

AUIS ENGR 244 (Engineering Computing), Course Assignment 2

Deadline:¹ October 25, 2017; Tutorial Discussion: November 6, 2017

1) The sequence of Fibonacci numbers is defined by $F_0 = 0$, $F_1 = 1$, $F_n = F_{n-1} + F_{n-2}$ for $n \geq 2$. Write a function which, if given a natural number k as its argument, returns the value of F_k . Make sure that with this function, at least the first 100 Fibonacci numbers can be computed.

2) What is wrong with this code? Find the mistakes and explain how to correct them:

```
#include <iostream>
using namespace std

int check_identity(int a, int b, int c)
{
    c = a - b
    if(c = 0) cout << "The values are equal: a = " << a << ", and b = " << b << ".\n"
    else cout << "The values are different: a = " << a << ", whereas b = " << b << ".\n"
    return c
}

int main()
{
    x = 7
    y = 7
    check_identity(x, y)
    return 0
}
```

3) Write a program that, within 0.001% accuracy, computes the constant e from

$$e = \sum_{n=0}^{\infty} \frac{1}{n!}.$$

A function `double exp(double x)` exists in the “<cmath>” part of the standard library. Do not use this function. Instead, numerically determine e from the series expression given above.

4) Write a function, with one argument, `int i`, and with the return type `bool`, that returns “true” if i is a prime number, and “false” if i is not a prime number.

The modulo operator “%” can be used to compute the modulo, or remainder after integer division, for two `int` values. Accordingly, e.g., “23 % 7” evaluates to 2, since $23 = 3 \cdot 7 + 2$. For two `int` values i and j , the logical expression “ $(i \% j) == 0$ ”, which is true if and only if the remainder for the division of i by j is zero, can be employed to check whether i is an integer multiple of j .

For a variable with the datatype `bool`, there are only two possible values: true and false.

5) Write a program that writes the first 1000 prime numbers to standard output.

¹ Submissions (on paper only), by groups of two or three people, can be handed in on Wednesday, Oct. 25, in class, or deposited in the mailbox in room B-F2-01 by Tuesday, Oct. 24. Each problem contributes 0.5% to the overall grade.

6) Explain how the outcome of the following function depends on its arguments:

```
void motion(double position[3], double velocity[3], double time)
{
    for(int d = 0; d < 3; d++) position[d] += time * velocity[d];
}
```

Is this a case of passing arguments “by value” or of passing them “by address” (by reference)? Please explain why. What is the meaning of the operator “+=”, and why is it used here? What is the output of the following program?

```
#include <iostream>
using namespace std;

void motion(double position[3], double velocity[3], double time)
{
    for(int d = 0; d < 3; d++) position[d] += time * velocity[d];
}

int main()
{
    double x[3] = {1.0, 1.0, 1.0};
    double v[3] = {0.5, 0.0, -0.5};
    motion(x, v, 2.0);
    cout << x[0] << " " << x[1] << " " << x[2] << "\n";
    return 0;
}
```

7) Explain how the return value of the following function depends on its arguments:

```
bool sphere_collision_detection(double position_i[3], double position_j[3], double sqr_diameter)
{
    double sqr_distance = 0.0;
    for(int d = 0; d < 3; d++) sqr_distance += (position_i[d] - position_j[d])*(position_i[d] - position_j[d]);
    if(sqr_distance < sqr_diameter) return true; else return false;
}
```

What is the output of the following program?

```
#include <iostream>
using namespace std;

bool sphere_collision_detection(double position_i[3], double position_j[3], double sqr_diameter)
{
    double sqr_distance = 0.0;
    for(int d = 0; d < 3; d++) sqr_distance += (position_i[d] - position_j[d])*(position_i[d] - position_j[d]);
    if(sqr_distance < sqr_diameter) return true; else return false;
}

int main()
{
    double xi[3] = {2.5, 1.0, 2.0};
    double xj[3] = {1.0, 1.5, 1.5};
    double radius = 1.0;
    if( sphere_collision_detection(xi, xj, 4.0*radius*radius) ) cout << "Collision detected.\n";
    else cout << "No collision detected.\n";
    return 0;
}
```