# Lecture 28

CSE 331

Nov 6, 2017

# Mini project video due next Mon

note

stop following 112 views

## Video submission now open on Autolab

Sorry, forgot to do this earlier: you can now submit your video (note still PDF with the link in it) on Autolab.

**YOU WILL NEED TO FORM YOUR GROUP ON AUTOLAB AGAIN BEFORE SUBMITTING.**

See the mini project page for the details:

http://www-student.cse.buffalo.edu/~atri/cse331/fall17/mini-project/index.html

#pin

mini_project

edit · good note | 0

Updated 3 days ago by Atri Rudra

# Anonymous feedback

note | stop following | 159 views

## 331 Feedback

If you have the time, please do fill in this feedback form:

https://docs.google.com/forms/d/e/1FAIpQLSeZldd6oBwjXeH3YBR6f6cxCVgOph1ialwtj47LGBLT-aSpOw/viewform?usp=sf_link

Filling in the form is optional and is anonymous. But your feedback would be very helpful. If you have limited time, I would encourage you to at least fill in the questions on the initiatives that are new to this Fall.

In a few weeks I will summarize some of the feedback and try and respond to the common comments/questions.
#pin

feedback

edit · good note | 0 Updated 4 days ago by Atri Rudra

# 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

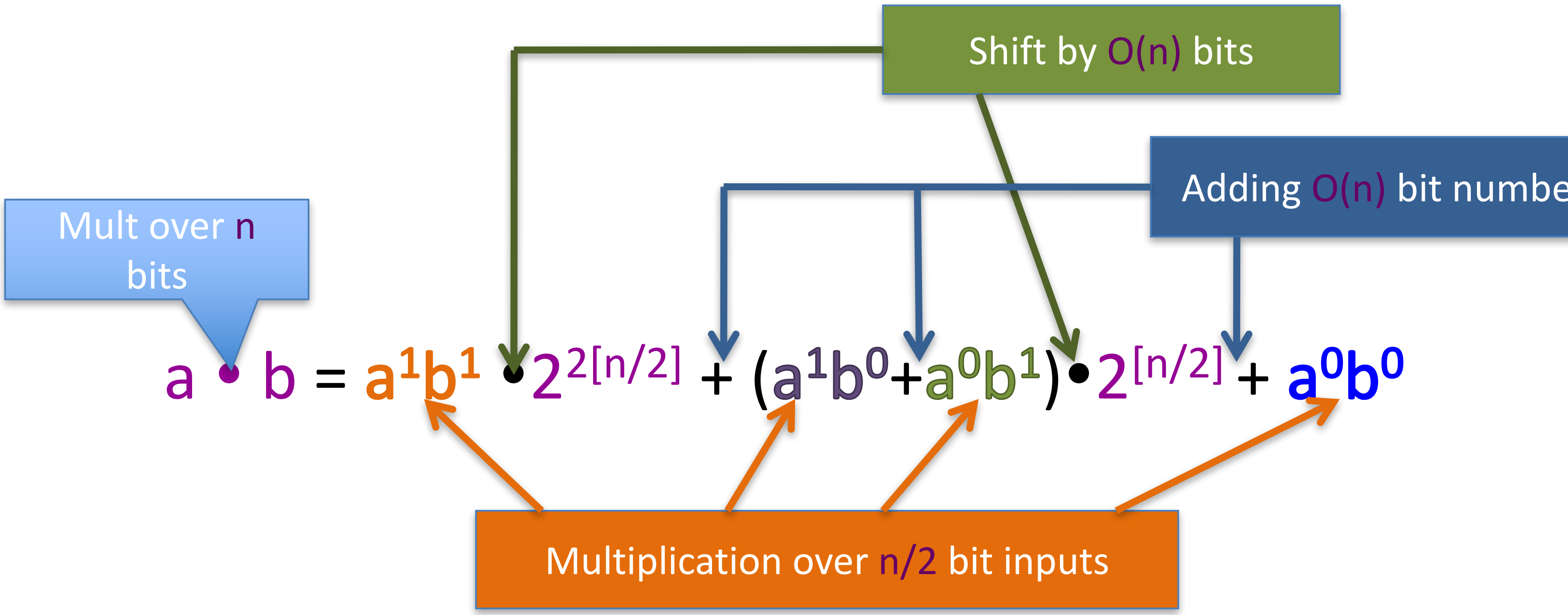
Given two numbers a and b in binary

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

Compute $c = a \times b$

Elementary school algorithm is $O(n^2)$

# The current algorithm scheme




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

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

$$T(1) \leq c$$

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

# The key identity

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

# The final algorithm

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

Mult $(a, b)$

If $n = 1$ return $a_0 b_0$

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

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

$T(1) \leq c$

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

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

All green operations are $O(n)$ time

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