Syllabus and Essential Information About This Class

This is the graduate version of a combined graduate/undergraduate course in parallel computing. The Computer Science Department has an informal policy that specifies how combined classes are to be taught and administered. This policy sets forth guidelines for how a graduate student's experience in the course should be different from an undergraduate student's experience. For the most part, the difference is in the amount and difficulty of the assigned work and exams. Graduate students have greater demand placed upon them than undergraduates. This document specifies the syllabus for graduate students only.

1 About This Document

You are expected to read this document entirely and know its contents. It contains important information about when and how this class meets, how it is graded, what is expected of you, how to get help, what to read and when to read it, and so on. It contains the dates of exams and other events of importance for the fall 2021 semester. The content of this document is considered to be course content and therefore questions about it might appear on an exam.

2 Course Format

This is an online course. It will meet at the scheduled class time ***online***, using the ***Zoom*** web conferencing application. Students will need to install the Zoom client application to attend the class. Instructions and details regarding Zoom and attending class are in Class Meetings and Zoom below.

3 Class Meetings and Zoom

- **Meeting Time**. Class meets every Monday and Wednesday, from 5:35 to 6:50 P.M. (Eastern Daylight Time), except for those days for which no classes are scheduled. Section Class Calendar and Important Dates lists the days on which there are no classes.
- **Meeting Place**. The URL of the class meeting is `https://us02web.zoom.us/j/82941936484`. It is password-protected, and only registered students will be allowed to attend. The password is posted in the *Announcements* page on ***Blackboard***.
- **Installing Zoom**. If you do not have the Zoom client, you can download it from the Zoom website `https://zoom.us/`. The ***Resources*** menu has a link to download clients for all operating systems. You can also install a plug-in to use Zoom within the Firefox and Chrome browsers, but it is better to install the client. When you install it, you will create an account with Zoom.
- **Zoom Display Name.** In each class session, ***you are required to be signed into Zoom with the name that you used to register for this class***, herein called your ***roster name***. Specifically, you must set the ***display name*** in your Zoom profile so that it is the same as your roster name.
  - To set the display name in Zoom, go to the ***Zoom Settings*** in the client application, find the ***Profile*** tab, and click the ***Edit Profile*** button. In the web page that opens, click on the Profile link and then find the Display Name box. Enter the same name there as you used to register for this class.
  - If you have a very long name and/or a middle initial in the roster name and you would prefer not to use it, you may instead enter just your first name and your full last name. If either of your first or last names is more than one word and you prefer not to use the full name, you must notify me ***before the start of the first class***, so that I can modify your name in the roster.

  - The purpose of this requirement is twofold: (1) to reduce the risk that someone who does not belong in class is in the session maliciously, and (2) so that your participation can be recorded correctly. Scripts that I use to record this activity are based on your roster name and they try to match it; if they fail to find a match, you get no credit.

- **Audio and Video**. *You are not required to turn on a camera for this class nor to turn on audio. The chat window may be used for asking and answering questions. Nonetheless, you are encouraged to turn on both video and audio.*

- **Legal Notice Regarding Video Recordings.** Students who participate in this class with their camera on or use a profile image are agreeing implicitly to have their video or image recorded solely for the purpose of creating a record for students enrolled in the class to refer to, including those enrolled students who are unable to attend live. If you are unwilling to consent to have your profile or video image recorded, be sure to keep your camera off and do not use a profile image. Likewise, students who un-mute during class and participate orally are agreeing to have their voices recorded. Anyone who is not willing to consent to have their voice recorded during class, needs to keep the mute button activated and communicate exclusively using the "chat" feature, which allows students to type questions and comments live.

---

4 Communication

Office Hours	Mondays, 10:00 - 12:00, or by appointment. Office hours are entirely online, through the *Zoom* web conferencing application. The URL for connecting is `https://us02web.zoom.us/j/82658967049` and the passcode is 476774.
Email	stewart.weiss@hunter.cuny.edu
Telephone	(212) 772-5469. I will not be in the office but I can retrieve messages remotely.

Regarding email, please note that

- I will not read email containing *Microsoft Word*-encoded documents. If you need to attach a document, it must be either plain text or PDF.

- I will not read email unless it is sent from your "`myhunter`" or another CUNY account. It is a violation of federal law (**FERPA**) to have an email conversation about school-related matters using a non-school account because there is no proof that it is not spoofed and might be insecure[1].

You can see me during my office hours without an appointment. If you need to see me at a different time, you need an appointment. The only way to make an appointment is to send me email, and it is best to include a few suggested times.

---

[1] Email sent from the *myhunter* account requires an authenticated login, it satisfies FERPA's written consent requirement. However because security measures for other email systems are not as strict, an email received from Gmail or other mail accounts, for example, would NOT satisfy FERPA requirements.

5 Resources

Lecture Notes My lecture notes for the class are required reading, although not all of the material in the notes will be covered in the class lectures. Topics to be covered from each chapter will be announced in advance, week by week. The lecture notes are on the webpage`http://www.compsci.hunter.cuny.edu/~sweiss/course_materials/csci493.65/csci493.65_lecture_notes.php`

Textbook The lecture notes were originally written to be used in conjunction with the excellent, but now out-of-print book by Michael Quinn:
Parallel Programming in C with MPI and OpenMP. McGraw Hill, 2004. ISBN 0-07-282256-2.
This book is available from used book sellers on the web for wildly different prices. You are required to read various chapters of this book as specifiedf in class.

Optional Textbook The Quinn book is a C programming book. Barlas has a very different book that covers parallel programming using bot C and C++, and has sections on several different paradigms. It is a good resource:
Gerassimos Barlas. *Multicore and GPU Programming An Integrated Approach*. Elsevier Science & Technology, 2014. ISBN 978-0-12-417137-4.

Computer Science Department Linux Network Registered students are given user accounts on the *Computer Science Department's* network of instructional computers. All hosts run *Ubuntu 18.04*. Students must use the secure remote login program, *ssh*, to access these accounts. See Programming and System Access below for more details about how to connect. ***Students will be required to use this network for most activities and assignments.***

Students are expected to know basic Linux commands in this class. Those students whose computing device runs Windows 10 or later can install a subsystem on their devices that allows them to run Linux commands. Instructions for doing this are available here:
`https://okunhardt.github.io/documents/Installing_WSL.pdf`

Course Website All course materials, including lecture notes, slides, assignments, syllabus, and other resources, including this document, are posted on my website, at
`http://www.compsci.hunter.cuny.edu/~sweiss/course_materials/csci795.24/csci795.24_f21.php`
(This is a redirect to the joint course page.)

Discussion Board This class uses *Piazza* as a discussion board. The sign-up link is `https://piazza.com/hunter.cuny/fall2021/cs4936579524`.The *Piazza* discussion pages are at
`https://piazza.com/class/kshlyqapsr31f7`
Please see the sectionCourse Materials, the Web, Piazza, and Blackboard below for the details.

Grading and Exams	All exams and quizzes will be administered through Gradescope. The entry code for this course is posted in ***Blackboard***. Grades will be posted in the ***Blackboard Grade Center***.

6 Course and Learning Objectives

Specific learning objectives of the course are that, after completing the course successfully, the student should be able to:

1. Write a correct and scalable parallel algorithm using both a message-passing based paradigm (MPI) and a shared-memory based paradigm (OpenMP and/or Pthreads).
2. Read and analyze a program that uses any of MPI, OpenMP, and Pthreads.
3. Parallelize a serial algorithm by applying the Foster Design Methodology (PCAM) using task decomposition and/or data parallel decomposition.
4. Determine the speed-up, efficiency, and scalability of a parallel system.
5. Discuss the concept of parallel processing and the relationship between parallelism and performance.
6. Explain the basic types of parallel architectures and netwok topologies.
7. Characterize the kinds of tasks that are a natural match for SIMD machines and those more suited to SMP architectures.
8. Explain how some Monte Carlo methods work.

7 About C and C++ in This Course

Although both MPI and OpenMP support parallel programming in both C and C++ (as well as Fortran77 and Fortran90), most of the programming examples that I use are written in C. The Pthreads library is a C library, designed to be linked from C programs. Some students have a knee-jerk reaction when they hear this, thinking, "but I don't know C." This is not quite true. The C++ language contains most of the C language. If you know C++, you know a great deal of C. There are minor differences that arise in the syntax of declarations (such as structure and function declarations), but the real problem is that most students never learn how to use the C standard libraries. Most students learn C++ stream I/O and never bother to learn what they think are archaic functions of the C standard I/O library. These functions are at times much more useful than any found in C++. In general, you ought to know some C, as a student of computer science, because there are things you can do much more easily and quickly in C than with C++. You will be free, however, to use C++ when possible in the course, if that is your preference.

8 Assignments, Exams, Presentations, and Grading

Graduate students are expected to be self-motivated and self-disciplined, and are expected to take the initiative to learn background material that is not covered in class. In addition, graduate students are required to do an in-class presentation on a topic approved by the professor. The final grade is based upon a weighted average of the following components:

Component	Weight
non-programming assignments	10%
programming projects	30%
presentation	10%
quizzes	10%
final exam	30%

8.1 Assignments

There will be several assignments, some of which do not involve programming, and others that do. In all cases, the work is to be yours alone; working in groups is not allowed, unless the assignment states otherwise. ***Assignments must be submitted on time and will not be accepted after their due dates.*** There will be at most four programming projects. A program's weight will depend on its difficulty and size but it will be known at the time that it is assigned. Programs must comply with the rules specified in the Programming Rules document `http://www.compsci.hunter.cuny.edu/~sweiss/course_materials/csci795.24/programming_rules.pdf`. Please read it carefully.

8.2 Presentations

Some of the topics that we will cover in class will be taught by graduate students. I will ask each student to read some of the material in my notes and in the Quinn book and prepare a 15 to 20 minute presentation on that topic. The presentation must include slides and may include other visual aids The objective is to present that topic to the rest of the class and then try to answer the questions that arise. I will assist as needed. Examples of topics are:

- a parallel solution to the n-body problem (chapter 3)
- a parallel solution to the Sieve of Eratosthenes
- an overview of parallel random number generators
- parallel quicksort
- computing π using OpenMP
- reader/writer locks in Pthreads

8.3 Exams

Quizzes ***may not be announced*** in advance and will usually be based on material from a scheduled reading, a previous class, or an assignment. Theses quizzes will be about ten minutes long. The final exam will cover all material from the start of the semester, i.e. ***the final exam is cumulative***. As of the writing of this syllabus, Hunter has not yet posted the final exam schedule for the fall 2021 semester.

8.4 Incomplete Grades

Assignments that are graded must be submitted by their due dates. **Late assignments will not be accepted and will be given a grade of zero**. Failure to take an exam counts as a zero grade on that exam. The only exceptions to these two rules are in the case that you have a legitimate, documented medical or personal emergency that prevents your timely completion of homework or sitting for an exam and have notified me in a timely manner about this emergency. I will schedule a make-up exam or grant a homework deadline extension only in that case. I do not give incomplete (IN) grades except to those students who were making progress through most of the semester and submitting assignments on time and who were unable to complete some work because of legitimate, documented medical or personal problems, and this is entirely at my discretion.

9 Class Calendar and Important Dates

The first day oif class is Wednesday, August 25. There are no classes on September 6, September 8, September 15, and October 11. ***The last day to drop without a W is September 14***. ***The last day to withdraw is November 5.*** The last day of class is Monday, December 13.

10 Programming and System Access

All students enrolled in the class are given accounts on the Computer Science Department's network. This entitles you to physical access to the 1001B lab, which is equipped with Linux workstations. This lab is normally open from early morning through late evening. You may also use the 1001B Linux/Windows Lab if there is no class using it. The account also enables you to work from home or another remote computer by connecting to any of the lab machines remotely. The details are described below.

The advantage of working in the lab, as opposed to working remotely, is that you will be sitting at the console of a Linux host and will not be subject to potential disconnections that can take place when working remotely. You will also be much less affected by network problems than if you connect remotely from outside of Hunter. The disadvantage is that you have to be in school to do this.

When you are in the lab there are a few important rules that must be followed:

- Never power down a machine for any reason.
- Never leave a machine without logging out.
- Never use lockscreen to lock the screen in your login.

There are several other rules regarding lab use, which are posted in the lab. Also, please read the documentation at

`http://www.geography.hunter.cuny.edu/tbw/CS.Linux.Lab.FAQ/department_of_computer_science.faq.htm`

for more information. Please take the time to read this page and the others referenced on it.

The Computer Science Department has a ***gateway*** machine named

`eniac.cs.hunter.cuny.edu`,

available to students who have accounts on the network. `eniac` is a gateway computer - you will be able to login to this host from any computer that has *ssh* client software on the Internet. Once you login to `eniac`, you must login from `eniac` to one of the computers in the network that are named `cslab1`, `cslab2`, `cslab3`, and so on, up to `cslab30`. You cannot *ssh* directly to those machines from outside of Hunter College for security reasons. For example, you can first login to `eniac`, and then when it gives you a prompt such as "`$`", you would type

```
ssh cslab5
```

and re-enter your network password at the prompt from `cslab5`.

Many computers come with a version of *ssh* already installed. If yours does not, you can get one for free. There are several free versions of *ssh*. *OpenSSH* is an open source version developed for the *OpenBSD* project. *PuTTY ssh* is a free version for the Windows operating systems, available at

`http://www.chiark.greenend.org.uk/~sgtatham/putty/.`

Macintosh computers come with a command-line *ssh* client.

11 Course Materials, the Web, Piazza, and Blackboard

All lecture notes will be posted on the course's home webpage (whose URL is above), which does not require special privileges to access. The only thing for which I use Blackboard is for posting of grades, which will be posted in the grade center there. This term we will be using Piazza for class discussion. The system is highly catered to getting you help fast and efficiently from classmates and me. Rather than emailing questions to me, you are to post your questions on Piazza. If you have any problems or need feedback for the developers, email *team@piazza.com*.

You can find our class's discussion page at:

`https://piazza.com/class/kshlyqapsr31f7`.

An invitation to join the Piazza discussion board will be sent to your Hunter College email address close to the start of the semester. You should accept this invitation. Your Hunter email address can be used for reading and sending messages to the group, or you can change the email address or add another on the settings page. In fact, you can request to join the group with any email address you choose, at

`https://piazza.com/hunter.cuny/fall2021/cs4936579524`

I require that you use the following protocol if you have a question:

1. Check whether the question you want to ask has been posted and answered on Piazza.
2. If it has been answered, you are finished. If not, post the question on Piazza.
3. Anyone in the class can answer the question. If no one else answers the question in a timely manner, I will post an answer to it.

I will ignore any non-personal questions sent to my Hunter email address. Personal questions (such as a questions about a grade or a missed class or alternative times to meet with me) should be sent via private email to my Hunter email address, not to Piazza.

12 Academic Honesty

Unless I state otherwise, all assignments and projects are to be your work alone. If someone else does part of this for you, it is considered to be academic dishonesty. Hunter College regards acts of academic dishonesty (e.g., plagiarism, cheating on examinations, obtaining unfair advantage, and falsification of records and official documents) as serious offenses against the values of intellectual honesty. The college is committed to enforcing the CUNY Policy on Academic Integrity and will pursue cases of academic dishonesty according to the Hunter College Academic Integrity Procedures. In this class, I will enforce the University's Policy on Academic Integrity and bring any violations that I discover to the attention of the Dean of Students Office.

13 ADA Compliance

In compliance with the *American Disability Act of 1990* (ADA) and with *Section 504* of the *Rehabilitation Act of 1973*, Hunter College is committed to ensuring educational parity and accommodations for all students with documented disabilities and/or medical conditions. It is recommended that all students with documented disabilities (emotional, medical, physical and/or learning) consult the *Office of AccessABILITY* located in Room E1124 to secure necessary academic accommodations. For further information and assistance, the student can call (212-772-4857)/TTY (212-650- 3230).

14 Hunter College Policy on Sexual Misconduct

In compliance with the *CUNY Policy on Sexual Misconduct*, Hunter College reaffirms the prohibition of any sexual misconduct, which includes sexual violence, sexual harassment, and gender-based harassment retaliation against students, employees, or visitors, as well as certain intimate relationships. Students who have experienced any form of sexual violence on or off campus (including CUNY-sponsored trips and events) are entitled to the rights outlined in the *Bill of Rights for Hunter College*.

- Sexual Violence: Students are strongly encouraged to immediately report the incident by calling 911, contacting NYPD Special Victims Division Hotline (646-610-7272) or their local police precinct, or contacting the College's Public Safety Office (212-772-4444).
- All Other Forms of Sexual Misconduct: Students are also encouraged to contact the College's Title IX Campus Coordinator, Dean John Rose (jtrose@hunter.cuny.edu or 212-650-3262) or Colleen Barry (colleen.barry@hunter.cuny.edu or 212-772-4534) and seek complimentary services through the Counseling and Wellness Services Office, Hunter East 1123.

- CUNY Policy on Sexual Misconduct Link: `http://www.cuny.edu/about/administration/offices/la/Policy-on-Sexual-Misconduct-12-1-14-with-links.pdf`

15 Changes to This Syllabus

Except for changes that substantially affect the implementation of the grading statement, this syllabus is a guide for the course and is subject to change with advance notice. Any changes will be posted to the course website and to the Piazza group for the course.

16 Content

The following table outlines the topics that we will most likely cover during the semester. The lectures are based on my own lecture notes, available on the course website. The exact timing of each class is an approximation; we may deviate from this plan. You are expected to read the lecture notes before the class in which the topic is covered, so that you are prepared for the class. You are also expected to read the Quinn book's related material.

Week	Lecture Topic
1	1 Background; Brief History of Parallel Computing;
2	2 Parallel architectures
3	3 Parallel Algorithm Design
4	4 Message-Passing Programming using MPI
5	5 Floyd's Algorithm using MPI
6	6 Performance Analysis
7	7 Matrix-Vector Multiplication using MPI
8	8 Monte Carlo Methods
9	8 Monte Carlo Methods
10	10 Shared-Memory Programming with PThreads
11	10 Shared-Memory Programming with PThreads
12	10 Shared-Memory Programming with Threads and OpenMP
13	10 Shared-Memory Programming with OpenMP
14	10 Shared-Memory Programming with OpenMP