Program Structure

Before the main function (ll.1-43) the code consists of pre-declarations of enumeration and structure types followed by function prototypes and global constants. Having data stored in one structure simplifies passing arguments to functions performing operations on the data and implementing principles of reusability of structures. Hereafter, the program calls the function **`getData`** with the purpose of affecting the fields of the structure **`data`** (ll. 46-47) by inputs provided through standard input stream. Using the acquired data, the program defines a multidimensional vector, **`grid`**, in which each element represents a pixel of the final display of the signal (l. 50). The vector is populated by the functions **`mapTime`** and **`mapSignal`** taking **`data`** and **`grid`** as arguments. The function **`mapSignal`** maps both theoretical and approximated signal values to **`grid`** by allocating sub-tasks to functions specific for each signal, hereby implementing the principle of abstraction (ll. 185-198). **`grid`** is subsequently displayed by the function **`printGrid`** (l. 56). Lastly, the recursive function **`dicoMax`** (l. 67) is called in order to find the maximum value of the approximated signal values of the functions **`square`** or **`sawtooth`** (ll. 327-334) hereby implementing the principle of reusability. The maximum value is displayed, and the program ends.

Complexity of 2nd task

For every **`nbL`** (number of lines) in **`grid`**, a corresponding quantity of columns is calculated. Lines and columns are correlated by a linear function. For every column, a computation dependent on **`nbN`** (number of terms) is calculated. Thus, the time complexity of the 2nd task is, $O(nbL^2 + nbL \cdot nbN)$.

Behavior of Maximum value as number of terms increases

As **`nbN`** approaches infinity, the maximum value found by the search algorithm approaches approximately 1.18. The highest value experimentally determined was 1.17897973 for **`nbN`** : 10^8 for the sawtooth and square signals. Otherwise, is the behavior of the triangle signal whose maximum value approaches 1. The deviation of the square and sawtooth signal from the theoretical values corresponds to approximately 9% of the discontinuous gap of 2 observed in the theoretical sawtooth (Fig 2) and square signals. As there is no discontinuity in the graph of the theoretical triangle signal, the deviation does not appear (Fig 1). The deviations are described by the Gibbs phenomenon and can be observed in the neighborhood of values 0 and 1 of the sawtooth signal.

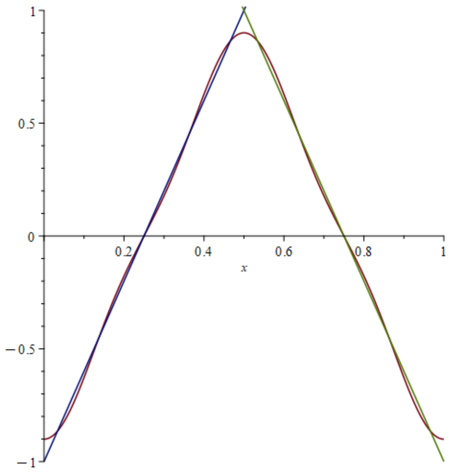

Fig. 1: Plot of approximated triangle signal (2 terms) and theoretical signal.

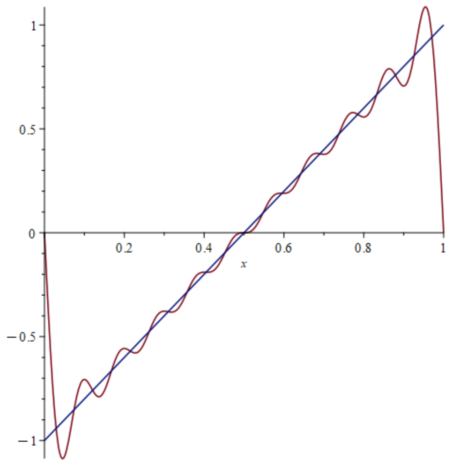

Fig. 2: Plot of approximated sawtooth signal (10 terms) and theoretical signal.

Pseudocode for Dichotomy Algorithm

Provided below is the pseudocode for the algorithm conceived for determining the maximum value of the approximated square signal, provided an interval on which solely a global maximum exists. The square function calculates the approximated square signal as a function of time.

```
Algorithm : SquareMax
Entries : low (lower interval bound), up (upper interval bound),
         max, last_max, count, epsilon

if (low-up < epsilon)                //stop condition
      count = count + 1
      if (count = 2)
            stop

a = square(low)
b = square(up)
last_max = max

if (a > b)
      max = a;
      low = low + (up-low) / 2
else
      max = b
      low = low + (up-low) / 2

SquareMax (low, up, max, last_max, count, epsilon)
```