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The Magic of Computer Science

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Aims

- Give you deeper understanding of core topics
  - Computational thinking
  - Algorithms
  - Importance of understanding people
  - Search algorithms
- Give you practical ways to teach computing in a fun, thought provoking way
  - away from computers, focus on concepts
- Linked activity sheets and booklets can be downloaded from our website:

www.teachinglondoncomputing.org

What is computational thinking?

- Used by computer scientists and magicians!
- The interesting parts are:
  - Algorithmic thinking
  - Decomposition
  - Abstraction and generalisation
  - Evaluation
    - attention to detail
    - testing, rigorous argument, proof
  - Logical thinking
  - Understanding people

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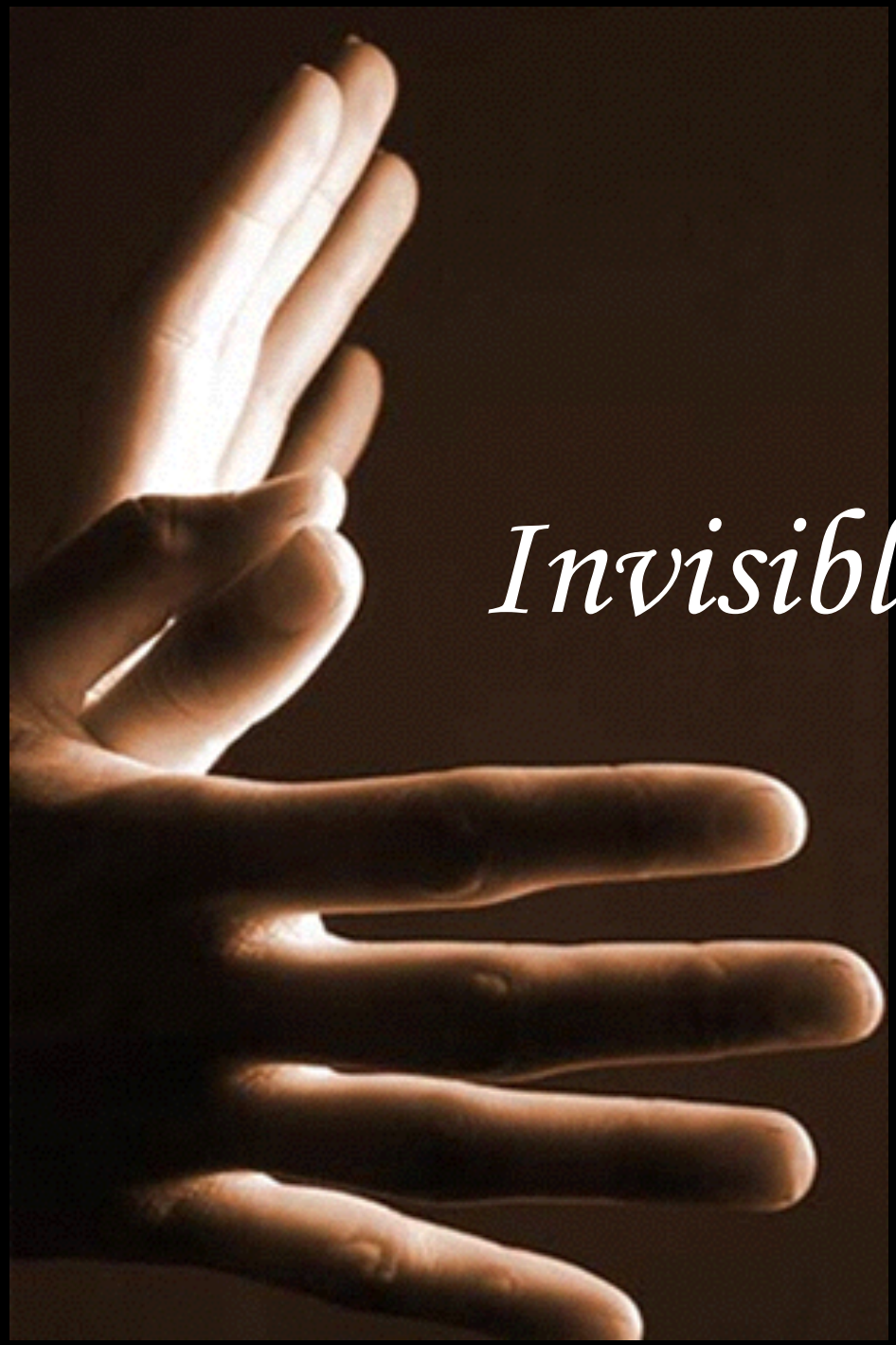
On to the magic …
Please keep the secrets

- I'm going to teach you how to do the tricks
- If you do perform them later for friends don't break the magician's code
  - Keep the secrets!
- If you do know then don't shout out
  - let others puzzle it out first!



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Invisible Palming

Ponder break

How on earth do they do that?

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It's just an algorithm - that's all programs are

1. Put two cards between the volunteer's fingers saying "2 cards make a pair" with the final card placed alone
2. Collect them up a pair at a time placing them into two piles
3. Ask the volunteer to choose where to put the extra single card
4. Put the card there
5. Pretend to move the card:
    1. Put your hand over it,
    2. lift your hand and show the card is invisible
    3. place it over the other pile and tap the back of your hand
6. Deal out the cards from the first pile in pairs to show the extra card has gone
7. Do the same to the second pile showing it now has the extra card

Algorithms

Having learnt the trick…

- Now write your own crib sheet
  - The instructions to learn and then follow to do the trick
  - Include all the detail
  - You are writing an algorithm!
  - You are doing algorithmic thinking!

- Make changes to the trick including its presentation to create your own version
  - You are doing computational thinking!

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Computing is about understanding people too

Magic = secret method + presentation

Software = algorithm + HCI

Both the algorithm and human-computer interaction must work!

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Computational Thinking Lessons

- Algorithmic thinking
- Logical Thinking
- Understanding people
- Abstraction
  - Hiding detail in the instructions
- Decomposition

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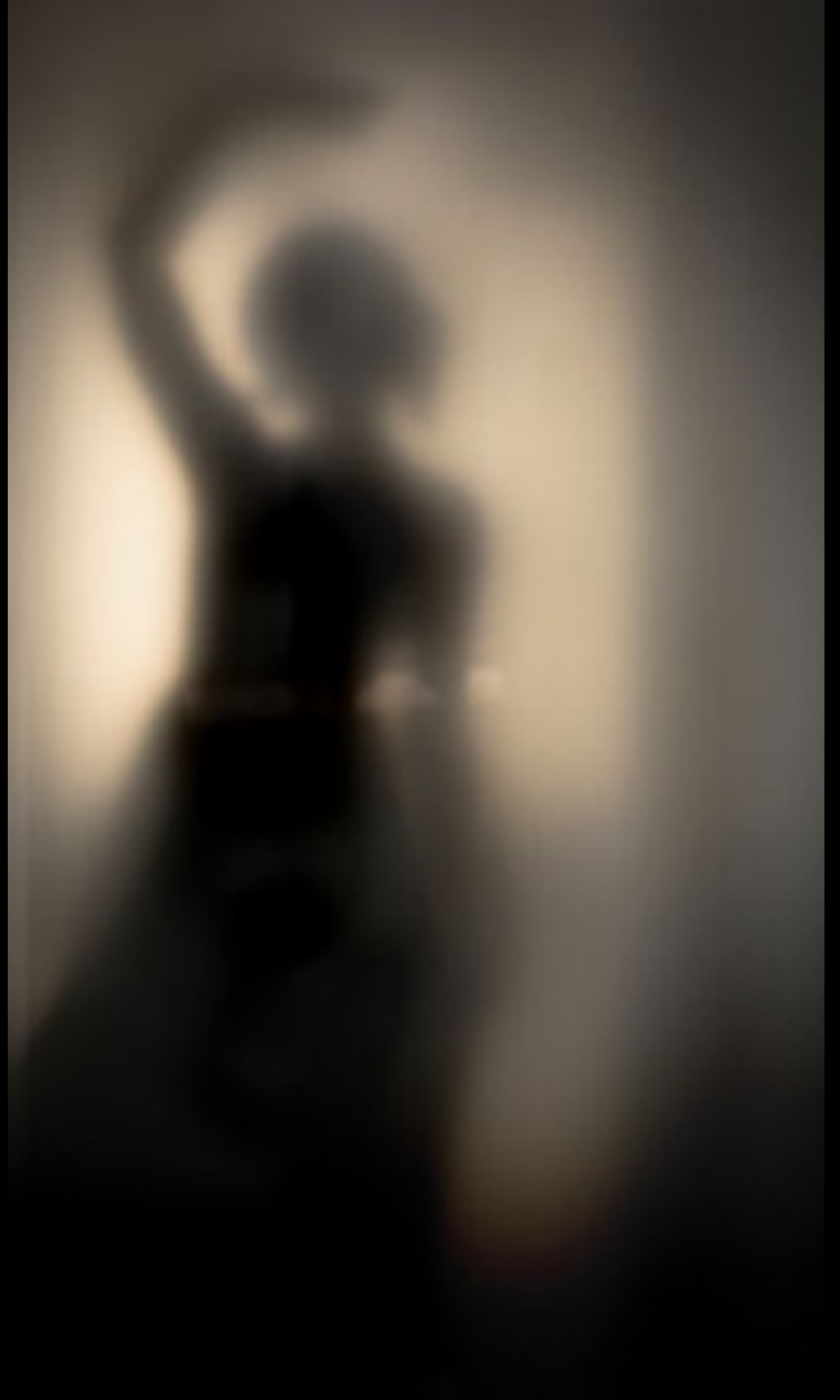
The Australian magician's dream



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Ponder break

How on earth do they do that?

The computer science?

It is a self-working trick: an algorithm

1. Place the chosen card in position 16
2. Discard roughly the bottom half
3. Repeat 4 times:
   Discard the first and then
   every second card thereafter
4. Reveal the card is the one predicted.

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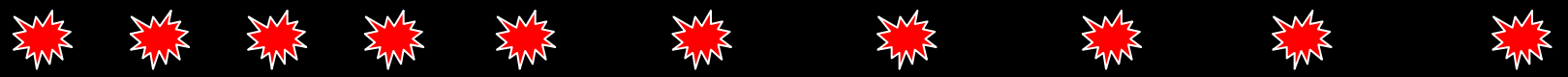
How can you be sure the trick always works?

- How long would it take to test all combinations of card starting positions and points cut is done?
- Instead use logical reasoning to cut down the number of options to test
  - The values of the other cards don't matter!
- Could we prove it works with no testing?

Some logical thinking

- Shows you will always be left with the 16th card
  - As long as there are between 16 and 32 cards in the pile

1,2,3,4,5,6,7,8,9,10,11,12,13,14,15,16,17,18,19,20,...



2, 4, 6, 8,10,12,14,16,18,20,...

4, 8,12,16,20,...

8, 16

16

I set my force card 16 from the top

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It is a real search algorithm

- It is not just that magic tricks are algorithms
- Real computer algorithms can be turned into magic tricks (and vice versa)

- This trick is actually a search algorithm
  - the algorithm was used by early computers to find data stored on punch cards
- Used to pull out a particular punch card based on numbers encoded in binary as holes and slots along the top of the card
  - A slot = 1
  - A hole = 0

We need some binary maths

16 in Binary is 10000

	16	8	4	2	1
x	1	0	0	0	0
=	16 +	0 +	0 +	0 +	0

5 in Binary is 00101

	16	8	4	2	1
x	0	0	1	0	1
=	0 +	0 +	4 +	0 +	1

0 means DISCARD the “down” pile
1 means KEEP the “down” pile

APPLY THIS RULE WITH PUNCH CARDS TO FIND ANY CARD

Searching for punch card 16

- Apply the rule below to a mixed up pile of punch cards.
  - Put the pin in each hole staring from the units hole, shaking out cards
    - 0 means DISCARD the “down” pile (the ones that drop out)
    - 1 means KEEP the “down” pile

16 in Binary is 10000

1 :	0	DISCARD the “down” pile
2 :	0	DISCARD the “down” pile
4 :	0	DISCARD the “down” pile
8 :	0	DISCARD the “down” pile
16 :	1	KEEP the “down” pile

You will be left holding punch card 16

Follow the binary for any number and you will find that card

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The Teleporting Robot

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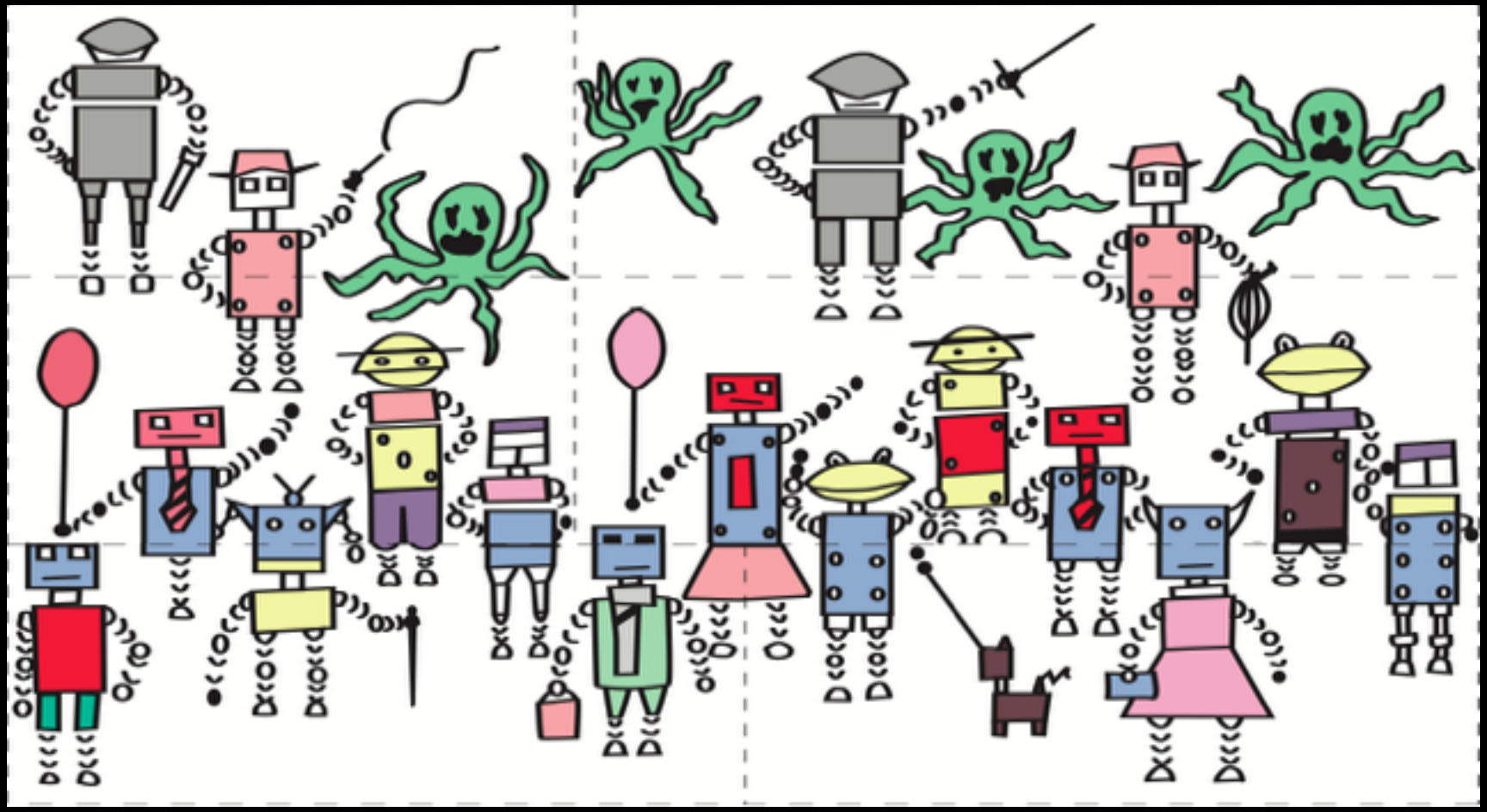
Which robot disappears?



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Ponder break

How on earth do they do that?

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Keep it simple, stupid

- We find it hard to take in lots of things at once
- Design simple, clear interfaces

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Microwave Racing

Summary

Programmers really are wizards!

- Programmers and magicians have to think in the same way
  - creating new tricks,
  - creating new programs
- It's all about computational thinking

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The big picture?

Magic = secret method + presentation

Software = algorithm + HCI

It's important that both the algorithm and Human-computer interaction design are correct!

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Design for people making mistakes

- People DO make mistakes
  - Design the machines to help avoid the problems!
- If things go wrong
  - Don't blame someone
  - Improve the machine so it can't happen again

Computational thinking is problem solving for people!

What is computational thinking?

- Computing is about thinking skills
  - Algorithmic thinking
  - Abstraction
  - Generalisation
  - Decomposition
  - Evaluation
  - Logical thinking
- Not just about computers!
  - Solutions for people

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Overall

- Computational thinking is…
  - about coming up with algorithmic solutions
  - But must make the solutions work for people
  - Must understand our limitations
- Magic is a fun way to introduce the ideas

More support

On our website to support this session:

- Activity sheets
- Story sheets
- Slides

Details of more worskshops/courses

- free unplugged sessions
- subsidised courses (e.g. GCSE programming)

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Thank you!

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