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Solutions to Introduction to Algorithms by Charles E. Leiserson, Clifford Stein, Ronald Rivest, and Thomas H. Cormen (CLRS). Contributor If I miss your name here, please pull a request to me to fix. You maybe interested in another repo gitstats which generates repo contribution of CLRS. This repo needs your help. If you are interested in this project, you could complete problems which are marked "UNSOLVED" in the following list. Or if you are interested in certain chapters that have not been completed, you could fork this project and issue a pull request to this repo. Appreciate your efforts. 如果你感兴趣,可以完成没有完成的题(下面有个UNSOLVED列表),或者如果你对某章节感兴趣想要完成,可以fork这个项目然后pull request进这个repo。 In order to speed up this project, we will ignore any hard problems (for instance, problems in the very end of each chapter) and review them when finishing mediocre problems. Moreover, we will only focus on sections that are interesting. You could also help to finish these hard problems. If a problem is too easy to solve, we'll mark it as straightforward in order to speed up the progress. Chapter Section Part I: Foundations I 1 2 p II 1 2 3 p III 1 2 p IV 1 2 3 4 p V 1 2 3 4 p Part II: Sorting and Order Statistics VI 1 2 3 4 5 p VII 1 2 3 4 p VIII 1 2 3 4 p IX 1 2 3 p Part III: Data Structures X 1 2 3 4 p XI 1 2 3 4 5 p XII 1 2 3 XIII 1 2 3 4 p XIV 1 2 3 p Part IV: Advanced Design and Analysis Techniques XV 1 2 3 4 5 XVI 1 2 3 XVII 1 2 Part V: Advanced Data Structures XVIII 1 2 3 XIX 1 2 XXI 1 2 3 Part VI: Graph Algorithms XXII 1 2 3 4 5 p XXIII 1 2 XXIV 1 2 3 4 XXV 1 2 3 XXVI 1 2 3 Part VII: Selected Topics XXXI 1 2 XXXII 1 2 3 4 XXXIII 1 XXXV 1 Data Structure&algorithm implementation BASIC DIVIDE and CONQUER TREE/ADVANCED BST RBT Btree BinomialHeap Driver SegmentTree Trie UnionFind DYNAMIC/GREEDY GRAPH GEOMETRY LineIntersection Convex Hull STRING UTILITY Split string by delimiter in C++ 31.1.11 31.2.7 31.2.9 32.2.4 32.3.4 32.4.6 Follow @louis1992 on github to help finish this task. You can also subscribe my youtube channel. Disclaimer: the solutions in this repository are crowdsourced work, and in any form it neither represents any opinion of nor affiliates to the authors of Introduction to Algorithms or the MIT press. Page 2 Using Figure 2.4 as a model, illustrate the operation of merge sort on the array A = [3, 41, 52, 26, 38, 57, 9, 49]. Answer Exercises 2.3-2 Rewrite the MERGE procedure so that it does not use sentinels, instead stopping once either array L or R has had all its elements copied back to A and then copying the remainder of the other array back into A. Answer code Exercises 2.3-3 Use mathematical induction to show that when n is an exact power of 2, the solution of the recurrence is 1.定义 2.当k = 1时，3.假设 4. Answer code Exercises 2.3-4 Insertion sort can be expressed as a recursive procedure as follows. In order to sort A[1..n], we recursively sort A[1..n -1] and then insert A[n] into the sorted array A[1..n - 1]. Write a recurrence for the running time of this recursive version of insertion sort. Answer Exercises 2.3-5 Referring back to the searching problem (see Exercise 2.1-3), observe that if the sequence A is sorted, we can check the midpoint of the sequence against v and eliminate half of the sequence from further consideration. Binary search is an algorithm that repeats this procedure, halving the size of the remaining portion of the sequence each time. Write pseudocode, either iterative or recursive, for binary search. Argue that the worst-case running time of binary search is Θ(lg n). Answer python code Exercises 2.3-6 Observe that the while loop of lines 5 - 7 of the INSERTION-SORT procedure in Section 2.1 uses a linear search to scan (backward) through the sorted subarray A[1..j - 1]. Can we use a binary search (see Exercise 2.3-5) instead to improve the overall worst-case running time of insertion sort to Θ(n lg n)? Answer 不可以，查找可以达到对数级的，但是依然要移动元素，依然是线性的. Although we can reduce the number of comparisons by using binary search, we still need to shift all the elements greater than key towards the end of the array to insert key. And this shifting of elements runs at Θ(n) time, even in average case (as we need to shift half of the elements). So, the overall worst-case running time of insertion sort will still be Θ(n^2). Pseudo-code: A = [1 .. n]; selectionSort(A){ for (i = 2) to (i = n) // find the correct position of A[i] in array A[1 .. i-1] pos = binarySearch(1,i-1,A[i]); // shifting of elements to place A[i] in its correct position pos for (j = i-1) to (j = pos) temp = A[j+1]; A[j+1] = A[j]; A[j] = temp; endfor endfor } binarySearch(low,high,v) mid = (low + high) / 2; // we are not looking for the value v explicitly, but for its correct position if (v >= A[mid] && v < A[mid+1]) return mid else if (v < A[mid]) return binarySearch(low,mid,v) else return binarySearch(mid,high,v) endif endif python code Exercises 2.3-7 Describe a Θ(n lg n)-time algorithm that, given a set S of n integers and another integer x, determines whether or not there exist two elements in S whose sum is exactly x. 先用mergesort进行排序，然后两根指针分别在集合的头和尾，往中间扫描~ 这个题目可以利用哈希表(散列表)达到O(n),my code Follow @louis1992 on github to help finish this task. Welcome to my page of solutions to "Introduction to Algorithms" by Cormen, Leiserson, Rivest, and Stein. It was typeset using the LaTeX language, with most diagrams done using Tikz. It is nearly complete (and over 500 pages total!!), there were a few problems that proved some combination of more difficult and less interesting on the initial pass, so they are not yet completed. The problems missing in each chapter are noted next to each link. I'd like to thank by wonderful coauthor Michelle Bodnar for doing the problems and exercises that end in even numbers. Some of the problems may require editing and further clarification. For the time being we would greatly appreciate if you could report any issue with the solutions to us. (ajl213 at math dot rutgers dot edu) for odd numbered problems/exercise, and (chellebodnar at gmail dot com) for even numbered problems/exercises. The solutions are all grouped by chapter. Once the remaining 5 problems are finished, I'll be preparing a combined pdf with all the solutions A crowdsourced work contributed from nice people all around the world. Getting Started This website contains nearly complete solutions to the bible textbook - Introduction to Algorithms Third Edition, published by Thomas H. Cormen, Charles E. Leiserson, Ronald L. Rivest, and Clifford Stein. I hope to organize solutions to help people and myself study algorithms. By using Markdown (.md) files and KaTeX math library, this page is much more readable on portable devices. "Many a little makes a mickle." Contributors Thanks to the authors of CLRS Solutions, Michelle Bodnar (who writes the even-numbered problems) and Andrew Lohr (who writes the odd-numbered problems), @skanev, @CyberZHG, @yinyanghu, @Gutdub, etc. Thanks to all contributors on GitHub, you guys make this repository a better reference! Special thanks to @JeffreyCA, who fixed math rendering on iOS Safari in #26. 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