Math/CS 466/666: Programming Project 1

Your work should be presented in the form of a typed report using clear and properly punctuated English. Where appropriate include full program listings and output. If you choose to work in a group of two, please turn in independently prepared reports.

1. Let $a \oplus b$ represent the result of adding two floating point numbers a and b on a digital computer. In class it was claimed that due to rounding, it may happen that

$$(a \oplus b) \oplus c \neq a \oplus (b \oplus c)$$

for some values of a, b and c. Thus, addition of floating point numbers is not associative. Consider the program

```c
#include <stdio.h>
main(){
    double a=1.0,b=2.0,c=3.0;
    printf("a=%.14e\nb=%.14e\nc=%.14e\n",a,b,c);
    double r1=(a+b)+c;
    double r2=a+(b+c);
    if(r1==r2){
        printf("In this case a+b+c is associative.\n");
    } else {
        printf("In this case a+b+c is NOT associative.\n");
    }
    return 0;
}
```

When this program is run it prints

```
a=1.00000000000000e+00
b=2.00000000000000e+00
c=3.00000000000000e+00
In this case a+b+c is associative.
```

Find a choice of a, b and c in the interval $[1, 100]$ which results in the output

```
In this case a+b+c is NOT associative.
```

2. Let $a \otimes b$ represent the result of multiplying two floating point numbers a and b on a digital computer. Is it true or false that multiplication of floating point numbers is associative? If true explain why; if false provide a counter example. Does your answer change if you assume the numbers a, b and c each lie in the interval $[1, 100]$?