BEBRAS

COMPUTING CHALLENGE 2014

ANSWERS AND INSIGHTS
HOUR OF CODE

ALL TASKS

Beehive

Benjamin: A

A bee must feed the larva.
In the beehive the bee can move from one cell in the hive to the next.
Some cells have walls around them that block the way for the bee.

Using arrows, show the bee how to get to the larva!

Answer:

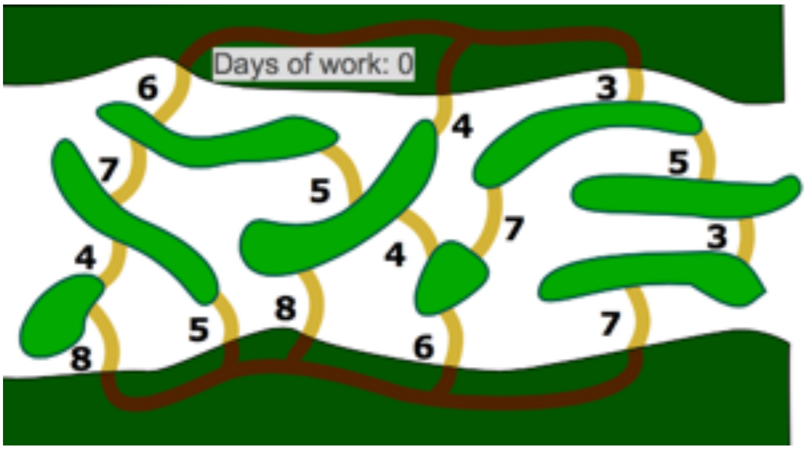
There are three ways to take five steps to the larve, but only one of them lets the fourth step be to the bottom right.

That's Computational Thinking:

Many goals can be achieved in several ways. In computer science, it is mostly a matter of finding the optimal path to a certain destination: the cheapest, shortest or most reliable, for example. These paths come with restrictions: here the length is fixed, but the restriction is that the fourth step is set to the bottom right.

Building Bridges

Benjamin: C
Senior: A

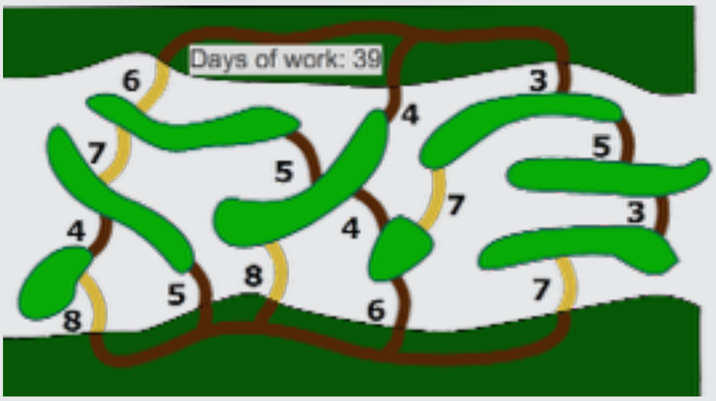


There are many islands in the river. Bob the Beaver wants to build bridges in order to make it possible to walk from every island to every other island, and from river bank to river bank. So far no bridges have been built.

Bob the Beaver wants to spend as little time as possible building. Bob has made a plan that shows all the places where it is possible to build a bridge. Bob has placed a number next to each potential bridge that indicates how many days of work it would take to build that bridge.

Show Bob how to build his bridges in as few days as possible.

Answer:
Bob needs at least 39 days.

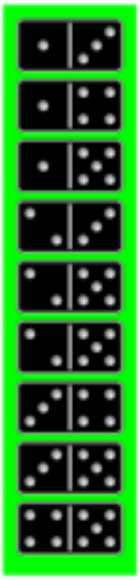


If you remove any bridge from the solution shown, at least one island or riverbank will not be accessible anymore. Because the planned bridges cost either the same amount of days or less than the unplanned bridges, this must be the best option.

That's Computational Thinking:
When you have to find an optimal solution, the answer often depends on the number of details included. Here, it depends on the number of bridges and islands. In computer science there are certain problems where, even though there are many details, there has to be a quick and simple way to find the most optimal solution. This task has to do with the ‚Minimum Spanning Tree' and its solution can be found in the Kruskal Algorithm. In essence, that algorithm says ‚with each step towards a solution, build a bridge for two islands that are not yet connected and for which you need little working days.'

Domino

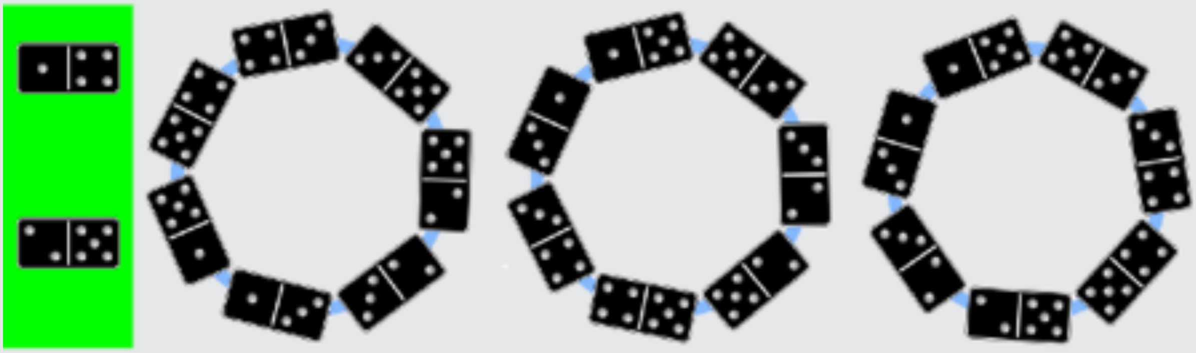
Junior: B
Senior: A



You are given some dominos and a circle.
A domino has two halves, each half has a different value.
Use the domins to create a domino ring. Dominos can only be placed adjacent to each other if the number of spots match.

Create a domino ring with as many domino's as possible.

Answer:



In a domino ring, every number should occur either twice or any other even number. Because 1, 2, 4 and 5 occur an uneven number of times, at least two dominos with these numbers can't be used in the ring. You can make different versions of the ring with the other seven dominos.

That's Computational Thinking:
At first glance the dominos seem the most important in this task, but most crucial are the number of spots (and their frequency). These can be represented in a ‚Graph', where the numbers are shown as nodes. The dominos are the lines between the numbers. In the dominos Graph (right) the thick lines represent the two dominos that cannot be used in the domino ring. In computer science, a good second look at a problem is often helpful!

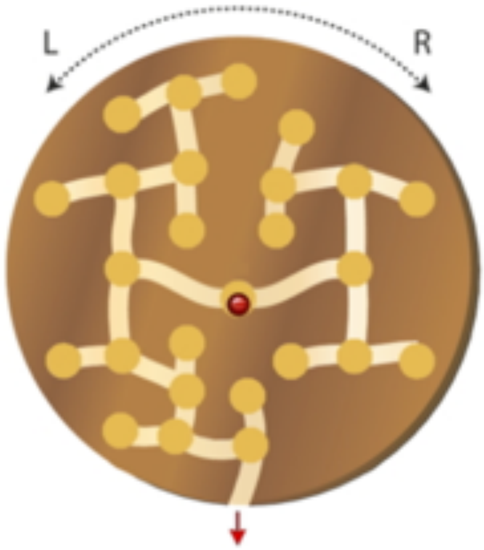
Spinning Toy

Benjamin: C
Cadet: B
Junior: B
Senior: A

Worms have built a network of nests and tunnels inside a wooden disc. The beavers have turned this disc into a fun game.

The beavers place a red marble in the nest in the middle of the disc.

By turning the disc left (L) and right (R) the beavers try to move the marble through the tunnels from nest to nest.

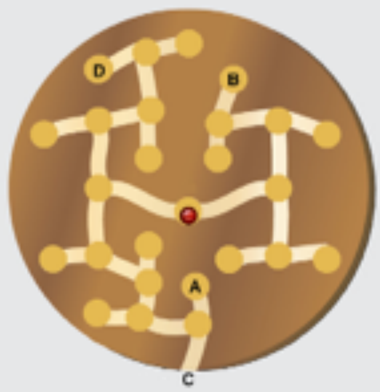


The goal is to get the marble out of the wooden disc by turning the network left and right.

Which order of moves will get the marble out of the disk?

A) LRRLRR
B) RRRL
C) LRRLRL
D) LLLRR

Answer:
In the picture you can see where the different answers lead to. If you want to save time, the first thing to notice is that it takes exactly 6 moves to get the marble to the finish. Only A and C will remain as possible answers.



That's Computational Thinking:
The nests of the worms (nodes) and the connecting tunnels (edges) can be seen as data structure, named a ‚Binary Tree'. The root of that tree is the nest in the disc center. The consequences of your moves are ‚Paths' from the root to certain ‚Leaves'. One of these leaves is your desired output.

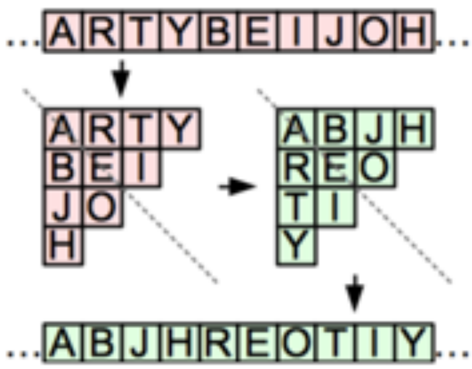
Triangle Code

Cadet: C

Betty wants to send a message to her best friend.

They invent a secret code so that no one will be able to read their messages. First Betty removes all the spaces between the words in her message and splits it into pieces that are 10 characters long. These 10 character sections are changed according to the following rules:

1 Arrange the characters in a triangle, as shown in pink below.
2 Flip the triangle across the diagonal (see illustration).
3 Write the characters in their new order, as shown in green below.



Betty's best friend receives the following piece of text:

RDIGEENORR

What was Betty's original piece of text?

Answer:
REORDERING.

Because this is a symmetrical set of rules, you can easily reverse it to get the right answer.

That's Computational Thinking:
This simple way of hiding messages is a variant of the Skytale that was used over 2500 years ago. Like all encryption methods they can be cracked, the longer the text the easier it is to crack. Unlike traditional encryption methods like the Caeser cipher or Vigenère cipher, Skytale can be applied quickly and without effort. Computer Science would advise a safer encryption, for example the One-time pad (http://en.wikipedia.org/wiki/One-time_pad)

Speed Kitchen

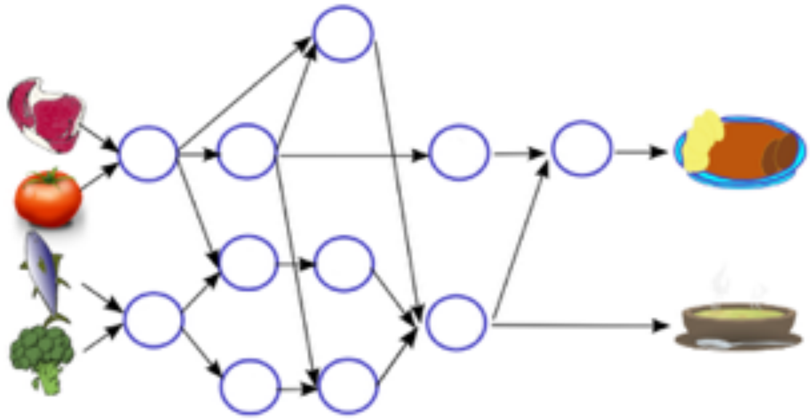
Senior: B

Anna and Ben have returned home and are very hungry. They wish to eat their dinner as soon as possible. In the fridge they find broccoli, fish, tomatoes and meat. They wish to cook two dishes from these ingredients.

Preparing the dishes takes several steps.

Most of the steps can only be started after the other steps have been finished.

The picture shows the steps as circles. The ordering of the steps is indicated with the arrows.

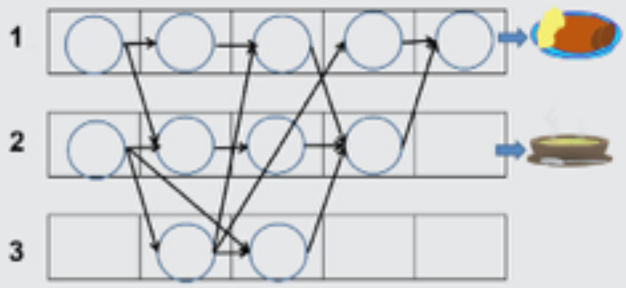


Unfortunately Anna and Ben's kitchen has only a three-burner stove.
This means that Anna and Ben can only work on three steps at the same time.
Every step of the preparation takes 5 minutes.

What is the least number of minutes it will take Anna and Ben to cook their dinner?

Answer:
It will take at least 25 minutes.

The picture shows how the steps can be divided over the three plates to achieve a minimal preparation time. Because stove number 1 is used 5 times, it will take at least 5 x 5 = 25 minutes preparation time.



That's Computational Thinking:
If you want to distribute a computerprogram on multiple processors, you have to disassemble this program into appropriate parts. The allocation to the processors should be done in a way that parts of the program must wait as shortly as possible on the results of the other parts of the program. Computer scientists are always trying to make better algorithms for this ‚job scheduling'.

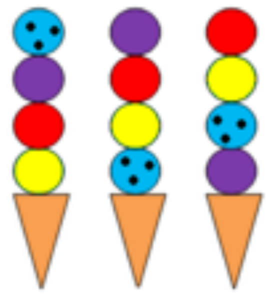
Ice Cream Cones

Benjamin: A

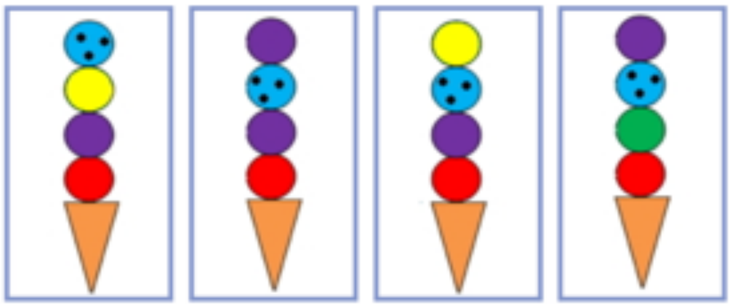
A special ice cream machine fills ice cream cones with four scoops.

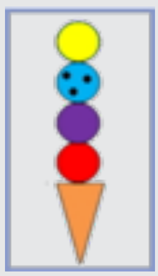
It does this in a very systematic way.

The picture shows, from left to right, the last three ice cream cones created by the machine.



What will be the next ice cream cone produced by the machine?





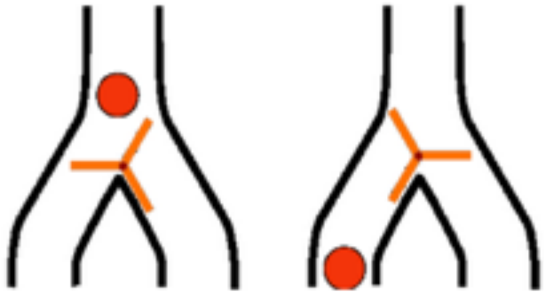
Answer:
The ice-cream machine uses the last scoop of the cone as the first one of the next cone. The order of the other scoops don't change.

That's Computational Thinking:
To understand how the ice cream machine works, a few observations are needed to reveal its regularities.

In computer science, we always try to find these regularities in more complicated things such as surfing online or exchanging e-mails. There have to be a lot of observations for this so powerful computers are needed, but everything is possible!

Flipflop

Benjamin: B
Cadet: A

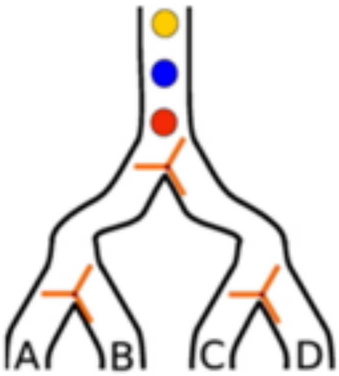


A flipflop is something that is always in one of two possible states. Every time a signal comes through a flipflop the state changes. The beavers use flipflops that work as follows:

The ball (the signal) falls from the top and then goes either left or right depending on the state of the flipflop.

While falling, it pushes the flipflop so that the next ball falls in the other direction.

The beaver builds a machine out of flipflops that looks like this:



Out of which pipe will the third (yellow) ball fall?

Pipe A
Pipe B
Pipe C
Pipe D

Answer:
Pipe B is the right answer. The first (red) ball will fall to the left at the first flipflop and to the left after that one: pipe A. The second (blue) ball will fall to the right first and to the left after that, so pipe C. The third (yellow) ball will fall to the left and then to the right: pipe B.

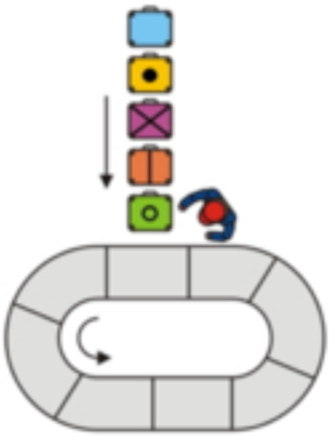
That’s Computational Thinking:
Because a flipflop can only be in one out of two states, it is ideal for storing a bit. One bit is the smallest unit of information in computer science. A bit can only have two values: ‚YES’ or ‚NO’, ‚1’ or ‚0’, ‚plus’ or ‚minus’, ‚left’ or ‚right’, etc. In computers, the memory flipflops tiny electronic circuits. Billions of them fit on a chip.

Airport

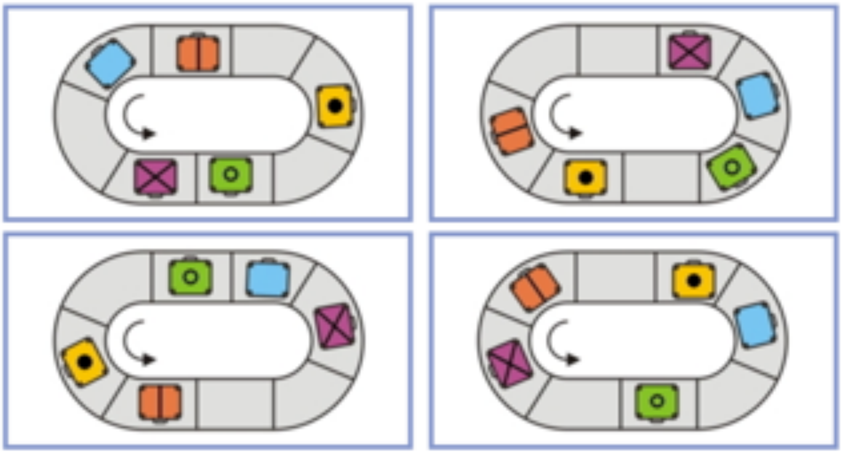
Cadet: B
Junior: A

An airport porter is loading bags on to a moving conveyor belt.

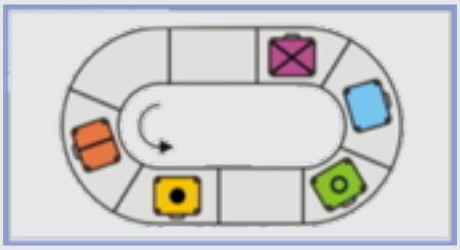
After placing a bag, he always puts the next bag on the third empty place that comes along. He stops when all five bags are on the conveyor belt.



How does the conveyor belt look with all 5 luggage bags?



Answer:



First, the green bag is placed on the empty conveyor belt. Three places behind the green one, the orange one is placed. Three places behind the orange one, the purple one is placed. Because the green bag is taking up a space, the yellow bag will be put one place later then you might think and the blue one has to be placed next to the purple one because that is the third free spot.

In answers A and D the bags are in the wrong order. If the belt would turn the other way around, C would be the right answer.

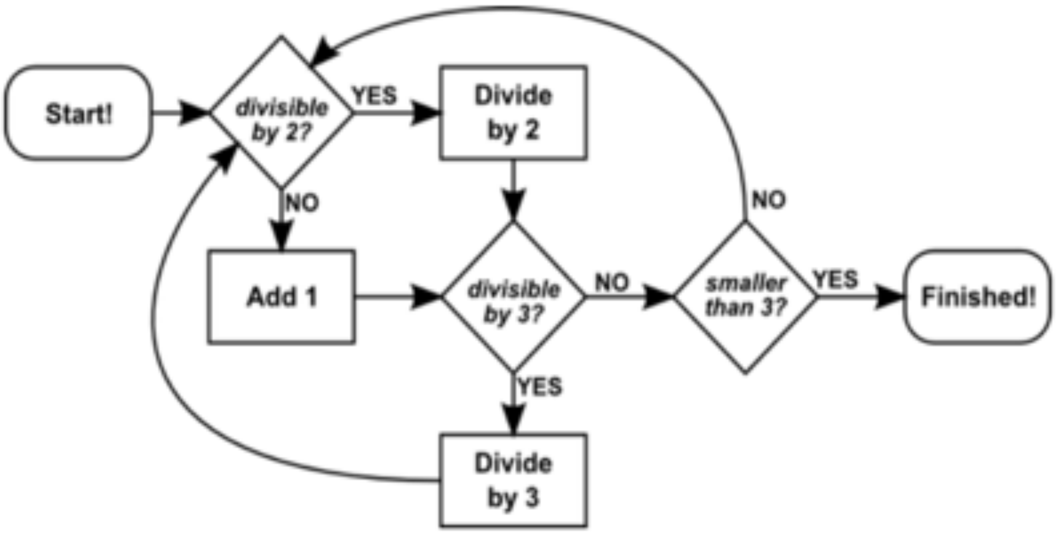
That’s Computational Thinking:
The conveyor belt consists of squares with the same capacity: a bag will fit on any square. The task has an easy rule (always use the third empty space).

The memory of computers, required by various programs, is also divided into equal-sized pieces. That way the memory can be easily managed and distributed to the programs.

Flowchart

Cadet: C
Junior: C

In school, beavers make complicated calculations using this flowchart.
They begin with a number at Start!



When starting with the number 18, what is the number when finished?

Answer:
The right answer is 2.

The following steps are taken in this flowchart:
Start with 18
Is 18 divisible by 2? Yes. 18 : 2 = 9.
Is 9 divisible by 3? Yes. 9 : 3 = 3.
3 divisible by 2? No. 3 + 1 = 4.
4 divisible by 3? No.
4 smaller then 3? No.
4 divisible by 2? Yes. 4 : 2 = 2
2 divisible by 3? No.
2 smaller than 3? Yes.
Finished!

That's Computational Thinking:
Flowcharts are one of the many methods to graphically show algorithms or processes. Because the complexity of the flowchart grows when more elements are shown, most of the time they only show the basics and separate diagrams are used to show particular elements more clearly.

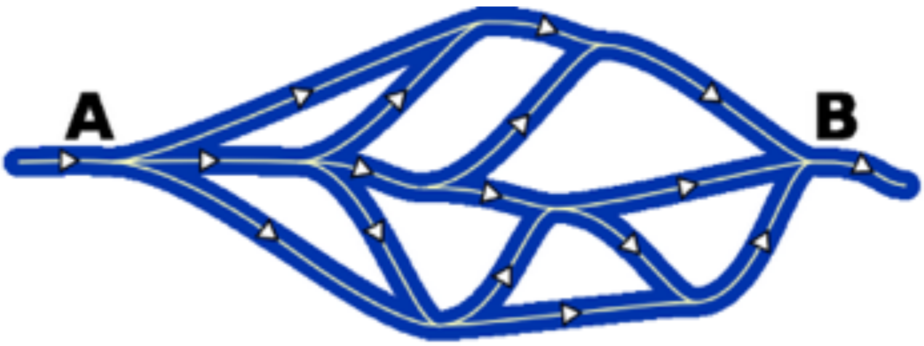
There are a lot of different methods to use. Others are the functional flow block diagram and Petri Nets.

River Check

Junior: C
Senior: B

Since water is so important for beavers, they have to check their rivers constantly.
In order to do a full river check at least one beaver has to swim through every branch of the river.

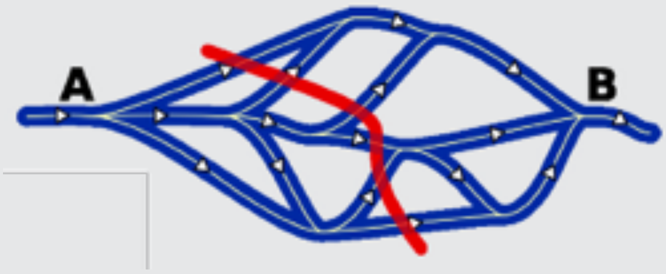
The beavers all start at A and meet up at B.
Every beaver swims exactly once, going with the flow, from A to B.



How many beavers are required in order to do a full river check?

- 3 Beavers
- 4 Beavers
- 5 Beavers
- 6 Beavers

Answer:
6 Beavers is the right answer.
One swims on the total left side,
one on the total right.
One swims ,center, left',
one swims ,center, center, left',
one swims ,center, center, right, left',
one swims ,center, right, left, right'.



The red line in the picture cuts through six branches of the river: it is impossible for one beaver to swim from A to B via more than one of those branches and the line can't intersect more than six branches, so six is the right amount of beavers needed.

That's Computational Thinking:
The system of the rivers can be modeled into a Graph, where the branches are nodes, the rivers are edges and the red line is the maximum cut of the Graph.

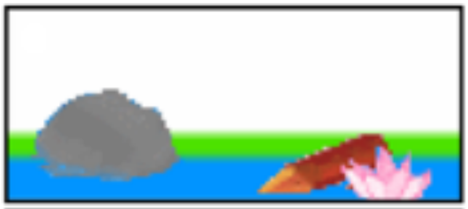
Computer science offers algorithmic solutions to most problems like this. They are often used in optimization of planning, logistics and communication networks. The (NP-complete) problem is often setting the maximum cut.

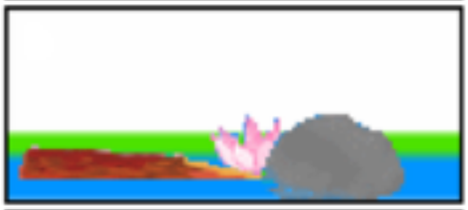
Fototour

Benjamin: B

A beaver goes for a short walk around a little pond. She starts in the position shown in the picture and walks around in the direction of the arrow.

During her trip she takes 4 pictures.

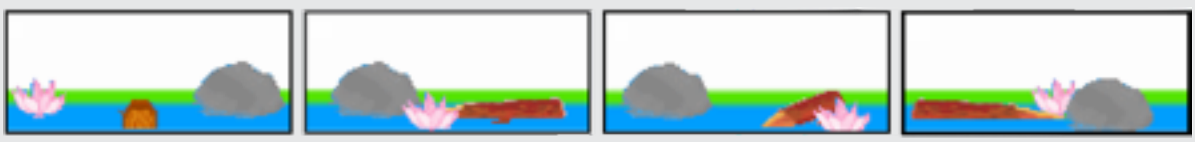




Drag the pictures in the order that she sees them!

Answer:
The pictures are made in the positions you can see on the right.

The pictures have to be placed in the following order:



That's Computational Thinking:
‚A picture is worth a thousand words', they say, and if it is more then one picture and they are related, analyzing can be interesting. At the moment computers are not as good as people in actually seeing things, but in a vary of computer science fields it's developing fast. Think about autonomous robotic vehicles, face-recognizing security cameras, etc.

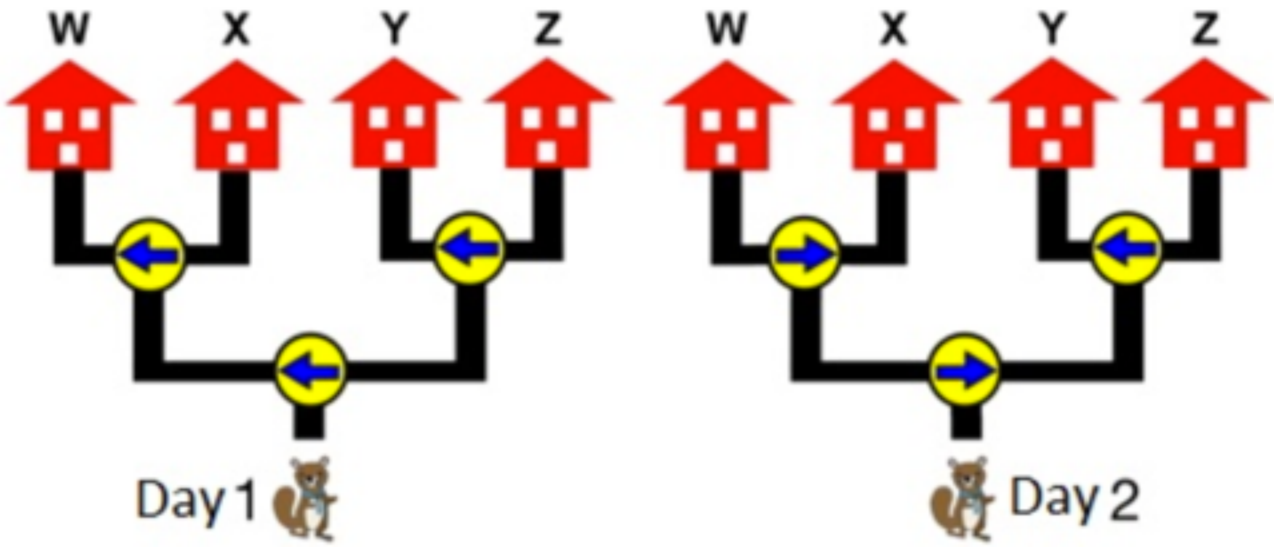
Visiting Friends

Junior: C
Senior: B

Mr. Beaver has four friends. They live in different houses. Each day he sets off from home to visit one friend.

When Mr Beaver reaches a fork in the road he follows the arrow but, as he passes, turns the arrow so that it now faces in the opposite direction. (He always ignores the arrows when returning home.)

On the first day he visits friend W. On day 2 he visits friend Y because he switched two arrows around the day before, etc.



Which friend does Mr. Beaver visit on day 30?

Answer:
On day 30, beaver visits friend Y. Mr. Beaver takes the left path when the number of times he passed that junction is odd and the right path when the number is even. On day 30 it's the 30th time he passes the first junction, so he takes the right path. Then it's the 15th time he passes the next junction, so he takes a left and ends at friend Y.

Another approach: on day 5 all arrows point in the same direction as on day 1. The different situations are all repeated every 4 days. Because of that, he situation on day 30 is the same as the situation on day 2 (30:4=7 rest 2).

That's Computational Thinking:
Each arrow has to positions: left or right. Just like a bit. Three bits can usually be put in 8 different states (2^3), but because the first arrow changes every time another arrow changes as well, it is redundant and acts like a Parity Bit.

Soda Machine

Benjamin: C

Oh no! The new drink machine at school has only two buttons.
But you can choose four drinks from the machine:
The hot drinks coffee and tea, and also the cold drinks apple juice and soda water.

The smart janitor has programmed the machine in such a way that you can select your drink by pressing twice:

First you press A to indicate a hot drink, or B to indicate a cold drink.
Then you press A for coffee or B for tea, or A for apple juice or B for soda water.

Unfortunately the janitor refuses to print a manual. Among the students various different instructions circulate. Unfortunately not all of those are correct.

The following is an example of a correct instruction:
First you press B, and then A, for apple juice.
Which instruction is correct?

A. First you press A, and then you press B for tea.
B. First you press B, and then you press B again for ice tea.
C. First you press A, and then you press A again for two hot drinks.
D. Press B for soda water.

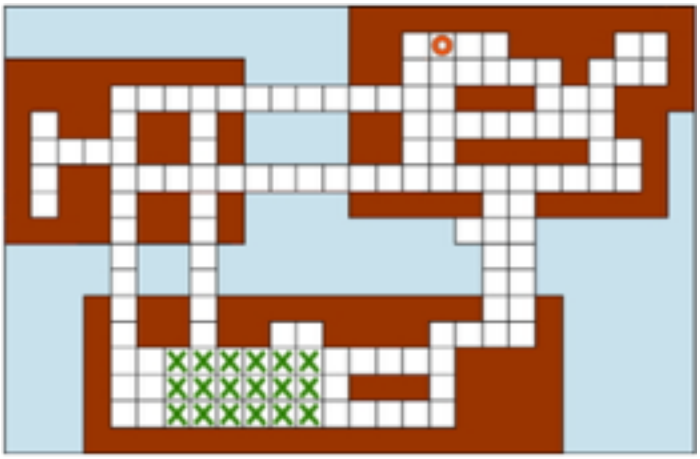
Answer:
First you press A, and then you press B for tea.

A. A - B means hot drink - tea. That's right.
B. B - B means cold drink - soda water. Cold tea is not there.
C. A - A is hot drink - coffee. It's just one hot drink.
D. B means cold drink. Another key must be pressed to select your drink.

That's Computational Thinking:
This drink machine works well with the Automata theory. It works with input, state and transitions. With two inputs (Button A and Button B), at least seven states (Waiting, A, B, A - A, A - B, B - A, B - B) and four drinks it's a simple example. A real beverage machine would have to be more practicable. To do so, you can add things like ‚If nothing happens for two seconds after pressing the button, the machine returns to its standby mode.

Going Home

Senior: C



The two islands have a road network that consists of squares. The islands are connected by bridges, that also consist of squares.

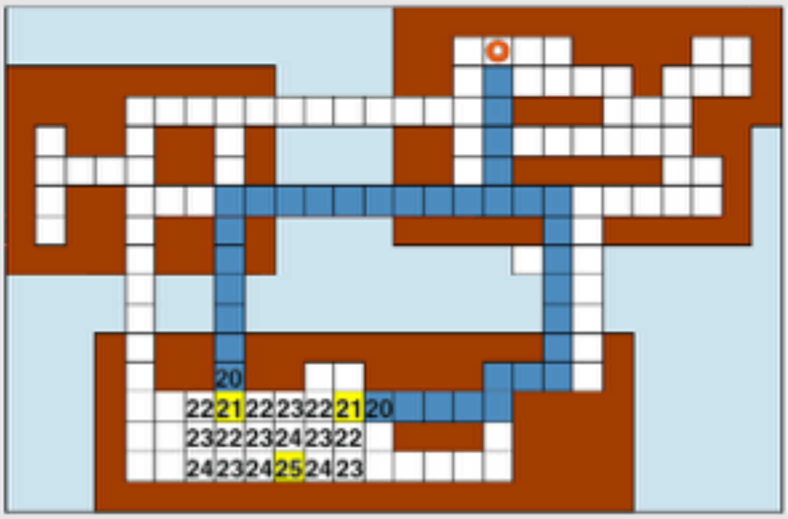
It takes Igodot beaver one minute to move from a square to the next square. Igodot will always move in straight lines, and will never go diagonally.

Igodot is somewhere on the field that is indicated with green crosses. He wishes to come home as soon as possible. His home is indicated with a circle.

How many minutes will it take Igodot to come home?

At least 21 minutes and at most 25 minutes
Exactly 20 minutes
At least 20 minutes and at most 24 minutes
Exactly 25 minutes

Answer:
At least 21 minutes and at most 25 minutes.



The answers with an exact number can't be right, because not all green crosses are at the same distance from his home.

That's Computational Thinking:
We know a lot, but we don't know everything. It's difficult to formally describe incomplete knowledge so it can be scored in computers and used for plans and expectations. Different areas of computer science are working on that problem. The topics include Interval arithmetic, Statistics, Pattern Recognition, Fuzzy Logic and Epistemology.

Hobbiber

Cadet: C

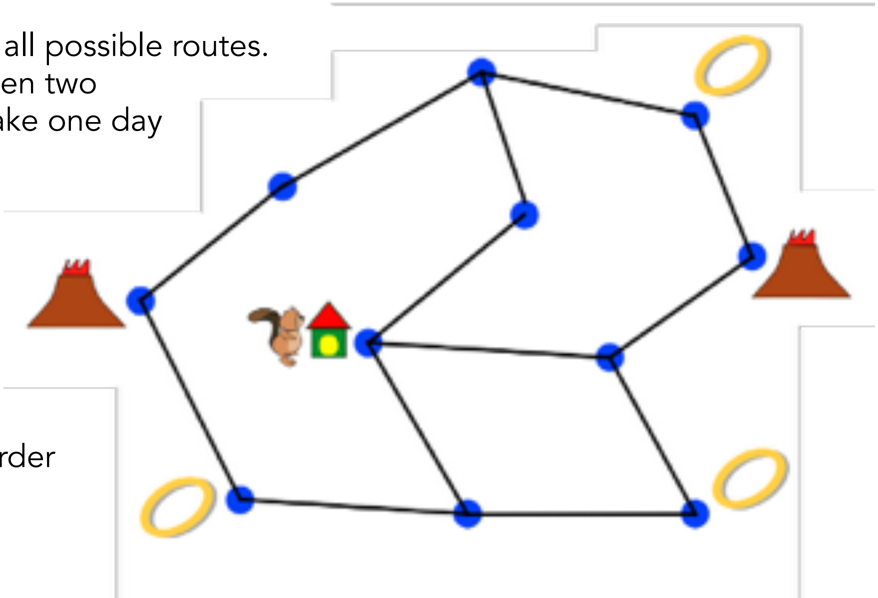
Hobbiber is going on a journey. His mission:

1 find three rings,
2 throw the rings in one of the volcanoes,
3 return home.

Hobbiber possesses a map with all possible routes. The map indicates a road between two points as a line. Each road will take one day of traveling.

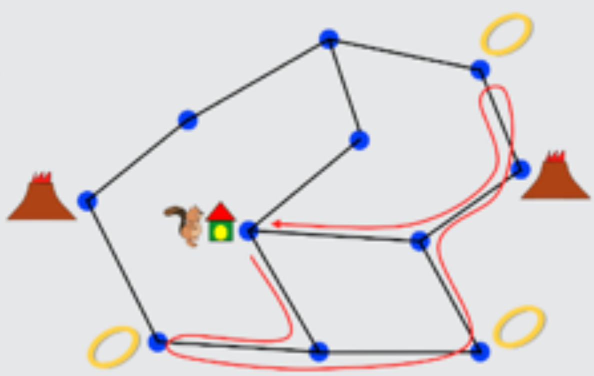
Hobbiber can travel across the roads as many times as he wishes. He does not have to travel across all the roads.

What is the least number of days Hobbiber has to travel in order to complete his mission?



Answer:
10 days is the right answer.

After two days the Hobbiber will have the first ring (on the down left). It's another two days to the ring on the right and another three to the upper ring, so it takes 7 days for him to get all the rings. From there it only takes one day to get to the volcano on the right and two days to get back home, so 10 days in total.



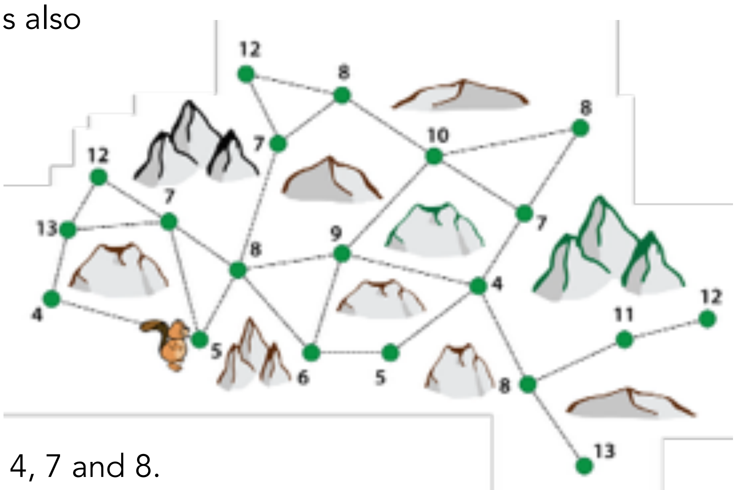
That's Computational Thinking:
When you are looking for a certain road that has to meet a couple conditions, you can look at it as a graph. If you tried to find a road by trying and thinking, it's difficult to know for sure if it's the shortest one.

Computer science has developed methods to search for these kinds of optimums. They make it easy to find a solution quickly. It's not optimal yet: mostly it's best if estimated that the optimum will not be much better but more time-consuming to find than the solution they found so far.

Tallest Tree

Benjamin: C
Cadet: B

The map below uses green dots to show where trees are. For each tree the height of the tree is also indicated.



The beaver cannot see far because of all the mountains. If he can see a tree from another tree, this line of sight is indicated by a green line between two points.

The beaver wants to cut down the tallest tree he can find. He starts his search at the tree that has height 5. From there he can see trees with heights 4, 7 and 8.

From this spot he goes to the tallest tree he can see. From each new location, he searches again for the tallest tree in a similar way. He continues until he cannot see a tree that is taller than the tree where he is standing.

How tall is the tree that the beaver cuts down?

9
10
12
13

Answer:
10 is the right answer.

From his starting point, the beaver will see trees of heights 4, 6 and 8. He goes to 8 and from there sees 6, 7 and 9. He goes to 9 and sees 4, 6, 8 and 10. He goes to 10 but will see only 7, 8 and 9 from there. They are all shorter than the tree he is standing next to, so he will cut it down.

The higher trees, 11, 12 and 13, are not in his sight from the place where he is standing now.

That's Computational Thinking:
In practice, looking for a global optimum is often to expensive, to time-consuming or in need of other resources. At that point, we choose to search for a local optimum. That's the case here with our beaver: he doesn't have to run over all the mountains and still gets to the seventh highest trees of the 20 trees on the map.

Tunnel Rescue

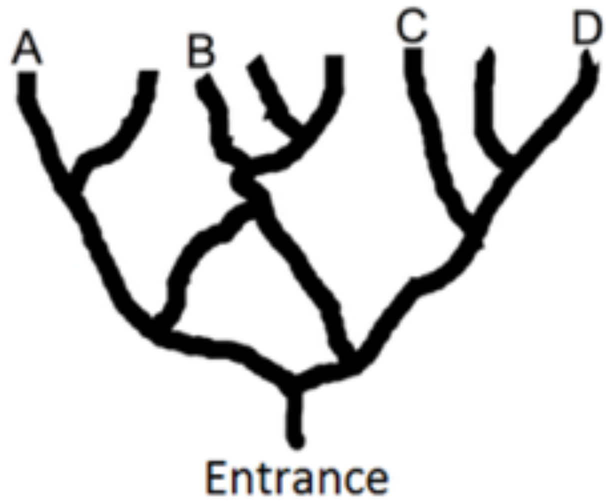
Benjamin: C

21 cave researchers want to work their way through a cave system.

They start as a single group at the entrance and whenever there is a fork they go deeper into the cave system. Every step they take moves them farther away from the entrance.

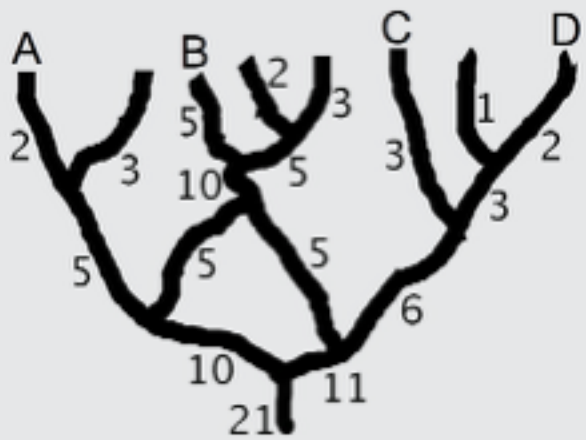
When a group reaches a fork it splits in two: the same number of people go left as go right. In the case of an odd number in a group, the extra person takes the right hand cave.

In which final cave will the largest number of researchers end up?



Answer:
Answer B.

Take a look at the picture on the right to see where all the researchers will go.



That's Computational Thinking:
You can put this information in a Graph: every cave road is an edge and every fork is a node.

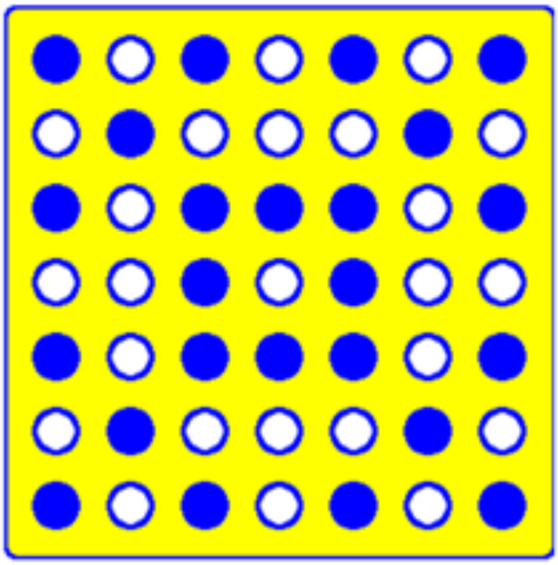
By specifying the direction the researchers walk to (always forward, deeper into the cave system), the Graph will become a Directed Acyclic Graph. This makes sure the researchers won't walk around in circles.

More information on the Graph:
http://en.wikipedia.org/wiki/Directed_acyclic_graph

Hotel Key Card

Senior: C

The Beaver Hotel has introduced a new key mechanism. Every guest receives a square plastic card with 7 x 7 small circles on it. Every circle can either be punctured or not punctured. An example key card is shown to the right.

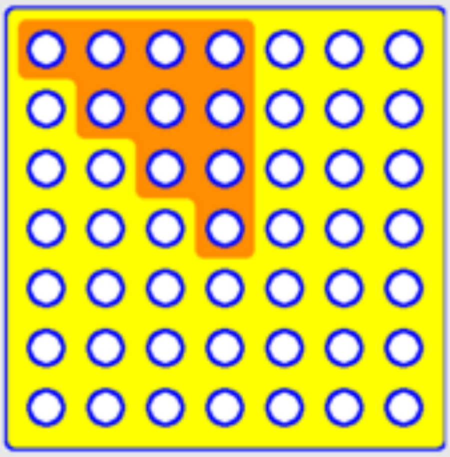


The door to each room has a key reader that accepts the key and checks the pattern of punctured holes on it. Since the keys are completely square, and back and front look exactly the same as well, it is important that every key looks exactly the same when turned or mirrored.

How many different key cards can be created?

16
49
1024
65536

Answer:
1024.



Because it has to be symmetric in fourfold, you can only change 10 circles of the card. If you change any other circle, it won't work when you turn or mirror the card.

Each code point is binary: perforated or non-perforated. This results in 2^10 = 1024 possible codes.

That's Computational Thinking:
Because computer science systems are mostly used by people, and people sometimes make mistakes, it's important to make a system as fault tolerant as possible.

The system in this task is fault tolerant because it doesn't matter how you insert the card into the key reader. The card contains the right code eight times: that redundancy makes it fault tolerant.

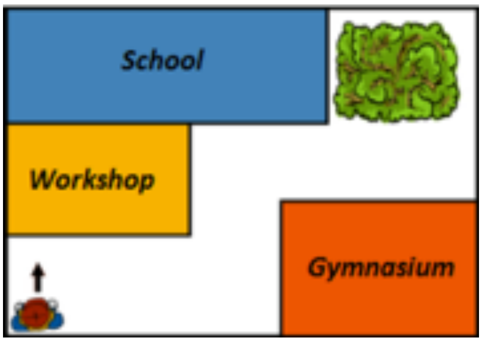
Jeremy in the Bushes

Benjamin: A

Some children are playing a robot game - Jeremy is the robot and he listens only to these orders: forward, left, right.

If he hears "forward", he walks straight ahead until he hits an obstacle (building, fence, bush).

If the children say "left", Jeremy turns left but doesn't move.



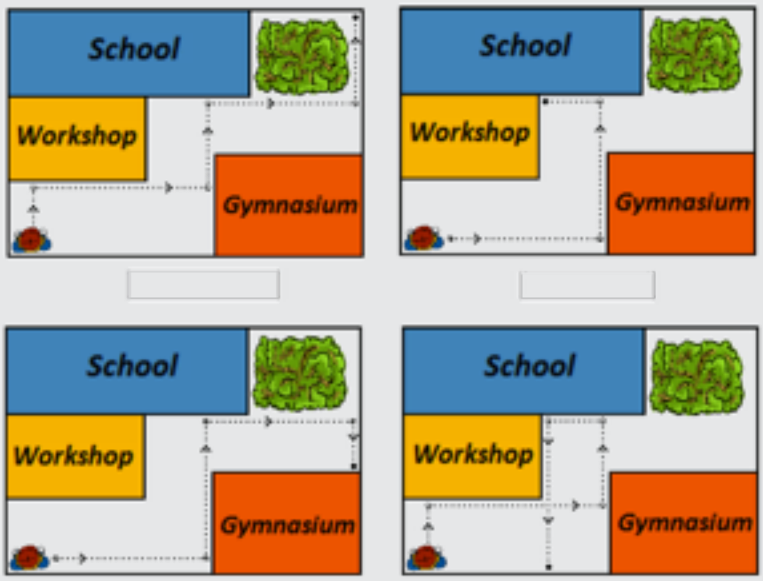
If the children say "right", he turns right but doesn't move.

Jeremy starts in the left lower corner of the playground and he looks at the workshop. The children want to navigate him into the bushes in the upper right corner of he playground.

Which orders will the children shout to navigate Jeremy into the bushes?

Forward, right, forward, left, forward, left, forward, left, forward
Forward, right, forward, left, forward, right, forward, left, forward
Right, forward, left, forward, right, forward, right, forward
Right, forward, left, forward, left, forward

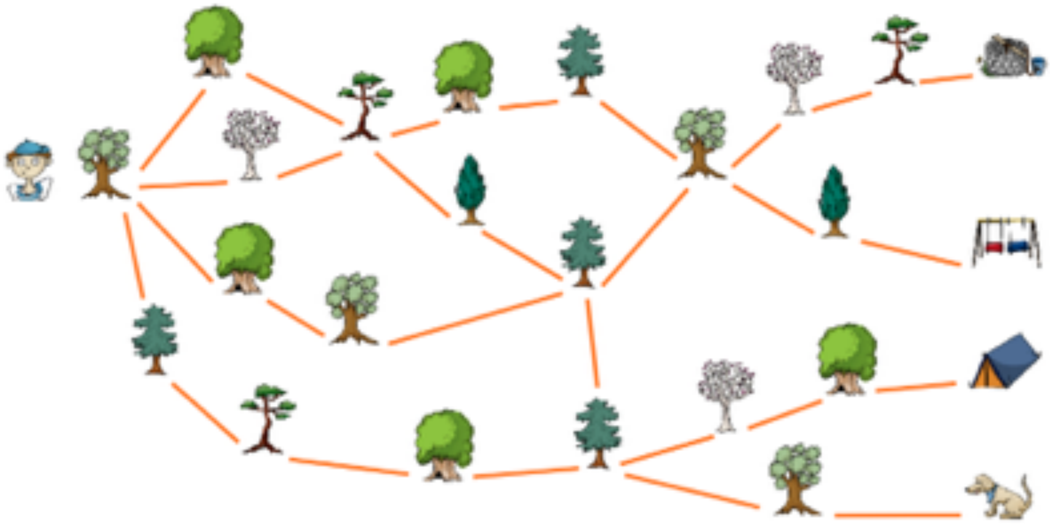
Answer:
Forward, right, forward, left, forward, right, forward, left.



That's Computational Thinking:
This task is about controlling robots. The commands that you can give a robot is its programming language and sequences of commands are his program. There are many different types of robots: on wheels, flying with propellers, diving, in space. Some have arms and grippers, others can see with cameras or hear with microphones, feel with buttons. The more sensors and actuators a robot has, the more versatile the programming language will be.

In The Forest

Benjamin: A



Rupert went for a walk in the forest.
There were several possible paths but the one Rupert chose led him to a dog.

Below are four possible paths Rupert may have taken. Which is the one that led him to the dog?

Answer:

You don't have to try every path to come to the right answer: try to exclude answers by looking at the last two trees. With the first option the last tree is incorrect, and with the right two options the second last tree is not correct. That's why it has to be the one on the bottom left.

That's Computational Thinking:
Often, really good solutions in computer science are found by looking at a problem backwards.

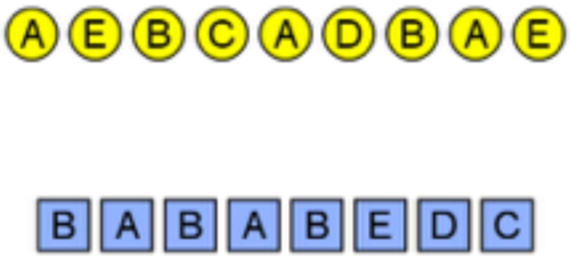
Connecting Letters

Benjamin: A

Draw lines with your mouse between circles and squares to connect the same letters. You do this by clicking on a circle and dragging with your mouse.

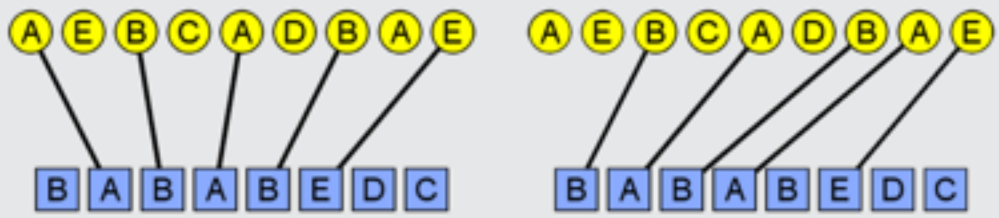
There are three rules you must obey:

- Only one line from each circle is allowed.
- Only one line to each square is allowed.
- The lines may not cross each other.



Draw as many connections as possible.

Answer:



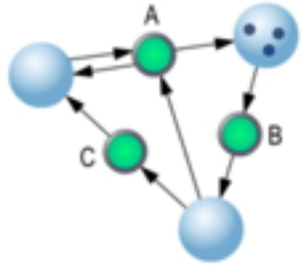
There is a maximum of 5 connections that can be drawn in one of the two ways shown above.

You can’t connect the left E, because then only the bottom left A and the bottom right C or D can be used. The same thing happens when you connect the circles C or D, because you’ll only have three circles left to connect when you use them (not counting the E we just excluded). If you do not use these letters, a maximum of 5 connections stays left.

That’s Computational Thinking:
To solve this task, officially you check what the longest identical letter combination is that can be made with the upper and bottom letters, while the order remains the same. In computer science this problem is known as the Longest Common Subsequence (LCS) problem. The solution to this problem can be used, for example, in comparing two text files. It is easy to see if someone deleted, changed and added something to a text file. To find the LCS, dynamic programming is applied: solving a problem by breaking it down into simpler subproblems.

Magical Machine

Senior: C



The beavers are playing with a magical machine. It is composed of glass bubbles containing coins. The bubbles are connected together with big push buttons. On the right is a picture of the magical machine.

If a bubble has an arrow coming from it, it is called a source bubble. If a bubble has an arrow going to it, it is called a target bubble. (A bubble can be both a source and a target for different push buttons.)

When one of the big push buttons is pressed two things happen in the order below:

1. The machine checks that there is at least one coin in all the source bubbles linked to this push button.

2. If check 1 is true, a single coin disappears from all of the source bubbles and appears in each of the target bubbles for that push button.

Example: If push button B is pressed, one coin will move from the top right bubble and appear in the bottom bubble.

Interestingly, there is a sequence of button pushes that ends up putting the magical machine into a stable state. In this state, no matter which button is pushed, nothing will change.

Which order of button pushes leads to this stable state?

Answer:
B-B-C-B-C-C.

You have got to get all the coins in the left bubble. Then there is no button that still has a coin in al its sources, so any of them can be pressed. This answer gets the machine in that state. Other given answers get the following output:

B-B-C-A-B-A:	Left 1, right 2, bottom 0.
B-C-B-C-B-A	Left 2, right 1, bottom 0.
B-C-B-B-A-A	Left 1, right 2, bottom 0.

All these outputs have coins in the right bubble, so the B-button can still change the state.

That's Computational Thinking:
This magical machine is a visualized Petri Net. These nets are used for modeling and simulation of discrete dynamical systems: office processes and production methods, for example. In computer science they are a useful tool in developing and analyzing software in those kinds of applications.

Zebra Tunnel

Benjamin: B
Cadet: A

The beaver railway has two special types of tunnels. If a train travels through a black tunnel, the passengers come out in reverse order:

If a train travels through a white tunnel, the first and last passenger automatically change position:

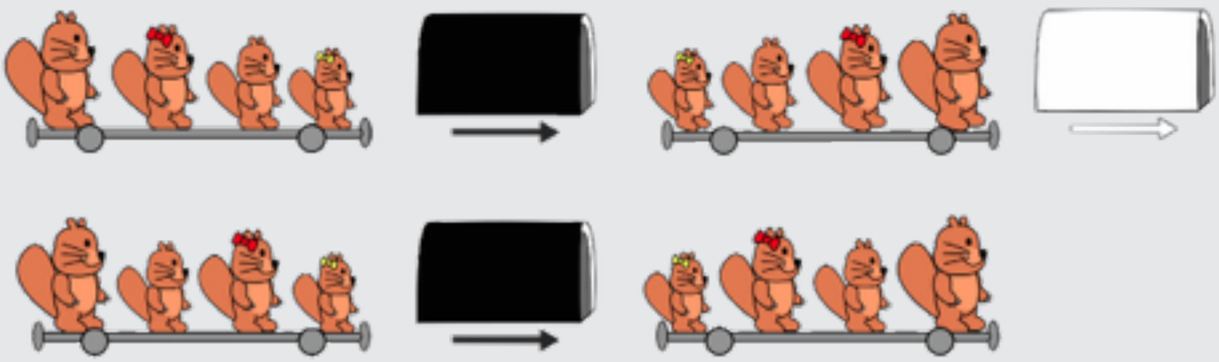
The following train goes through three tunnels:

In which order do the beavers come out of the last tunnel?

Zebra Tunnel

Benjamin: B
Cadet: A

Answer:



When you start, the order is 1234. After the first black tunnel it's 4321. After the white tunnel it's 1324 and after the second black one it's 4231.

That's Computational Thinking:
The tunnels represent two functions. Both change the order of the sequence, but they have a special property: they inverse themselves. When a car drives through two black ones, they are right back in the order in which they started.

If you have a very long set of tunnels, the only thing you need to know is whether the number of white or black tunnels is even or odd. 67 black tunnels and 33 white ones have the same result as 1 black and 1 white one.

Another classic computer science story about interactions between algorithms and data structures can be found here:
http://www.cs.utexas.edu/users/EWD/ewd03xx/EWD365.PDF

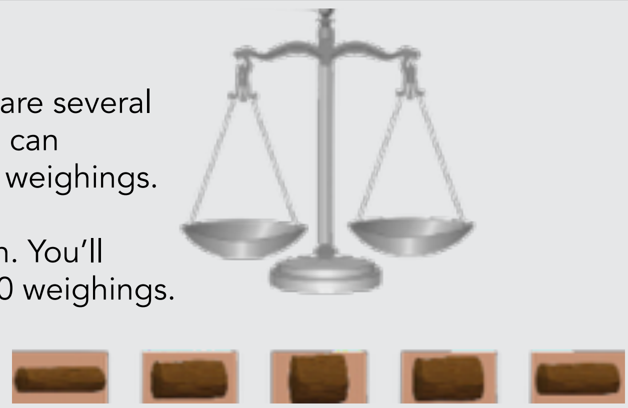
By Weight

Cadet: C
Junior: A

The beavers wish to sort five logs by size. You have to help them.
Pull two logs at a time onto the scale to compare their weights.
Then pull the logs to the proper spot below the scales.

Sort all five logs by order of weight; the lightest on the left, the heaviest on the right.

Answer:
The answer is shown on the right. There are several ways to find this order. For example, you can determine the lightest log by doing four weighings. Then you can do three weighings to determine the second lightest, and so on. You'll get a good answer with a maximum of 10 weighings.

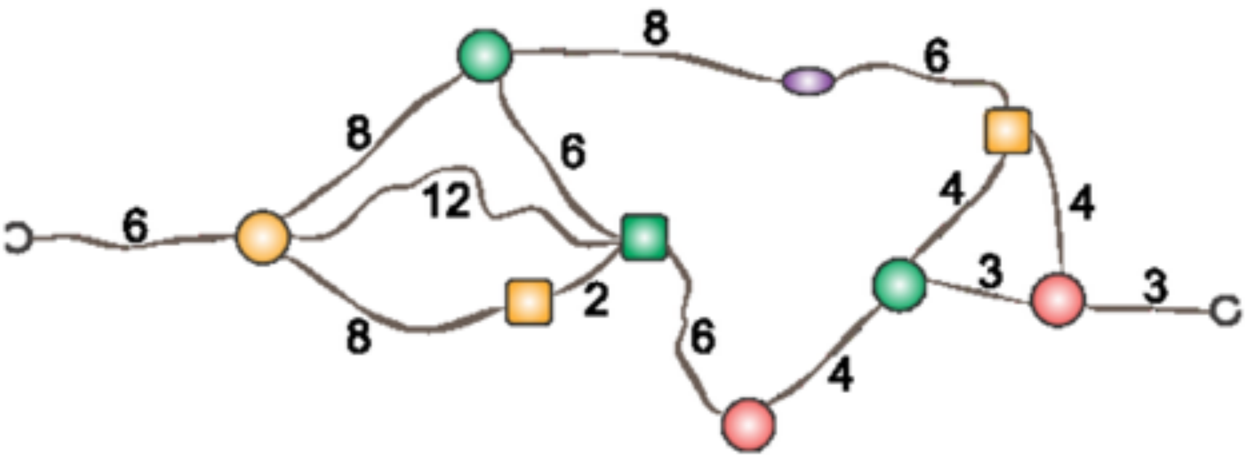


That's Computational Thinking:
Data has to be sorted in almost every computer program: that makes it better to handle for the computer. Like a sorted phonebook is more efficient for us than an unsorted one. That's why there have to be good methods for sorting. Talking about the sorting process, computer scientists often talk about sorting algorithms. They are a classic part of computer science education. The proposed method in this task answer comes close to the ‚Selection sort', but there are many other methods that can be used.

A Fitting Necklace

Cadet: A
Junior: A

Kim has knotted a wonderful necklace using colored pearls. But will it fit around her neck?



The numbers indicate (in centimeters) the length of a piece of string between two pearls.

The parts to lock the necklace around her neck are on the far left and far right.

What is the maximum size of neck around which the necklace will fit?

26 centimeter
32 centimeter
34 centimeter
35 centimeter

Answer:
32 centimeter.

The necklace is just as long as its shortest string, and in this case that's
6 + 8 + 2 + 6 + 4 +3 + 3 = 32.

That's Computational Thinking:
If you're getting used to computational thinking, you'll see right away that this task can be transposed to a Graph with the pearls and locking parts as nodes and the strings as edges. You'll get the shortest path between the locking parts left and right.

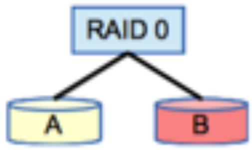
There are efficient algorithms to get the shortest path between two nodes in a graph, which is important here. This one, with 11 nodes and 14 edges, can be done without using a computer, but it gets more complicated when you have to calculate the fastest route by bus or train in a medium sized city for example. The number of possible connections will be much bigger!

RAID

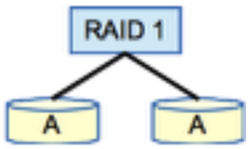
Senior: C

RAID is a special technology where several hard disks are bundled to be used as a single drive. We will look at the following two types of RAID:

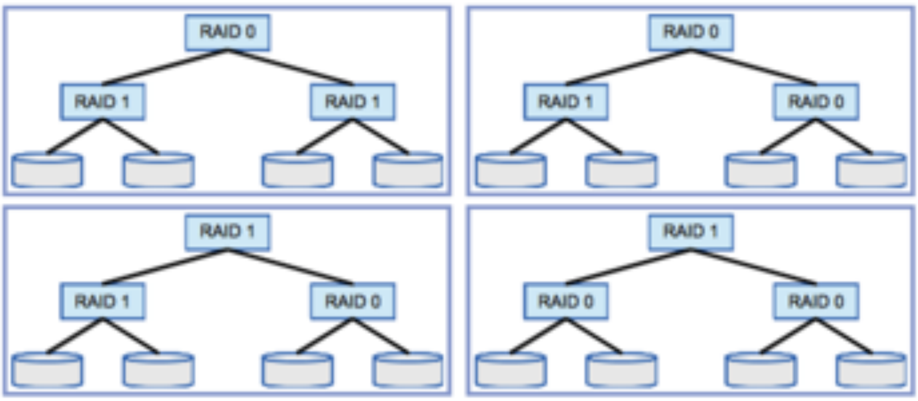
RAID 0:
Your stored data is split between two hard disks.
This means that each hard disk has completely different content. Your drive will look twice as big but the risk of data loss when one of the hard disks breaks down is large.
The picture shows RAID 0 with two hard disks.



RAID 1:
Your data is stored on one hard disk and an exact copy is made on a second hard disk. This means that both hard disks look exactly the same. Your drive will not be bigger but if one of the hard disks crashes you still have a copy of all your data on the other hard disk.
The picture shows RAID 1 with two hard disks.



In which of the following arrangements is it possible for ANY TWO hard disks to break down without losing any data?



Answer:
The bottom left answer is right: RAID 1, RAID 1 and RAID 0. All data is saved twice in the bottom RAID 1 and once in RAID 0. If any two break down, there will still be one left. In the top two choices, data will be lost if the left two disks break down and in the bottom right one data will be lost if one disk of the left and one disk of the right RAID 0 break down.

That's Computational Thinking:
With this RAID technology you can either increase data protection or the stored data speed. A RAID can be managed in the software of an operating system or in the hardware.

Back Side

Junior: C
Senior: C

Aristo places four cards in front of him.
On one side of each card is a letter; on the other side is a number.

Aristo makes the following claim: "If one side of the card shows a vowel, then the other side is always an even number."

You know that 'E' is a vowel', V' is a consonant, '2' is even and '7' is odd.

Which cards must you turn over to check his claim? Turn over only those cards, and no other cards!

Answer:

The card with an E must be turned over: if there is an odd number on the back, Aristo lied. He didn't say anything about consonants so there is no use in turning over the V. There is no need to flip the 2: if there is a consonant on the back it wouldn't mean he lied and if it's a vowel he is telling the truth. The 7 must be turned over as well: if there is a vowel on the back, Aristo lied.

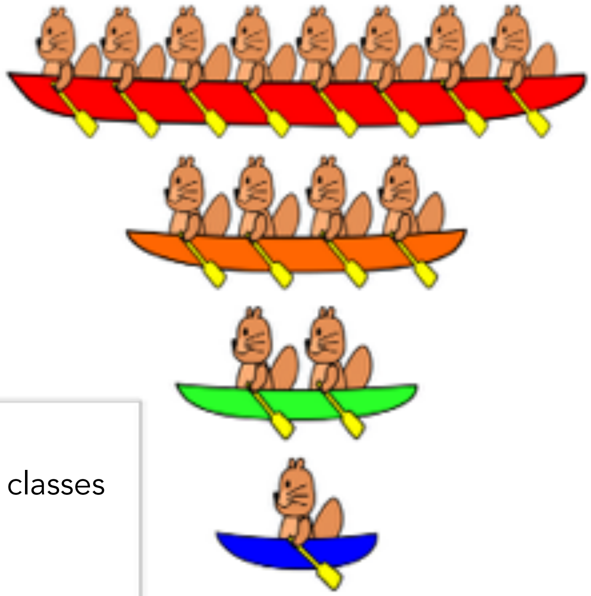
That's Computational Thinking:
It's not difficult to let a computer do the thinking for you. Especially when it comes to terms of classical logic implications. (IF a THEN b) is one of the basics in almost every programming language. In some of them you can even program something that a human brain can't understand: (IF (IF a THEN b) THEN (IF b THEN a)).

Rowing Tournament

Cadet: B
Junior: A

Some Beavers want to participate in a rowing tournament. They have only four boats: one of each for the following boat classes:

one for eight beavers,
one for four beavers,
one for two beavers,
one for a single beaver.



The rules of the Tournament state that each beaver may only compete in one boat.

The beavers' coach wants all the beavers to take part and has to decide into which of the boat classes he will enter teams of beavers.

On the entry form the coach has to enter 1 if he is entering a boat and 0 if he is not. His entries must be in size order, starting with the largest boat.

For example, if ten beavers participate he would write down 1010 which means one boat of eight, no boats of four, one boat of two and no boats of one.
This year thirteen beavers would like to participate.

What does the coach write down?

Answer:
1101. It stands for 8 + 4 + 0 + 1 = 13.

0111 would mean 0 + 4 + 2 + 1 = 7
1011 would mean 8 + 0 + 2 + 1 = 11
1110 would mean 8 + 4 + 2 + 0 = 14

That’s Computational Thinking:
The binary system is a numeral system where instead of 0-9 only 0 ad 1 are used. To change the binary system into our regular numeral system, you have to multiply the number with 2^it’s place. That means, for the number 1101:

$$1\times(2^3) + 1\times(2^2) + 0\times(2^1) + 1\times(2^0) = 8+4+0+1 = 13.$$

Dice

Junior: B

The three instructions "draw-1", "draw-2a" and "draw-2b" will create a small drawing that looks like the side of a dice.

draw-1 draw-2a draw-2b

The instruction "turn90" will turn a drawing 90 degrees clockwise. If you follow several consecutive instructions different drawings appear.

For example, "draw-2b, turn90" creates the following drawing: 

"draw-1, draw-2a, turn90" produces this drawing: 

Which set of instructions will result in the following drawing? 

draw-2a, turn90, draw-2a, draw-2b
draw-2b, draw-2a, turn90, draw-2a
draw-2b, turn90, draw-2a, draw-1
draw-2a, draw-2b, turn90, draw-2a

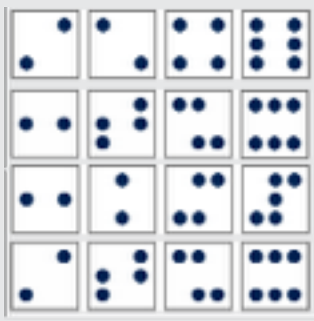
Answer:

draw-2a, turn90, draw-2a, draw-2b ->

draw-2b, draw-2a, turn90, draw-2a ->

draw-2b, turn90, draw-2a, draw-1 ->

draw-2a, draw-2b, turn90, draw-2a ->



So the first answer is correct.

That's Computational Thinking:
The things you can do with this point pattern language are very limited. No repetitions or loops, no conditional branches, no parameters… It's definitely not universal! The only thing you can do with it is changing a matrix of three by three points, by using four constructions.

You can train your programming skills by writing the shortest program to get a certain point pattern.

Serial Transmission

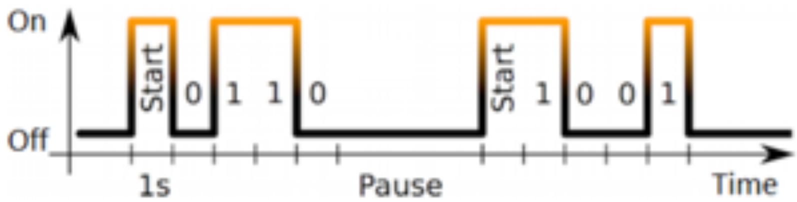
Cadet: C
Junior: B
Senior: A

Alice and Bob use flashlights to send each other messages at night.
The messages are sent in blocks. Each message block contains four digits; the digits are either 0 or 1.

A message always starts with a flashlight signal of one second. The message block signals are sent following this start signal.

To send 1 the flashlight is switched on for 1 second.
To send 0 the flashlight is switched off for 1 second.

After each four digit block a pause of at least 1 second is made. Here is an example showing the transmission of the blocks 0110 and 1001:



Which message is sent in the following picture?

Only message block 0101
Message blocks 0011 and 1100
Message blocks 0011 and 1110
Message blocks 1100 and 0011

Answer:
The second answer is correct: 0011 and 1100.

The first part of the transmission takes 5 seconds: the starting second and then four digits 0011. Then there is a pause of 2 seconds and the second part of the transmission: start, four digits 1100.

The first answer doesn't take into account that each digit only takes one second. The third answer mistakes the start of the second block as a digit. The last answer is exactly the other way around with 0 as the flashlight goes on and 1 when it goes off.

That's Computational Thinking:
This task describes the well known RS-232, which is a standard for serial communication transmission of data. It was first introduced in the 1960's but still commonly used because it's a simple, reliable way to communicate between all possible devices.

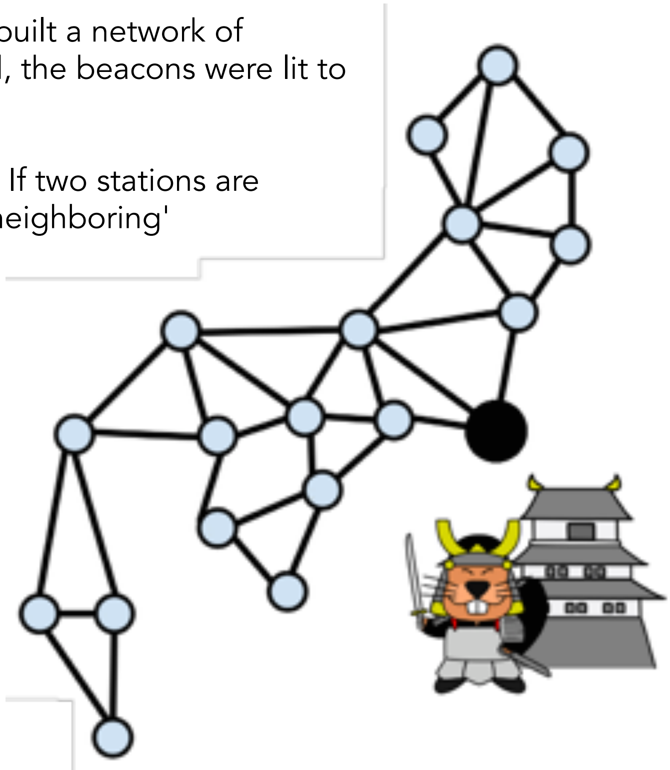
Letters can also be converted to numbers using coding tables as ASCII or Unicode, by using bits (zeroes and ones). Nowadays 8 bits per block are transmitted instead of four like shown above.

Beacon

Benjamin: B
Cadet: B
Junior: A
Senior: A

A long time ago, the beaver samurai of Japan built a network of beacon stations. When an emergency occurred, the beacons were lit to warn the whole country.

The stations are shown as circles in the picture. If two stations are connected by a line, this means that they are 'neighboring' stations.

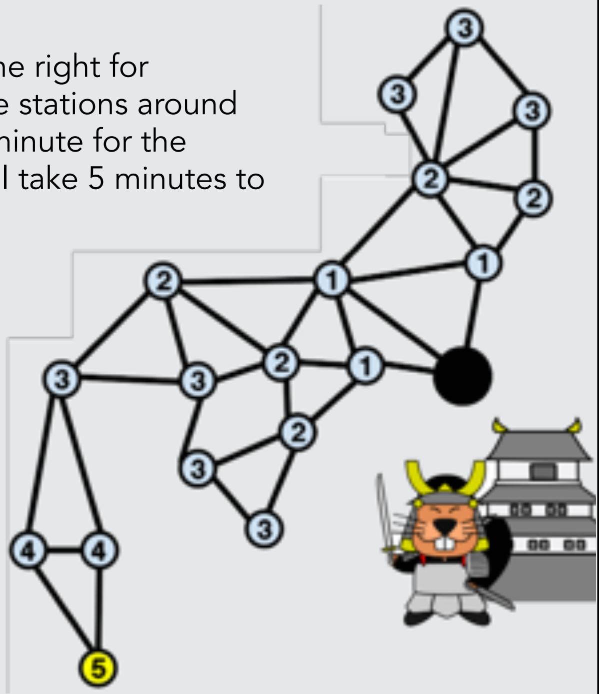


When a beacon is lit, it will take a minute before the neighboring beacons will see the signal fire. They then ignite the fire in their own beacons.
After another minute, the neighbors of these neighbors will see the signal fire and ignite their beacons. This sequence is repeated until all stations have lit their beacons.

One day the beacon of the headquarters is lit (the large black circle on the map).
How many minutes does it take until all the beacons are lit?

4, 5, 6, or 8 minutes?

Answer:
The correct answer is 5. See the picture on the right for explanation: it will take a minute for the three stations around the headquarters are lit. It will take another minute for the stations around those are lit, and so on. It will take 5 minutes to reach the bottom station.



That's Computational Thinking:
The tasks is designed as a graph data structure. It's an abstract data type. You'll see it all around you when you know where to look: think of the metro network maps, for example. In the case here, the distance between two stations (or nodes, in the graph) are always equal, so the solution will be found when you calculate the shortest road to headquarters for every station and select the longest one as your answer. This can be done using the BFS strategy: a Breadth-first Search.

Swapping

Benjamin: B
Cadet: A

During the big flood of last spring Benny Beaver has lost everything except for the feather on top of his hat. He wishes to trade his feather for something else, that he will then again trade for something else, etc. His goal is to obtain a nice beaver home after several trades.

Benny has found the following possible trades on the beaver net. For example, Anna would like to trade his feather for a balloon.

How can Benny get a home by making consecutive trades?

Drag the appropriate trade offers to the right side, and place them in the correct order.

Beaver	Takes	Gives
Anna	Feather	Balloon
Bert	Feather	Basket
Claudia	Balloon	Boat
Daniel	Boat	Motor Cycle
Emile	Balloon	Bicycle
Francisca	Basket	Boat
Gustav	Basket	Dog
Helen	Dog	Balloon
Ivo	Bicycle	Balloon
Jeanine	Dog	Rug
Klaus	Rug	Motor Cycle
Lili	Painting	Rug
Monika	Bicycle	Motor Cycle
Norbert	Rug	House

Beaver	Takes	Gives

Drag from the left to here and then place in the correct order!

Answer:

Beaver	Takes	Gives
Bert	Feather	Basket
Gustav	Basket	Dog
Jeanine	Dog	Rug
Norbert	Rug	House

That’s Computational Thinking:
This exchanging task can be seen as a Graph, where the nodes are the objects that can be traded and the edges the exchanges. Not every node can be reached from another node, and the ‚house‘ node can only be reached from the ‚rug‘. It helps to see this as a directed graph.

From A to C

Junior: C
Senior: B

You have a toy robot that can execute the following commands:

F	move one step forwards
L (x)	turn x degrees left
R (x)	turn x degrees right

Initially your robot is always located at point A. It is facing to the right and is waiting for instructions. If the robot has to execute several instructions consecutively, those instruction are separated by a +.

For example: F + L(20) + F + R(2) means:
The robot takes a step forwards, turns left 20 degrees, then takes another step forwards and finally turns right 2 degrees.

If your robot has to execute the same instructions several times, this is indicated with a *, for instance: 180*(F + L(1)) means that the robot will take a step forward and then turn left 1 degree 180 times.

By using this program the robot would move from A to B in approximately the way shown in the illustration.

Which program would cause the robot to move from A to C in approximately the way shown in the picture?

90*(F+L(1)) + 90*(F+R(1))
90*(F+L(1) + F+R(1))
90*(F+L(1)) + R(30) + 90*(F+R(1))
L(90) + 90*(F+L(1)) + R(90) + 90*(F+R(1))

Answer:
90*(F+L(1))+90*(F+R(1)).

90*(F+L(1)) is a quarter circle to the left, 90*(F+R(1)) is a quarter circle to the right.
90*(F+L(1) + F + R(1)) will get the robot to point C in almost a straight line.
90*(F+L(1)) + R(30) + 90*(F+R(1)) won't even get the robot to point C and
L(90) + 90*(F+L(1)) + R(90) + 90*(F+R(1)) makes the robot start running upwards instead of to the right.

That's Computational Thinking:
The commands the robot knows can be formulated into a simple programming language. Computer science knows many different programming languages and new ones are always being developed. Some are well suited for certain applications like statistics of simulation, but most programming languages are universal: with them you can program everything a computer is able to do.

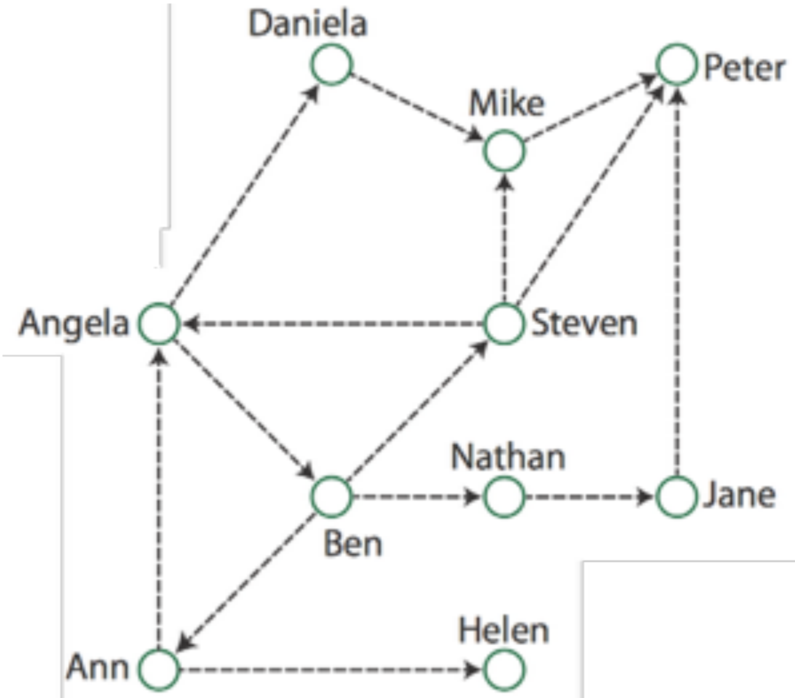
What's New?

Cadet: A

The beavers in school like to chat with each other and spread gossip.

The image shows which beavers talk to which other beavers. As an example, Steven, tells everything to his friends Angela, Mike and Peter.

Today, Ann brought an interesting piece of news to school that spread quickly. During the lunch break Helen, Peter, Steven and Jane sat together and found out that Helen and Peter had heard the gossip, but Steven and Jane had not.



There must be someone absent from school today that stopped the spreading of the gossip. Who was absent today?

Nathan, Angela, Ben or Mike?

Answer:
Ben.

If Peter heard the news but Steven and Jane did not, Peter must have heard it from Mike, Daniela and Angela. Angela and Mike must have been there, either of them cannot be the right answer. If Steven didn't hear the news, Ben didn't tell him. If he was in school, he would have heard the news from Angela, so Ben wasn't there. That's the reason Jane didn't hear anything, wether Nathan was there or not.

That's Computational Thinking:
Information is flows through networks. This is the case with humans, like in this task, but also with computers. If nodes are broken or out of order, like Ben in this task, the flow is disrupted. Networks like the internet are build in such a way that information still gets to it's destination when one or several nodes break down. People learn from that; as we are communicating more in such a way that more people know about it. Think of the exchange of e-mails or having friends on social networks.

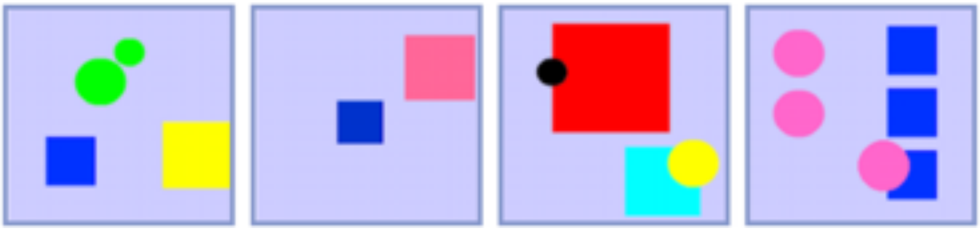
Random Gift Paper

Junior: B
Senior: B

A factory produces gift wrapping paper. Printing a sheet of paper works as follows: The printer prepares colored squares and circles in the computer's memory and then prints them on the sheet of paper. The printer follows the following instructions:

1. Prepare a circle with a random color and size and call this C.
2. Repeat the following set of instructions a random number of times:
   a. Prepare a square with a random color and size and call this Q.
   b. Set the size of C randomly to either Small or Large.
   c. Print C at a random position on the sheet of paper.
   d Print Q at a random position of the sheet of paper.

Which of the following patterns could NOT have been printed by this factory?



Answer:

Because the color of C is randomly set at the start and not changed afterwards, all circles on one paper must have the same color, they can only have different sizes. Also, the printing works as follows: print a circle, then a square, then a circle, then a square. In C, you see the circles overlay the squares which means they are both printed after the squares. That's not possible: the printer has to start with one circle. Note: the second result shown can happen when two squares are printed directly on the two circles.

That's Computational Thinking:
One of the main concepts of computational thinking is algorithm: a structured sequence of instructions that get executed by a machine. The instructions in this task are like an algorithm: his structure is set by the printing instructions and the repetition.

Algorithms that use random elements are called ‚Randomized' in computer science. These algorithms don't always get optimum results (like the second option in this task), but they are easy to understand en provide good results for difficult problems. Computer Scientists are working to understand the effects of this randomized algorithms and control those effects. Eventually they would like to have a program that knows how well it's own results are.