
Exercise: WCET

1. Introduction

For hard real-time systems we need to know the Worst Case Execution Time (WCET) of an algorithm on the hardware where we will execute the algorithm later when being used in the hard real-time system.

However, for algorithms where the runtime depends on the input, we need to identify the worst input regarding the runtime for these algorithms.

The goal of this exercise is to show you how difficult this can be. I have chosen a simple example for this exercise: the [Binary Search](#) algorithm - a well-studied search algorithm in Computer Science for testing whether some number is present in an array of sorted numbers.

2. Implement the binary search algorithm in C++

First try to understand how this algorithm works: how does it check whether a given number X is stored in some array A?

Then implement this algorithm in C++ in a function `binary_search()`.

What is the worst case input?

3. Do runtime measurements for your implementation on your hardware

Prepare a large array of strictly monotonous increasing numbers (with ~10.000.000 elements) which are randomly chosen.

Then measure the runtimes for two scenarios. i) The average case where we search for a number that is present in the field and ii) the worst case where we search for a number that is not present in the field. For the worst case search e.g. for a number that is larger than the largest number stored in the array.

Repeat each experiment (by running it in a loop) for about 1.000.000 times and compute the overall computation time. Further, also check how often the loop has to be executed in the average case (number is present) vs. the worst case (number is not present).

Output the runtimes and the loop counters similar to this:

```
Exercise: WCET analysis
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Search array size           : 10000000
Number of search experiments : 10000000
```

Average Case Execution Runtime test:

Results:

```
Total number of loops done      : 223222809
Total runtime for all experiments : 0.7880000000000000 sec
Estimated average case runtime   : 0.000000078800000 sec
```

Worst Case Execution Runtime (WCET) test:

Results:

```
Total number of loops done      : 230000000
Total runtime for all experiments : 0.4300000000000000 sec
Estimated WCET                   : 0.000000043000000 sec
```

Finished. Press a key to exit.

Compare the runtimes and the numbers of loops done. Are you surprised?