ALGORITHM Multiplication Analyses

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Group: *193-1*

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Problem statement

Goal:

To implement 3 different algorithms of multiplication using C++ languages , estimated their work time by construction a graph basing on data that program provides .

Complexity of Algorithms :

1. **Great School Multiplication algorithm :** *O(n^2)*

2. **Karatsuba :** *O(n^log(2,3) , T(n) = 3T(n/2)+O(n).*

3. **Divide and Conquer :** *T(n) = 4T(n/2)+O(n)*, By Master Theorem *O(n^log(2,4) or O(n^2).*

Implementation of Algorithms

Great School Algorithm

Just implemented the usual way or multiplying , by multiplying each digit of first number on last digit of the second number , then on pre-last and etc.

Divide & Conquer

Did multiplication with following formula : *x1*x2 = ac*10^n + ad*10^(n/2) + bc*10^(n/2)+bd;* where a, b are halves of x1 and c, d are halves of x2, and n is the maximum length of multiplied numbers.

Karatsuba

Karatsuba is kind of derivative of D&C , it just a reduce of amount of operators . After reduce we got following formula : *x1x2 = ac*10^n+(ad+bc)*10^(n/2) + bd .*

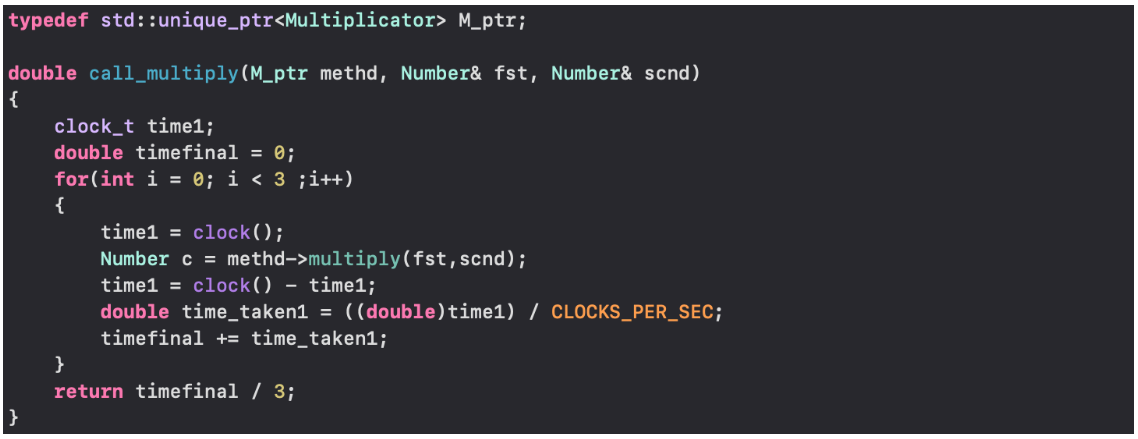
Code

I implemented class Number via std::string for storing numbers of unlimited length and provide all the necessary semantic for working with them . I did only necessarily overloading , and i want to pay your attention , overloading of * in Number class is used only for multiplication of two numbers less then 10 (1 digit length) .

Multiplicator class is performed with virtual destructor and virtual function multiply which begin override in derived classes GSM,Karatsuba ,Divide&Conquer . Function for generating random number is marked static

In main.cpp I just made function to conduct experiments and write results in csv file .

As we need to call each function of multiplication 3 times ant take average I made following decomposition :



```cpp
typedef std::unique_ptr<Multiplicator> M_ptr;

double call_multiply(M_ptr methd, Number& fst, Number& scnd)
{
    clock_t time1;
    double timefinal = 0;
    for(int i = 0; i < 3 ;i++)
    {
        time1 = clock();
        Number c = methd->multiply(fst,scnd);
        time1 = clock() - time1;
        double time_taken1 = ((double)time1) / CLOCKS_PER_SEC;
        timefinal += time_taken1;
    }
    return timefinal / 3;
}
```

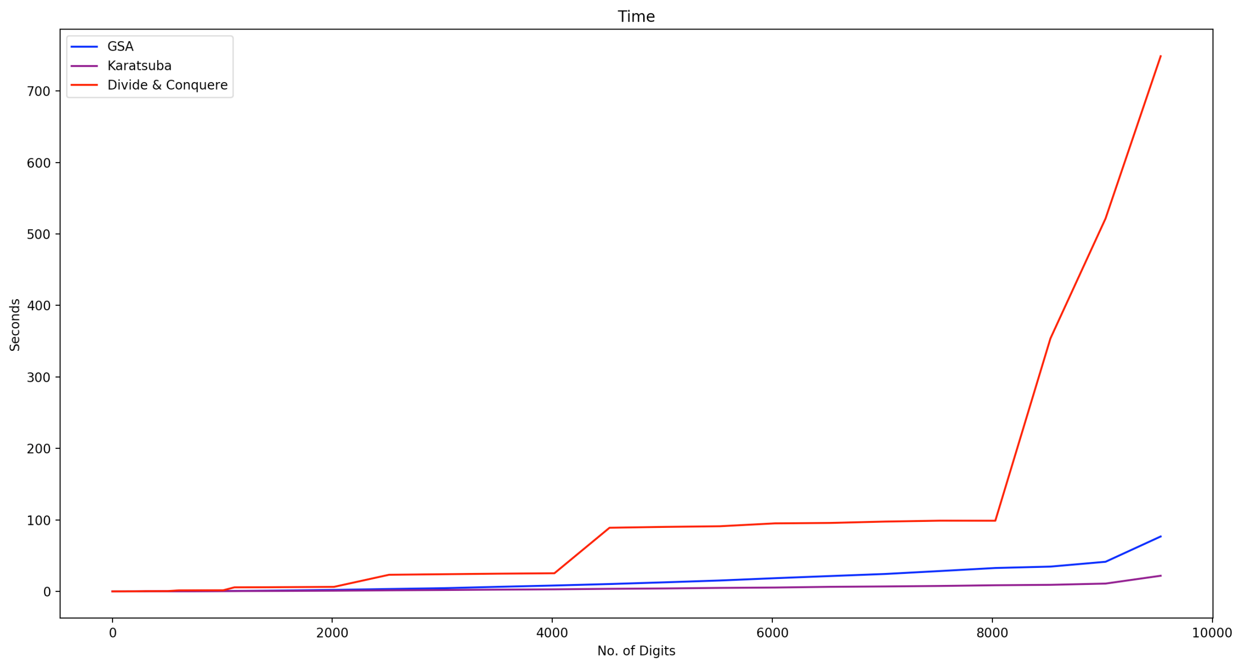
I'm passing a smart pointer to the function I need to call ,as a parameter of call_multiply .

Python part .

Simple code for building graphs with matplotlib, and getting data from csv with panda library . Simplest part of the workshop)

Result

As a result you can observe my graphs which provides with all necessarily information :



Conclusion

As a result , you can observe csv file attached to my project with information about algorithm run time , and visual representation of that data via graph above . I could have improved my project by spending more time on code style and implementing D&C in more efficient way , and in my personal opinion changing base case in Karatsuba and calling GSA in base cause would lead to more effective results .

URL to repository :

https://github.com/SKYMAN44/dsba--ads2020--hw1