



PROGRAMMING, DATA STRUCTURES AND ALGORITHMS USING PYTHON

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INTENDED AUDIENCE : Students in any branch of mathematics/science/engineering, 1st year

PRE-REQUISITES : School level mathematics.

INDUSTRIES APPLICABLE TO : This course should be of value to any company requiring programming skills.

COURSE OUTLINE :

This course is an introduction to programming and problem solving in Python. It does not assume any prior knowledge of programming. Using some motivating examples, the course quickly builds up basic concepts such as conditionals, loops, functions, lists, strings and tuples. It goes on to cover searching and sorting algorithms, dynamic programming and backtracking, as well as topics such as exception handling and using files. As far as data structures are concerned, the course covers Python dictionaries as well as classes and objects for defining user defined datatypes such as linked lists and binary search trees.

ABOUT INSTRUCTOR :

Prof. Madhavan Mukund studied at IIT Bombay (BTech) and Aarhus University (PhD). He has been a faculty member at Chennai Mathematical Institute since 1992, where he is presently Professor and Director. His main research area is formal verification. He has active research collaborations within and outside India and serves on international conference programme committees and editorial boards of journals.

He has served as President of both the Indian Association for Research in Computing Science (IARCS) (2011-2017) and the ACM India Council (2016-2018). He has been the National Coordinator of the Indian Computing Olympiad since 2002. He served as the Executive Director of the International Olympiad in Informatics from 2011-2014.

In addition to the NPTEL MOOC programme, he has been involved in organizing IARCS Instructional Courses for college teachers. He is a member of ACM India's Education Committee. He has contributed lectures on algorithms to the Massively Empowered Classroom (MEC) project of Microsoft Research and the QEEE programme of MHRD

COURSE PLAN:

Week 1:

Informal introduction to programming, algorithms and data structures
Downloading and installing Python
gcd in Python: variables, operations, control flow - assignments, condition-als, loops, functions

Week 2:

Python: types, expressions, strings, lists, tuples
Python memory model: names, mutable and immutable values
List operations: slices etc
Binary search
Inductive function definitions: numerical and structural induction
Elementary inductive sorting: selection and insertion sort
In-place sorting

Week 3:

Basic algorithmic analysis: input size, asymptotic complexity, $O()$ notation
Arrays vs lists
Merge sort
Quicksort
Stable sorting

Week 4:

Dictionaries
More on Python functions: optional arguments, default values
Passing functions as arguments
Higher order functions on lists: map, lter, list comprehension

Week 5:

Exception handling
Basic input/output
Handling files
String processing

Week 6:

Backtracking: N Queens, recording all solutions
Scope in Python: local, global, nonlocal names
Nested functions
Data structures: stack, queue
Heaps

Week 7:

Abstract datatypes
Classes and objects in Python
"Linked" lists: find, insert, delete
Binary search trees: find, insert, delete
Height-balanced binary search trees

Week 8:

Efficient evaluation of recursive definitions: memoization
Dynamic programming: examples
Other programming languages: C and manual memory management
Other programming paradigms: functional programming