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Introduction to Computer Science, Winter Semester 2017
Practice Assignment1

Discussion: 07.10.2017 - 12.10.2017

Exercise 1-1   City of Lies & Truth

You are at an unmarked intersection ... one way is the *City of Lies* and another way is the *City of Truth*.

Citizens of the *City of Lies* always lie.

Citizens of the *City of Truth* always tell the truth.

A citizen of one of those cities (you don't know which) is at the intersection. What question could you ask to them to find the way to the *City of Truth*?

Solution:

You ask "In which of those two directions do you live?"

A Citizen of the *City of Lies* will point to the *City of Truth* A Citizen of the *City of Truth* will point to the *City of Truth*

Exercise 1-2   Play Game

To teach you a bit about algorithms we will play a game. You will be divided into groups, each group is given a drawing on graph paper, your task is to write an algorithm so that the other group can draw the drawing you received just by following your algorithm. The algorithm can be written using the following symbols:
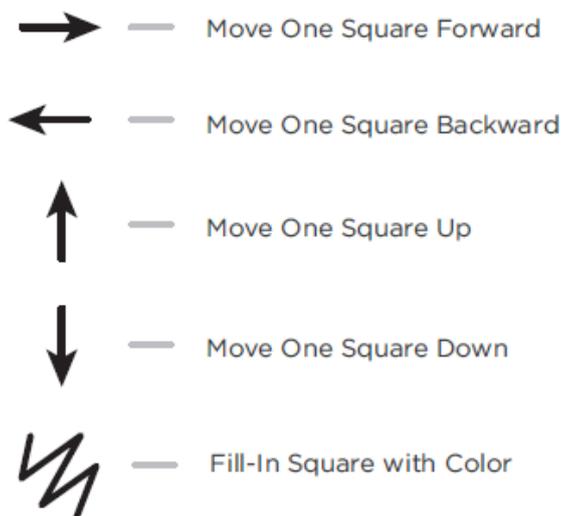

Figure 1: Instructions for drawing

After writing the instructions the member is to pass it to the one next to him without communicating in any way but through the instructions he wrote.

First group to finish is the winner .

Exercise 1-3   Towers of Hanoi

The **Towers of Hanoi** is a mathematical puzzle invented by a mathematician in 1883. The puzzle setting consists of eight disks and three pegs. Disks can slide onto the pegs. Initially, the disks are neatly stacked in order of their sizes on one peg so that they form a conical shape. The objective of the puzzle is to move the disks from one peg to another using only the three pegs. The following rules have to be obeyed during the moves:

- The same order of the pegs has to be maintained after moving them.

- Only one disk has to be moved at a time.

- No large disk can be placed on a smaller one.

A simple version of the towers of Hanoi consists of **three** disks instead of eight. In plain simple English write a set of steps by which you can move the three disks from one peg to the other.

Exercise 1-4   Cut Block

Cut Block puzzles were devised by Japanese puzzle inventor Naoki Inaba.

There are two rules that must hold of a completed cut block puzzle.

- Each area marked out by darker lines must contain the numbers from 1 up to the number of squares in the area. For example, the top most area in the first puzzle below consists of 5 squares so those squares must be filled with the numbers: 1, 2, 3, 4 and 5 with no repeated numbers. If the area has two squares, like the one bottom left below, then it must be filled with the numbers 1 and 2.

- No number can be next to the same number in any direction, whether horizontally, vertically or diagonally. So in the grid below, the fact that there is a 4 on the side means there cannot be a 4 in any of the 5 squares surrounding it.

Figure 2: Cut Block

Solution:

1	3	2	5	3	2	3
2	4	1	4	1	4	1
1	3	2	3	2	3	2
2	4	6	1	4	1	4
3	1	5	2	3	2	5
2	4	3	1	5	1	4

Figure 3: Cut Block Solution

Exercise 1-5   Crates of Fruit

You work at a fruit factory.

There are 3 crates in front of you. One crate contains only apples. One crate contains only oranges. The other crate contains both apples and oranges. And each crate is labeled. One reads "apples", one reads "oranges", and one reads "apples and oranges".

But the labeling machine has gone crazy and is now labeling all boxes incorrectly.

If you can only take out and look at just one of the pieces of fruit from just one of the crates, how can you label ALL of the crates correctly?

Solution:

One possible solution:

Take a piece of fruit from the "apples and oranges" crate. If it's an apple then you know that is the "apples" crate since **all the crates are labelled incorrectly**. This means the crate marked "apples" must be "oranges" and the crate marked "oranges" must be "apples and oranges".

Exercise 1-6   Balance puzzle

The **Balance puzzle** is a logic puzzle that is based on balancing similar-looking items. A well-known example has 8 balls that are identical in weight except for one odd ball. The objective of the puzzle is to find the different ball using the least number of weighings.

  a) Start by trying to find the smallest the number of weighings for 4 balls, knowing that the odd ball is heavier than the rest. What could be the number weighings for 8 balls?.

  b) What will happen if you know that the odd ball is just different i.e could be heavier or lighter?
     What could be the number weighings for 4 balls? Can you do it for 6, what about 8, what about 13?

Exercise 1-7   Race

Andrew, Britney and Carol race each other in a 100*meter* race. Each of them run at a constant speed throughout the race.

Andrew beats Britney by *20 meters.*

Britney beats Carol by *20 meters.*

By how many meters does Andrew beat Carol?

Solution:

Since the speeds are constant we know that at any point Britney has travelled 80% as far as Andrew and Carol 80% as far as Britney.

It seems reasonable to calculate that the distance Carol has travelled is

$$0.8 * 0.8 + D_A = 0.64 D_A$$

where D_A corresponds to Andrew's Distance (100 meter).

In other words, the covered distance by Carol is 64 meters at the time that Andrew was at 100 meters.

Thus Andrew beat Carol by 36 meters.

You can also find the solution through mathematical equations. Try it yourself.

Exercise 1-8   A Trip to the Market

A farmer is on her way to the local village with her sheepdog, Mist, who goes with her everywhere. To get to the village she has to cross a fast flowing river. An inventor living on the village side of the river has created a contraption to make it easier to get across. It consists of a rope and pulleys, with a seat hanging from the rope just big enough for one person. The locals have agreed to always leave the seat at the village side where the inventor lives so that it is easy for her to pack it away each evening: after all she is not charging anyone to use it. When she gets to the river the farmer pulls the seat across from the far side using the rope. She gets in, hugging Mist, then pulls herself across and continues into the village.

On one particular day she buys a new hen and a sack of corn. Returning home later in the day she arrives back at the ravine, and quickly realises she has a problem. She can only carry one thing across with her as she crosses using the seat. She will have to make several trips. The trouble is, if she leaves the hen and the corn alone on either side, the hen will eat the corn. Similarly if she leaves Mist and the hen together on one side the dog will worry the hen and may mean it stops laying eggs. Mist doesn't eat corn so it will come to no harm if left with him.

Write down the series of steps that she must take to get everything across so she can continue on her way.

Solution:

Here is one possible answer, there is another efficient solution that is similar.

   a) Farmer travels across with the hen (Dog left with Corn but that is okay).

   b) Farmer returns.

c) Farmer travels across with Dog.

d) Farmer returns with Hen (as otherwise dog will eat it)

e) Farmer travels across with corn.

f) Farmer returns (leaving dog and corn again)

g) Farmer travels across with the hen.

h) **Farmer sends the seat back to the other bank.**

It is very common to get this puzzle wrong by forgetting to return the seat at the end returning the seat. The aim is to get everything across so the farmer can carry on home. However, once that was done you had to put the seat back to the side it came from. If you made the mistake you cannot claim you did not know. It was there in the instructions, and you were even told why it was important. Making this kind of mistake where there is a last tidying up task to do is so common it has a special name - it is called a post-completion error. It appears in lots of situations like forgetting a credit card at a supermarket checkout or self service machine. When designing software you have to design the way the task is done too and avoid last steps that are easily forgotten like this.