations of in-progress home exercise questions), and — side comment: I do leave the TA some flexibility to use his or her discretion and judgment as to where the line is between what is answering question about underlying material (which is fine) and what is an answer/explanation of the in-progress home exercise (which is not fine), since sometimes this is a line that one could see as falling in different places depending on one’s judgment, and please note that on things when consulting with groupmates or classmates is allowed, that is a likely your go-to resource (and a valuable part of the process—working together to understand things).

Regarding class participation, you are expected to attend class, to be prepared for class, and to participate in class. For example, if you are called on to put up your answer (or your group’s answer) to a home exercise, it should be clear that you have put in a serious amount of time and thought. Note that, even if you do not know a perfect answer, if you clearly have put in careful thought (e.g., you have partial results or a clear description of what issue is stumping you), that certainly will make a much better impression than if you clearly have not thought at all about it. As another example, your of course should always have done any assigned reading.

By the way, if you have a question in class about some of the course material, it usually is a good idea to ask it. Probably other students have exactly the same question,2 and you will be doing yourself, them, and the class a big favor by asking, so we all can explore whatever issue you raise!

(Some caveats: This is a course on certain material, not a course on how to design and teach a course on that same material. Thus please do not ask course-design/course-logistics questions such as “Why are there so many exercises?” or “Why can’t I use my supersmart pet dog Fido or my computer (so I can search the internet and find an answer rather than me or my groupmates having to solve the problem) during exercises?” I don’t answer questions about the “why”s of the course’s design or its rules. (Most of the rules are designed to help teach a good course and to allow the TAs (if any, though there are none this year) the TA and me to spend as much of our time as possible

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2Even professors sometimes—more often than they would like to admit—don’t understand talks/lectures, even in their own areas! Here is a cute, relevant anecdote from Moshe Vardi’s introduction to the September 2011 issue of CACM, where he mentions asking, at a top theoretical computer science conference, how many people understood at least N% of at least N% of the papers—to get 50% of the people to say yes, he had to drop N down to 50. Understanding lectures is a nontrivial challenge, and requires a lot of focus!
on content. And also, some rules are related to CETL-accommodation issues.

Audio or video recording of the class sessions is not permitted, except if you have a documented disability that would need such recording, in which case please speak to me about this. More generally (again except in the case of CETL accommodation on which I have received a letter about that on you from CETL), no laptops/tablets/smartphones/etc. may be opened or out or in use in class—except any laptop that is connected to the projector to give the day’s talk—nor may you Skype in—not even in silent view-only mode—on days you can’t attend class, nor may you have a classmate electronically record or transmit that class session for/to you. If you cannot attend, though, of course do get promptly from a classmate (in the dream case, one that you have warned to please take notes for you due to you having to miss the class session) a detailed account of what happened in class (including what was assigned and what home exercise if any was given out) and if some of our course slides were covered in class that day you’ll want to find out from your classmate which were, and read them.

Finally, regarding asking questions about the course material: Questions should not be asked by email, but rather please ask them in class, or use my office hours—and please also keep in mind that your 286/486 classmates are often a great resource with which to discuss the course material (let us label this sentence β2, and if you do ask questions by email, I probably will either refer you to this sentence, or will simply not reply since I expect that you know that the expected thing to do is to come into an office hour or to, when doing so is within the rules, discuss with your classmates); a corollary is that if you have a question sometime after my Wednesday office hour, you likely won’t get an answer to it before, for example, Monday’s class session, or whenever you discuss it with a classmate.

Grading: The overall course grades (A, A-, etc.) will not be any fixed curve, but rather will reflect the instructor’s judgment about what grade is appropriate based on performance.

Everything in the course comes in 100-point chunks. All 100-point chunks are created equal, whatever they come from. Most or all of the chunks will be exercises (some in class and some home ones). If late in the course students in groups present a unit (e.g., book chapter), that will count as 9 100-point chunks, “superchunked.” What I mean by that is if your score on it is 88, that will be recorded in Blackboard as 9 100-point chunks each with a score of 88. It is not impossible that some other items in the course (you will in such cases be told this either on the item itself or beforehand) will be handled as superchunks.

If you are taking the course as 486, at the end of the course we will average all your chunks, after dropping the lowest three. If you are taking the course as 286, at the end of the course we will average all your chunks, after dropping the lowest eight.

Note that the grading scheme is very different from that of a course where there are major exams that count for a large part of the course grade and sometimes people try learning things the day before the exam (and forgetting them the day after perhaps). In contrast, our stress, since almost all the chunks are coming from your exercise grades week in and week out, is on having/gaining/sustaining day-after-day and week-after-week performance, competence, and with luck mastery, as reflected in your work on the exercises. It is a 14-week course, not a 150-minute course.

As to grades (and what is made public and what is not), each student gets his or her own grade on each item, (and of course I assume and expect that you will keep each given-back item/grade for items that are on paper and are given back marked), and through Blackboard he or she will see some information about the overall class performance each of those items, and at the end of the course he or she will receive his or her course grade either from the registrar or from me. However, I in general do not give out grade or grade-distribution or grade-range-cutoffs info beyond that (or provide guesses of what letter grade a student is “headed toward”), though of course if a student
wishes to share with some classmate his or her grades on some items or the course, that is up to him or her.

Note that, very informally put, the chunk dropping in some sense covers 286 students for six-eight chunks of misses, and 486 students for three-five chunks of misses. However, I would urge each of you to attend every class (except when sick) and do all items; you will learn far more and enjoy the course far more; and that will let the drops just end up dropping whichever chunks you happened not to do well on, rather than ones you skipped outright.

Beyond that, in grading the course, the 286 students will have their grades assigned with consideration of the fact that they are taking the course as 286. (Thus, 286 students should not view themselves as being in competition with the 486 students—though actually no one should view him- or herself as being in competition with anyone else in the course.) All undergraduates in the course (except those who did excellently in CSC280) should speak with me immediately after the first class, so we can get a handle on exactly what your background is as it relates to the current course, and whether you are ready for this course, as also should any grads who have any worries about their background.

We will use Blackboard to store and to share with you the grades on each item.

This course is available for audit credit, but only with my permission, so if you want to audit this course, please do make sure to talk with me (by email or on the first day of class).

**Class Attendance and Credit Hours:** Class attendance is required. This is a 4 credit-hour course.3

**Academic Honesty:** On all aspects of the course, it is very important to follow appropriate norms of academic honesty and professional conduct, most importantly including those regarding plagiarism; do not plagiarize. Please see the link from the course’s main web page to the school’s site on academic honesty. And note carefully the rules about what you can and cannot do/discuss together with classmates (note the discussion at the start of the section “Collaboration and Class Participation” of this document) and the rules on what notes/etc. you can/cannot have during exercises.

**Missed Items/Lateness/Etc. and Some Issues Regarding What Items We Will Have:** No makeups (not after the fact; not before the fact). No exceptions (except for religious holidays discussed long in advance4) As a bow to sicknesses, broken cars, varsity events, conferences, and other compelling excuses, each 486 student will have his or her three-five lowest chunks dropped (but no more, even with good excuses). As a bow to sicknesses, broken cars, varsity events, conferences, and other compelling excuses, each 286 student will have his or her six-eight lowest chunks dropped (but no more, even with good excuses). The only exceptions to the above will be with a letter from a convincing (i.e., one with the authority to mandate exceptions to course policies) Dean who has read the course’s policy regarding no makeups and that dropped chunks are given to all students in

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3The course follows the College credit hour policy for four-credit courses. This course meets twice weekly for three academic hours per week. The course also includes independent out-of-class assignments for an average of at least one academic hour per week. In this course, students will complete group activities that will variously use course materials, readings, and notes. These activities include team-based work on challenging problems.

4To be explicit: You should, no later than September 15, noon, send me an email if any of the class days fall on days where due to observance of a religious holiday you will not be able to attend; in that email, you should please let me know all such days for the entire term. If you have a religious conflict told to me by the above date, I’ll regarding the in-class exercise (if any) give you a makeup (perhaps oral or perhaps written) one or will simply try to avoid having an exercise on that day. If a home exercise that is being written up and handed in falls due on a religious holiday, you should take that into account and make sure you nonetheless turn it in on or before the deadline; you may email that item “csc486staff,” no later than the deadline of course, as a pdf, if for some reason (religious holiday; illness; etc.) you cannot attend class on its due date to hand it in yourself.
the above way to account for all reasons) and who having seen that has determined that your case is so extraordinary that he or she is mandating an exception to the policy in your case.

By the way, regarding sickness or other times you’ll be missing a class session at which some item that will be graded is being collected, let me mention that if you send in your (for example) home exercise to class, in a sealed envelope, with a friend who remembers to turn it in when the exercise is collected, then your item will be graded. Alternatively, you can do your item and mail it to me as a pdf (e.g., computer typeset, or as a scan of your handwritten take-home quiz), to the address csc486staff “at” cs.rochester.edu, and as long as it arrives in that mailbox before the 2:00 start of class (after sending it, keep looking for a few minutes to see if you get a “bounce” error message, e.g., because you misspelled the email address or you sent a file so large the mailer bounced it—the UR faculty email system as least used to bounce any message on which the total size of the message, including all attachments, was 20MB or more, although I am not sure if it still does), I will grade it as if you had turned it in at the class session.

The no-exceptions policy is so settled and broad that I expect you to understand it and not to ask for exceptions; and so if you email asking for an exception, I generally won’t reply to the email, but rather the answer is implicitly a “no.”

There will be no midterms and no finals. There will be many, many exercises. You should assume that each class may well have exercises—some more than one, or some for home and some for class.

Please use only black or blue pen (no pencil allowed) on handwritten turn-ins and even in computer-generated text (such as if you typeset exercise answers on a computer) please don’t use the colors red or purple, as I may use those when I annotate or grade things. As to in-class exercises that will be graded, ideally you’ll do those in black or blue pen, but if you truly feel that writing in pencil is far better for you than using pen, you may do your in-class quizzes in (black, number 2) pencil.

By the way, if you see in Blackboard a 0.01% as your grade on an exercise, what that means is the following: If you don’t submit something, I of course record a 0.00%. But if you hand something in and get a zero (or even any grade between 0 and 0.01%), I will often record it in Blackboard as a 0.01%, so that I can see that you did hand it in.

As mentioned earlier, depending on how the course goes, we might do discovery-based learning for the entire rest of the course once we start that part of the course;5 or we might have a superchunked in-groups project in the form of tackling and presenting a topic (usually some chapter that I assign your group from our Hemaspaandra and Ogihara textbook).

Anyone with a documented disability for which accommodation is relevant to this course should please have the appropriate university office inform me of this and the related accommodations immediately (and should please speak privately with me after the first class so we can start on the logistics related to those accommodations).

Typically, during in-class exercises (and home ones too but those are covered above) you should not ask any questions; see §1 above; aha... see... we now have actually invoked that label! If you see on a quiz something that you’re sure makes solving the problem impossible (or equivalent to something such as resolving P versus NP that is something I wouldn’t possibly ask you on a quiz) or

5Caveat: I mean once we get past the prefix of the course that will take around four weeks and will review/cover the basics—and possibly some far more than basic things—about computability and complexity. However, things are in fact a bit more (no pun intended) complex, since this year, as a prelude to that prefix, we will spend the very first few classes doing an actually quite advanced set of discovery-based learning exercises, so that you can see up front—in order to help you decide if this course is for you—the flavor of our discovery-based learning course... that is, so that you can see the flavor that will occupy basically all of the course except the prefix covering the just-mentioned basics and the time near the end of the course—if we have that this year—when in groups you’ll be presenting a topic/unit, most likely, as is about to be mentioned in the main body of this document’s text, (parts of) a chapter from the Hemaspaandra-Ogihara textbook.
makes the problem meaningless or incoherent, what you should do is that as part of your answer you or your group should clearly explain what you have noticed, and why it seems to make the problem impossible or meaningless or incoherent. If what you notice seems to be a very minor technical typo and you are sure it is and you see the correction, you probably should note that, fix it, and the solved the fixed problem (but if the original one was really what was meant, you probably won’t get credit—if this is a graded-excise setting—if you change it to a different problem; and just noticing for example a spelling error or a missed “the” doesn’t get you out of having to solve a problem).

Timing of the Reading, in the Context of Discovery-Based Learning: For the discovery-based learning in class to work well, it is extremely important that you do the readings in the time periods in which I assign them. Obviously, you should complete each reading by its “Due” date/time. But I mention that, though doing so is not forbidden, if you try to read ahead in order to guess and find the answer to a day’s discovery-based learning challenges, you may be cheating yourself of much of what the course offers. The challenges are to help you explore and learn and prove, and to learn how to prove, but if you come in having read an answer intentionally, you won’t get that effect.

That is, if you pre-guess or pre-read a problem/solution, you’ll be doing more harm than help to your learning, as you’ll have lost the chance to work to find the insights that the exercise I assign is hoping you and your classmates will reach.

After some in-class discovery research days, I’ll on the web site or via Blackboard-announce post reading that covers or is related to what we just learned. In those cases, you absolutely should do that reading before the next class (or by its due date, but the due date will typically be the start of the next class in such cases).

Regrading: Most of your chunks will come from the grades I assign to exercise solutions you or a group put up on the board, or to your superchunked presentations/slides on a chapter, and regrading does not apply to those. But if, for example on an in-class exercise, if any, where you individually write a solution for grading and I hand it back (at a later class or by email, typically) graded and with comments, on those you can ask for regrading during the 48-weekday-hour window from when they are given back (the window applies even if you skip the class where they are given back), and to do that, you must notify me (only via the email address “csc486staff” in the domain cs.rochester.edu—not via my personal email address—since of address—since “csc486staff” sends it to me and the TA) of that via email within 48 weekday hours (i.e., Sat and Sun do not count against those) of it being given back, along with an emailed explanation of what you feel was graded incorrectly, and an emailed color scan (B&W is ok if you don’t have access to a color scanner) of your entire graded item (all parts of it—not just the lines you are asking for a regrade of). Note that the entire item that you are asking to be regraded may be regraded (not just the issue about which you are asking), and the grade may move either up or down (and moving down is a very real possibility, e.g., if I (or the TA) discover that a the TA (or I) I missed some errors, or just graded overgenerously—relative to what the regrader thinks during the regrading. The TA or I will usually send you the outcome of the regrading within a week of when you make your regrading request, although that is not a promise; rare cases may take longer. Also, a regrading request is irrevocable; once you make it, you cannot withdraw it. And regarding the scan you must submit, it must be identical to what was handed back to you; altering what was handed back to you, in any way, before scanning it for a regrading request will be treated as an Academic Honesty violation.

When does asking for a regrade make sense (and when does it not)? It makes sense to use regrading if I gave you almost no credit for an answer that in fact was correct; regrading is not there so students can try to argue their way to a few more partial-credit points on an incorrect answer.

The only exception to the above time limits and scheme is that during the last 10 calendar days before the last day of classes (i.e., from December 1 onward), the 48-weekday-hour period is