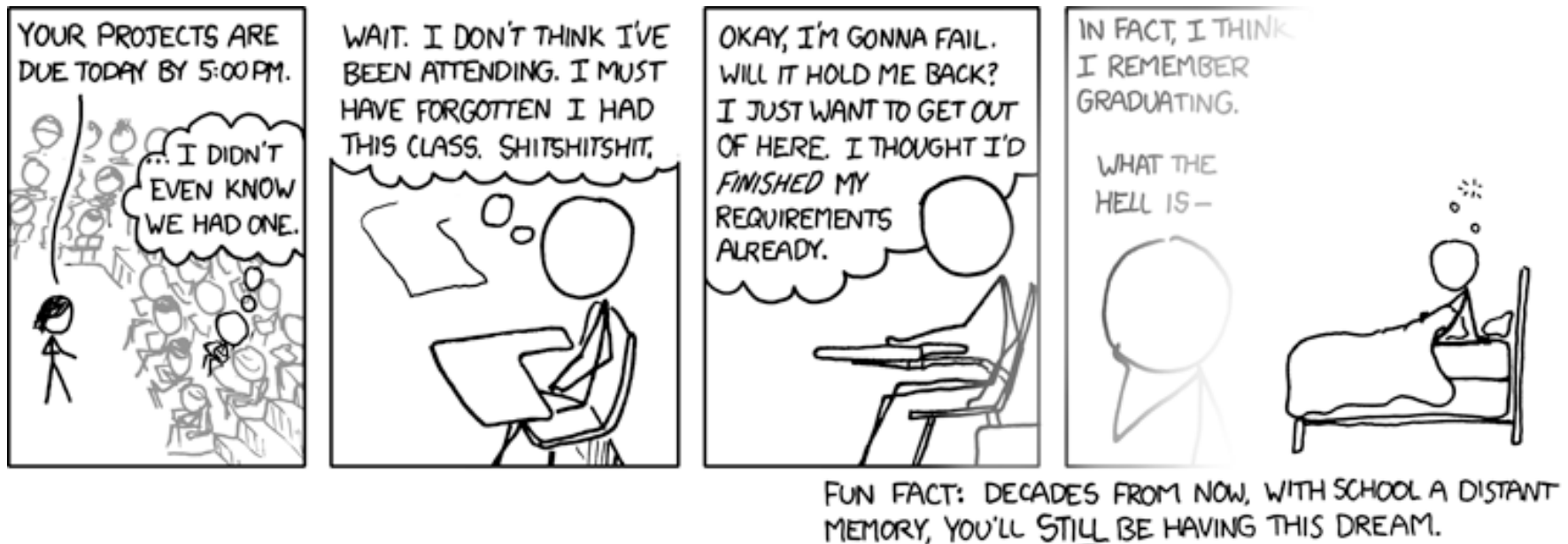


# VE280 Programming and Elementary Data Structures

Paul Weng

UM-SJTU Joint Institute

## Introduction



# Today

- Course organization
- Course content

# Logistics

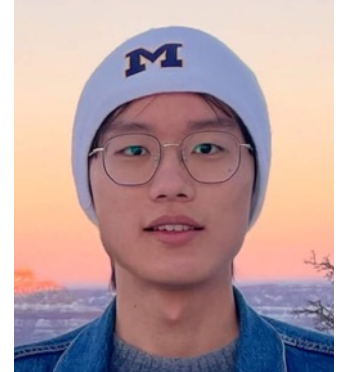
- **Time:** Tuesday 4pm–5:40pm,  
Thursday 4pm–5:40pm,  
Friday 4pm–5:40pm (on odd week).
- **Location:** DXY305
  - **Except** during week 4 (May 30<sup>th</sup>, June 1<sup>st</sup>) online
- **Textbook Recommended (Not Required):**
  - *C++ Primer*, 5<sup>th</sup> Edition, by Stanley Lippman, Josee Lajoie, and Barbara Moo, Addison Wesley Publishing, 2012.
  - *Problem Solving with C++*, 10<sup>th</sup> Edition, by Walter Savitch, Addison Wesley Publishing, 2021.
  - *Data Structures and Algorithm Analysis*, Edition 3.2 (C++ Version) by Clifford Shaffer, Available online, 2013.

# Instructor

- Paul Weng
- Email: [paul.weng@sjtu.edu.cn](mailto:paul.weng@sjtu.edu.cn)
- Phone: 3420-6075 (Ext. 4061)
- Office: Room 406, JI Building
- Office hours
  - Monday 8pm–9pm
  - Thursday 9am–10am
  - Or *by appointment*

# Teaching Assistants

- Fan, Luoyi
  - Email: [luoyi\\_fan@sjtu.edu.cn](mailto:luoyi_fan@sjtu.edu.cn)
  - Office hour: TBD
- Rong, Ziqi
  - Email: [rongziqui@sjtu.edu.cn](mailto:rongziqui@sjtu.edu.cn)
  - Office hour: TBD
- Xu, Zixuan
  - Email: [linus\\_xu@sjtu.edu.cn](mailto:linus_xu@sjtu.edu.cn)
  - Office hour: TBD



# Grading

- Composition
  - Participation (class attendance, graded quizzes, Piazza): 5%
  - 5 programming projects: 40%
  - 3 virtual labs 10%
  - Midterm exam (written): 20%
  - Final exam (written): 25%
- We will assign grades on a curve, in keeping with past grades given in this course.
- Questions about the grading?
  - Must be mentioned to 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++17 standard is allowed.
  - Compile with the option `-std=c++17`
- We will grade your programs in the Linux environment.
  - They must compile and run correctly on this operating system.

# 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.

# 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?
  - Scan QR Code or click on it
  - 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??





# What is the storage duration of a function parameter?

Choose one answer:

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

# Collaboration and Cheating

- You may discuss orally 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!**
- After passing this course:
  - Please don't share your solutions
  - Please don't post the course materials online
  - Honor code has been updated to cover such behaviors

# Collaboration and Cheating

- Any suspicion 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://jicanvas.com/courses/336/>
- Check the class webpage on Canvas regularly for
  - Announcements
  - Slides
  - Projects
  - Labs
  - Grades
- Course slides will be uploaded onto Canvas before each lecture.
- Use Piazza for Q&As and discussion

# 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
  - Exercises graded on JOJ
  - Questions and discussions on Piazza and OH
    - Ask private questions if you need to show some parts of your code

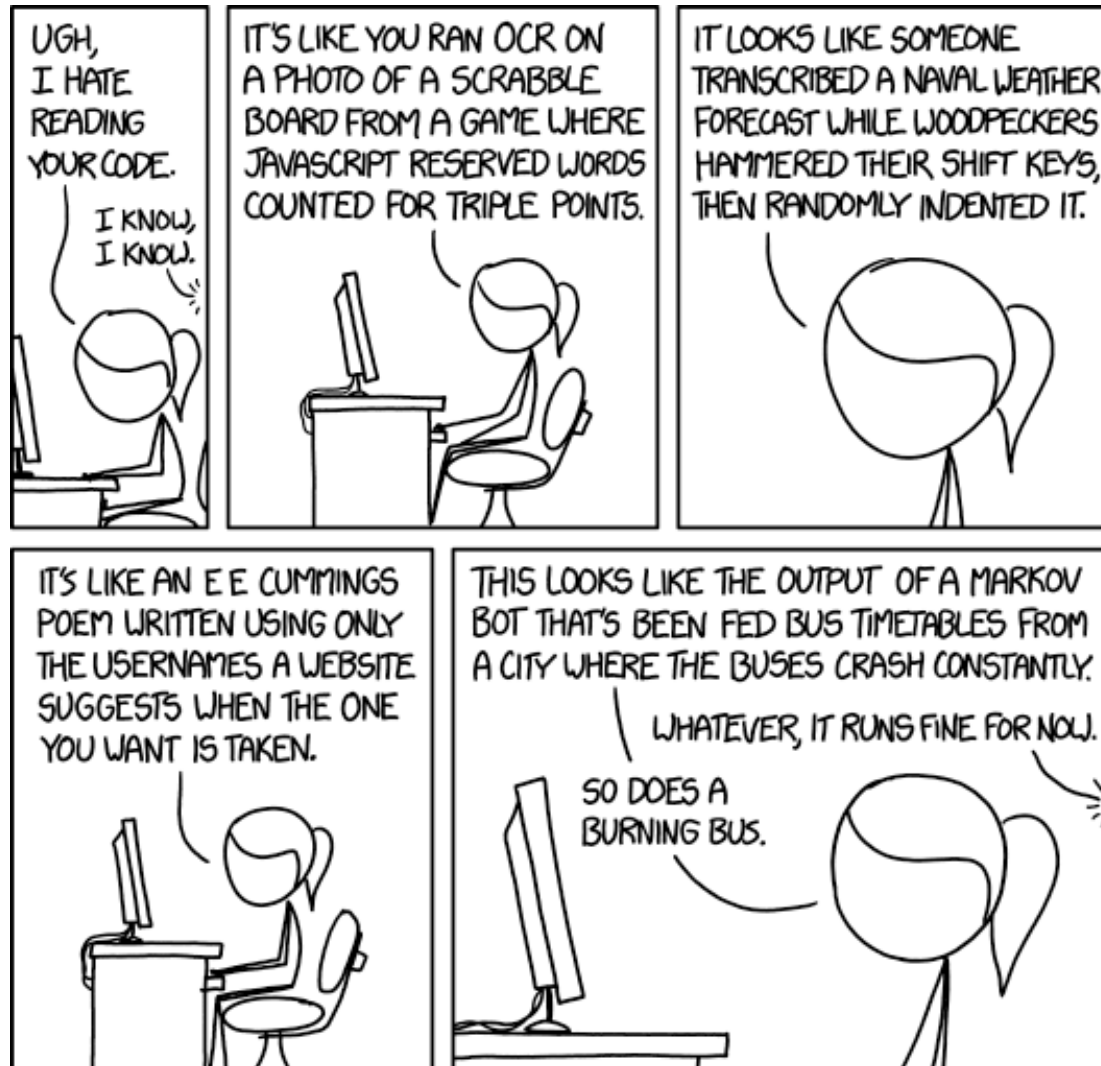
# Some Suggestions

- 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!

# More Suggestions!

- 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

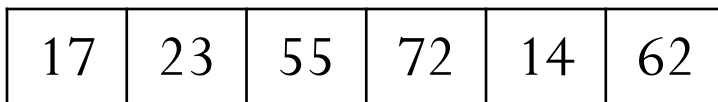
- Sometimes, the amount of memory needed to solve a problem can vary a lot
- Of course, you can write your program considering the worst-case memory usage
  - For example, a large enough array to hold data
  - However, this may lead to some waste in memory use
- We will learn a solution: **dynamic memory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

# Elementary Data Structures

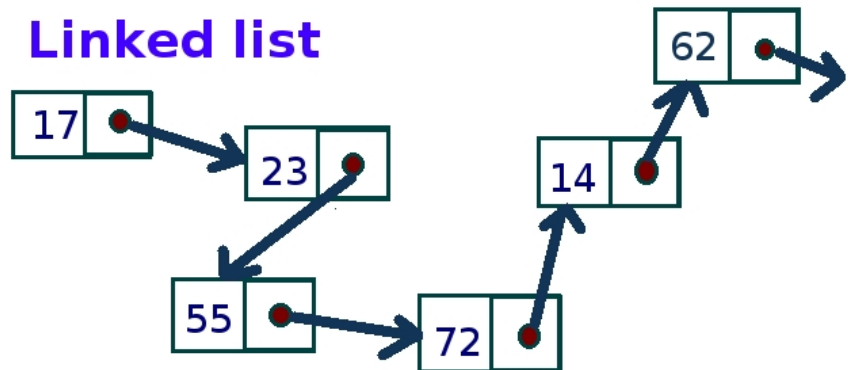
- Data structures are concerned with the **representation** and **manipulation** of data.
- All programs manipulate data.
- So, all programs represent data in some way.

Example: Store a list of numbers

**Array**



**Linked list**





# 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 and debugging
- Linux commands



## 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 * a; }
    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

**Comments**

**Meaningful  
Naming**

**Indentation**

**Consistency!**

```
// 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; i++) {
        result += coef[i] * x_power;
        x_power *= x;
    }
    return result;
}
```

# Programming Style

- Programmer/team/project/company dependent, e.g., [EECS280 Style Guide](#) or [Google C++ Style Guide](#)
- Much more than indentation, naming, and formatting
- Also, covers:
  - What the forbidden C++ constructs are, e.g., `goto`
  - What the allowed C++ constructs are, e.g., STL
  - When to use them, e.g., global variables
  - How to use them, e.g., pointers
- Not to be followed blindly, deviation allowed when justified

# 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
  - Present many data structures
  - Learn about efficiency of algorithms.
  - Ve280 focuses on correctness, only covers some basic data structures.
- Ve477 Introduction to Algorithms
  - Paradigms for algorithm design and complexity analysis

Questions?