Quantitative Finance
COURSE NUMBER: 22:839:615
COURSE TITLE: Special Topics Oriented Programming 2

COURSE DESCRIPTION

This course assumes a student has prior programming language experience with C++. It is designed for studying advance data structures using C++ programming language. Basic concepts such as time and space complexity analysis will be discussed. Data structures such as linked lists, stacks, queues, deques, backtracking with recursion and concepts of recursions will be covered. Different kinds of tree structures will be covered. The binary tree, binary search tree, heap, priority queues, Huffman tree will be discussed. Associate containers such as Maps, Sets, Hash tables, Hash maps will be covered. Different kinds of sorting methods and their time complexity analysis will be compared. SelfBalancing Search Tree structures such as AVL tree, Red-Black tree, and B-Tree among others will be discussed. Issues and concepts related to graphs will be covered. Some other interesting algorithms, algorithm development skills, and analysis will also be discussed.
In addition to C++ programming language and its application to financial applications, Basic concept of databases such as SQL, database model, database design, and popular databases will be discussed. Python programming will be covered this semester. The basic data structures, and control structures of this programming language will be discussed.

COURSE MATERIALS

Suggest Reference Books:
C++ How to Program, by P. J. Deitel and H. M. Deitel, 9th ed. Prentice Hall
Data Structures and Algorithm Analysis in C++, 4th ed., by Mark Allen Weiss, Pearson
Objects, Abstraction, Data Structures and Design Using C++, by Elliot B. Koffman, and
Paul A. T. Wolfgang, Wiley
Introduction to C++ for Financial Engineers: An Object-Oriented Approach, by D. Duffy, Wiley
Murach’s SQL Server 2012 for Developers, by Bryan Syverson, and Joel Murach, Murach
Practice of Computing Using Python, 2/E, William F. Punch and Richard Enbody,
CLASS ORGANIZATION & ADMINISTRATION

Course outline

Review of C++ basics
Review of software design and analysis
Efficiencies and Correctness of programs
Sequential containers reviews and enhancements
Stacks
Stack ADT
Implementations of stacks
Applications such as Postfix expression evaluations
Converting among Prefix, Postfix, and Infix expressions
Queues
Queue ADT
Implementations of queues
Simulations using queue structures
Deque and its implementations
Backtracking using recursive constructs.
Introduction of tree structures
Tree traversals
Implementation of tree structures
Binary search tree and its operations
Heap basic
Heap implementation
Priority queue
Using heap as basis of priority queue
Huffman coding tree
Introduction of associate containers
Set and Multiset
Map and Multimap
Introduction of hash table
Applications using hash tables
Traversing of hash table and collision reductions
Implementation of hash tables
Selection Sort
Bubble sort
Insertion sort
Shell sort
Merge sort
Heapsort
Quick sort
Time and space comparisons of different sorting algorithms
Balancing and rotating on nodes of a tree
The concepts of self-balancing search tree
AVL tree and its implementation
Red-Black trees and performance analysis
2-3 tree
2-3-4 and B-tree
Directed and undirected graphs
Adjacency list and Adjacency Matrix
Breath first search of graph
Depth first search of graph
Shortest path
Minimum spanning tree
Introduction of structured query language
Microsoft SQL server basic

Create databases and tables of relational databases

Manipulation and retrieve data on relational database tables

Introduction of Normal forms

Brief introduction of open source database system: MySql

Brief introduction of web site design and development  Analysis huge datasets using non-traditional analysis approaches

Concepts of supervised machine learning and unsupervised machine learning

Apply artificial neural networks to predict and forecast financial and economic data

Introduction of Python programming languages

Decision tree classifier use in financial applications

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**FINAL GRADE ASSIGNMENT**

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Prediction of trend of stocks using artificial neural network or other machine learning algorithms
You may propose different project for any financial application subject to the approval of instructor

**Note**

- Form a study group of 2 to 4 people and give a name for your group and designate a leader for your team; submit the information to your instructor; team leader hold responsibility to submit all assigned team homework, team assignment, or team project. The submission shall include all team members’ names
- Each individual student is responsible to submit his/her own independent homework, independent assignment, and independent project.
- Check e-mail for class cancellation in case of snow emergency, In case we have to meet online, a link will send to you so you can login to the virtual classroom.
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