PROGRAMMING LANGUAGES & TRANSLATORS

Instructor: Baishakhi Ray

Fall 2023

Instructor

Prof. Baishakhi Ray

Associate Professor

rayb@cs.columbia.edu

https://rayb.info

Office Hours: Wednesday noon to 1 pm/by Appointment

Location: CEPSR 6LE1

Class Covid Protocol

- All the class lectures will be recorded by CVN and will be available in video library tabs in CVN.
- Do not come altogether to the instructors.
    - I will prefer email communications
    - If you absolutely need to meet me in person
        - Come to my office hour (Wednesday 10-11)
        - Or, email and we can schedule meeting

PLT 4115

- Lectures:
  - Mondays and Wednesdays, 1:10 PM-2:25 PM @ CSB 451
  - September 13 – December 13

- Get all the class updates in the website
  - https://www.rayb.info/plt4115-fall2021

- We will us Ed Discussion for class communication
  - See your course work tab option

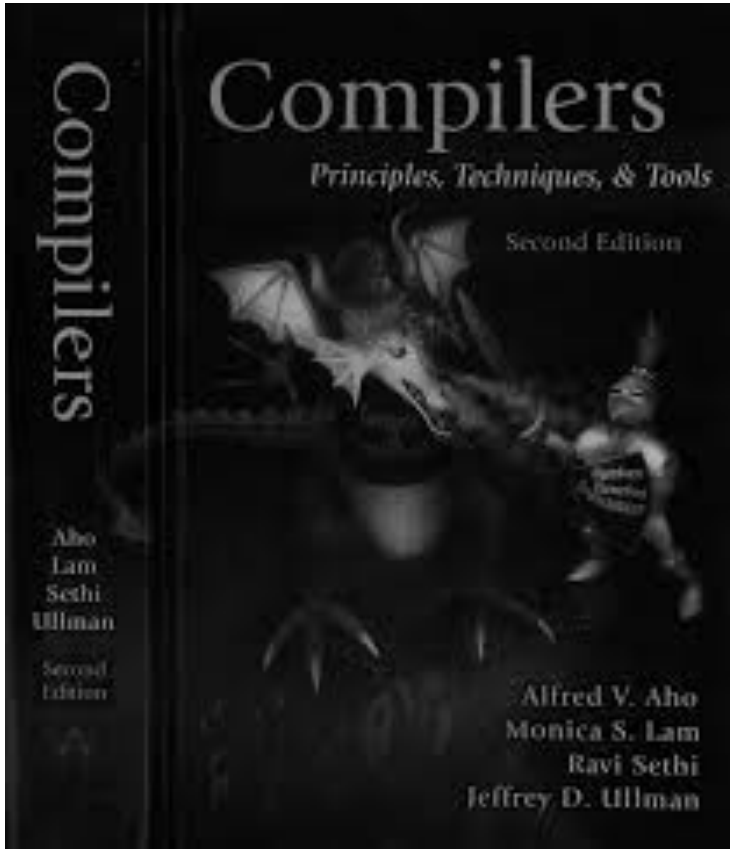
Programming Language & Translators

How can a computer program written in a high-level **programming language** (e.g., C, Python) be **translated** to a lower-level language (e.g., assembly language or machine code) to create an executable program?

Recommended Text

- Compilers: Principles, Techniques, and Tools
  - By Alfred V. Aho, Monica S. Lam, Ravi Sethi, and Jeffrey D. Ullman.
  - 2nd Edition
  - Addison-Wesley, 2006

- We will follow this book, but not line-by-line/ section-by-section



This Class

- Theory: Learn different phases of a compiler design (50%)
- Practice: Implement different phases of compilers (50%)
  - Implement modules on top of an existing compiler (Clang/LLVM)

Theory deliverables:
- Written assignments
- Midterm
- Final

	Lectures	Programming
1	Introduction	
2	Lexical Analysis	Prog1
3	Syntax Analysis	Prog2
4	Semantic Analysis	Prog3
5	Run-Time Environment	
6	Code Generation	Prog4
7	Optimization	Prog5, Prog6

Programming deliverables:
6 prog assignments

All are individual assignments

Assignments and Grading

• Programming Assignments	50%
• Written Assignments	10%
• Midterm	20%
• Final	20%
• Extra Credit	10%

- Programming assignments are most important, but most students do well on it. Grades for tests often vary more.

Extra Credit:

- 10% of earned (extra credit/total extra credit) will be added with the original 100% from other assignments/exams
  - If you earn 50 out of 100 in extra credit, 5 will be added with your total (100%) achievement.

Assignments Policy

- Hard Deadline
  - There will be no extension unless you produce medical certificate or permission from school authorities
  - The instructor or TAs will not reply to such email requests.
  - Plan ahead so that you can finish the assignments on time.
    - There can be challenges that you have not anticipated

- Written Assignments will be submitted through Gradescope
  - We will share Gradescope entry code
  - Type your submission

- Programming Assignments will be submitted through Github Classroom
  - TAs will send you detailed instructions

Assignments Policy

- Work individually
- Programming assignments: work individually.
  - You can discuss with TAs/Instructor/Classmate
- Written assignments: do by yourself.
  - No discussion
  - Only clarification questions are allowed on Ed Discussion
  - TAs/Instructors will not respond to individual email
- DO NOT USE AI-Assisted Tool.
  - You will not learn
  - We will check for plagiarism

Submission Policy

Don't be a cheater (e.g., copy from each other).
If I catch you cheating I will send you to the dean.

- Read the CS Department's Academic Honesty Policy: https://www.cs.columbia.edu/education/honesty/
- **OK**: Discussing lecture content
- **Not OK**: Solving a homework problem with classmates
- **OK**: Doing programming assignments together
- **Not OK**: Copying from others' solutions.
- **Not OK**: Posting any homework questions or solutions.
- **Not OK**: Use AI-assisted tools to find the answers.

Exam Policy

- Exams: Open book
  - Follow CU honor code.
- In-Class Participations
  - Class participation is important
  - Instructor will ask questions that you have to answer

Prerequisites

1. Advanced Programming on C/C++
2. Computer Science Theory
    1. Regular languages and expressions
    2. Context-free grammars
    3. Finite automata (NFAs and DFAs)
3. Fundamentals Of Computer Systems
    1. Memory layout
    2. Register
    3. Instruction Set
    4. Performance Analysis

We will conduct an entrance exam on 15th September during class time to test your basic knowledge on the above topics.

Entrance Exam

- Will be held on 15th September from 1:10 pm to 2:30 pm
- Open Book/Open Internet
- Only pass/fail to check your ability to test the class
    - Grades of entrance exam **will not be** added to final course grade

- We will email a Google Form link right before the exam.
- Use your **uni email** to sign in to the Google form
    - This will help us to track you
- All the registered and wait-listed students have to pass the exam in order to take the class
- You may not need to come to the class, you can give the exam from anywhere.

Entrance Exam

- Don’t be a cheater
  - It’s open book/open internet
  - You are not allowed to discuss with anyone

- Read the CS Department’s Academic Honesty Policy: https://www.cs.columbia.edu/education/honesty/
- If you cheat to pass the exam, it will be ultimately your loss as you will have immense difficulty to take the course
  - Instructor or TAs will not entertain questions that you already are supposed to know

Exam Schedule

- Midterm : October 27
- Final: December 13

Submission Links

- **Written Assignments** : gradescope
  Entry Code will be posted in Coursework
- **Programming Assignments** : github classroom
  Details will be posted in Coursework


Q&A

Programming Assignments/Projects

- We will implement some compiler functionalities through out the semester
- Three projects —- you can pick any one of the following three options
  - Dead-code elimination
  - Finding resource leak
  - Finding uninitialized variables
- We will implement the compiler functionalities step-by-step to achieve the final goal.
  - There will be 6 programming assignments that will help you to reach the goal

Programming Assignments

- 6 programming assignments
- We should have a good knowledge of C/C++
- Linux is preferred operating system
  - All the instructions will be given based on Linux

Programming Assignments

- The assignments will be done on top of LLVM infrastructure
  - LLVM is a state-of-the art compiler (default compiler in MAC)
  - Some of the assignments are inter-dependent
  - We will provide Google cloud resource for LLVM related assignments
- Each student will be provided with google cloud resource for programming assignment.

Programming Assignments

- In all the assignments, some partial code will be given.
- Based on the instructions, you have to finish the rest.
- Scripts to setup the environment and run the code will also be provided.
- Each assignment will come with a bunch of test cases
  - Your goal is to pass all the test cases.
  - However, passing all the test cases do not mean the program is correct.
- Submit all programming assignments through GitHub Classroom.

Written Assignments

- After every topic, there will be a written assignment
  - Q&A
  - Multiple Choice
  - Problem Solving
- Midterm and Finals will follow written assignments patterns

TA

- Yangruibo Ding (Office hour: Friday 10-12 @ CSB 452C)
- Dongdong She TBD
- Sai Satwik Vaddi TBD


Q&A