CSN-101 (Introduction to Computer Science and Engineering)

Lecture 16: Problem Solving using Computers

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Piazza Class Room: https://piazza.com/iitr.ac.in/fall2019/csn101

[Access Code: csn101@2019]

Moodle Submission Site: https://moodle.iitr.ac.in/course/view.php?id=45

[Enrollment Key: csn101@2019]

Plan for Lecture Classes in CSN-101 (Autumn, 2019-2020)

Week	Lecture 1 (Monday 4-5 PM)	Lecture 2 (Friday 5-6 PM)	
1	Evolution of Computer Hardware and Moore's Law, Software and Hardware in a Computer	Computer Structure and Components, Operating Systems	
2	Computer Hardware: Block Diagrams, List of Components	Computer Hardware: List of Components, Working Principles in Brief, Organization of a Computer System	
3	Linux OS	Linux OS	
4	Writing Pseudo-codes for Algorithms to Solve Computational Problems	Writing Pseudo-codes for Algorithms to Solve Computational Problems	ETE
5	Sorting Algorithms – Bubble sort, selection sort, and Search Algorithms	Sorting Algorithms – Bubble sort, selection sort, and Search Algorithms	
6	C Programming	C Programming	
7	Number Systems: Binary, Octal, Hexadecimal, Conversions among them	Number Systems: Binary, Octal, Hexadecimal, Conversions among them	
8	Number Systems: Negative number representation, Fractional (Real) number representation	Boolean Logic: Boolean Logic Basics, De Morgan's Theorem, Logic Gates: AND, OR, NOT, NOR, NAND, XOR, XNOR, Truth-tables	
9	Computer Networking and Web Technologies: Basic concepts of networking, bandwidth, throughput	Computer Networking and Web Technologies: Basic concepts of networking, bandwidth, throughput	
10	Different layers of networking, Network components, Type of networks	Network topologies, MAC, IP Addresses, DNS, URL	
11	Different fields of CSE: Computer Architecture and Chip Design	Different fields of CSE: Data Structures, Algorithms and Programming Languages	ETE
12	Different fields of CSE: Database management	Different fields of CSE: Operating systems and System softwares	
13	Different fields of CSE: Computer Networking, HPCs, Web technologies	Different Applications of CSE: Image Processing, CV, ML, DL	Term Project
14	Different Applications of CSE: Data mining, Computaional Geometry, Cryptography, Information Security	Different Applications of CSE: Cyber-physical systems and IoTs	

Problem Solving Concepts:

PURPOSE

To provide basic knowledge for solving problems using computers and to impart the necessary skills for the development of applications.

INSTRUCTIONAL OBJECTIVES

- To understand the basic concepts of problem solving using computers and to learn different problem solving strategies

- To discuss the importance of algorithms in the problem solving process

- To identify the necessary properties of good algorithms

- To use pseudo-code to implement, test, and debug algorithms for solving simple problems

What is a Problem?

- A state of difficulty that needs to be resolved
- PROBLEMS EXIST WHERE GOALS NEED TO BE ATTAINED AND THERE IS UNCERTAINTY ABOUT SOLUTION

Problem Faced in Everyday in Life:

- People make decisions everyday
- Examples:
- Should I wear casual or formal today?
- Should I watch TV or go out to cinema?
- Which career?
- Which course?
- Everything needs a DECISION AS A SOLUTION TO THE PROBLEM

- What happens when **bad decisions** are made? WASTAGE OF TIME AND RESOURCES

Problem Solving:

Approaches to solve a problem:

- Algorithmic

- Heuristic

- Solutions that can be solved with a series of known actions are called Algorithmic Solutions

- Employing a self-learning approach to the solution of a problems is known as Heuristic Solutions
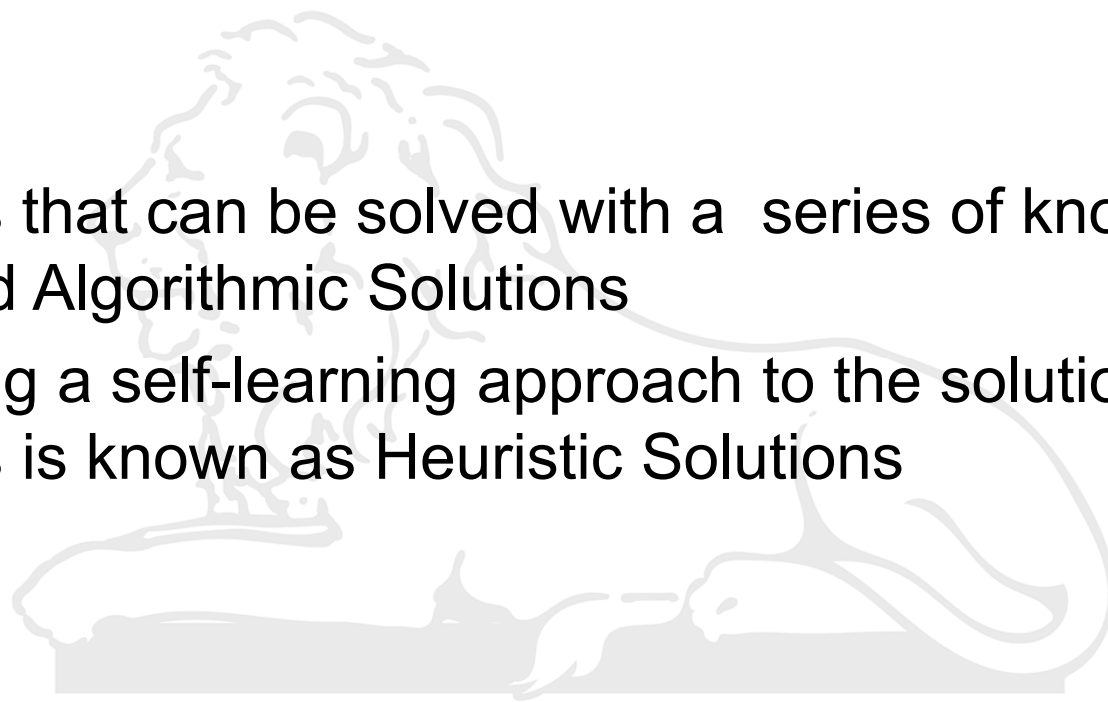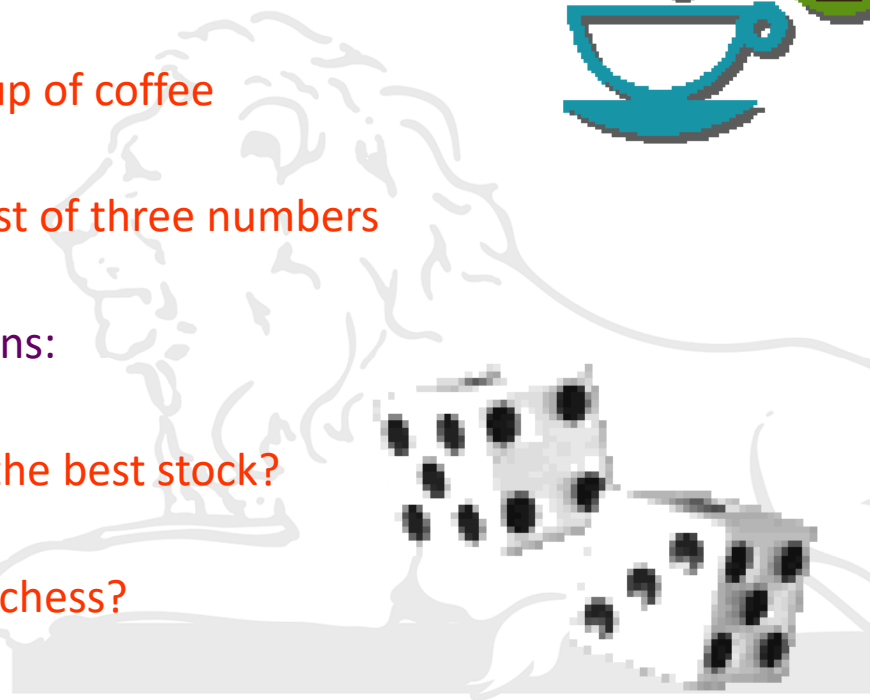
Examples:

Algorithmic solution:

- To make a cup of coffee

- To find largest of three numbers

Heuristic solutions:

- how to buy the best stock?

- How to play chess?

Problem solving with computers:

Computers use algorithmic solutions

- <u>Program</u> – set of instructions that make up solution to a problem

- <u>Results</u> – outcome of running the program

- <u>Testing</u> – Are the outcomes what you expected and correct

- <u>Documentation</u> – manual documentation – instructions telling users how to use the program
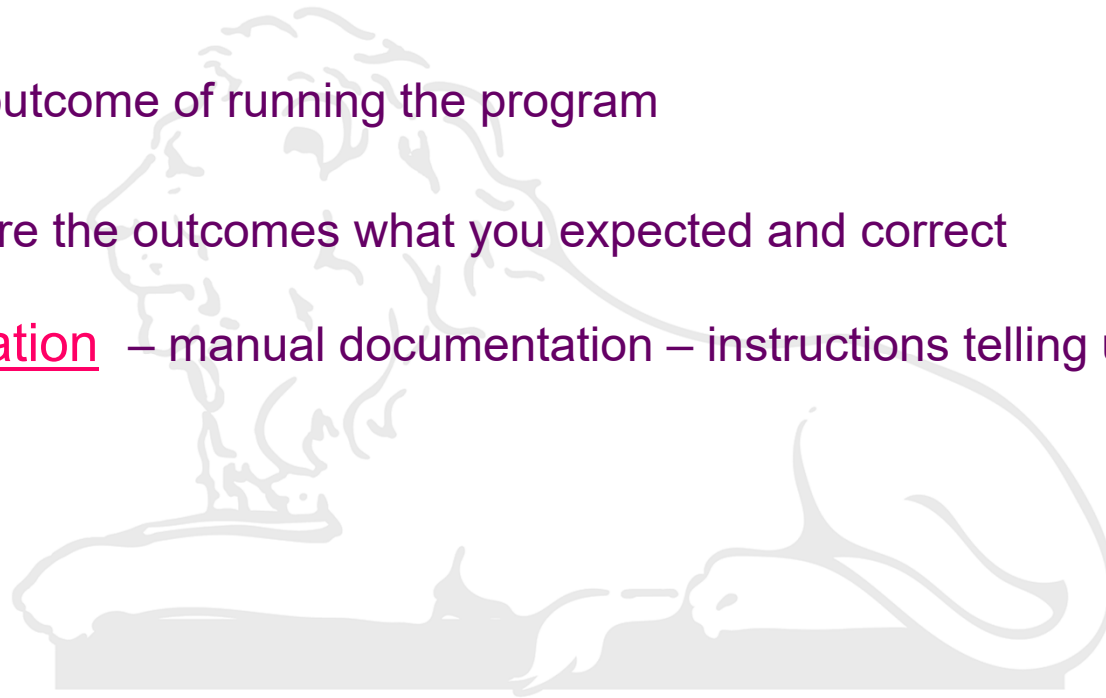
Problem solving with computers involves several steps:

- Clearly define the problem.
- Analyse the problem and formulate a method to solve it.
- Describe the solution in the form of an algorithm.
- Draw a flowchart of the algorithm.
- Write the computer program.
- Compile and run the program (debugging).
- Test the program (debugging).
- Interpretation of results.

"Algorithm"word:

- https://www.youtube.com/watch?v=oRkNaF0QvnI
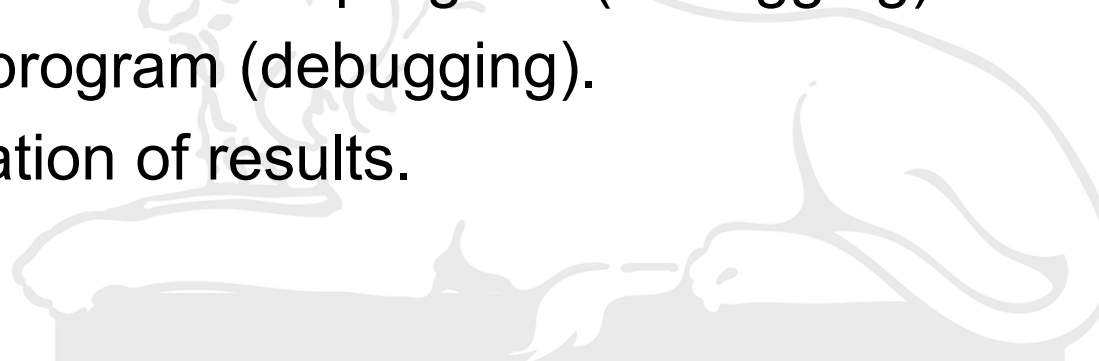
Algorithms

- What is it?
  - Is a finite sequence of logical steps used to solve a problem
  - Example: prepare and serve a scrambled egg on a whole wheat bread
    1. Take out a frying pan from the cabinet
    2. Heat up the frying pan
    3. Pour some oil into frying pan
    4. Take out an egg from the fridge
    5. Scramble it in a bowl
    6. Pour it into the frying pan
    7. Take out a spatula
    8. Flip the egg to the other side in a minute
    9. Take out a piece of a howl wheat bread and place it on a plate
    10. Check if the egg is ready
    11. If yes, put it on a slice of a whole wheat bread; If not, keep checking every minute.
   12. Serve the meal

Algorithms

- Other examples
  - Driving to school/work/mall/beach, etc.
- **<u>Algorithms are critical and essential component of a problem solving process.</u>**
- Problem:
  - Algorithms are sequential
  - Poor handling of multiple flows based on different conditions
    - Example: step # 10 and 11 in our scramble egg preparation algorithm

Flowcharts

- Flowchart is a graphical representation of an algorithm or a process

- Four basic elements:
  - Start
  - Action
  - Condition
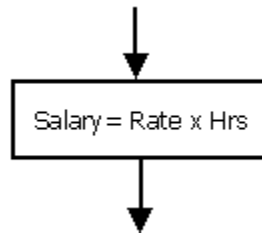 - End

Flowchart: Start Element

- Indicates the beginning of a flowchart
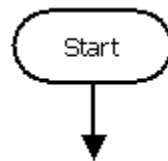
- Is the first one on the flowchart.
- Other elements are connected to it by using an arrow originating from this element and pointing to the connecting element.
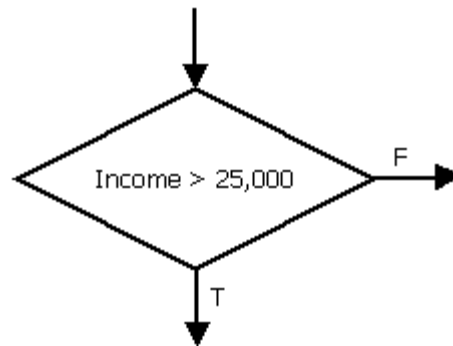
Flowchart: Action Element

- Denotes any action to be performed

$$Salary = Rate \times Hrs$$

- Is connected to other elements in a flowchart by using arrows.

- Arrows that point to this element are originated from preceding elements, while an arrow that originates from this element points to the subsequent element on the flowchart

Flowchart: Condition Element

- Indicates conditions

- Connected to other elements in a flowchart by using arrows.
- Arrows that point to this element are originated from preceding elements, while arrows that originate from this element points to the subsequent element on the flowchart.
- Conditions have two outcomes: it's either true or false.
- Each diamond sign must have two arrows originating from it; each one is labeled as either "T" or "F".

Flowchart: End Element

- Indicates the end of a flowchart
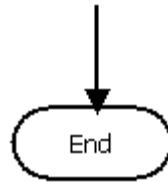
- Is the last one on the flowchart.
- Other elements are connected to it by using arrows originating from the connecting elements and pointing to this element.

More on Flowcharts

- all elements on a flowchart must be connected to a preceding element except for the "start" element.
- all elements on a flowchart must connect to subsequent elements except for the "end" element.
    - For example, if you have any rectangles or diamond signs without arrows pointing to them and arrows originating from them, then your flowchart is incorrect: re-examine it and make appropriate changes.
- Flowcharting software
    - Microsoft Visio
    - A word-processing software such as Microsoft Word
    - Dia
    - Kivio
    - OpenOffice Draw,
    - You can also draw flowcharts on paper, but, it is a hassle to make changes to it =>you will need to re-draw it every time.

Problem Statement:

Problem Statement help diagnose the situation so that your focus is on the problem, helpful tools at this stage include Algorithms and flowcharts for identifying the expected steps of a process. Therefore to solve any problem,

- Collect and analyze information and data
- Talk with people familiar with the problem
- If at all possible, view the problem first hand
- Confirm all findings

Algorithm:

The algorithm is part of the blueprint or plan for the computer program, an algorithm is:

"An effective procedure for solving a class of problems in a finite number of steps."

Every algorithm should have the following 5 characteristic feature:

1. Input
2. Output
3. Definiteness
4. Effectiveness
5. Termination

Algorithm (Contd…):

- <u>To find largest of three numbers</u>

1) Start

2) Read 3 numbers: num1, num2, num3

3) if num1 > num2 then go to step 5

4) if num2 > num3 then

                print num2 is largest

  else

                print num3 is largest

  goto step 6

5) if num1 > num3 then

                print num1 is largest

  else

                print num3 is largest

6) end.