

Algorithm Analysis and Design

CS-007 3L 1T 2P

Credit : 4.5

Motivation and Fundamentals

Course Instructor

Dr Deepak Garg



Motivation for the course

- ✿ It is the study of data structures and algorithms. Course covers various design strategies with the help of fundamental cases which will help in solving most of the problems that will be encountered in the projects done in various organizations
- ✿ Only Prerequisite for this course is knowledge of any one programming language
- ✿ Keep in mind that objective is to learn how to evolve a solution of a problem by choosing a good data structure with a good algorithm design. So every aspect of Computer Science will be looked from a different angle of efficiency.
- ✿ From all perspectives it is the most important course in CS&E to be a SE and will be required throughout your studies and career.
- ✿ A must for getting any placement

Books

- Introduction to Algorithms from PHI by Cormen, Leiserson, Rivest and Stein Third Edition
- Algorithm Design from Wiley by Goodrich and Tamassia
- Algorithm Design from Addison Wesley by Jon Kleinberg and Eva Tardos



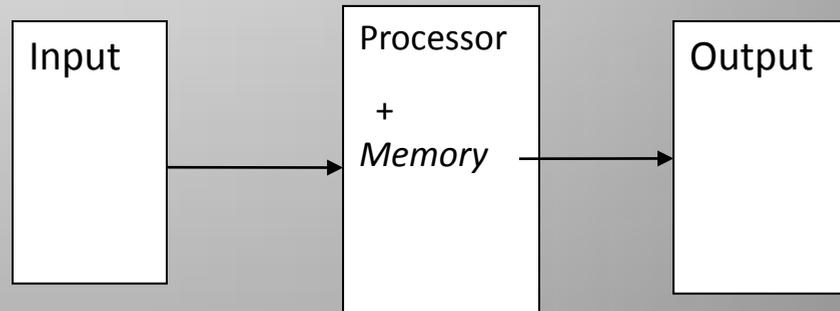
Evaluation

- ✿ 4 Quizzes on 1st Monday of every month for 4 marks each: 16 Marks
- ✿ 4 Lab Assignments, one every month for 4 marks each: 16 Marks
- ✿ 8 marks for Tutorial Work
- ✿ 20 marks Mid Semester Test
- ✿ 40 marks End Semester Test
- ✿ Total 100

Administration

- ✿ If you are not on time or absent, then it is up to you to be ready for understanding the remaining part
- ✿ Any administrative problems related to time table and evaluation schedule through the CR only
- ✿ Questions are encouraged any time during the class/Tutorial and lab hours
- ✿ All of you are requested to put an extra effort for the subject

Computer



- ❑ Is today's computer sufficiently described by this model (yes/No?)
- ❑ Now Computer not only means Compute or processing of numbers but also communication/ storage/ analysis/ designing.
- ❑ Now it is not the privilege of a few big organization but a must have device for the masses

Memory Hierarchy

- ✿ Registers
- ✿ L1 Cache (Internal cache)-SRAM
- ✿ L2/L3 Cache (External Cache)-SRAM
- ✿ DRAM-Main Memory
- ✿ Hard Disk – Secondary Storage
- ✿ External Storage – Floppy, CD, DVD, Flash Drive
- ✿ Size is increasing(individually and hierarchically)
- ✿ Cost/byte is decreasing
- ✿ Speed is decreasing

Evolution

- Vacuum Tubes-> Transistors-> ICs->LSICs->VLSIs->UISICs
- Thousand 10^3 ->Million 10^6 ->billion 10^9 ->trillion 10^{12} instructions per second
- Byte->Kilo->Mega->Giga->Terabits of memory
- 8bit-> 16 bit->32bit->64->128 bit processors
- Machine Code-> Assembly Language-> HLLs
- Procedural-> structured -> object oriented languages
- Numbers+ Chars+ Text+ Graphics+ Audio+ Video+ Multimedia

Data Structure

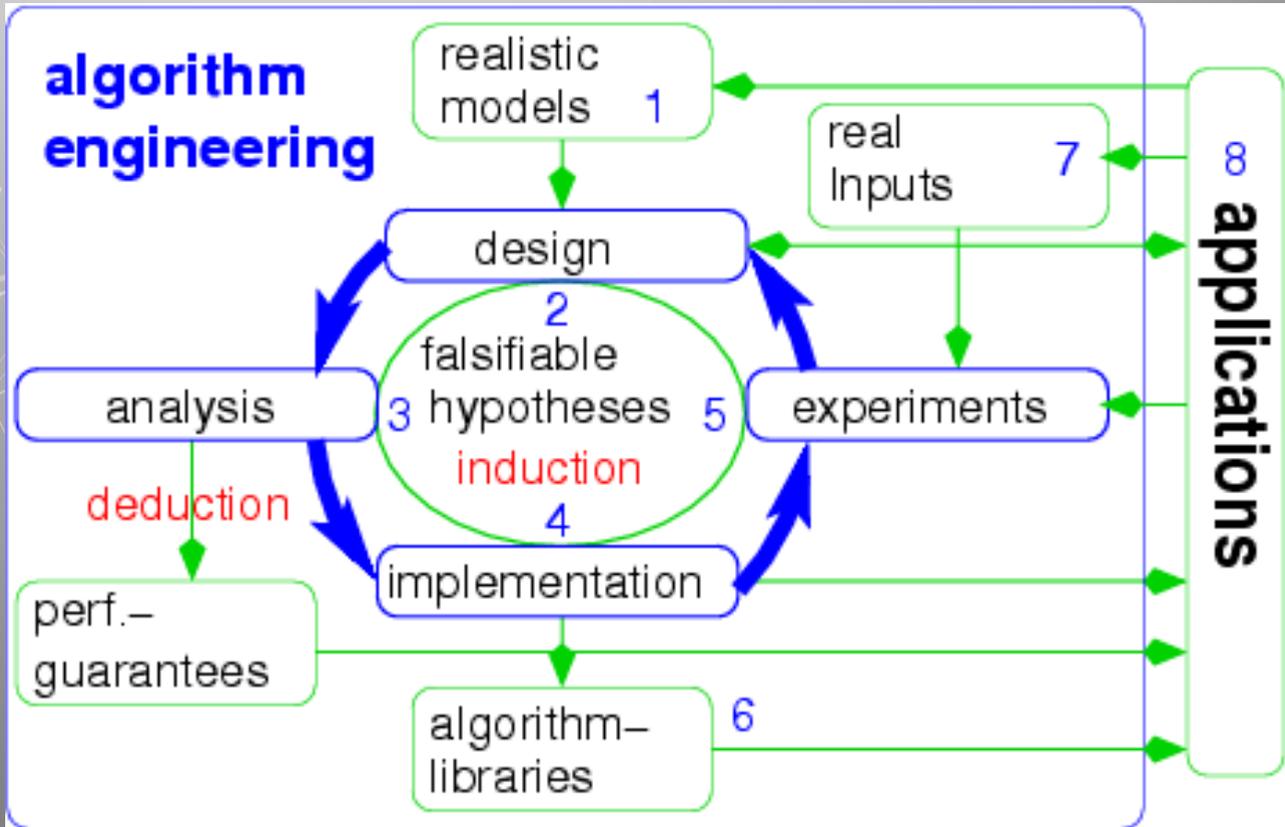
- ✿ Data structure is a way to store and organize data in order to facilitate access and modifications.
- ✿ Example of storing an array in randomly stored Memory matrix, which would have been possible if objects were stored in an organized way
- ✿ If the strengths and limitations of a structure will be known, then we can utilize the best one available for a given structure.
- ✿ Static: Values are fixed
- ✿ Dynamic Data Structure: updations can take place, insertions, deletions can happen
- ✿ Data Structures for geometric Problems like KD-Trees
- ✿ Data Structures for external Memory, Cache-oblivious data structures
- ✿ Self-adjusting data structures, Persistent Data Structures, Retroactive Data Structures

Algorithm

- ✿ Algorithm is a sequence of Finite and unambiguous computational steps that transform the input into the correct output effectively.
- ✿ Finite theoretically means having finite number of steps, but for an algorithm to be effective this finite amount has to be within reasonable limits of computing resources available.
- ✿ Unambiguous means deterministic
- ✿ In some cases incorrect solutions are acceptable if they are within the range of allowed error, which is also good in many cases, where the correct algorithms are not available with the limitation of current resources.
- ✿ Algorithm is also called a pseudo code
- ✿ Assume we have infinite speed processors with infinite memory, do we still need to study data structure and algorithms.
- ✿ Yes! It is an art... It is fun... Why people run in a race. Even if there are cars and airplanes
- ✿ Examples of Online Banking, Shopping, Reservations and Biotechnology

Desirable characteristics of an algorithm

- ✿ Modularity
 - ✿ Scalability
 - ✿ Graceful Degradation for size and number of inputs
 - ✿ Maintainability
 - ✿ Simple
 - ✿ User friendly
 - ✿ Extensible
 - ✿ Programmer Time
 - ✿ Concurrency
 - ✿ Distributed
 - ✿ Security
 - ✿ Power Efficiency
 - ✿ Hardware/OS compliant
- ✿ Performance draws line between feasible and impossible. Algorithms give language for talking about program behavior. Performance can be used to "pay" for other things, such as security, features and user-friendliness



Binary Number	Octal Number*	Decimal Number	Hexadecimal Number**
0000	0	0	0
0001	1	1	1
0010	2	2	2
0011	3	3	3
0100	4	4	4
0101	5	5	5
0110	6	6	6
0111	7	7	7
1000	10	8	8
1001	11	9	9
1010	12	10	A
1011	13	11	B
1100	14	12	C
1101	15	13	D
1110	16	14	E
1111	17	15	F