

VE280 Programming and Elementary Data Structures

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UM-SJTU Joint Institute

Introduction



FUN FACT: DECADES FROM NOW, WITH SCHOOL A DISTANT MEMORY, YOU'LL STILL BE HAVING THIS DREAM.

Today

- Course organization
- Course content

What is Flipped Classroom?

- Outside class
 - Students read/watch teaching material
- In class
 - Discussions about difficult concepts
 - Quizzes to check understanding
 - Demos
 - Exercises and problems solving

Why Flipped Classroom?

- **Advantages:**
 - Students can study at their own pace
 - Content can be covered more in-depth
 - Class more interactive, more engaging, hopefully more fun?
 - Research shows that students learn/retain concepts better
- **Drawback:**
 - More efforts for both students and instructors
- **Poll:** Do you want Ve280 to be taught like this?

What is the storage duration of a function parameter?

Choose one answer:

- A. static
- B. automatic
- C. dynamic
- D. other

Logistics

- **Time:** Tuesday 10:00-11:40 am, Thursday 10:00-11:40 am, and Friday 10:00-11:40 am (on odd week).
- **Location:** Online
- **Textbook Recommended (Not Required):**
 - “C++ Primer, 4th Edition,” by Stanley Lippman, Josee Lajoie, and Barbara Moo, Addison Wesley Publishing, 2005.
 - “Problem Solving with C++, 8th Edition,” by Walter Savitch, Addison Wesley Publishing, 2011.
 - “Data Structures and Algorithm Analysis,” by Clifford Shaffer. Online available:
<http://people.cs.vt.edu/~shaffer/Book/C++3e20120605.pdf>

Instructor

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- Office: Room 406, JI Building
- Office hour
 - Tuesday 1:30pm – 2:30pm
 - Thursday 1:30 pm – 2:30 pm
 - Or *by appointment*

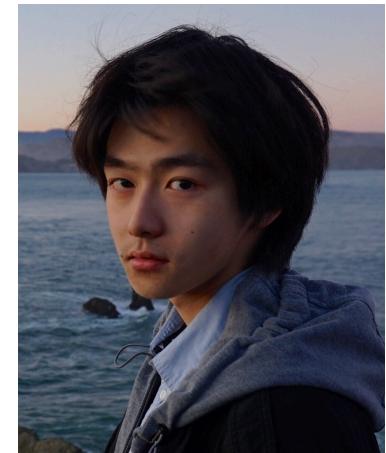
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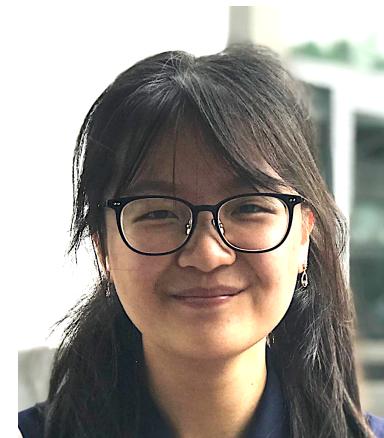


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Grading

- Composition
 - In-class quizzes: 10%
 - (About) 5 programming projects: 40%
 - 11 virtual labs 10%
 - Midterm exam (written): 20%
 - Final exam (written): 20%
- We will assign grades on a curve, in keeping with past grades given in this course.
- Questions about the grading?
 - Must be mentioned to TAs and instructor within one week after receiving the item.

Projects

- Projects require:
 - Read and understand a problem specification
 - Design a solution (in your mind)
 - Implement this solution (simply and elegantly)
 - Convince yourself that your solution is correct

Projects

- We will give you a few simple test cases to get started. You should design your own set of tests (very important!).
- You will have chance to pre-test your program before the deadline.
 - We will use an online judge.
- Grading projects will be done by a combination of testing (correctness) and reading (implementation requirement and simplicity/elegance).

Programming Environment

- We require you to develop your programs on **Linux operating systems** using compiler g++.
- C++11 standard is allowed.
 - Compile with the option `-std=c++11`
- We will grade your programs in the Linux environment.
 - They must compile and run correctly on this operating system.

Aside: Fun Quizzes!

- What?
 - Multiple-choice questions on slides with 
 - **Non-graded** and **Anonymous**
 - Feel free to answer even if you're not sure!
- How?
 - Poll via Zoom
 - Answer
- Why?
 - Have fun!
 - Allow you to check your understanding
 - Allow the instructor to adapt his teaching
- Let's try one!



Do you know Linux?

Choose one answer:

- A. I can write bash scripts!
- B. I have already used Linux.
- C. I have heard about Linux.
- D. What is Linux??

Project Deadline

- Each project will be given a due date. Your work must be turned in by 11:59 pm on the due date to be accepted for full credit.
- However, we still allow you to submit your homework within 3 days after the due date, but there is a late penalty.

Hours Late	Scaling Factor
(0, 24]	80 %
(24, 48]	60 %
(48, 72]	40 %

- No work will be accepted if it is more than 3 days late!

Project Deadline

- In **very occasional** cases, we accept deadline extension request.
 - Deadline extension requests will only be considered if you contact the course instructor in person. Do not contact TAs!
 - **ONLY** granted for **documented** medical or personal emergencies that could not have been anticipated.
 - **NOT** granted for reasons such as accidental erasure/loss of files and outside conflicting commitments.

Some Suggestions

- Practice! Build demos yourself
 - You have the freedom. Even try something wrong on purpose.
- Learn from your mistakes!
 - Take notes on the mistakes you make. Review frequently.
- Start your project early!
 - Don't wait until the last minute. Numerous lessons before.
 - **Hofstadter's Law:** It always takes longer than you expect, even when you take into account Hofstadter's Law.
- Make copies frequently in case your computer crashes.
 - Consequence: “computer crash” is NOT a reason for late submission!

Collaboration and Cheating

- You may discuss in oral with your classmates.
- **But** you must do all the assignments yourself.
- Some behaviors that are considered as cheating:
 - Reading another student's answer/code, including keeping a copy of another student's answer/code.
 - Copying another student's answer/code, in whole or in part.
 - Having someone else write part of your assignment.
 - Using test cases of another student.

“**Another student**” includes a student in the current semester or in previous semesters.

Collaboration and Cheating

- The previous lists of behaviors are deliberate cheating, but some unintentional actions could make you look like cheating. For example,
 - Testing your code with another one's account. Another's code may be overwritten by you. So, we see two identical copies.
 - You use another's computer to upload your code (in some cases like network/computer problems), but upload another's copy.
- We suggest you not to do those “dangerous” things.
 - If due to network/computer problem, you cannot upload, then send your code to TA's by email. By this way, you can double check the attachment.

Collaboration and Cheating

- In summary, you are wholly responsible for all answers/codes you submit. If you submit a copy of another student's work (or overwrite another student's work), it is considered cheating, **no matter the reason!**

Collaboration and Cheating

- Any suspect of cheating will be reported to **the Honor Council at JI.**
- For programming assignments, we will run an automated test to check for unusually similar programs. Those that are highly similar - in whole or in part - will be reported to **the Honor Council at JI.**
- Penalty of honor code violation
 1. Reduction of the grade for this assignment to 0, **plus**
 2. Reduction of the final grade for the course by one grade point, e.g., B+ → C+, for **both students** involved

Canvas

- Log into Canvas: <https://umjicanvas.com/courses/1604/>
- Check the class webpage on Canvas and Piazza regularly for
 - Announcements
 - Slides
 - Grades
- Course slides will be uploaded onto Canvas before each lecture.

Getting Help

- If you have any technical questions:
 - Use Piazza preferably
 - Come to see TAs and instructor during the office hours!
 - Answering technical questions through email is inefficient.

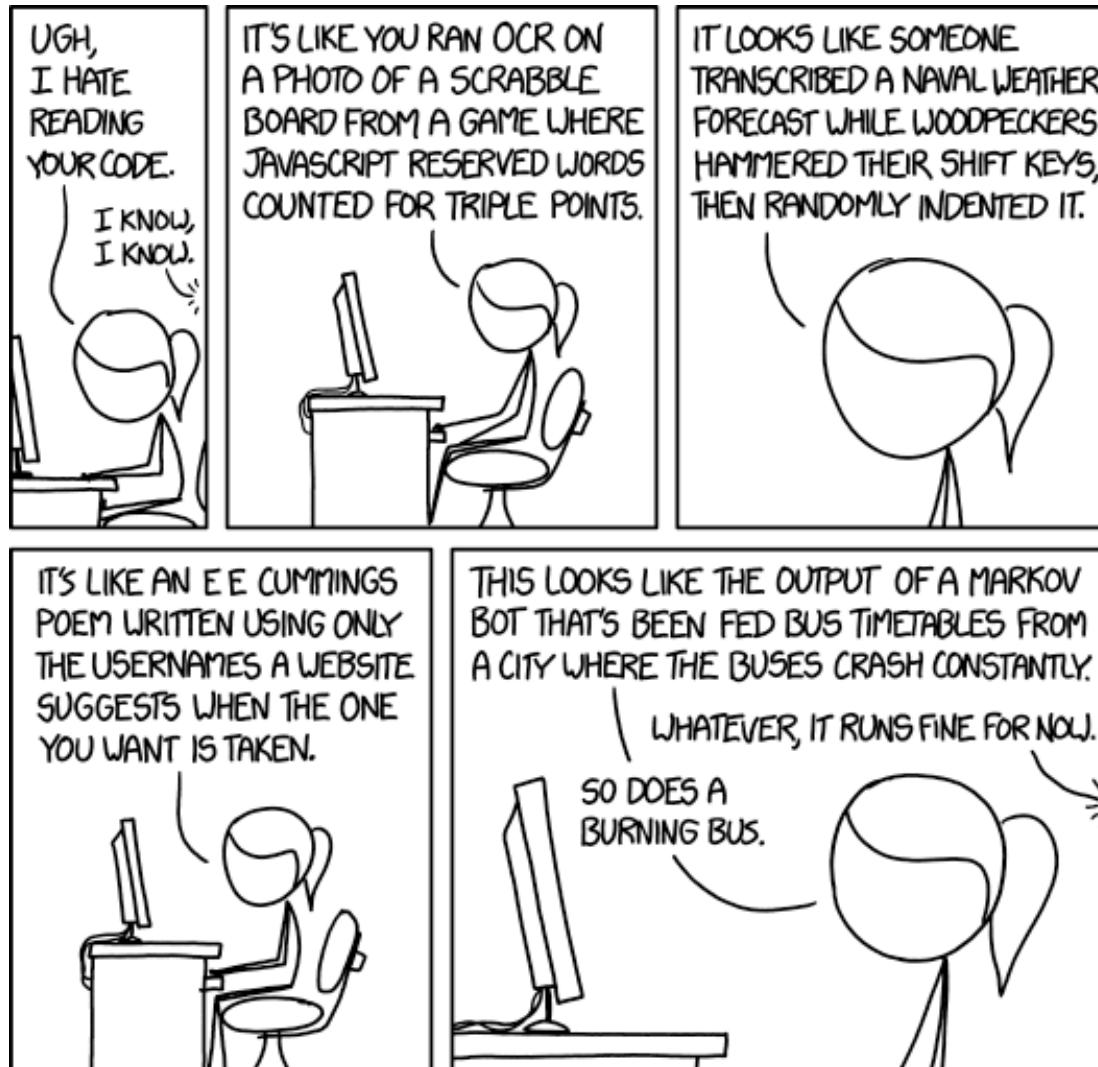
Recitation Classes and Virtual Labs

- Recitations
 - Before exams, and on demand
- Virtual labs
 - Weekly exercises graded on JOJ
 - Questions and discussions on Piazza and OH
 - Ask private questions if you need to show some parts of your code

Advice

- Take written notes
- Review the material regularly
- Follow the pace of the course
- Organize your time
- Don't hesitate to ask for help: Piazza, OH, email, schedule meeting
- Don't hesitate to provide us some feedback

Course Content



What I Assume You Know

- Some basics of C++
 - Variables
 - Built-in data types, e.g., int, double, etc.
 - Operators, e.g., +, -, *, etc.
 - Flow of controls, e.g., if/else, switch/case, while, for, etc.
 - Functions; function declaration versus definition.
 - Arrays
 - Pointers
 - References
 - Struct



What does crazy_function(1, 2, 0) print and return?

```
float crazy_function(int a, double b, int c) {  
    while (c<=0) ++++c;  
    cout << (a/b);  
    return (a/c);  
}
```

Choose the correct answer:

- A. It prints “0.5” and returns 0.5.
- B. It prints “0.5” and returns 0.
- C. It prints “0” and returns 0.5.
- D. It prints “0” and returns 0.

The Task of Programming

- Accept some specifications of the problem. (e.g., find the shortest way to go from my home to school.)
- Problem solving phase:
 - Design an algorithm that
 - 1) correctly satisfies the specification.
 - 2) is efficient in its usage of **space** and **time**.
- Implementation phase:
 - Implement the algorithm **correctly** and **efficiently**
 - 1) An implementation of an algorithm is correct if it behaves as the algorithm is intended for all inputs and in all situations.
Correctness is never negotiable!
 - 2) **Efficient** can mean fast, simple, and/or elegant.

Key Points of Ve280

- The focus of Ve280 is on the **implementation** part. Some **key points** you will learn include
 - Abstraction and its realization mechanism
 - Techniques to increase code reuse
 - Techniques to efficiently use memory
 - Elementary data structures
 - Some other essential parts of C++ programming

Abstraction

- One important concept about programming
 - Provides only those details that matter
 - Eliminates unnecessary details and reduces complexity
 - You already know one realization of abstraction: function (e.g. $\exp(x)$), which is procedural abstraction
- We will talk about
 - Basics about abstraction
 - Procedure abstraction (i.e., function), in more detail
 - Data abstraction (i.e., class)
 - Basics about class: constructor, destructor, etc.
 - Abstract base class

Techniques to Increase Code Reuse

- Function and class, which are basic ways to increase code reuse
- Class inheritance and virtual function
- Template and polymorphism
 - Template: write one thing, used for many different types

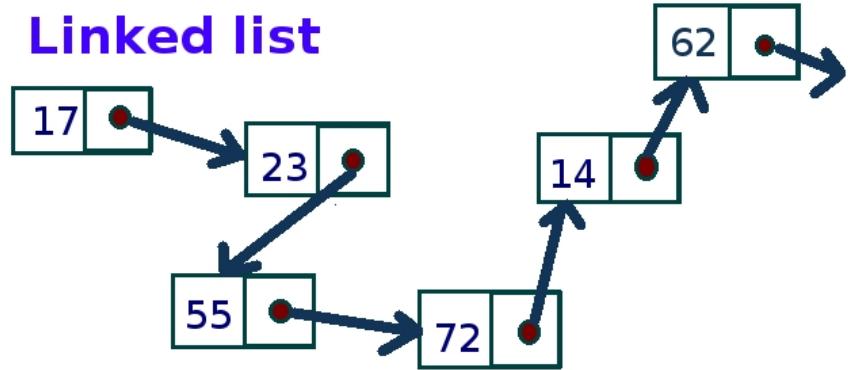
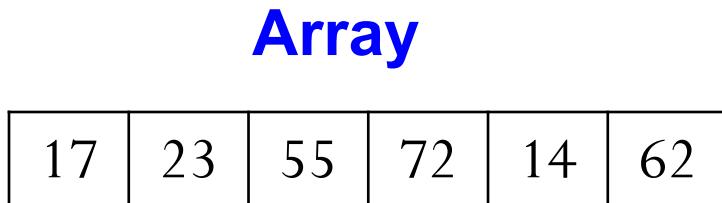
Techniques to Efficiently Use Memory

- Sometimes, the amount of memory needed to solve a problem can vary a lot
- Of course, you can write your program considering the worst-case memory usage
 - For example, a large enough array to hold data
 - However, this may lead to some waste in memory use
- We will learn a solution: **dynamic memory management**
 - Dynamic memory allocation and de-allocation

Elementary Data Structures

- Data structures are concerned with the **representation** and **manipulation** of data.
- All programs manipulate data.
- So, all programs represent data in some way.

Example: Store a list of numbers



Elementary Data Structures

- We will learn
 - Linked list
 - Linear list
 - Stack
 - Queue
 - Tree
- **Note:** This course only shows a few elementary data structures
 - More data structures will be taught in a following course, Ve281 Data Structures and Algorithms

Other Essential Parts

- Writing programs that take arguments
- I/O streams, including file I/O
- Error handling
- Testing
- Linux
- Bash/Perl scripting (if time permits)



What are the issues with this code?

```
int f(int a, int *b, unsigned int c)
{
    int s = 0;    int p = 1;
for(unsigned int i = 0; i <= c; i++) {
    s = s + b[i] * p;
    p = p * x; }
    return s; }
```

Choose all correct answers:

- A. There is no comment.
- B. The naming of variables/function is not clear.
- C. The code is not indented.
- D. The style is not consistent.



Good Programming Style

```
// Evaluate the polynomial on x
int poly_eval(int x, int *coef, unsigned int degree) {
    int result = 0;
    int x_power = 1;
    for(unsigned int i = 0; i <= degree;
        result += coef[i] * x_power;
        x_power *= x;
    }
    return result;
}
```

Indentation

Comments

Meaningful
Naming

Consistency!

Relation with Other Courses

- Vg101 Introduction to Computers and Programming
 - Very basic programming skills.
 - Ve280 will go in depth. To connect, we will review some basics.
- Ve281 Data Structures and Algorithms
 - Focus on the efficiency of the algorithms.
 - Ve280 focuses on correctness. It will show you some very basic data structures.
- Ve477 Introduction to Algorithms
 - Paradigms for algorithm design and complexity analysis

Questions?