Exercise 1

What is the (asymptotic) running time of each of the following pseudo-codes, as a function of n? Justify your answers.

a)

```
for i = 1 to 10 do
     for j = 1 to n do
          sequence of statements
     end for
end for
```

b)

```
for i = 1 to n do
     for j = i to n do
          sequence of statements
     end for
end for
```

c)

```
for i = 1 to n do
    for j = 1 to 2 * i + 1 do
        sequence of statements
    end for
end for
```

d)

```
for i = 0 to m do
    t ← 1
    while (t < m) do
        sequence of statements
        t ← t * 2
    end while
end for
```

e)

```
for i = 1 to n * n do

    for j = 1 to i do

        sequence of statements

    end for

end for
```

Exercise 2

What is the worst-case complexity of the following code fragments?

a) Two loops in a row:

```
for (i = 0; i < N; i++) {

    sequence of statements

}

for (j = 0; j < M; j++) {

    sequence of statements

}
```

How would the complexity change if the second loop went to N instead of M?

b) A nested loop followed by a non-nested loop:

```
for (i = 0; i < N; i++) {

    for (j = 0; j < N; j++) {

        sequence of statements

    }

}

for (k = 0; k < N; k++) {

    sequence of statements

}
```

c) A nested loop in which the number of times the inner loop executes depends on the value of the outer loop index:

```
for (i = 0; i < N; i++) {

      for (j = N; j > i; j--) {

            sequence of statements

      }

}
```

Exercise 3

Estimate the complexity of an algorithm if this complexity behaves in function of the given expression (O(f(n))). Justify your answer.

$f(n)$
$2n + 3n^3 + 100$
$11n + 2^n + 0.2n^3$
$\log_2(n) + 5n$
$a(1 + cos(2\pi n)) + b\log_2(n) + cn$