Rack of server in the Computer Center, CERN

Google Arts & Culture

Beyond the Computer

Lesson plan created with

VA TABLET ACADEMY

Beyond the Computer

Join us as we explore the world of computers. You will discover what they are, the development of computing technology and where computing is going in the future.

This lesson plan is designed to support you as you explore Google Arts & Culture stories related to the lesson topic. This lesson is suitable for anyone but is recommended for students aged 11-13 years.

You can complete the lesson on your own working at home, with a group of friends, or in your classroom. They are designed so that you can work through them at a pace that suits you.

If you get stuck, you can talk to a teacher or parent.

Throughout the lesson you will find tasks to complete and questions to answer, so when you reach the end, you will have used a range of skills to create something on your own that demonstrates your knowledge and understanding of the subject.

All you need to get started is any device with internet access.

In this lesson, discover more about the inventions that led to the computer and then technology like smartphones. Learn more about how computers have been used and then find out more about the people involved in this field.

Things you'll need to complete this lesson.

Tablet, laptop or computer with internet access.

Paper, or a notebook, and pen to make notes as you go.

Drawing materials, such as coloring pens and pencils, paper etc.

Scissors, glue, scrap paper and general stationery items.

Art materials, specifically paints and brushes.

A printer would be beneficial but not necessary – why not draw instead?

Beyond the Computer

What can you expect to learn?

Computers play a significant role in modern life. They come in all shapes and forms and can be tiny, hand-held or even fill a room. In this lesson, you will learn about early machines, and then explore the latest developments, including artificial intelligence (AI) and robotics. Find out about some of the people who have played important roles in the history of computing and some individuals who are leading innovation and building the future of computing.

Activities to complete

1. Test your knowledge of new terms in a special anagram test.
2. Draw a timeline showing the history of computers.
3. Test your skills with binary, by taking a real-world technical test.
4. Take the end of lesson quiz to test the knowledge you have gained about computers and computing.

Outcomes you will achieve

- Learn about the history of computing, from mechanical to electronic devices.
- Appreciate the inventions that were needed to create the smartphone.
- Explore a range of areas where computers have made an impact.
- Discover the next steps in computer technologies.
- Learn about some of the people who have been involved in the development of computing.

Look out for the following tips which tell you what to do when during the lesson.

Key information to remember and to help guide you through the lesson.

Estimated time to complete a section or activity within the lesson.

Optional headphones to listen to videos and audio recordings.

Explore online content. Discover videos, stories, and zoom into pictures.

Activity - time to design, make or write something of your own.

Vocabulary
Words to look out for in the lesson

abacus, AI, algorithm, analogue, Apple I, Arpanet, artificial intelligence, automate, automatics, BBC Micro, binary, byte, calculator, camera, cassette, central processing unit, chip, cipher circuits, Colossus, communications, computer games, computing, continuous, cordless, CPU, cryptanalysis, cryptanalyst, data processing, digital, ENIAC, Enigma Code, handheld, hardware, HTML, HTTP, humanoid, hyperlink, hypertext, IBM PC, information flow, information processing, infrastructure, innovation, input, interactions, Internet, invention, LAN, machine learning, mainframe, mathematical, mechanism, memory, microchip, microphone, microprocessor, model, networks, output, packets, pattern recognition, processor, protocols, recorder, reel-to-reel, robot, robotics, smartphone, software, storage, telecommunications, terminal, transistor, Turing machine, URL, valve, voltage, WAN, web browser, web server, World Wide Web

Beyond the Computer

Introduction

Computers are all around us, powering everything from our washing machines and fridges, to the devices we use to communicate. We interact with them, not just in the home, but in most aspects of modern life. In fact, computers are such an intrinsic part of everyday life, it is hard to imagine a time without them.

The history of computing goes back further than you would think. Even before we had digital computers, the idea of computing can be traced back thousands of years to the invention of the abacus. However, the evolution of the mechanised and digitised computers we know today really began around 200 years ago, with the invention of the Difference Engine in the 1820s.

Significant developments were made as a result of World War Two (WW2) and then the invention of the transistor created the opportunity for computers to become smaller. This made computing more practical and expanded the potential for computing to revolutionize how we live and work.

In this lesson we will explore how this history has led the world of computers we live in today and how they have changed the way that we do things.

If you make notes on the stories you read, this will help you for the end of lesson quiz.

Dekatron Random Access Memory (RAM) Unit (The WITCH), Ted Cooke-Yarborough, 1951, The National Museum of Computing

EDSAC (Electronic Delay Storage Automatic Calculator), Maurice Wilkes, 1949, The National Museum of Computing

What is this lesson about?

In this lesson we will look at a brief history of computers and computing. You will see how computers have changed over time and explore some areas where computers have altered the way we do things. People are at the heart of computing, here you will get to learn more about some individuals who helped shape computing in the past and those who are innovating in computing today.

This lesson will take around 120 minutes.

What is a Computer?

Explore a brief history of computing and then will learn about the inventions that led to the smartphone. Finally, find out more about artificial intelligence and machine learning.

This chapter will take around 45 minutes.

History

Explore a brief and concise history of computers. Learn about what analogue devices are and how they were used. Then follow the development of digital devices and the creation of the microchip, a core component powering computing devices today.

Communications

Modern computing devices that we use everyday need to be connected together. Learn about how computers were used to develop modern communication systems, which are used today through the Internet, smartphones and cloud computing

Smartphone

Smartphones are a common part of modern life, changing the way we communicate, socialize and work. This powerful computing device was developed due to innovations in other technologies. Discover more in this chapter.

Artificial Intelligence (AI)

Ever wondered how your smartphone autocorrects your spelling? Or how it often wants to enter phrases that you commonly use? This is an example of AI in action. There are many examples of the use of AI in everyday life. Find out more in this chapter.

A Concise History
## From analogue devices to microchips

As humans, we use innovative ideas to invent ways to solve problems. The is true in the on-going development of the computer. If we take the word computing back to its origins, it means 'to calculate'. Therefore, we could say that the first computer was the abacus, which was used to record complex calculations. This is evident in ancient civilisations in China, Greece and Egypt and is thought to go as far back as Mesopotamia, in around 2700BCE.

An ancient Greek artefact, the Antikythera Mechanism, is thought to date back possibly as far as 205BC. It is credited as the world's first computer, calculating the movement of the solar system.

The first steps towards a mechanised computer were made in the 1820s by Charles Babbage, a Mathematics professor at the University of Cambridge. His idea was to create a machine that would calculate and print mathematical tables.

The development of digital computing was accelerated by Alan Turing during the early 20th century, with the creation of the Turing Machine, a precursor to digital computers. With WW2 came the construction of the Colossus and ENIAC computers, the world's first digital, programmable computers.

The creation the transistor, changed the face of modern computing as it made it possible for computers to be made smaller. Computing today would not have evolved the way it has without this important invention.
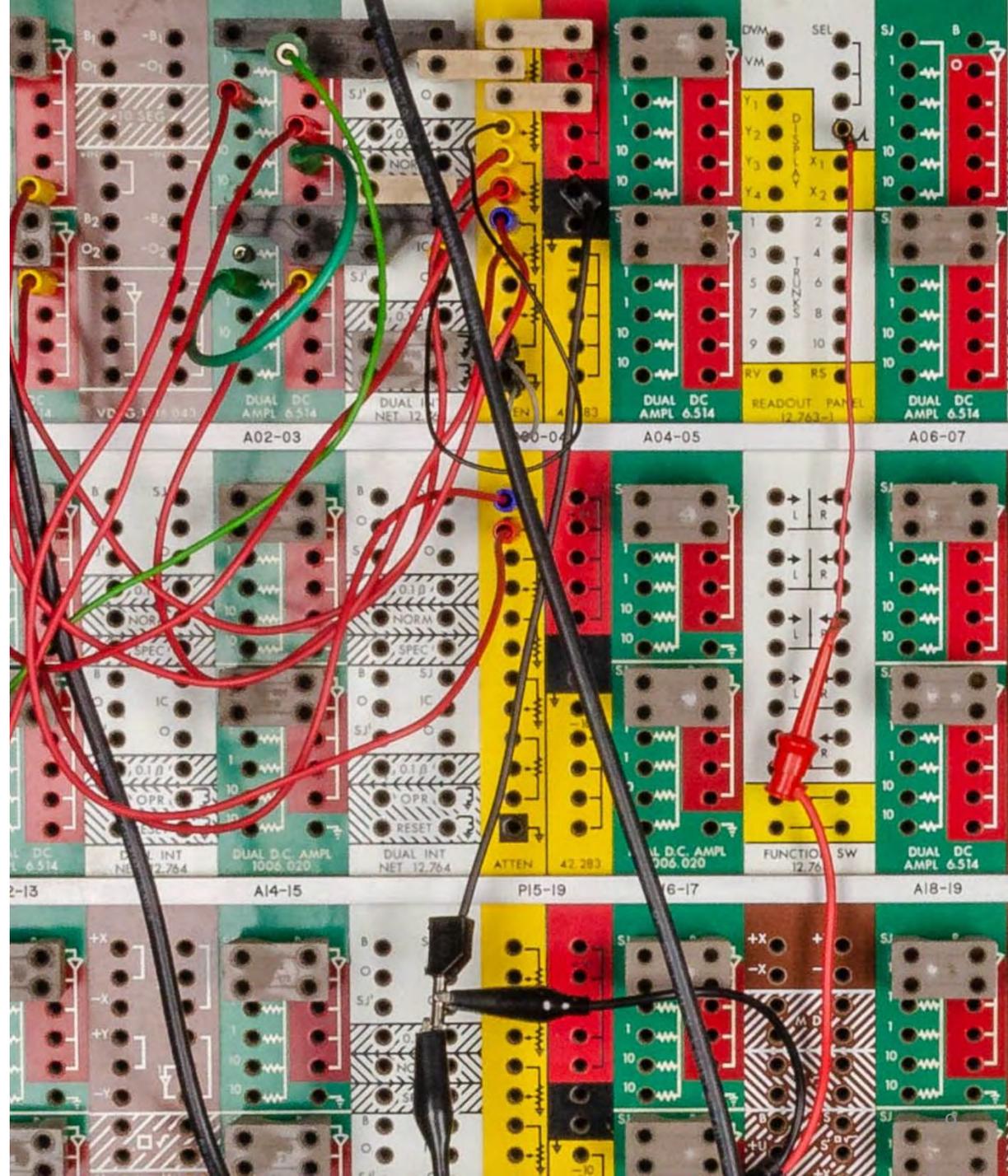
Analogue to Digital

Computers have evolved over thousands of years. From early analogue machines designed to calculate and automate, to the digital computers we use today.

Learn about the different stages of the development of computing from early analogue machines to digital and how computers became part of everyday life. Here you will also explore the fundamentals of how computers work, including the importance of circuits and switches and the use of binary code.

Find out more by clicking on the 'Explore' button below.

Explore

IBM System 360 195 computer, manufactured by IBM, United States, IBM, 1971, Science Museum

Communications
How computers transformed communications

The use of computers and the invention of the Internet has changed the way we communicate. We have moved from telephone exchanges, where people connected calls manually using different plugs and switches, to being able to talk to someone via video on the other side of the world at the press of a button.

To understand how computers communicate with each other, we need to know how networks operate. Before data is transferred across a network, it is broken down into packages called data packets. The packets are then sent across the network.

Computers can be connected to each other on a local area network (LAN). Using this method, computers in businesses and homes can communicate with each other and share resources across the network, like printers and internal file storage.

For different networks to communicate with each other, they need to speak the same language, which was why it was so important that a universal set of rules was created. The invention of TCP/IP internet communication protocols showed us that it was possible for multiple different computer systems to communicate across a wider network.

However, it was the invention of the World Wide Web in 1989, that simplified the way data packets were handled and this led to the internet being available to be used by everyone.

There have been many developments in the way we use technology to communicate and the impact of these can be seen all around us.

Important milestones are often linked with military defense and university research, including the invention of ARPANET. This was the first network to span a wide geographical area and one of the first to use TCP/IP protocols. It is the precursor to the Internet that we know today.

The World Wide Web was invented by a computer scientist at CERN, looking for a simpler way to share information using the Internet. His innovation completely changed how we communicate today.

Click on the 'Explore' button below to learn more about these milestones and other important events in the development of digital communication.

Explore

The Smartphone
Innovation at our fingertips

How would you describe a smartphone? A small computer than can make calls? A phone with a camera? Smartphones have been evolving over the last 30 years, bringing together many of the innovations we have looked at so far. They are the result of many different inventions and technologies, brought together in one hand-held device.

Inventions like the transistor, the development of the microprocessor and the introduction of the internet have all played important roles in the creation of the smartphones we use today. There are other key innovations that are included too, like the lens of the camera, lithium batteries and radio frequency antennas. All of these were developed for other purposes but have become essential elements in modern smartphones.

Early mobile phones, produced in the late 1980s and early 1990s, had the capacity to make calls, receive voicemails and send text messages. They often had software applications like notes, a calendar, an address book and simple games. However, their primary purpose was as a phone.

The biggest change came when early smartphones were able to connect to the internet, through the introduction of 3G. This accelerated the development of the smartphone significantly and vastly changed how we use them.

There are many inventions, which have contributed to the smartphones we use today.

The invention of the telephone is a good starting point. As is the invention of the personal computer and the development of the Internet.

We could add to that the invention of the transistor and subsequently the transistor radio. Giving us an early portable device for playing music.

Let's include the design of the television, which gives us the display of the phone. We shouldn't forget the invention of the camera lens either, as the camera is an essential part every smartphone.

There are many other innovations that have helped to bring the smartphone to life.

Click on the 'Explore' button below to take a journey though the inventions that led to the smartphone.

Explore

Artificial Intelligence (AI)
Learn about AI and Machine Learning

What is AI? Simply put, artificial intelligence is where computers take the place of humans in tasks that would normally require the human brain to complete. A simple example would be using Google Maps to get directions from one place to another. Historically, this is a task that would require a human to use map-reading skills to plan the route manually.

If we think of typical computing, computers have been programmed to carry out specific tasks depending on how we interact with them. Machine learning, doesn't work on this typical principle. Instead, the computer has been programmed to use data to learn what tasks to perform and it does these without specific instructions. For instance, when the computer tries to predict what you are intending to type or when your favourite streaming service recommends things you might want to watch or listen to, based on what you have played previously.

The idea of non-human machines and statues that take on human-like thought has been written about as myth and science fiction as far back as ancient Greece. However, we are now beginning to see the reality of AI and robotics working together and there is a growing relationship between the two different areas of technology.
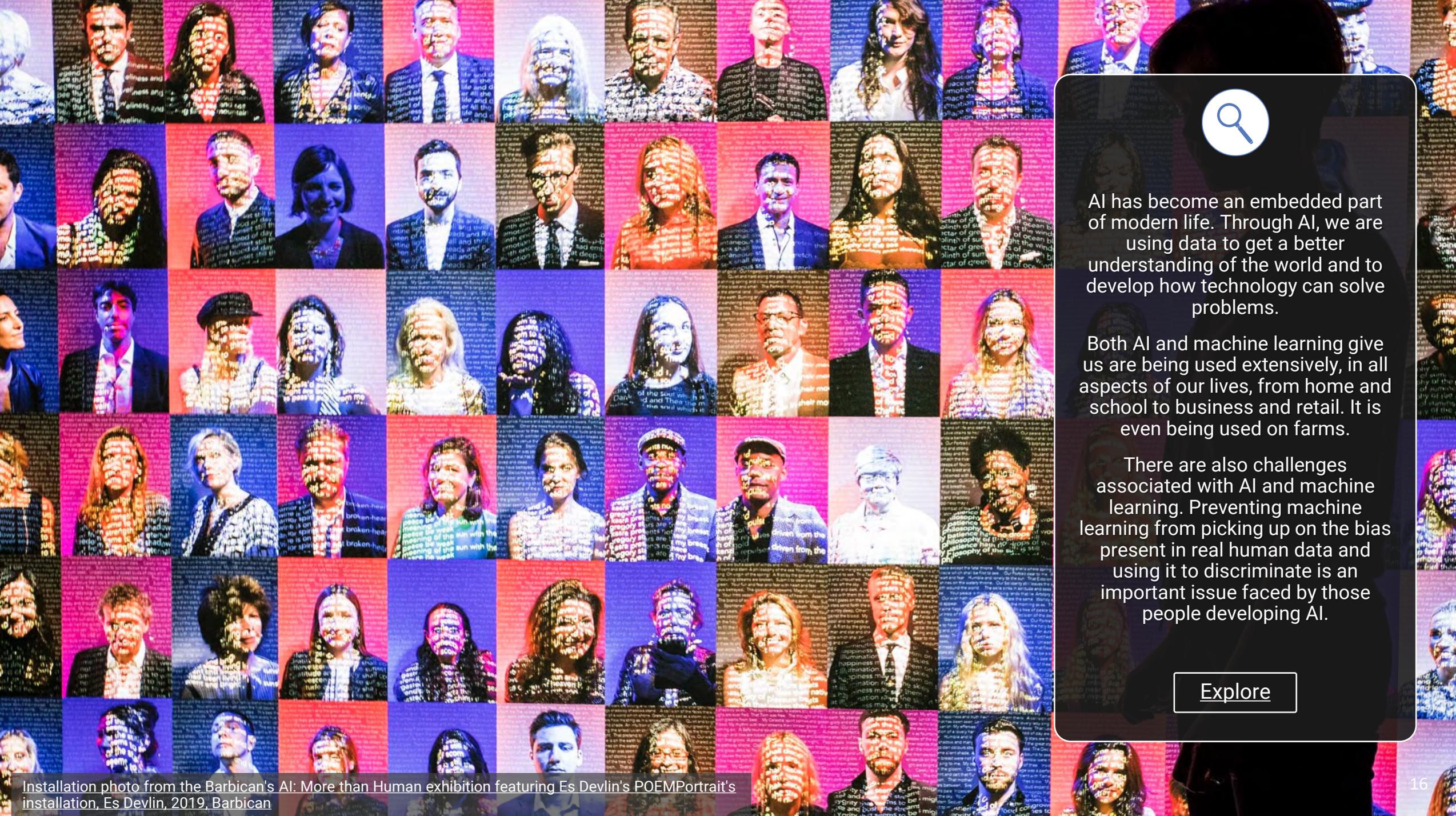
AI has become an embedded part of modern life. Through AI, we are using data to get a better understanding of the world and to develop how technology can solve problems.

Both AI and machine learning give us are being used extensively, in all aspects of our lives, from home and school to business and retail. It is even being used on farms.

There are also challenges associated with AI and machine learning. Preventing machine learning from picking up on the bias present in real human data and using it to discriminate is an important issue faced by those people developing AI.

Explore

Installation photo from the Barbican's AI: More than Human exhibition featuring Es Devlin's POEMPortrait's installation, Es Devlin, 2019, Barbican

**Activity 1**

Create a Computing Timeline

Review what you have learned in this chapter. Consider key dates for items that you feel are important in the development of the computer. Then choose your top ten and create a timeline for when these ten dates occurred. Your timeline should begin at the earliest date point you have chosen, either at 200BC, 1800 or 1935.

Cray-1A Supercomputer, 1976, Computer History Museum

1st Item

10th Item

-200 or 1800 or 1935

Today
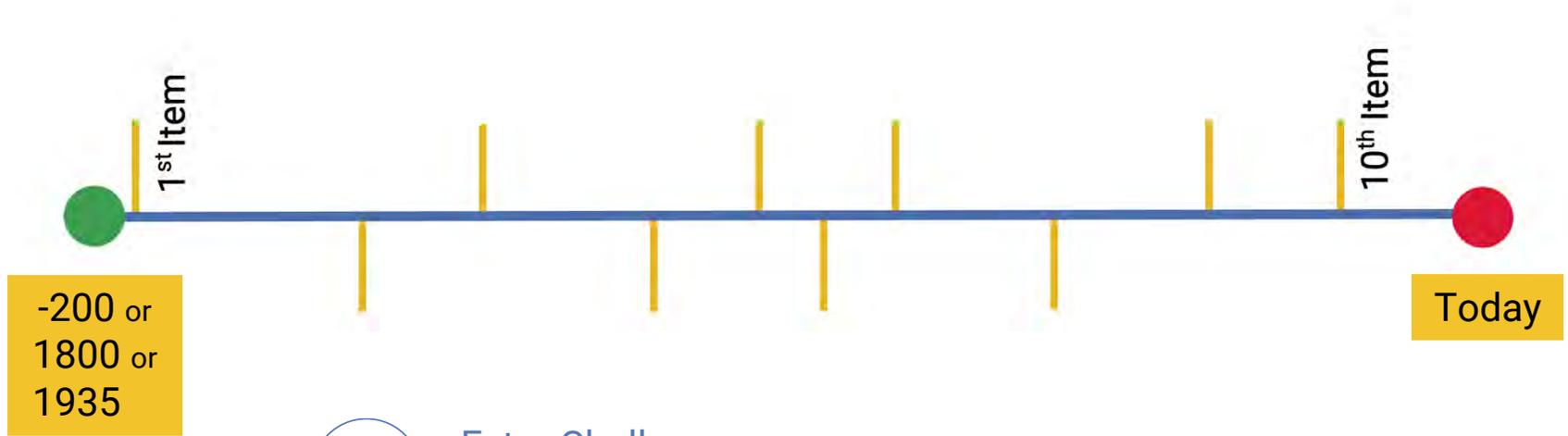
Extra Challenge

Consider what you have learned about the development of the smartphone. Think about the major technologies that make up the smartphone, such as the telephone, transistor radio, television, recorder, networks, the Internet and microprocessors. Produce a different timeline to place these technologies in relation to the smartphone. The end date would be the launch of the iPhone in 2007.

15 to 20-minute activity

The Computer Re-imagined

Computers are created to solve problems; sometimes the solutions have had a revolutionary impact on society. Learn about code-breaking machines in wartime and then explore the origins of computer gaming. See how the Microcomputer changed our relationship with computers and find out more about computers that can replicate human actions and interactions.

This chapter will take around 45 minutes.
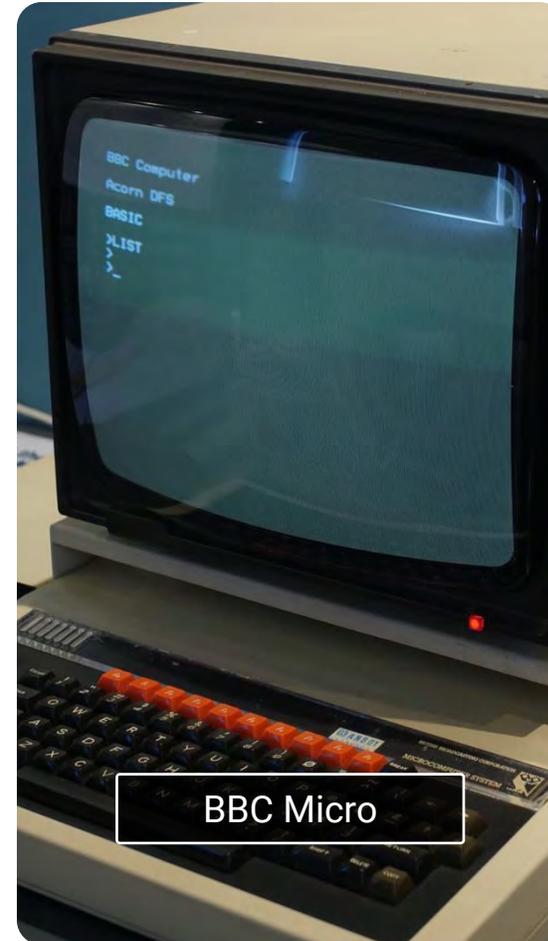
18

The Computer Re-imagined
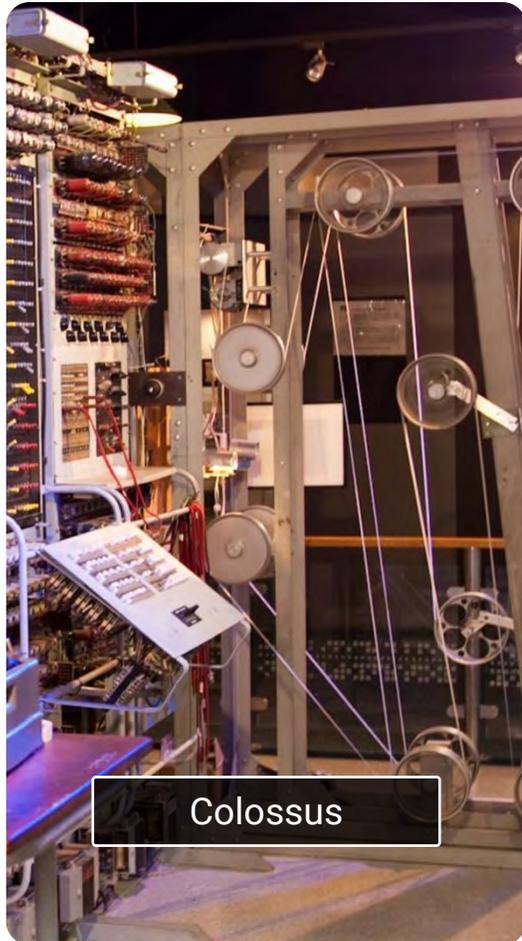
Colossus

The Rebuild of Colossus Mark II,
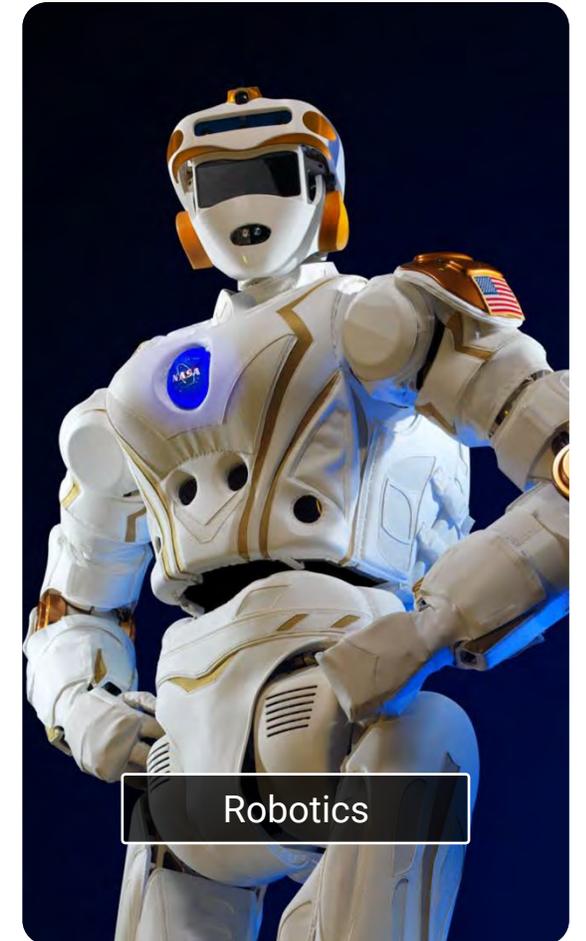2014-01-06, The National
Museum of Computing

Computer Games

The Oregon Trail: American Settler
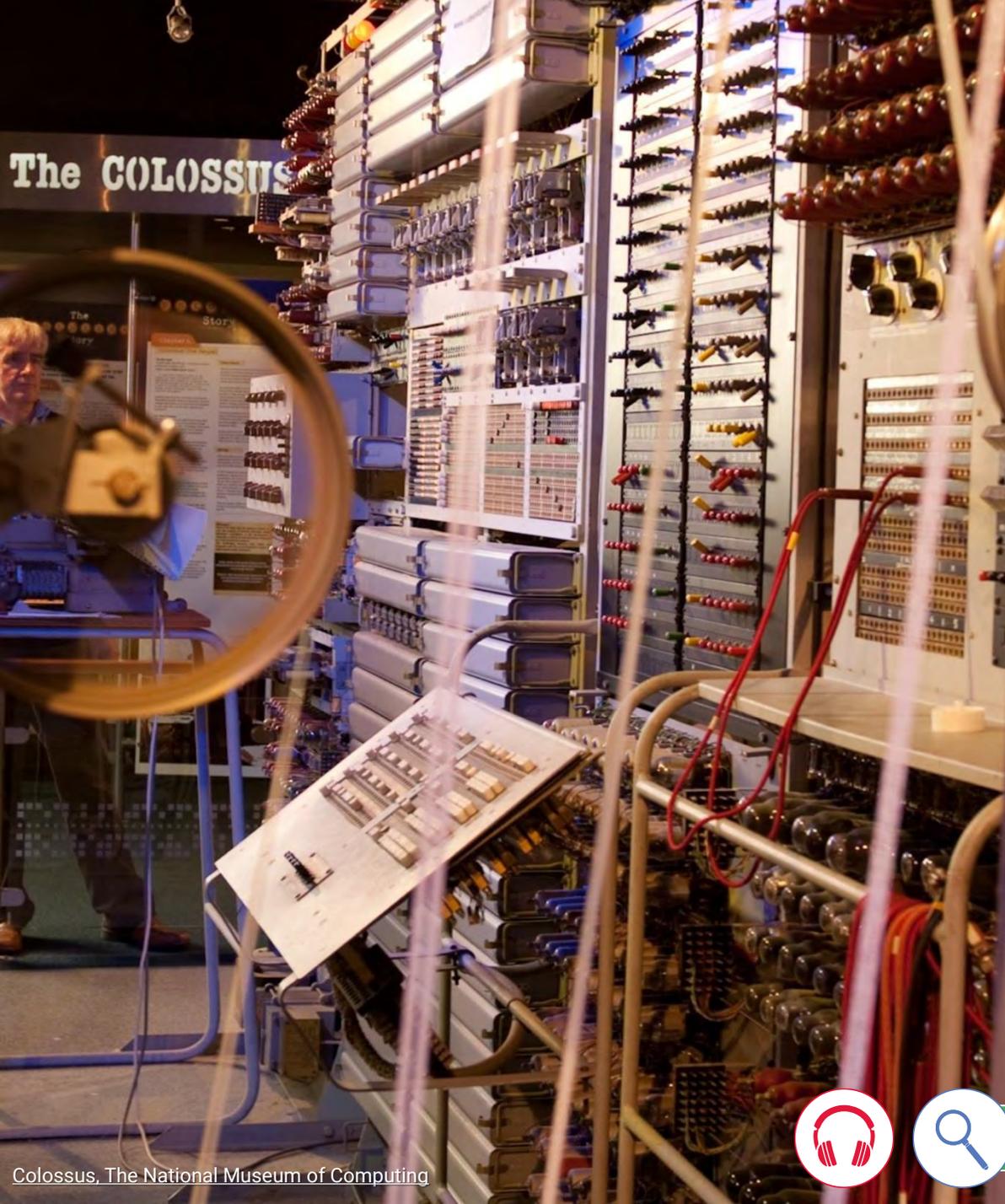Screen Capture, Gameloft, 2015-12,
The Strong National Musuem of Play

BBC Micro

BBC Micro Model B, Acorn
Computer Company, 1981, The
National Museum of Computing

Robotics

Der humanoide NASA-Roboter
Valkyrie, Deutsches Museum

Colossus
Wartime code cracker

During World War Two, the German Army used cipher machines to communicate encrypted messages between different army commands and bases. These messages held important information about their military plans. The machines and their codes were believed to be unbreakable.

Based at Bletchley Park in the UK, the Government Code and Cypher School (GC&CS) brought together some of the most gifted computational thinkers and cryptanalysts (code breaking experts) in a bid to use technology to decode the messages.

The experts at the GC&CS created the Colossus computer in 1943 to tackle the Lorenz cipher, which was highly complicated and incredibly difficult to break. Even more so than the Enigma code, which was used by the German Army for the day-to-day running of the war effort. The Lorenz cipher was used to communicate the larger plans and deciphering these would prove essential to ending the conflict.

Colossus was one of the first programmable digital computer and was used to speed up the process of deciphering many thousands of strategic messages.

By the end of the war, there were ten Colossus machines working constantly to break the codes that had been intercepted.

Explore

Automated Chess
The first automated game

Video games are an established part of our modern culture and use of technology. Whether through consoles, computers, tablets or apps on smartphones, automated games play a part in everyday life. However, the first automated, computer game was the Chess Player.

It was created around 1912, by Leonardo Torres y Quevedo in Spain and was shown to the public in 1914. He wanted to prove an early theory of machine learning, where he suggested that a machine could make intelligent decisions.

The idea behind his automated game was that it could use data about chess moves to understand when the human player had made a wrong or right move. It would then choose moves based the moves made by its opponent.

The early machine had a mechanical arm to move the chess pieces. However, in a later version he used an electromagnetic approach, where the pieces would be moved by magnets underneath the board.

Explore

The BBC Micro
Bringing computing into homes

The idea of computing being accessible to individuals started to gain momentum in the 1970s and 1980s. In order to provide computers that would be accessible for education and for the home, the BBC teamed up with a computing company called Acorn to design and produce the BBC Micro.

Launched in 1982, the core focus of the BBC Micro was to excite and engage people about personal computing and for people to learn how to code. Initially, it was commissioned for a small number of units, but It was so successful, that it sold over 1.5 million units and the British Government funded it to be put in schools across the UK.

For many people the BBC Micro was their first introduction to a computer and people were encouraged to learn how to code games and other activities using the BASIC programming language. The Micro was also capable to hosting other software, like a word processor and a wide range of 8-bit games.

Explore

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Robots
Carrying out human tasks

Robots come in many different shapes and sizes. Although we often think of robots as being human-like, actually many are designed to suit the job they are designed to fulfil.

The first fully programmable robot was invented in 1954 by George Devol and went on to form part of the assembly line at a General Motors car plant in New Jersey, USA. The robot was employed on a task that was considered highly dangerous for humans, with risk of serious injury or death.

Robots are often used in this way to substitute humans, where there is a danger to life, especially in the event of natural disasters and war. For example, drones can be used to carry out surveillance of areas that are impossible to reach because of an earthquake and they can also be used to deliver supplies.

The adoption of driverless cars is on the horizon in the future; the technology exists, and trials are being carried out to determine if they are safe. We even have the technology for automated robots to deliver takeaway food.

As robots develop further, we are seeing greater application of AI and machine learning coupled with robotics.

Explore

The Binary Game

This is a test of your mathematical skills and a chance to think like a computer. You are going to play a game from CISCO. It is used to help train technicians how to read binary numbers. A digital computer is made up of tiny electronic switches. The binary code 1 represents the switch is ON, and the binary code 0 that the switch is OFF. This is the reason why binary codes are used in modern day computers.

To find out more about binary codes click on this link from the BBC. It should help you to remember what you learned about binary numbers in your class. Now you will take the test. This is a real-world test and so it tends to move onto the next challenge quickly. **See how quickly you can complete level 1.**

Click the link from CISCO, to go to the game. Remember, this is designed to test your math skills as well as your binary. If you are unsure what to do, look to see how you can make the number using the binary switches on the orange lines and identify the number highlighted on the green lines.
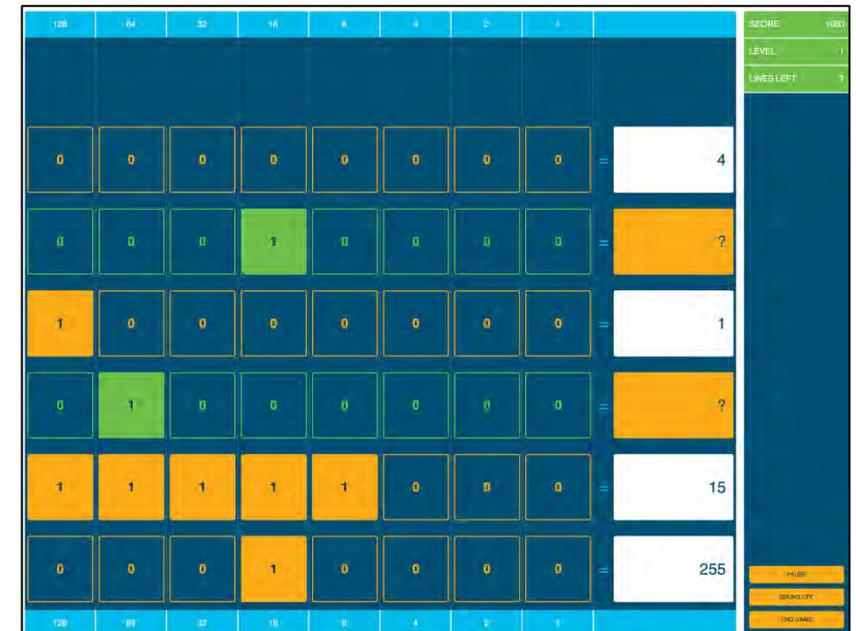(Hint: if all the 1s are highlighted (1111 1111) the number is 255)

You may need help from your parents or teacher with this activity

CISCO Binary Game

Examples of where binary codes are used in computers:

• Each time you press a letter on your keyboard you send a binary code to the processor.
• For example, a common code for the letter 'a' is 0110 0001.
• Computer processors are measured by how many bits they can process at a single time. 8-bit devices can process 8 binary digits at the same time, giving a total of 256 combinations.
• Modern-day processors can process 32-bits and above. This gives them over 4 million combinations. This is one of the reasons why they are so powerful compared to older computers.

15 to 20-minute activity

Ishiguro with Geminoid HI-4 (2013) by Hiroshi Ishiguro Laboratory, Osaka University, Hiroshi Ishiguro, 2013/2013, Barbican

People and Computing

There would be no computer revolution without the people involved. Their inventiveness and thinking helped shape how computers came into being and created the foundations for the vast array of computing technology that exists in our world today. Meet some of these people who have changed the world and have helped us to continue to push the boundaries of how we use technology.

This chapter will take around 30 minutes.

Learn about one of the great thinkers in computing. Alan Turing invented the Turing Machine. Click the 'Explore' button to learn more.
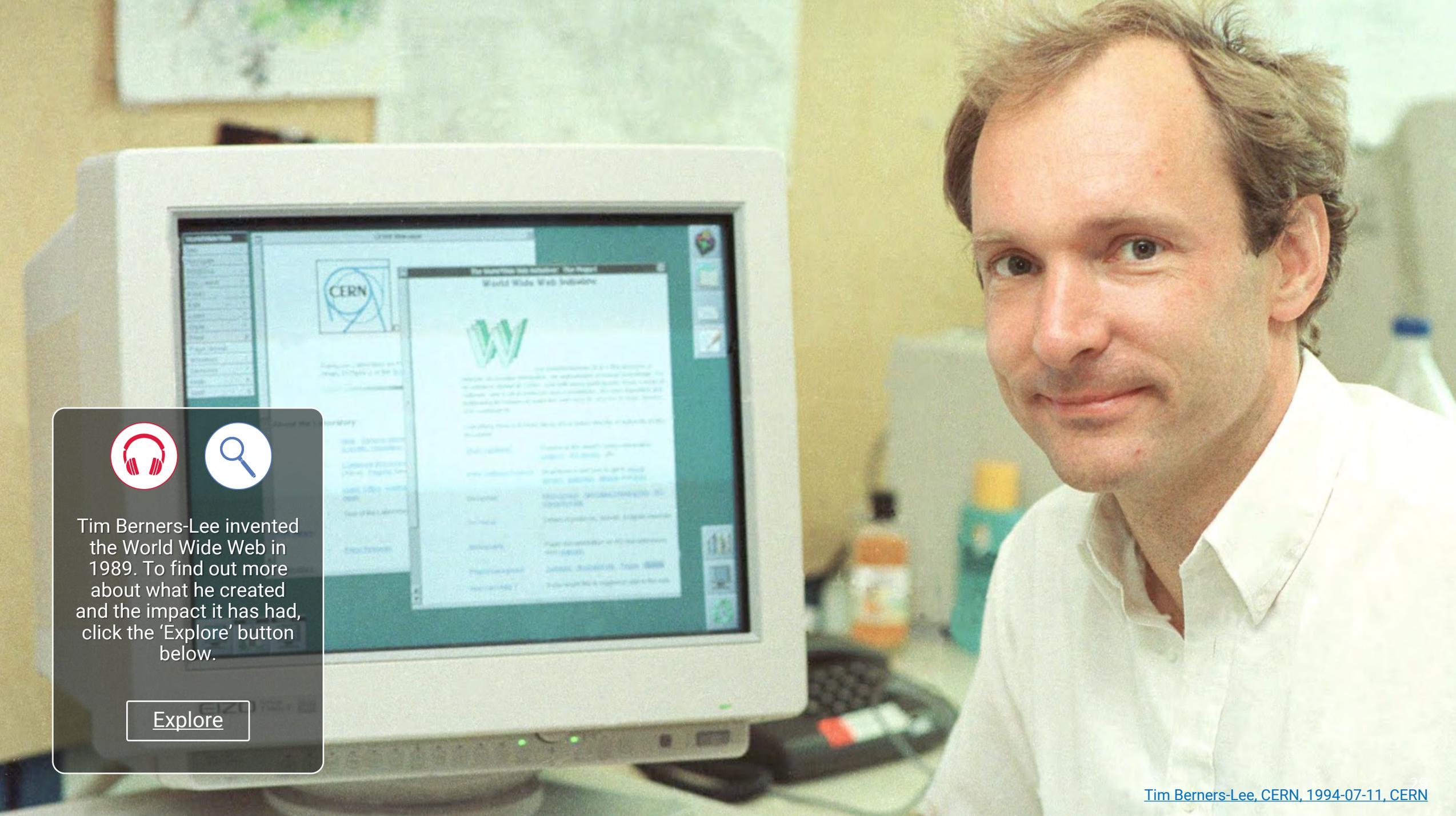
Explore

Women have played an important role in the development of the computer and how it can be used. To learn more about the role women played in computing, particularly during wartime Britain, click the 'Explore' button.

Explore

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Japan has become a world leader in the development of robots. Meet Professor Ishiguro who discusses how he got started with the creation of humanoid robots. Click the 'Explore' button below.

Explore

Tim Berners-Lee invented the World Wide Web in 1989. To find out more about what he created and the impact it has had, click the 'Explore' button below.

Explore

Can you work it out?

Working with computers requires you to know a lot of terms. Can you identify these terms mentioned in this lesson?

1. Aa lounge   *= Analogue*
2. my orem
3. neomorphic
4. lbw widowered
5. arnhem pots
6. rose waft
7. alpines reconstructing
8. inhaler menacing
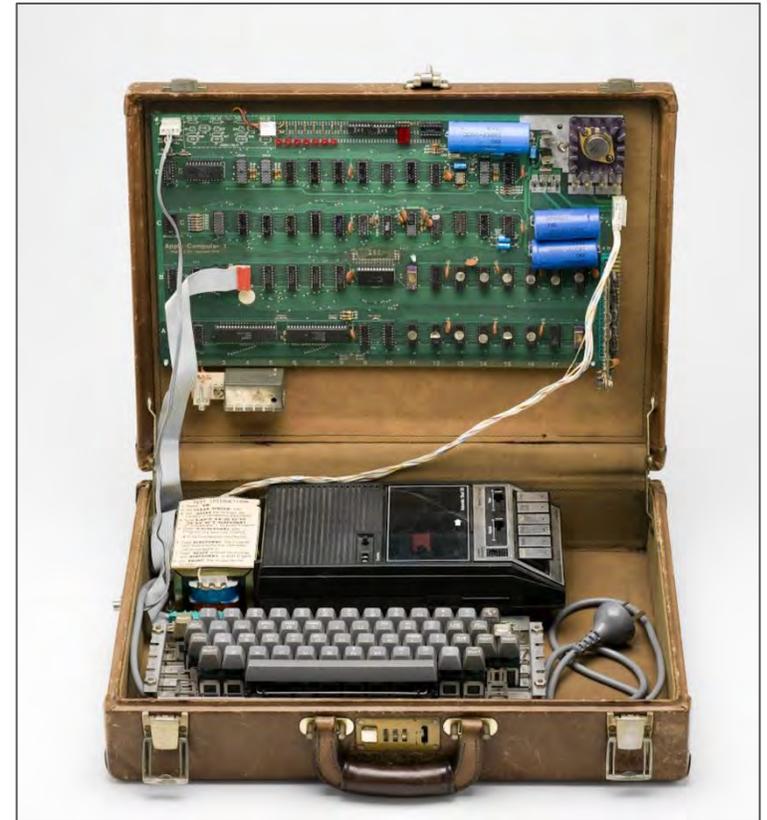9. octo ribs
10. manicure thing

Need help? Check out the vocabulary list on page 4. Answers are on page 33.

Extra Challenge

Making up anagrams can be fun. Have a go at making up anagrams for the following terms?

Recorder, binary, networks, abacus, telecommunications.

Apple I computer, Steve Wozniak, 1976, Museum of Applied Arts and Science

10 to 15-minute activity

Fill in the Blanks

See if you can recall what you have learned from this lesson. How many blank words can you fill without going back through the pages?

1. ……………………….. was a British mathematician who came up with the concept of a digital computer in the 19th Century.

2. The world's first **programmable general purpose digital computer** was created in the USA during World War II. It was called ………….

3. The Turing machine was created by a famous British mathematician and cryptanalyst. What was his first and last name?

4. AI is short for ……………………………………

5. Apart from computer and communication devices, name one of the other inventions which were needed to help in the development of the smartphone?

6. ……. is one of the leading countries in the study of Robots.

7. An ……… signal is a continuous current. These types of computers are best used to solve problems using equations.

8. Tim Berners-Lee created the WWW. What does WWW mean?

arcade game: Computer Quiz Nutting Associates, 1968, The Strong National Museum of Play

15 to 20-minute activity   You will find the answer to this quiz on page 33.

Want to Learn More?

Now you've completed this lesson you may want to continue to find out more about inventions and computers, this is a good place to start. To see how artists meet with machine learning, click here.

Anagram answers

Here are the answers to the anagrams. How did you do?

1. Analogue
2. memory
3. microphone
4. World Wide Web
5. smartphone

6. software
7. Central processing unit
8. machine learning
9. robotics
10. Turing machine

Quiz Answers

End of Lesson Quiz

Here are the answers to the quiz. How did you do?

1. Charles Babbage
2. ENIAC
3. Alan Turing
4. Artificial Intelligence
5. One from: microphone, camera, recorder, transistor radio, television, flashlight, music player
6. Japan
7. analogue
8. World Wide Web

Yuri Suzuki Re-imagines Raymond Scott's Electronium, Yuri Suzuki, Pentagram, 2019/2019, Barbican Centre