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CS362 Undergrad Algorithm II

modelled after CS561 Grad Algorithm

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Textbook : CLR Introduction to Algorithms

Topics:

① Background

Big O notations, solving recurrence relations

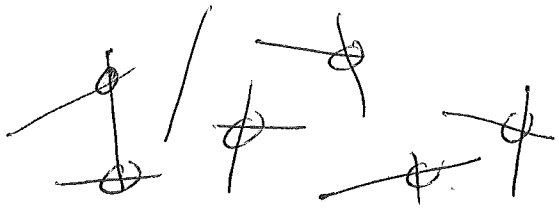
Log, Exponentiation, ...

② Design of Algorithms by Induction

Shortest path algorithm

MST

Dynamic Programming



③ Design of Algorithms by Recursion

Divide and Conquer

Decrease and Conquer

④ Randomized Algorithm

⑤ Complexity

Exam Dates:

Exam 1 Feb 25th (Thursday)

Exam 2 Apr 7th (Thursday)

Exam 3 May 5th (Thursday)

Grading:

HW(25%) + Exam 1 (25%) + E2 (25%) + E3 (25%)

= 100%

≥ 9% A

≥ 6% C

Highese A+

Homework Policy:

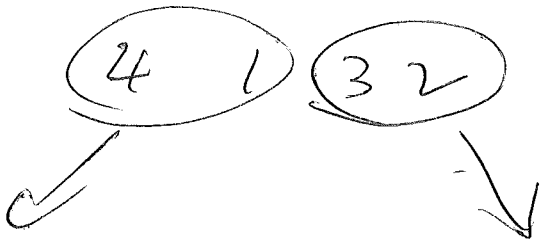
① All homework must be typewritten

② Submission must have a cover page

③ Outline Solutions

ⓐ Paragraph briefly describe your key ideas

ⓑ a worky example illustrate your solution



ⓒ pseudo-code

ⓓ Running time analysis

$$T(n) = 2T\left(\frac{n}{2}\right) + n \Rightarrow T(n) = O(n \lg n)$$

④ HW must be turned in at the beginning of the class period

⑤ All grade changes must be resolved with in 7 days

Academic Honesty:

Def An algorithm is a step by step procedure for solving a problem

Computationally, an algorithm is a well-defined computation procedure ~~for~~ that takes some value as input and produce some value as output.

The word algorithm originates from

Abu al-Khwarizmi [1,2],

On the calculation of Hindu Numerals

Latin name: "Algoritmi de numero Indorum"

Def (Data Structure):

a way to store and organize data

for efficient access and modification

Computation Model: Random Access Machine

(1) Instructions are executed sequentially

(2) No memory hierachy

everything resides in an infinite main memory

(3) Each standard data type (int, double;)

takes one unit of memory.

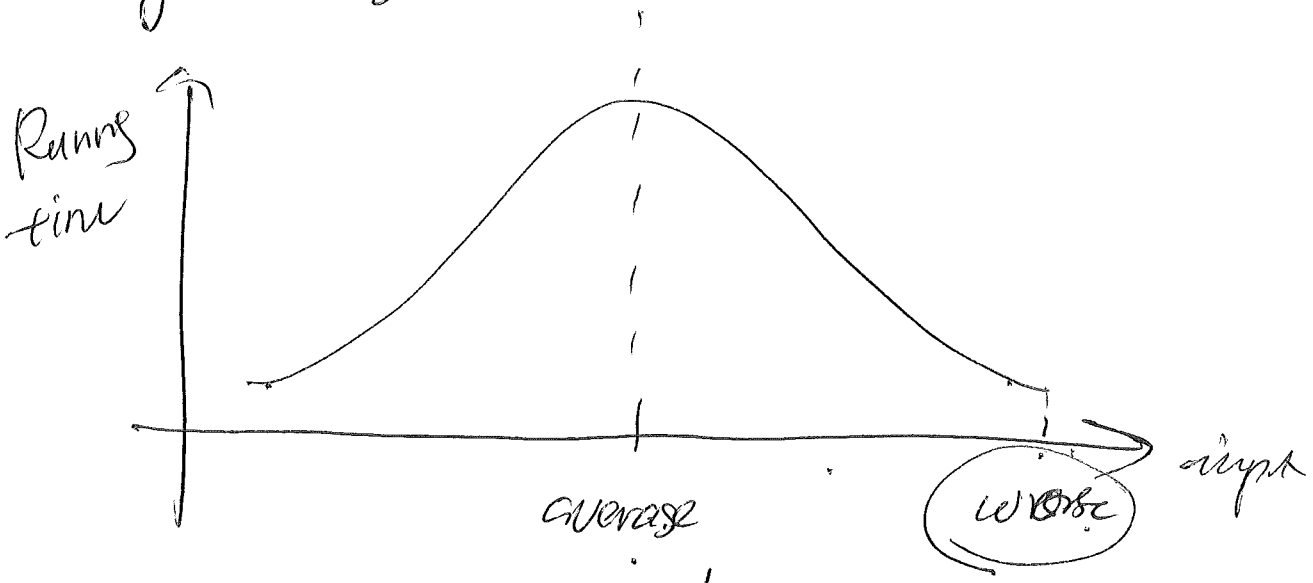
(4) Each memory access takes unit time for a standard data type

(5) Each simple operation takes unit CPU time (addition, ~~sub~~ multiplication, ...)

The running time is the number of CPU steps as a function of the amount of input

input by the # of memory cells used

The space complexity is # of memory cells used by the algorithm



Example Given an array $A[1..n]$ of n distinct numbers from $\{1, 2, \cdots, n+1\}$

Determine the missing integer.

Algorithm 1:

Key Ideas: sum up all the numbers in A

subtract the sum from $\sum_{j=1}^{n+1} j$

Pseudo-code

```
Sum = 0
For j = 1 to n
    Sum = Sum + A[j]
return (n+1)(n+2)/2 - Sum
```

$$\sum_{j=1}^{n+1} j = \frac{(1+(n+1))(n+1)}{2}$$

Running time: $2n+4$ Space: n

Algorithm 2.

return $\dfrac{(n+1)!}{\prod_{j=1}^{n} A[j]}$

running time: $2n + n + 1 = 3n+1$

space n

Algorithm 3:

Create a binary / Boolean array $B[1..n+1]$

initialized B to be F for every entry

For every $A[j]$, mark $B[A[j]] = T$

The entry in B equal to F will be the missing number

$A = \{1, 3, 4\}$

$B = \boxed{F \mid F \mid F \mid F}$

1 2 3 4

$\boxed{T \mid F \mid T \mid T}$ ✓

Running time:

$(n+1) + 2n + (n+1)$

$= 4n+2$

Space $2n$