NYU PARIS

Data Structures

CSCI-UA 9102

Instruction Mode: Hybrid

Time Zone: (UTC+1)

SPRING 2021

We know that you may be taking courses at multiple locations this semester. If you are enrolled in this course 100% remotely and are not a Go Local/Study Away student for this course site, please make sure that you've completed the online academic orientation via NYU Classes so you are aware of site specific support structure, policies and procedures. **Please contact the site academic staff (**Marion Aller **ma5461@nyu.edu)** if you have trouble accessing the NYU Classes site.

If you are attending in person, you will be assigned a seat on the first day and are expected to use that seat for the entire semester due to NYU COVID-19 safety protocol.

Instructor Information

- Augustin Cosse,
- Office hours: NYU Paris, Thursday, 2.15pm - 3.45pm (UTC+1)
- Main Office: 57 Boulevard Saint-Germain, 75005 Paris, France

Course Information

- CSCI-UA 9102
- Data Structures
- Course website : see http://www.augustincosse.com/teaching
- Class meeting days and times:
    - Meeting days: (Lectures) Tuesday/Thursday 12.30pm - 1.45pm
      (Recitations) Tuesday 2.15pm - 3.45pm
    - Classroom number: 410
    - Classroom building: NYU Paris, 57 Boulevard Saint-Germain, 75005 Paris

- Exam schedule (to be confirmed) : Midterm: Around March 25, Final: Around May 12

- Course Description: The design and analysis of efficient data structures is a vital subject in computing and is part of the curriculum of every computer science and computer engineering student. In this course, we will learn how to model computational problems. We will cover the most important algorithms, algorithmic paradigms and data structures used to solve those problems. We will discuss efficiency and scalability.
  More specifically, the course will cover topics such as object oriented programming, as well as Sorting and Trees, Hashing, Number theoretic algorithms including RSA encryption, Graphs and Shortest paths and the notion of NP-Completeness. The students will get the opportunity to code the algorithms that are discussed during the lectures in Java.

- Prerequisite
  - *CSCI-UA 101: Introduction to Computer Science*

Course Overview and Goals

Upon Completion of this Course, students will be able to:

- Understand, implement and use the most important data structures including
  - arrays
  - objects, classes
  - Stacks
  - Queues
  - Trees
  - Graphs
  - Lists
  - …
- Describe how those structures can be represented efficiently in memory
- Describe common applications for the those structures
- Understand and efficiently implement inheritance/polymorphism
- Be able to list and implement the main methods used for tree traversal
- Understand the notion of recursion and implement it efficiently
- Understand and implement Hashing functions
- Discuss the computational efficiency of the principal algorithms for sorting, searching, hashing
- Be able to efficiently use and read the Java programming language. In particular, be able to code each of the concepts listed above within this language
- Understand and efficiently implement the main graph algorithms including DFS, BFS topological sort, Min. Spanning tree, Ford Fulkerson,..
- Efficiently solve small problems by relying on the aforementioned structures and algorithms.

Course Requirements

Class Participation

You are expected to attend class in person or remote synchronously. Your active participation in class and attendance will be reflected in this part of the course requirements. The camera should be turned on for the duration of the course.

Class Participation

Students are always encouraged to ask questions and to take an active role in class activities and discussions. They are also strongly encouraged to attend office hours, especially when they feel that they are lacking a clear understanding of some of the concepts covered during the lectures.

Assignments

There should be a number of assignments following the main chapters covered during the lectures. The assignments will be given at the end of the lectures, or at the end of the week, and will be collected about 2 weeks after the start date. Assignments will either require to apply the material covered during previous lectures and programming sessions or to read and apply new material in preparation for future lectures.

Personal project

Students will get the opportunity to work on a personal project, investigating a question of their choice in connection with the course. They will be asked to implement a related algorithm and/or to summarize the related scientific literature. Finally they will be asked to design a poster/presentation summarizing their work and will get the opportunity to present and defend their work during a dedicated session towards the end of the semester.

Assigned Readings

- All the information will be shared on the website http://www.augustincosse.com/datastructures2021
- Examples of assignments and programming sessions can be found on GitHub: (see https://github.com/acosse)
- Relevant papers and/or book chapters available free of charge on the internet might also be assigned throughout the semester

Additional (yet not required) interesting textbooks include:

- *Data Structures and Algorithms*, Michael T. Goodrich, Roberto Tamassia, Michael H. Goldwasser.

- *Introduction to Algorithms*, Thomas H Cormen, Charles E. Leiserson, Ronald Rivest, Clifford Stein
- *Introduction to Java Programming (and data structures) 10th edition (or more recent)*, Comprehensive version, Y. Daniel Yang.
- *A Java Reference: Assorted Java Reference Material*, Paul N. Hilfinger

The grade for this course should be determined according to the following formula:

Assignments/Activities	% of Final Grade
Assignments	30%
MidTerm	30%
Final	30%
Project	10%

Letter Grades

Letter grades for the entire course will be assigned as follows:

Letter Grade	Points	Description
A	16-20	Outstanding
A-	15	Excellent
B+	14	Very Good
B	13	Good
B-	12	Satisfactory

C+	11	Above Average
C	10	Average
C-	9	Below Average
D+	8	Unsatisfactory
D	7	Low Pass
D-	6	Low Pass
F	5	Fail

View Grades

Grades will be available on the NYU Classes site.

Course Schedule

Topics and Assignments

The acronyms used below should be related to each of the textbooks mentioned above. I.e. GTG refers to *Data Structures and Algorithms* by Goodrich, Tamassia and Goldwasser, CLRS refers to *Introduction to Algorithms* by Cormen, Leiserson, Rivest and Stein, ...

Week/Date	Topic	Reading	Assignment Due
Week 1, 01/26 - 01/28	Reminders/Intro to Java, Elementary programming	GTG Chapter 1 Liang2010 Part I	Assignment 1 given

	including loops, strings, arrays, objects, classes,..		
Week 2, 02/02 - 02/04	Object Oriented Programming and Design, Part I	GTG Chapter 2 Liang2010 Part II	
Week 3, 02/09 - 02/11	Object Oriented Programming and Design Part II including inheritance and Abstract classes	GTG Chapter 2 Liang2010 Part II	Assignment 1 due Assignment 2 given
Week 4, 02/16 - 02/18	Fundamental data structures Multidimensional arrays, Linked Lists, Numerics, integers, RSA encryption	GTG Chapter 3 CLRS Chapter 10	
Week 5, 02/23 - 02/25	Algorithm analysis including Asymptotic Analysis and the “Big Oh” notation	GTG Chapter 4, CLRS Chapter 3	Assignment 2 due Assignment 3 given
Week 6, 03/02 - 03/04	Recursion	GTG Chapter 5 Liang2010 Chapter 18	Assignment 3 due Assignment 4 given
Week 7, 03/09 - 03/11	Stacks, Queues and Deques (Possibly List ADT)	GTG Chapters 6,7 Liang2010 Chapter 20, 24	
Week 8, 03/16 - 03/18	Trees Part I including general and Binary Trees, Tree Traversal algorithms,..	GTG Chapter 8 CLRS Chapter 12 Liang2010 Chapter 25,40	Assignment 4 due
Week 9, 03/23 - 03/25	Trees Part II (including Search Trees, Balanced Search Trees) + Priority queues	GTG Chapter 11, 9 Liang2010 Chapter 25,40	MidTerms

Week 10, 03/30 - 04/21	Maps, Hash Tables	GTG Chapter 10 CLRS Chapter 11 Liang2010 Chapter 27	
Week 11, 04/06 - 04/08	Sorting Part I	CLRS Chapter 6-9 GTG Chapter 12 Liang2010 Chapter 23	
Week 12, 04/13 - 04/15	Sorting part II	CLRS Chapter 6-9 GTG Chapter 12 Liang2010 Chapter 23	Assignment 4 due Assignment 5 given
Week 13, 04/20 - 04/22	Graph Algorithms including BFS, DFS, topological Sort, Min Spanning trees, Max Flow,..	CLRS Chapters 22-26 GTG Chapter 14 Liang2010 Chapter 28	Assignment 5 due Assignment 6 given
Week 14, 04/27- 04/29	Advanced Topics including Dynamic Programming, Linear Programming, Approximation and Randomized Algorithms,...	CLRS Chapters 5, 15, 18, 29, 35,.. GTG Chapter 15	Assignment 6 due
Week 15, 05/04 - 05/06	Revisions		
Week 16 05/11 - 05/13	Finals Week		

Course Materials

Required Textbooks & Materials

- None

Optional Textbooks & Materials

- See above

Resources

- **Access your course materials**: NYU Classes (nyu.edu/its/classes)
- **Databases, journal articles, and more**: Bobst Library (library.nyu.edu)
- **Assistance with strengthening your writing**: NYU Writing Center (nyu.mywconline.com)
- **Obtain 24/7 technology assistance:** IT Help Desk (nyu.edu/it/servicedesk)

Course Policies

Hygiene/Physical Distancing policies

- Students will be assigned/choose a seat on the first day of class. For NYU COVID-19 Safety protocols, please use the same seat for the duration of the semester.

Attendance and Tardiness

Studying at Global Academic Centers is an academically intensive and immersive experience, in which students from a wide range of backgrounds exchange ideas in discussion-based seminars. Learning in such an environment depends on the active participation of all students. And since classes typically meet once or twice a week, even a single absence can cause a student to miss a significant portion of a course. **To ensure the integrity of this academic experience, class attendance at the centers or online through NYU Classes if the course is remote synchronous/blended, is expected promptly when class begins. Unexcused absences will affect students' semester participation grade. If you have scheduled a remote course immediately preceding/following an in-person class, you may want to discuss where at the Academic Center the remote course can be taken** Students are responsible for making up any work missed due to absence. Repeated absences in a course may result in failure.

Students are responsible for making up any work missed due to absence. This means they should initiate email and/or office hour discussions to address any missed lectures and assignments and arrange a timeline for submitting missed work.

Classroom Etiquette/Expectations

Things to consider:

- Please be mindful of your microphone and video display during synchronous class meetings. Ambient noise and some visual images may disrupt class time for you and your peers.

- If you are not using your cell phone to follow the lesson, cell phones should be turned off or in silent mode during class time.
- Make sure to let your classmates finish speaking before you do.
- Please do not eat during class and minimize any other distracting noises (e.g. rustling of papers and leaving the classroom before the break, unless absolutely necessary)
- If deemed necessary by the study away site (ie COVID related need), synchronous class sessions may be recorded and archived for other students to view. This will be announced at the beginning of class time.
- Students should be respectful and courteous at all times to all participants in class. Consider using the chat function or "raise hand" function in order to add your voice to class discussions especially if leaving the video on presents challenges.

Final Exams

Final exams must be taken at their designated times. Should there be a conflict between final exams, please bring it to the attention of the site Academic representative as soon as this is known to facilitate alternate arrangements. Final exams may not be taken early, and students should not plan to leave the site before the end of the finals period.

Late Assignment

1) Written work due in class must be submitted during the class time to the professor.
2) Late work should be emailed to the faculty as soon as it is completed.
3) Students who arrive to class late for an exam do not have automatic approval to take extra time to complete the exam.
4) Students who miss an exam (including the final) without previously arranged permission will receive a zero on that exam.
5) Assignments due during finals week that are submitted more than 3 days without previously arranged extensions will not be accepted and will receive a zero. Any exceptions or extensions for work during finals week must be discussed with the Site Director.

Incomplete Grade Policy

An "incomplete" is a temporary grade that indicates that the student has, for good reason, not completed all of the course work. This grade is not awarded automatically nor is it guaranteed; rather, the student must ask the instructor for a grade of "incomplete," present documented evidence of illness, an emergency, or other compelling circumstances, and clarify the remaining course requirements with the instructor.

In order for a grade of "incomplete" to be registered on the transcript, the student must fill out a form, in collaboration with the course instructor and the academic administration at the site; it should then be submitted to the site's academic office. The submitted form must include a deadline by which the missing work will be completed. This deadline may not be later than the end of the following semester.

Academic Honesty/Plagiarism

As the University's policy on "Academic Integrity for Students at NYU" states: "At NYU, a commitment to excellence, fairness, honesty, and respect within and outside the classroom is essential to maintaining the integrity of our community. By accepting membership in this community, students take responsibility for demonstrating these values in their own conduct and for recognizing and supporting these values in others." **Students at Global Academic Centers must follow the University and school policies.**

The presentation of another person's words, ideas, judgment, images, or data as though they were your own, whether intentionally or unintentionally, constitutes an act of plagiarism.

NYU X takes plagiarism very seriously; penalties follow and may exceed those set out by your home school. All your written work must be submitted as a hard copy AND in electronic form to the lecturer. Your lecturer may ask you to sign a declaration of authorship form.

It is also an offense to submit work for assignments from two different courses that is substantially the same (be it oral presentations or written work). If there is an overlap of the subject of your assignment with one that you produced for another course (either in the current or any previous semester), you MUST inform your professor.

For guidelines on academic honesty, clarification of the definition of plagiarism, examples of procedures and sanctions, and resources to support proper citation, please see:

NYU Academic Integrity Policies and Guidelines

NYU Library Guides

Religious Observances

Students observing a religious holiday during regularly scheduled class time are entitled to miss class without any penalty to their grade. This is for the holiday only and does not include the days of travel that may come before and/or after the holiday.

Students must notify their professor and the local Academics team in writing via email at least 7 days before being absent for this purpose.

Inclusion, Diversity, Belonging and Equity

NYU is committed to building a culture that respects and embraces diversity, inclusion, and equity, believing that these values – in all their facets – are, as President Andrew Hamilton has said, "...not only important to cherish for their own sake, but because they are also vital for advancing knowledge, sparking innovation, and creating sustainable communities." At NYU PARIS, we are committed to creating a learning environment that:

• fosters intellectual inquiry, research, and artistic practices that respectfully and rigorously take account of a wide range of opinions, perspectives, and experiences; and

• promotes an inclusive community in which diversity is valued and every member feels they have a rightful place, is welcome and respected, and is supported in their endeavours.

Moses Accommodations Statement

Academic accommodations are available for students with documented and registered disabilities. Please contact the Moses Center for Student Accessibility (+1 212-998-4980 or mosescsd@nyu.edu) for further information. Students who are requesting academic accommodations are advised to reach out to the Moses Center **as early as possible in the semester for assistance**. Accommodations for this course are managed through the site sponsoring the class once you request it.

Instructor Bio/About Your Instructor

Augustin Cosse received the BS and MS in Engineering and applied mathematics at the University of Louvain, Belgium in 2009 and 2011 respectively. He then obtained a PhD in applied mathematics and electrical engineering which was funded by the Belgian National Science Foundation (FNRS). He was a visiting student at MIT between 2013 and 2014, a visiting fellow at Harvard (IACS) between 2014 and 2015 and visited the University of Chicago, Galton school of Statistics, between 2015 and 2016. He completed a one year Postdoc at the Courant Institute and Center for Data Science in NYC before joining the department of Mathematics at Ecole Normale Superieure, Paris, as a postdoctoral researcher in 2017. In parallel, he joined NYU Paris as a lecturer in Computer Science in 2018.

His research interests include applied analysis and inverse problems, convex optimization, high dimensional probability and statistics, machine learning and theoretical computer science.