(1 - 1) Computer Software & Software Development
H&K Chapter 1

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Course Collaborators

- A lot of material for this course was adapted from Chris Hundhausen's course or developed concurrently with him

What is Expected in this Course?

- To learn how to approach and solve problems differently, including some interview like questions
- To build enough programming skills to be one step closer to landing an internship
- Dedication
- And of course, hard work

- You up for the challenge?

What is Computer Science? (1)

- Computer science is the study of computers and computational systems, with a particular focus on *algorithms*
  - Intersects theory with practice
  - Requires thinking in abstract and concrete terms
  - Not just about building computers and developing programs
  - Involves planning, designing, developing and applying systems
  - Applies analysis to algorithm efficiency, and software performance
- What are areas of study in Computer Science?
  - Artificial intelligence
  - Machine Learning
  - Networks
  - Graphics
  - Security
  - Big data / data analytics
  - Bioinformatics
  - Software engineering
  - Computer systems
  - Database systems
  - Many others

What is Computer Science? (2)

- What is an algorithm?
  - A sequence of instructions that solve a problem
- Why are algorithms so important to computer science?
  - If we can specify an algorithm…
    - We can automate the solution
    - We can also repeat a solution to a problem

Activities: Discuss, Write, and Execute an Algorithm

- Activities (in pairs):
  - (1) Verbally discuss (only) an algorithm using for drawing a triangle on the whiteboard with a dry erase marker – wait until the instructor indicates to move forward
  - (2) Write an algorithm using basic English words and phrases (not programming language statements) for drawing a triangle on the whiteboard with a dry erase marker – wait until the instructor indicates to move forward
  - (3) Execute the algorithm and draw the triangle described by the algorithm on a tablet, piece of paper, or the whiteboard

Class Analysis of Triangle Drawing Activity? (1)

- Was the triangle drawn as expected?
  - If no:
    - Was there any miscommunication between you and your partner about how to write the algorithm?
    - Was it because the algorithm was incomplete and/or ambiguous?
    - Was it because the activity statements were incomplete and/or ambiguous?
      - What kinds of clarifying questions could you ask to better understand the activity statements?

Class Analysis of Triangle Drawing Activity? (2)

- Does your triangle look the same as others in the class?
  - If no, why?
    - Could the activity statements have provided more information?
    - Could you have asked clarifying questions?

Formal Definition of Algorithm

- A well-ordered collection. . .
- Of unambiguous and effectively computable operations. . .
- That produces a result. . .
- And halts in a finite amount of time.

Is this an Algorithm? (4)

- Apply small amount of shampoo to hair
- Work into scalp for about 1 minute
- Rinse thoroughly
- Repeat

No! Why not?

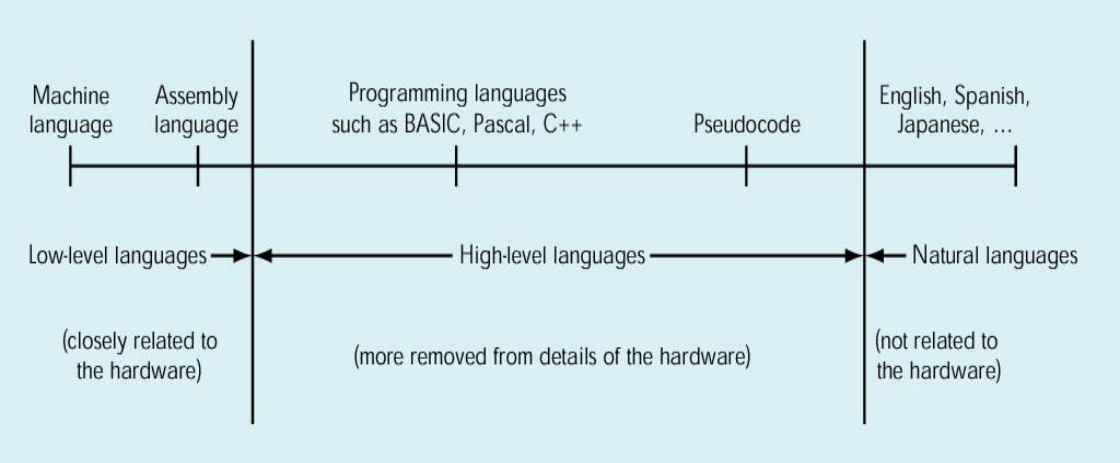
Hint: Is it well ordered? Does it halt?

How are Algorithms Put Together?

- Sequenced instructions
  - do them in the order given
- Conditional instructions
  - do them if a condition is true
- Iterative instructions
  - do them while a condition is true

High-Level Programming Languages (1)

- High-level programming languages
  - The continuum of languages:



  - Low-level languages were created from the perspective of the machine; working with 1's and 0's, also known as logic levels
  - High-level languages, have natural language like elements

High-Level Programming Languages (2)

- Problem: Computers can't understand high-level programming languages
- Solution: They must be translated
  - Programmer uses a text editor to write a text-based source file in a programming language
  - Compiler translates source file
    - Checks to make sure that program is syntactically correct
    - If so, the compiler translates the program into an object file with machine language instructions

High-Level Programming Languages (3)

- Object file translated by compiler will not execute!
  - High-level programs often make use of software libraries containing predefined pieces of code, including
    - Math functions
    - Input/output functions
  - In order to execute, object file must be *linked* to object files containing these predefined pieces of code
  - A *Linker* program performs this operation
  - A *Loader* program loads the linked program into memory so that it can be executed

High-Level Programming Languages (4)

- Executing Programs
  - In this class, programs will execute in a text-based window called a *console*
  - Input data can be entered at command-line prompts
  - Output results will be displayed in the console window
  - In the real world, many programs have a graphical user interface (GUI)
  - GUI programming is, however, beyond the scope of this course

High-Level Programming Languages (5)

- Integrated Development Environments (IDE)
  - Combine compiler, linker, and loader with a source code editor – we use Microsoft Visual Studio Community 2026 in this course
    - Generally, a single button will start the translation process
  - Provide a variety of tools to assist programmers, for example:
    - Source code syntax highlighting
    - Autocompletion lists ("Intellisense")
    - A debugger, which allows a programmer to step through programs, one instruction at a time
    - A testing framework for developing unit tests

Software Development Method

- Equivalent to the “Scientific Method” in the sciences, and the “Systems Approach” in business
- Six basic steps:
  1. Specify problem requirements
  2. Analyze the problem
  3. Design an algorithm to solve the problem
  4. Implement the algorithm
  5. Test and verify the completed program
  6. Maintain and update the program

Applying the Software Development Method (1)

- Developing software is an iterative process, your first solution is generally not your best!
- Your understanding of software your required to build evolves as you understand the problem more!
- At this point don't be afraid to make mistakes!
- Example problem: *Compute the volume of a cone*

Applying the Software Development Method (2)

- Data Requirements
  - Problem input:
    radius (of the base), height (of the cone)
  - Problem output:
    volume (of the cone)
  - Relevant formula:
    volume = 1 / 3 * pi * radius^2 * height

Applying the Software Development Method (3)

- Design
  - Algorithm
    - Get the radius and height for the cone
    - Compute the volume of the cone
    - Display the resultant volume of the cone
  - Refined algorithm
    - Get the radius and height for the cone
    - Compute the volume of the cone
      - volume = 1 / 3 * pi * radius^2 * height
    - Display the resultant volume of the cone

Applying the Software Development Method (4)

- Implementation (in C)

```
#include <stdio.h> /* Needed for printf (), scanf () */
#define PI 3.14159 /* Constant macro */

int main (void)
{
        int height = 0, radius = 0;
        double volume = 0.0;

        printf ("Enter height of cone as integer: "); /* Displays prompt message */
        scanf ("%d", &height); /* Gets the value from the user/keyboard */
        printf ("Enter radius of base of cone as integer: ");
        scanf ("%d", &radius);

        /* Compute the volume of the given cone */
        volume = ((double) 1 / 3) * PI * radius * radius * height;

        /* Display the resultant volume of the given cone */
        printf ("Volume of cone with radius %d and height %d is %lf.\n", radius, height, volume);

        return 0;
}
```


Applying the Software Development Method (5)

- Note: At this point, don't worry about understanding the details of C syntax! We'll get to that later
- Testing
  - We would execute the program, trying several different input data values and observing the results
    - Debugging is NOT testing! It's a result of testing!
  - Each test is defined by a test case
    - A test case provides actual inputs, system state or configuration information, and expected results
  - Should always test "boundaries" of inputs and conditions

Applying the Software Development Method (6)

- Maintenance
  - Most software requires continual improvements, adaptations, and corrections; software patches are a result of maintenance

Next Lecture…

- We've covered the general software development method
- It's time to start learning the C language!

References

- J.R. Hanly & E.B. Koffman, *Problem Solving and Program Design in C (8th Ed.)*, Pearson Education, Inc., 2016