COMPUTING AT SCHOOL
EDUCATE · ENGAGE · ENCOURAGE
In collaboration with BCS, The Chartered Institute for IT

Computer Science for every child:

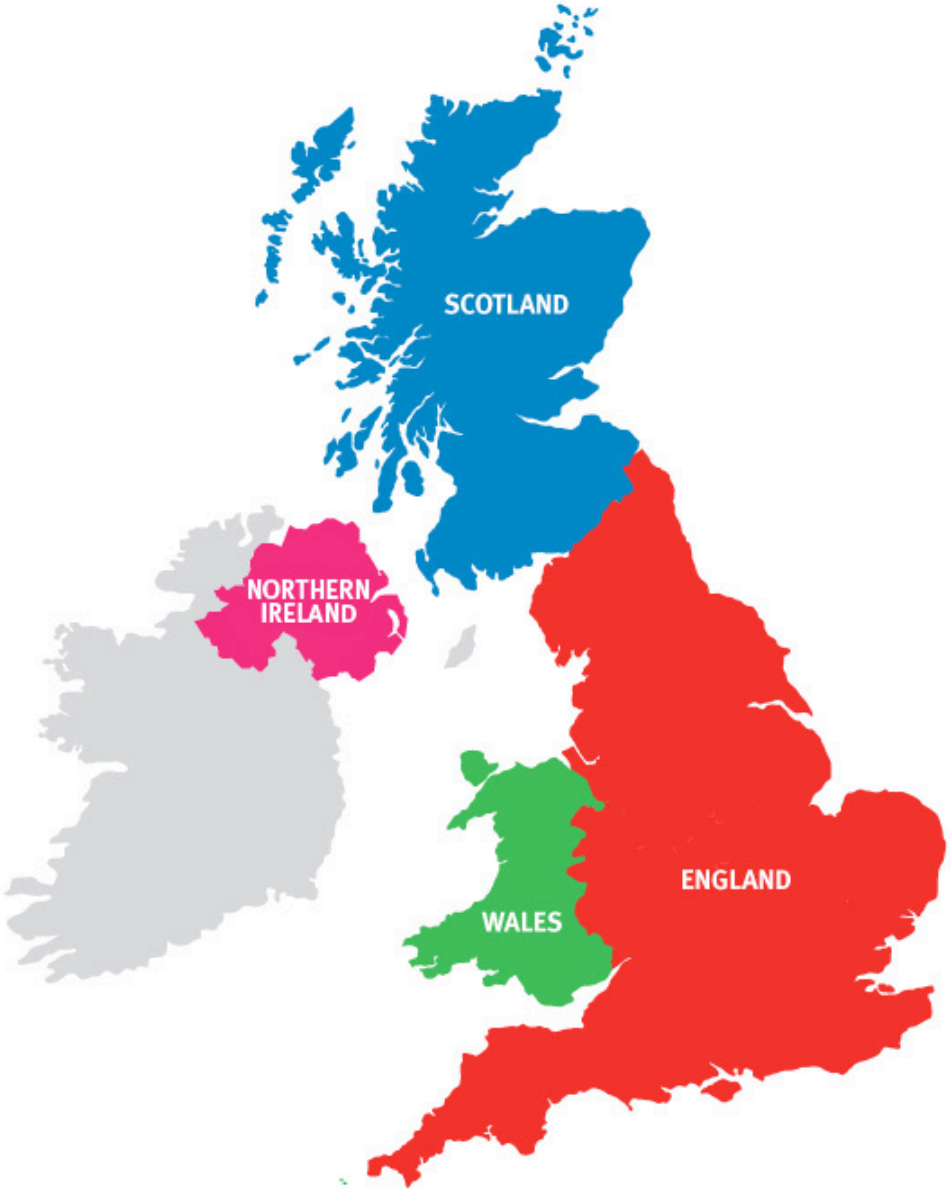
England's story.

Duncan Maidens
Associate Professor – Birmingham City University –UK

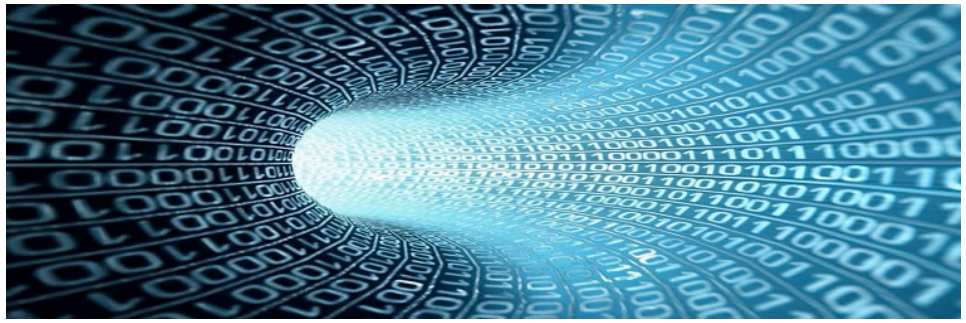
Based on slides by Simon Peyton Jones,
Microsoft Research and Computing at School

Why England's Story ?

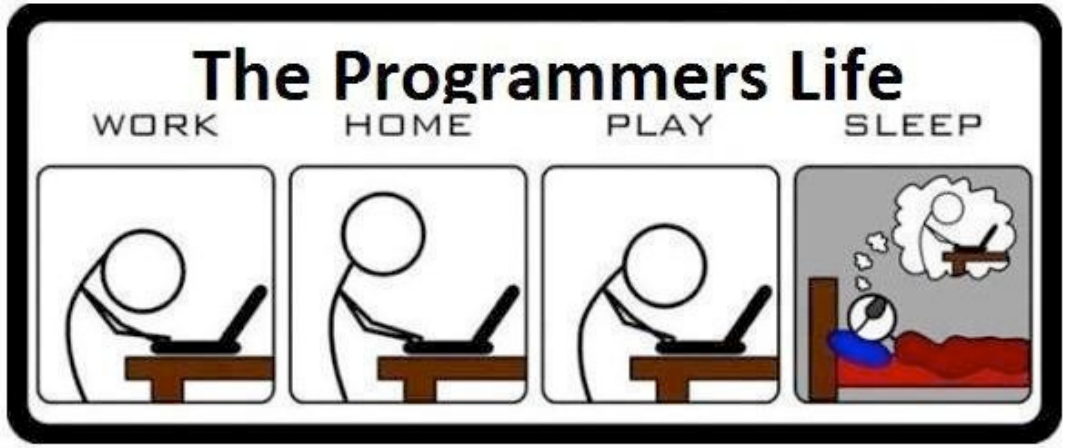
- The United Kingdom is a sovereign state.
- England, Scotland Wales and Northern Ireland have some devolved governing powers.
- Education has been devolved to each country to manage.

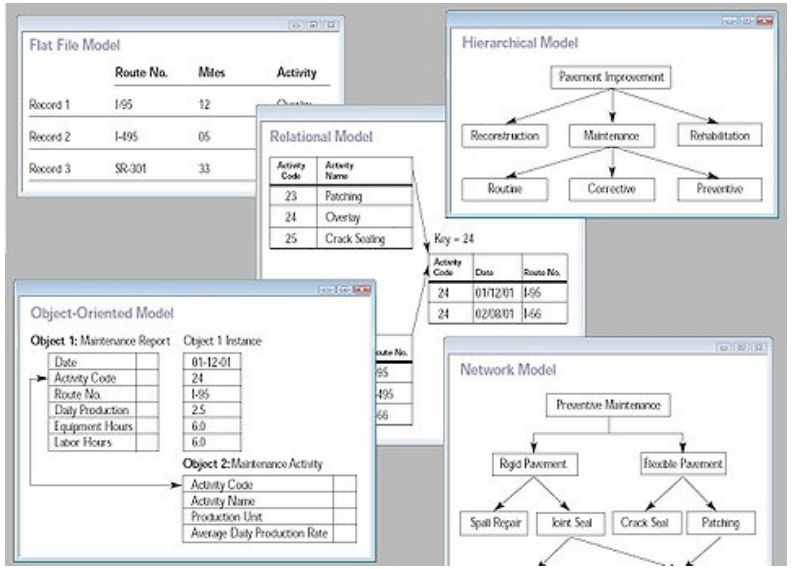


Why are our children not inspired by Computer Science ?



Microsoft® Office™





First computing revolution 40 years ago

```
 310 LET A=USR 18288
 320 IF INKEY$="" THEN GOTO 320
 330 POKE 17901,INT (RND*128)
 335 IF PEEK 21623<>178 THEN POK
E ((PEEK 16396+256*PEEK 16397)+6
6),0
 340 POKE 16522,CODE INKEY$
 350 LET A=USR 18224
 360 IF PEEK 16519>=128 THEN GOT
O 5000
 370 FOR N=0 TO 5
 380 NEXT N
 390 IF PEEK (PEEK 16514+17920)<
>45 THEN GOTO 330
 400 FOR N=0 TO 30
 405 POKE 17901,INT (128*RND)
 410 LET A=USR 18224
 420 FOR M=0 TO 3
 425 NEXT M
 430 NEXT N
 440 CLS
 450 GOTO 2520

 370 FOR N=0 TO 0
```

What do our children see today ?

As educators what do we want ?

“Education should prepare young people
for jobs that do not yet exist,
using technologies that have not yet been
invented,
to solve problems of which we are not yet
aware.”

Richard Riley

Disciplines

Skills

Disciplines

Ideas, knowledge, principles, techniques, methods

Maths, science, history, English

Skills

Artefacts, devices, programs, products, organisations, business

Presentation skills, metalwork, textiles, food technology, teamwork

Computer Science

ICT

Information and Communication Technology

Spreadsheets, databases, PowerPoint, web, internet, audio, video, e-safety

This was the situation in the UK during the 2000's

Too much focus on technology

Discipline

Computer science

So what goes here?

Skills

Digital skills

Not enough on underlying concepts

Why the change now ?

We are truly at the start of the Digital Age

1 The accelerating pace of change ...

Agricultural Revolution ← 8,000 years → Industrial Revolution ← 120 years → Light-bulb ← 90 years → Moon landing ← 22 years → World Wide Web ← 9 years → Human genome sequenced

2 ... and exponential growth in computing power ...

Computer technology, shown here climbing dramatically by powers of 10, is now progressing more each hour than it did in its entire first 90 years

3 ... will lead to the Singularity

2045
Surpasses brainpower equivalent to that of all human brains combined

Surpasses brainpower of human in 2023

Surpasses brainpower of mouse in 2015

COMPUTER RANKINGS
By calculations per second per $1,000

Analytical engine
Never fully built, Charles Babbage's invention was designed to solve computational and logical problems

Colossus
The electronic computer, with 1,500 vacuum tubes, helped the British crack German codes during WW II

UNIVAC I
The first commercially marketed computer, used to tabulate the U.S. Census, occupied 943 cu. ft.

Apple II
At a price of $1,298, the compact machine was one of the first massively popular personal computers

Power Mac G4
The first personal computer to deliver more than 1 billion floating-point operations per second

Hollerith Tabulator
IBM Tabulator
National Ellis 3000
Zuse 2
Zuse 3
ENIAC
BINAC
IBM SSEC
Whirlwind
EDVAC
Datamatic 1000
IBM 1620
DEC PDP-4
IBM 1130
DEC PDP-10
Data General Nova
Intellec-8
IBM PC
Compaq Deskpro 386
Pentium PC
Pentium II PC
Dell Dimension 8400
Mac Pro
Nvidia Tesla GPU & PC

10^{26}
10^{20}
10^{15}
10,000,000,000
100,000
1
0.00001

ELECTROMECHANICAL → RELAYS → VACUUM TUBES → TRANSISTORS → INTEGRATED CIRCUITS

1900 1920 1940 1960 1980 2000 2011 2020 2045

Opportunity and challenge

- **Opportunity**. The ice is melting. Everything is in flux
- **Challenge**
  - What should we teach? What ARE the big ideas of computer science?
  - How should we teach it?
  - How can we encourage, support, and equip our teachers to teach with confidence?
- **Risk**. In 10 years time it turns out to be no more than coding classes

Vision

Computer science is a
foundational
subject discipline,
like maths and natural science,
that every child should learn
from primary school onwards

Careful positioning

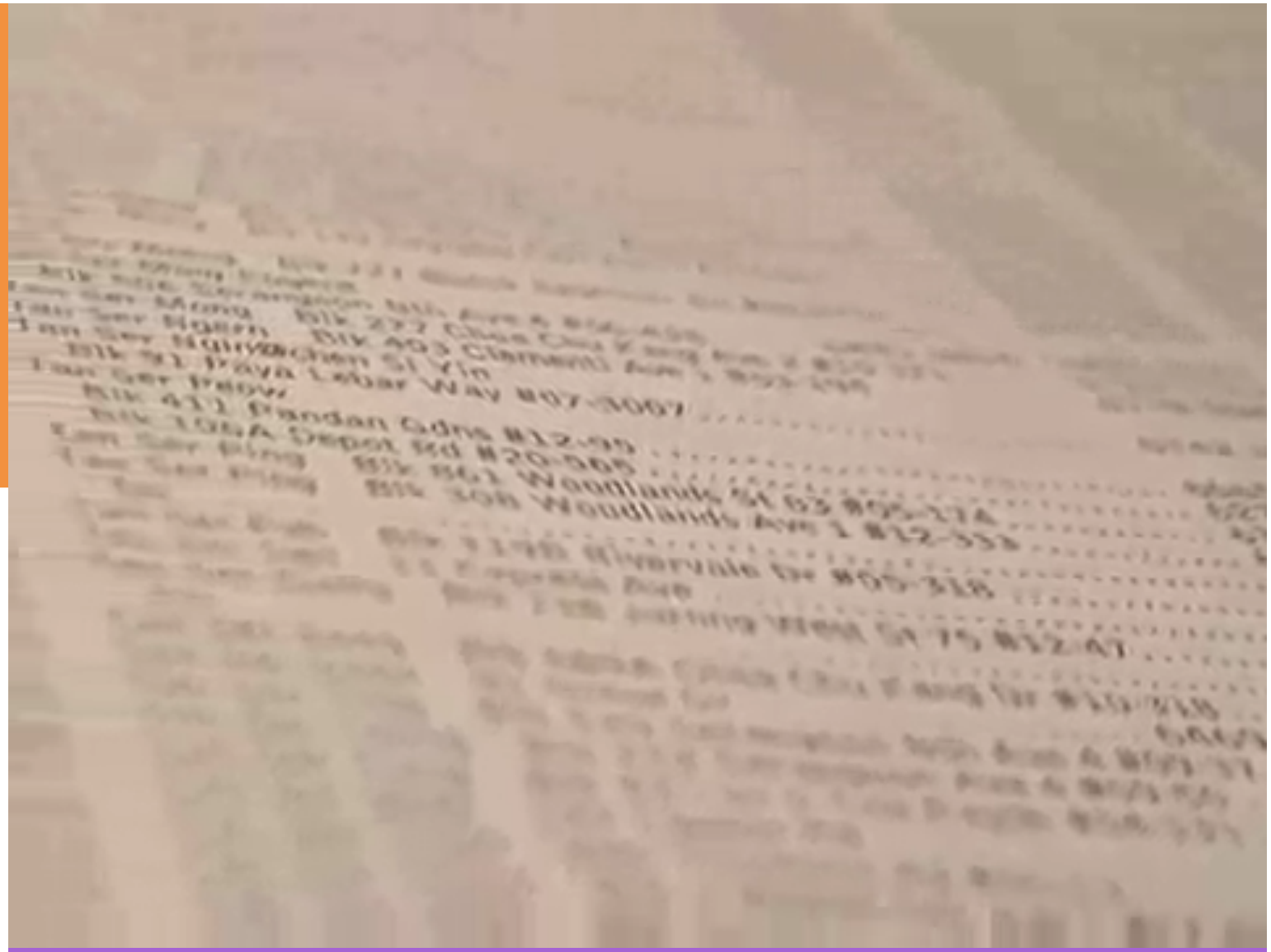
- ***Ideas*, not *technology***
  Not even primarily about computers
- *Every child*, not just *geeks*
- *Educational* not *instrumental*:
  Not just a vocational/economic imperative
- *Discipline*, not *skill*
  In particular, not just coding

Computational thinking (Jeannette Wing)

Computational thinking is the process of *recognising* aspects of information and computation in the world that surrounds us, and *applying* tools and techniques from computing to understand and reason about both natural and artificial systems and processes.

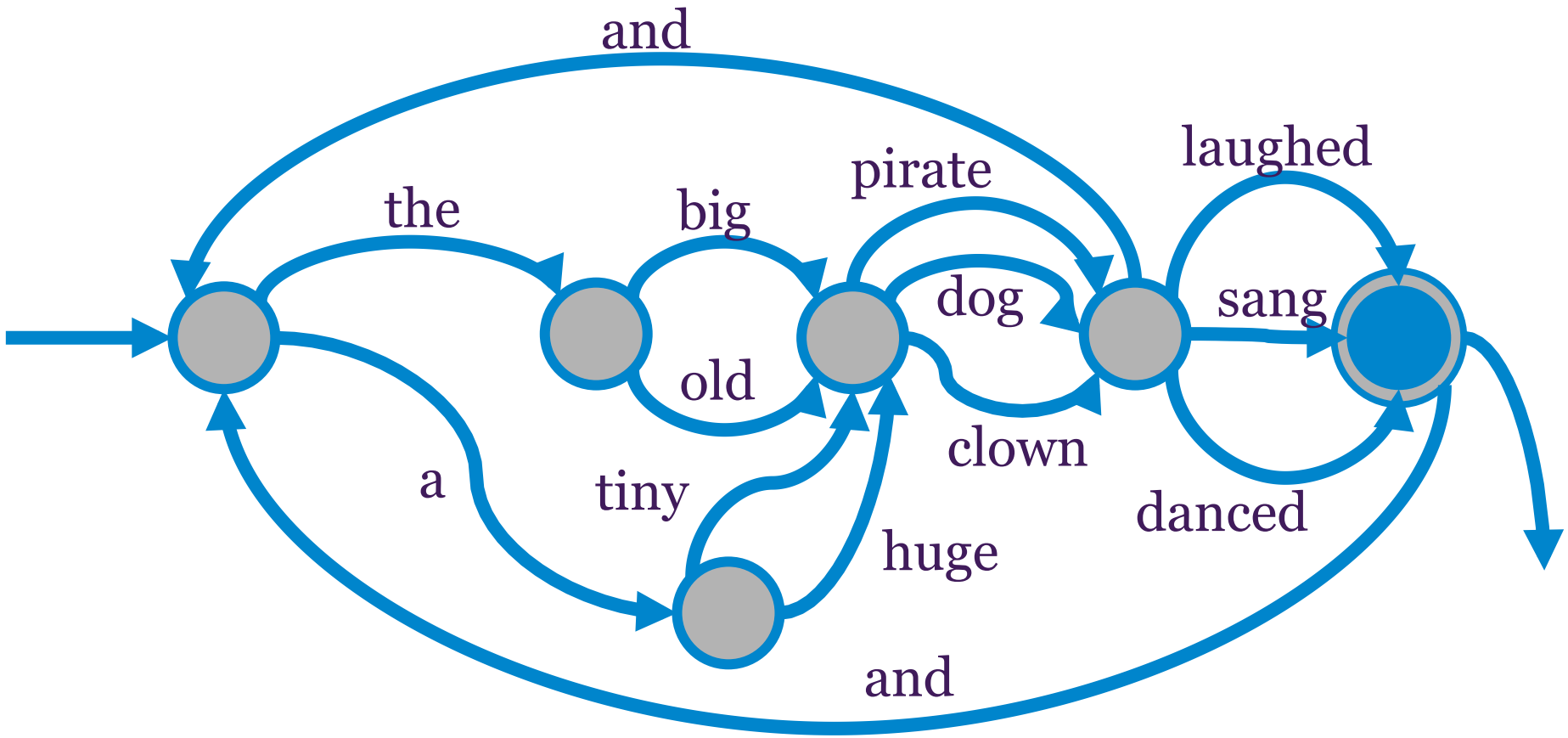
- Computational thinking is something **people** do, not something **computers** do
- Computational thinking is ubiquitous; it is useful in every profession, and in daily life

Look!
No computers



http://csunplugged.org/sorting-networks

Follow the arrows to generate a sentence



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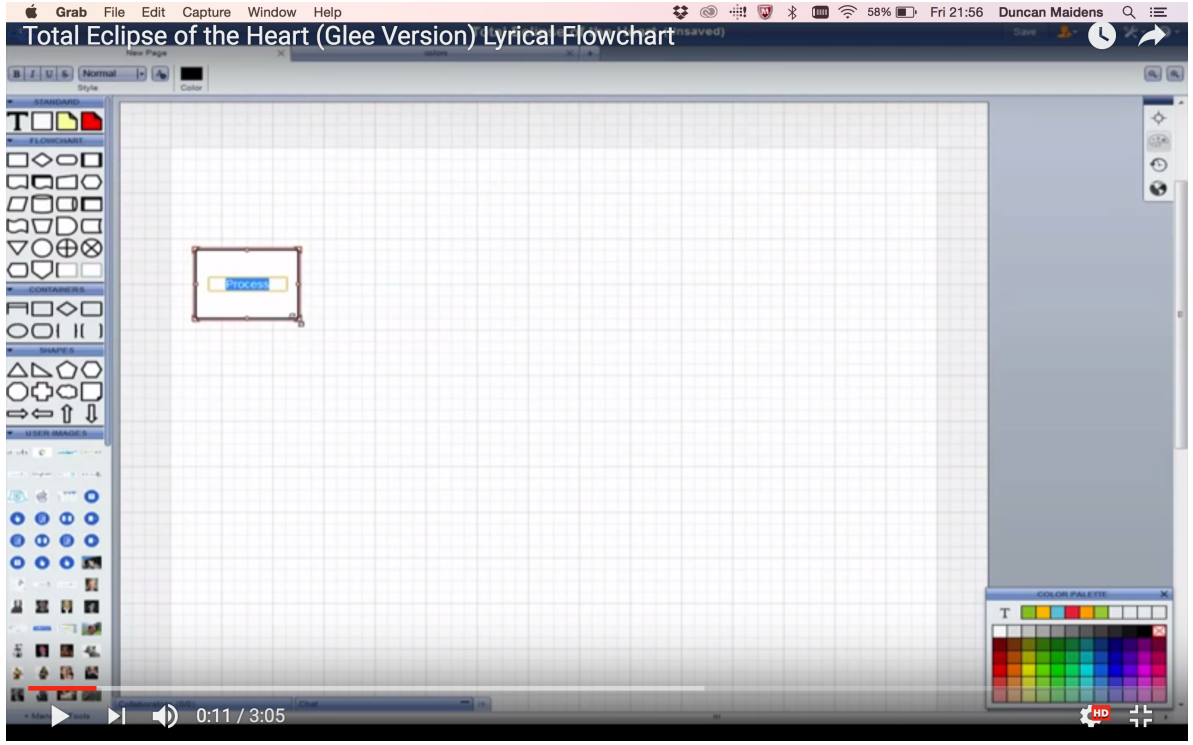
Every child

- Understand the natural world
- Understand the human world
- Understand the digital world
- Gain skills for almost any job

Computational Thinking in Music



https://youtu.be/j7uAfo6t7kQ

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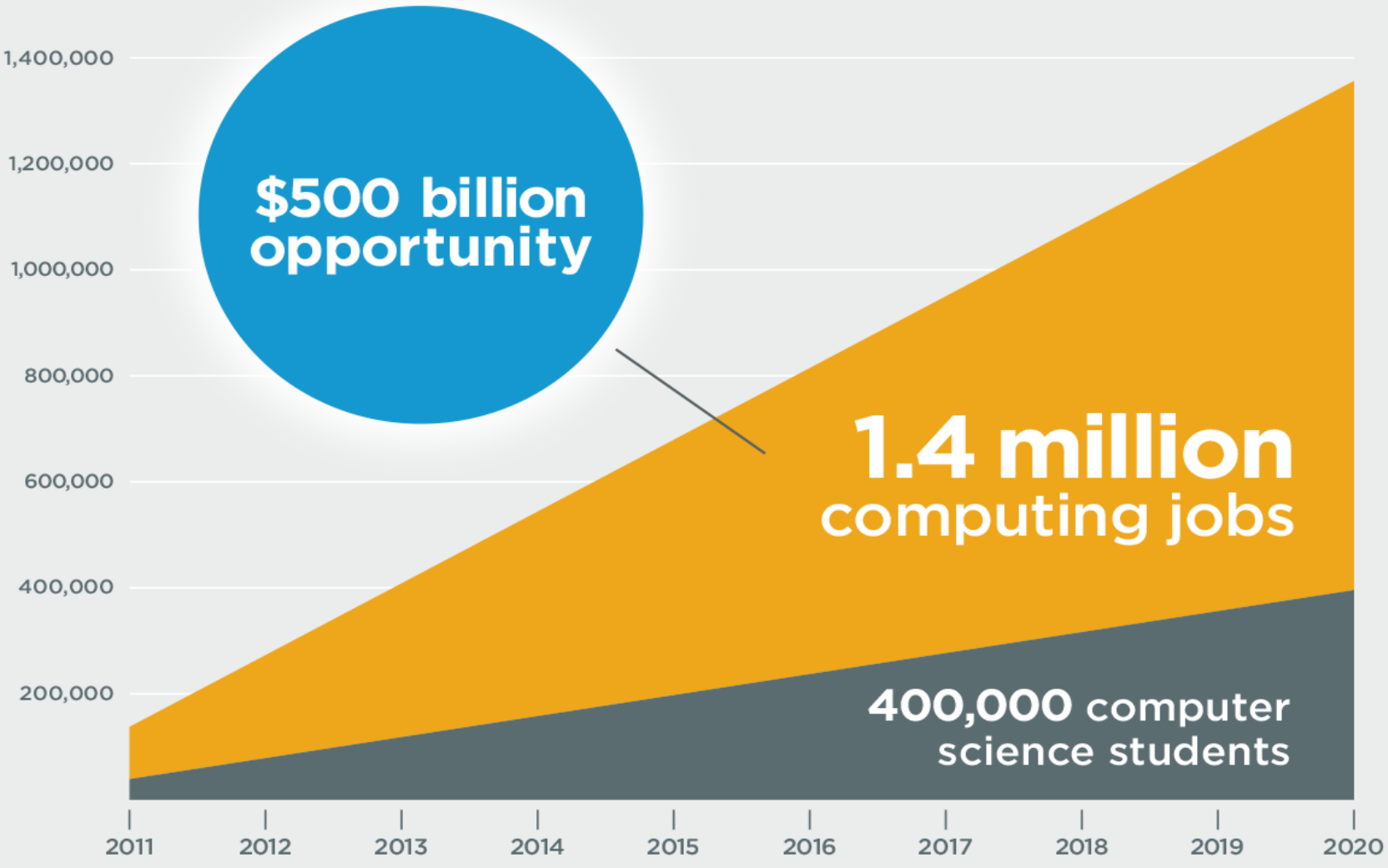
1,000,000 more jobs than students by 2020



Computer science **is a top paying college degree** and computer programming **jobs are growing at 2X the national average.**

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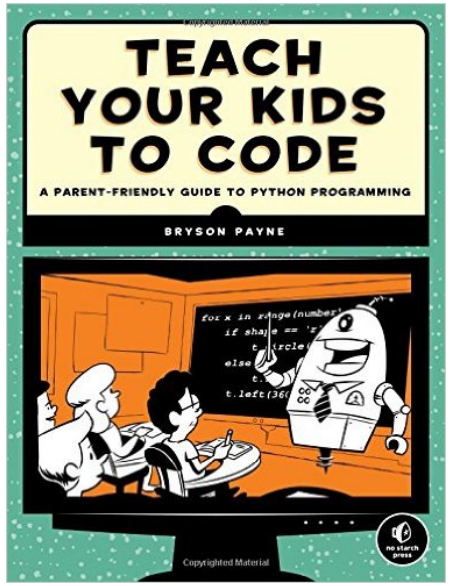
The Telegraph

Teaching our children to code: a quiet revolution

The next wave of the digital revolution arrives next year, with every child in the UK being taught computer programming. But is Britain ready?



Why Our Kids Must Learn to Code

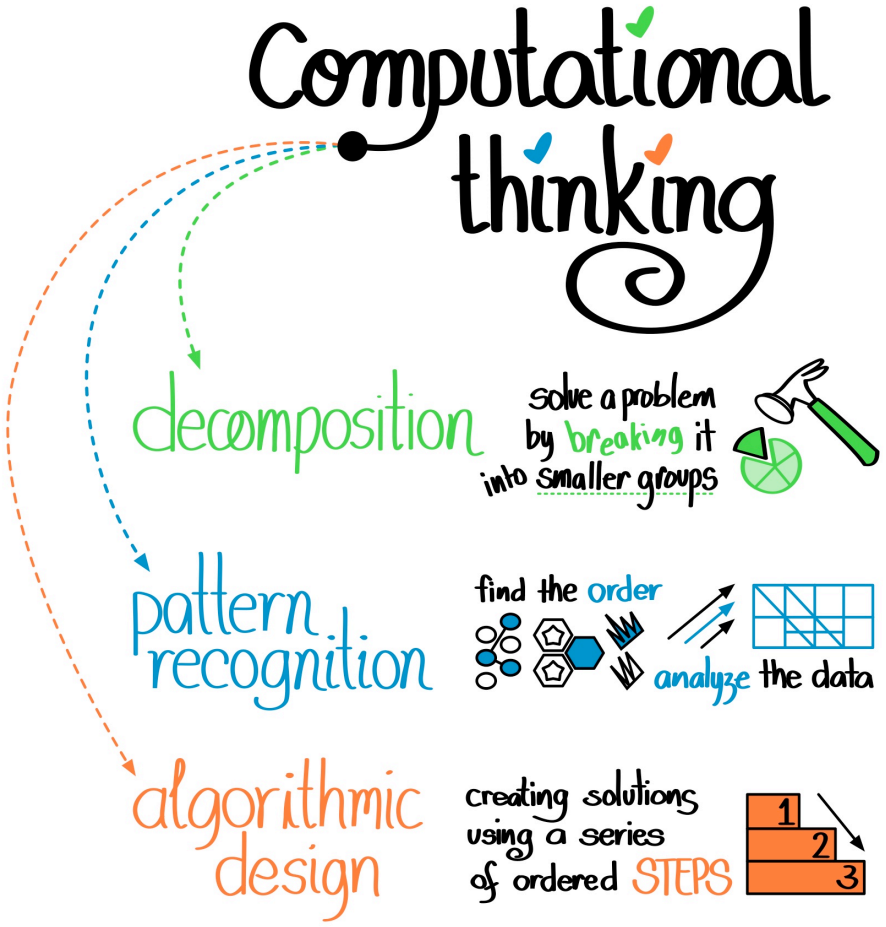
Computer science and IT The Observer

Why all our kids should be taught how to code

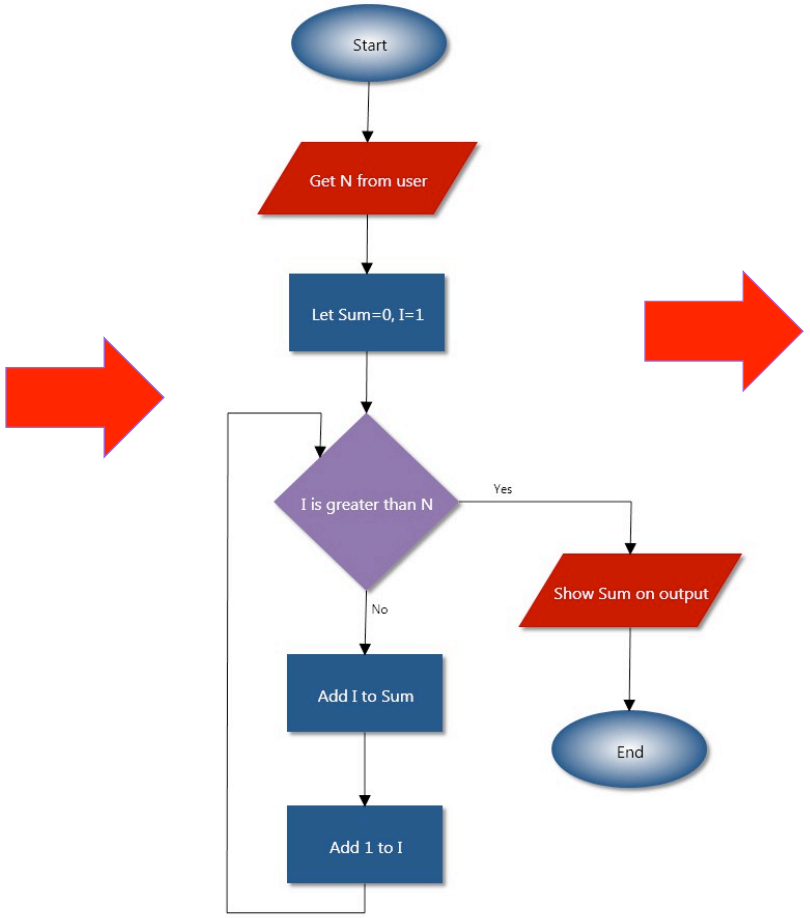
15 Reasons Why We Should Be Teaching Our Kids To Code

BY JAYNE CLARE · APRIL 20, 2013 · BLOG · 13 COMMENTS

Coding bring Computation Thinking to life



Sequencing

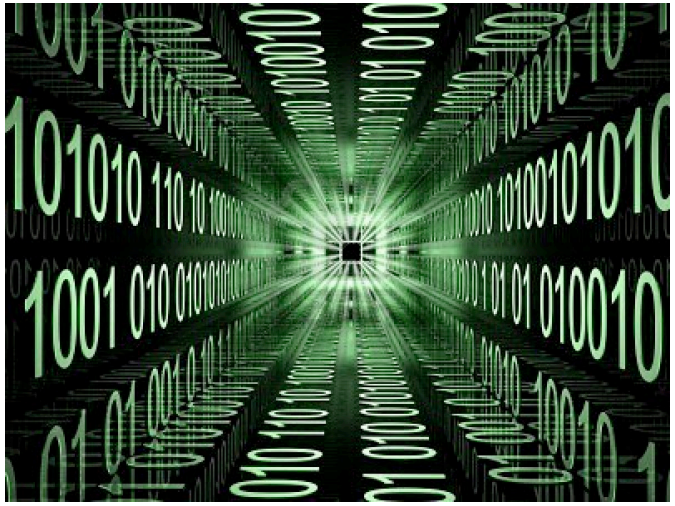


Coding

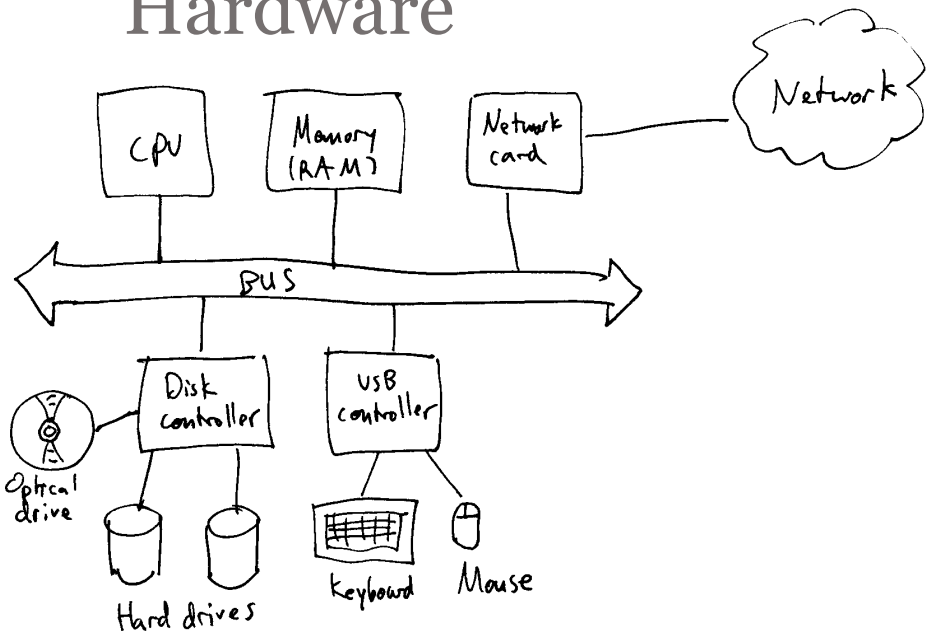
How the code makes things happen

Coding

Data Representation and Compiling



Hardware



The England’s journey

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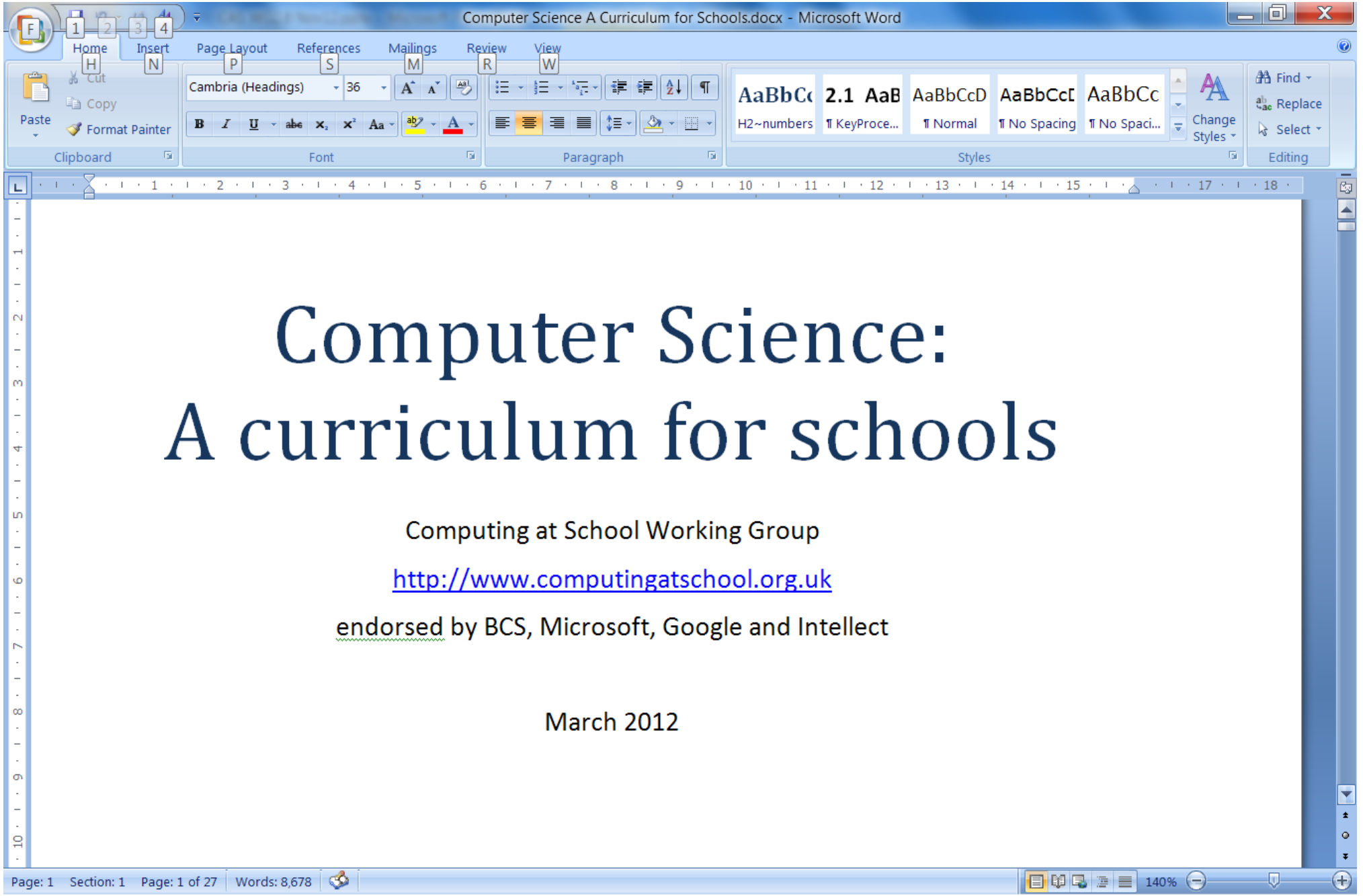
CAS is formed

CAS curriculum (35 pages)

2008 2009 2010 2011

2010


Computer Science A Curriculum for Schools.docx - Microsoft Word
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Mailings
Review
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36
Clipboard
Font
Paragraph
Styles
Change Styles
Find
Replace
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Editing
Computer Science:
A curriculum for schools
Computing at School Working Group
http://www.computingatschool.org.uk
endorsed by BCS, Microsoft, Google and Intellect
March 2012
Page: 1
Section: 1
Page: 1 of 27
Words: 8,678
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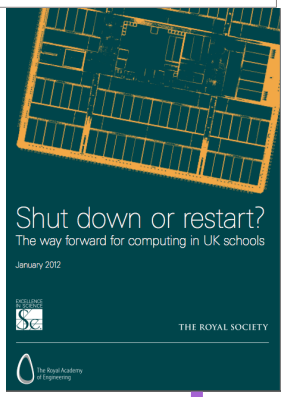
Shut Down or Restart Report by Royal Society



Eric Schmidt (Google) tells us we should be educating our children in CS!

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2008 2009 2010 2011 2012 2013 2014

Review of the National Curriculum in England

Shut down or restart

- "The current delivery of Computing education in many UK schools is highly unsatisfactory"
- "Computer Science is a rigorous academic discipline and needs to be recognised as such in schools"
- "Every child should have the opportunity to learn Computing at school"

Shut Down or Restart Report by Royal Society

Eric Schmidt (Google) tells us we should be educating our children in CS!

BCS invited to create a working group to draft the new Computing curriculum

COMPUTING AT SCHOOL
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CAS is formed

CAS curriculum (35 pages)

New curriculum (2 pages) published

New curriculum launches

2008 2009 2010 2011 2012 2013 2014

Review of the National Curriculum in England

Department for Education

Computing

Programmes of study for Key Stages 1-4

Starting Sept 2014 in England

Aims

The National Curriculum for computing aims to ensure that all pupils:

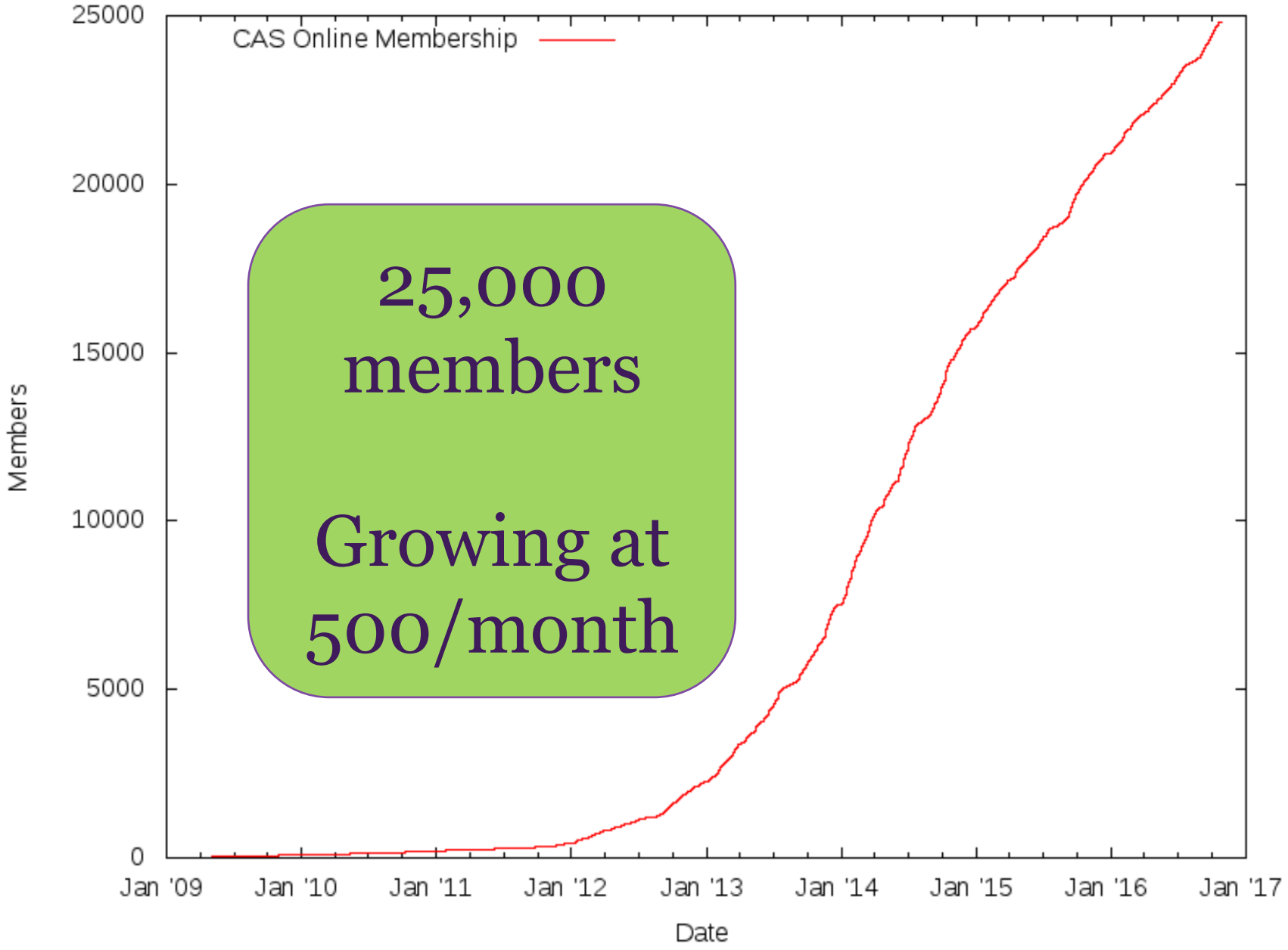
- can understand and apply the fundamental principles of computer science, including logic, algorithms, data representation, and communication
- can analyse problems in computational terms, and have repeated practical experience of writing computer programs in order to solve such problems
- can evaluate and apply information technology, including new or unfamiliar technologies, analytically to solve problems
- are responsible, competent, confident and creative users of information and communication technology.

National Awards

Computer Science

Computing at School launched (2007/8)

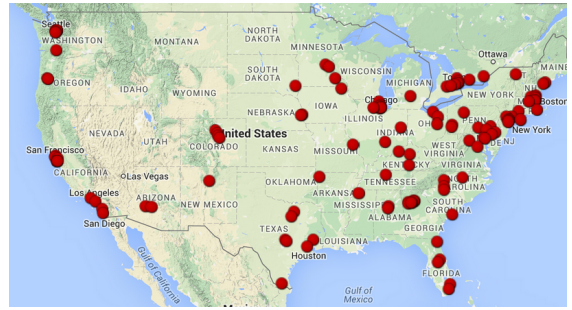
- **CAS is a grass roots movement:** teachers, professionals, academics..
- **CAS is a community of practice**, to support, encourage, equip, give vision to computing teachers
- **CAS is independent**: speaks for the subject, not for teachers, or academics, or companies, or govt.



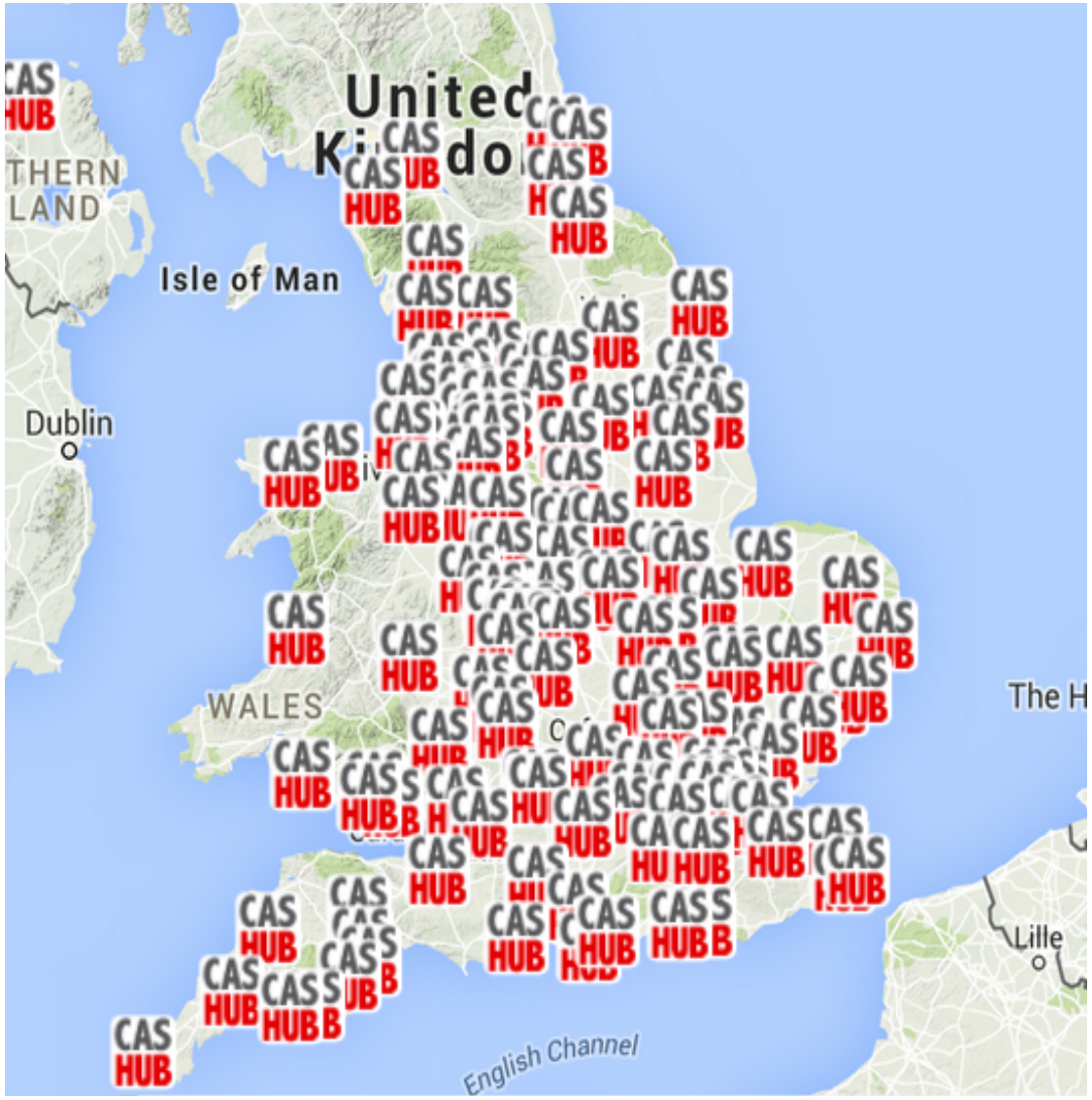
About 3/4 teachers, both primary and secondary

But not all! Developers, IT professionals, parents…

UK-centric, but open to international members

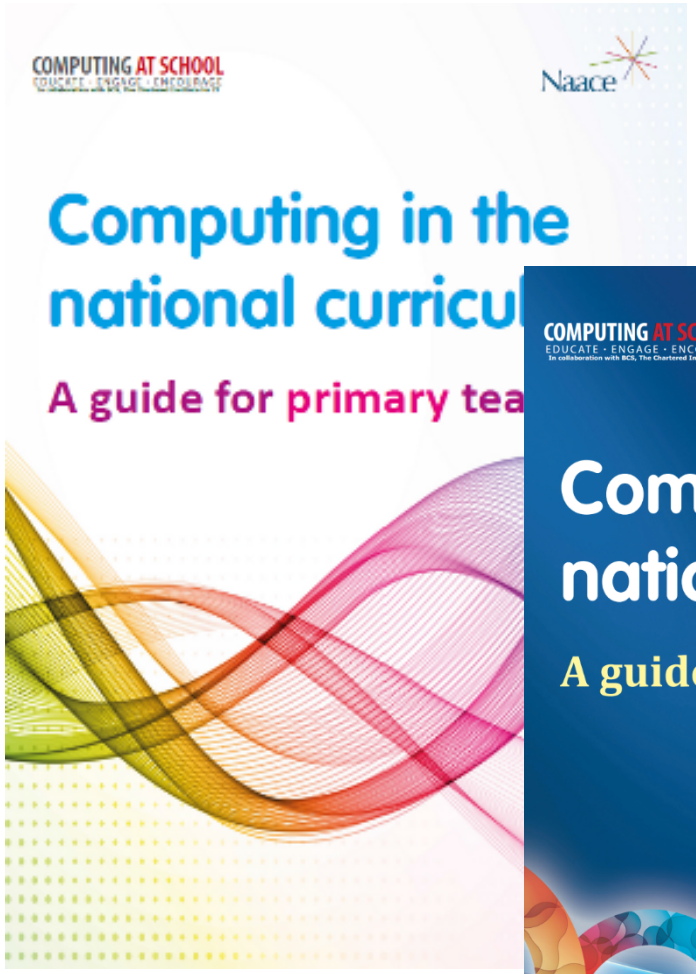


Loose, decentralised organisation



- Ten Regional Centres (based in universities)
- 89 universities
- 200+ Hubs
- 400+ Master Teachers
- 450 Lead Schools
- Masses of training events
- Amazing termly magazine
- Online community

Resources


COMPUTING AT SCHOOL
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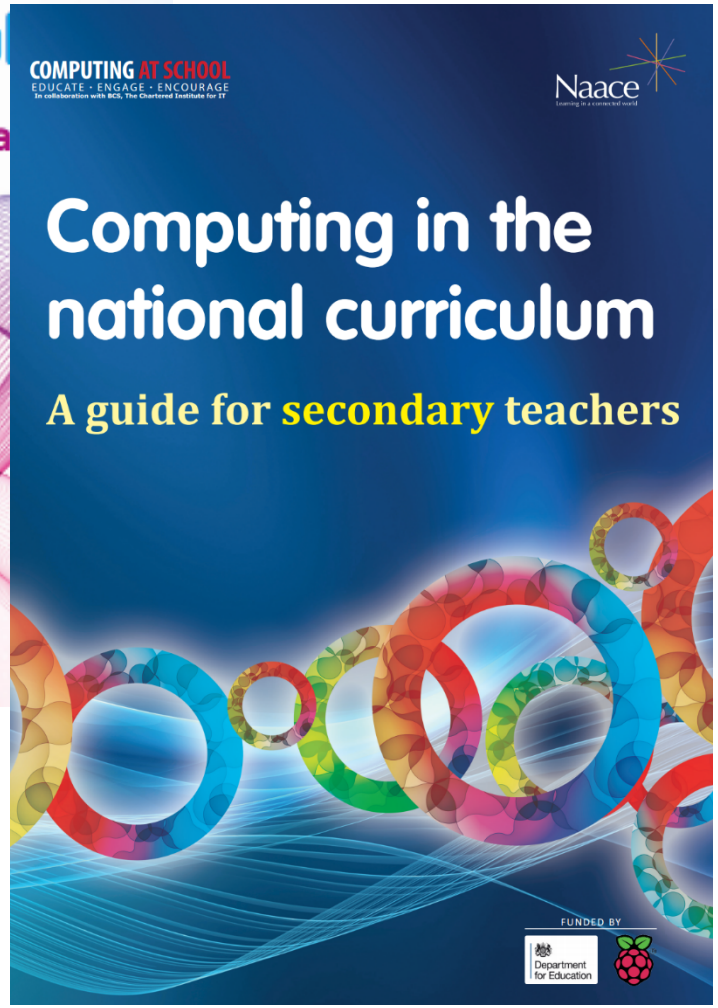
Computing in the national curricul
A guide for primary tea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Department for Education

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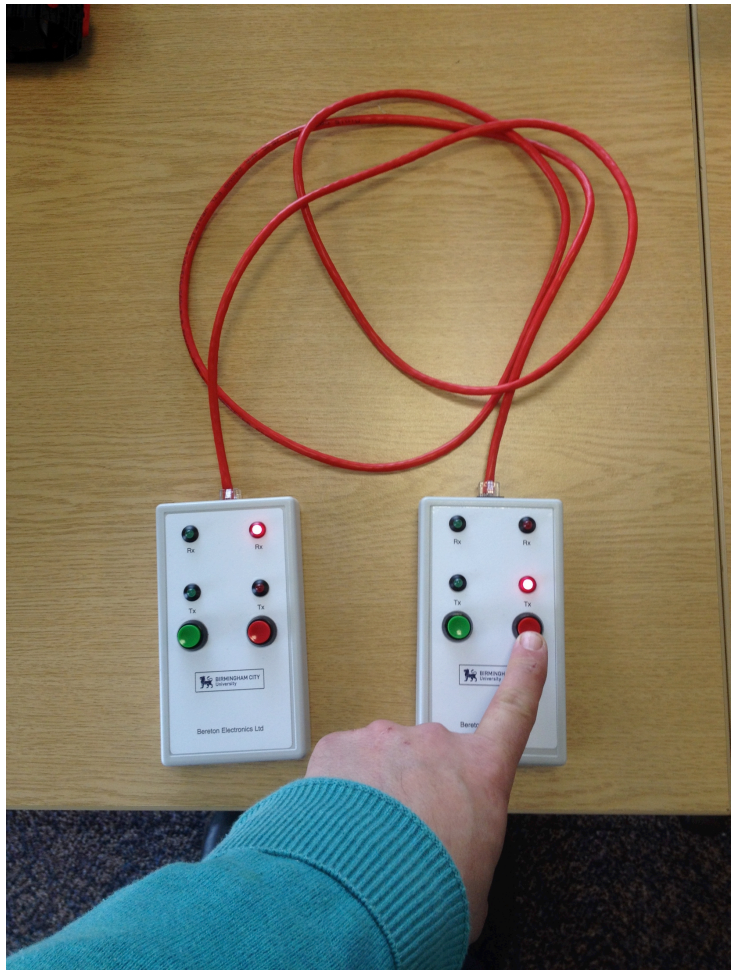
EDUCATE · ENGAGE · ENCOURAGE
SWITCHEDON
COMPUTING AT SCHOOL NEWSLETTER
SUMMER 2014
COUNTDOWN TO COMPUTING
INSIDE THIS ISSUE

COMPUTING AT SCHOOL
QuickStart Computing
A CPD toolkit for primary teachers
COMPUTING AT SCHOOL
A CPD toolkit for secondary teachers

How to teach data communications and TCP/IP to a 7 year old

1. Don't teach it
2. Learn through investigation
3. Discover the need for it
4. Develop the solution



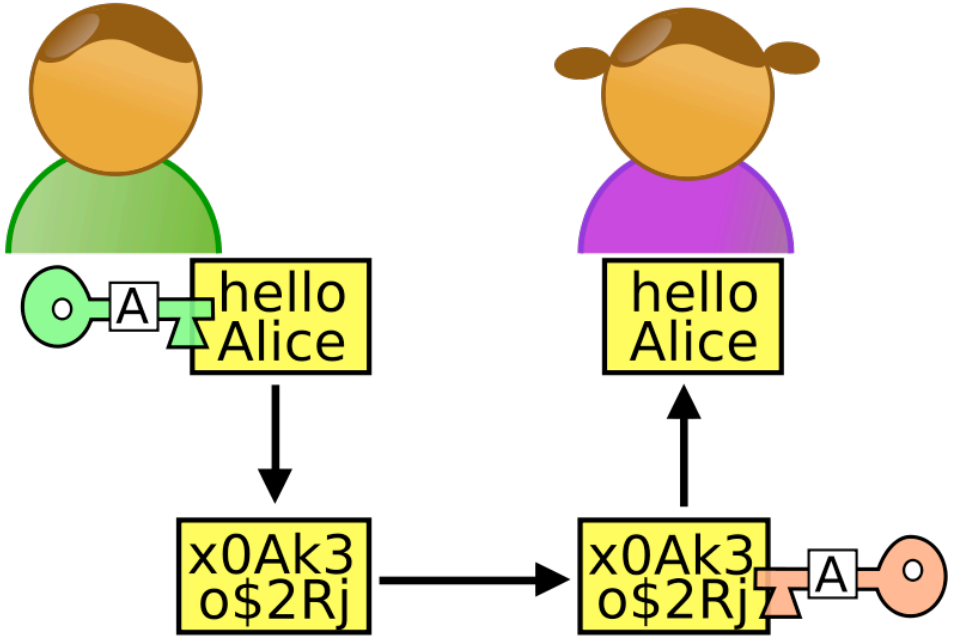
6 Bit Binary Coding Scheme

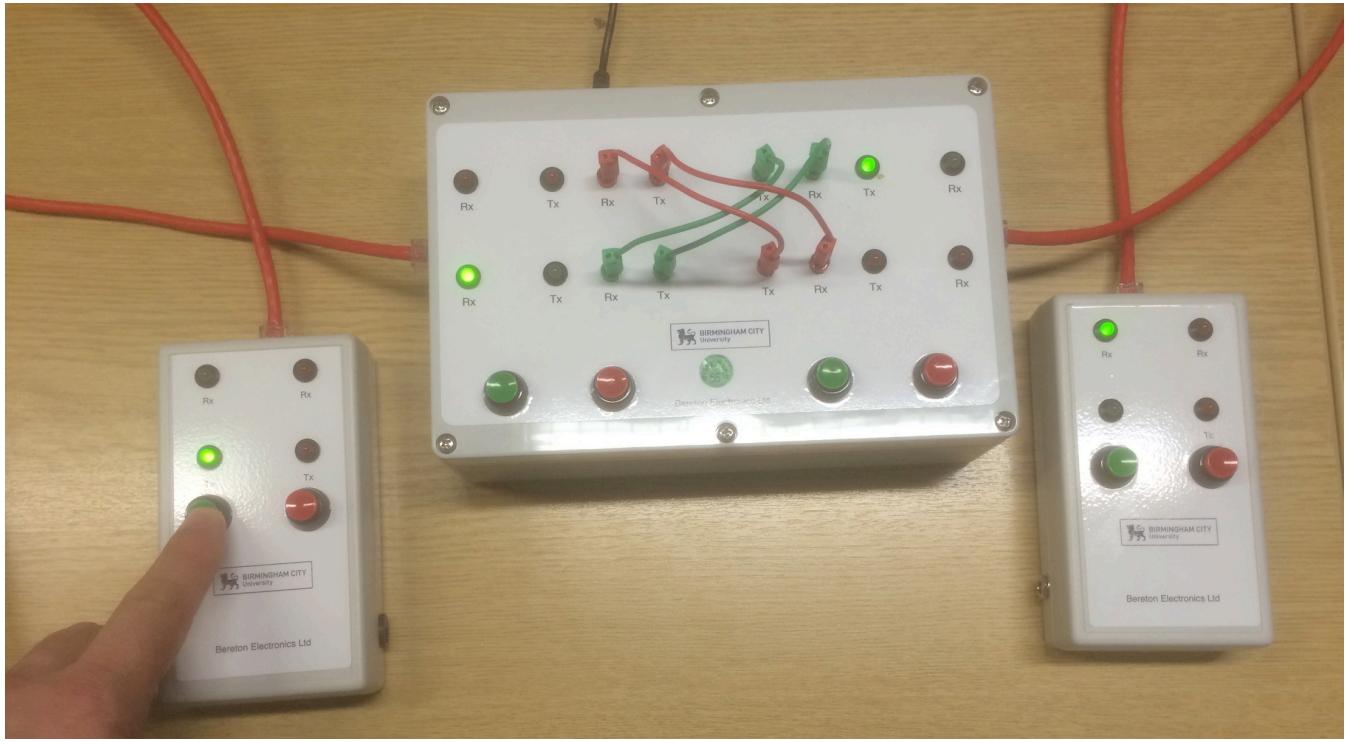
		000	001	010	011	100	101	110	111
		●●●	●●●	●●●	●●●	●●●	●●●	●●●	●●●
000	●●●	A	I	Q	Y	6	$		
001	●●●	B	J	R	Z	7	%		
010	●●●	C	K	S	0	8	*		
011	●●●	D	L	T	1	9	(		START
100	●●●	E	M	U	2	"	)		END
101	●●●	F	N	V	3	!			RESTART
110	●●●	G	O	W	4	?			ERROR/ NACK
111	●●●	H	P	X	5	£			OK / ACK

Sent the column heading then the row heading. Hence R = 010 001 ●●● ●●●

Break out Boxes - Cryptography -

Hacking and 'Man in the Middle' attacks





Funding

- DfE gives us our baseline funding, currently around £1m/yr.
  - Always vulnerable, but absolutely crucial
- Employers have been generous; typically project funding:
  - QuickStart (Microsoft)
  - Barefoot (BT)
  - Tenderfoot (Google)

Department for Education

bcs The Chartered Institute for IT Academy of Computing

Microsoft Google

Ensoft

BT

The Computational Thinker: Concepts & Approaches

Barefoot Computing

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Concepts

- **Logic** predicting & analysing
- **Algorithms** making steps & rules
- **Decomposition** breaking down into parts
- **Patterns** spotting & using similarities
- **Abstraction** removing unnecessary detail
- **Evaluation** making judgement

Approaches

- **Tinkering** experimenting & playing
- **Creating** designing & making
- **Debugging** finding & fixing errors
- **Persevering** keeping going
- **Collaborating** working together

www.barefootcas.org.uk

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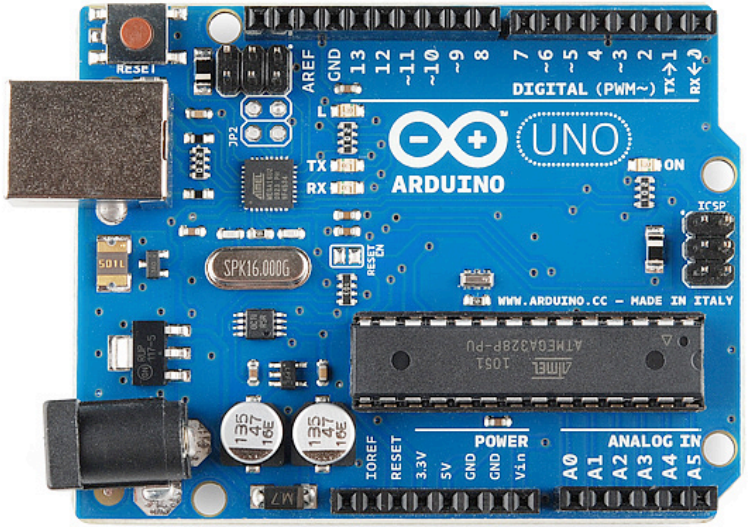
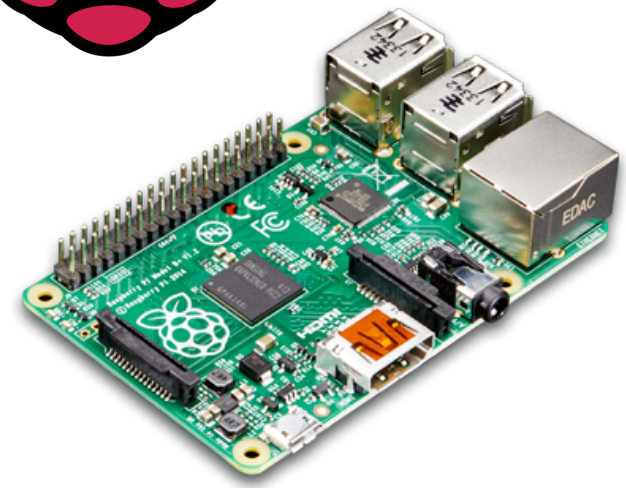
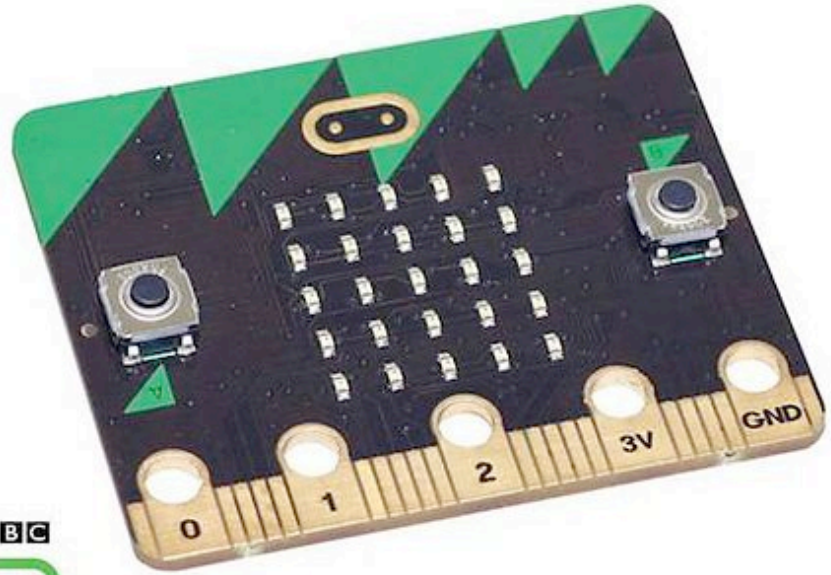
Barefoot would like to acknowledge the work of Julia Briggs and the eLIM team at Somerset County Council for their contribution to this poster.

Other Supporting Hardware Initiatives

ARDUINO™

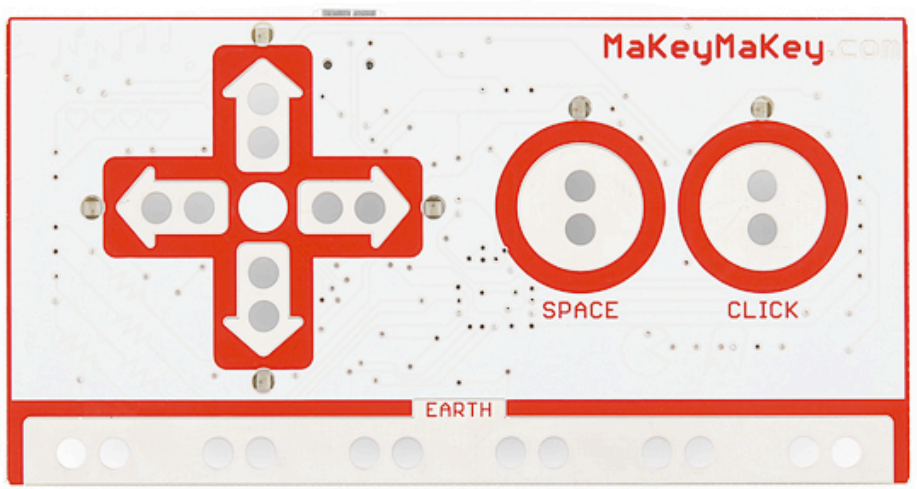


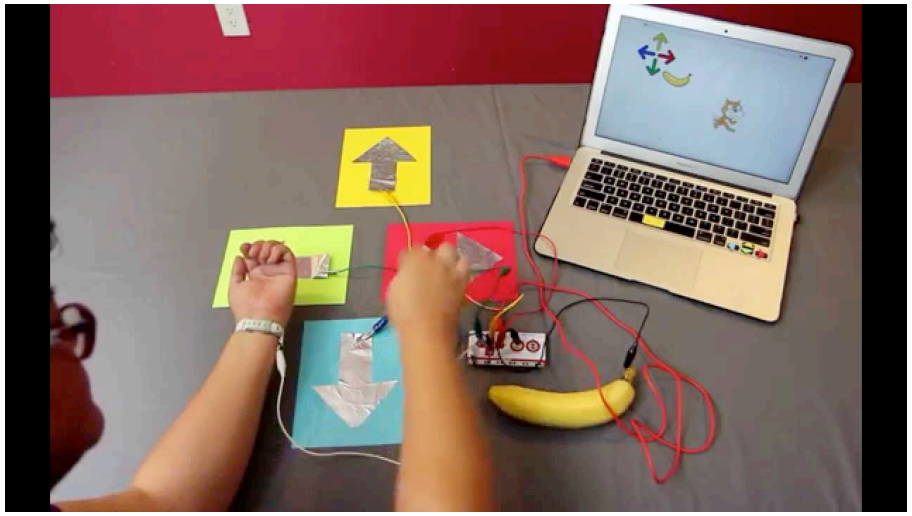




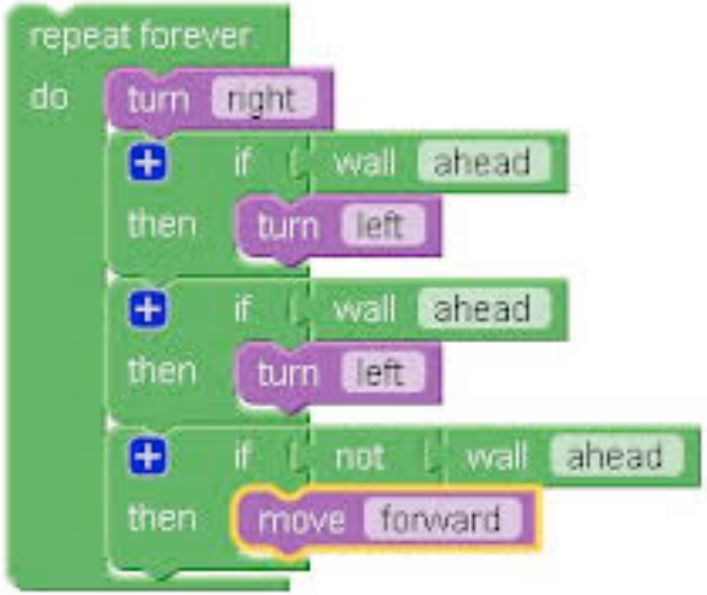
BBC micro:bit

Computer I/O – Makey Makey



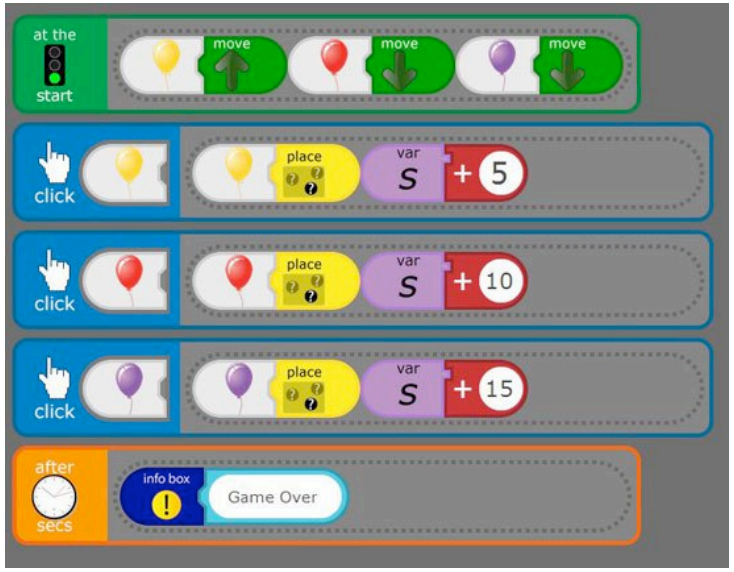


Coding

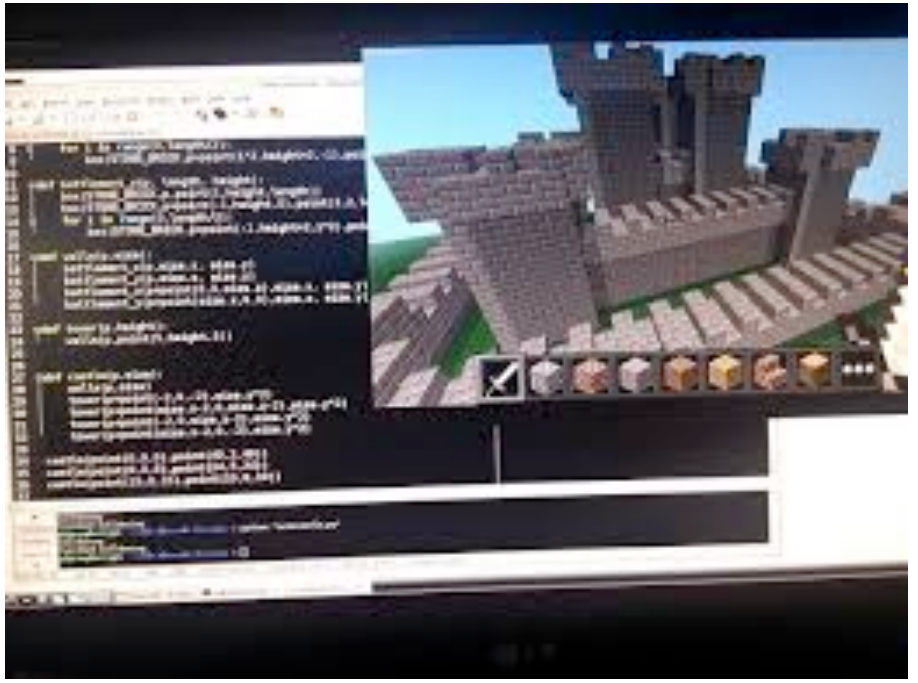

repeat forever
do
turn right
if wall ahead
then turn left
if wall ahead
then turn left
if not wall ahead
then move forward

forever
imagine
program
share

KODU
GAME LAB
RESUME
LOAD WORLD
OPTIONS
HELP
QUIT KODU

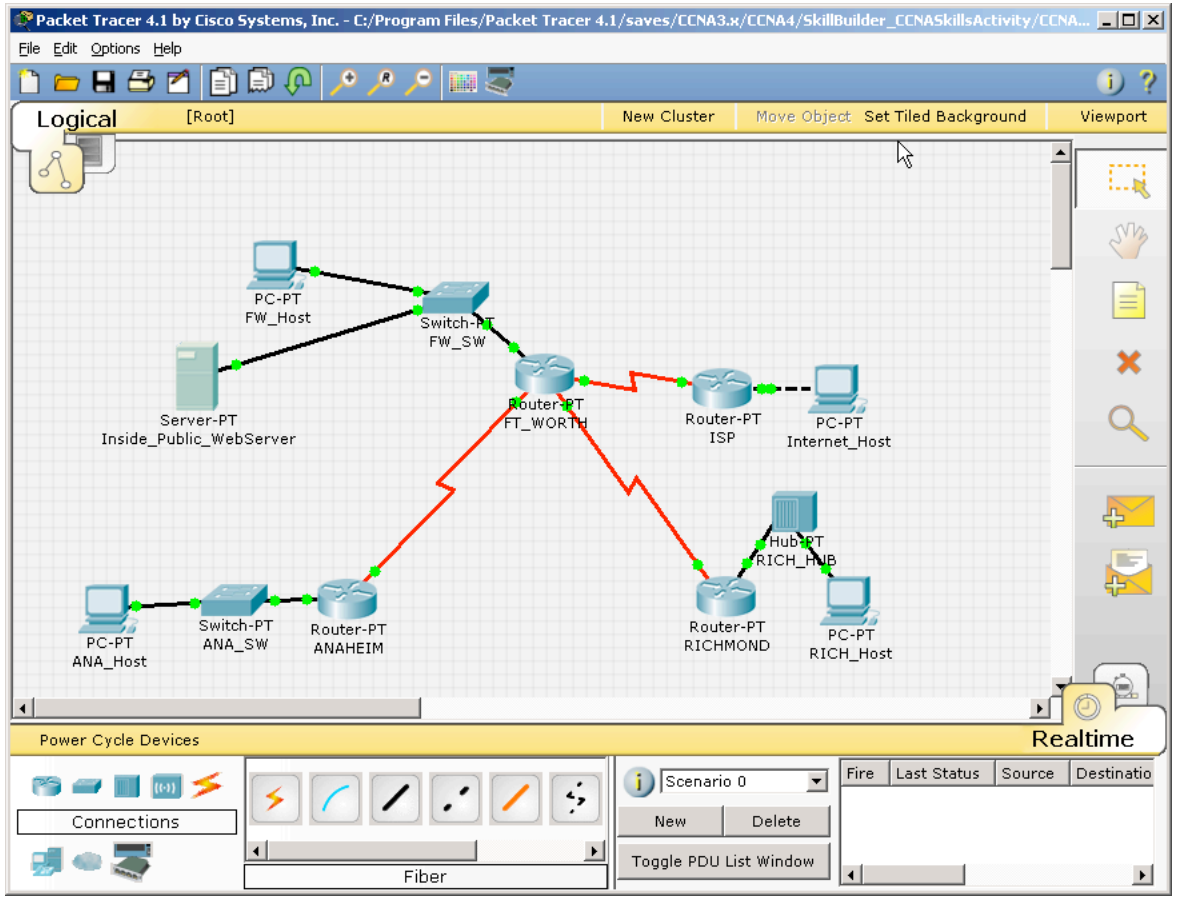

at the start
move
move
move
click
place
var s + 5
click
place
var s + 10
click
place
var s + 15
after secs
info box
Game Over

Coding in Python to build the Minecraft World



Cisco Network Academy

A course on data communications and Computer Networking



Lessons: what worked for us

- **A singular focus**: CS as a foundational subject
- **An educational message**, not just an instrumental one
- **A single voice**, not competing special interests
- **An independent, grass-roots group**, not an employers group, not a teachers group, not a higher-ed group
- **Support from professional bodies** (e.g. Royal Soc): influences civil servants
- **Support from industry leaders** (e.g. Eric Schmidt speech): influences politicians
- **Don't wait for policy change**: just get on with it
- **Luck**: the Review of the National Curriculum was hugely serendipitous

Key links collected here

http://community.computingatschool.org.uk/resources/3084

Engaged, curious

Empowered, informed

Creative, playful

Employed

MINISTRY OF EDUCATION
TE TĀHUHU O TE MĀTAURANGA

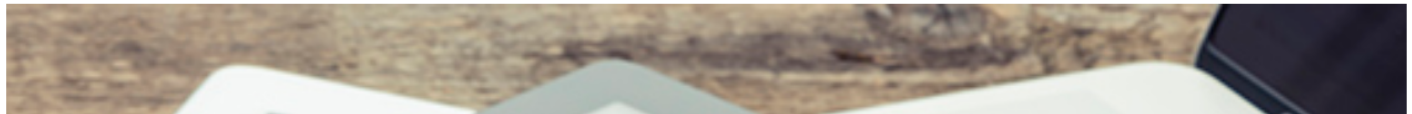
NEW ZEALAND Education Gazette
TUKUTUKU KŌRERO

Sunday 30 October 2016

FEATURE IN PRINT 25 JUL 2016

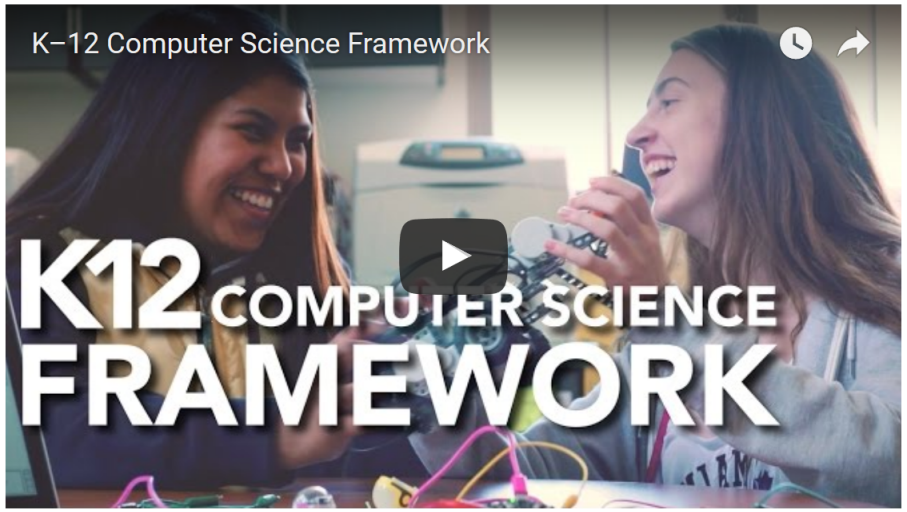
Digital technologies to become part of the national curriculum

On 5 July Education Minister Hekia Parata announced digital technologies will be fully integrated into *The New Zealand Curriculum* and *Te Marautanga o Aotearoa* from 2018.



https://k12cs.org/ October 2016

VISION FRAMEWORK STATEMENTS IMPLEMENTATION GUIDANCE RESOURCES



Computer science has

driven innovation in every field

and is powering approaches to many of our world's toughest challenges.

See the concepts and practices | Download the framework

The Association for Computing Machinery, Code.org, Computer Science Teachers Association, Cyber Innovation Center, and National Math and Science Initiative have collaborated with states, districts, and the computer science education community to develop conceptual guidelines for computer science education.

The *K-12 Computer Science Framework* comes at a time when our nation's education systems are adapting to a 21st century vision of students who are not just computer users but also computationally literate creators who are proficient in the concepts and practices of computer science. States, districts, and organizations can use the framework to inform the development of standards and curriculum, build capacity for teaching computer science, and implement computer science pathways.

The framework provides a unifying vision to guide computer science from a subject for the fortunate few to an opportunity for **all**.

Informatics education:

Europe cannot afford to miss the boat

Report of the joint
Informatics Europe & ACM Europe Working Group
on Informatics Education
April 2013

Informatics Europe:
Walter Gander (chair), ETH Zurich, Switzerland
Antoine Petit, Inria & ENS Cachan, France

THE ROYAL SOCIETY

Education | Research & policy | Partnership Grants | Associate Sch

Computing in Schools
Shut down or restart?

January 2012

Teaching computer science in France

Tomorrow can't wait

Report of the
Académie des Sciences
(French Academy of Sciences)

May 2013

CEPIS
Council of European Professional
Informatics Societies

Computing in Schools

A Call for Action from Informatics Societies

Autumn 2014

COMPUTING AT SCHOOL
EDUCATE · ENGAGE · ENCOURAGE
In collaboration with BCS, The Chartered Institute for IT

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