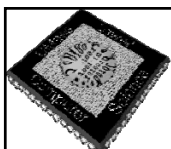


UMass Lowell Computer Science 91.404
Analysis of Algorithms
Prof. Benyuan Liu

Lecture 1
Introduction/Overview

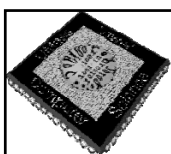
Course webpage: <http://www.cs.uml.edu/~bliu/404-F13>



Nature of the Course

- ↗ Core course: *required for all CS majors*
- ↗ Advanced undergraduate level
 - ↗ Graduate students take separate course (91.503)
- ↗ No programming required
 - ↗ “Pencil-and-paper” exercises
 - ↗ Lectures supplemented by:
 - ↗ Programs
 - ↗ Real-world examples





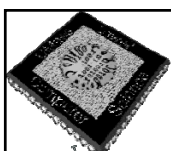
What's It All About?

➤ Algorithm:

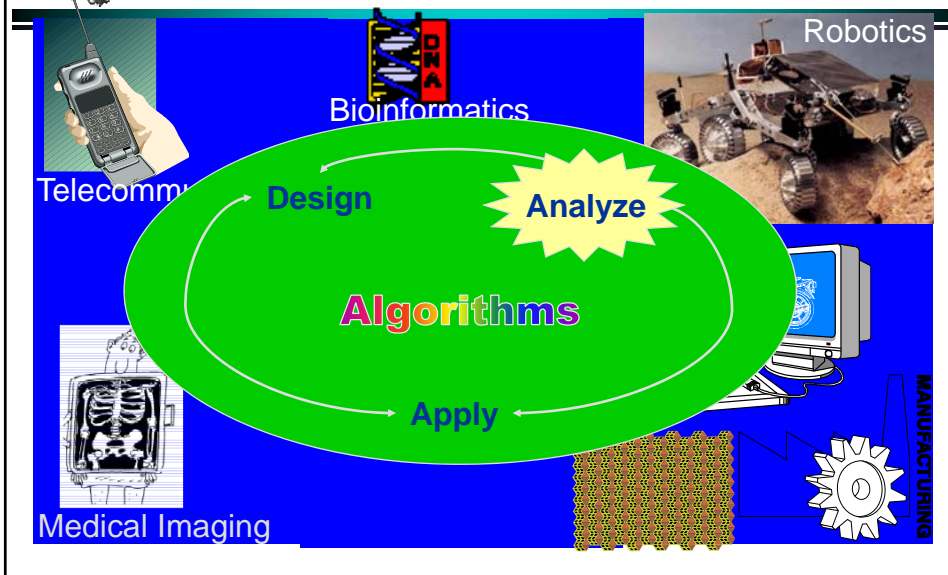
- steps for the computer to follow to solve a problem
- *well-defined computational procedure* that transforms input into output

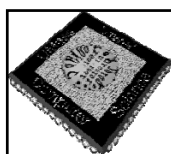
➤ Some of our goals:

- recognize structure of some common problems
- understand important characteristics of algorithms to solve common problems
- select appropriate algorithm to solve a problem
- tailor existing algorithms
- create new algorithms



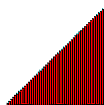
Some Algorithm Application Areas





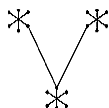
Some Typical Problems

Sorting



Input: Set of items
Problem: Arrange items "in order"

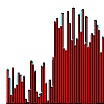
Minimum Spanning Tree



Input: Graph $G = (V, E)$ with weighted edges

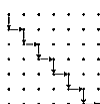
Problem: Find subset of E of G of minimum weight which forms a tree on V

Median finding



Input: Set of numbers or keys
Problem: Find item smaller than half of items and bigger than half of items

Shortest Path

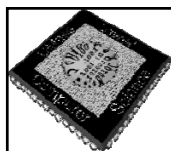


Input: Edge-weighted graph G , with start vertex s and end vertex t

Problem: Find the shortest path from s to t in G

SOURCE: *Steve Skiena's Algorithm Design Manual*

(for problem descriptions, see graphics gallery at <http://www.cs.sunysb.edu/~algorithm>)



Tools of the Trade

➤ Algorithm Design Patterns such as:

➤ divide-and-conquer

➤ Data Structures such as:

➤ trees, linked lists, hash tables, graphs

➤ Algorithm Analysis Techniques such as:

➤ asymptotic analysis

➤ probabilistic analysis

Summations

Proofs

MATH

Permutations

Combinations

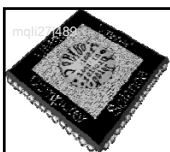
Sets

Logarithms

Growth of Functions

Probability

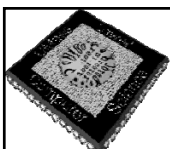
Recurrences



Tools of the Trade: (continued) Algorithm Animation

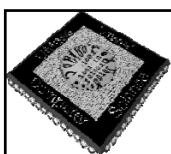
<http://www.sorting-algorithms.com/>

<http://www.site.uottawa.ca/~stan/csi2514/applets/sort/sort.html>



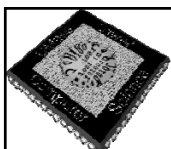
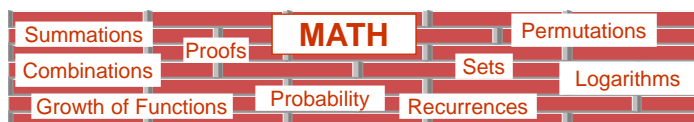
What are we measuring?

- ↗ Some Analysis Criteria:
 - ↗ Scope
 - ↗ The problem itself?
 - ↗ A particular algorithm that solves the problem?
 - ↗ “Dimension”
 - ↗ Time Complexity? Space Complexity?
 - ↗ Type of Bound
 - ↗ Upper? Lower? Both?
 - ↗ Type of Input
 - ↗ Best-Case? Average-Case? Worst-Case?
 - ↗ Type of Implementation
 - ↗ Choice of Data Structure



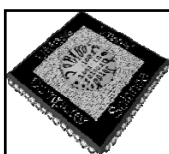
Prerequisites

- ↗ Computing I (91.101)
- ↗ Computing II (91.102)
- ↗ Discrete Math I & II (92.321, 92.322)
- ↗ Statistics for Scientists and Engineers (92.386)
- ↗ Calculus I-II (92.131-132)



Course Structure: 4 Parts

- ↗ Foundations
 - Part 1** ↗ Analyzing & Designing Algorithms, Growth of Functions, Recurrences, Probability & Randomized Algorithms
- ↗ Sorting
 - Part 2** ↗ Heapsort, Priority Queues, Quicksort, Sorting in Linear Time
- ↗ Data Structures
 - Part 3** ↗ Stacks and Queues, Linked Lists, Introduction to Trees, Hash Tables, Binary Search Trees, Balancing Trees: Red-Black Trees
- ↗ Graph Algorithms
 - Part 4** ↗ DFS, BFS, Topological Sort, MST, Shortest paths



Textbook



Required:

➤ *Introduction to Algorithms* (third edition)

➤ by T.H. Corman, C.E. Leiserson, R.L. Rivest, Clifford Stein

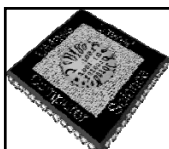
➤ McGraw-Hill

➤ 2009

➤ ISBN 978-0-262-03384-8

➤ See course website for recommended texts

Third Edition



CS Theory Math Review Sheet The Most Relevant Parts...

➤ p. 1

➤ O , Θ , Ω definitions

➤ Series

➤ Combinations

➤ p. 2 Recurrences & Master Method

➤ p. 3

➤ Probability

➤ Factorial

➤ Logs

➤ Stirling's approx

➤ p. 4 Matrices

➤ p. 5 Graph Theory

➤ p. 6 Calculus

➤ Product, Quotient rules

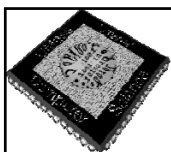
➤ Integration, Differentiation

➤ Logs

➤ p. 8 Finite Calculus

➤ p. 9 Series

Math fact sheet (courtesy of Prof. Costello) is on our web site.



Grading

↗ Homework (~8)	30%
↗ Midterm (chapters 1-6, open book & notes)	25%
↗ Quiz (~2)	10%
↗ Final Exam (cumulative, open book & notes)	25%
↗ Discretionary (attendance, participation, quiz)	10%