



Design and Analysis  
of Algorithms I

# Introduction

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## Integer Multiplication

# Integer Multiplication

Input : 2 n-digit numbers  $x$  and  $y$

Output : product  $x*y$

“Primitive Operation” - add or multiply 2 single-digit numbers

# The Grade-School Algorithm

Handwritten multiplication of 5678 by 1234 illustrating the grade-school algorithm. The numbers are aligned as follows:

5678			
× 1234			
<hr/>			
22712			
17034	-		
11356	-		
5678	- -		
<hr/>			
7006652			

A red oval highlights the inner loop of the multiplication (the four rows of partial products). A green bracket on the right indicates that there are roughly  $n$  operations per row up to a constant.

# of operations overall  $\sim \text{constant} * n^2$

# The Algorithm Designer's Mantra

“Perhaps the most important principle for the good algorithm designer is to refuse to be content.”

-Aho, Hopcroft, and Ullman, *The Design and Analysis of Computer Algorithms*, 1974

CAN WE DO BETTER ?  
[ than the “obvious” method]