

Student Number	
Signature	

University of Cape Town ~ Department of Computer Science  
Computer Science 3003S Theory of Algorithms ~ 2017

## ToA Open Practical

### Procedure

Personal belongings are to be left at the front of the room. You may take a calculator, writing implements, and your student card to your assigned workstation.

This handout includes a sheet that you may use for rough work.

All materials must be returned before you leave.

You may consult the electronic Java and C/C++ API documentation ([docs.cs.uct.ac.za](http://docs.cs.uct.ac.za)), and submit to the automatic marker via Vula ([vula.uct.ac.za](http://vula.uct.ac.za)), but nothing else! You may NOT use your class notes, textbooks, internet or files on your flash disk, hard drive, etc.

### Submission

The automatic marker contains a submission entry bearing the name of this practical.

Submit your source files within a single compressed, '.ZIP', archive.

Make sure you create a '.ZIP' archive, not a gzipped, '.gz', or tar-gzipped, '.tgz', or other kind of file.

Make sure your source file is the only item within the archive. Especially, avoid submitting an archive containing a folder containing the file.

When submitting a Java source file copied from an editor like Eclipse or Netbeans, please remove any package line that may appear at the beginning of the code.

## Question One

100 Marks

### File names

- Use `product.c` if you are writing your program in C.
- Use `product.cpp` if you are writing your program in C++.
- Use `Product.java` if you are writing your program in Java.
- Use `product.py` if you are writing your program in Python.

### Problem description

Given a sequence of  $n$  floating point numbers  $[x_1, x_2, \dots, x_n]$ , a contiguous sub sequence is a sequence formed using the elements of the original sequence, where all the elements were adjacent in the original sequence and appear in the same order in the subsequence as in the original sequence. A contiguous sub sequence can be constructed by selecting two numbers in the original sequence and forming the sub sequence by including all numbers in between the two selected. For example, if we have the sequence  $[9.4, 8.2, 0.01, 3, 4.222, 2.6, 6.1, 1.1, 5.9]$ , then  $[9.4, 8.2, 0.01]$ ,  $[3, 4.222]$ , and  $[4.222, 2.6, 6.1, 1.1, 5.9]$  are all contiguous sub sequences. However,  $[8.2, 0.01, 4.222]$ ,

2.6, 6.1] is not contiguous, as it is missing the number 3. Your task is, given a sequence of floating point numbers, to find the length of the contiguous subsequence with the maximum product.

#### Example

You are given the sequence [0.5, 1.0, 1.5, 0.001, 20, 1.1, 0.01]. The contiguous subsequence with the maximum product is [20, 1.1], which has length 2.

#### Input and output

Program input and output will make use of stdio streams (System.in and System.out in Java) i.e. not file I/O.

#### Input

The input will consist of a single line of  $n$  real numbers, separated by spaces.

Sample Input:

```
0.1 20 5 6.6 7 0 20 0.01 0.5 0.0067
```

#### Output

Your output should consist of single integer, which is the length of the contiguous subsequence with the maximum product.

Sample output:

```
4
```

#### Constraints

$1 \leq n \leq 100\,000$

$-10\,000 \leq x_i \leq 10\,000$

#### Scoring

Each test case that is answered correctly will earn 5 points.

## Question Two

50 Marks

#### File names

- Use `threes.c` if you are writing your program in C.
- Use `threes.cpp` if you are writing your program in C++.
- Use `Threes.java` if you are writing your program in Java.
- Use `threes.py` if you are writing your program in Python.

#### Problem description

Given the binary string representation of a number, your job is to find the minimum number of cuts that need to be made to this string, such that each of the resulting binary strings represents a number which is a power of three.

#### Example

You are given the string `1010001111001`. The minimum number of cuts required is 2. This can be done by cutting the string into `1010001 = 34`, `11 = 31`, and `1001 = 32`.

#### Input and output

Program input and output will make use of stdio streams (System.in and System.out in Java) i.e. not file I/O.

### *Input*

The input will consist of a single line, which is a binary string.

Sample Input:

1011011001100010001011

### *Output*

Your output should be a single integer, which is the number of cuts required.

Sample output:

1

### *Scoring*

Each test case that is answered correctly will earn 5 points.

END