Lecture 26

CSE 331

Nov 3, 2023

Coding Project 1+2 due today

Tue, Oct 31		(**HW 5 in**)
Wed, Nov 1	Multiplying large integers F22 F21 F19 F18 F17 x^2	[KT, Sec 5.5] *Reading Assignment:* Unraveling the mystery behind the identity
Fri, Nov 3	Closest Pair of Points F22 F21 F19 F18 F17 x^2	[KT, Sec 5.4] (**Project (Problems 1 & 2** `Coding` **) in**)
Mon, Nov 6	Kickass Property Lemma F22 F21 F19 F18 F17 x^2	[KT, Sec 5.4] (**Project (Problems 1 & 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 instruction 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.

Click to add notes

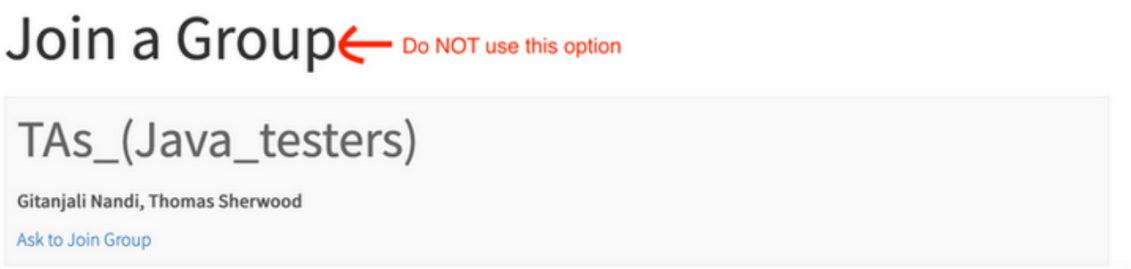
Do not use Join a Group “feature”

note @331 stop following 143 views

Actions

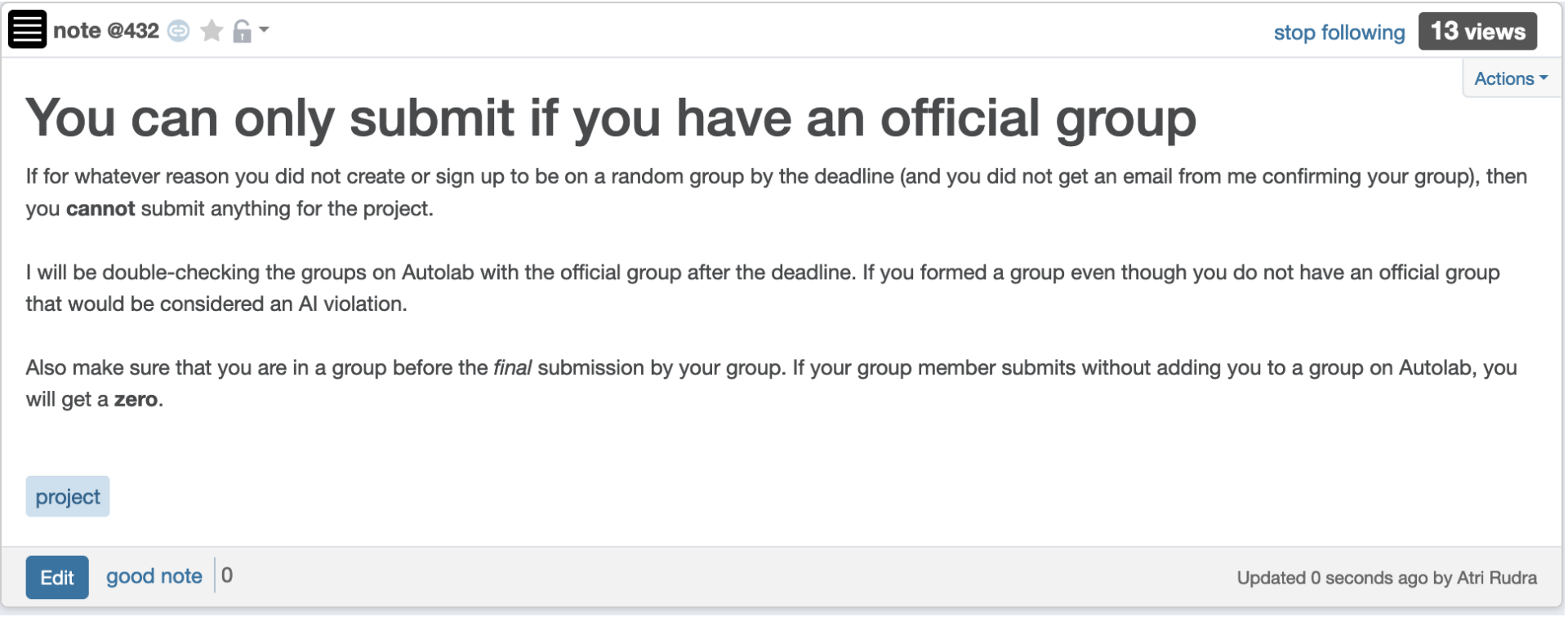
When forming groups on Autolab

I forgot to add this warning earlier but I have updated the Autolab project page to add a warning to **not click on the "Join a Group" function when you are creating your group on Autolab:**

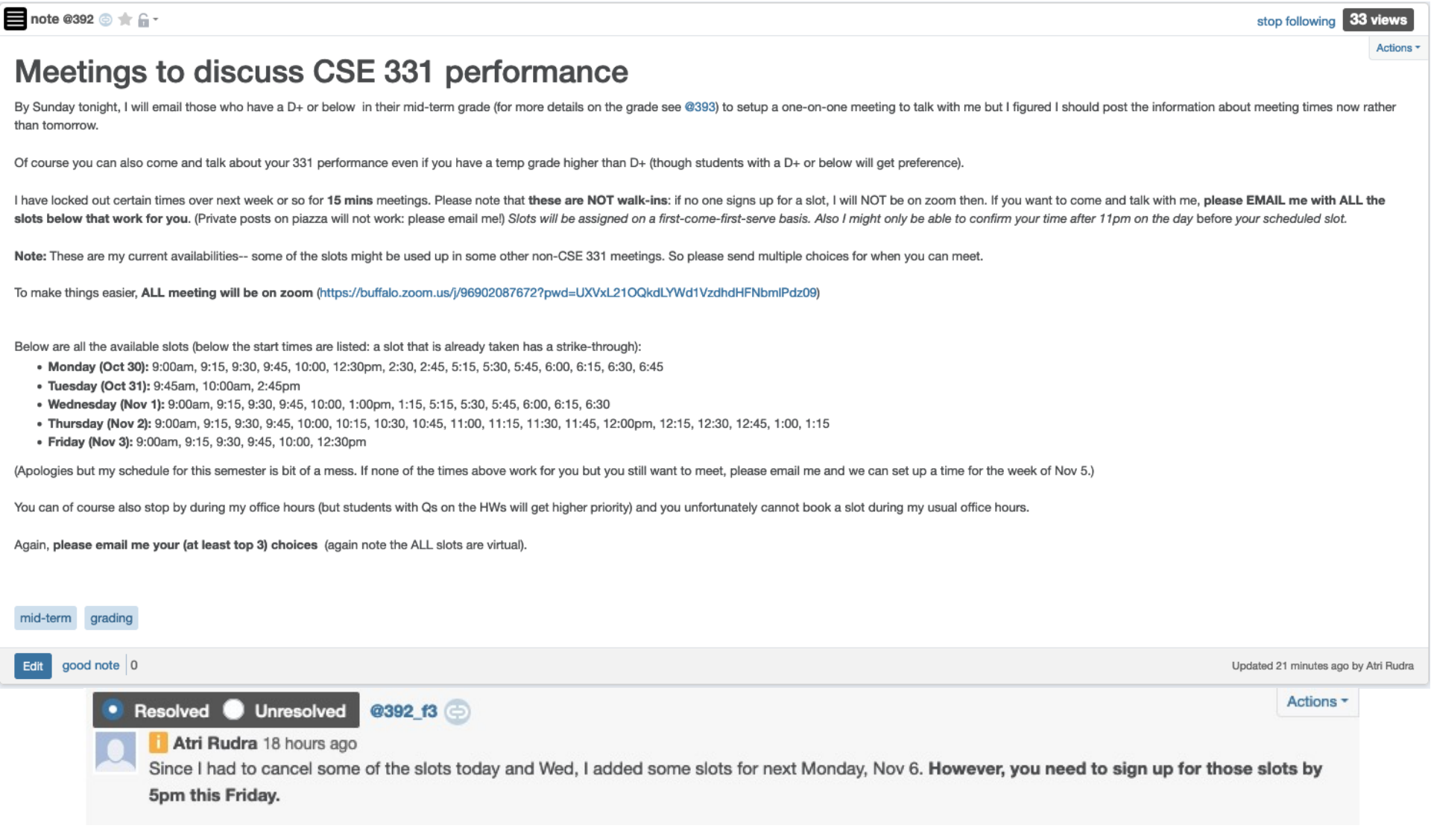
> **Do NOT click on `Join a Group`**
>
> **Do NOT use the "Join a Group" feature. ONLY follow the instructions above EXACTLY.**
>
> This step can be un-done but needs intervention on our part BUT that'll cause delays on your side and we are not responsible if you miss your deadline due to this delay.
>
> Here is what such an option looks like (the actual group name and group members would be different in your case:
>
> 
>

project autolab

No project group => no submission



1-on-1 meeting slots



note @392

stop following 33 views

Actions

Meetings to discuss CSE 331 performance

By Sunday tonight, I will email those who have a D+ or below in their mid-term grade (for more details on the grade see @393) to setup a one-on-one meeting to talk with me but I figured I should post the information about meeting times now rather than tomorrow.

Of course you can also come and talk about your 331 performance even if you have a temp grade higher than D+ (though students with a D+ or below will get preference).

I have locked out certain times over next week or so for **15 mins** meetings. Please note that **these are NOT walk-ins**: if no one signs up for a slot, I will NOT be on zoom then. If you want to come and talk with me, **please EMAIL me with ALL the slots below that work for you.** (Private posts on piazza will not work: please email me!) *Slots will be assigned on a first-come-first-serve basis. Also I might only be able to confirm your time after 11pm on the day* before *your scheduled slot.*

Note: These are my current availabilities-- some of the slots might be used up in some other non-CSE 331 meetings. So please send multiple choices for when you can meet.

To make things easier, **ALL meeting will be on zoom** (https://buffalo.zoom.us/j/96902087672?pwd=UXVxL21OQkdLYWd1VzdhdHFNbmlPdz09)

Below are all the available slots (below the start times are listed: a slot that is already taken has a strike-through):

- **Monday (Oct 30):** 9:00am, 9:15, 9:30, 9:45, 10:00, 12:30pm, 2:30, 2:45, 5:15, 5:30, 5:45, 6:00, 6:15, 6:30, 6:45
- **Tuesday (Oct 31):** 9:45am, 10:00am, 2:45pm
- **Wednesday (Nov 1):** 9:00am, 9:15, 9:30, 9:45, 10:00, 1:00pm, 1:15, 5:15, 5:30, 5:45, 6:00, 6:15, 6:30
- **Thursday (Nov 2):** 9:00am, 9:15, 9:30, 9:45, 10:00, 10:15, 10:30, 10:45, 11:00, 11:15, 11:30, 11:45, 12:00pm, 12:15, 12:30, 12:45, 1:00, 1:15
- **Friday (Nov 3):** 9:00am, 9:15, 9:30, 9:45, 10:00, 12:30pm

(Apologies but my schedule for this semester is bit of a mess. If none of the times above work for you but you still want to meet, please email me and we can set up a time for the week of Nov 5.)

You can of course also stop by during my office hours (but students with Qs on the HWs will get higher priority) and you unfortunately cannot book a slot during my usual office hours.

Again, **please email me your (at least top 3) choices** (again note the ALL slots are virtual).

mid-term grading

Edit good note 0

Updated 21 minutes ago by Atri Rudra

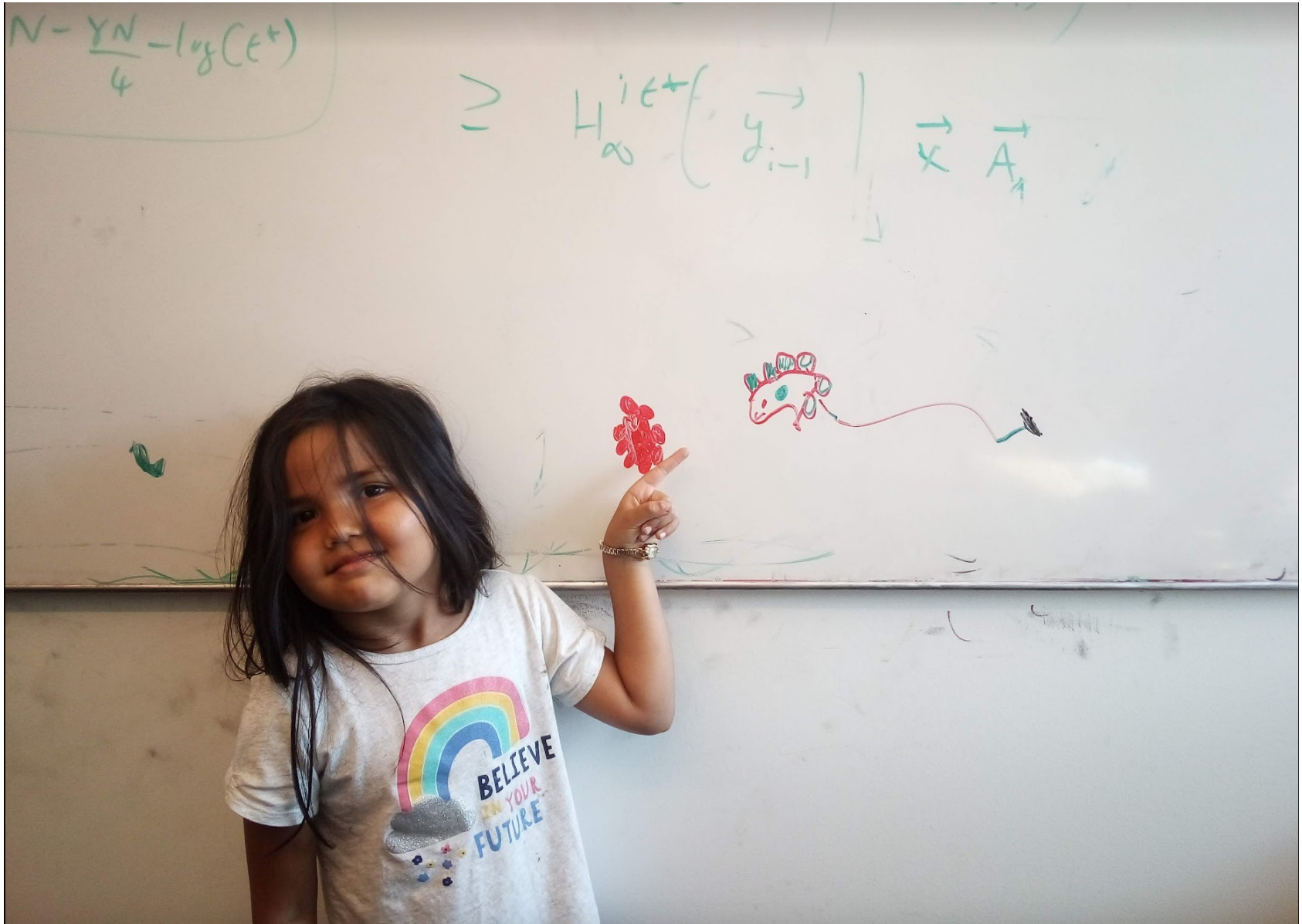
Resolved Unresolved @392_f3

Actions

Atri Rudra 18 hours ago

Since I had to cancel some of the slots today and Wed, I added some slots for next Monday, Nov 6. **However, you need to sign up for those slots by 5pm this Friday.**

Questions/Comments?



Divide and Conquer

Divide up the problem into at least two sub-problems

Recursively solve the sub-problems

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

Improvements on a smaller scale

Greedy algorithms: exponential → poly time

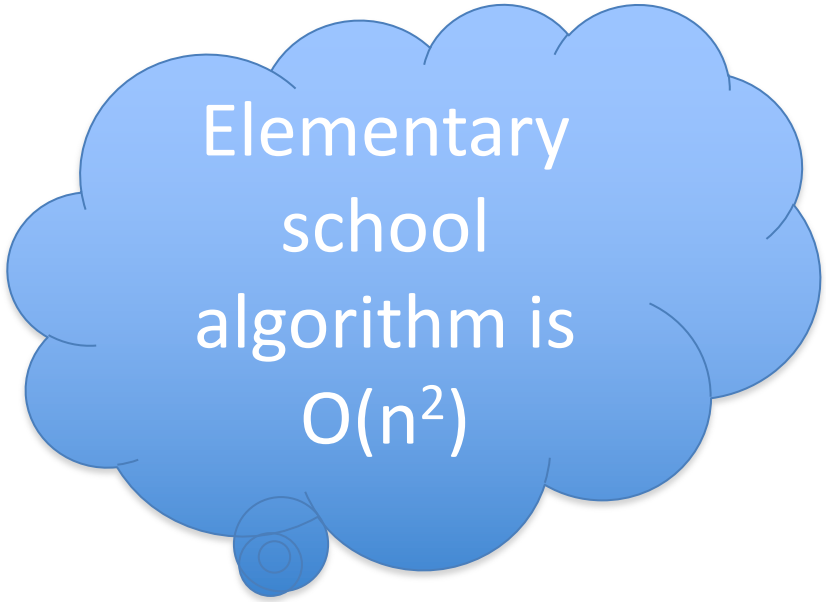
(Typical) Divide and Conquer: $O(n^2)$ → asymptotically smaller running time

Multiplying two numbers

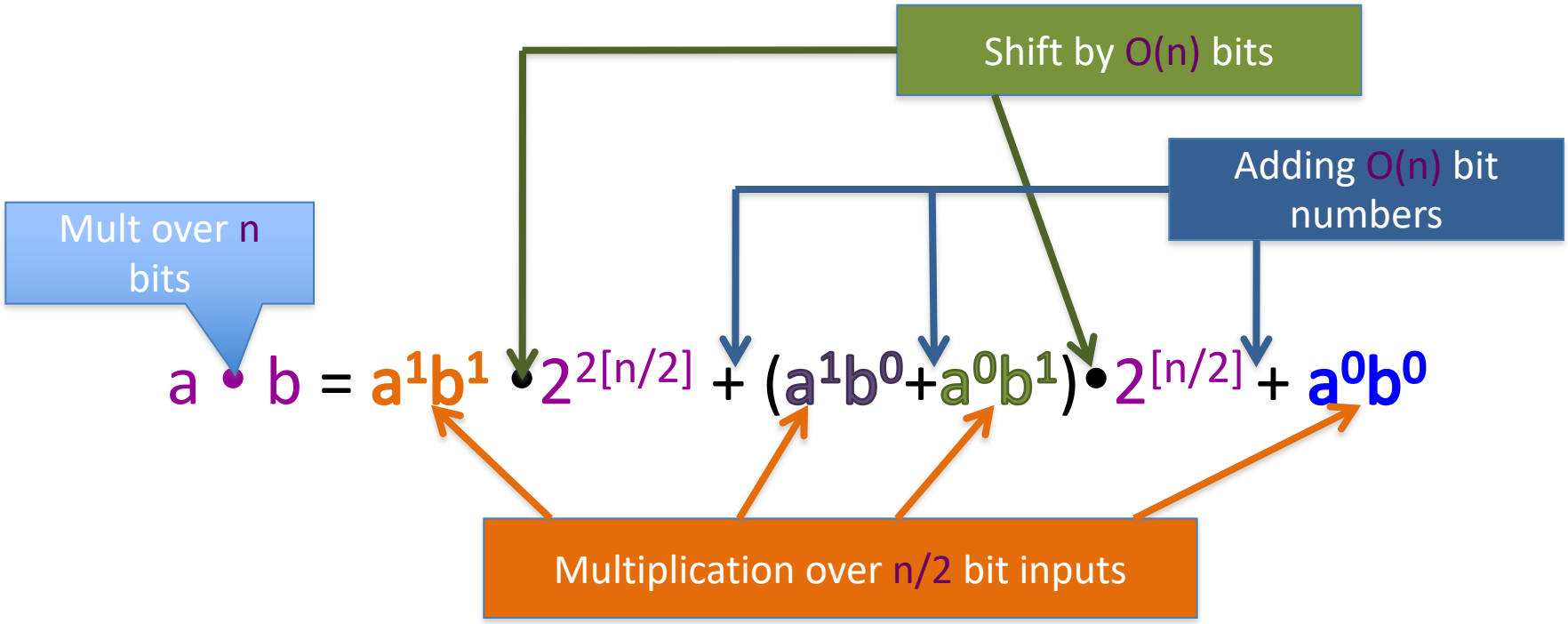
Given two numbers a and b in binary

$a=(a_{n-1},..,a_0)$ and $b = (b_{n-1},\ldots,b_0)$

Compute c = a x b



The current algorithm scheme



$T(n) \le 4T(n/2) + cn$

$T(1) \le c$

$T(n)$ is $O(n^2)$

The key identity

$$a^1b^0+a^0b^1 = (a^1+a^0)(b^1+b^0) - a^1b^1 - a^0b^0$$

Wait, how do you think of that?

De-Mystifying the Integer Multiplication Algorithm

In class, we saw an $O\left(n^{\log_2 3}\right)$ time algorithm to multiply two n bit numbers that used an identity that seemed to be plucked out of thin air. In this note, we will try and de-mystify how one might come about thinking of this identity in the first place.

The setup

We first recall the problem that we are trying to solve:

> **Multiplying Integers**
> Given two n bit numbers $a = (a_{n-1}, \ldots, a_0)$ and $b = (b_{n-1}, \ldots, b_0)$, output their product $c = a \times b$.

Next, recall the following notation that we used:

$$a^0 = \left(a_{\lceil \frac{n}{2} \rceil - 1}, \ldots, a_0\right),$$

$$a^1 = \left(a_{n-1}, \ldots, a_{\lceil \frac{n}{2} \rceil}\right),$$

The final algorithm

Input: $a = (a_{n-1},..,a_0)$ and $b = (b_{n-1},\ldots,b_0)$

Mult (a, b)

If $n = 1$ return $a_0 b_0$

$a^1 = a_{n-1},\ldots,a_{[n/2]}$ and $a^0 = a_{[n/2]-1},\ldots, a_0$

Compute b^1 and b^0 from b

$x = a^1 + a^0$ and $y = b^1 + b^0$

Let p = Mult (x, y), D = Mult (a^1, b^1), E = Mult (a^0, b^0)

$F = p - D - E$

return $D \bullet 2^{2[n/2]} + F \bullet 2^{[n/2]} + E$

$T(1) \le c$

$T(n) \le 3T(n/2) + cn$

$O(n^{\log_2 3}) = O(n^{1.59})$ run time

All **green** operations are $O(n)$ time

$$a \bullet b = a^1 b^1 \bullet 2^{2[n/2]} + ((a^1+a^0)(b^1+b^0) - a^1 b^1 - a^0 b^0) \bullet 2^{[n/2]} + a^0 b^0$$