

Lecture 24

CSE 331

Oct 28, 2022

Coding P1 due TODAY!

Fri, Oct 28	Counting Inversions  ^{F21}  ^{F19}  ^{F18}  ^{F17} x^2	[KT, Sec 5.3] (Project (Problem 1 Coding) in)
Mon, Oct 31	Multiplying large Integers  ^{F21}  ^{F19}  ^{F18}  ^{F17} x^2	[KT, Sec 5.5] (Project (Problem 1 Reflection) in) <i>Reading Assignment: Unraveling the mystery behind the identity</i>
Wed, Nov 2	Closest Pair of Points  ^{F21}  ^{F19}  ^{F18}  ^{F17} x^2	[KT, Sec 5.4]
Fri, Nov 4	Kickass Property Lemma  ^{F21}  ^{F19}  ^{F18}  ^{F17} x^2	[KT, Sec 5.4] (Project (Problem 2 Coding) in)
Mon, Nov 7	Weighted Interval Scheduling  ^{F21}  ^{F19}  ^{F17} x^2	[KT, Sec 6.1] (Project (Problem 2 Reflection) in)

Group formation instructions

Autolab group submission for CSE 331 Project

The lowdown on submitting your [project](#) (especially the [coding](#) and [reflection](#)) problems as a group on Autolab.

Follow instructions **EXACTLY** as they are stated

The instructions below are for Coding Problem 1




You will have to repeat the instructions below for EACH coding AND reflection problem on project on Autolab (with the appropriate changes to the actual problem).

Form your group on Autolab

Groups on Autolab will NOT be automatically created

You will have to form a group on Autolab by yourself (as a group). Read on for instructions on how to go about this.

Make sure you are in your group

note #386   

stop following **2 views** [Actions](#)

Coding P1 due today


A gentle reminder that the [first coding problem](#) is due by 11:58pm tonight!

Finally, make sure that you are officially included in your group on Autolab for the coding problem 1 before your group submits its code. If you are not included in the group on Autolab, you will get a ZERO on coding problem 1.

Please make sure that you verify that you see a submission for yourself on Autolab. It is your **PERSONAL RESPONSIBILITY** to make sure that this is the case. If your group forgets to do this is it your responsibility to remind them that you need to be included.

If your group has already submitted without you, make sure you are included in the group on Autolab and then someone from your group should re-submit.

[project](#)

[Edit](#) good note 

Updated 2 minutes ago by Art Rude

Questions/Comments?



Rankings



How close are two rankings?

Google [Advanced Search](#)

Web [Show options...](#) Results 1 - 10 of about 23,700,000 for **compare rankings**. (0.30 seconds)

Comparison Reviews Sponsored Link
[Anglesist.com](#) Your neighbors' ratings on local service companies. Award-winning.

Ranking - Wikipedia, the free encyclopedia
In competition **ranking**, items that **compare** equal receive the same **ranking** number, and then a gap is left in the **ranking** numbers. The number of **ranking** ...
[en.wikipedia.org/wiki/Ranking](#) - [Cached](#) - [Similar](#) - [Print](#)

A Comparison of Ranking Methods for Classification Algorithm Selection
is based on Spearman's rank correlation coefficient. To **compare ranking** methods, a combination of Friedman's test and Dunn's multiple com- ...
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College Football Ranking Comparison
College Football Ranking Comparison. Sunday, November 8, 2009 (127 Rankings) | Last Week | Archived | FBS | FCS | Summary | CSV Data | ...
[www.masseyratings.com/cfbcompare.htm](#) - [Cached](#) - [Print](#)

College Basketball Ranking Comparison
Monday, April 6, 2009 (36 Rankings) Cor 923 810 923 896 819 868 888 777 839 899 860
243 246 245 248 241 251 247 249 248 264 Ranking Violation % 254 ...
[www.masseyratings.com/cbbcompare.htm](#) - [Cached](#) - [Print](#)

FIFA.com - Compare Teams
With FIFA.com you can **compare** the progress of up to four teams in the FIFA/Coca-Cola World **Ranking**. See how teams have risen and fallen since August 1993 ...
[www.fifa.com/worldfootball/ranking/compare/compareteams.html](#) - [Cached](#) - [Similar](#) - [Print](#)

GetEducated.com | Rate, Rank & Compare Online Colleges & Degrees
GetEducated.com's directory of online degrees provides **rankings**, ratings, and comparison tools to help you choose the best online degrees from the best ...
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Compare your website rankings in Google Caffeine « Advanced Web ...
Aug 18, 2009 ... To help you **compare** your website **rankings** from Google with the **rankings** from Google Caffeine we have created a quick step-by-step tutorial.

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FIFA.com - Compare Teams
With FIFA.com you can **compare** the progress of up to four teams in the FIFA/Coca-Cola World **Ranking**. See how teams have risen and fallen since August 1993 and pinpoint their ...
[www.fifa.com/worldfootball/ranking/compare/compareteams.html](#) - [Cached page](#)

How to Compare Graduate School Rankings | eHow.com
Choosing a graduate school can be a stressful and confusing process for any student. By comparing graduate schools and their **rankings** a student can choose which one fits her ...
By eHow Education Editor · Difficulty: Moderate · 0 posts
[www.ehow.com/how_2051516_compare-graduate-school-rankings.html](#) - [Cached page](#)

Ranking - Wikipedia, the free encyclopedia
Items that **compare** equal receive the same **ranking** number, which is the mean of what they would have under ordinal **rankings**. Equivalently, the **ranking** number of 1 plus the number of ...
[en.wikipedia.org/wiki/Ranking](#) - [Enhanced view](#)

Ranking Compare
Ask Google Yahoo Search | Web browser tool - Shows search results for a given keyword or phrase on the top three engines, Google, Yahoo and MSN.
[tools.essential-seo.com/ranking-compare](#) - [Cached page](#)

SchoolDigger.com - School Rankings, Reviews and More - Public and ...
Find the best elementary, middle, and high schools. Search for schools near any address, **compare** test scores, sort by school **ranking**, class sizes, and more using SchoolDigger.
[www.schooldigger.com](#) - [Cached page](#)

College and university rankings - Wikipedia, the free encyclopedia
The College and university **rankings** are a lists of universities and liberal arts colleges in higher education, an order determined by any combination of factors.
International ... · Regional and national ... · Criticism (North America)
[en.wikipedia.org/wiki/College_and_university_rankings](#) - [Enhanced view](#)

www.hospitalcompare.hhs.gov
[www.hospitalcompare.hhs.gov/Hospital/Search/SearchCriteria.asp?version=default&browser=IE...](#)

Rest of today's agenda

Formal problem: Counting inversions

Divide and Conquer algorithm

Problem definition on the board...




Solve a harder problem

Input: a_1, \dots, a_n

Output: LIST of all inversions

```
L =  $\phi$ 
for i in 1 to n-1
  for j in i+1 to n
    if  $a_i > a_j$ 
      add (i,j) to L
return L
```



Optimal for
the listing
problem

Example 1: All inversions-- $(2i-1, 2i)$

2	1	3	4	6	5	7	8
---	---	---	---	---	---	---	---

Only check $(i, i+1)$ pairs

Q1: Solve listing problem in $O(n)$ time?

Q2: Recursive divide and conquer algorithm to count the number of inversions?

CountInv (a, n)

if $n = 1$ return 0

if $n = 2$ return $a_1 > a_2$

$a_L = a_1, \dots, a_{\lfloor n/2 \rfloor}$

$a_R = a_{\lfloor n/2 \rfloor + 1}, \dots, a_n$

return CountInv($a_L, \lfloor n/2 \rfloor$) + CountInv($a_R, n - \lfloor n/2 \rfloor$)

Can be horribly wrong in general

CountInv (a,n)

if $n = 1$ return 0

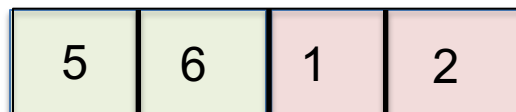
if $n = 2$ return $a_1 > a_2$

$a_L = a_1, \dots, a_{\lfloor n/2 \rfloor}$

$a_R = a_{\lfloor n/2 \rfloor + 1}, \dots, a_n$

return CountInv($a_L, \lfloor n/2 \rfloor$) + CountInv($a_R, n - \lfloor n/2 \rfloor$)

Example where instance has non-zero (can be $\Omega(n^2)$) inversions and algo returns 0?



All 4 "crossing" pairs are inversions

Bad case: “crossing inversions”

CountInv (a,n)

if $n = 1$ return 0

if $n = 2$ return $a_1 > a_2$

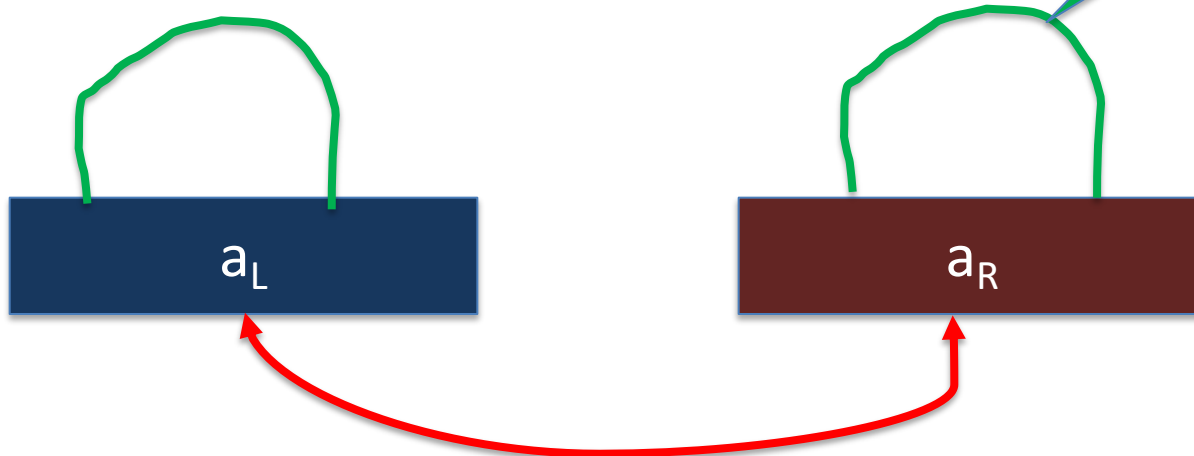
$a_L = a_1, \dots, a_{\lfloor n/2 \rfloor}$

$a_R = a_{\lfloor n/2 \rfloor + 1}, \dots, a_n$

return CountInv(a_L , $\lfloor n/2 \rfloor$) + CountInv(a_R , $n - \lfloor n/2 \rfloor$)

Yes!

Are a_L
and a_R
sorted?



Example 2: Solving the bad case



a_L



a_R

a_L is sorted

First element in a_L is larger than first/only element in a_R

$O(1)$ algorithm to count number of inversions?

return size of a_L

Example 3: Solving the bad case

1

a_L

5 | 6 |

a_R

a_R is sorted

First/only element is a_L is smaller than first element in a_R

$O(1)$ algorithm to count number of inversions?

return 0

Solving the bad case

First element of a_L is larger than first element of a_R



a_L



a_R

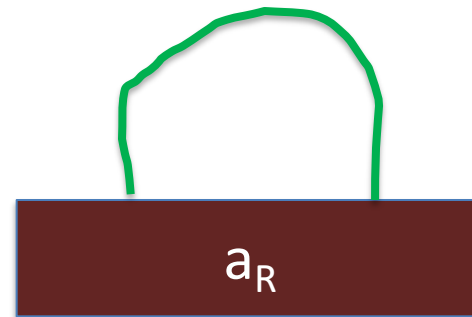
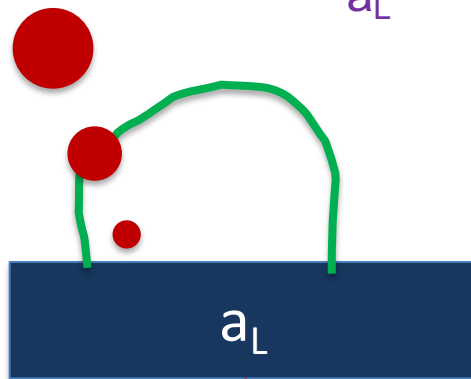
First element of a_L is smaller than first element of a_R



a_L



a_R



Try to
modify
the
MERGE
algorithm

Divide and Conquer

Divide up the problem into at least two sub-problems

Solve all sub-problems: Mergesort

Recursively solve the sub-problems

Solve stronger sub-problems: Inversions

“Patch up” the solutions to the sub-problems for the final solution

MergeSortCount algorithm

Input: a_1, a_2, \dots, a_n

Output: Numbers in sorted order+ #inversion

MergeSortCount(a, n)

If $n = 1$ return (0 , a_1)

If $n = 2$ return ($a_1 > a_2$, $\min(a_1, a_2)$; $\max(a_1, a_2)$)

$a_L = a_1, \dots, a_{n/2}$ $a_R = a_{n/2+1}, \dots, a_n$

(c_L, a_L) = MergeSortCount($a_L, n/2$)

(c_R, a_R) = MergeSortCount($a_R, n/2$)

(c, a) = MERGE-COUNT(a_L, a_R)

return ($c+c_L+c_R, a$)

$$T(2) = c$$

$$T(n) = 2T(n/2) + cn$$

$O(n \log n)$ time

$O(n)$

Counts #crossing-inversions+
MERGE

MERGE-COUNT(a_L, a_R)

$a_L = l_1, \dots, l_{n'}$

$a_R = r_1, \dots, r_m$

```
c = 0
```

```
i, j = 1
```

```
while i ≤ n' and j ≤ m
```

```
    if  $l_i \leq r_j$ 
```

```
        add  $l_i$  to output
```

```
        i ++
```

```
    else
```

```
        add  $r_j$  to output
```

```
        j ++
```

```
        c += n' - i + 1
```

```
Output any remaining items
```

```
return c
```



a_L



a_R



a_L



a_R