Exercise 1

The paper "DART: Directed Automated Random Testing" written by Patrice Godefroid, Nils Klarlund, and Koushik Sen presents a tool for automatically testing software.

(i) Read the DART paper.

(ii) Apply DART on method `medianOf3`.

Compute a set of tuples of input values \((x, y, z)\) that covers all paths of `medianOf3`. Each tuple \((x, y, z)\) is a test case which covers one path of `medianOf3`. Provide the concrete execution, the symbolic execution and the path constraints.

(iii) For each generated test case, determine your expected return value of `medianOf3` (i.e. the test oracle is you). Is method `medianOf3` faulty? If so, name the test case generated in (ii), that reveals the bug, if possible.

(iv) Is it guaranteed for DART to reveal the bug in this particular example? Justify your answer.

(v) Assume a program \(P\) contains loops or function calls (which return non-deterministic values). Is DART able to deal with those issues? If not, what are your suggestions?

```c
int medianOf3(int x, int y, int z) {
    int m;
    m = z;
    if ( y < z ) {
        if ( x < y ) {
            m = y;
        } else if ( x < z ) {
            m = y;
        }
    } else {
        if ( x > y ) {
            m = y;
        } else if ( x > z ) {
            m = x;
        }
    }
    return m;
}
```

Exercise 2

Consider the following method, which is supposed to return the index of the first element that equals the specified integer value or −1 if the array does not contain the given integer:

```java
public int search(int[] array, int target) {
    int pos = array.length;
    while (pos >= 0) {
        if (array[pos] == target)
            return pos;
        --pos;
    }
    return -1;
}
```

A call to `search` with the input parameters `array = {1, 2, 3}` and `target = 3` throws an `ArrayIndexOutOfBoundsException` on line 4.

1. For each statement $S$ of the method
   (a) Calculate the set $D_S$ of all statements $S_D$ such that $S$ is data dependent on $S_D$.
   (b) Calculate the set $C_S$ of all statements $S_C$ such that $S$ is control dependent on $S_C$.

2. Apply the algorithm for the systematic discovery of defects from the lecture in order to track down the defect in `search`. Where is the origin of the defect?