# Report on OGO 2.2 Softwarespecification assignment 1a

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**Abstract**

This document presents a formal specification and implementation of assignment 1a of OGO 2.2 Softwarespecification. Also included are the informal requirement of the stakeholder, their judgement about the formal specification and testcases for the implementation.

## 1 Informal requirements

**Input** A simple textfile consisting of real numbers separated with whitespace.

**Output** Given is a sequence of numbers from which some numbers needs to be summed. The indices of the numbers that need to be added are given by the Fibonacci sequence. The output is the result of the sum in flat text.

**Example** Input: {-5 43 25 -83 67 -97 73 14 -58 25 84 29 81 -54}
The input has 14 elements, so the following part of the fibonacci sequence is used: $\{0, 1, 1, 2, 3, 5, 8, 13, 21, ...\}$. Using the sequence as indices of the numbers on input, we get the following numbers that need to be summed:
-5, 43, 43, 25, -83, -97, -58, -54.
The summation of these numbers is -186.

## 2 Formal specification

This section describes a formal specification adhering to the informal requirements described above.

We first have to define a function *fib* that returns the $n$'th Fibonacci number. Fibonacci numbers are recursively defined using the two previous Fibonacci numbers.

$$
\begin{array}{|l}
fib : \mathbb{N} \to \mathbb{N} \\
\hline
fib(0) = 0 \\
fib(1) = 1 \\
\forall\, n : \mathbb{N} \mid n \geq 2 \bullet fib(n) = fib(n-2) + fib(n-1)
\end{array}
$$

Next, we also need a function *sum* that returns the summation of a given sequence of numbers. This function is recursively defined as well, by computing the sum of the tail of the sequence until the sequence is empty, and adding all of the heads to this sum.

$$
\begin{array}{|l}
sum : \mathbb{P}(\operatorname{seq}\mathbb{R} \to \mathbb{R}) \\
\hline
\forall (x, y) : sum \mid x = \langle\rangle \bullet y = 0 \\
\forall (x, y) : sum \mid x \neq \langle\rangle \bullet y = sum(tail\, x) + head\, x
\end{array}
$$

Last but not least, we need a method that selects the numbers with Fibonacci indices from a sequence and places those numbers in a new sequence. This is a bit tricky, because sequences begin numbering with one, and the Fibonacci sequence starts with zero. Therefore, we increment each Fibonacci number with one, and decrement each sequence index by one to get a correct mapping from Fibonacci numbers to indices.

$$
\begin{array}{|l}
selectfibindices : \mathbb{P}(\operatorname{seq}\mathbb{R} \to \operatorname{seq}\mathbb{R}) \\
\hline
\forall (x, y) : selectfibindices;\ z : \mathbb{N} \mid \\
\qquad 1 \leq z \land z \leq \#y \land fib(z-1) + 1 \leq \#x \bullet \\
\qquad y(z) = x(fib(z-1) + 1)
\end{array}
$$

The real algorithm to take the summation of all numbers with a Fibonacci index is now very straightforward and given below.

*Algorithm*

$input? : \operatorname{seq} \mathbb{R}$
$output! : \mathbb{R}$

---

$output! = sum(selectfibindices(input?))$

# 3 Judgement of the formal specification

# 4 Testcases for the implementation

**Null testcase** This case checks whether an empty input creates the correct output.
Input: {}
Expected output: 0 (test succeeded).

**Double one testcase** This case checks whether the number on index one is summed twice.
Input: {0 1}
Expected output: 2 (test succeeded)

**Negative numbers** This case checks whether negative numbers are summed correctly.
Input: {-3 -2 -5 -8 -10}
Expected output: -20 (test succeeded)

**Large mixed list** This case check whether a longer list with mixed positive, negative and non-integer numbers are summed correctly.
Input {-800 2,85 -85,15 -7482,2654 87 0,002 -0,008 784 -235 12}
Expected output: -8596,7134 (test succeeded)

# 5 Implementation

We chose to implement the algorithm in the Java programming language, because everyone in our group is familiar with it. There is no precondition

in the code because the input is correct as long as it consists of real numbers and there is no simple method of checking for non-reals in the formal specification. The postcondition of the formal specification is fully met. The method implementing the algorithm is shown below and requires an import for *java.io.InputStream* and *java.io.Scanner*:

```
/**
 * This method is an algorithm that gives the sum of
 * the (real) numbers in a stream. But only the numbers
 * with indices equal to a fibonacci number are used.
 *
 * @param stream The stream to take the numbers from
 * @return The sum of the elements in the stream
 *         with indices equal to a fibonacci number
 */
public static double fibAlgo(InputStream stream) {
    Scanner scanner = new Scanner(stream);
    // Fibonacci is repeatedly computed using older
    // fibonacci numbers (this is more efficient than
    // calculating each fibonacci number from scratch)
    int secondOldFib = 0;
    int firstOldFib = 1;
    int fib = 0;
    double current;
    // Index represents the index of the double in the
    // stream
    int index = 0;
    double sum = 0;
    while (scanner.hasNextDouble()) {
        current = scanner.nextDouble();
        // When the index equals to the fibonacci
        // number, we add it to the sum
        if (index == fib) {
            sum += current;
            // Index one is an exception because it
            // occurs twice in the fibonacci sequence
            if (index == 1) {
                sum += current;
```

```
            }
            // Calculate the new fibonacci number and
            // store the old numbers
            fib = secondOldFib + firstOldFib;
            secondOldFib = firstOldFib;
            firstOldFib = fib;
        }
        index++;
    }
    return sum;
}
```