



**ARISTOTLE UNIVERSITY OF THESSALONIKI**  
**DEPARTMENT OF COMPUTER SCIENCE**



**PROGRAMMING LANGUAGES & LANGUAGES**  
**LABORATORY SOFTWARE TECHNOLOGY**

**LESSON:** Artificial Intelligence  
**WORK:** 1<sup>n</sup>  
**DATE OF COMMUNICATION:** 18/3/2022  
**DELIVERY DATE:** 1/5/2022

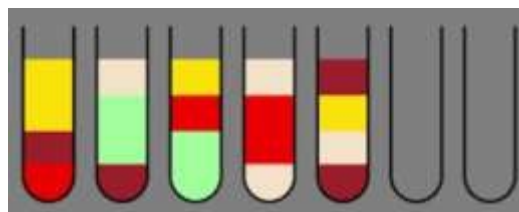


Figure 1

**Description of the problem**

The figure above shows a problem with  $N$  containers ( $N < 20$ ) of 4 ml each which can contain initial coloured liquids (up to 4 ml in total). In the problem there are a total of 4 ml of  $N-2$  liquids of different colours which are divided into the  $N$  containers (each container can contain an integer number of ml of any of the coloured liquids). For example, in the figure above there are 7 containers and 5 coloured liquids (yellow, burgundy, red, white, green). Container 1 contains 1 ml of red liquid, 1 ml of burgundy liquid and 2 ml of yellow liquid.

The aim of the above problem is to collect the entire amount (all 4 ml) of each coloured liquid in a separate container (and therefore leave 2 empty containers). For example, 4 ml of the red liquid could be collected in 1<sup>o</sup> container, 4 ml of the burgundy liquid in 2<sup>o</sup>, 4 ml of the yellow liquid in 3<sup>o</sup> and so on (the order of the colours does not matter).

The permissible moves in the above problem are to move  $k$  ml ( $k$  : integer greater than 0) of a coloured liquid that are together on top of the same container (with no liquid of another colour interposed between them) either to an empty container or to a container that has a liquid of the same colour on top and, of course, the necessary empty space.

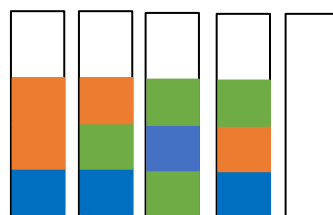


Figure 2

For example, in the snapshot in Figure 2, the only allowed moves are:

1. Move 2ml from the orange liquid in container 1 to 5
2. Move 1 ml from the orange liquid in container 1 to 2 (note that only 2 ml of the orange liquid can be transferred to container 5 at a time)
3. Move 1ml from the orange liquid in container 2 to 1 or 5
4. Move 1ml from the green liquid in container 3 to 4 or 5 (note: the green liquid at the bottom of container 3 can only be moved after removing the liquids above it)
5. Move 1ml from the green liquid in container 4 to 3 or 5

You are invited to implement in C/C++:

- a) the modelling of the above problem
- b) the Breadth First Search algorithm to solve the above problem

### **Deliverable**

You must send in **time** via the online system elearning.auth.gr a zip file containing :

1. The files with the source code of the program
2. A word document containing a report summarizing your design choices (e.g. problem representation, implementation of key methods, assumptions, how to implement the algorithm, at least 3 problems of your choice with increasing complexity and the solution statistics).

### **Comments**

- The work is individual
- The name of the zip file should **be named with the student's AEM**. E.g. 1045.zip
- The Word document should contain the student's details (name and AEM).