BLG336E - Analysis of Algorithms II
2018–2019 Spring, Project 2 04.04.2019
Submission Deadline: 19.04.2019 23:00

Overview

In this project you are going to implement algorithm for the following problem.

Problem:

Multiplying two polynomials efficiently is an important issue in a variety of applications, including signal processing, cryptography and coding theory. Multiplication operations are very costly for very large numbers in terms of time consumption. Especially for algorithms with high mathematical processing density, multiplication and exponent operations should be fast. Therefore, you are expected to develop an application that multiplies binary bit sequences in a way that reduces time complexity. Given two binary strings that represent value of two integers, find the product of two strings. The numbers should be 32, 64, 128, 256, 512 and 1024 bits and the result should be in decimal. For example, if the first bit string is "1000" and second bit string is "1010", output should be "80". You are expected to multiply two randomly generated binary numbers by classical method and given methods in algorithm1. As a result of the operations performed, you are expected to reduce the time complexity of the multiplication compared to the ordinary multiplication method. You have to show the time values in the classical method and given method. You are expected to explains which approach you see in the given algorithm.

Algortihm 1:

```
function multiply(x, y)

Input: Positive integers x and y, in binary
Output: Their product

n = max(size of x, size of y)
if n = 1: return xy

xL, xR = leftmost [n/2], rightmost [n/2] bits of x
yL, yR = leftmost [n/2], rightmost [n/2] bits of y

P1 = multiply(xL, yL)
P2 = multiply(xR, yR)
P3 = multiply(xL + xR, yL + yR)

return P1 × 2^n + (P3 − P1 − P2) × 2^(n/2) + P
```

A) Implementation (50p)

1) Formalize this problem.

You may have a look at your course slides or internet resources to find out which method you can use.

2) Reduce the result of time complexity

3) Run your algorithm and analyze the results in terms of the running time

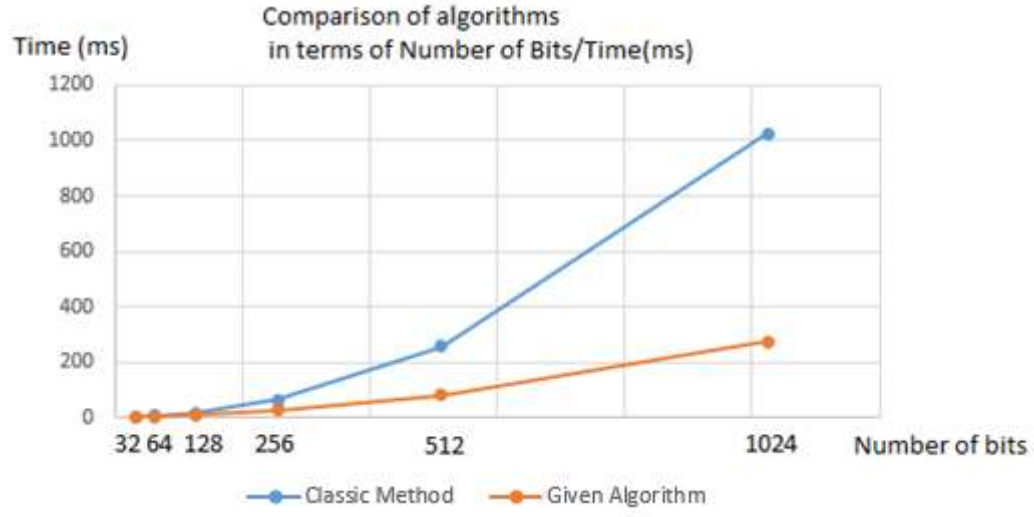
4) Save time results (time, number of digits) and plot it in a graph for all method. (classical method vs. given method) (For your report)

4) Your program should compile and run using the following commands:

```
g++ yourStudentID.cpp –o project2
./project2 output.txt
```

B) Report (50p)

1) Explain the multiplication problem with your own words briefly. What do given approach? (max: 3 lines)
2) Present your problem formulation in detail.
3) How does your algorithms work?
   Write your pseudo-code.
   Write the time complexity of your algorithm on your pseudo-code.
   Write the time complexity of your reduced method.
4) Analyze and explain the algorithm results on the your graph. See example below:



Note: If you have any questions, please feel free to contact Res. Asst. Burcu SÖNMEZ via e-mail (sonmezb18@itu.edu.tr).
Policy: ● You may discuss the problem addressed by the project at an abstract level with your classmates, but you should not share or copy code from your classmates or from the Internet. You should submit your own, individual project. ● Academic dishonesty including but not limited to cheating, plagiarism, collaboration is unacceptable and subject to disciplinary actions.

Submission Instructions:

● Please submit your homework through Ninova e-Learning System.
● You must submit all your source code in a single cpp file and a softcopy report (PDF). You can define multiple classes in a single cpp file.
● All your code must be written in C++, and we must be able to compile and run on it on ITU's Linux Server (you can access it through SSH) using g++.
 For Windows users: If you wish, you can use WinSCP to upload your source code in to ITU SSH Server, and use PuTTY to compile and run your algorithm. If don't, please make sure that your code is able to compile and run on ITU's Linux Server.
● When you write your code, try to follow an object-oriented methodology with well-chosen variable, method, and class names and comments where necessary.
● Your code must compile without any errors; otherwise, you may get a grade of zero on the assignment.
● You should be aware that the Ninova e-Learning System clock may not be synchronized with your computer, watch, or cell phone. Do not e-mail the teaching assistant or the instructors your submission after the Ninova site submission has closed. If you have submitted to Ninova once and want to make any changes to your report, you should do it before the Ninova submission system closes. Your changes will not be accepted by e-mail. Connectivity problems to the Internet or to Ninova in the last few minutes are not valid excuses for being unable to submit. You should not risk leaving your submission to the last few minutes. After uploading to Ninova, check to make sure that your project appears there.