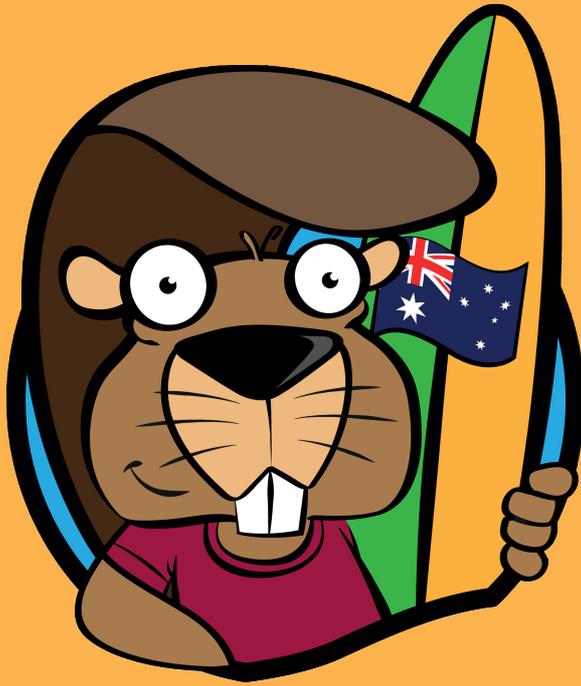


digitalcareers

bebras.edu.au



Bebras Australia Computational Thinking
Challenge
Tasks and Solutions 2014

Editors:
Karsten Schulz, NICTA
Sarah Hobson, Good News Lutheran School

Acknowledgements

We would like to thank the international Bebras Community for allowing us to use the tasks that they have developed over recent years. Bebras is a collective effort of many countries and we are grateful for the warm welcome that Australia has received. Team Australia's buddy in the international Bebras Community is Team Germany, which has a long-standing involvement in Bebras since 2006. We have started to contribute Australian-made tasks back to the international Bebras community and are glad to be part of such a wonderful sharing group of countries. Special thanks goes to Eljakim Schrijvers from The Netherlands who is a master of the Bebras System and a key go-to person for Bebras Tasks.

Computer science is a very international discipline, and Bebras embodies this principle outstandingly.

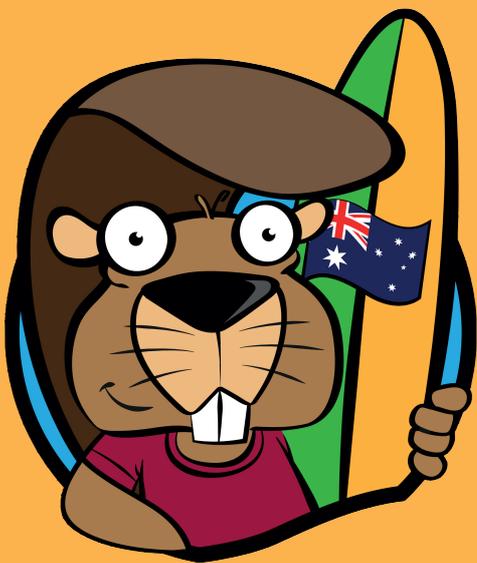
We would like to thank the Australian Government as represented by the Department of Communications for providing funding to the Digital Careers Initiative which is running Bebras Australia.

We would also like to thank the Australian Curriculum, Assessment and Reporting Authority (ACARA) for providing advice regarding Bebras tasks.

Introduction

About Bebras Australia

The Bebras Australia Computational Thinking Challenge was established in 2014 to enable Australian primary and secondary school students to have a go at Digital Technologies without programming. The format is designed to engage students in a light and problem-oriented way.



For Australia, we have developed the two characters Bruce and Beatrix who accompany the students in many of the tasks. Beavers are hardworking animals that sink their teeth into problems and work tirelessly until they have accomplished their task. This is how we imagine our young computer scientists.

Everyone can do it

The challenges consist of a set of short questions called Bebras tasks that are delivered via the internet. The tasks can be answered without prior knowledge about computational thinking, but are clearly related to computational thinking concepts.

Work alone or in teams

To solve the tasks, students are required to think about information, how information is organised, how data will be processed, and make decisions that can both demonstrate an aspect of computational thinking and test the talent of the participant.

There are 15 problems to be solved. These are presented under three levels of difficulty – Easy, Medium, Hard – each consisting of five questions. The questions get progressively more difficult as students progress through the levels of schooling.

Bebras is aligned with and supports the new Australian Curriculum: Digital Technologies.

Bebras: International Contest on Informatics and Computer Fluency

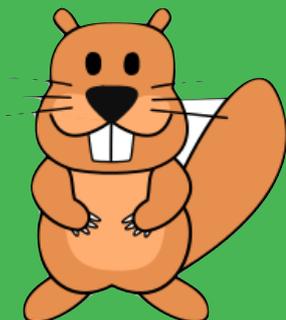
Bebras is an international initiative whose goal is to promote computational thinking for teachers and students (ages 8-17; years 3-12).

The idea of Bebras was born in Lithuania, by Prof. Valentina Dagiene from University of Vilnius. Bebras is the Lithuanian word for “beaver”. The idea emerged during the travel around Finland in 2003 and discussions about how to attract students to learn informatics. The activity of beavers in strands was so noticeable, that it suggested the symbol of the contest... Beavers look like persistent workers who endeavour for perfection in their field of activities and beaver away to reach the target. Their everyday job seems to

be a trial: the one who pulls down more trees will stem more streams... Therefore, our competition was named after the hard-working, intelligent, and lively beaver.



UK Beaver



Japanese Beaver

The first Bebras contest was organised in Lithuania in 2004. By 2013, the Bebras contest had spread across the world with more than 700.000 participating students. Bebras is the non-school activity in Informatics education with the largest audience.

The international Bebras Community jointly develops the tasks for the annual Bebras Week. Australia, France, Japan, Canada, The Netherlands, Austria, Switzerland and Germany use a common online system, which is being developed and managed by the Dutch company Eljkim IT.

Further information about Bebras International and its member countries is available at www.bebas.org.

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Bank Notes

A BEBRA is the currency unit of a country. The country uses six kinds of bills worth 1 BEBRA, 2 BEBRAs, 4 BEBRAs, 8 BEBRAs, 16 BEBRAs and 32 BEBRAs.



What is the fewest number of bills needed to pay exactly 50 BEBRAs without receiving change?

Answer:

(number input)

Solution: 3 (notes)

The banknotes correspond to each digit of the binary number.

$$(50)_{10} = (110010)_2$$

Therefore, 50 BEBRAs consist of one 32 BEBRAs, one 16 BEBRAs and one 2 BEBRAs note.

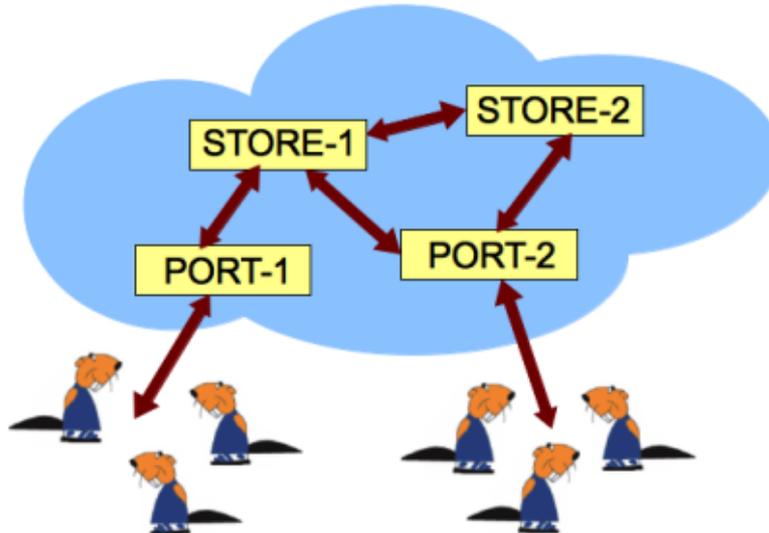
It's Informatics:

A computer is representing data internally with binary numbers. The bits array expresses a certain number by using each digit meant 1, 2, 4, 8, 16, 32, ... In this question, children can explore the mystery of the internal expression of computers through the use of the banknote corresponding to a binary digit.

See also: <http://csunplugged.org/binary-numbers>

Beaver Cloud

The beavers store their data in a cloud containing four servers. The image shows all connections between the servers.



To lower the risk of losing data, all data are stored on both STORE-1 and STORE-2. To increase the accessibility, all data are available through both PORT-1 and PORT-2.

No data is stored on PORT-1 and PORT-2.

Which statement is FALSE?

Answers:

A	If STORE-1 and PORT-2 crash, all data become inaccessible.
B	If PORT-1 and PORT-2 crash, all data become inaccessible.
C	If STORE-1 and STORE-2 crash, all data are destroyed.
D	If PORT-1 and PORT-2 crash, all data are destroyed.

Solution: D)

If PORT-1 and PORT-2 crash, then all data in the cloud become inaccessible, but are not destroyed.

It's Informatics:

For any data there are risks that data might become inaccessible for some time, or get lost completely. If you manage the storage of your data yourself, you decide yourself what risks you take.

If you transfer the responsibility for your data to a 3rd party IT service company, you should know, what risks they take. Besides loss and inaccessibility there are many more risks, e.g. your data might be copied and misused by someone, so your privacy is compromised; your data might be changed maliciously, so you cannot trust it anymore. Is the careless "cloud" metaphor just a commercial trick to obscure from you the many risks you take when giving away the responsibility for your data?

Keywords:

data safety, data risks, cloud

Beavers secret code

Beaver would like to send secret messages to his friend, the hare.

They've come up with a secret code for encrypting the messages, so nobody else can read them.

In their secret code, the vowels (A, E, I, O, U) and the punctuation remain unchanged.

The consonants are replaced by the next consonant in the alphabet, where Z becomes B.

How would Beaver write "GIVE ME A CALL" in his secret code?

Answers:

A	GOVE MI E CELL
B	FITE LE A BAKK
C	HOWE NI E DEMM
D	HIWE NE A DAMM

Solution: D)

The first consonant G of the message is encrypted as H. The vowel I remains. V becomes W, E unchanged and so forth.

It's Informatics:

To transfer or protect data, computer scientists encrypt data. Rules determine how the data is encrypted and how it can be decrypted. By repeatedly applying the rules through an algorithm, the message gets encoded. In this task, each letter is treated individually and the encoded message is as long as the unencoded message. By applying the algorithm in reverse order, the original message can be retrieved.

Keywords:

encryption, algorithm

Bebrocarina

The Bebrocarina is a special musical instrument: It has only six different tones.

And: after a tone is played, only the same tone or the tone directly above or below it can be played.

Therefore, a melody for the bebrocarina can be written with only three different symbols:



o	Play the same tone again.
+	Play the tone next tone above it.
-	Play the next tone below it.

With these three symbols, one can write down melodies, based on a single starting tone. It is however possible to write melodies with these symbols that cannot be played on the bebrocarina.

Which of these melodies can **NOT** be played with a bebrocarina?

Answers:

A	(+ooo+ooo+ooo+ooo+)
B	(-----o++++o-----)
C	(---o+-o---ooo+)
D	(---+++--o+---)

Solution: D)

If the bebrocarina can play only 6 different tones, the minimum number of steps the player can use to move from the highest to the lowest tone is 5 steps. It corresponds to “-” marks in the notation of the melody. Thus, the difference between the number of “-” signs and “+” signs should not be bigger than 5 in every part of the notation.

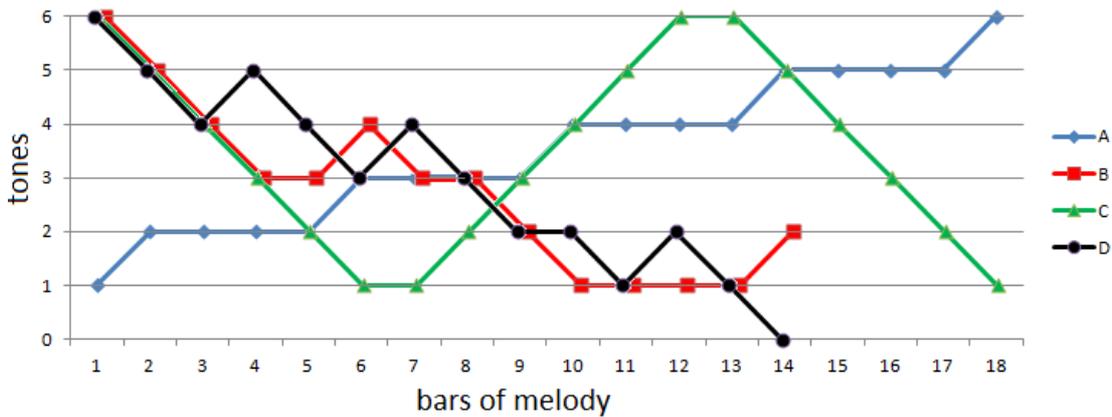
The same rule applies in reverse. The number of “o” signs is not limited.

Answer A is right because the sequence of the tones we pass through is 5.

Answer B has 6 “+” signs but not in a sequence, there is one “-” sign in between, so that the total number of tones is 5.

Answer C has a sequence of 5 “-” signs. The first leads from the highest to the lowest tone and the following sequence of 5 “+” signs returns melody to the highest tone. The last sequence of 5 “-” signs leads to the lowest tone once more. We do not need more than 6 tones.

Answer D contains 9 “-” signs and only 3 “+” signs, the difference is 6.



Look at the graph. The A, B, C, D melodies are visualised on it. It is visible that melody D needs 7 different tones.

It's Informatics:

“In communications and information processing, code is system of rules to convert information—such as a letter, word, sound, image, or gesture—into another, sometimes shortened or secret, form or representation for communication through a channel or storage in a medium. An early example is the invention language, which enabled a person, through speech, to communicate what he or she saw, heard, felt, or thought to others. But speech limits the range of communication to the distance a voice can carry, and limits the audience to those present when the speech is uttered. The invention of writing, which converted spoken language into visual symbols, extended the range of communication across space and time.

The process of encoding converts information from a source into symbols for communication or storage. Decoding is the reverse process, converting code symbols back into a form that the recipient understands.

One reason for coding is to enable communication in places where ordinary plain language, spoken or written, is difficult or impossible. For example, semaphore, where the configuration of flags held by a signaller or the arms of a semaphore tower encodes parts of the message, typically individual letters and numbers. Another person standing a great distance away can interpret the flags and reproduce the words sent.” Source: <http://en.wikipedia.org/wiki/Code>

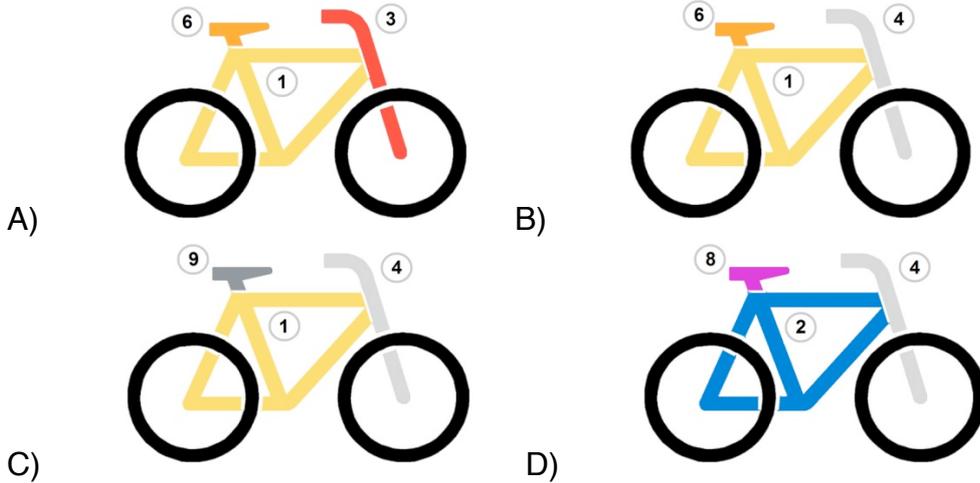
Keywords:

code

Further Information:

<http://en.wikipedia.org/wiki/Code>

Answers:



Solution:

B) does not conform to the specification, as after selecting the light orange bicycle frame and the grey coloured handle bar only the colours pink and dark grey (and not orange) are allowed to be used for the saddle.

All other bikes are in line with the specification.

It's Informatics:

A decision tree is a commonly used structure in informatics. Such structures are often present in computer programs. Depending on the history of an issue all possible options may not be allowed any more, only selected options.

Keywords:

Decision tree

Building dams

Three beavers with 'a', 'b' and 'c' on their bellies are building a dam under the management of their leader.

The beavers can carry out four tasks: "carry", "build", "eat" and "pause".

Each beaver can only do one task at a time, and any task can only be assigned to one beaver at a time.

In the beginning, the tasks are assigned to the different beavers as follows:

carry	build	eat	pause
 	 	 	

Then the leader gives the command "carry → pause", which means that the beaver that is carrying, must switch to pausing.

After this command the tasks are assigned as follows:

carry	build	eat	pause
	 	 	 

The leader gives several more commands, which are properly executed by the beavers. After these commands, the tasks are assigned as follows:

carry	build	eat	pause
 	 	 	

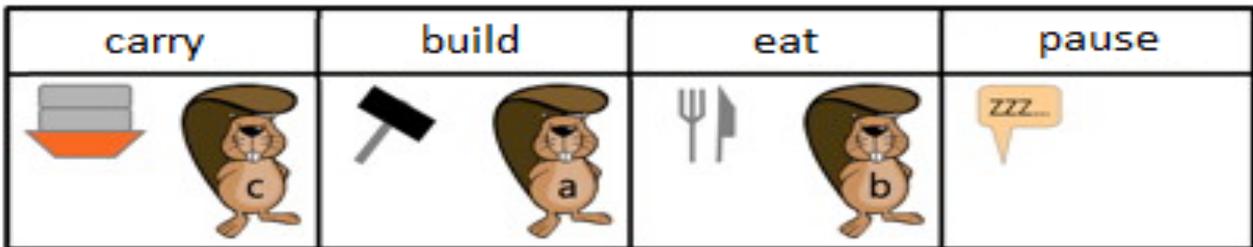
Which commands did the leader give and in which order?

Answers:

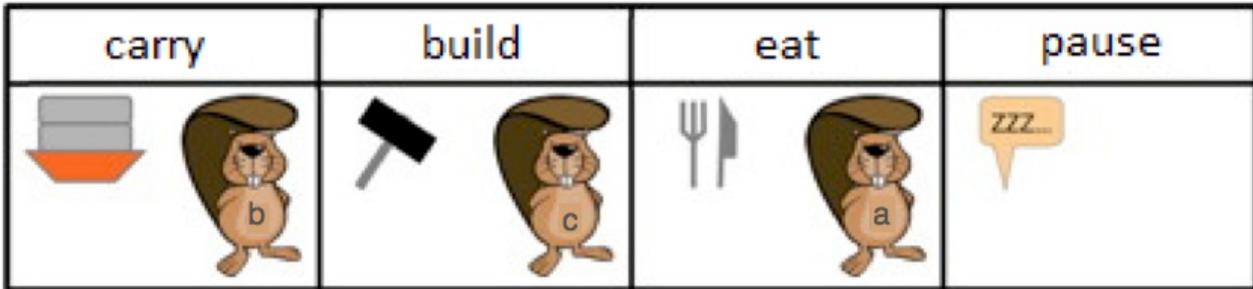
A	pause → build ; eat → carry ; build → eat
B	eat → carry ; build → eat ; pause → build
C	build → carry ; eat → build ; pause → eat
D	pause → carry ; build → pause ; eat → build ; pause → eat

Solution: B

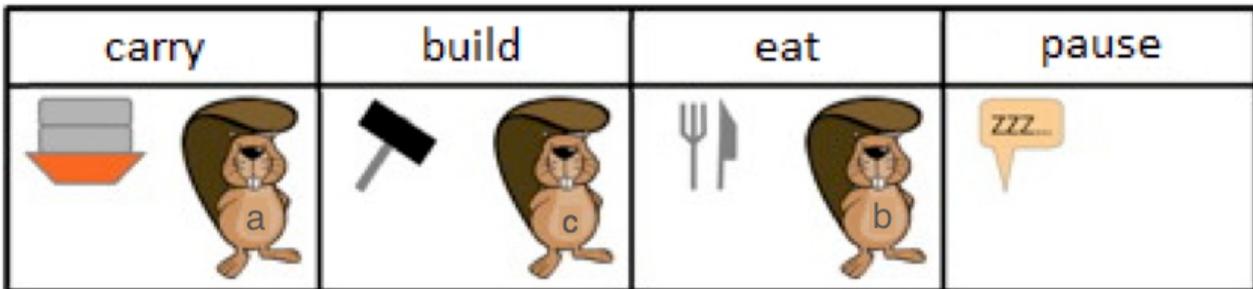
After all the instructions have been completed, beavers' states will be changed as follows: Answer A). It is impossible because two beavers would be at state "carry" at same time. Answer B). This sequence of instructions is correct.



Answer C). Beaver 'a' should be at state 'build'. Beaver 'b' should be at state "eat". Beaver 'c' should be at state "carry".



Answer D) Beaver 'a' should be at state "build". Beaver 'c' should be at state "carry".



It's Informatics:

In computer science, a state transition system is often used to maintain a defined set of states of a program. The system consists of a set of states and valid transitions between states, which may be labeled with labels chosen from a set. This concept is further applied in workflow management and business information systems.

Keywords:

State transition, workflow, process

Further information:

http://en.wikipedia.org/wiki/Finite_state_machine

<http://en.wikipedia.org/wiki/Workflow>

Business Cards

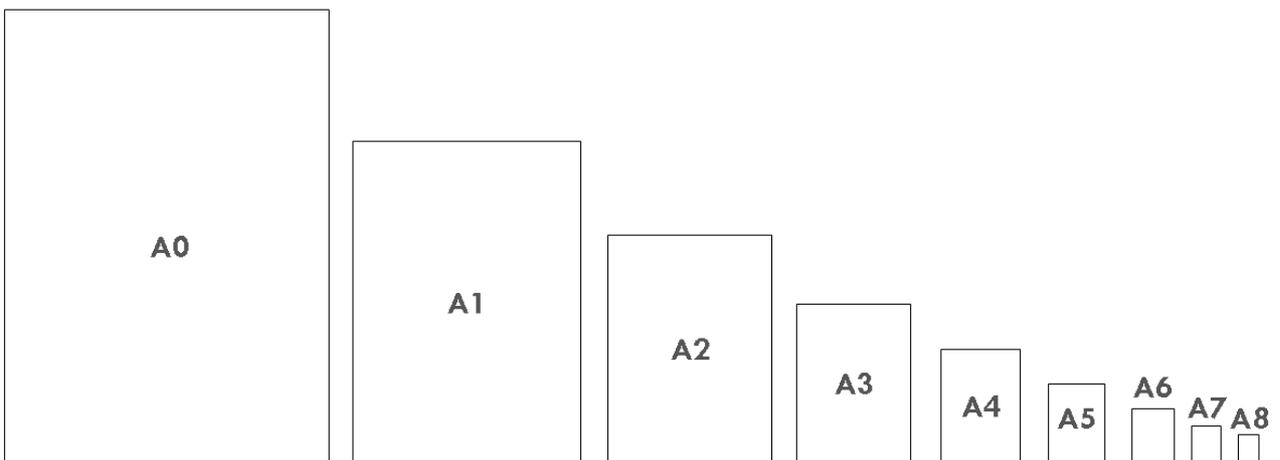
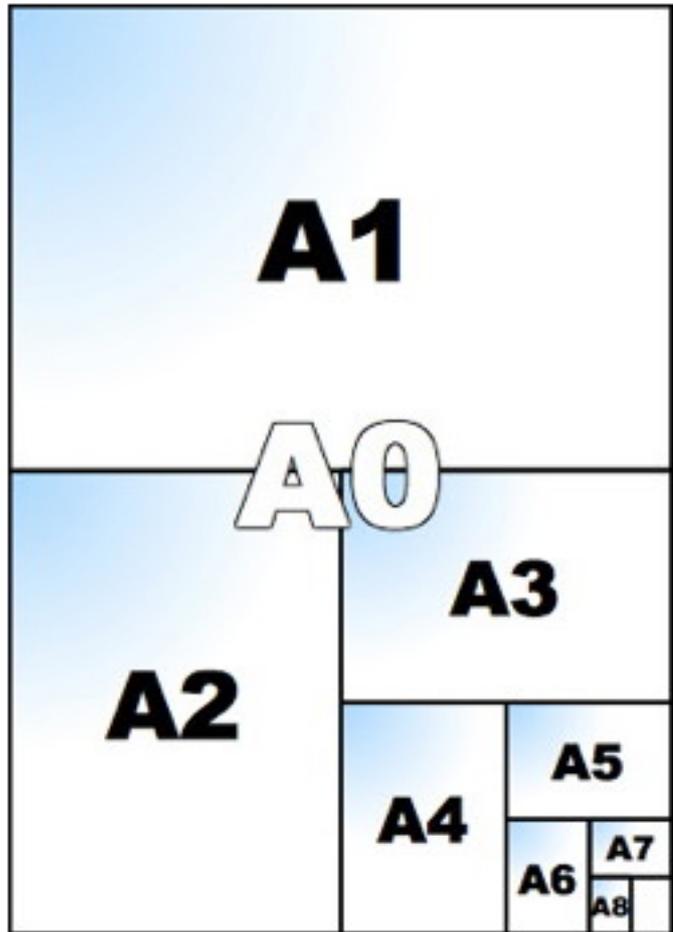
Standard paper sizes can be deduced from the size of a piece of paper with size A0 (1189 mm x 841 mm), by splitting it in half one or more times, as shown in the diagram on the left.

When A0 is split in half, it becomes A1. When A1 is split in half, it becomes A2. And so on.

We have eight sheets of paper with the sizes A1, A2, A3, A4, A5, A6, A7 and A8.

We would like to produce 19 business cards of size A8.

We don't want to waste paper, so we only use complete sheets.



Which entire sheets must we use?

Answers:

- A) A4, A7 and A8
- B) A5, A6 and A8
- C) A3 and A7
- D) A4 and A6

Solution: A)

Sheets of A8, A7, A6, A5, A4, A3, A2, A1, A0 sizes contain correspondingly 1, 2, 4, 8, 16, 32, 64, 128, 256 pieces of A8. We have $19 = 16 + 2 + 1 = 2^4 + 2^1 + 2^0$, and the values $2^4 = 16$, $2^1 = 2$, $2^0 = 1$, are exactly the number of business cards that can be obtained using A4, A7 and A8.

In other answers, the number of business card are not equal to 19. B) gives $32+2=34$, C) gives $8+4+1=13$, and D) gives $16+4=20$.

It's Informatics:

Doubling and halving of numbers is an elementary part of informatics. It plays a big role in the binary system, with which computers work internally. If we want to double a number in the binary system, we only need to add a 0 to the end of the number.

A binary number, e.g. "01100" can be read as follows (from right to left): (0×1) plus (0×2) plus (1×4) plus (1×8) plus (0×16) is 12. We often speak in this context about powers of two. Here are a few more: 32, 64, 128. and 256.

Keywords:

Power of two, binary system.

Commands

Very easy applications have only a few commands. A command tells something (or someone) what has to be done.

Which of these lines could be seen as an easy application?

Answers:

A	"What is information?"
B	"Come in and close the door!"
C	"Two plus two is four."
D	"Welcome to reality!"

Solution: B)

Command-1 is "come in", Command-2 is "close the door". It works properly, if you start being outside, and the door is open, and you execute the commands sequentially. What happens to you executing the program with the door being closed?

Answer A) is not a program but a question. C) is an equation, but nothing to do. D) is a message for somebody who just escaped the Matrix, but it is nothing to do.

It's Informatics:

Commands and data are fundamental principles of informatics. Commands tell the computer what it should do with data, or computers can instruct actuators (things that do something in the real world) to perform an action in the real world.

Many commands can be expressed as a program for humans, for robots, for computerised gadgets, etc. To express something, a language is needed.

It is not yet decided whether the natural human languages, spoken or written, in the long term will be easily useable for programming. People working in Informatics research this problem.

So far, logical and very strictly structured calculuses serve as programming "languages". If you learn to program, you have to learn how to properly transform natural language based ideas about the what to do into syntactically correct and semantically almost error-free command sequences.

Because of that, some people believe that programming is not only a craft, but an art!

Keywords:

Command, language

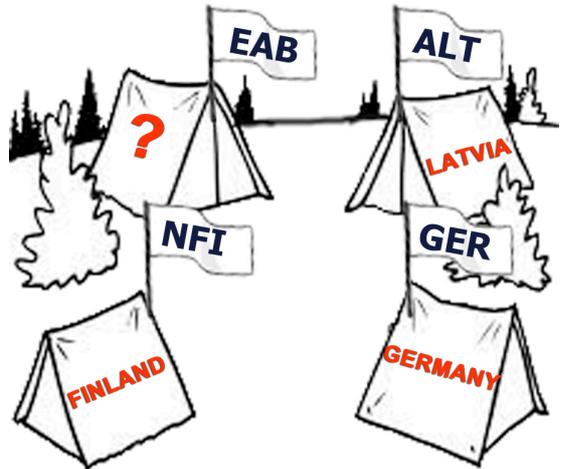
Country codes

Beaver Bruce has a system for making country codes. He takes the English name of the country (for instance LITHUANIA) and counts the frequency of each letter. He then uses the three most frequently occurring letters. The most used letters are used first; letters with the same frequency are used in the order they appear first in the country name.

The country code for LITHUANIA is IAL (I and A occur two times, the first I appears first. Of all characters that occur only once the L appears first).

A few other examples:

Country name	Country code
FINLAND	NFI
GERMANY	GER
LATVIA	ALT



Beaver Bruce realizes there will be a problem, since there are many countries which will get the same country code.

Which of these countries does not have country code EAB?

Answers:

- A. BEAVERIA
- B. BEAVERLAND
- C. BEAVERONIA
- D. BEAVERANIA

Solution: D)

It has country code AEB instead.

It's Informatics:

In computer science, data often needs to be compressed wither to save storage space, or to improve data transmission throughput. There are lossy or lossless compression techniques and their use depends on the application. The MP3 music compression algorithm is a lossy compression method. It has been designed to reduce the amount of data required to represent an audio recording and still sound like a faithful reproduction of the original uncompressed audio for most listeners. [Wikipedia].

Keywords:

data compression, data representation

Further Information:

http://en.wikipedia.org/wiki/Data_compression

<http://en.wikipedia.org/wiki/MP3>

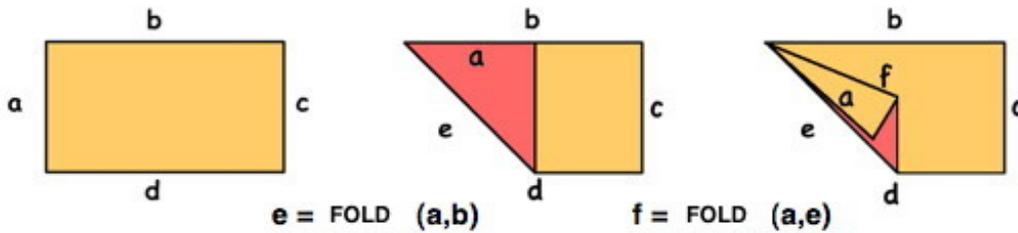
Folding Paper

The beavers have come up with a language for describing how a piece of paper should be folded. The commands in this language are called FOLD.

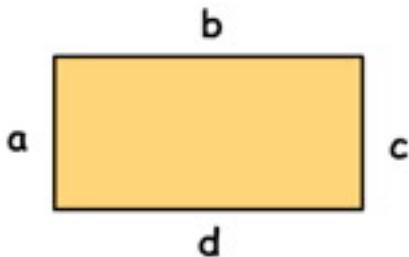
$z = \text{FOLD}(x,y)$ for example means:

Fold the piece of paper in such a way that side x and side y overlap. This way, a new side is created. We call this side z .

An example with two consecutive commands:



Imagine a rectangle-shaped piece of paper of which side b is twice as long as side a .



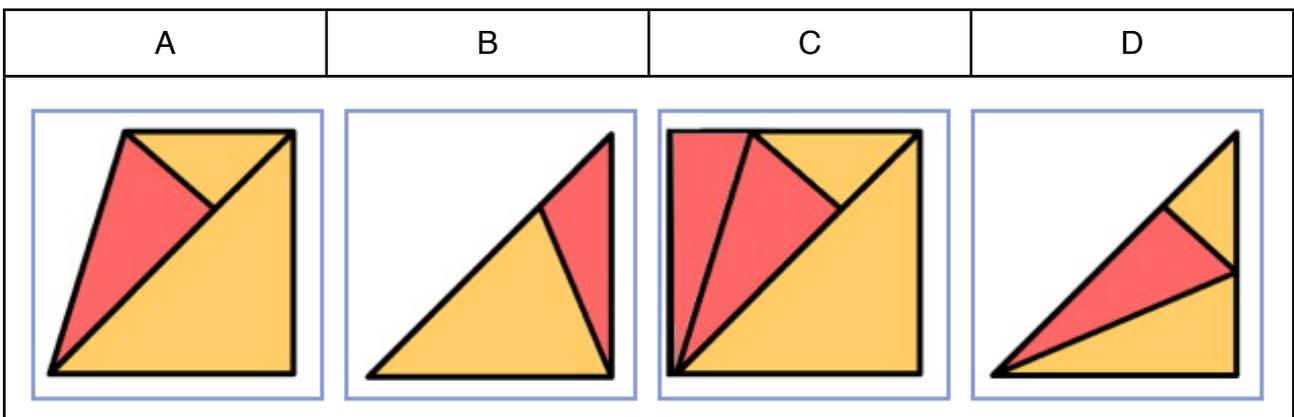
You are not allowed to turn the piece of paper over.

The following sequence of commands is executed:

$e = \text{FOLD}(c,a)$ $f = \text{FOLD}(c,d)$ $g = \text{FOLD}(a,f)$

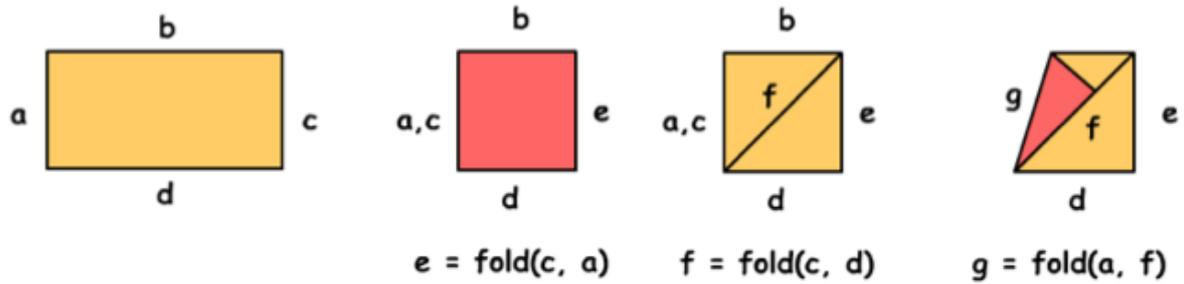
What will the piece of paper look like afterwards?

Answers:



Solution: A)

The following images explain the execution of the fold-operation step by step.



It's Informatics:

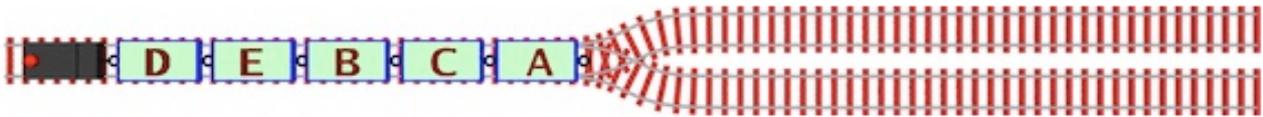
Functions are an important concept in programming. A function call is considered to be the start of some activity. Programmers say: The function accepts some parameters (here: two sides), processes some data and returns an object (here: the fold). This is different from the concept of functions in mathematics.

Keywords:

function, parameter, object

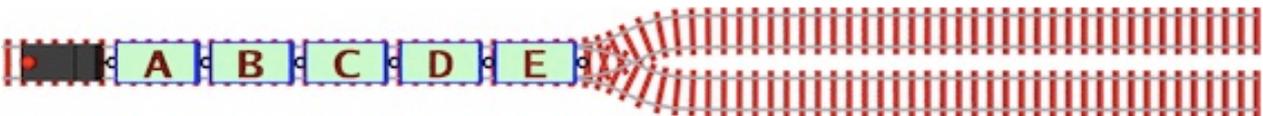
Freight Train

The wagons of the freight train from Beaver Railroad are placed in the order D-E-B-C-A:



The locomotive can move forwards and backwards and is able to pull and push an infinite number of wagons. Connecting or de-connecting a wagon is called a railroad operation.

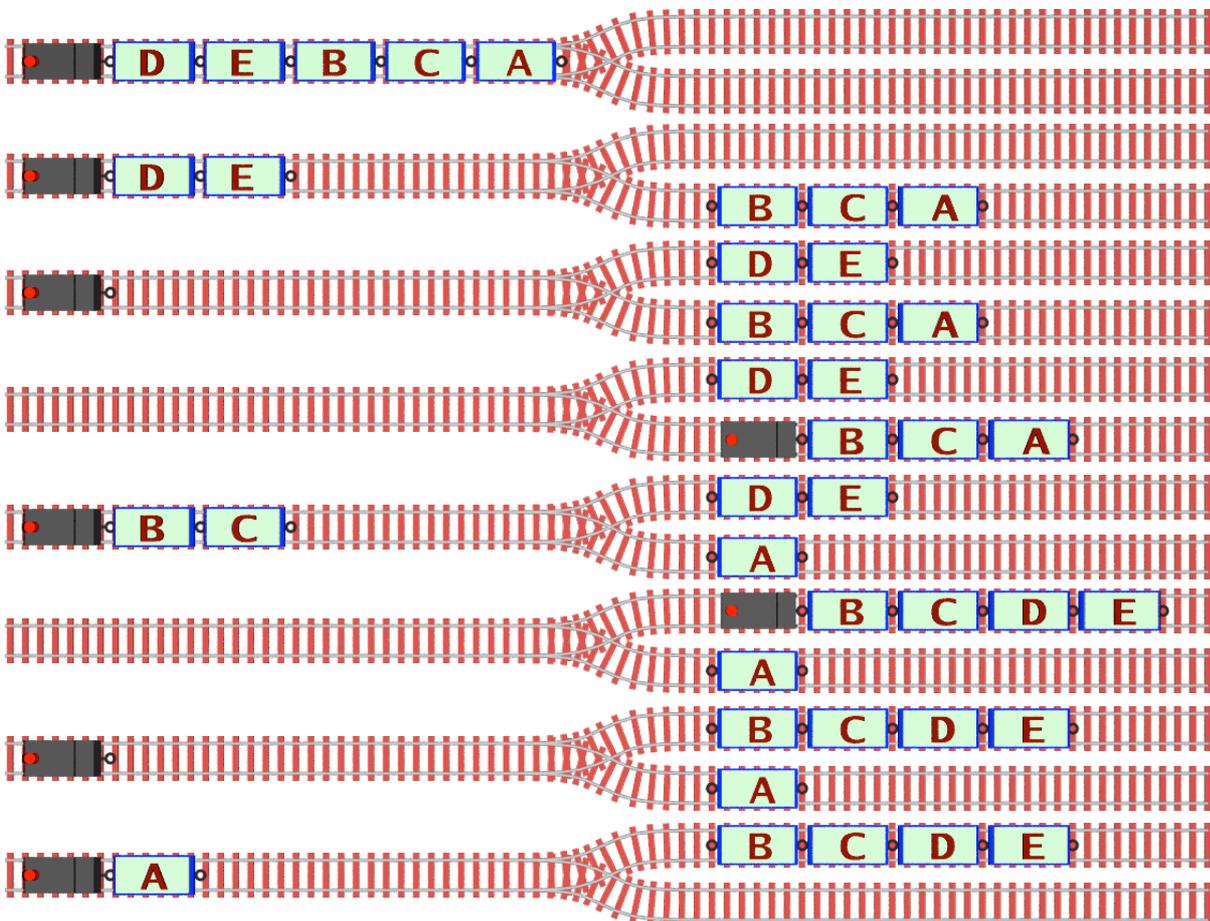
How many railroad operations are necessary to put the wagons in the order A-B-C-D-E again?

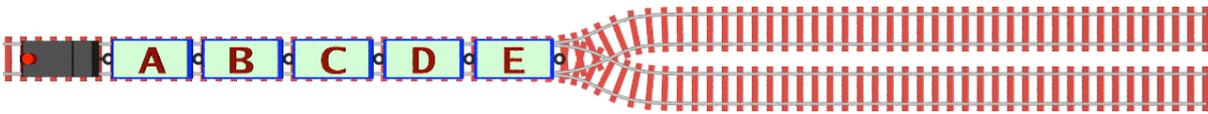


Answers:

(number input)

Solution: 8 (operations)





This shows there is a possibility to do it in 8 steps.

Is it possible to do it in less steps?

To answer this, consider a train with only 2 wagons. If you want to change the order, you will need to detach and connect both wagons. So you will need at least 4 steps and both tracks.

In this question we have three parts that are sorted in the wrong direction, because we will never detach the wagons D and E, or B and C. To change the order of two parts takes 4 steps. We can look at these changed part as one new part. To exchange this with the other part takes again 4 steps. So you need at least 8. The order of consecutive steps can differ, but with less than 8 it is impossible.

The only way to do it with less steps will be to use more tracks.

It's Informatics:

This is actually the modified data structure stack. There are two operations with stacks: pop and push. Push puts one item on the top of the stack and pop removes the top item from the task. In this task one or more freight cars can be “popped” from the end of the train on the main rail and “pushed” to side rail a or b. From the side rails one or more freight cars can be “popped” and then “pushed” to the end of the train on the main rail.

This task has also some similarity to the famous task Towers of Hanoi.

Keywords:

data sorting, last in - first out

Group Assignment

For a group assignment a class is split up into four groups. Each group divides the different tasks between the group members. Three groups manage to finish the complete assignment, but one group fails to do so.

What happened?

Our beavers, Bruce and Beatrix, have analysed the four groups. They found out that most group members have to wait for other group members before they can start with their own tasks.

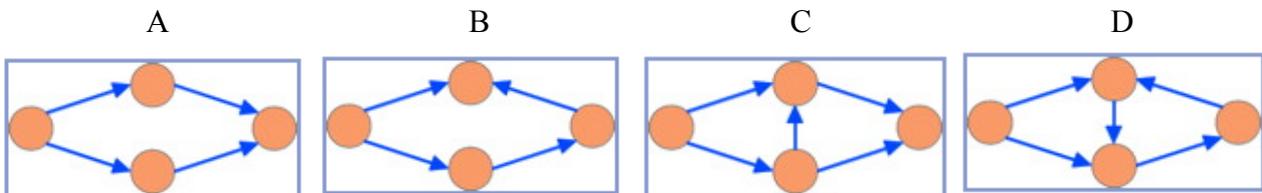
Bruce and Beatrix have made a diagram for each group to show the dependencies between students in each group:

A circle represents a student.

An arrow from student 1 to student 2 means that student 2 has to wait for student 1 to finish their tasks.

Which diagram represents the group that did not finish the assignment?

Answers:



Solution: D)

The pictures can each be interpreted as dependency graphs of sets of four processes. A set of processes with dependencies between each other will be blocked if there is a cycle in its dependency graph. Only graph D contains such a cycle.

It's Informatics:

In most computing systems, many so-called processes are running concurrently to make the system work. On your PC, you may have an open word processor window with a homework task while you search the web for information for that homework and listen to the music that your music software is playing. On a smartphone you can play a game and still receive a call. Such processes often depend on others and have to wait for other process results. For system designers, it is important to make sure that a situation, where processes get stuck because they are waiting for each other at the same time, never occurs. Such a situation is called 'deadlock', and computer scientists have spent much effort in providing both theoretical insight and practical solutions to the deadlock problem.

Keywords:

deadlock, semaphore, dependency

Half Sliding

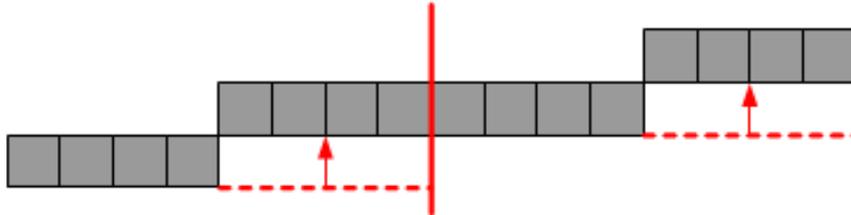
A paper strip is divided into 16 equal pieces:



Such a strip can be used for "half sliding". This is done by splitting the strip in half and sliding the right half up:



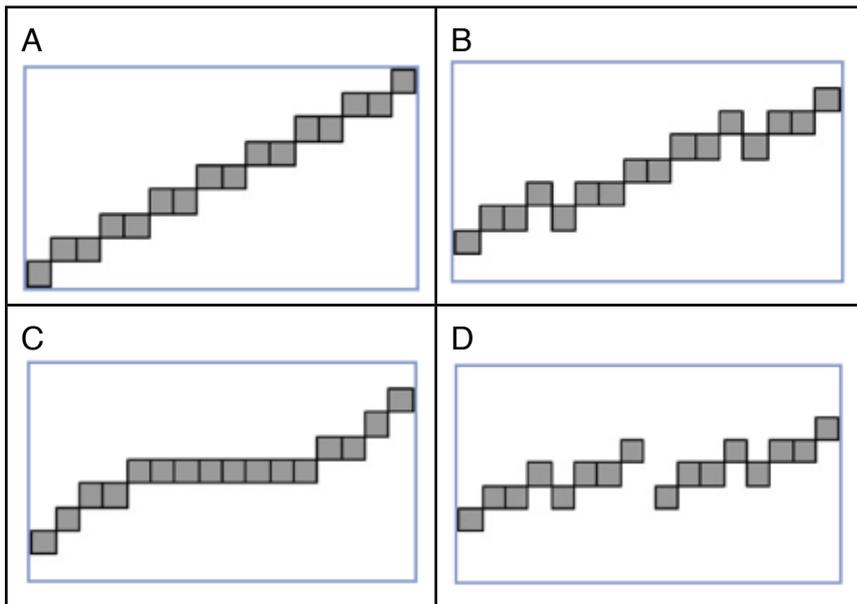
The two halves are also split in half and again, both right halves are slid up. This would look like this:



We do this again with the four-piece strips and, after that, with the two-piece strips.

What will the final result look like?

Answers:



Solution: D)**It's Informatics:**

The problem describes an algorithm for cutting the paper strip. The execution can be understood by first doing a global action on the strip, then running the whole algorithm on both halves of it. This is a very common kind of algorithm, called divide and conquer algorithms.

Keywords:

recursion, programming, subroutine

Hangar

The Bebras Airport has a 6 x 5 hangar, a 3 x 8 hangar and a 5 x 4 hangar. There are two sizes of planes. Large planes require 4 x 3 space in a hangar. Small planes require 3 x 2 space in a hangar.

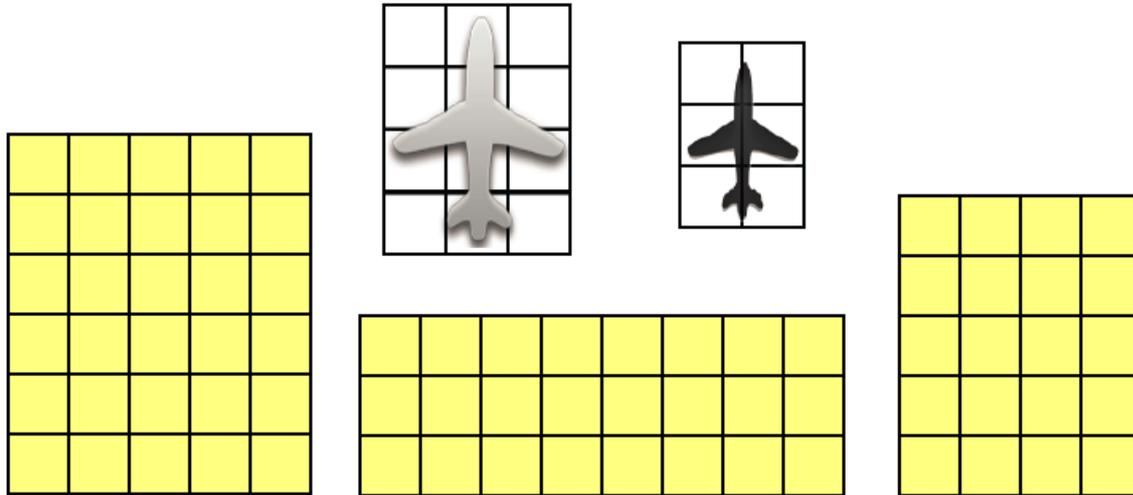


Fig. Bebras airport hangars and planes

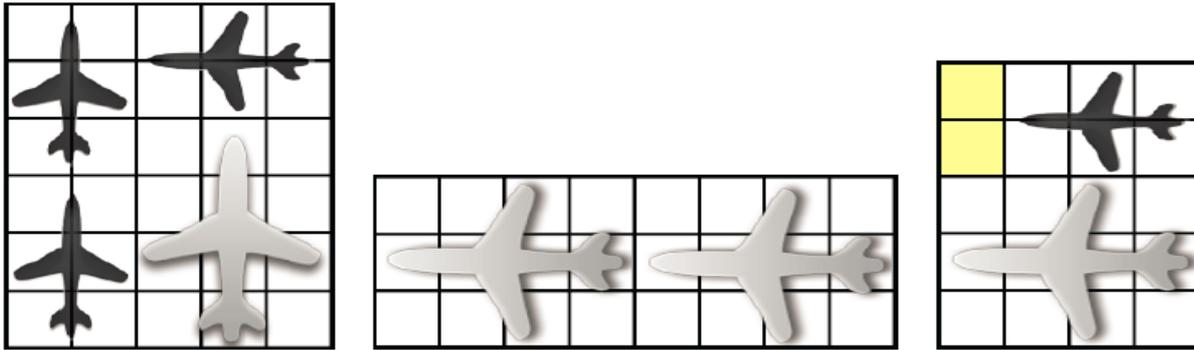
Aeroplanes can be arranged in any direction, and all hangars can be entered from any side.

There are four big planes and some small planes. After placing all of the big planes in the hangars, what is the maximum number of small planes that can be placed in the hangars?

Answers:

A	<input type="text" value="2"/>
B	<input type="text" value="3"/>
C	<input type="text" value="4"/>
D	<input type="text" value="5"/>

Solution: D)



It's informatics:

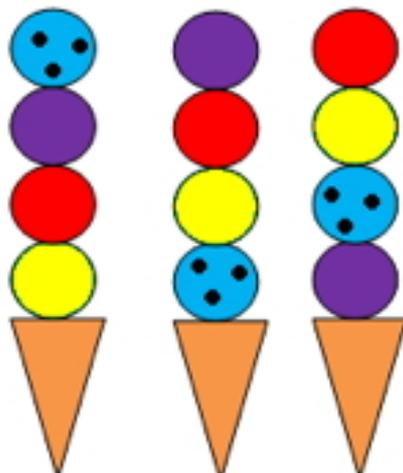
It is necessary to allocate a consecutive memory space for a computer program. In this question we see how small memory areas can be arranged after big memory areas are allocated.

Keywords:

memory, fragmentation

Ice Cream Machine

This special ice cream machine creates cones with 4 scoops of ice cream. It does so in an ordered way. Here you see, from left to right, the last 3 ice creams that the machine has made.



Which ice cream will the machine produce next?

Answers:

A	B	C	D

Solution: A)

The order always is yellow – blue – purple – red – yellow – blue – purple – red ... In the picture you can see that red is followed by green, green is followed by blue, ...

It's Informatics:

Detecting the operation of an algorithm is sometimes required in informatics. In many fields of information technology, computer scientists observe traces of computer activity and are checking the semantics (meaning) of programs.

Keywords:

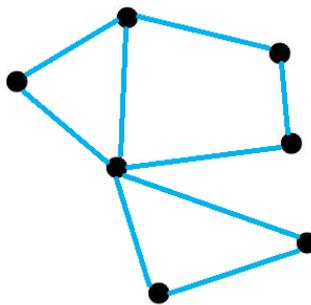
Algorithm, machines, loop, reverse engineering

Islands and bridges

The settlements of the Beavers are divided over different islands. They want to build bridges, so trading goods will become easier.



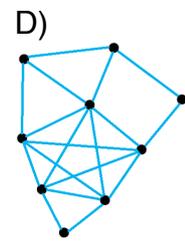
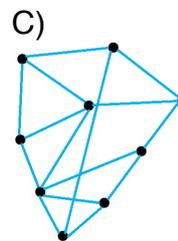
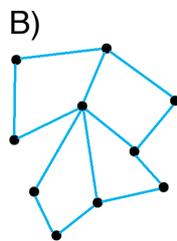
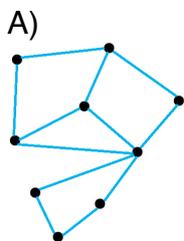
Beaver Beatrix has made a plan, which you can see below. The islands are represented by dots, the bridges by lines.



The other beavers would prefer a different plan though, on which the islands are represented by lines and the bridges by dots.

What would this plan look like?

Answers:



Solution: D)

It's Informatics:

Representation of real situations by using graphs or models is an important area in informatics. As can be seen by this example, different assumptions in the data representation can lead to simpler or more complex models.

Keywords:

Graphs, data representation

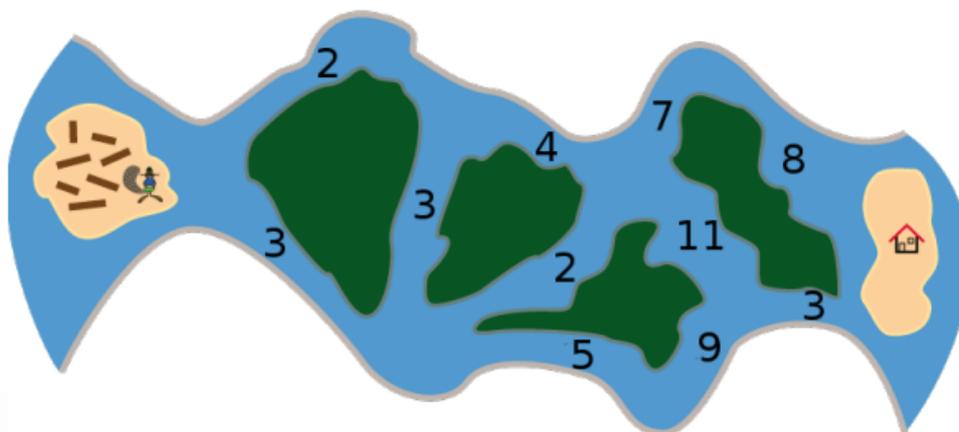
Further information:

http://en.wikipedia.org/wiki/Graph_theory

Log Jam

The beavers collected 50 logs on Beaver Island. They want to bring these logs to their home through the river system. At various points in the river system, they lose a certain number of logs.

The beavers begin on Beaver Island (at the left side of the diagram) and wish to get home (which is on the right side of the diagram). On the river there are numbers, which show how many logs the beavers would lose, if the beavers use this river on their route home.



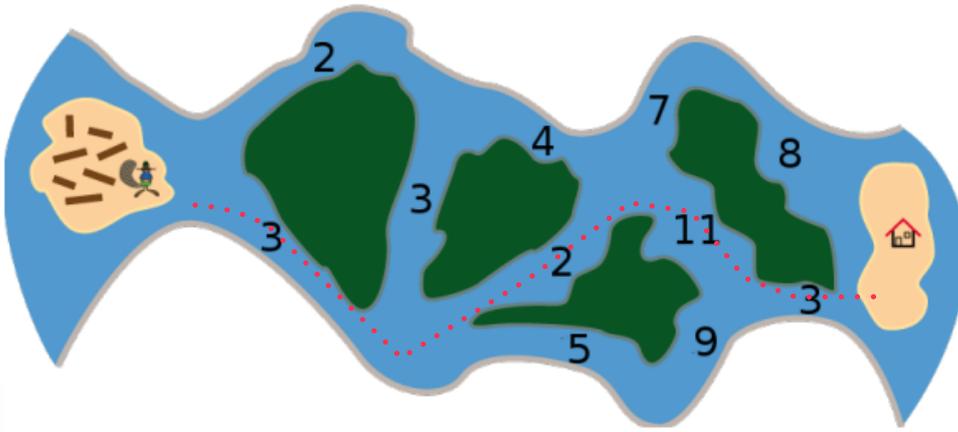
What is the fewest logs the beavers could lose?

Answers:

A	20 logs
B	23 logs
C	15 logs
D	19 logs

Solution: D)

The path with the lowest total value from start to finish is $3+2+11+3=19$. All other paths have a higher value.



It's Informatics:

Determining a solution that conforms to set requirements, such as shortest path or lowest cost is an often encountered problem in informatics. GPS systems are now frequently-used helpers that many people use every day. In this task, we have encountered a variation of the shortest path problem, in which the number of lost logs should be minimised. An approach to achieve a solution is to look at nodes where different possible paths meet and determine the segment with the lowest value. The chain of all segments that have been obtained this way represents the solution to the problem.

Keywords:

Shortest path, graph theory

Further Information:

http://en.wikipedia.org/wiki/Shortest_path_problem

Mirrored or not?

Sandy and her friend Horatio got new computers last week. The computers have a built-in camera at the top of the screen. When Sandy is chatting with her friend, the chatting software has two windows: a big one which is showing Horatio chatting and a small one showing herself chatting. The chatting software has two possible settings for showing the video streams: "mirror mode" - right eye on the right side of the screen and "picture mode" - right eye on the left side of the screen. Look at this picture of Sandy and Horatio chatting:



Which settings does the chatting software have on Sandy's computer?

Answer:

A	Sandy's video stream in picture mode and Horatio's video stream in picture mode
B	Sandy's video stream in picture mode and Horatio's video stream in mirror mode
C	Sandy's video stream in mirror mode and Horatio's video stream in picture mode
D	Sandy's video stream in mirror mode and Horatio's video stream in mirror mode

Solution: C)

Looking at Horatio we can see that the tilt of his head is matching his head on the computer screen, so his image is in picture mode. This eliminates options B) and D).

The asymmetric cut of Sandy's hair is the cue to the fact that her video is mirrored, i.e. her image is looking back at her as if she was looking at a mirror.

It's Informatics:

In image processing, computer scientists often need to imagine what an image would look like if it were mirrored or rotated. It is helpful to be able to do these things in one's head. Cues help to eliminate options that don't apply. Closely related to image processing are [computer graphics](#) and [computer vision](#).

Keywords:

Image processing. computer vision, computer graphics.

Missing piece

Beaver Bruce has received a secret message sent on a 6 x 6 grid. Unfortunately, part of the message has been destroyed by a spill of red juice.

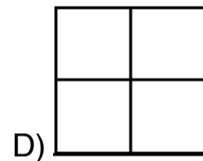
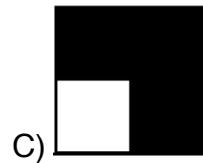
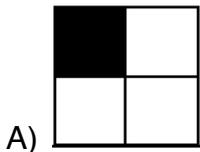
This case was foreseen (Bruce spills a lot of juice) and there are additional squares in the message that can help Bruce determine the secret message.

Each square in the rightmost column (column 6) is coloured such that the number of black squares in each row is even. Similarly, each square in the bottommost row (row 6) is coloured such that the number of black squares in each column is even.

	1	2	3	4	5	6
1	Black	Black	White	White	Black	Black
2	White	White	White	White	White	White
3	White	Black	Red	Red	Black	White
4	Black	Black	Red	Red	White	Black
5	White	White	White	White	Black	Black
6	White	Black	White	Black	Black	Black

Which of the following images could be the pattern underneath the red spill?

Answers:



Solution: B)

	1	2	3	4	5	6
1	Black	Black	White	White	Black	Black
2	White	White	White	White	White	White
3	White	Black	Black	Black	Black	White
4	Black	Black	Black	White	White	Black
5	White	White	White	White	Black	Black
6	White	Black	White	Black	Black	Black

The following diagrams illustrate how row 6 and column 6 would look like with patterns A), C), and D).

A)

C)

D)

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

It's Informatics:

Detecting errors is an important part of informatics. Data that is stored or being transmitted can be distorted. It is important to have a system in place that can help identify that an error occurred and then aid in the restoration of the data.

Keywords:

Error detection, checksums

Further Information:

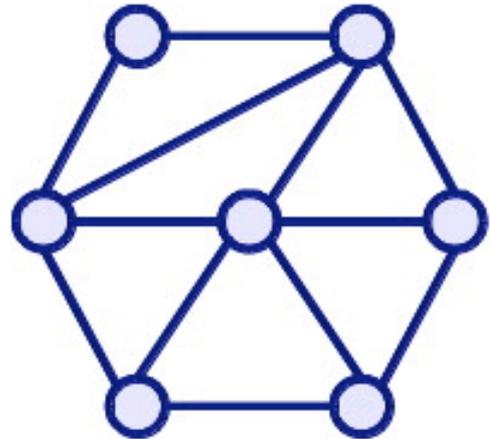
<http://csunplugged.org/error-detection>

Neighbourhoods

Neighbourhoods in areas on maps can be presented as a diagram. In such a neighbourhood diagram each neighbourhood is represented by a node.

A line between two nodes means that the two neighbourhoods share one or more borders.

The diagram on the right shows the connections between seven neighbourhoods in a certain area.



Which of the following maps is described by this diagram?

Answers:

A	B	C	D

Solution: B

In diagram A, there is one neighbourhood (brown, top left) that is only connected to one other neighbourhood. In diagram C, there are only six neighbourhoods in total, one short of the seven in the network diagram. Diagram D does not contain a neighbourhood with four connected neighbourhoods. However, the network diagram contains two nodes with four neighbourhoods.

It's Informatics:

The interpretation of graphical information is a useful capability. Graphs provide an abstract representation of real-world relationships between objects of all sorts. They are being applied for the development of models for different computer programs, such as navigation systems. Graph theory is an important area of computer science and mathematics.

Keywords:

network diagram, graph, data representation

Further Information:

http://en.wikipedia.org/wiki/Graph_theory

No Anonymity Anymore

The medical records of patients contain personal data, which should not be made public. For the publication of a research project, the hospital has made some data public, without mentioning the names of the patients. The table on the left shows a part of this list.

Because of the upcoming elections, the city with postcode M1 1AA publishes a list with all constituents at the same time. This table on the right shows the constituents who are born on January 1st.

Date of birth	Gender	Postcode	Case		Date of birth	Gender	Name
01/01/1974	male	B33 8TH	Diabetes		01/01/1958	female	Melanie Meyer
01/01/1976	male	M1 1AA	Lung cancer		01/01/1976	male	George Smith
01/01/1976	female	CR2 6XH	Breast cancer		01/01/1976	male	Robert Jones
01/01/1976	female	AB1A 1GD	Miscarriage		01/01/1984	female	Catharine Free
01/01/1984	female	DN55 1PT	Heart attack		01/01/1984	female	Eve Miller
01/01/1985	female	W1A 1HQ	Breast cancer		01/01/1988	female	Anne Beaver
01/01/1987	female	EC1A 1BB	Skin cancer		01/01/1988	male	Roman Peterson
01/01/1988	male	M1 1AA	Diabetes		01/01/1988	female	Isabelle Bourne
01/01/1988	female	M1 1AA	Influenza		01/01/1989	male	Martin Klaus

Thanks to these two tables, you know for sure that one of the persons on the right has a disease and you also know which disease it is.

What is the name of this person?

Answers:

A	<input type="text" value="George Smith"/>
B	<input type="text" value="Roman Peterson"/>
C	<input type="text" value="Eve Miller"/>
D	<input type="text" value="Isabelle Bourne"/>

Solution: B)

Starting in the left table:

- line 1, 3, 4, 5, 6, 7, the patient is not in city M1 1AA
- line 2 : 1976, male, M1 1AA. Two possible inhabitants in the right table, lines 2 and 3.
- line 8 : 1988, male, M1 1AA. One solution in the right table : **Roman Peterson**
- line 9 : 1988, female, M1 1AA. Two possible inhabitants in the right table, lines 6 and 8

It's Informatics:

The computerisation of databases raises very serious concerns about anonymity. On the one hand, one needs to erase enough information from the excerpt database to ensure that individuals cannot be traced. On the other hand, the more precise the information remains in the excerpt, the more useful it might be for researchers.

Computer science researchers have recently developed a formal notion to capture what it means for the excerpt of a database to be properly anonymised. An excerpt of a database is said to be "k-anonymous" (for $k \geq 1$) if each row from this table matches no fewer than "k" individuals. When k is 1, it means that the database allows to identify at least one person. When k is, say, 3, it means that we can find a group of 3 individuals such that we know that at least one of them is sick, but without knowing which one. More generally, a high value of "k" indicates good anonymisation

The definition of k-anonymity gave rise to interesting studies. For example, one problem is to find the minimal number of cells that need to be erased from a table in order to make it k-anonymous. The definition of k-anonymity also highlighted the fact that significant care is required when it comes to releasing anonymised data. For example, the release of two excerpts, each of which being k-anonymous when considered individually, may very well result in disclosing all personal information.

Keywords:

big data, database anonymisation, data table

Packing Logs

Beatrix has a backpack that holds a maximum of 7 kg of wood. Large 3 kg logs are worth 5 coins each. Medium 2 kg logs are worth 3 coins each. Small 1 kg logs are worth half a coin.



How many logs of each size should Beatrix pack in her backpack to maximise the total worth?

Answers:

A	One large log and two medium logs
B	Two large logs and one small log
C	Three medium logs and one small log
D	One large log, one medium log and two small logs

Solution: A)

One large log and two medium logs is correct. They are worth $5+3+3=11$ coins. B) Two large logs and a small one will be worth $2 \times 5 + 0.5 = 10.5$ coins. C) Is worth $3 \times 3 + 0.5 = 9.5$ coins. D) is worth $5+3+2 \times 0.5 = 9$ coins.

It's Informatics:

Packing in the most valuable logs first and then filling the spaces with the ones that fit will not work in this example since the small logs are next to worthless. This strategy is better known as the 'greedy' strategy and often used when it comes to sharing resources. Every choice of packing the backpack limits the options of the next step, since the total weight limit is 7 kg. Since each choice has a monetary value attached, the solution can be expressed as a weighted graph.

Keywords:

optimisation, strategy, weighted graphs

Further Information:

[http://en.wikipedia.org/wiki/Graph_\(mathematics\)#Weighted_graph](http://en.wikipedia.org/wiki/Graph_(mathematics)#Weighted_graph)

Planting Flowers

A big and a small beaver are planting flowers in the garden. The small beaver has shorter arms and legs than the big beaver. Therefore, his steps are smaller and the flowers he plants are closer to each other.



The beavers start back to back and are looking in opposite directions.

They both follow these directions:

Repeat two times:

Plant a flower on your right

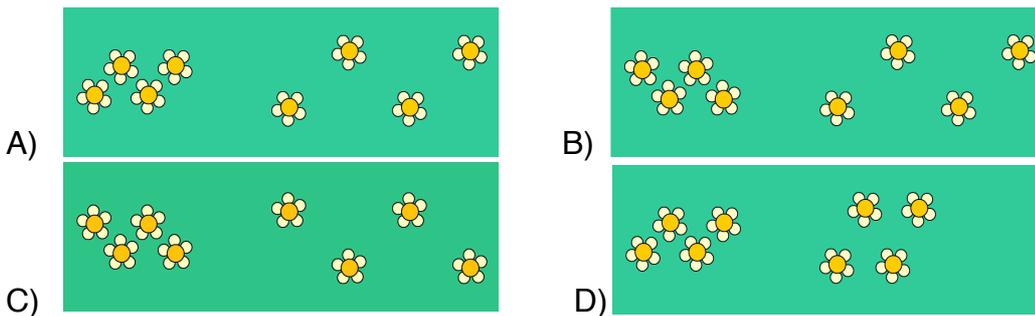
Go one step forward

Plant a flower on your left

Go one step forward.

What will the garden look like after this?

Answers:



Solution: A)

The little beaver has smaller arms and smaller legs than the big beaver. Little beaver's steps are short and it plants the flowers at positions closer to its body. Big beaver's steps are large and it plants the flowers at positions further away from its body.

Answer B is wrong because they both start planting flowers on their left hand sides. In answer C the little beaver begin incorrectly with the left hand side. In answer D the steps of both beavers are of the same length.

It's informatics:

In robotics, algorithms are interpreted and executed by devices with certain physical properties. The program developer has to take this into account. Different machines may move in slightly different ways executing the same program. In many fields of information technology, computer scientists observe traces of computer activity, checking the semantics (meaning) of programs.

Keywords:

robotics, algorithm

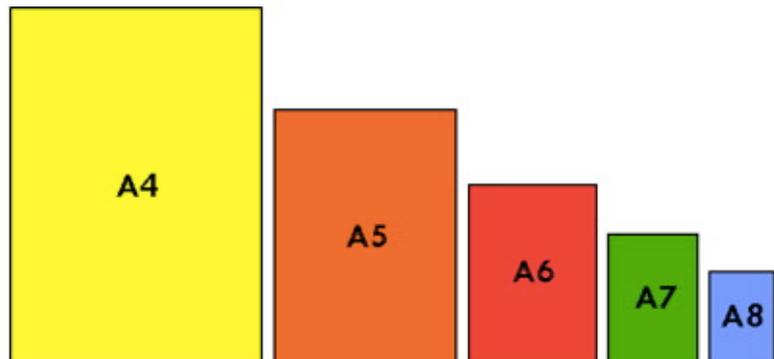
Playing Cards

The beavers want to make playing cards out of five pieces of cardboard.

The pieces of cardboard have different sizes: A4, A5, A6, A7 and A8.

A4 is twice as big as A5, A5 is twice as big as A6 and so on.

They need 12 playing cards of size A8 and they don't want to waste any paper.



Which pieces of cardboard should they use?

Answers:

A	<input type="text" value="A4 and A5"/>
B	<input type="text" value="A6 and A7"/>
C	<input type="text" value="A5 and A6"/>
D	<input type="text" value="It is not possible!"/>

Solution: C)

The A4 cardboard alone is 16 times the size of A8, so answer A cannot be true. Answer B): A6 equals 4 x A8 and A7 equals 2 x A8, which is only 6xA8. Answer C): A5=8 x A8 and A6=4 x A8, which is a total of 12 x A8, which is the solution to the question.

It's Informatics:

Doubling and halving of numbers is an elementary part of informatics. It plays a big role in the binary system, with which computers work internally. If we want to double a number in the binary system, we only need to add a 0 to the end of the number.

A binary number, e.g. "01100" can be read as follows (from right to left) : (0 x 1) plus (0 x 2) plus (1 x 4) plus (1 x 8) plus (0 x 16) is 12. We often speak in this context about powers of two. Here are a few more: 32, 64, 128. and 256.

Keywords:

Power of two, binary system.

Programmed Robot

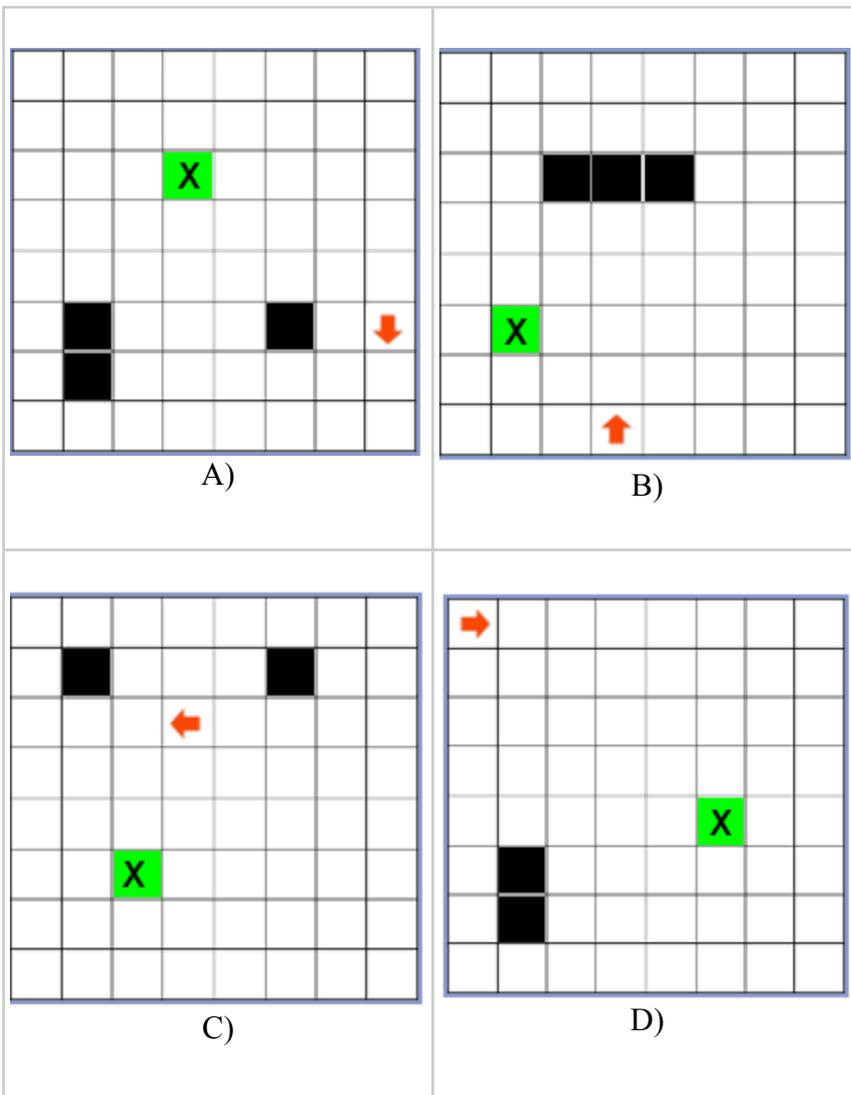
A robot is programmed to find a target (the green field marked with X) on a map of square fields. The robot has its movements programmed as follows:

- The robot moves straight forward until it reaches an obstacle (black field) or the edge of the map.
- When reaching an obstacle or the edge of the map, the robot turns right by 90°.
- When the robot moves out of a field, the field becomes a black obstacle.

The arrows on the maps below show the starting position as well as the starting direction of the robot.

On which map does the robot NOT eventually reach the target (green field marked with X)?

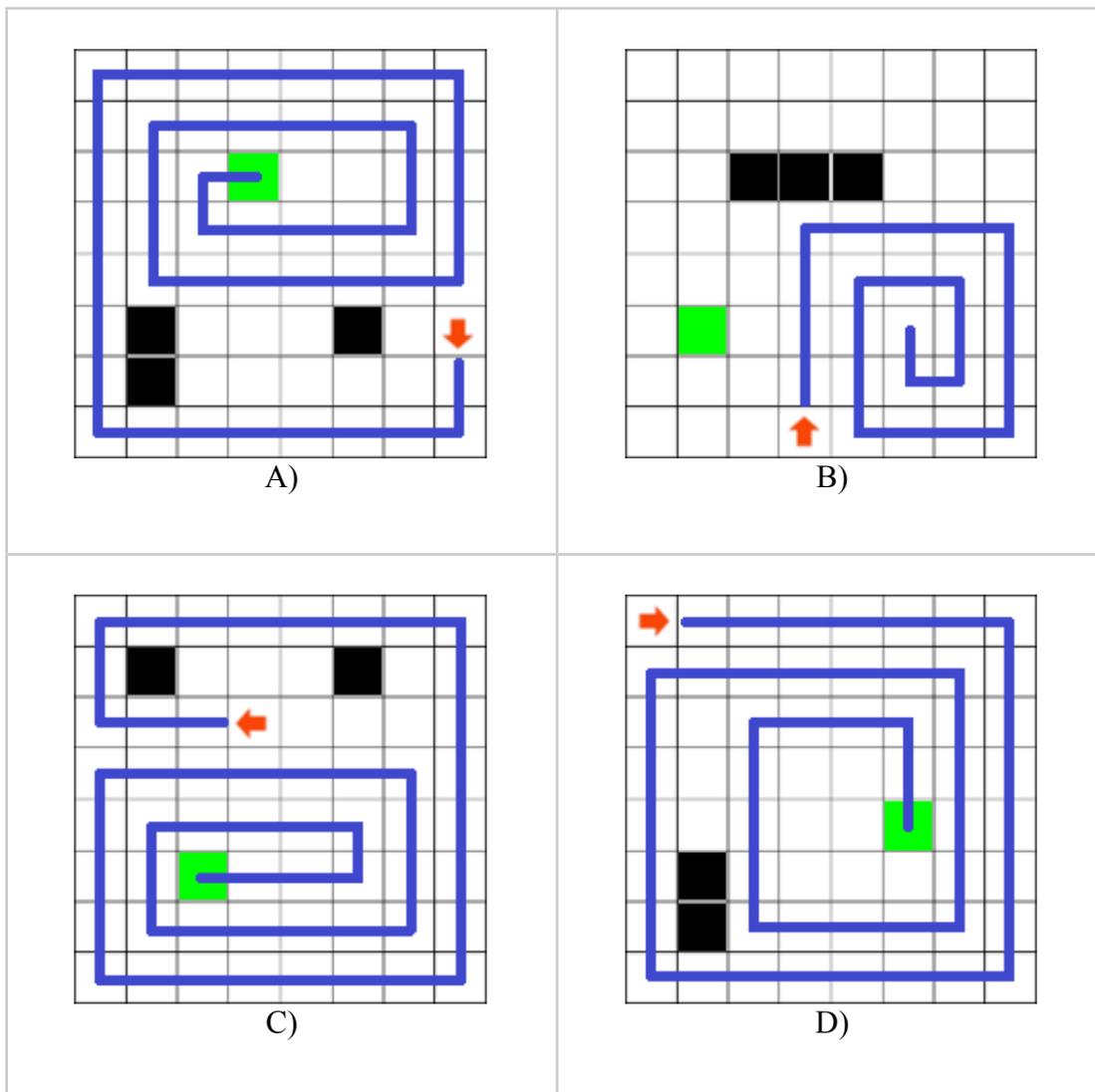
Answers:



Solution: B)

The robot does not reach the green target field, as all the fields the robot is passing when going up to the black field and then towards the right edge of the map become obstacles. Therefore the robot cannot reach the target field any more, see also the robot path in the figure below.

In all other maps the robot will find the target field as shown below.



It's Informatics:

Algorithms are fundamental in informatics. Algorithms are providing a scheme, how a certain problem (here to find the target field) is to be solved. It is really important that algorithms are designed in a way that they always solve a certain problem and not only in special cases. Therefore the algorithm, which is presented in this task, should be replaced by a better one, which will always find the target field.

Keywords:

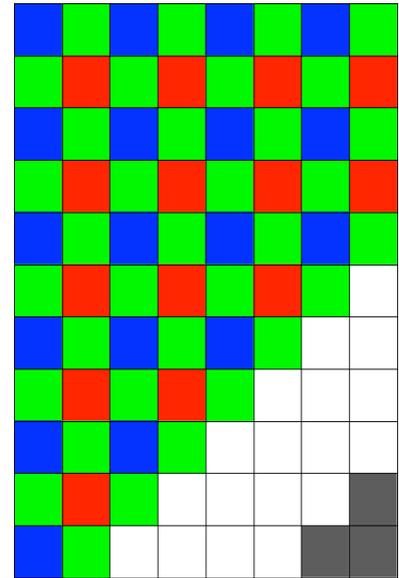
algorithm, loop, robot

RGB Grid

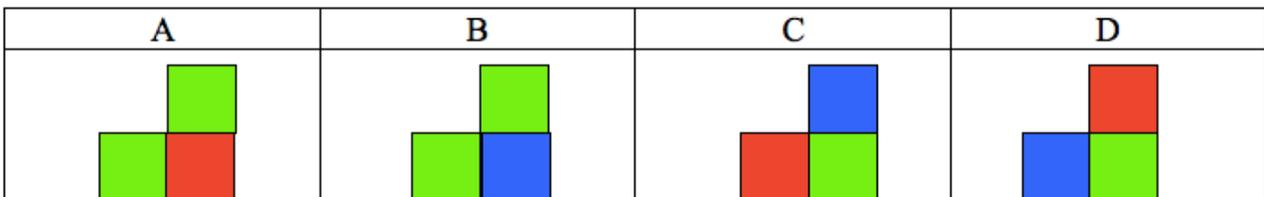
The RGB colour model is often used in electronics and computing. Squares (often called pixels) are coloured either red, green or blue.

A pattern is used to fully colour an 8 x 11 grid. Part of this colouring is shown below. The pattern is alternating blue-green in the first row, alternating green-red in the second row, alternating blue-green in the third row, etc.

What coloured squares fit the pattern in the bottom right corner of the grid?

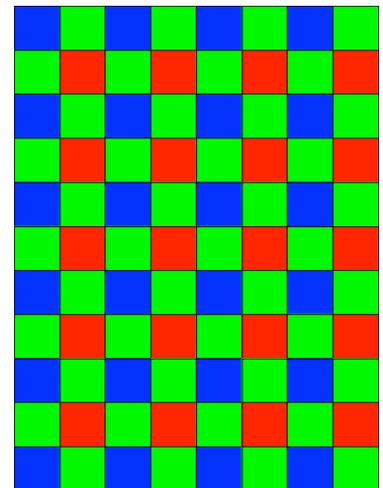


Answers:



Solution: D)

The solution to this question can be found by applying the following algorithm: Every second diagonal line is green, so the bottom right corner field must be green. Blue only occurs on odd numbered rows and red only on even numbered rows.



It's Informatics:

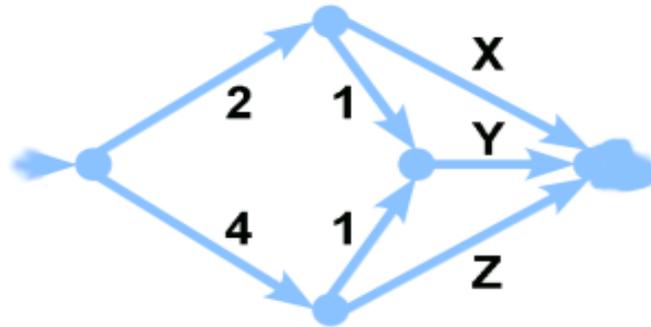
Informatics involves patterns and repetition of rules, both of which are important aspects of sequential programming languages.

Keywords:

Patterns, rules

Rivers and Dams

In the Beaver valley, a river splits several times on its way from the source to a nearby lake. Using smartly built dams, the beavers can regulate the amount of water in each arm of the river for maximum efficiency.



At a fork, the amount of water is divided over the two arms of the river. In the image above, the amount of water that can flow through the different arms (arrows) per second is shown.

How should the beavers regulate the arms X, Y and Z to get as much water in the river per second as possible?

Answers:

A	<input type="text" value="X=1, Y=0, Z=5"/>
B	<input type="text" value="X=1, Y=2, Z=3"/>
C	<input type="text" value="X=2, Y=2, Z=2"/>
D	<input type="text" value="X=4, Y=3, Z=2"/>

Solution: B)

The answer B) is right because we have at most 1, 2 and 3 units of water per second on the arms X, Y and Z.

The answer A) is impossible because on arm Z there can be at most 3 units of water per second.

The answer C) is impossible because on arm X there cannot flow more than one unit of water per second.

The answer D) is impossible because on arms X and Y can respectively only flow at most 1 and 2 units of water per second.

It's Informatics:

Problems like these arise in computer science in the field of optimising network flow. They often are solved with so called backtracking algorithms, like the Ford-Fulkerson-Method.

Keywords:

optimisation, network flow

Further Information:

http://en.wikipedia.org/wiki/Ford-Fulkerson_algorithm

Sailing Home

Sailor Beaver is going home. The flag marks the spot where he must drop anchor.

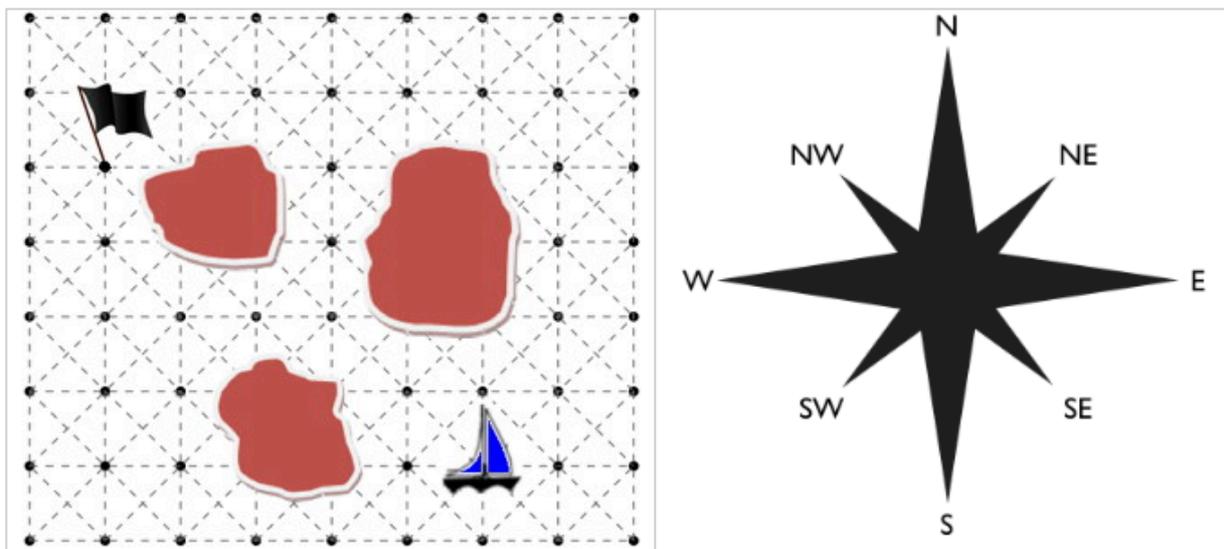
It is getting dark so he wants to get there as quickly as possible by taking the shortest course home but he does not want to crash into the islands.

He takes out his compass and plots the course home.

He must follow the shipping lanes, shown as broken lines on the map and he may change direction only on the black dots. He writes down the course he must follow.

For example "2N" means go two black dots North, "3SW;2S" means go three black dots South West. Change direction, go 2 black dots South.

His boat is on a black dot as shown on the map.



Which instructions will lead the ship to its goal as fast as possible without crashing into an island?

Answers:

A	4NW ; 1W
B	2NW ; 2N ; 1NW ; 1W ; 1SW
C	2NW ; 2W ; 2N ; 1W
D	2NW ; 2W ; 1NW ; 1N

Solution: D)

The correct answer is D). This route leads the boat to the flag safely and has 6 steps. Answers A) and C) lead the boat to collisions. Route B) has 7 steps.

It's Informatics:

The students are requested to analyse sequences of instructions (programs) and interpret the result of their application.

Keywords:

command, program

Short story

Here's a short story for you:

"On his way home, Hans finds a cat in front of his house. Because it's raining cats and dogs, he decides to take it inside. The cat gets comfortable at the chimney and falls asleep. When Hans' mother arrives home, she accidentally bumps into the cat. The cat gets scared and scratches her leg."

This story can be summarised using abbreviations.
Everything that can't be shortened, is left out.

scratch(A,B)	means	"A scratches B".
sleep(A)	means	"A falls asleep".
take(A,B)	means	"A takes B home".
H	means	"Hans".
C	means	"Cat".
M	means	"Mother".

Which summary fits the story above?

Answers:

A	take(H,C) ; sleep(C) ; scratch(C,M)
B	sleep(C) ; take(H,C) ; scratch(H,M)
C	take(C,H) ; sleep(C) ; scratch(M,C)
D	take(C) ; sleep(C) ; scratch(H,H)

Solution: A)

The correct answer is A), which describes the situation in the correct order with the correct parameters to the functions. All the other possible answers either are in the incorrect order or the parameters are incorrect.

It's Informatics:

This question deals with abstracting information: the actions are now functions, and the characters in the story are parameters. When we create functions, the order of the parameter is important, and the order of calling functions is also important in order to make our algorithms correct.

Keywords:

functional abstraction, sequences of operations, parameters

Sorting tree trunks

Robot Alan is sorting tree trunks.

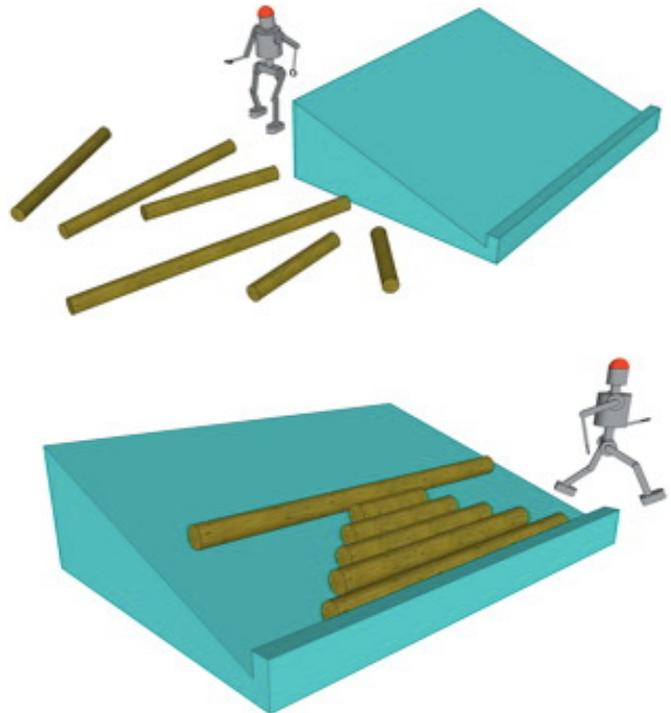
Unfortunately, we forgot how he was programmed exactly.

On the ground, there are several tree trunks of different lengths.

Alan chooses a tree trunk following a certain formula, lays it on top of the ramp and lets it roll down.

He repeats this, until there are no more tree trunks on the ground.

See the result:



Which formula does Alan use to decide in which order the tree trunks have to be placed on the ramp?

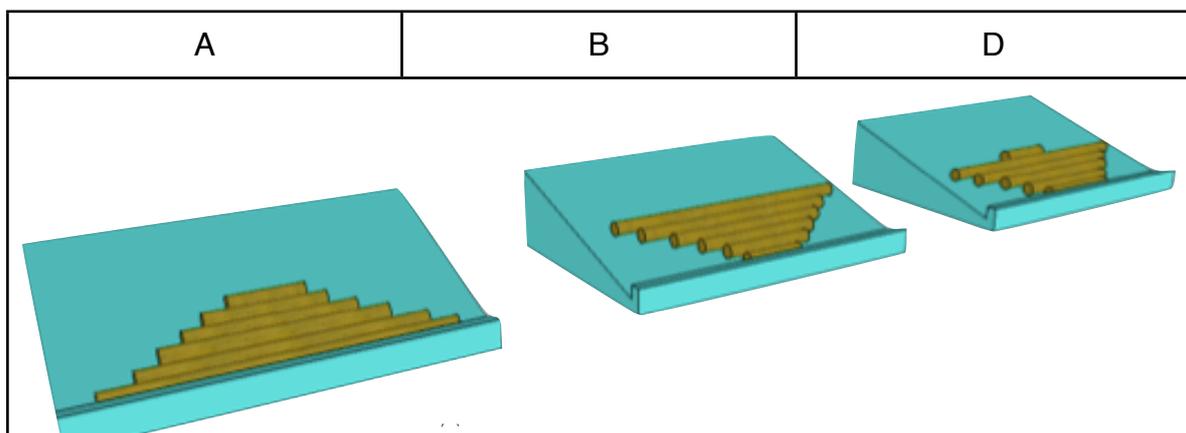
Answers:

A	Take the longest tree trunk.
B	Take the shortest tree trunk.
C	Take the second longest tree trunk. If only one tree trunk remains, take that one.
D	Take the second shortest tree trunk. If only one tree trunk is left, take that one.

Solution: C)

According to rule C), the second longest tree trunk has to be at the bottom of the ramp. Above it the second longest tree trunk of the rest and so forth. The tree trunks get shorter as we move up the ramp. In the end, only one tree trunk is left, which is the longest one, which will be put on the top.

The other rules lead to the following results:



It's Informatics:

This task is about sorting, or more precisely, it is a variation of sorting called sorting by a direct choice. Sorting algorithms are an important field of informatics. Many programs contain some sort of sorting algorithm, which depend on the particular purpose of the program.

Keywords:

algorithm, sorting

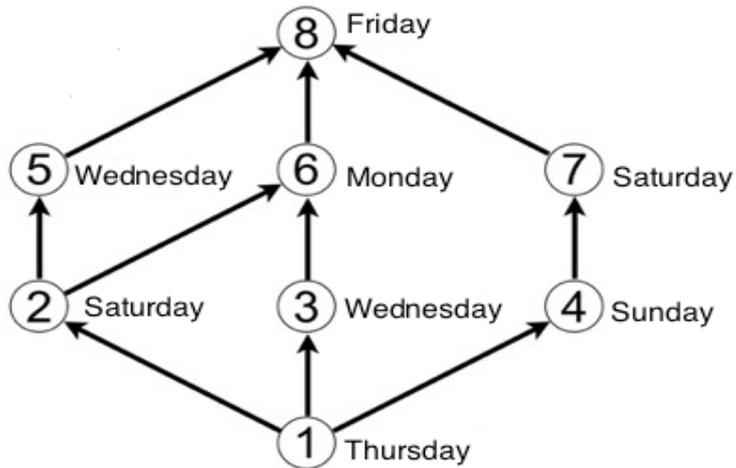
Further Information:

A very famous sorting algorithm is Quicksort: <http://en.wikipedia.org/wiki/Quicksort>

Stage Coaches

In the Wild West, where the cowboy beavers live, the Bebras Stage Coach Company built a network of stage coach routes between eight settlements.

In the plan of transportation, you can see at which days of the week the stage coaches will depart at the different settlements. A stage coach departs early in the morning and arrives at the next settlement in the evening of the same day.



What is the fastest way to get a package from settlement 1 to settlement 8?

Answers:

A	1 - 2 - 5 - 8
B	1 - 3 - 6 - 8
C	1 - 2 - 6 - 8
D	1 - 4 - 7 - 8

Solution: C)

The table below summarises the results of the different answers.

	Thu	Fri	Sat	Sun	Mon	Tue	Wed	Thu	Fri	Sat	Sun	Mon	Tue	Wed
A	*		*				*							
B	*						*					*		
C	*		*		*									
D	*			*						*				

It's Informatics:

Routing is a classical problem in Informatics. Often, as in this example, the data is being represented as a graph. To solve a routing problem it is often not possible to try out all possible paths. Medium to large graphs can be too large for even a fast computer to produce a result before the end of the Universe. Computer scientists have developed clever algorithms which can also manage large graphs within a reasonable amount of time. Two examples are:

http://en.wikipedia.org/wiki/Dijkstra's_algorithm

http://en.wikipedia.org/wiki/A*_search_algorithm

Keywords:

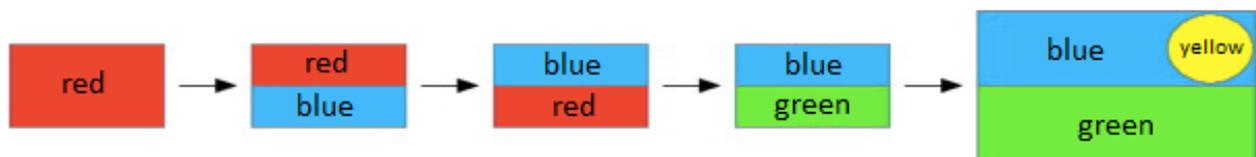
Graph, traveling salesman problem

Stamp Machine

A simple stamp machine gets his instructions from programming cards. A red sheet of paper should be coloured. The instructions on the cards should be followed in the right order (1 - 2 - 3 - 4):

1	Colour the lower half blue (this will be the sky).
2	Turn the sheet 180 degrees.
3	Colour the lower half green (this will be the grass).
4	Stamp a yellow circle in the upper right corner (this will be the sun).

The red sheet of paper will transform in the following way:



Unfortunately, the programming cards get mixed up and the order of the instructions changes into (3 - 1 - 2 - 4).

What will the sheet of paper look like after the instructions are followed in this order?

Answers:

A	B	C	D

Solution: C)



Answer A) is the result of (3 - 4 - 2). Answer B) is the product of (3 - 2 - 1 - 4). Answer D) is made by (1 - 2 - 3 - 4).

It's Informatics:

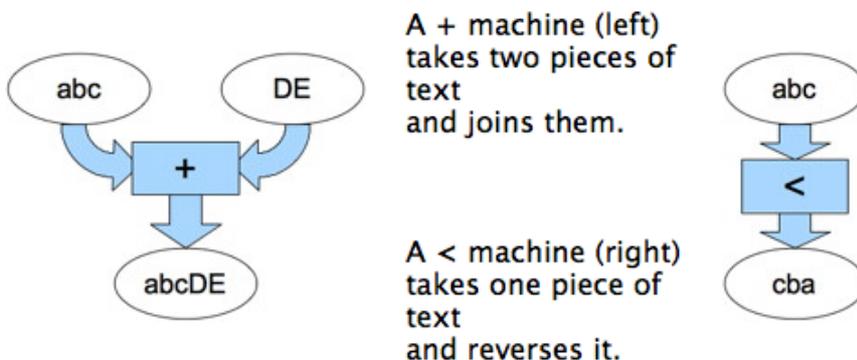
The change in the order of commands in a program often leads to a changed behaviour of this program. Seldom, programs remain unchanged during their lifetime. Further functions are added (upgrade) and existing functions are updated to reflect legislative or environmental changes. Also, errors are corrected. After every change in a program a thorough testing regime is required to determine if the program behaves as expected. Sometimes, a well-intended upgrade of a program can make the program perform worse than before. Keep calm and keep testing :-).

Keywords:

Command, order, execution

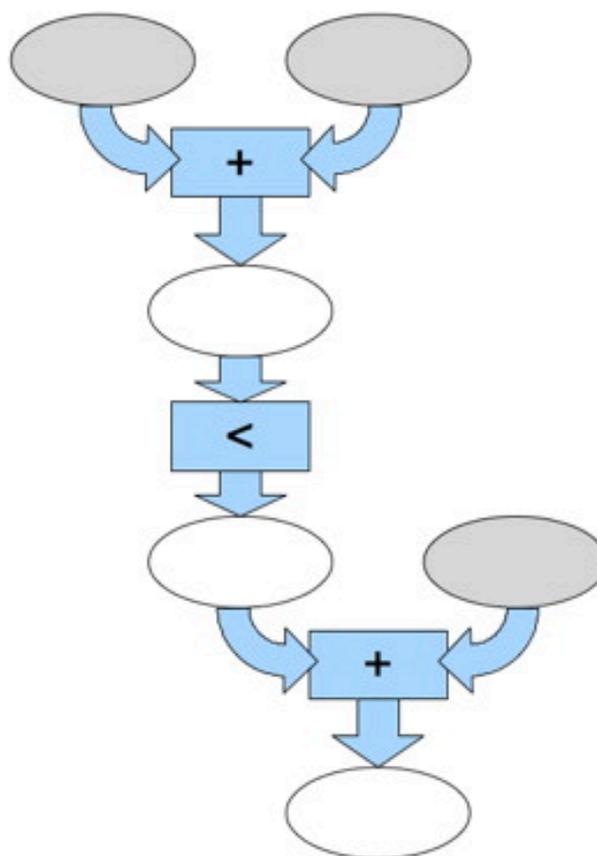
Text Machine

We have two types of text machines.



By linking two + machines and one < machine to each other we get a more complex text machine.

It needs three pieces of text (in the grey ellipses) and writes text in the white ellipses.



Our complex machine needs three texts to work on (grey ellipses), processes them, and gives one text as the result of its work in the bottommost ellipse.

Which three text pieces do you need to put in this text machine in order to get the text INFORMATION in the lowest ellipse?

Answers:

A	AMR OFNI TION
B	INF ORMA TION
C	AMR OFNI NOIT
D	FNI AMRO NOIT

Solution: A)

The answer can be worked out by trying the inputs.

AMR+OFNI =AMROFNI
< AMROFNI = INFORMA
INFORMA+TION = INFORMATION

Note that the question does not explicitly state which input text should be put into which input ellipse.

It's Informatics:

Data manipulation is a key strength of computers. By defining rules according to which the data is to be processed, computers can manipulate large data sets at very high quality. In programming, we often use string manipulations, such as appending strings, dividing strings, changing case, extracting or replacing substrings, or converting strings into numeric values.

Keywords:

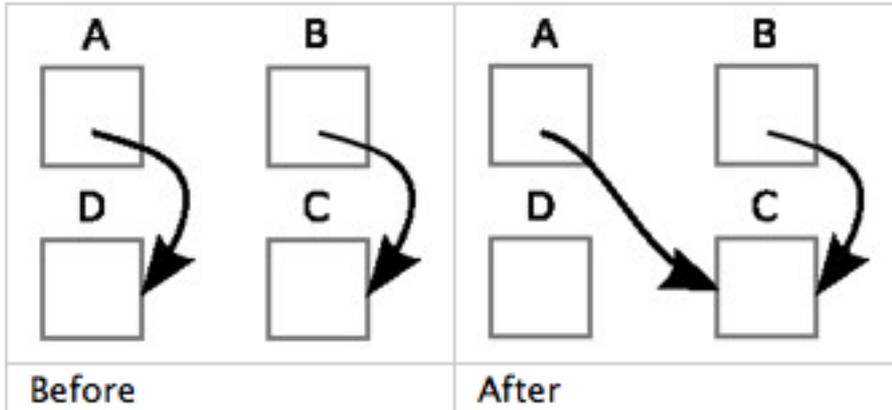
String Manipulation

Further Information:

http://computing.scbc.wa.edu.au/ait2b/content/info/html/data_manip.html
https://developer.apple.com/library/mac/documentation/Cocoa/Reference/Foundation/Classes/NSString_Class/Reference/NSString.html

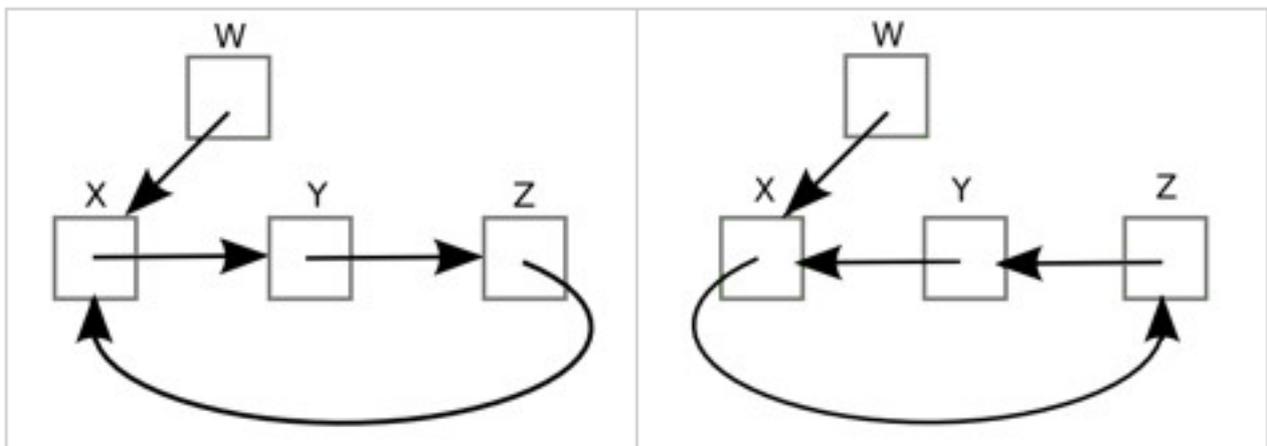
Turning Arrows

The instruction $A \leftarrow B$ changes an image with squares and arrows in the following way:



The arrow starting in square A now points to the same square as the arrow starting in square B.

Which set of instructions, executed consecutively, lets the image on the left transform into the image on the right?



Answers:

A	<input type="text" value="X ← Y, Y ← Z, Z ← X"/>
B	<input type="text" value="Z ← Y, X ← Z, Y ← W"/>
C	<input type="text" value="X ← Z, Z ← X, Y ← W"/>
D	<input type="text" value="Z ← X, X ← Y, Y ← W"/>

Solution: D)

Start state (image left): W points to X, X points to Y, Y points to Z, Z points to X. After instruction $Z \leftarrow X$: W points to X, X points to Y, Y points to Z, Z points to Y. After instruction $X \leftarrow Y$: W points to X, X points to Z, Y points to Z, Z points to Y. After instruction $Y \leftarrow X$: W points to X, X points to Z, Y points to X, Z points to Y. This is the end state (image right).

The other sets of instructions do not produce the image on the right hand side:

- End state answer A: W points to X, X points to Z, Y points to X, Z points to Z
- End state answer B: W points to X, X points to Z, Y points to X, Z points to Z
- End state answer C: W points to X, X points to X, Y points to X, Z points to X

It's Informatics:

Computer scientists have many names for information that tells us where other information is located: Reference, pointer, link, path, index, etc. Such information can look very different, such as: <http://www.bebas.edu.au>

Computer scientists have to work with entire networks of information objects and their pointers can change on a continuous basis. To be clear about what happens it is useful to use arrows and boxes, especially when the number of information objects is low. Otherwise, as in the case of the world wide web, more powerful tools are required to represent the data. Information about information is common place. We also call this metadata. For example, metadata on an Australian Curriculum content description connects to resources in Scootle.

Keywords:

metadata, pointer

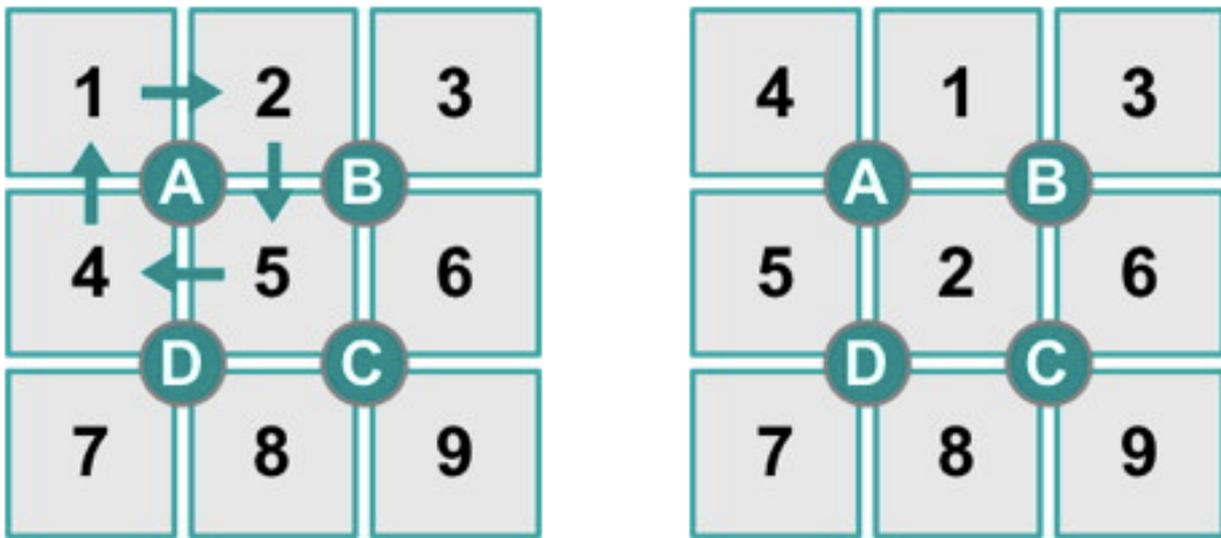
Further Information:

<http://en.wikipedia.org/wiki/Metadata>

Turning numbers

In the game of "Turning Numbers" you can scramble the numbers 1 to 9. At the start of every game, the numbers are orientated as shown in the picture on the left.

When you push button A, B, C or D, the numbers around make a quarter turn. For example: when you push button A, the numbers will be placed as shown in the image on the right side.



You start a new round and push the following buttons:

D, C, B, B.

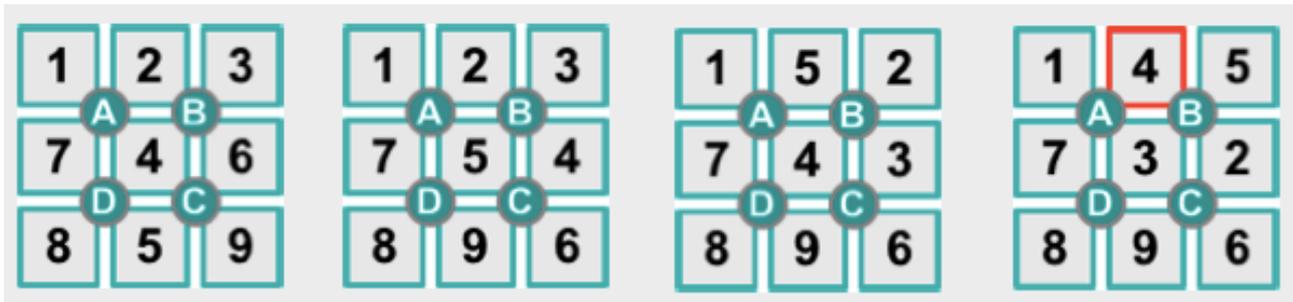
Where will the number 4 be at the end?

Answers:

A	B	C	D

Solution: C)

Here you see what happens when the buttons are being pushed:



It's Informatics:

A program that is being executed on a computer changes the computer's state. Different functions, like the four buttons with their respective functions, can change the same data. In the game, two buttons 'share' two fields on the game board. The field in the centre is being influenced by all four buttons. In computer science we apply atomic (indivisible) operators. Atomic operations must not be interrupted. Two atomic operations have to run in sequence: One after the other. In the game, the push of a button and the resulting rotation of the numbers is considered an atomic operation.

Keywords:

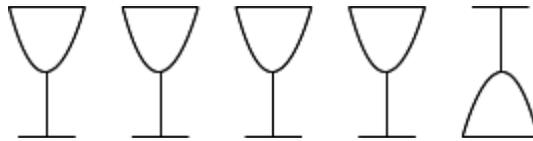
Atomic operation

Further Information:

http://wiki.osdev.org/Atomic_operation

Turning Glasses

There are five drinking glasses on the table. One of them is turned upside down.



In this game, you have to get all glasses upright again. But: you have to turn exactly three glasses every turn.

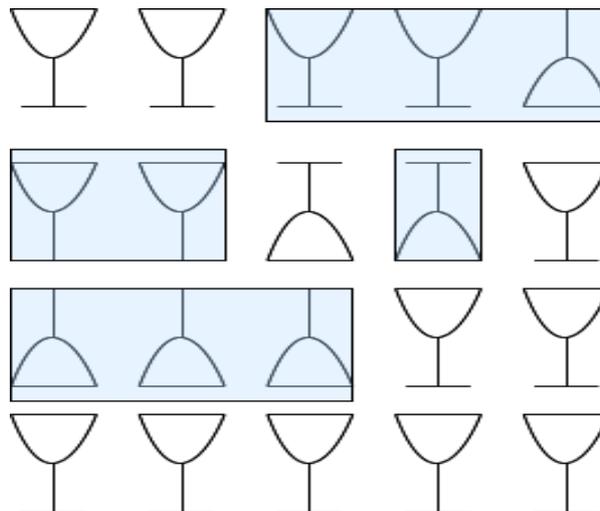
How many turns do you need at least to get all the glasses standing upright?

Answers:

- A) 2 turns
- B) 5 turns
- C) 3 turns
- D) it is impossible!

Solution: C)

For example:



Notice that there must be an odd number of turns, since after the first turn, there will be either 2 or 4 glasses which are upside-down. On the next turn, there will be an odd number (1,3,5) of glasses which are upside-down. Thus, we require more than 2 moves and in general we require an odd number of moves. We have shown a solution which uses 3 turns, which must be the minimum.

It's Informatics:

Following an algorithm, we can keep track of the state of the system or its variables. Reasoning about parity and arguing correctness for an algorithm are important aspects of informatics. One possible way to analyse the solution is to consider either deterministic finite automata (self-operating machines) or to consider a breadth-first search.

Keywords:

binary set, least amount, parity and odd parity

Further Information:

http://en.wikipedia.org/wiki/Breadth-first_search

Vigenère encryption

Beavers Beatrix and Bruce encrypt their private messages, so others cannot read them. They use the same key for encrypting and decrypting the messages. The key they use is CAB.

Beatrix encrypts a message to Bruce:

Key, as often as needed	CABCABCABCA B
Message without spaces	WHENDOWEMEE T
Encrypted message	ZIGQEQZFOHF V

Because the C is the third letter in the alphabet, the first letter in the message (W) is replaced by the letter which comes three places after it in the alphabet (Z).

Because the A is the first letter in the alphabet, the second letter in the message (H) is replaced by the letter which comes one place after it in the alphabet (I). And so on, until the complete message has been encrypted.

Bruce answers:	DUGOFXHO
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When do they meet?

Answers:

(text input)

Solution:

ATELEVEN

When an encrypted message is being decrypted, the cypher is being applied in reverse order. In our example, we move up the alphabet: the encrypted D becomes A (decrypted). T becomes U, G turns into E, etc.

It's Informatics:

Encryption is widely used in informatics to assure that only authorised persons are able to read data. There are many different encryption schemes available providing different levels of security, e.g. for secure traffic exchange between the computer and the server when surfing in the web, for secure transport of emails or to be able to safely store data on a hard disk.

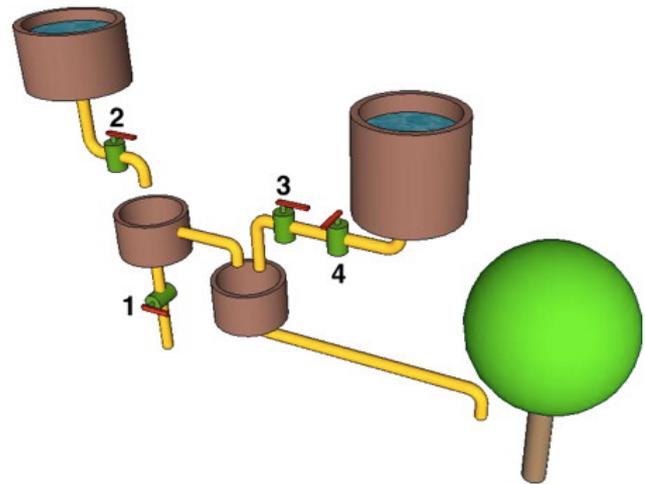
Keywords:

encryption, decryption

Watering a tree

The beaver has made a pipe system for watering his apple tree. Valves 1, 2, 3 and 4 can be opened or closed independently.

In which case does the water reach the apple tree?



Answers:

A	Valve 1 closed, 2 open, 3 closed, 4 closed
B	Valve 1 open, 2 closed, 3 closed, 4 open
C	Valve 1 open, 2 open, 3 closed, 4 closed
D	Valve 1 closed, 2 closed, 3 closed, 4 open

Solution: A)

A): The water flows from the left container through the open valve 2, fills the small container above the closed valve 1 and into the next small container and from there through the pipe to the apple tree.

B) and D): No water flows from the left container, because valve 2 is closed. No water flows from the right container because valve 3 is closed.

C): The water flows from the left container through the open valve 2 and and further through the open valve 1. No water flows out of the right container because valve 4 is closed.

It's Informatics:

Classic logic is the basis of all computer chips. We also call it binary logic. Only two values are allowed TRUE and FALSE, ONE and ZERO.

Keywords:

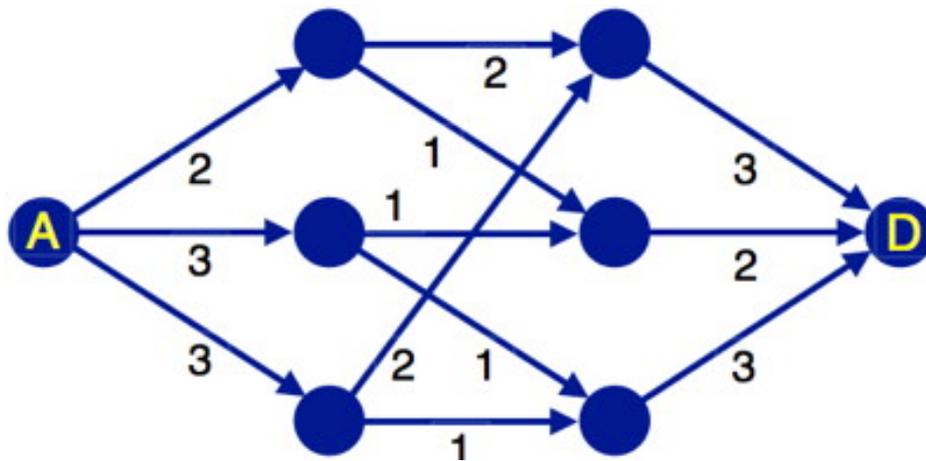
binary logic

Wood streams

In forest (A) is an area where the beavers fell trees for their dams. They transport the tree trunks to their new project - the biggest dam of all times (D) - through an infrastructure of channels.

The arrows represent the channels, the dots are points where the water splits up or comes together.

Every channel has a restricted capacity. The numbers next to the channels show how many tree trunks can be transported through the channels in one minute.



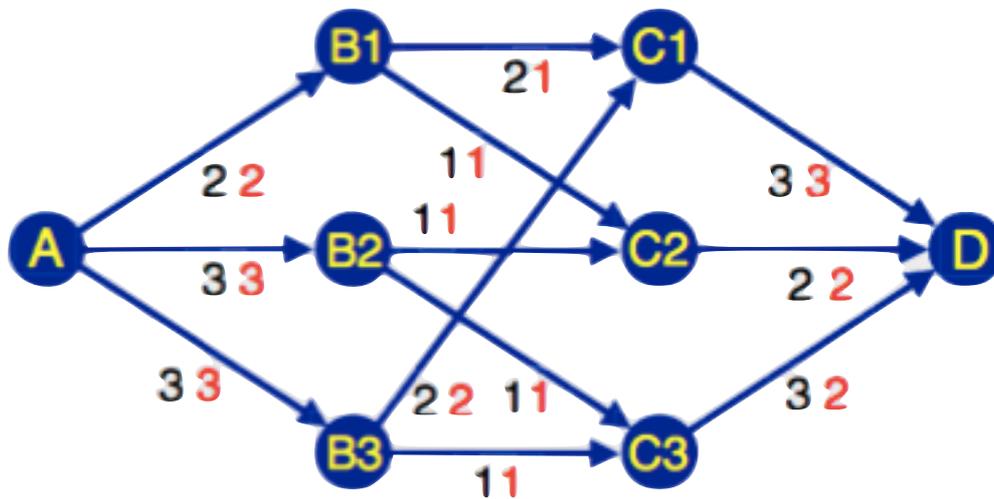
How many tree trunks can be transported from A to D at most in one minute?

Answers:

(number input)

Solution: 7

We need to consider that though a channel has a capacity x , it does not automatically mean that, in fact, x tree trunks can be transported per minute through the channel. There could be a bottle neck in front of the channel, which prevents the channel from using its full capacity. The image shows an ideal situation, according to which the tree trunks can float through the channel system. In contrast, the red numbers in the next figure represent the real numbers of tree trunks that can be transported. Every red number is at maximum as large as the corresponding black number, but it can also be smaller. For example: Only 2 tree trunks per minute can float from C3 to D, although the capacity is 3, because C3 only received 2 tree trunks per minute. The result can be seen when we add the channels that lead to D: $n = 3 + 2 + 2 = 7$.



It's Informatics:

The calculation of the maximum flow through a network with capacity is an example of a common optimisation problem. In our example, we can determine the solution by applying a simple analysis. However, one can imagine more complex problems, such as the delivery of bread by a fleet of trucks to the supermarkets in a country. This is called smart logistics.

Keywords:

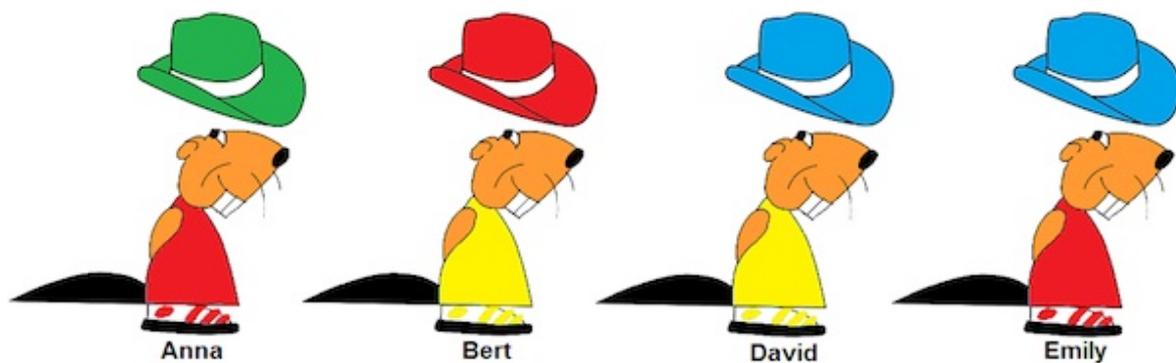
Network optimisation

The Wrong Hat

Anna, Bert, David and Emily Beaver have two rules for choosing what clothes to wear:

- Normally, they wear a hat of their favourite colour.
- They wear a shirt with a different colour than the hat.

One day, they change hats, just for fun. Now they all wear a hat of another colour than their favourite one.



Which beaver owns the green hat?

Answers:

- A) Anna
- B) Bert
- C) David
- D) Emily

Solution: D)

David and Emily both wear a blue hat, so the blue hats belong to Anna and Bert. The red hat cannot belong to Emily because she already has a red shirt so the red hat belongs to David. So, in conclusion the green hat belongs to Emily.

It's informatics:

In data analytics, we combine different pieces of information to reach conclusions about the world. Prior to writing a computer program, we need to understand the rules that govern a problem. Computers can help us to hypothesise about potential solutions by simulating the effects of different approaches and by comparing them to real-world observations.

Keywords:

matching information, data analytics, simulation

Further Information:

http://en.wikipedia.org/wiki/Data_analysis

<http://en.wikipedia.org/wiki/Simulation>

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