

# A Tour of C++

ksolomon

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## Abstract

Notes on Algorithms Course Pt 1

## 1 Introduction

Highly recommend to code up every single algorithm presented in the course in favorite programming language to fully grasp the concepts.

*"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*

### 1.1 Multiplication

**Integer Multiplication** Grade school algorithm is  $O(n^2)$ .

#### Karatsuba Multiplication

**Theorem 1** let  $x = 5678, y = 1234$

let  $a = x/100, b = x \bmod 100$

let  $c = y/100, d = y \bmod 100$

1.  $a*c = 672$
2.  $b*d = 2652$
3.  $(a+b)(c+d) = 134*46 = 6164$
4.  $(3) - (2) - (1) = 2840$
5.  $(1)*10000 + (2) + (4)*100 = 6720000 + 2652 + 284000 = 7006652$

$$x.y = (10^n ac + 10^{n/2}(ad + bc) + bd$$

1. Recursively compute  $ac$
2. Recursively compute  $bd$
3. Recursively compute  $(a+b)(c+d) = ac+bd+ad+bc$

Gauss' Trick :  $(3) - (1) - (2) = ad + bc$

Upshot : Only need 3 recursive multiplications (and some additions)

Q : which is the fastest algorithm ?

Figure 1: Recursive Karatsuba Multiplication