1. **SOME RECURRENCES:**

   (a) \( t(0) = t(1) = 2 \)

   \[ t(n) = t\left(\left\lfloor \frac{n}{2} \right\rfloor \right) + 2n + 2 \]

   (b) \( t(0) = 2 \)

   \[ t(1) = 3 \]

   \[ t(n) = 5 + t\left(\left\lfloor \frac{n}{2} \right\rfloor \right) \]

   (c) \( t(n) = \begin{cases} 
   2^n & \text{if } n < 2112014 \\
   t\left(\left\lfloor \frac{n}{2} \right\rfloor \right) + 3 & \text{if } n \geq 2112014 
   \end{cases} \)

2. **COUNTING INVERSIONS:** Let \( A \) be an array of \( n \) distinct numbers. An \textit{inversion} in \( A \) is a pair of indices \( i < j \) such that \( A[j] < A[i] \); in English, it is a pair of elements out of increasing order.

   Describe an algorithm that computes the number of inversions in \( A \) in \( O(n \log n) \) time.

3. Given a sorted array \( A[1, \ldots, n] \) of distinct integers, you want to find out whether there is an index \( i \) for which \( A[i] = i \). Give an algorithm that runs in time \( O(\log n) \).

   [Hint: divide thy enemy, and then conquer thy enemy.]

4. Let \( A, B \) be two sorted arrays each of size \( n \). Give an \( O(\log n) \) algorithm to find the median element in the union of the two lists.

   [Hint: Suppose \( n \) is a power of 2 and try to find the \( n \)th element.]

5. Suppose we are given a set \( S \) of \( n \) points in the plane. For two points \( (u, v) \) and \( (x, y) \), we say that \( (x, y) \) dominates \( (u, v) \) if \( x \geq u \) and \( y \geq v \). A point \( p \) in \( S \) is \textit{maximal} if there is no other point \( q \in S \) dominating \( p \).

   Describe an algorithm (the faster, the better) that computes the set of maximal points in \( S \). For simplicity, you may assume that no two points in \( S \) have the same \( x \) or \( y \)-coordinate.

6. Suppose you are given the following tree traversals of a binary tree. Describe an algorithm that reconstructs a tree matching the traversals.
(a) **In-order** (For example: b d e f a c)
  **Pre-order** (For example: e d b a f c)

(b) **In-order** (For example: b d e f a c)
   **Post-order** (For example: b d f c a e)

(c) **Pre-order** (For example: e d b a f c)
   **Post-order** (For example: b d f c a e)