CSEN 102– Introduction to Computer Science

Lecture 1:
Administrative Stuff
The Definition of Computer Science
Informal and Formal Definitions of Algorithms

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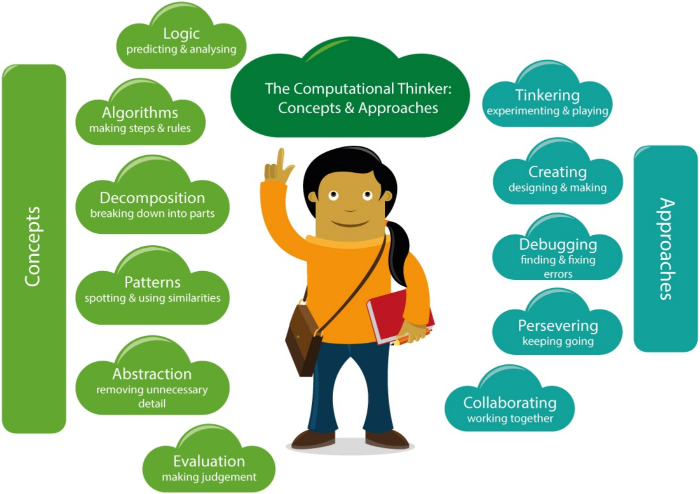
Main Objective of the Course: Computational Thinking



What is Computational Thinking?

Computational thinking involves

- Solving problems
- Designing systems
- Understanding human behavior by drawing on the concepts fundamental to computer science.
- It includes a range of mental tools that reflect the breadth of the field of computer science

What are the elements of Computational Thinking?

- Logical Thinking
- Algorithmic Thinking
- Efficient Solutions
- Scientific Thinking
- Innovative Thinking

Overview

What is CSEN 102?

- Introduction to Computer Science principles
- A course with no prerequisites: no background in computer science needed

What isn't CSEN 102?

- A Computer literacy course
- A programming course

Why should you learn CSEN 102?

- To use computers for problem solving
- Acquire new skills that will allow you to create useful and customized computer-based applications
- Improve your problem solving skills (clarity, precision, logic, . . .)
- It is in the curriculum
- Acquire a useful vocabulary that will impress others in geeky conversations

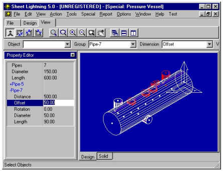
Course Objectives

At the end of this course, you should be able to:

- Demonstrate skills in problem solving
  1. Express Problem solutions in the form of algorithms using Python
  2. Analyze algorithms in term of efficiency
- Identify basic concepts in data representation and manipulation
- Build simple computer circuits using Boolean Logic
- Relate the concepts gained to understand the Von Neumann architecture
- Identify basic issues related to the software systems

Applications

Uses of computing machinery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File Edit View Action Tools Special Report Options Window Help Test
File Design View
Property Editor
Design Solid
Select Objects

Object | Group Pipe-7 | Dimension Offset

Pipes	7
Diameter	150.00
Length	600.00
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-Pipe-7	
Distance	500.00
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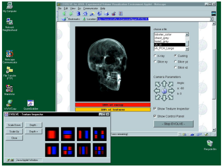
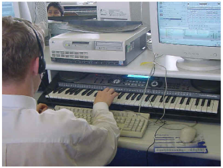




- Engineering:
  - Simulation models of the physical world
  - Signal and image processing
  - Graphical tools (CAD)
- Medicine
- Business
- Art, Movies, Music
- Space Exploration

Organization of the Course

- Lectures: 2 hours per week
- Tutorials and Labs: You have to attend!
  - Tutorials: 2 hours per week
  - Labs: 2 hours per week
- Evaluation: Grade is based on
  - a midterm exam
  - a final exam
  - 3 in-class quizzes
  - In-class assignments and lab tests

Tentative grading

The tentative overall weighting for your grade

- Assignments (Theoretical): 10%
- Assignments (Practical): 10%
- Quizzes (Theoretical): 15%
- Mid-Term Exam (Theoretical): 25%
- Final Exam (Theoretical): 40%

Survival guide

Tell me and I will forget;
show me and I may remember;
involve me and I will understand.

Keep up with the course material

- Attend lectures, tutorials, and labs
- Participate in the discussions (be active)
- Solve the assignments and understand the model answers provided

WWW-page

Visit course home page regularly for announcements and supplemental material

`met.guc.edu.eg`

Survival guide

Do not copy !!!

Survival guide

Keep in touch

- E-mail
- Office hours

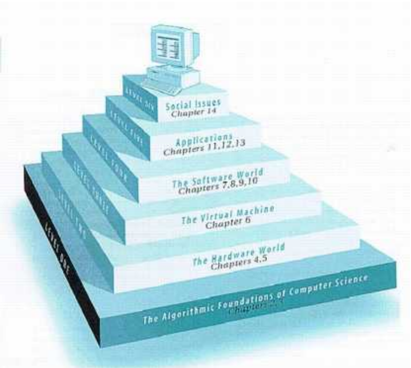
Ask for help when you need it

- Professor
- TAs

Structure of this course

We will follow the pyramid of steps from Schneider and Gersting's Textbook

1. Algorithmic Foundations
2. Hardware World
3. Virtual Machines
4. Software World
5. Applications



End of Administrative Stuff

What is Computer Science?

What is Computer Science not?

Or, more accurately, what is it not only

Computer Science is **NOT** restricted to

- The study of computers: Computers are tools used in the field
- The study of how to write computer programs: Programming is an important part of computer science, but primarily as a a tool to implement ideas.
- The study of the uses and applications of computers and software: This only provides competency in tool usage

So, what is Computer Science?

What is Computer Science then?

Computer Science is the **study of algorithms**, including

- Their formal and mathematical properties
- Their hardware realizations
- Their linguistic realizations
- Their applications

This definition may seem a little puzzling, until we learn a bit more about algorithms.

OK, but What is an Algorithm?

Consider the following problem: We want to wash our hair twice.

Algorithm

1. Wet your hair
2. Lather your hair
3. Rinse your hair
4. Lather your hair
5. Rinse your hair
6. Stop, you have finished shampooing your hair

Informally:

- An algorithm is a step by step method for solving a problem

Algorithms

Algorithms are not necessarily limited to simple tasks.

We use algorithms all the time in our daily life, for example:

- Cooking recipes
- Directions how to get to places
- Performing mathematical tasks such as:
  - Calculate the students' GPA
  - Calculate the interests for invested money in a bank
  - . . .

An Algorithm for Calculating the area of a square

- Step 1. Get the value of Side
- Step 2. Area $=$ Side $\times$ Side
- Step 3. print the value of Area

Why is this important?

If we can specify an algorithm to solve a problem, then we can automate its solution.

Definition (Computing agent)

A computing agent is an entity capable of performing the steps described in the algorithm, that is, execute the algorithm

This could be

- a person
- a robot
- a living cell (of an organism or a bacteria)
- a computer

In our case, typically a computer.

Why use a computer?

- Computers are fast: they can perform operations without errors at speed unattainable by human beings.
- They can store very large amount of information: Human beings have a difficulty managing and keeping track of a large number of objects.
- They are not task specific: they can be programmed to perform different tasks. Most other tools can do only one thing.
- Their tasks can be automated: computers are excellent at performing the same task over and over again on similar pieces of data (*i. e.*, preparing payment bills for every mobile phone user)

Definition of Computer Science

Computer Science is the study of algorithms, including

- Their formal and mathematical properties
  - How to design algorithms to solve a wide range of problems
  - How to determine whether problems are (efficiently) computable
  - Studying the behavior of algorithms
- Their hardware realizations
  - Designing and building computer systems
- Their linguistic realizations
  - Designing programming languages and translating algorithms so they can be executed by the hardware
- Their applications
  - Identifying important problems for computers
  - Designing software to solve these problems

Is any Step-by-Step Procedure an Algorithm?

- Instructions how to use a shampoo bottle
  - Step 1. Wet hair
  - Step 2. Lather
  - Step 3. Rinse
  - Step 3. Repeat
- Make the crust
- Write out the exact decimal value of π
- Make a list of all positive integers

What is an Algorithm?

Definition (Algorithm)

An algorithm is a well-ordered collection of unambiguous and effectively computable operations that, when executed, produces a result and halts in a finite amount of time.

- An algorithm is well-ordered: each step of the algorithm is executed in the order in which it is written, or else the order is clearly stated.
- An algorithm is unambiguous: The algorithm must be clearly stated, in terms that the computing agent (*e. g.*, computer) understands.
- An algorithm is effectively computable: It must be possible for the computing agent to perform the operation and produce a result.
- An algorithm must halt in a finite amount of time: must even if it would take centuries to finish.

Algorithm: Historic roots

Named after the Persian mathematician Muhammad Ibn Musa Al-Khwarismi

- 780-850 in Khwarism (today Khiva), Usbekistan
- developed a strategy for calculating heritage proportions for rich Arabians with four woman using algebraic methods
- His name was turned into Algorism and that evolved Algorithm

Algorithm: Historic occurrence

- The oldest known algorithm is probably Euclid's Algorithm to determine the greatest common divisor (GCD) of two integers (circa 365-275 BC)
- Method: To find the GCD of two numbers, repeatedly replace the larger by subtracting the smaller from it until the two numbers are equal.
  - Only subtraction and comparison operations are needed.

Example (GCD of 132 and 168)

132	168
132	36
96	36
60	36
24	36
24	12
12	12

⇒ So the GCD of 132 and 168 is 12.

Representing algorithms

- What language to use?
    - Expressive
    - Clear, precise and unambiguous
- For example, we could use:
    - Natural Languages (*e. g.*, English)
    - Formal Programming Languages (e.g. Java, C++)
    - Something close?