

1. Show how to multiply two degree- $n$  single-variable polynomials of  $x$  in  $O(n^\alpha)$  time for some  $\alpha < 2$ .
2. Given two sorted lists of numbers of length  $m, n$ . Give an algorithm that finds the  $k$ 'th smallest number in the union of the lists, in time  $O(\log m + \log n)$   
(You can assume that all numbers in the input are distinct).
3. Given a sequence of distinct integer  $x_1, x_2, \dots, x_n$ . Give an algorithm that computes the number of inversions in  $O(n \log n)$  time.  
(We call  $(i, j)$  is an inversion if  $i < j$  and  $x_i > x_j$ .)
4. **Extra Credit:** Solve the closest pairs problem in 3 dimensions in  $O(n \log^2 n)$  time.