

## TECHNIQUES ALGORITHMIQUES ET PROGRAMMATION

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# A\* Algorithm – Binary Heap

## Minimum Binary Heap

A binary heap (*heap*) will be represented by the following structure :

```
typedef struct{
    void* *array;
    int n, nmax;
    int (*f)(const void*, const void*);
} *heap;
```

where `array[]` is the storage array for the objects in the heap (each of them being a `void*` stored starting from index 1, index 0 being unused), `n` is the number of objects stored in the heap, `nmax` is the maximum number of objects that can be stored in the heap, and finally `f()` is the comparison function for two objects used to define the notion of a minimum heap (a function similar to `qsort()`).

**Question 1.** Recall the definition of a binary heap as well as the principle of its implementation using an array. In particular, specify for an element at index  $i$  in the array what the indices of its children and its parent are.

**Question 2.** Recall the principle of adding an element to the heap. Give its complexity as a function of the number  $n$  of elements in the heap.

**Question 3.** Same question for removing the minimum.

We assume that a dynamic array is used for `array[]` with the following strategy : when the heap is full, the size of the array is doubled (and thus copied).

**Question 4.** With this strategy, give the complexity of filling a heap with  $n$  elements, i.e., the total complexity for performing  $n$  additions starting from an empty heap and an initial array of size 1. To establish this total complexity, specify the cost of the  $n$  insertions on one hand and the reallocations on the other.

## Lab Session

Download the files corresponding to the lab session from the course page available below :

<http://dept-info.labri.fr/~gavoille/UE-TAP/>

You will need to complete `heap.c`, which you will test with `./test_heap` after compiling with `make -B test_heap` using the same `Makefile`. You do not need to modify `heap.h` but simply read the specifications of the functions to be programmed in `heap.c`. It is preferable to place the `heap` files in the same directory containing the `Makefile` and the `tools` files.