PDST

Professional Development Service for Teachers | An tSeirbhís um Fhorbairt Ghairmiúil do Mhúinteoirí

An Roinn Oideachais agus Scileanna
Department of Education and Skills

National Workshop 2

LEAVING CERTIFICATE
COMPUTER SCIENCE

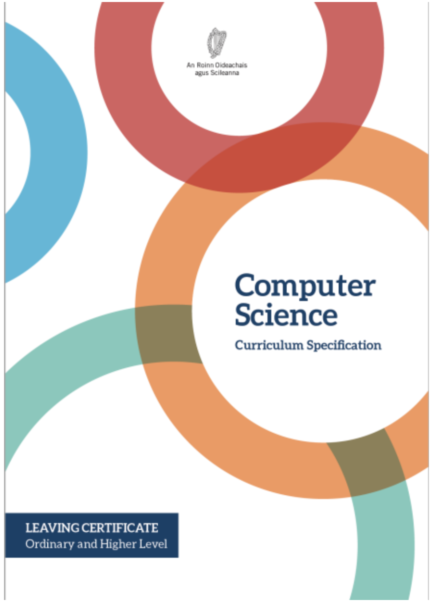
Session 2
Computational Thinking

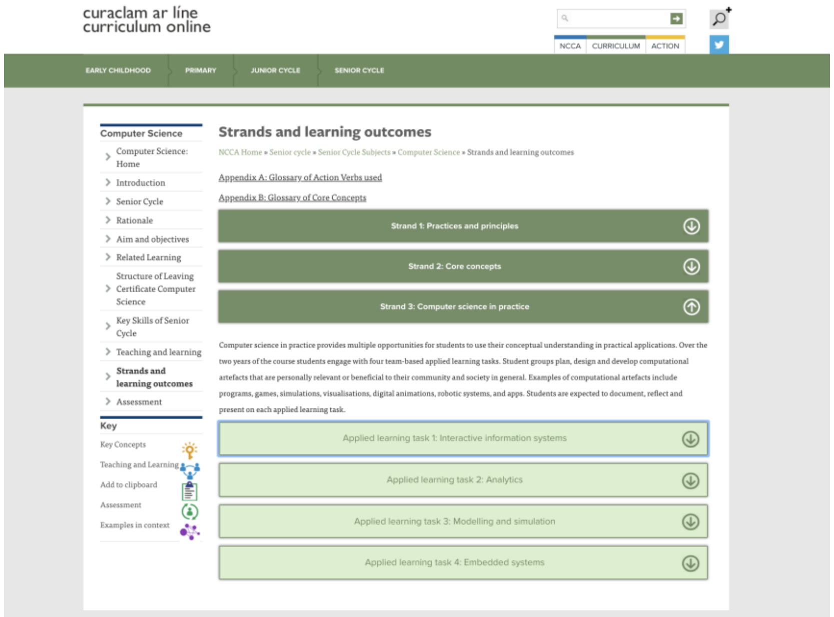
By the end of this session :

Participants will have be enabled to:

- develop their understanding of Computational Thinking (CT) concepts
- consider the questions What is Computational Thinking and Why is Computational Thinking important?
- reflected on successful pedagogies for teaching Computational Thinking skills

LCCS Curriculum Specification





https://www.curriculumonline.ie

What does the specification say?

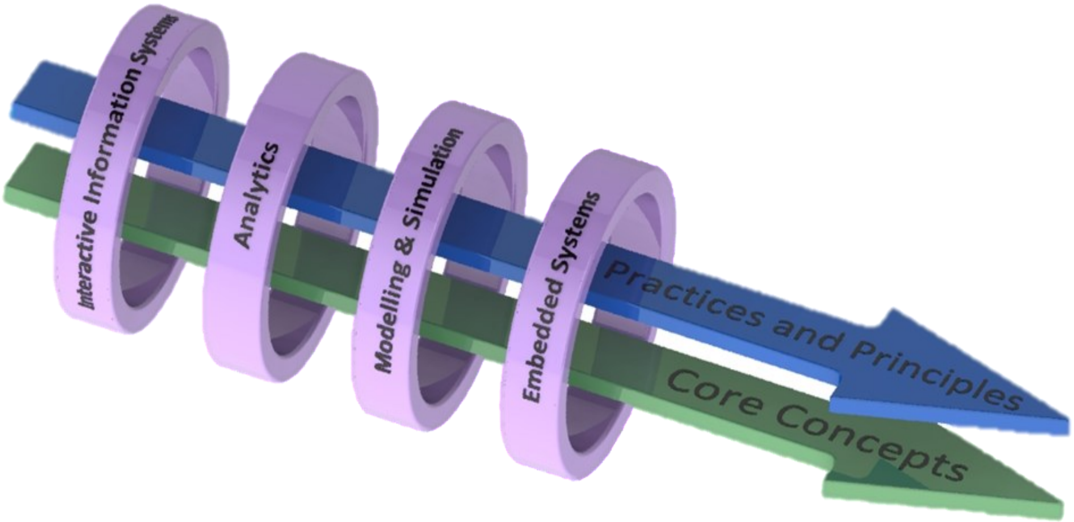
*"Computer science is the study of computers and algorithmic processes. Leaving Certificate Computer Science includes how programming and **computational thinking** can be applied to the solution of problems, and how computing technology impacts the world around us."*

[LCCS Spec. Page 2, paragraph 1]

Strand 1: Practices and principles	Strand 2: Core concepts	Strand 3: Computer science in practice
▸ Computers and society ▸ Computational thinking ▸ Design and development	▸ Abstraction ▸ Algorithms ▸ Computer systems ▸ Data ▸ Evaluation/Testing	▸ Applied learning task 1 - Interactive information systems ▸ Applied learning task 2 - Analytics ▸ Applied learning task 3 - Modelling and simulation ▸ Applied learning task 4 - Embedded systems

What does the specification say?

*"The role of programming in computer science is like that of practical work in the other subjects — it provides motivation, and a context within which ideas are brought to life. Students learn programming by solving problems through **computational thinking** processes and through practical applications such as applied learning tasks."* LCCS specification (2017)



What is Computational Thinking?

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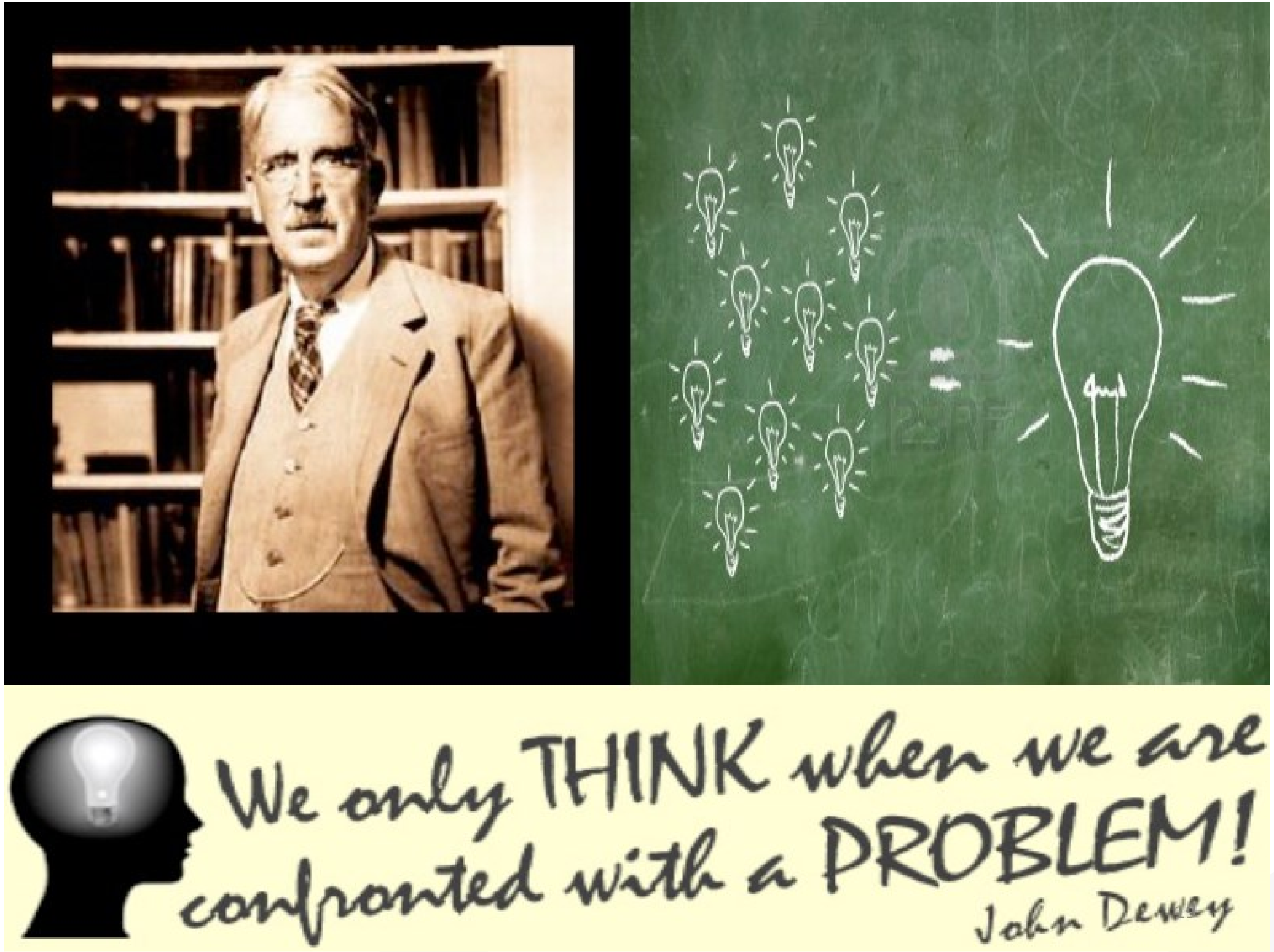


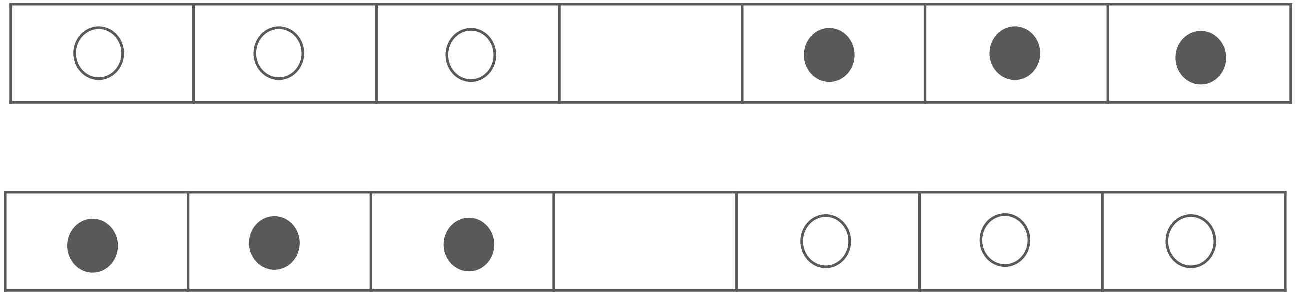
What is Computational Thinking?

Computational thinking is a way of solving problems, designing systems, and understanding human behaviour that draws on concepts fundamental to computer science… a fundamental skill for everyone, not just computer scientists. (Wing, 2006)

"Computational Thinking is the thought processes involved in formulating problems and their solutions so that the solutions are represented in a form that can be effectively carried out by an information-processing agent." (Wing 2011)

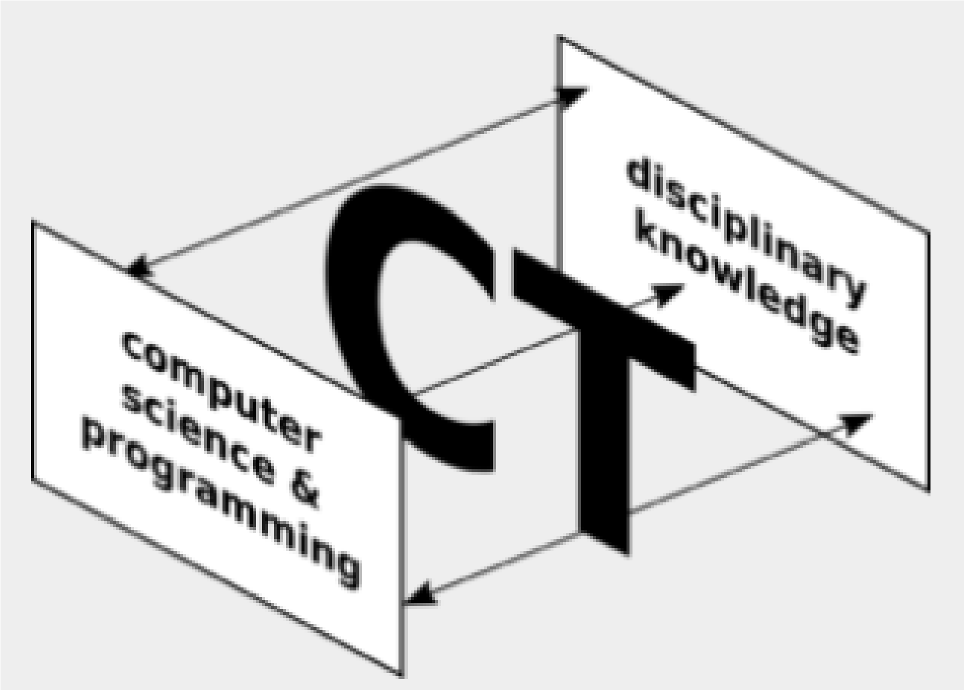
Devise an algorithm …

The aim is swap the positions of the black and white pieces.



Pieces can move either by sliding into an adjacent empty square, or by jumping a single adjacent piece into the empty square immediately beyond.

“Computational Thinking is about connecting computing to things in the real world” (Martin, 2018)



Source: http://advocate.csteachers.org/2018/02/17/rethinking-computational-thinking/

Simple Daily Examples

Looking up a name in an alphabetically sorted list

    Linear: start at the top

    Binary search: start in the middle

Standing in a queue at a bank, supermarket, check in desk, passport control

    Performance analysis of task scheduling

Taking your children to football, music and the swimming pool

    Traveling salesman (with more constraints)

Cooking a gourmet meal

    Multi-tasking, Parallel processing:

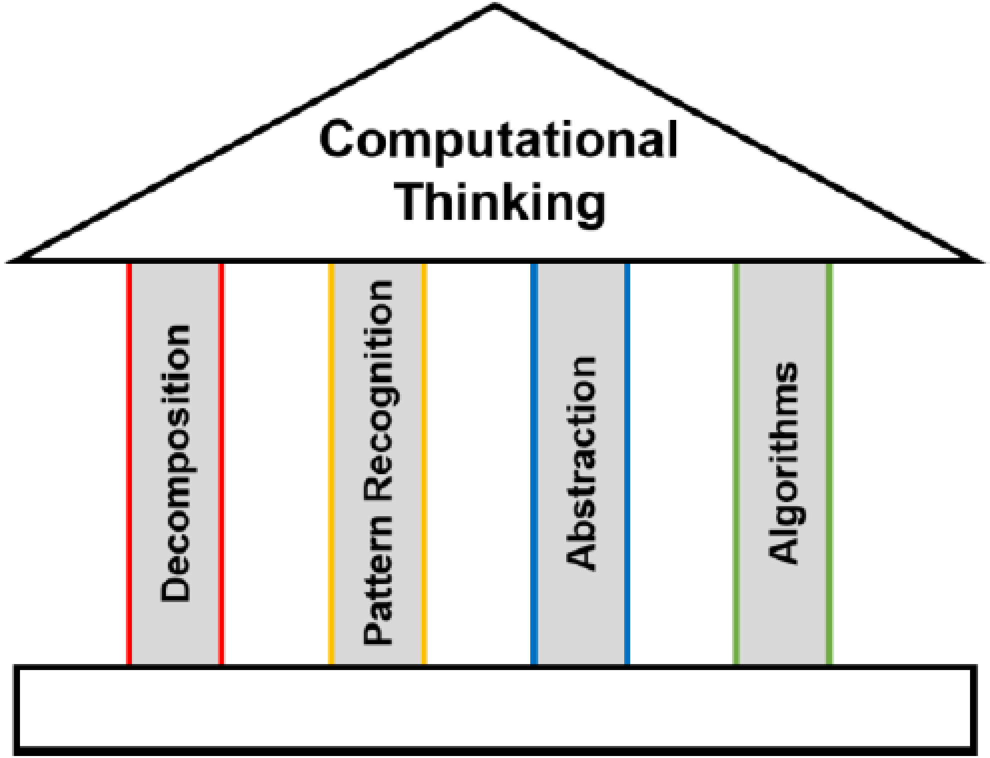
Cleaning out your garage

    Keeping only what you need vs. throwing out stuff when you run out of space.

Storing away your child's toys scattered on the floor

    Using hashing (e.g., by shape, by color)

Pillars of Computational Thinking



Decomposition – breaking down problems into more manageable sub-problems.

Patterns recognition involves looking for parts of a problem/solution that are similar to something that has been solved before .... This leads to a generalised solution – transforming problems and re-using solutions

Abstraction – the process of extracting the important details and hiding unnecessary detail.

Algorithmitic thinking refers to how solutions can be expressed as a set of instructions (as opposed to a specific, single answer).

Why is Computational Thinking Important?

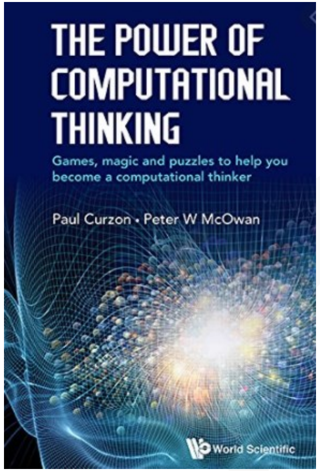
Why is Computational Thinking Important?

- It moves students beyond being technologically literate
- It creates problem solvers instead of software technicians
- It emphasises the creation of knowledge rather than the use of information
- It presents endless possibilities for creative problem solving
- It enhances the problem-solving techniques you already teach

(Source: Pat Phillips, NECC 2007, Atlanta)

“What are effective ways for teaching computational thinking?”

How to Teach Computational Thinking



- ❑ Increase your own CT knowledge
- ❑ Integrate CT concepts into everyday instruction
- ❑ Use CT terms for everyday tasks

e.g. “Let’s create an algorithm for …”

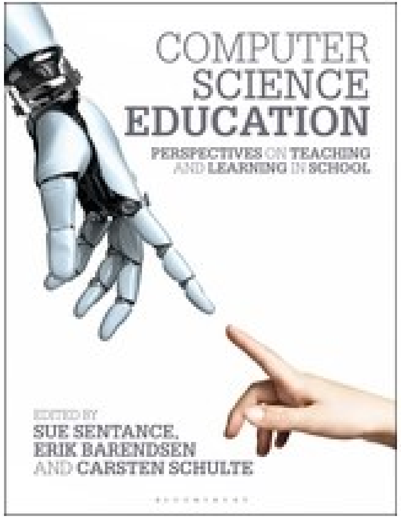
- ❑ Encourage students to formulate and test their own hypotheses

e.g. “Crime rates are on the rise …”

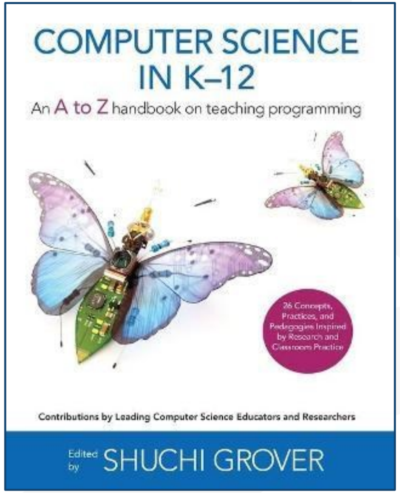
- ❑ Provide opportunities for students to transfer their learning to other situations

Successful CT Pedagogies

- ❑ Analogy / Storytelling
- ❑ CS Unplugged
  - Kinaesthetic
  - Role Playing
  - Puzzles
  - Art
  - Games
  - Magic
- ❑ Enquiry Based Learning (TEMI)



See chapter 8



Programming Practice (Python / JavaScript)

5 minute stretch break

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Session 2 CT Examples

Learning Outcomes / Intentions

Outcomes:

- To develop an understanding of the centrality of Computational Thinking in CS.
- To understand and apply the concepts / pillars of Computational Thinking.

Intentions:

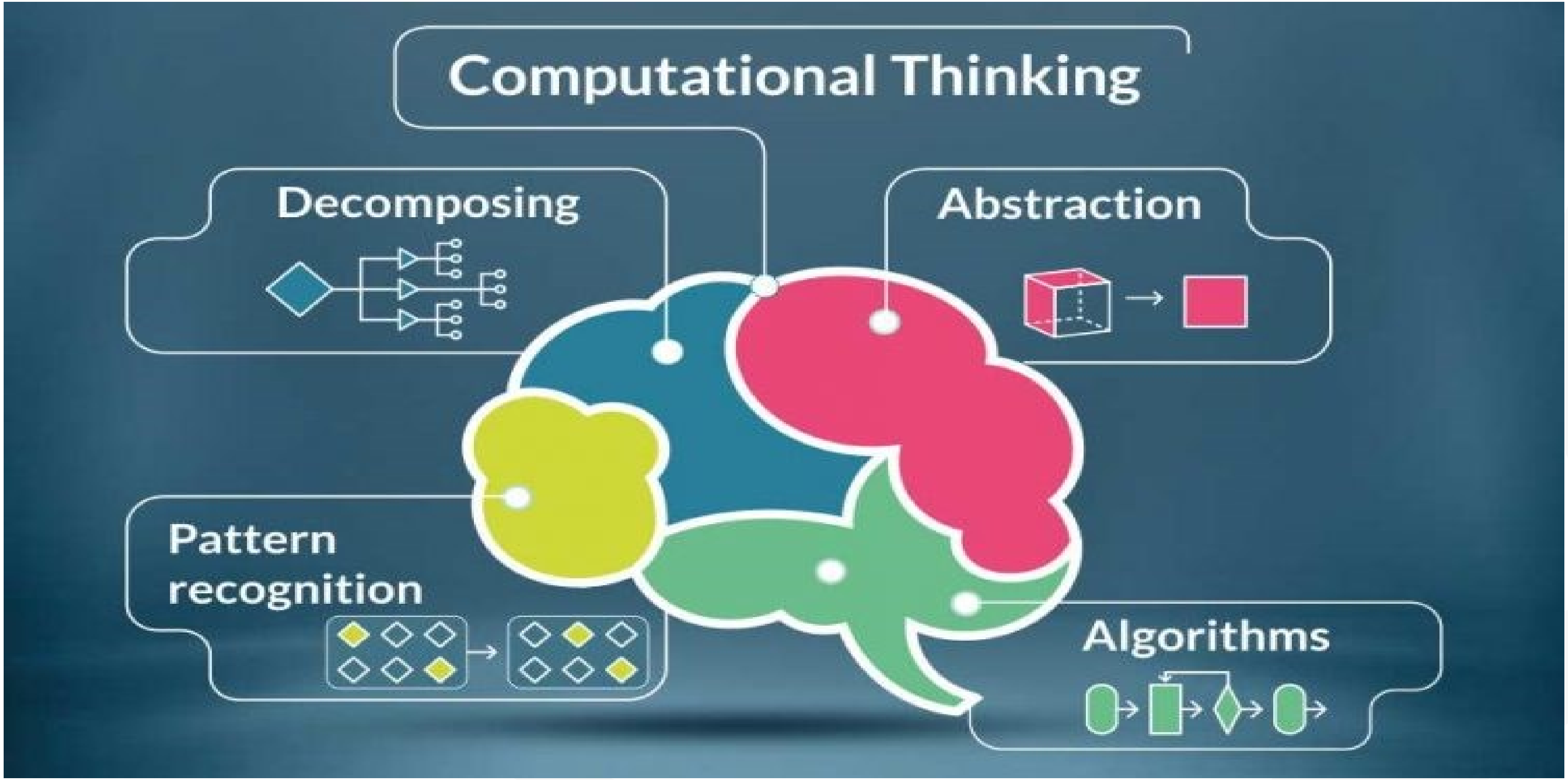
- To analyse and develop solutions to problems of various types using Abstraction, Decomposition, Pattern Recognition, Algorithm formation.

Computational Thinking – Rationale for Examples

- Different Pillars - 4 pillars ……. 6 pillars …… 7 pillars
- Licence / Help for students – not a straight jacket

- Computer? ‘The Imitation Game’ / Blechley Park
- Why choose ‘logic’ problems: Monty Hall / Sisters and not Skiing Holidays

- Pillars …….Concepts


Computational Thinking
Decomposing
Abstraction
Pattern recognition
Algorithms

Examples

Chinese Babies

The basis of this problem in the One-Child policy introduced by the Chinese government in 1979. Many Chinese families wanted a boy.

Let's abstract a model of families where if a boy is born, they have no more children, and if a girl is born, they have another child and keep going until they have a boy. We ignore other biological, geographical or sociological factors.

If this model was run, would the population trend towards more boys, more girls or the same?

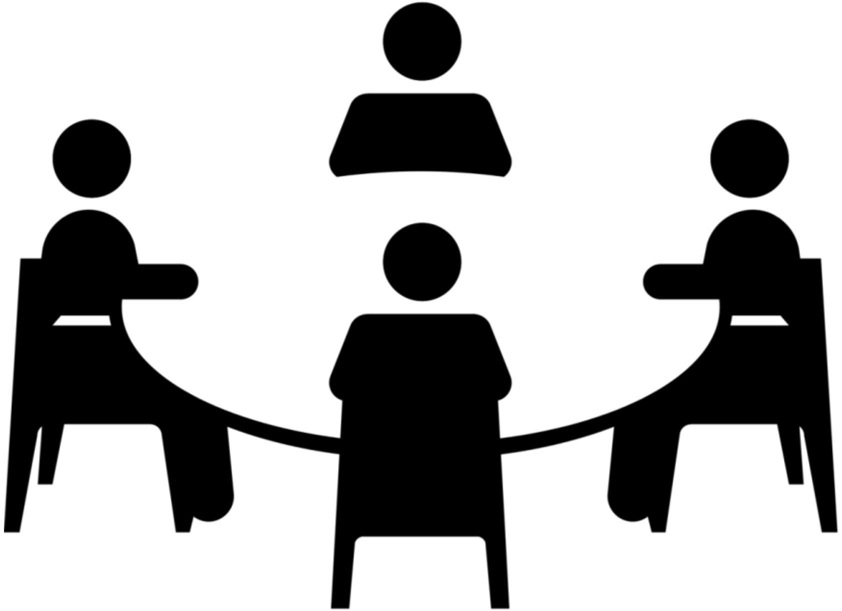
Chinese Babies

Try different ways to solve:

- *English (nó Gaeilge) /Pseudocode / Algorithms… or any of pillars*
- *Diagram / Flowchart (ish)*
- *Model*
- *Code*

Chinese babies Google doc

Group Activity



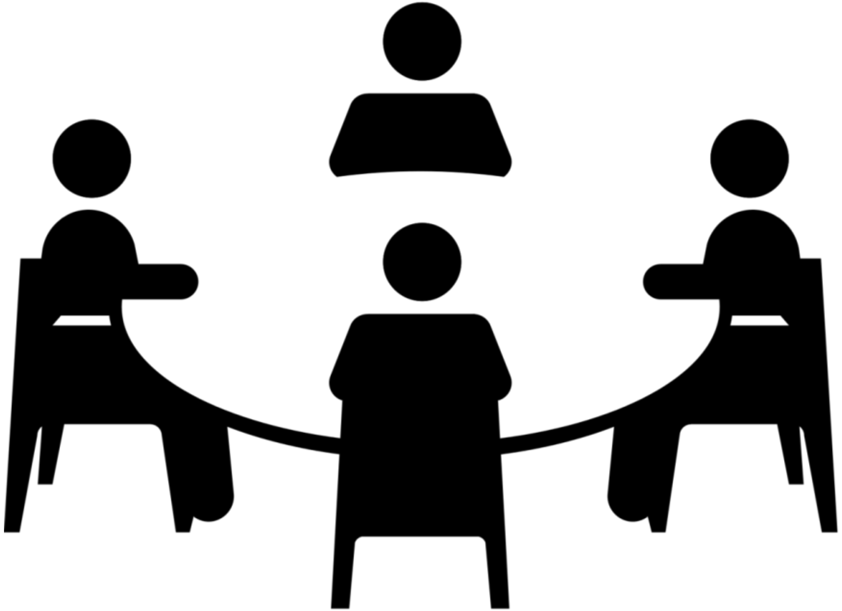
Chinese Babies

Farmer’s Problem

A farmer wants to cross a river and take with him a wolf, a goat, and a cabbage. There is a boat that can fit himself plus either the wolf, the goat, or the cabbage. If the wolf and the goat are alone on one shore, the wolf will eat the goat. If the goat and the cabbage are alone on the shore, the goat will eat the cabbage.

How can the farmer bring the wolf, the goat, and the cabbage across the river?

Group Activity



Farmer's Solution

1. Begin on side A
2. Take goat across to side B
3. Return with empty boat to side A
4. Take wolf across river to side B
5. Return with goat to side A
6. Take cabbage to side B
7. Return with empty boat to side A
8. Take goat to side B
9. END

A closer look ...

Initial Position

FARMER	WOLF	CABBAGE	GOAT
0	0	0	0

Final Position

FARMER	WOLF	CABBAGE	GOAT
1	1	1	1

All Positions

FARMER	WOLF	CABBAGE	GOAT

FARMER	WOLF	CABBAGE	GOAT
0	0	0	0
0	0	0	1
0	0	1	0
0	0	1	1
0	1	0	0
0	1	0	1
0	1	1	0
0	1	1	1
1	0	0	0
1	0	0	1
1	0	1	0
1	0	1	1
1	1	0	0
1	1	0	1
1	1	1	0
1	1	1	1

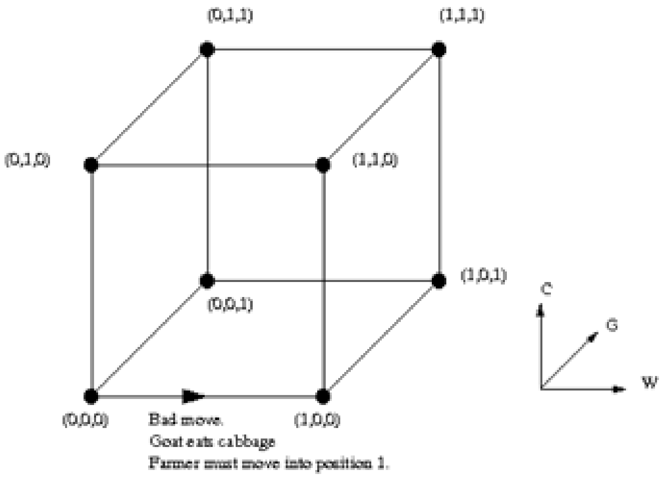
However …

Goat cannot be left alone with the cabbage: ***f=g=c V g<>c***

Goat cannot be left alone with the wolf: ***f=g=c V g<>w***

FARMER	WOLF	CABBAGE	GOAT	
0	0	0	0	✓
0	0	0	1	✓
0	0	1	0	✓
0	0	1	1	✗
0	1	0	0	✓
0	1	0	1	✗
0	1	1	0	✓
0	1	1	1	✗
1	0	0	0	✗
1	0	0	1	✓
1	0	1	0	✗
1	0	1	1	✓
1	1	0	0	✗
1	1	0	1	✓
1	1	1	0	✓
1	1	1	1	✓

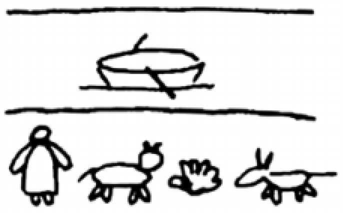
10 good and 6 bad



Farmer’s Problem – re-stated

A farmer wants to ferry an alpha and two betas across a river. However his boat is large enough to only take one of them at a time, making several trips across the river necessary.
Also, an alpha cannot be left alone with a beta.

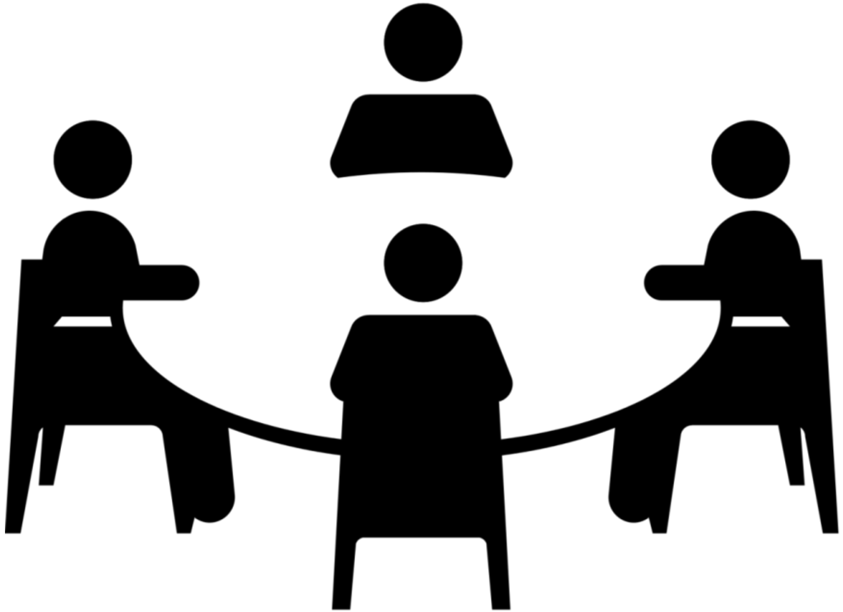
How can the farmer achieve the task?



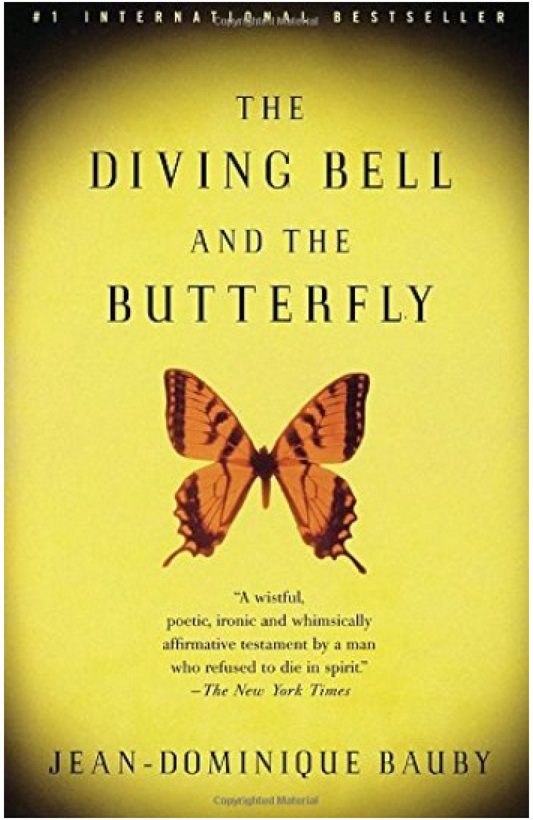
Solution: Take the alpha across,
then a beta returning with the alpha.
Then take the second beta across
followed by the alpha

Rock Paper Scissors

Group Activity



Scenario 1



https://www.youtube.com/watch?v=t4Ek4ZBpshs

'The Diving Bell and the Butterfly' is an incredibly uplifting book. It's the autobiography of Jean-Dominique Bauby, written after he woke up in a hospital bed totally paralysed. In the book, he describes life with locked-in syndrome. He did have a way to communicate not only to write the book but also with medics, friends and family. He did it without any technology at all. How?

Pair Activity

What CT concepts are you explaining?

What pedagogy are you using?

Presentation

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