WORKBOOK

COMPUTATIONAL THINKING

3rd – 6th class

Taina Lehtimäki

Science Foundation Ireland sfi For what's next
SMART FUTURES
Maynooth University
National University of Ireland Maynooth

This is the first in a series of computational thinking workbooks made by the PACT team at the Department of Computer Science, Maynooth University, County Kildare, Ireland.

This workbook can be used as a 10 lesson introduction to computational thinking for primary school pupils from 3rd through 6th class, or it can serve as material for an after-school science club activity. This book consists of 10 carefully selected computational thinking tasks from the international Bebras Challenge, plus an associated extra work page for each task.

Teacher notes including solutions, lesson plans, and extension activities are available from our website: https://pact.cs.nuim.ie/qr/workbook.

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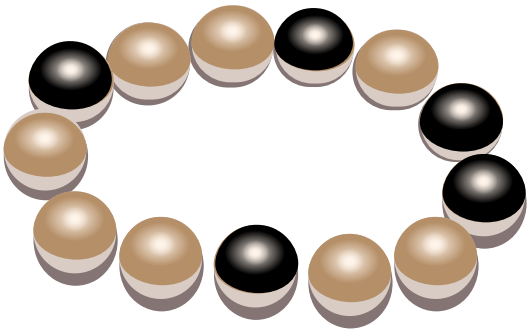
Pearl bracelet

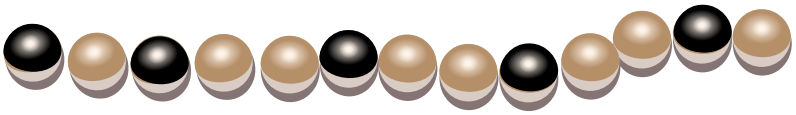
For the grand ball, a princess put on the bracelet with light and dark pearls shown below. After the ball, she unfastened the bracelet between two pearls and put it in a chest. The next evening, she wanted to put on the same bracelet but there were many similar bracelets in the chest.



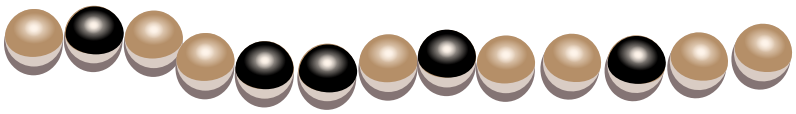
QUESTION 1

Which of the following bracelets did the princess wear to the grand ball?

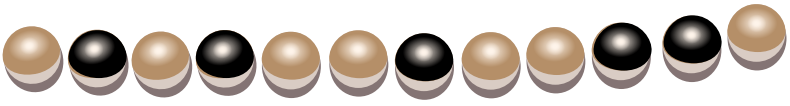
A.



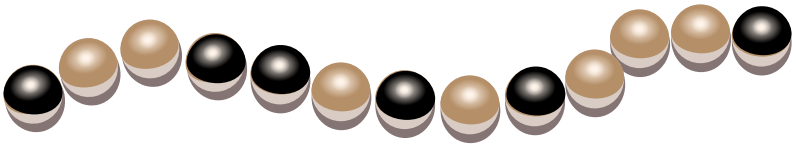
B.



C.



D.

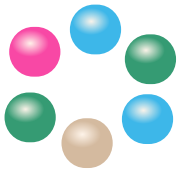


Well done!

You can colour in 1 star for solving this task.
You can get an extra 2 stars by solving the tasks on the next page!

Can you solve these ones too?

2.

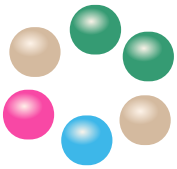


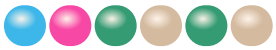
A. 

B. 

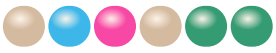
C. 

3.

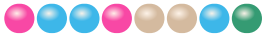


A. 

B. 

C. 

4.

A. 

B. 

C. 

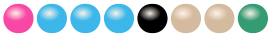
D. 

5.

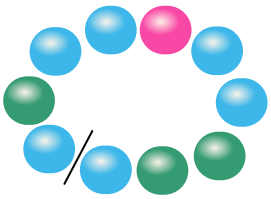
A. 

B. 

C. 

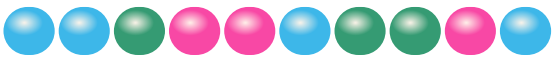
D. 

6.

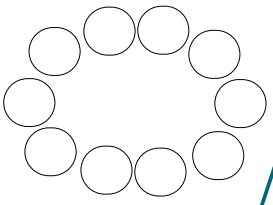


Colour in your answer!

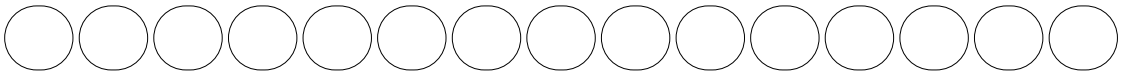
7.



Colour in your answer!



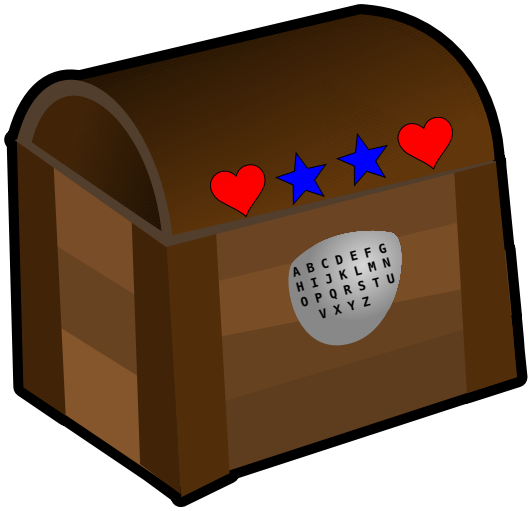
Design your own bracelet



Draw how your bracelet looks when fastened:

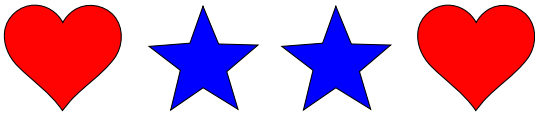
Passwords

Percy the pig has forgotten the password to unlock his treasure. He has drawn symbols to help him remember which password is for which chest. Can you help him out?



QUESTION 1

Look at the shapes and try to figure out the matching password.
Percy knows the password is one of these four, but which one?



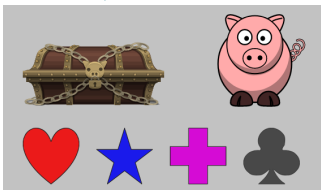
- ☐ S I O T
- ☐ W O O T
- ☐ W Q M
- ☐ T O O T

Way to go!

You got 1 star for solving the password!
You can get 2 more stars By solving the passwords on the next page!

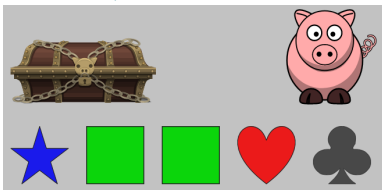
Can you figure out these ones too?

QUESTION 2



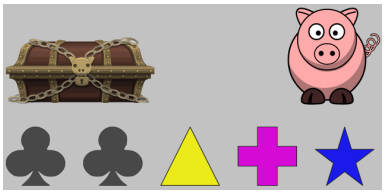
- ☐ WRPFT
- ☐ TCQG
- ☐ WQM
- ☐ CZGSRF

QUESTION 3



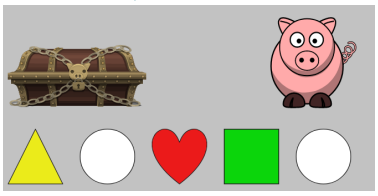
- ☐ XMTCC
- ☐ XWTTG
- ☐ ZBBCR
- ☐ BBVCT

QUESTION 4



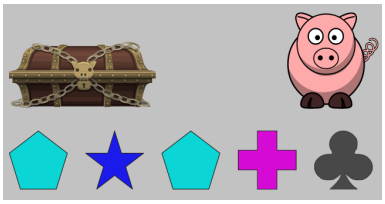
- ☐ QNFFG
- ☐ TGGFS
- ☐ VVDRZ
- ☐ ZQGHH

QUESTION 5



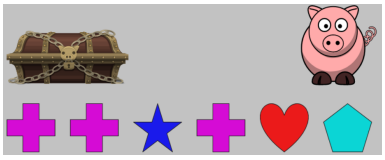
- ☐ KSQKB
- ☐ CSHKH
- ☐ CGSGH
- ☐ GQHXQ

QUESTION 6



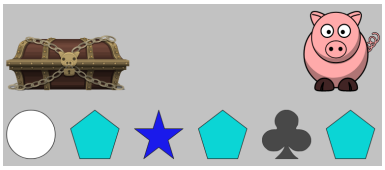
- ☐ MVMXD
- ☐ BXWXS
- ☐ VWSDV
- ☐ MWSGS

QUESTION 7



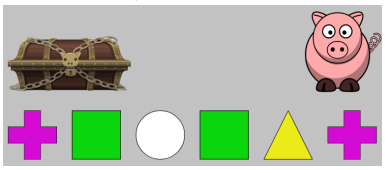
- ☐ XPLLGL
- ☐ DLDDGV
- ☐ GXPLLL
- ☐ XXPXKL

QUESTION 8



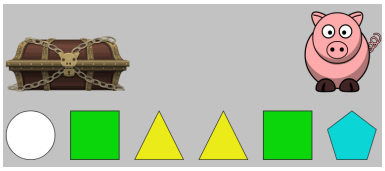
- ☐ DNXZZZ
- ☐ MWWBWN
- ☐ SWDWZW
- ☐ ZZXNWZ

QUESTION 9



- ☐ QHLHQZ
- ☐ WNCNFW
- ☐ FCCWNF
- ☐ NZLCLN

QUESTION 10



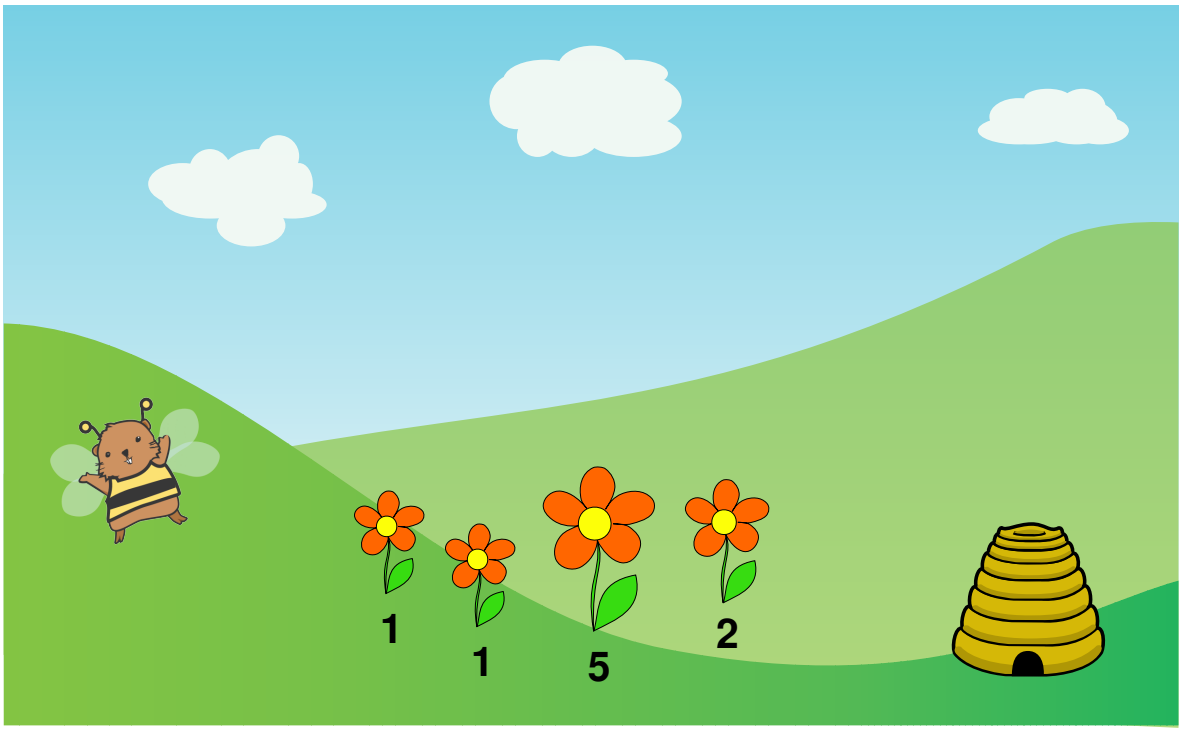
- ☐ CLTTGG
- ☐ BTQQTL
- ☐ GCGBCS
- ☐ HCSGCH

What was your “trick” to help Percy? _____

_____

Collecting nectar

Beever the bee collects nectar in a field of flowers. On each flight, he visits only one flower and can collect up to 2 bee-spoons of nectar. He can visit the same flower again if there is still nectar left. The number of bee-spoons of nectar in each flower is shown below.



QUESTION 1

What is the maximum amount of nectar that Beever can collect in 4 flights?

A. 4 bee-spoons

B. 5 bee-spoons

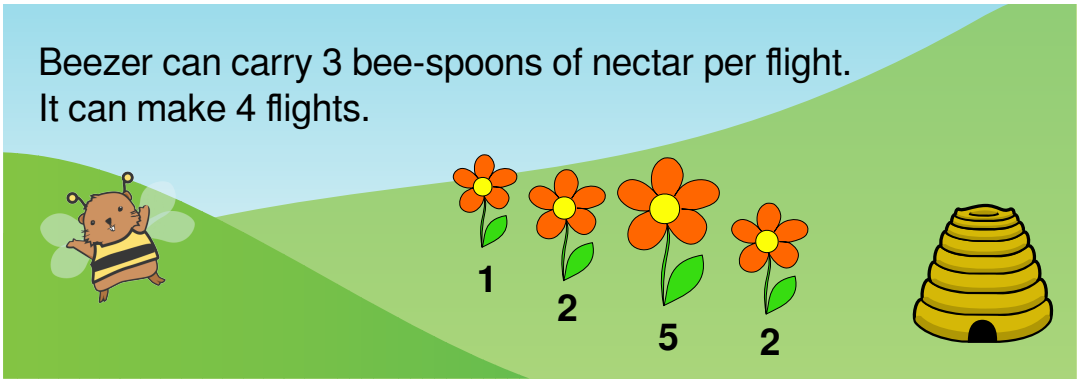
C. 7 bee-spoons

D. 8 bee-spoons

How much nectar can these bees get?

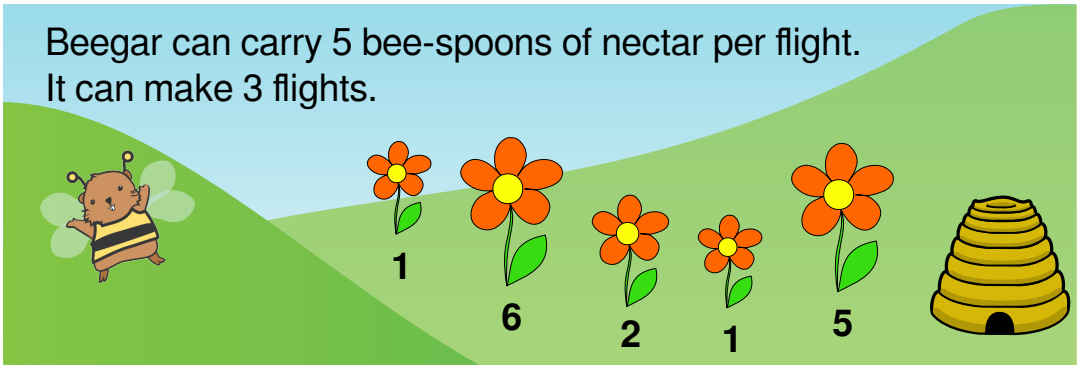
Bzzzzzz: Bees want to collect the maximum amount of nectar. But they can make limited number of flights and they can only visit one flower per flight.

QUESTION 2



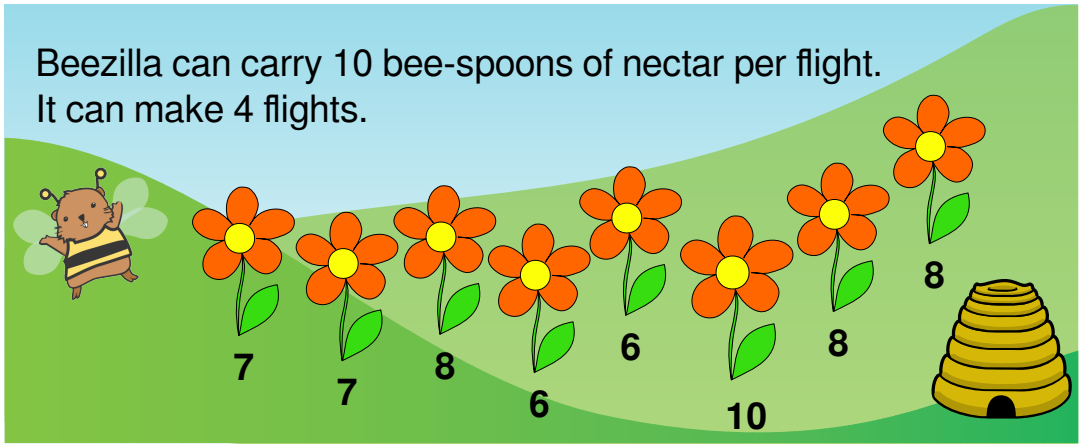
How much nectar can Beezer get?_____

QUESTION 3



How much nectar can Beegar get?_____

QUESTION 4



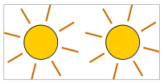
How much nectar can Beezilla get?_____

Beaver code

Barbara has been given two stamps.

With one she can produce a little flower, and with the other a little sun.

Being a clever girl, she thinks of a way to write her own name by using the code below:

Letter	B	A	R	E	Y
Code					

So “BARBARA” becomes:

QUESTION 1

She writes a name of her friend:

What is her friend’s name? _____

QUESTION 2

Ray is also her friend. How would she write RAY using the stamps?

____ ____ ____ ____ ____ ____ ____ ____ ____ ____

QUESTION 3

How would she write ABBY?

____ ____ ____ ____ ____ ____ ____ ____

QUESTION 4

How would she write ARYA?

_____

Make your own code

What letters you need to write your own name?

Invent a code for those letters and write your name using the code.

Letter						
Code						

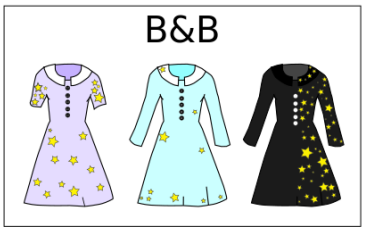
My name is:

Dream dress

Kate wants to buy her dream dress. It must have:

- short sleeves
- more than 3 buttons
- stars on its sleeves

Four shops sell the dresses shown.



QUESTION 1

Which shop sells Kate's dream dress?

A. BeaverYorker

B. BeaverNova

C. B&B

D. Tom Teaver

Design your own fashion items

It must have:

OR

AND

It must have:

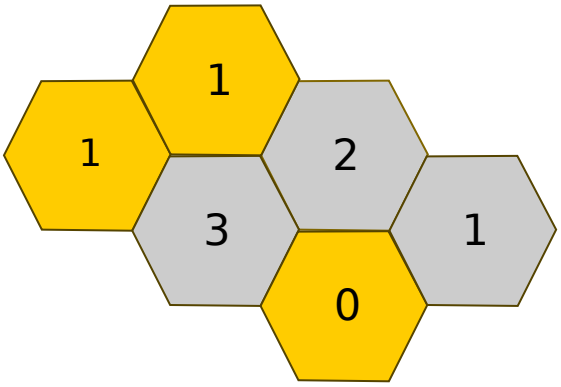
OR

Draw your designs here

Beehive

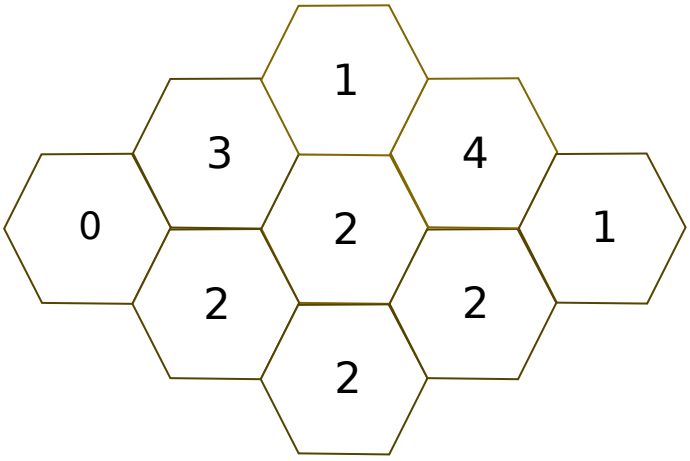
A bear knows which hexagons in a honeycomb contain honey. In each hexagon, the bear writes the number of other hexagons touching it that contain honey.

The example below shows how the bear writes the numbers in a small honeycomb. Yellow hexagons contain honey and grey hexagons are empty.



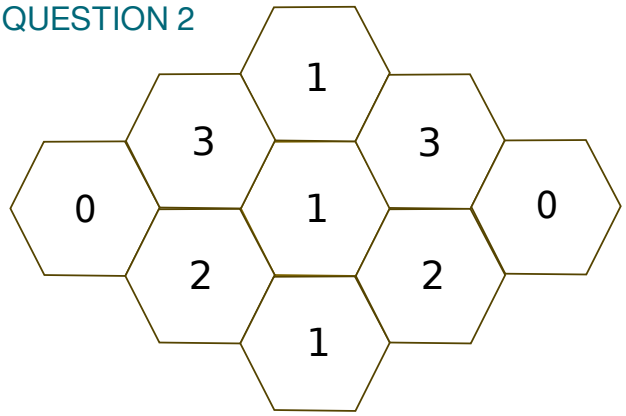
QUESTION 1

Can you figure out which hexagons contain honey for this honeycomb? Colour the hexagons with honey in yellow and the empty ones in grey.

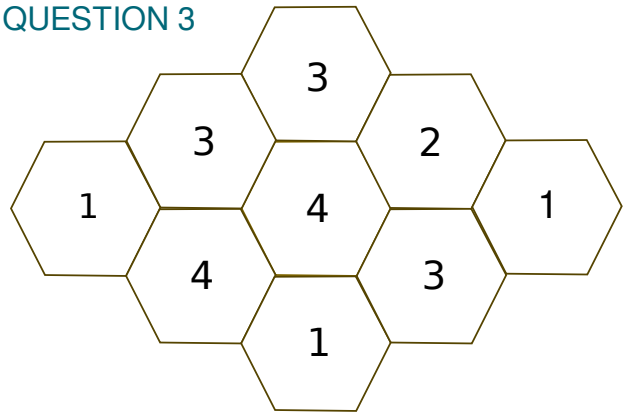


How about these honeycombs?

QUESTION 2



QUESTION 3



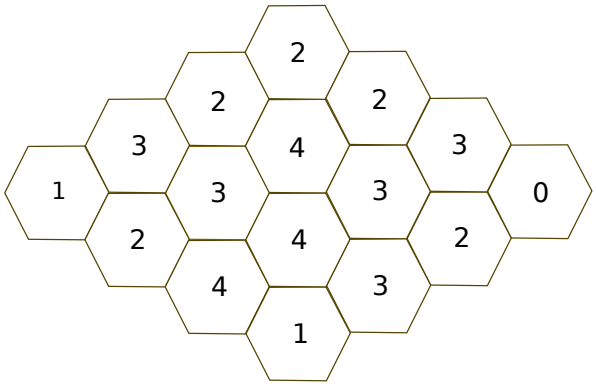
What was your strategy? How did you start solving these?

_____

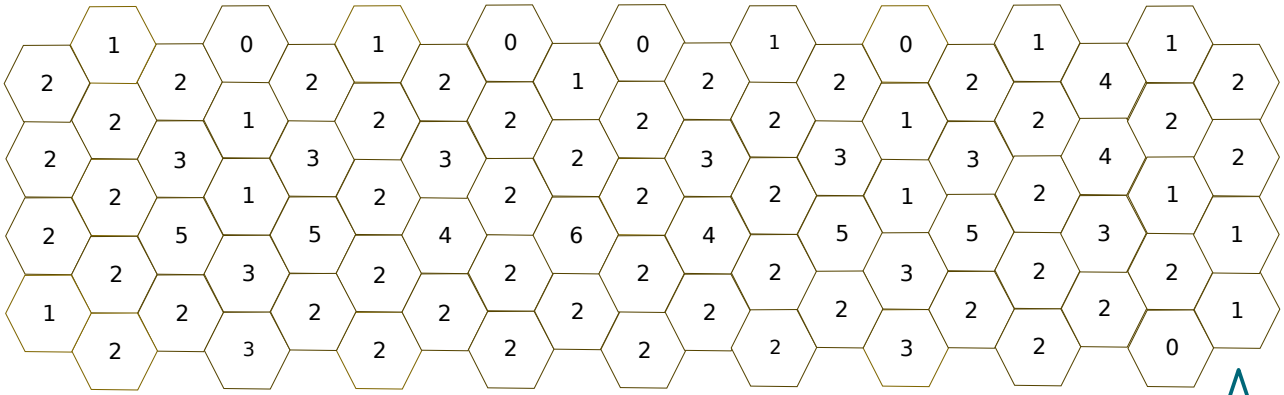
_____

Can you find the honey in this bigger one?

QUESTION 4



And finally this REALLY BIG one?



Throw the dice

During the holidays, a group of young friends often play together. To avoid quarrels about where to play, they throw three six-sided dice.

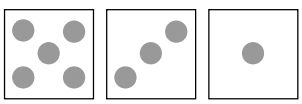
They decide according to this rule:

```
IF    the first throw is greater than the second throw
THEN  we go to play in the woods
ELSE  IF    the third throw is less than the first throw
      THEN  we go to play at the river
      ELSE  we go to play on the field
```

QUESTION 1

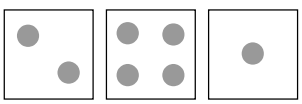
Where will the friends play after these throws during the holiday week?

Monday



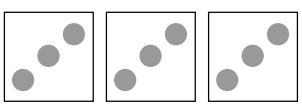
_____

Tuesday



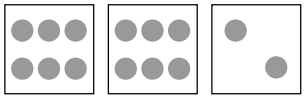
_____

Wednesday



_____

Thursday



_____

QUESTION 2

The friends still have to decide where to play on Friday, Saturday and Sunday.
Throw a dice three times for each day and draw what you get.
Follow the rules and write down for each day where the friends will play.

Friday	Saturday	Sunday
☐ ☐ ☐	☐ ☐ ☐	☐ ☐ ☐
_____	_____	_____

Make your own play rules!

IF the first throw is

THEN

ELSE

IF

THEN

ELSE

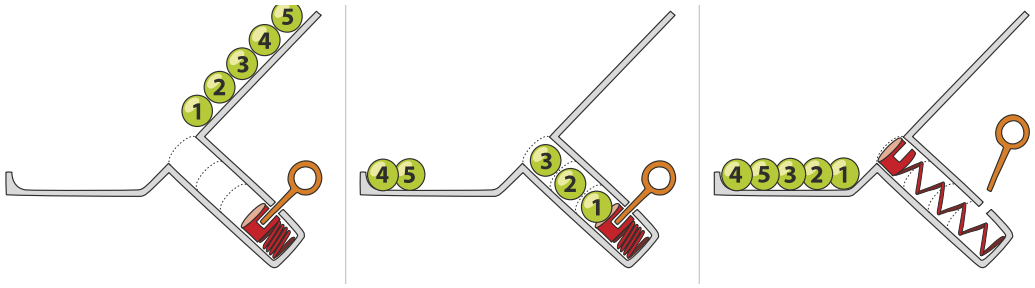
Test if your rules work by planning your own holiday week.

Monday	Tuesday	Wednesday	Thursday
☐ ☐ ☐	☐ ☐ ☐	☐ ☐ ☐	☐ ☐ ☐
_____	_____	_____	_____

Friday	Saturday	Sunday
☐ ☐ ☐	☐ ☐ ☐	☐ ☐ ☐
_____	_____	_____

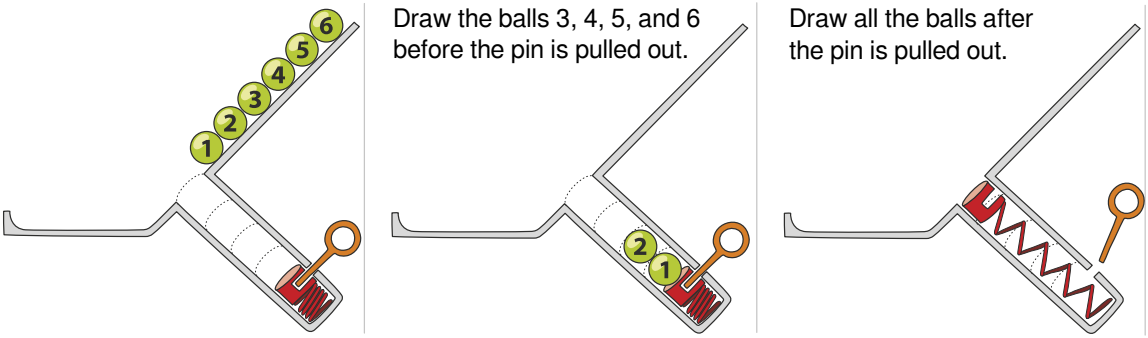
Balls

Numbered balls roll down a slope. The diagram shows what happens when the balls pass a hole the size of three balls. As each ball passes the hole, if there is enough space, the ball falls in, otherwise, the ball rolls past the hole. After all the balls have stopped rolling, a pin at the bottom of the hole can be pulled which ejects the balls in the order shown in the diagram.



QUESTION 1

What will happen if there are six balls passing a hole the size of four balls?



Draw the balls 3, 4, 5, and 6 before the pin is pulled out.

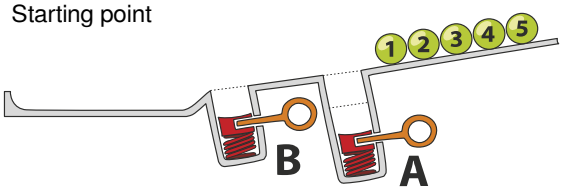
Draw all the balls after the pin is pulled out.

What order will the balls be in at the end? _____

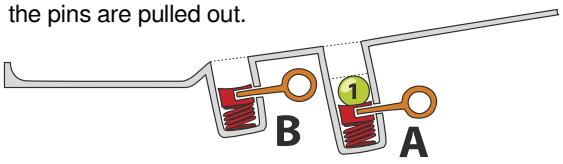
QUESTION 2

What will happen if we have five balls and two holes A and B as shown below? Pin A is pulled first and pin B is pulled only after the previous balls have stopped rolling.

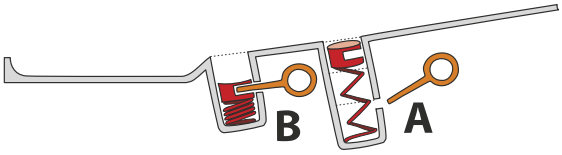
Starting point



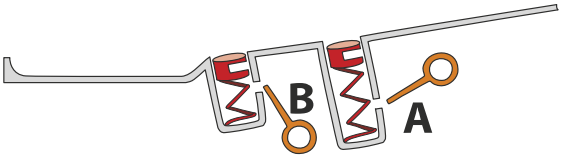
Draw the balls 2, 3, 4, and 5 before the pins are pulled out.



Draw the balls after the pin A is pulled out.



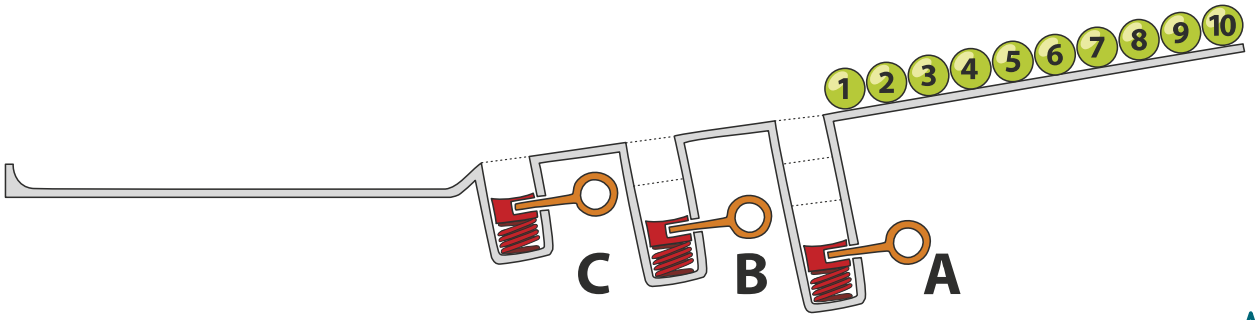
Draw the balls after the pin B is pulled out.



What order will the balls be in at the end? _____

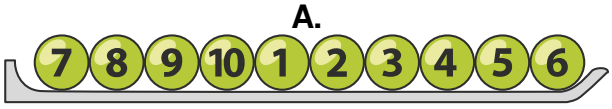
QUESTION 3

Ten balls roll down the slope as shown below. Three holes A, B, and C have space for 3, 2, and 1 balls as shown. The pins are pulled in the order A, B, C, but, each time, only after the previous balls have stopped rolling.

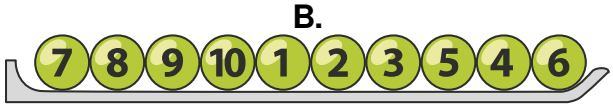


What order will the balls be in at the end?

A.



B.



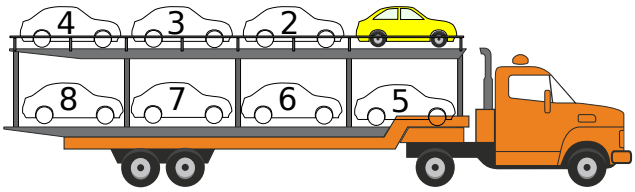
C.

D.

Car transportation

A new red car comes from a factory every 7 minutes. A new yellow car comes from another factory every 5 minutes. Both factories start working at the same time. As soon as a car comes from either factory it is loaded onto a transport truck in the order shown below.

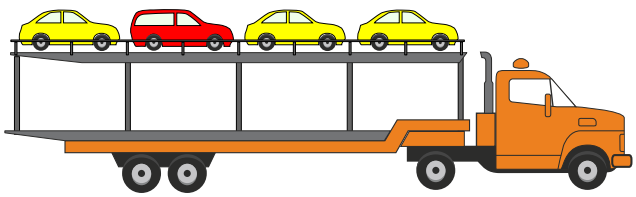
Transport truck after the first car is loaded:



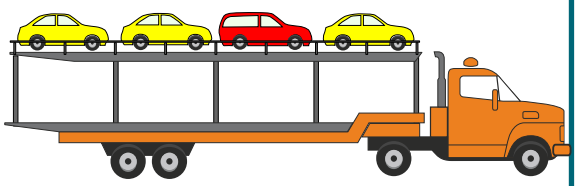
QUESTION 1

How will the transport truck look after the first four cars have been loaded?

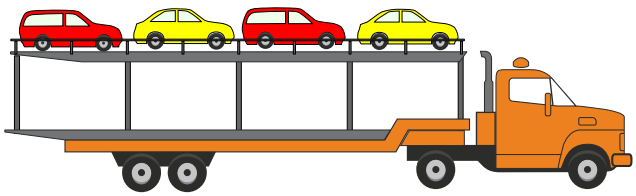
A.



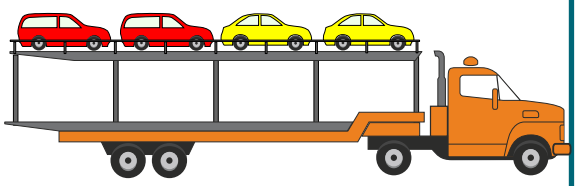
B.



C.

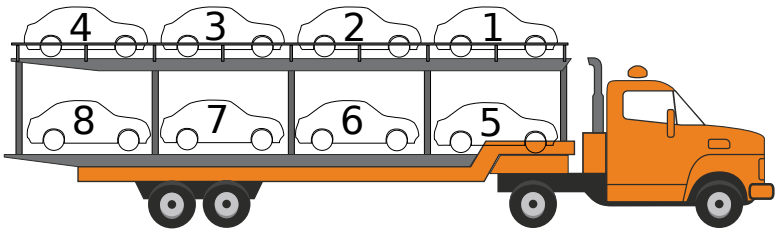


D.



QUESTION 2

How will the transport truck look when it is full? Colour in your answer.

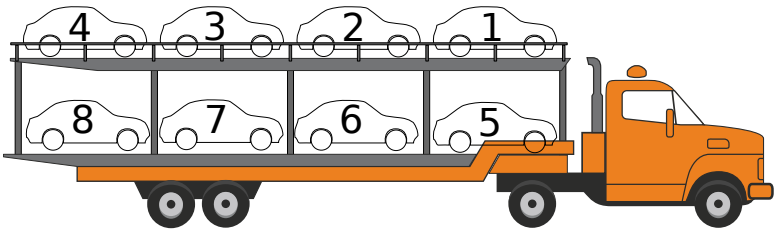


Colour in the full transport trucks

Can you figure out how the trucks leaving from these factories will look?

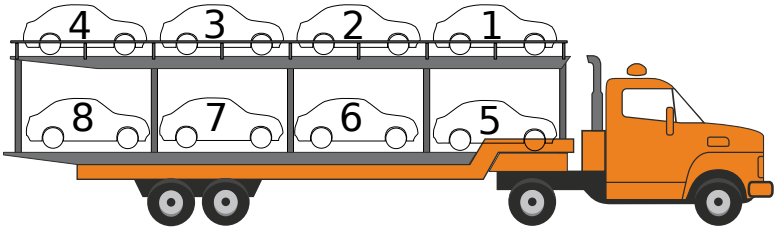
QUESTION 3

A red car every 2 minutes and a yellow car every 11 minutes



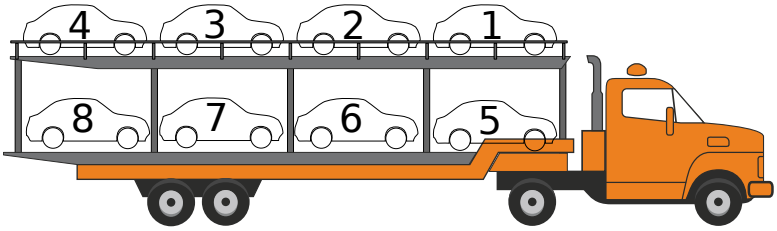
QUESTION 4

A red car every 9 minutes and a yellow car every 4 minutes



QUESTION 5

A red car every 3 minutes, a yellow car every 7 minutes, and a blue car every 5 minutes



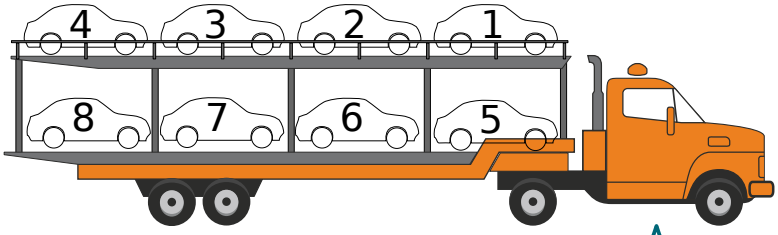
Make your own rules

Decide your own colours and timings for two car factories. You may also need a rule what happens if two cars come out at the same time. Colour in your truck when it's full.

A _____ car every __ minutes

A _____ car every __ minutes

If two cars come from factories at the same time, the _____ car is loaded first and the _____ car next.



Footprints

The instructions for a 1-tree:

- Step forward 1 step to make one footprint, go back in your own prints.

When you know how to make a 1-tree, you can learn how to make a 2-tree:

- Step forward 2 steps to make two footprints.
- Turn left and make a 1-tree.
- Turn right and make a 1-tree.
- Go back in your own prints.

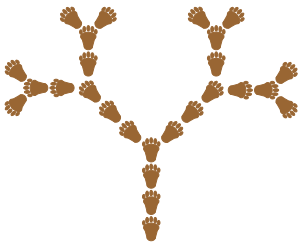
It is easy to explain how to create a 3-tree because a 3-tree consists of 2-trees:

- Step forward 3 steps to make three footprints.
- Turn left and make a 2-tree.
- Turn right and make a 2-tree.
- Go back in your own prints.

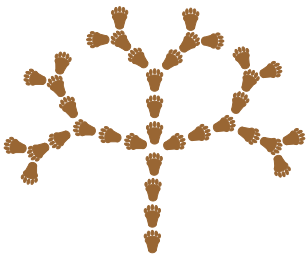
QUESTION

In a similar way you can create a 4-tree.
Which of the following trees is a proper 4-tree?

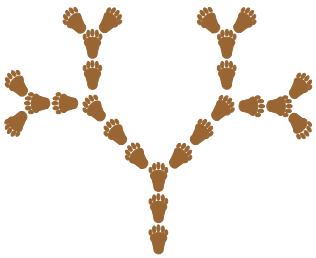
A.



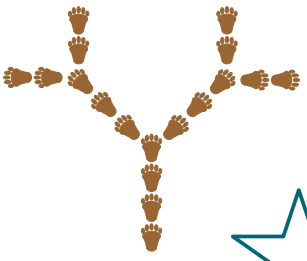
B.



C.



D.



How about a 5-tree?

Making a 5-tree

- A 5-tree consists of two ___-trees.
- Step forward ___ steps to make _____ footprints.
- Turn left and make a __-tree.
- Turn right and make a __-tree.
- Go back in your own prints.

Draw a 5-tree

Solve at home with the family

Note for parents:
Here is a computational thinking task to solve with the family at home.
You can find the correct solution for the task by scanning the QR code opposite or by visiting our website https://pact.cs.nuim.ie/qr/workbook.

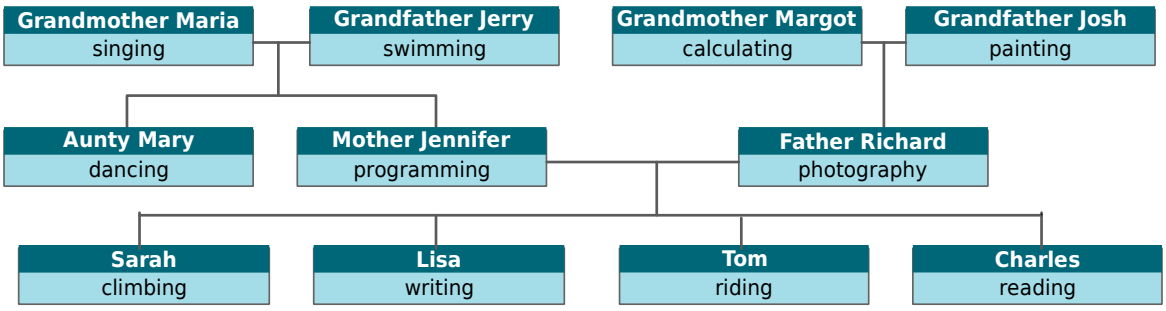
This workbook was made by the PACT team at the Department of Computer Science, Maynooth University. If you found it useful and would like us to make more free computational thinking materials for schools, please complete our feedback form for parents on the same website.

Superpower family

All members of a family have superpower abilities.

- Each daughter inherits her abilities from her mother.
- Each son inherits his abilities from his father.
- Each family member also has one extra ability.

The diagram below shows the relationships between the family members. It also shows the extra ability for each person.
For example, Mother Jennifer has inherited the ability to sing from Grandmother Maria, and she also has the ability to program. Lisa inherits both abilities from her mother and also has the ability of writing. This means she can write, program, and sing.



QUESTION

Which of these statements is true?

A. Tom's abilities are riding, painting, and photography.

B. Sarah has abilities in reading, programming, and singing.

C. Tom inherits from Grandmother Margot the ability to calculate.

D. Aunt Mary has abilities in dancing and swimming.

Information for teachers

This workbook gives examples of different types of computational thinking problems for primary school pupils. Solving these types of problems will develop pupils' problem solving skills. They will learn strategies for tackling complex problems, for example, by breaking the problem down into smaller parts, figuring out what information is relevant, finding patterns, and evaluating their solutions.

What is computational thinking?

Computational thinking is a set of problem solving skills that computer scientists use when they do their everyday work. It intersects with all STEM subjects because computational solutions have proven useful in all scientific fields.

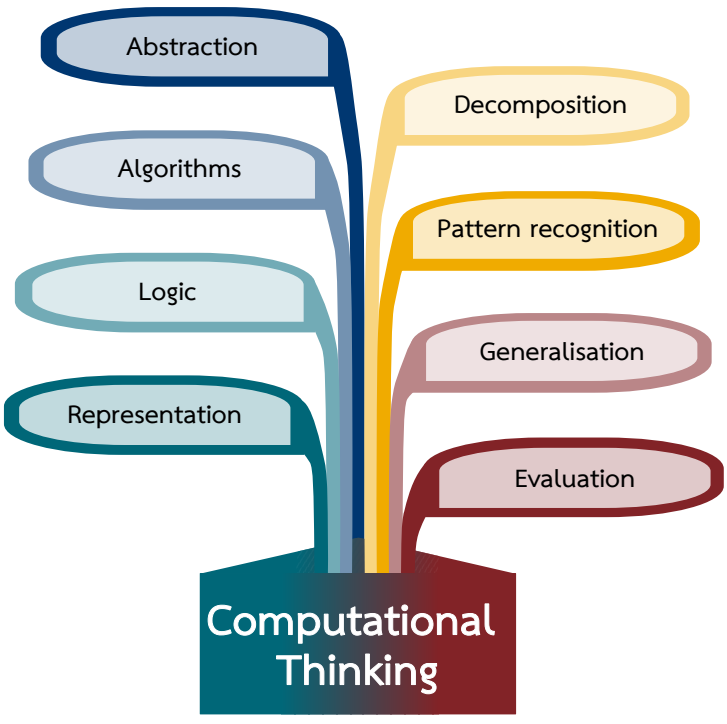
Computational thinking concepts

Abstraction
figuring out what is important and what can be ignored

Algorithms
step-by-step instructions that yield the solution we seek

Logic
deducing new information from the information available

Representation
finding the most efficient abstractions/ layouts of data



Decomposition
breaking a problem into smaller parts

Pattern recognition
finding structure, repetitions, similarities

Generalisation
using a solution to one problem to solve a different one

Evaluation
testing for correctness, debugging, comparing solutions, optimisation

Information for teachers

For each of the ten lessons in this workbook, extra teacher materials are available including solutions and a lesson plan. These materials explain the connections to computational thinking and computer science, give hints for class discussion, give links to the primary curriculum, and suggestions for extension activities.
To access the teacher materials, please visit our website https://pact.cs.nuim.ie/qr/workbook or scan the QR code:

You can also fill out the feedback form on the same website. We would really appreciate hearing your opinions on this workbook, how the tasks worked with your class, and suggestions for how we could make our computational thinking materials more suitable for you in the future.

To sign up for our mailing list for information about our teacher workshops, school visits, and teacher resources, please visit our website or email pact@mu.ie.

Materials for this workbook are based on Bebras® tasks. Bebras is an international initiative to promote computational thinking among primary and secondary students. It was founded by Prof. Valentina Dagienė, Vilnius University, Lithuania. The annual Bebras Computational Thinking Challenge is one of the most popular gender-balanced computer science-related activities for primary and secondary school students worldwide e.g. 2.5 million participants from 56 countries in 2020. The flags on the task pages acknowledge the country of origin of each task. (www.bebras.org)

The Irish Computer Society (ICS) is the National Bebras Organiser for Ireland. The ICS organises the Bebras Ireland challenge as part of its Tech Week activities each November. Teachers can sign their class up for the Bebras Ireland Challenge at https://bebras.techweek.ie/ .

The PACT team at Maynooth University Department of Computer Science develops resources and supports to allow teachers to teach topics in computer science at both primary and secondary school level. We specialise in computational thinking resources and supports (see https://pact.cs.nuim.ie).

Since 2016, PACT members have been the Ireland representatives to the annual International Bebras Task Workshop where tasks for the subsequent international Bebras Challenges are developed. Bebras Ireland tasks created by the PACT team have been translated into tens of different languages by overseas national Bebras organisations and tackled by hundreds of thousands of primary and secondary students worldwide. Over recent years the PACT team has been funded by Maynooth University Department of Computer Science, the Google CS4HS programme, and the Science Foundation Ireland Discover programme.

Graphics used in this workbook originate from Bebras, freesvg.org, and pixabay.com.

Maynooth University
National University of Ireland Maynooth

Science Foundation Ireland sfi For what's next

SMART FUTURES

COMPUTATIONAL THINKING

Workbook

This workbook can be used as a 10 lesson introduction to computational thinking for primary school pupils from 3rd through 6th class, or it can serve as material for an after-school science club activity.

This workbook develops problem solving skills. Pupils will learn strategies for tackling complex problems, for example, by breaking the problem down into smaller parts, figuring out what information is relevant, finding patterns, and evaluating their solutions. These types of computational thinking skills are essential for the problem solvers of the future!

Created by the PACT team at the Department of Computer Science, Maynooth University

Maynooth University
National University of Ireland Maynooth

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SMART FUTURES