University at Buffalo
Department of Computer Science and Engineering
School of Engineering and Applied Sciences

CSE 220: Systems Programming

1 - *Introduction*

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CSE 220: Systems Programming

- **Instructor:** Karthik Dantu (this section)
  Ethan Blanton (another section)
- **Office Hours:** 12:30-2:00 pm (MW)
- **Course Website**: https://droneslab.github.io/cse220/
- **Discussion Forum**: https://piazza.com/buffalo/fall2019/cse220/resources
- **Syllabus**: https://droneslab.github.io/cse220/lectures/syllabus.pdf
- **Textbooks**:

  Randal E Bryant and David R O'Hallaron. *Computer Science: A Programmer's Perspective.* Third Edition. Pearson. 2016.

  Brian W Kernighan and Dennis Ritchie. *The C Programming Language.* Second Edition. Prentice Hall. 1988.

CSE 220: Objectives

- **Objective**: Understand how hardware (processor, memory, GPU, disks, network) and software (OS, compilers, libraries) come together to execute application programs
- **Benefits of CSE 220**

  Become better programmers

  Identify and eliminate bugs and program bottlenecks efficiently

  Understand and tune program performance

  Stepping stone for other Systems classes in CS and CE

    CSE 421: Operating systems

    CSE 489: Modern Networking Concepts

    CSE 305: Intro to Programming Languages

    CSE 341: Computer Organization

    CSE 321: Realtime and Embedded Systems

    …. and many more

CSE 220: Content

- Hardware
  - Decades of evolution of processor technology
  - Memory and storage have evolved in parallel
  - I/O (including disk and network) dominate interactivity changing the usage model
- Software
  - OS abstracts the hardware and provides a unified interface (system calls)
  - Libraries provide interfaces for commonly used programming fragments (data structures, math operations, user interaction etc.)
- Application programs
  - Sit on top of all the above hardware/software
  - Execute *higher-level commands*
  - Are typically compiled/interpreted by a compiler/interpreter
- This class helps you understand the interaction of application programs with all the above - and hopefully interest you in delving into looking under the hood of a computer program!

CSE 220: Expectations

- Probably your toughest CSE class until now - one of the harder classes in general!
- Attendance - Mandatory!
  - I will not re-do lectures
  - Recitations will also not repeat lectures
  - If you skip lectures, expectation is that you'll catch up on your own
- Labs - at least as important as the lectures!
  - Practice what you learn in class
  - Frequent lab exams to test your understanding
  - Significant portion of the grade
- Assistance - ask for help *early* and *often*
- Meet pre-reqs
  - Some programming experience
  - Understand linked lists and object references

This class elevates expectations from you in terms of your off-class learning. We strongly believe this is the systems-way of thinking – and 220 is designed to inculcate this in you!

CSE 220: Etiquette

- Attend every class and lab !
- Be respectful to instructors, TAs and classmates
- **Adhere strictly** to the academic integrity policy (more in a bit)

Behave as adults and strive to maximize your and your classmates' learning experience in this course.

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CSE 220: Ways To Fail

- Missing classes and labs
- Start assignments at the last minute
- Not visiting office hrs
- Not asking questions on Piazza
- Waiting until the deadline to submit for the first time
- Cheat!

CSE220: Academic Integrity Guidelines

Academic Integrity

Cheating is submitting any work that you did not perform by yourself as if you did.

CSE220: Academic Integrity Guidelines

- References (when cited)
  Wikipedia, Wikibooks (or similar): **OK**
- Public Code
  StackExchange/StackOverflow: **Not OK**
- Discussing concepts/ideas with classmates
  "A hash index has O(1) lookups": **OK** (except exams)
- Sharing code or answers with anyone
  "Just look at how I implemented it": **Not OK**
  For-hire code: **NOT OK**

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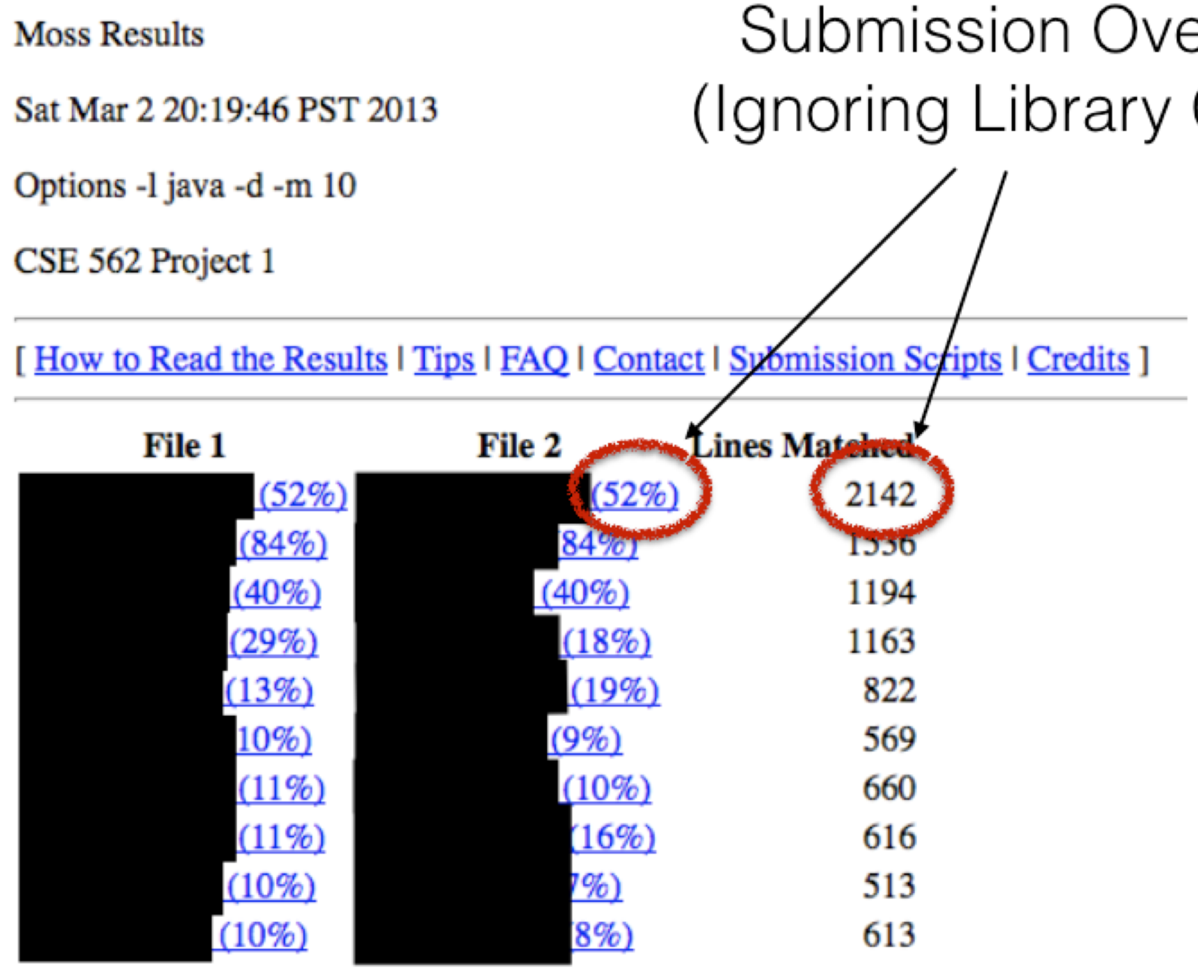
CSE 220: Academic Integrity

- We use sophisticated code checkers such as `moss`
- Trust me – it is better than any disguise you can do in short order!
- We also compare with submissions from previous years, as well as publicly available repos

Submission Overlap
(Ignoring Library Code)



Moss Results

Sat Mar 2 20:19:46 PST 2013

Options -l java -d -m 10

CSE 562 Project 1

[How to Read the Results | Tips | FAQ | Contact | Submission Scripts | Credits]

File 1	File 2	Lines Matched
[redacted] (52%)	[redacted] (52%)	2142
[redacted] (84%)	[redacted] 84%)	1536
[redacted] (40%)	[redacted] (40%)	1194
[redacted] (29%)	[redacted] (18%)	1163
[redacted] (13%)	[redacted] (19%)	822
[redacted] 10%)	[redacted] (9%)	569
[redacted] (11%)	[redacted] (10%)	660
[redacted] (11%)	[redacted] (16%)	616
[redacted] (10%)	[redacted] 7%)	513
[redacted] (10%)	[redacted] 8%)	613

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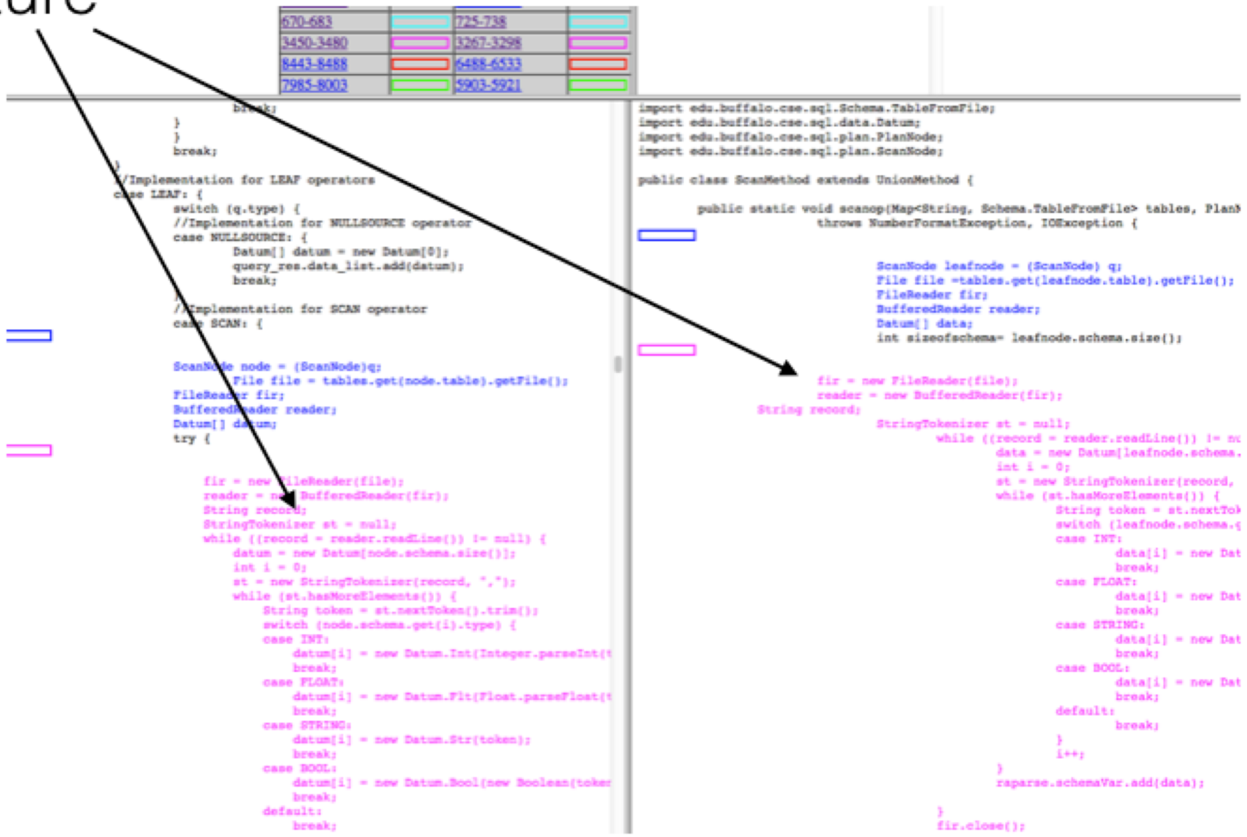
CSE 220: Academic Integrity

Identical Code Structure



670-683	🟦	725-738	🟦
3450-3480	🟪	3267-3298	🟪
8443-8488	🟥	6488-6533	🟥
7985-8003	🟩	5903-5921	🟩

```
                        break;
                }
                }
                break;
        }
        //Implementation for LEAF operators
        case LEAF: {
                switch (q.type) {
                //Implementation for NULLSOURCE operator
                case NULLSOURCE: {
                        Datum[] datum = new Datum[0];
                        query_res.data_list.add(datum);
                        break;
                }
                //Implementation for SCAN operator
                case SCAN: {


                ScanNode node = (ScanNode)q;
                        File file = tables.get(node.table).getFile();
                FileReader fir;
                BufferedReader reader;
                Datum[] datum;
                try {


                    fir = new FileReader(file);
                    reader = new BufferedReader(fir);
                    String record;
                    StringTokenizer st = null;
                    while ((record = reader.readLine()) != null) {
                        datum = new Datum[node.schema.size()];
                        int i = 0;
                        st = new StringTokenizer(record, ",");
                        while (st.hasMoreElements()) {
                            String token = st.nextToken().trim();
                            switch (node.schema.get(i).type) {
                            case INT:
                                datum[i] = new Datum.Int(Integer.parseInt(t
                                break;
                            case FLOAT:
                                datum[i] = new Datum.Flt(Float.parseFloat(t
                                break;
                            case STRING:
                                datum[i] = new Datum.Str(token);
                                break;
                            case BOOL:
                                datum[i] = new Datum.Bool(new Boolean(toker
                                break;
                            default:
                                break;
```

```
import edu.buffalo.cse.sql.Schema.TableFromFile;
import edu.buffalo.cse.sql.data.Datum;
import edu.buffalo.cse.sql.plan.PlanNode;
import edu.buffalo.cse.sql.plan.ScanNode;

public class ScanMethod extends UnionMethod {

        public static void scanop(Map<String, Schema.TableFromFile> tables, PlanN
                        throws NumberFormatException, IOException {


                                ScanNode leafnode = (ScanNode) q;
                                File file =tables.get(leafnode.table).getFile();
                                FileReader fir;
                                BufferedReader reader;
                                Datum[] data;
                                int sizeofschema= leafnode.schema.size();


                        fir = new FileReader(file);
                        reader = new BufferedReader(fir);
                String record;
                                StringTokenizer st = null;
                                        while ((record = reader.readLine()) != nu
                                                data = new Datum[leafnode.schema.
                                                int i = 0;
                                                st = new StringTokenizer(record,
                                                while (st.hasMoreElements()) {
                                                        String token = st.nextTok
                                                        switch (leafnode.schema.g
                                                        case INT:
                                                                data[i] = new Dat
                                                                break;
                                                        case FLOAT:
                                                                data[i] = new Dat
                                                                break;
                                                        case STRING:
                                                                data[i] = new Dat
                                                                break;
                                                        case BOOL:
                                                                data[i] = new Dat
                                                                break;
                                                        default:
                                                                break;
                                                        }
                                                        i++;
                                                }
                                                raparse.schemaVar.add(data);

                                        }
                                        fir.close();
```

Code in Case Statement

Code in "Operator Class"

CSE 220: Academic Integrity Policy

- First offense
  - Zero on the assignment, lower grade, or an F in the class (instructor judgement)
  - Your name reported to university black list that will follow you through your time at UB
  - If your name is already on black-list, you get an F with note – **you will fail the class and transcript will reflect your cheating**
- Share code, share blame
  - If someone else submits your code as their own, you will be penalized as well

CSE 220: AI Best Policies

- Be careful with your code – including permissions on shared UB filesystems, GitHub, Bitbucket etc.
- **Don't look** at someone else's code!
- Cite liberally
- Check with department[1] and university[2] policies
- Talk to instructors/TAs if you have any questions

[1] https://engineering.buffalo.edu/computer-science-engineering/information-for-students/policies/academic-integrity.html

[2] https://academicintegrity.buffalo.edu/policies.php

Questions/Concerns?

CSE 220: Expectations

- Systems hacking can be fun!
- My best undergrad course was Operating Systems – the sort-of follow up to this course
- You get out of it what you put in; no more, no less !
- If you are willing to put in time, we are more than happy to help
- If you need a better grade, do better work

I hate grade negotiations at the end of the semester – please chat with me through the semester on your progress, but you will get the grade you earned at the end !

CSE 220: Other Logistics

- Re-grading is done only for grading errors
- No incompletes are given in the class
- In principle, no makeup exams will be given except for valid reasons

  Please make sure you talk to me well in advance if you have a valid reason – I will not entertain last minute requests
- **No grades will be changed** for any reason other than grading error

CSE 220: Course Materials

- Follow progress on the course website
- Revise using slides on the course website
- Each class has required and optional readings – read them even if I don't mention it in class
- All discussion/communication will be via Piazza

  Register on Piazza today!

  Make sure you read the posts before you ask a question

  However, if you are not sure about something, just ask!

All important class announcements and materials will be posted on Piazza – you are responsible to follow them!

CSE 220: Platform

- You will work on Linux on x86-64 hardware
- We have a VM Image[1] for you to get started quickly
- You don’t need to use this image
  - But you will be responsible to make sure your submissions are compatible to this image
  - We will not support platform issues on any other platform
- If in doubt, please use this image

[1] https://www.cse.buffalo.edu/~eblanton/misc/vm/

Programming Projects

- Significant portion of your course grade will be projects
  - These are individual projects
  - Projects will be written in C
- To reiterate: projects must run on the course VM image
- We will use GitHub Classroom
  - For assignment distribution
  - For providing assistance
- You must have (or create) a GitHub account
- You are expected to use git and GitHub for development
- If you are not already familiar, learn git
  - [1] Git book: https://git-scm.com/book/en/v2
  - [2] Git tutorial: https://alistapart.com/article/get-started-with-git/
  - [3] Git usage: https://www.google.com/search?q=using+git

Project Assistance

- TAs will be your primary source of help for projects
- To get the most out of the TAs, do:
  - Try the obvious things first
  - Create minimal examples to show problems
- Consult the documentation
- To avoid wasting TA time and failing to get help, don't:
  - Ask for help before you've tried to understand the problem
  - Start at the last minute
- That said, if you've spent many hours to identify the problem and can't, please ask for help

Programming Tools

- We will learn a lot of tools in this class
- You will be expected to use a few tools for this course:
  - The C compiler
  - Make
  - Gdb
  - A programming editor
  - Others …

- We will help you learn these tools

Editors

- We don’t care what editor you use
- Your life will be simpler if you use a programmer’s editor that can do the following:
  - Syntax highlighting
  - Automatic indentation
  - Brace/paranthesis matching
  - Extensibility
- It will be difficult for us to help you if you are not using a reasonable environment
- I personally use emacs – installed on the course VM image
- Other candidates
  - vi
  - Sublime
  - Atom

Project Submission

- All submissions are done through autograder [1]
- Submission rules:
  Submitted within 24 hrs after the deadline: -20%
  Doesn’t count Saturday or Sunday
  Doesn’t count University holidays
- Projects submitted after 24 hrs will not be accepted
- Example: Project is due Friday at 11:59 PM, turned in Monday at 3 pm – 20% penalty
- Example: Project is due Monday at 11:59 PM, turned in Wednesday at 12:15 AM – not accepted

[1] https://autograder.cse.buffalo.edu/

Grading

- Passing this course requires three major conditions:
  - Completion of the AI quiz with perfect score
  - Completion of Lab 01 with perfect score
  - At least a 60% average on all exams and lab exams
- Failure to achieve any of these three points will result in failure in the course
- Your course grade will be calculated per the information in the syllabus

Today’s Assignments

- Immediately:
  Read the Syllabus
  Join the Piazza instance
- By beginning of lab this week:
  Create a GitHub account if you don’t already have one
  Download and install the course VM
- By Friday:
  Complete the AI quiz:
  https://www.cse.buffalo.edu/~eblanton/misc/academic_integrity/ and turn it in on Autograder

Labs

We have labs this week!

Next Class

- Overview of C
- Overview of POSIX API
- Little bit about data types

Required Readings

- Course syllabus
- K&R: 1.1-1.3