15-351 / 15-650 / 02-613 – Algorithms & Advanced Data Structures
Fall 2016

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Textbook: *Algorithm Design*, by Jon Kleinberg and Éva Tardos.
Addison Wesley, 2005. ISBN: 0-321-29535-8.

Office hours: TBA on the class Piazza webpage. You are encouraged to make use of office hours. The TAs will help explain materials and homework questions.

Course objective: The objective of this course is to study general computational problems and their algorithms, with a focus on the principles used to design these algorithms. After this semester, you should be able to:

- analyze running time for algorithms
- design divide-and-conquer algorithms
- design dynamic programming algorithms
- design network flow-based algorithms
- write linear / integer programs
- apply large-scale search / heuristic algorithms
- efficiently store and answer queries about data
- prove a problem is NP-complete

Homework / Exams: There will about 10 homework assignments that will include algorithm design and analysis problems. There will be 2 midterms, and a final exam. The midterm exams will be non-cumulative, while the final exam will cover everything from the class.

Grading: The class will be graded on a curve. Your grade will be computed in two ways, and we will use whichever approach gives you the higher grade (note that you have to complete *all* homework assignments to be eligible):

- Standard grading: 20% for homework, 25% for each of the midterms, and 30% for the final.
- Alternative minimum grade: 20% for homework, 15% for the lower midterm, 25% for the higher midterm, 40% for the final.

Lecture Schedule (tentative): The class has four major subunits.

1. Introduction, Minimum Spanning Tree case study (with Heaps, Union Find, Graph data structures), Asymptotic analysis [$\approx$ 1 week]
2. Divide & conquer and graph algorithms [3 weeks]
   - Graph search: Breadth first, depth first, topological sorting
   - Finding closest pair of points
   - Fast Fourier Transform
   - Matrix Multiplication
   - Shortest path algorithms
   - A* heuristic search
3. Additional Data Structures [$\approx$ 1.5 weeks]
   - Suffix trees & string matching
   - Splay trees & amortized analysis
4. Advanced algorithmic design techniques [2nd half of semester]
   - Dynamic programming (edit distance, RNA folding, chains of matrix multiplication, etc.)
   - Network flow and its use for solving problems (e.g., matching, survey design)
   - Linear and integer programming
   - NP-completeness
   - Randomized algorithms (hashing & global minimum cut)

Homework Policies:

- Homework assignments are due at the beginning of class on the due date. They should be submitted through Blackboard. Note that *No late homework will be accepted* – turn in what you have completed. If you will have to miss class, please turn in the homework early.
- Answers to homework problems should be written concisely and clearly. Homework answers must be typeset and submitted as PDFs through Blackboard.
- Homework problems that ask for an algorithm should present: a clear description with pseudocode, an explanation that the algorithm is correct, and an analysis of the running time. Note that your goal is to explain the algorithm to a human, so lengthy pseudocode or source code without explanation will not help explain an algorithm.
- Regrade requests should be made *in writing* within 1 week of the homework being returned. The entire homework or exam in question will be regraded, which may result in a higher or lower grade than originally returned.
- You may discuss homework problems with classmates. You must list the names of the class members with whom you worked at the top of your homework. *However, you must write up your own solution independently!* Note that it is really the exams that count for most of your grade, so there's little benefit in writing down a homework answer that you don't really understand. If we find instances where students have copied each other's homework answers, such instances are referred to the University according to the academic integrity violation policy.
- You may *never* use, look at, study, or copy any answers from previous semesters of this course.

Excused absences: Students claiming an excused absence for an in-class exam or midterm must supply documentation (such as a doctor's note) justifying the absence. Absences for religious observances must be submitted by email to the instructor during the first two weeks of the semester.

Academic honesty: All class work should be done independently unless explicitly indicated on the assignment handout. You may *discuss* homework problems with classmates, but must write your solution by yourself. If you do discuss assignments with other classmates, you must supply their names at the top of your homework. No excuses will be accepted for copying others' work (from the current or past semesters). In particular: use of a previous semester's answer keys or online solution manuals for graded work is absolutely forbidden. Any use of such material will be dealt with as an academic integrity violation.

The university's policy on academic integrity can be found here:
`http://www.cmu.edu/policies/student-and-student-life/academic-integrity.html`

In part it reads "Unauthorized assistance refers to the use of sources of support that have not been specifically authorized in this policy statement or by the course instructor(s) in the completion of academic work to be graded. Such sources of support may include but are not limited to advice or help provided by another individual, published or unpublished written sources, and electronic sources." You should be familiar with the policy in its entirety.

Take care of yourself: *Do your best to maintain a healthy lifestyle this semester by eating well, exercising, avoiding drugs and alcohol, getting enough sleep and taking some time to relax. This will help you achieve your goals and cope with stress.*

All of us benefit from support during times of struggle. You are not alone. There are many helpful resources available on campus and an important part of the college experience is learning how to ask for help. Asking for support sooner rather than later is often helpful.

If you or anyone you know experiences any academic stress, difficult life events, or feelings like anxiety or depression, we strongly encourage you to seek support. Counseling and Psychological Services (CaPS) is here to help: call 412-268-2922 and visit their website at http://www.cmu.edu/counseling/. Consider reaching out to a friend, faculty or family member you trust for help getting connected to the support that can help.

Frequently Asked Questions

What's the difference between 02-613, 15-650, and 15-351? All the courses have the same structure, same lectures, same TAs, etc. Those who are signed up for one of the graduate numbers (02613 or 15650) will have a few additional assignments. The grading curve will also be computed separately in each of the three courses.

What about programming? This course is *not* a programming course. It is an algorithm design and analysis course. Part of the point of the course is to learn to be able to think about algorithms separately from programming. The course's focus is on being able to understand algorithms theoretically not empirically.

Is there some extra work I can do to improve my grade? No, we cannot make exceptions to the course work and grading policy. If you are concerned about your grade, please come to see me or one of the TAs ASAP. There will be no exceptions to this policy during or after the class has completed.

I have to be out of town, and I would like an extension on my homework. Can I have one? No. This is a very large class, and it is not possible to accommodate individualized deadlines for everyone. You can always turn your homework in early (if the link is not available, please ask a TA). You can also always turn your homework in remotely since we will use Blackboard to submit homework assignments.