Lesson 1. Intro

What is meant by a problem belongs to the class P, NP, EXP or EXP-Complete? Can you give an example?

What is meant by a problem has a feasible solution? Can you give an example for a problem that has feasible solution? Can you give an example for a problem that has no feasible solution?

Can you "prove" (give logical argument) Algorithm gcd will halt?

Do you think one day someone will be able to write a program to solve nxn Chess in polynomial time?

What is halting Problem? Why that is important in our discussion?

Lesson 2. Intro to Complexity

Can you write a recursive algorithm (not Java Program) for

(a) Binary Search
(b) Linear Search
(c) Merge Sort
(d) Selection Sort
(e) Quicksort
(f) Quickselect

For all those algorithms can you write the recurrence relations? Can you solve it using Master Theorem?

What is the significance of a, b and k in the Master Theorem?

Can you visualize in your mind, binary search as an algorithm which has "width 1 and depth log n?" and thus has the time complexity O(log n)?

Can you visualize in your mind, linear search as an algorithm which has "width n and depth 1?" and thus has the time complexity O(n)?

Can you visualize in your mind, merge sort as an algorithm which has "width n and depth log n?" and thus has the time complexity O(nlog n)?

Can you visualize in your mind, selection sort as an algorithm which has "width n and depth n?" and thus has the time complexity O(n^2)?

Remember Toy Sort? What is its complexity? How O(nlog k) is in agreement with Quicksort's time complexity?

Remember to visualize the "area" covered by the algorithm. Now you know why Quickselect is Θ(n)

Lesson 3. Probability

You have thrown two dices. Let X be the value of the "first dice" and Y be the value of second dice.

(a) What is the expected value of X?

(b) What is the expected value of X+Y?
(c) What is the expected value of 3X + 4Y?
(d) Is E(aX + bY) = aE(X) + bE(Y)?

What is meant by two events are independent?

I have thrown a dice 5 times and I already saw faces 1, 2, 3, 4 and 5 exactly once. What is the probability that I will see face 6 in my sixth throw?

Remember the for formula $\frac{1}{p}$ and two more! Now how to prove all three of them.

Lesson 4: Average case analysis and Amortized cost analysis

What is inversion?

If there are n elements, what is the maximum number of inversions possible? Answer: n(n-1)/2. Can you prove?

What is the average number of inversions possible? Answer: n(n-1)/4. Can you prove?

What is the average time complexity of any inversion bound algorithm? Why?

What is a lower bound?

What is the lower bound of search (an unsorted array)?

What is the lower bound of inversion bound sorting algorithms?

Can you name three inversion bound sorting algorithms and their best, average and worst case time complexities?

What is the worst case time complexity of any inversion bound algorithm? Why?

What is the "best case" for insertion sort? What is the best case time complexity of insertion sort?

What is amortized cost analysis? When is it useful? Can give illustrate the idea using a simple example?

Review both examples in the class notes.

What is the lower bound on comparison based sort algorithms?

What is the logic?

There are n! permutations. Thus there are n! leaves in the decision tree. Hence its height has to be log n!. Now log n! is Ω(n logn).

List two algorithms that are comparison based.

Lesson 5

Can you show merge sort is not inversion bound?

What is meant by a sorting algorithm is stable?

Is Merge Sort stable (as in our class notes)?

If not, what minor modification you can suggest so that the modified Merge sort is stable.

The recurrence relation and solution we already covered in Lesson 2.

Math Review

Arithmetic Series: Sum and its proof., nth term.

Geometric Series: Sum (finite and infinite) and its proof. nth term.

Mathematical Induction

Lessons after weekend

Radix sort

Data structures : Arrays, Lists, Stacks and Queues.

Binary search trees and BST: Traversals, search, insert, delete