Randomized Algorithms
Syllabus, Policies, and Procedures

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1 Randomized Algorithms

This course is about the design and analysis of *randomized algorithms*. Randomization has become an essential component of algorithm design and is both *useful in practice* and *highly consequential in theory*. One component of the class will be in developing basic probability theory and using randomized techniques to design *better algorithms*. Some examples include hashing, sketching, importance sampling, dimensionality reduction, and randomized rounding. These are techniques that every modern algorithmist should be able to flexibly apply in new and diverse situations. By the end of the class, students will be *comfortable* applying these techniques, will automatically incorporate randomization into their design process, and will be able to *combine* the techniques in novel and interesting ways. Another component of the class studies more technically sophisticated randomized algorithms. These are the breakthroughs ideas that stretch the imagination, and might inspire similar breakthroughs in one's own research. Some examples include graph and matrix sparsification, metric embeddings, randomization in low-dimensional geometries, random walks, derandomization, and probabilistically checkable proofs of NP-hard problems. The goal is to *expose* students to these big ideas and stress the deep *connections* between them, so that students are positioned to benefit from their tremendous upside when the opportunity presents itself. The first part of the course will put greater emphasis on developing the basics, and the second part will explore the deep connections and wonderful implications of randomization. Many of the topics will satisfy both ends of this spectrum.

This course has recently been approved to satisfy a *core Theory requirement* in graduate CS programs. The instructor cautions, however, that this course is (by far) the most challenging way to satisfy this requirement. Mathematical maturity and algorithmic background (as taught in CS580) are expected. The material can be unintuitive and the homework problems are meant to be challenging. One should not expect to solve all problems perfectly. (There is a very forgiving homework policy, as discussed below.)

2 On the COVID-19 pandemic

This course will be impacted by the ongoing COVID-19 pandemic. Purdue has been very active about making the campus safe and more information can be found at the following url.

`https://protect.purdue.edu`

*Last updated August 24, 2020

In particular, we are all expected to uphold the *Protect Purdue Pledge*.

The instructor will exercise caution and otherwise try his best to simulate a normal and engaging experience. In particular, it seems prudent to conduct the first few weeks online as we all gather more information. The instructor will reassess the situation in the third and fourth weeks and remains hopeful about the prospects of resuming in-person instruction.

Initially, the class will be conducted *online over Zoom* at the regularly scheduled time, at the following Zoom meeting room.

`https://purdue-edu.zoom.us/j/94663689769`

This meeting room will also be used for office hours.

The instructor is mindful of the importance of interaction among students, which has been negatively impacted by the pandemic. The instructor is exploring creative solutions to help in this regard.

Certain adjustments may have to be made due to the extenuating circumstances. One point in particular is in-person assessment. Currently an evening, in-person midterm is scheduled, but may be replaced with a different assessment mechanism depending on how the semester develops.

3 Correspondence

The course website is

`www.fundamentalalgorithms.com/randomized`,

where notes, references, and homeworks will be posted.

3.1 Piazza

There is a Piazza for the course at the following address.

`https://piazza.com/purdue/fall2020/cs590ra/home`

The main goal of Piazza is to increase interactions among the students, and the students are strongly encouraged to help one another. (The instructor will take note of the most helpful students.) Piazza will also be used to make course announcements. The instructor will check Piazza regularly (but not continuously).

3.2 Email

The instructor can also be reached at his `@purdue.edu` email address. Please note that the instructor processes emails periodically in batch, so one should not expect rapid email responses. If the email concerns a question that could benefit others in the class, please post the question to Piazza instead.

4 Grading

- 50% Homework
- 25% Midterm
- 25% Final

Normally, the midterm and final would be a written exam. The COVID-19 pandemic may impact how the midterm and final assessments are implemented.

5 Homework

This course has regular homework assignments. Typically there will be a couple problems accompanying each lecture, which will be due at 2:45 PM (before the lecture) a week later.

One should expect more (and often times simpler) problems in the beginning of the semester, when many basic ideas are being introduced, and less (and possibly harder) problems towards the end, when the content is deeper and slower-paced.

5.1 Typesetting

Homework submissions that are not typeset in LaTeX or equivalent will not be graded. Some tips on typesetting are listed below.

5.2 On writing

The onus is on the student to make the arguments in their solution clear, and points will be docked if the grader cannot easily verify that the solution is correct. The class is as much about *communicating complicated ideas* as solving problems and applying techniques. Particularly clear exposition will be awarded with extra credit (see below).

5.3 Gradescope

Homework will be collected online at `gradescope.com`. To enroll, either use the code `9PDKBJ`, or follow the link in BrightSpace.

5.4 Collaboration

The instructor encourages the students to try to do each problem by themselves. That said, collaboration is allowed and interaction among students is encouraged. Students should indicate who they collaborated with somewhere in their submission. Each student should express their solutions in their own words.

5.5 Dropping scores

In the overall homework grade, the bottom 15% of homework problem scores will be dropped. More precisely, if there are n total problems assigned in homework, then the $\lceil .15n \rceil$ lowest scores will be dropped.

5.6 Late policy

Late submissions will not be graded, with no exceptions (except possibly for a doctor's note). Recall from above that some homework scores are automatically dropped. There are also many opportunities for extra credit (see below).

5.7 Solutions

The instructor will select exemplary submissions and publish them on Piazza as solutions. If you have a strong preference to be excluded from consideration for a particular homework problem, please indicate it clearly and explicitly at the top of your submission (for each problem).

5.8 Second chance submission system

The instructor believes it is more important to learn from one's mistakes than to be perfect on the first try. To implement this principle, homeworks will have a *two round submission* process where the second round gives students a chance to correct errors in their initial submission.

- *Round 1:* In the first round, assignments are collected (as usual).
- *Solution release:* The instructor will then release solutions for the collected homework problems.
- *Round 2:* In the second round, due one week later, students will make a second submission with the following 3 parts:
  1. The original submission.
  2. A new version where students may learn from the published solutions and adjust their original submission. *While the solutions are offered as guidance, students must still explain the answer in their own words.*
  3. A brief itemized list enumerating the differences between the original version (what parts were missing or incorrect, and what was changed to address them).

The instructor will grade both the original submission and the new version, and the overall score will be the sum of the two scores. Of course one can simply submit the original submission twice if there is nothing to change.

5.9 Bonus points

To encourage certain good habits (observed to be strongly correlated with good performance in past courses), extra credit will be rewarded (between 5 and 10 percent) for each of the following.

- *Eager submission.* The homework is submitted before 2:45PM on the day of the first lecture after the homework was assigned.
- *Clear writing.* The homework is particularly well-written and easy to verify.

5.10 IDK

One may simply write "I don't know" or "IDK" and automatically get 25% of the possible points.

5.11 Typesetting tips

- The standard for typesetting mathematics is LaTeX. Even if you do not know LaTeX now, you will probably have to learn it sooner or later in your graduate studies.
- The instructor uses `emacs` to write LaTeX, but any editor will do. There is also a website called `overleaf.com` for typesetting LaTeX.
- Alternatively, the software `typora` allows one to write LaTeX within a markdown document, which is particularly easy to use.
- `LyX` is another popular latex editor that is WYSIWYG.
- There are several apps for scanning documents (e.g., when inserting pictures) that are much better than taking a photo. The instructor recommends `scanbot`, and other popular apps include `microsoft office lens`, `camscanner`, and `evernote scannable`.

6 Academic integrity

Behavior consistent with cheating, copying, and academic dishonesty is not tolerated. Depending on the severity, this may result in a zero score on the assignment or exam, and could result in a failing grade for the class or even expulsion. Purdue prohibits "dishonesty in connection with any University activity. Cheating, plagiarism, or knowingly furnishing false information to the University are examples of dishonesty." (Part 5, Section III-B-2-a, University Regulations) Furthermore, the University Senate has stipulated that "the commitment of acts of cheating, lying, and deceit in any of their diverse forms (such as the use of substitutes for taking examinations, the use of illegal cribs, plagiarism, and copying during examinations) is dishonest and must not be tolerated. Moreover, knowingly to aid and abet, directly or indirectly, other parties in committing dishonest acts is in itself dishonest." (University Senate Document 7218, December 15, 1972). You are expected to read both Purdue's guide to academic integrity (http://www.purdue.edu/purdue/about/integrity_-statement.html) and Prof. Gene's Spafford's guide (http://spaf.cerias.purdue.edu/integrity.html) as well. You are responsible for understanding their contents and how it applies to this class.

7 Posting Class Material

Posting material associated with this class (e.g., solutions to homework sets or exams) without the written permission of the instructor is forbidden and may be a violation of copyright.

8 Purdue's Honor Pledge

As a boilermaker pursuing academic excellence, I pledge to be honest and true in all that I do. Accountable together - we are Purdue. https://www.purdue.edu/provost/teachinglearning/honor-pledge.html

9 Grief Absence Policy

Purdue University recognizes that a time of bereavement is very difficult for a student. The University therefore provides the following rights to students facing the loss of a family member through the Grief Absence Policy for Students (GAPS). According to GAPS Policy, students will be excused for funeral leave and given the opportunity to earn equivalent credit and to demonstrate evidence of meeting the learning outcomes for missed assignments or assessments in the event of the death of a member of the student's family.

10 Conduct and Courtesy

Students are expected to maintain a professional and respectful classroom environment. This includes: silencing cellular phones, arriving on time for class, speaking respectfully to others and participating in class discussion. You may use non-disruptive personal electronics for the purpose class participation (e.g., taking notes).

11 Students with Disabilities

Purdue University is required to respond to the needs of the students with disabilities as outlined in both the Rehabilitation Act of 1973 and the Americans with Disabilities Act of 1990 through the provision of auxiliary aids and services that allow a student with a disability to fully access and participate in the programs, services, and activities at Purdue University. If you have a disability that requires special academic accommodation, please make an appointment to speak with the instructor within the first three (3) weeks of the semester in order to discuss any adjustments.

It is the student's responsibility to notify the Disability Resource Center (http://www.purdue.edu/drc) of an impairment/condition that may require accommodations and/or classroom modifications. We cannot arrange special accommodations without confirmation from the Disability Resource Center.

12 Instructor absence:

The instructor will be away for a few classes. There will be a guest instructor for these classes. If there is a need to reschedule additional classes, then this will be done an as-needed basis. The plan is to use video lectures to supplement for any missing class periods.

13 Emergencies

In the event of a major campus emergency, course requirements, deadlines and grading percentages are subject to changes that may be necessitated by a revised semester calendar or other circumstances beyond the instructor's control. Relevant changes to this course will be posted onto the course website and/or announced via email. You are expected to read your purdue.edu email on a frequent basis. Emergency Preparedness: Emergency notification procedures are based on a simple concept: If you hear an alarm inside, proceed outside. If you hear a siren outside, proceed inside. Indoor Fire Alarms are mean to stop class or research and immediately evacuate the building. Proceed to your Emergency Assembly Area away from building doors. Remain outside until police, fire, or other emergency response personnel provide additional guidance or tell you it is safe to leave. All Hazards Outdoor Emergency Warning sirens mean to immediately seek shelter (Shelter in Place) in a safe location within the closest building. "Shelter in place" means seeking immediate shelter inside a building or University residence. This course of action may need to be taken during a tornado, a civil disturbance including a shooting or release of hazardous materials in the outside air. Once safely inside, find out more details about the emergency. Remain in place until police, fire, or other emergency response personnel provide additional guidance or tell you it is safe to leave. In both cases, you should seek additional clarifying information by all means possible: Purdue Home page, email alert, TV, radio, etc. Review the Purdue Emergency Warning Notification System multi-communication layers at http://www.purdue.edu/ehps/emergency*preparedness/warning-system.html. Please review the Emergency Response Procedures at https://www.purdue.edu/emergency*preparedness/flipchart/index.html. Please review the evacuation routes, exit points, emergency assembly area and shelter in place procedures and locations for the building. Video resources include a 20-minute active shooter awareness video that illustrates what to look for and how to prepare and react to this type of incident. See http://www.purdue.edu/securepurdue/police/video/

14 Violent Behavior Policy

Purdue University is committed to providing a safe and secure campus environment for members of the university community. Purdue strives to create an educational environment for students and a work environment for employees that promote educational and career goals. Violent Behavior impedes such goals. Therefore, Violent Behavior is prohibited in or on any University Facility or while participating in any university activity.

15 CAPS Information

Purdue University is committed to advancing the mental health and well-being of its students. If you or someone you know is feeling overwhelmed, depressed, and/or in need of support, services are available. For help, such individuals should contact Counseling and Psychological Services (CAPS) at (765) 494-6995 and http://www.purdue.edu/caps/ during and after hours, on weekends and holidays, or through its counselors physically located in the Purdue University Student Health Center (PUSH) during business hours.

16 Nondiscrimination

Purdue University is committed to maintaining a community which recognizes and values the inherent worth and dignity of every person; fosters tolerance, sensitivity, understanding, and mutual respect among its members; and encourages each individual to strive to reach his or her own potential. In pursuit of its goal of academic excellence, the University seeks to develop and nurture diversity. The University believes that diversity among its many members strengthens the institution, stimulates creativity, promotes the exchange of ideas, and enriches campus life. Purdue University prohibits discrimination against any member of the University community on the basis of race, religion, color, sex, age, national origin or ancestry, marital status, parental status, sexual orientation, disability, or status as a veteran. The University will conduct its programs, services and activities consistent with applicable federal, state and local laws, regulations and orders and in conformance with the procedures and limitations as set forth in Executive Memorandum No. D-1, which provides specific contractual rights and remedies.

17 Privacy

The Federal Educational Records Privacy Act (FERPA) protects information about students, such as grades. If you apply for a job and wish to use the instructor as a reference, you should tell the instructor beforehand. Otherwise, the instructor cannot say anything about you to a prospective employer who might call. The instructor is happy to provide references and to write letters of recommendation for his students as needed.

18 Changes to the syllabus

This syllabus is subject to change and changes will be announced appropriately.