Algorithms – I (CS29003/203)

Autumn 2022, IIT Kharagpur

Last 2+ Years

IIT Kharagpur asks students to vacate hostels by June 20

More than 3,000 students are now on the campus

IIT Kharagpur
Telegraph file picture

Welcome Back

Source: https://tinyurl.com/3rtxr6as

Logistics

- **Course Name and code**: Algorithms - I, CS21003/CS21203
- **Time**: Wednesday (10:00-10:55 am), Thursday (09:00-09:55 am), Friday (11:00am-12:55 pm)
- **Venue**: NC243 (Roll no.s ending with odd digits), NC341 (Roll no.s ending with even digits)
- **Course website**: https://cs21203au22.github.io/
- **Prerequisites**: PDS

Logistics

- **Moodle Classroom**: https://moodlecse.iitkgp.ac.in/moodle/ and then the class name is – Algorithms - I Theory (CS21003/CS21203)
- Login to moodle -> In Home, scroll down to 'Course categories->Autumn Semester (2022-23)'. Search with code 'ALGOTH-A22-23'
- Enrollment key: **ATHSTU2223**

- **TAs**: Kothapalli Dileep (kothapallidileep10122000@gmail.com), Pankaj Kumar Agarwal (pankaj08072000@gmail.com).
  - One more will be added soon.

The Team

Instructors

Abir Das

Ayan Chaudhury

Teaching Assistants

Pankaj K. Agarwal

Kothapalli Dileep

- **And YOU!!**

Course Information

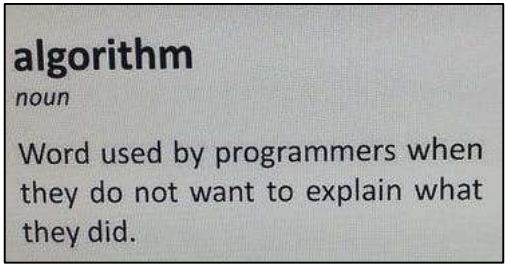
- **Books and References**:
  1. Thomas H Cormen, Charles E Lieserson, Ronald L Rivest and Clifford Stein, Introduction to Algorithms. (3rd Edition)
  2. Jon Kleinberg and Éva Tardos, Algorithm Design, Pearson, 2005.
  3. Sanjoy Dasgupta, Christos H. Papadimitriou and Umesh V. Vazirani, Algorithms, Tata McGraw-Hill, 2008.
  4. Jeff Erickson, Algorithms, 2019.
  5. Mark Allen Weiss, Data Structures and Algorithm Analysis in C.

- More references specific to the lectures will be added in the course website as and when needed.

Course Information

- **Evaluation**: ClassTest (20%) – 2; Mid Sem (30%); End Sem (50%). [**Tentative**]
  - ClassTests and Semester Exams:
    - They will have a combination of Mathematical, Analytical and short coding based problems.
  - Tentative class test dates: I. Aug end/Sept start II. Oct end/Nov start
  - Will be taken outside class timings (evening is most likely)
  - Practice homeworks will be given in moodle. These will **not** be graded.

What are algorithms?



Source: http://redd.it/b5mtc7

Dictionary definition: A procedure for solving a mathematical problem (as of finding the greatest common divisor) in a finite number of steps that frequently involves repetition of an operation.

By Donald E Knuth: An algorithm is a finite, definite, effective procedure, with some input and some output.

By Cormen *et al.*: An algorithm is a sequence of computational steps that transform the input into the output.

Why is the study of algorithms worthwhile?

- Especially, modern computers are pretty fast and memory cost is low
- (If for no other reason) – show that your algorithm produces the right answer always
- Different algorithms for the same problem often differ dramatically in terms of efficiency
- Before showing an example, lets step into the practical world!

Why is the study of algorithms worthwhile?

- typical job interview process, e.g., Google's software developer [Source: Link]

- Round 1: online assessment (~90 Minutes)
  - Two data structures and algorithms questions you have to complete
  - Write your own test cases and must pass all test cases that you cannot see
  - You can use any IDE of your choice
  - The recruiter will not review your resume if you do not pass the OA

- Round 2: Technical phone interview
  - Solve data structure and algorithm questions
  - Write code (usually in txt/cloud doc) and explain the correctness/time complexity
  - Additional behavioral questions that are usually not decisive

Why is the study of algorithms worthwhile?

- typical job interview process, e.g., Google's software developer [Source: Link]

- Round 3: Onsite interviews (May not be applicable in India)
  - Spend a full day at a Google office and do four to six interviews.
  - Topics asked are usually data structure and algorithm and system design
  - You are expected to do extremely well in coding interviews

- Of course algorithms are also important for doing research in all CS areas

Why is the study of algorithms worthwhile?

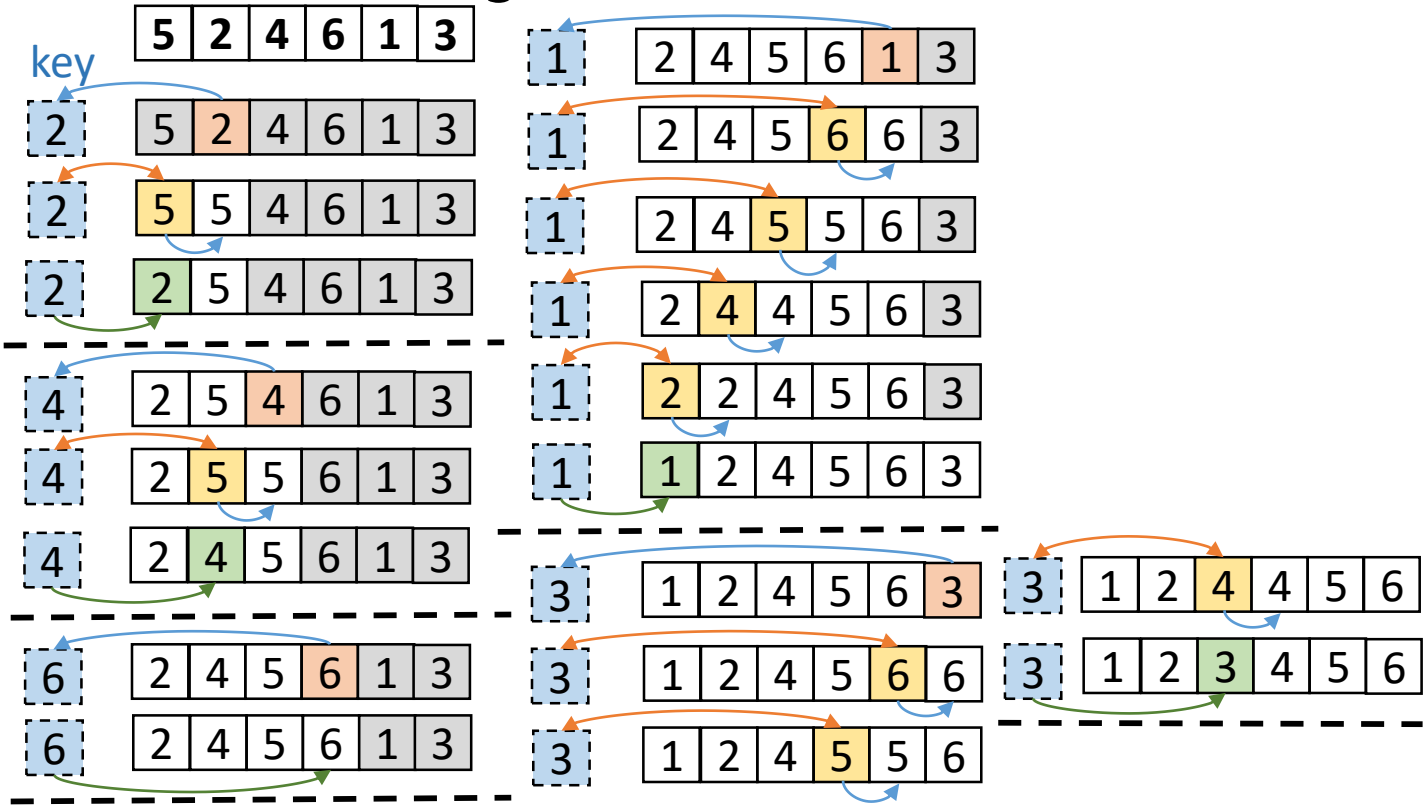
- Lets see an example of variation of efficiency
- Suppose you want to sort n numbers
  - Algorithm 1 takes $c_1 n^2$ units of time
  - Algorithm 2 takes $c_2 n \log n$ units of time
  - c_1 and c_2 are constants and not dependent on n
- Let computer A execute 10 billion operations/second and computer B execute 10 million operations/second
- Let Algorithm 1 is run on computer A while Algorithm 2 is run on computer B
- Let Algorithm 1 is translated into code really beautifully and Algorithm 2 is not.
  - This results in $c_1 = 2$ and $c_2 = 50$

Why is the study of algorithms worthwhile?

- To sort $n = 10$ million numbers, Computer A takes
  $\frac{2 \times (10^7)^2}{10^{10}} s = 2 \times 10^4 \approx 5.55$ hrs

- For the same, Computer B takes
  $\frac{50 \times 10^7 \log 10^7}{10^7} s \approx 1163\, s < 20$ mins

First Algorithm: Insertion Sort



First Pseudocode: Insertion Sort

- Let us write a pseudocode describing this process

- But before that – what is a pseudocode and how is it different from a real code?
  - Pseudocode does not bother much about language specific synatxes
  - Whatever helps to express the idea is used
  - Is not concerned with issues of software engineering

First Pseudocode: Insertion Sort

```
INSERTION-SORT(A)
1  for j = 2 to A.length
2      key = A[j]                    key
3      // Insert A[j] into the sorted sequence A[1 . . j − 1].
4      i = j − 1
5      while i > 0 and A[i] > key
6          A[i + 1] = A[i]
7          i = i − 1
8      A[i + 1] = key
```

Thank You!!