程序代写代做 CS编程辅导





Foundations of Computer Science

WeChat: cstutorcs

Lecture 11: Algorithmic Analysis Assignment Project Exam Help

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Motivation

Standard Approach

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Algorithmic analysis: motivation

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arbitrarily large insta



Want to compare algae particularly ones that can solve

We would like to be able to talk about the resources (running time, memory, energy consumption) required by a program/algorithm as a function f(n) of somesparamete Pro(e.g. Exercite) of its input.

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How long does a given sorting algorithm take to run on a list of n elements? QQ: 749389476elements?

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Problems



- The exact resource and algorithm are difficult to pin down. Heav
 - Environment the program is run in (hardware, software, choice of language, wxternaltfactors of language)
 - Choice of inputs used
- Cost functions can be complex, e.g. Exam Help

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$$n \log(n) + (n - 100) \log(n)^2 + \frac{1}{2^n} \log(\log(n))$$

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Need to identify the "important" aspects of the function.

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Order of growth

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Example

Consider two time-cc

- $f_1(n) = \frac{1}{10}n^2$ milks and
- $f_2(n) = 10n \log n$ milliseconds

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Input size	$f_1(\underline{n})$	$f_2(n)$. 1
100 ssignm	entorroje	ct ₂ Exam H	lelp
1000 nail: tu	utores@1	63.com	
10000	1m40s	6m40s	
100000749	3 2047 r6	1h23m	
1000000	11d14h	16h40h	
10000000	itores.com 3y3m	8d2h	

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Algorithmic analysis

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Asymptotic analysis is about how costs **scale** as the input increases.

Standard (default) a

- Consider asymptotic growth of cost functions
- Consider worst-Wase (haighestutost) inputs
- Consider running time cost: number of elementary operations

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NB

Other common analyses in Aug 89476

- Average-case analysis.//tutorcs.com
- Space (memory) cost

Elementary operations

Informally: A single c 被 to takes a constant number of computation cycles.

Examples:

- Arithmetic oper
- Comparison of two values
- Assignment of a Walter to a Variable
- Accessing an element of a Paviect Exam Help
- Calling a function Email: tutores@163.com
- Returning a value
- Printing a single Qaracter 89476

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Count operations up to a constant factor, O(1), rather than an exact number.

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Examples

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Example

Squaring a number (First version):

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square(n):

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Running time: O(1) Email: tutorcs@163.com

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Running time vs Execution time

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Previous example shows one difference between running time and execution time.

In general, running time: pproximates execution time:

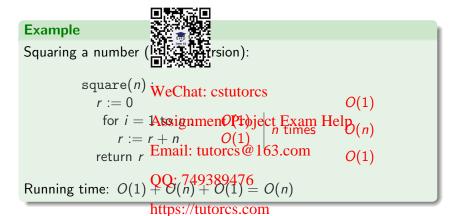
- Simplifying assumptions about elementary operations
- Hidden constants in big-Ocstutorcs
- Big-O only looks Astribinition the Big-O only looks Astributed the Big-O only looks Astribu

Examples Email: tutorcs@163.com

- Implementations of square (п) will take longer as n gets bigger
- A program that https://www.mrun in O(1) time.

Examples

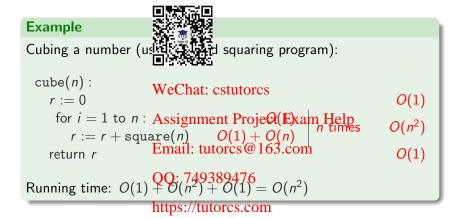
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Examples

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Worst-case input assumption and big-O combine to *simplify* the analysis:

Example

Sum of squares (Using second squaring program):

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```

sumOfSquares(n):

r := 0 Assignment Project Exam Help O(1)

for i = 1 to Email: tutores @ 163 commes $O(n^2)$ r := r + square(i) O(n)

return r QQ: 749389476 O(1)

Running time: O(1) https://www.sigom $O(n^2)$

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Worst-case input assume and big-O combine to *simplify* the analysis:

```
Example
```

```
Finding an element (x) in an array (L) of length n:

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find(x, L):

for i = 0 to Assignment Project Exam Help

if L[i] = \text{Email: tutorcs}(1)

return i

O(1)

Running time: O(n) http://tutorcs.com
```

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Worst-case input assigned big-O combine to *simplify* the analysis:

NB

Simplifications might lead to sub-optimal bounds, may have to do a better analysis to getelerate bounds of the sub-optimal bounds of the sub-optimal

- Finer-grained upper bound analysis
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- Analyse specific cases to find a matching lower bound (big-Ω)

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 $Big-\Omega$ is a **lower bound** analysis of the worst-case; NOT a "best-case" analysis. https://tutorcs.com

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Analyse specific cases to find a matching lower bound (big- Ω)

Example

Let L_n be an *n*-element L_n be an *n*-element L_n be an L_n be an

Finding an element (x) in an array (L) of length n:

WeChat: cstutorcs find(x, L):

for i = 0 to Assignment Hoject Exam Help if L[i] == x: $\Omega(1)$ $\Omega(n)$ times return Email: tuto 163.com

return -1 QQ: 749389476 $\Omega(1)$

Running time of find(105:h)time(28.com Therefore, running time of find(x, L): $\Theta(n)$ $\Omega(n)$

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```
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Example
Factorial:
        fact(n):
          if n == 0
                                                   O(1)
                                                   O(1)
             return
           else: WeChat: cstutorcs
             return n * fact(n-1) O(1) + T(n-1)
Assignment Project Exam Help
Running time for fact (n): T(n) where:
                 T(0) = 749339478(1) = O(1)
                T(n) = T(n-1) + O(1)
https://tutorcs.com
Running time: T(n) \in O(n)
```

```
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Example
Summing elements of \mathbf{r} is in the summing elements of \mathbf{r} is the summing elements of \mathbf{r}.
       sum(L):
          if L.isEmpt⊟i
                                                                                   O(1)
                                                                                   O(1)
              return 0
                              WeChat: cstutorcs
          else:
              return L. data + sum (L. pext)
Assignment Project Exam Help T(n-1)
Running time for sum Truffor where 63.com
                         T(\mathbf{0}\mathbf{0}\mathbf{0}\mathbf{5}\mathbf{7}4\mathbf{9}\mathbf{3}\mathbf{9}\mathbf{4}\mathbf{7}\mathbf{6}(1) = O(1)
                         T(n) = T(n-1) + O(1)
\in O(n)
```

```
Example
                    程序代写代做 CS编程辅导
Insertion sort (L has <u>n elements</u>):
           sort(L)
              if L.ilid
                                                O(1)
                                                O(1)
             else: WeChat: cstutorcs
                L2 := sort(L.next) T(n-1)
                inseAssignment, Project Exam Holp)
                return L2
Email: tutorcs@163.com
                                                O(1)
Running time for sort 745384476
                T(0) + O(1) + O(1) = O(1)

T(n) = T(n-1) + O(n) + O(1)
                      \in O(n^2)
```

```
Example
                  程序代写代做 CS编程辅导
Euclidean algorithm for gcd(\underline{m}, n) (N = m + n):
        gcd(m, n):
          if m > n
                                                O(1)
                                    \leq T(N-1)
          else if n We Chat: cstutor Q(1)
                                   \leq T(N-1)
             return gcd(m, n - m)
                Assignment Project Exam Help(1)
          else :
Running time for gcd mail: thtors, @163.com
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                 That ps: \angle tuton(x) \cdot coin + O(1)
                        \in O(N)
```

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Example

Euclidean algorithm for gcd(m, n) (N = m + n):

Running time: O(N) WeChat: cstutorcs

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NB

Email: tutorcs@163.com N is not the input size. Input size is $\log(m) + \log(n)$

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```
Example
                   程序代写代做 CS编程辅导
Faster Euclidean algorithm for gcd(m, n) (N = m + n):
      gcd(m, n):
         if m > n > 
                                                    O(1)
           return gcd(m \% n, n)
                                            \leq T(N/1.5)
         else if n > \mathbf{w} \in \mathbb{C}_{n} at: cstutorcs O(1)
           return gcd(m, n \% m)
                                       \leq T(N/1.5)
                  ressignment Project Exam Help O(1)
         else :
Running time for gcd mail: thtors @163.com
                  QQ: 749389476
                  T https://tuton(over.com) + O(1)
                         \in O(\log N)
```

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Example

Faster Euclidean algo $\mathbf{1}$ gcd(m, n) (N = m + n):

What about lower bounds? cstutorcs

- Can show algorithmical expression $\mathbf{F}_{\mathbf{k}}$ where F_k is the k-th Fibonacci number Email: tutorcs@163.com
 • Can show $1.5^k \le F_k \le 2^k$, so $k \in \Theta(\log F_k)$
- Therefore $gcd(F_k, F_{k-1}, \frac{749389476}{2}(\log(F_k + F_{k-1}))$

Exercise

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Exercise

n.

RW: 4.3.22 The follows: The follows: The follows: $\frac{1}{2}$ The follows: The follows: $\frac{1}{2}$ The follows: $\frac{1$



WeChap. (estutions) p = 1

Assignment Project Exam Help

Email: $\underset{p}{\text{while }} i > 0$. $\underset{p}{\overset{\cdot}{\text{mail}}} : \underset{p}{\text{while }} i > 0$. $\underset{p}{\overset{\cdot}{\text{mail}}} : \underset{p}{\text{mail}} : \underset{p}{\text{while }} i > 0$.

QQ: 749389476 1 return *p* https://tutorcs.com

Determine the running time of this algorithm.

Exercise

Exercise

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RW: 4.3.21 The following algorithm gives a fast method for raising a number a to a power with the second se

 \square rast-exp(a, n):

WeChat: cstutoresq = a

Assignment Project Exam Help

Email: while i > 0: tutorcs @ 163.com

QQ: 749389476 * 9

q = q * qhttps://tutorcs.icom

return p

Determine the running time of this algorithm.