Computer Science Colouring Book

A gentle and fun introduction to Computer Science

William Lau

when ⚑ clicked
ask What's your name? and wait
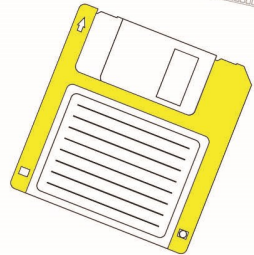set name to answer
repeat 10
say join Hello name
wait 1 seconds
stop all

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For the latest free download of this book, go to http://bit.do/CSColouring

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For Zi and Q

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Introduction

When we think of computer science, we may think it is difficult or perhaps it is only for certain people. However, the beauty of computer science should be something that everyone is exposed to, regardless of age, gender, race or income.

It is true that computer science is challenging, but so to is learning to walk, so to is learning to ride a bike and so to is learning how to speak. Despite the initial struggle, we have managed to overcome these. There are always small steps which we can take in order to achieve our goals in life and the same is true of computer science.

I hope this book becomes a stepping stone to helping you learn more about computer science. Yes, it will be challenging, however once you have learnt the basics, you will find that the subject is empowering, liberating and fun in the same way as walking, cycling and talking to friends.

Why a colouring book?

I made this book based on the accessibility of colouring and the freedom which colouring offers. People often think of computers as silver, black, white or beige. But they don't have to be. You can re-imagine these in any colours that you choose. There may be many objects that you have heard of but have no idea what they look like or how they actually work. The images and accompanying text help demystify the different devices, hardware and software that make up the foundations of computer science.

Be bold. Get your colouring pencils, gel pens or glitter pens ready and embark on a fun and gentle introduction to computer science. Feel free to share your creations on social media using the hashtag #CSColouringBook

Desktop Computer

The first desktop computers such as the IBM PC were beige-coloured – how boring! Later, companies made black, grey and silver desktops. In 1998, Apple famously released their iMac G3 desktops in a range of colours.

Go wild, you can colour in this desktop with whatever colours you choose!
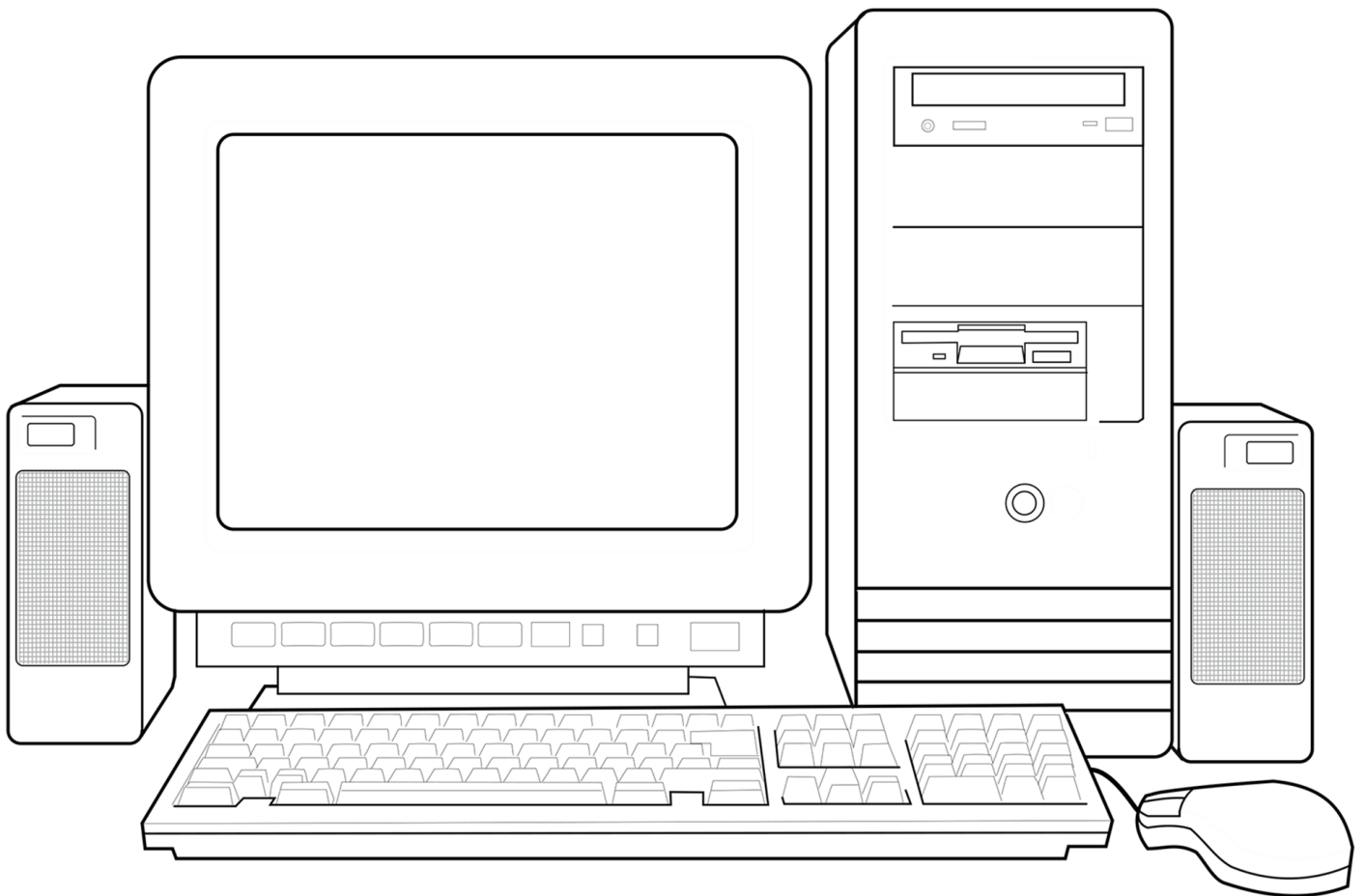
The desktop computer is a general-purpose computer system. This means it can perform a wide range of tasks. Whilst ready-made desktops can be bought in shops, some people choose to build their own desktop with specific hardware. We will cover a range of hardware throughout this book.

Laptop Computer

Computer systems come in many different forms. A popular portable version is a laptop. Whilst laptops can perform most of the tasks that a larger desktop can, they are generally less powerful than a desktop. Many come with built-in webcams, microphones and speakers.
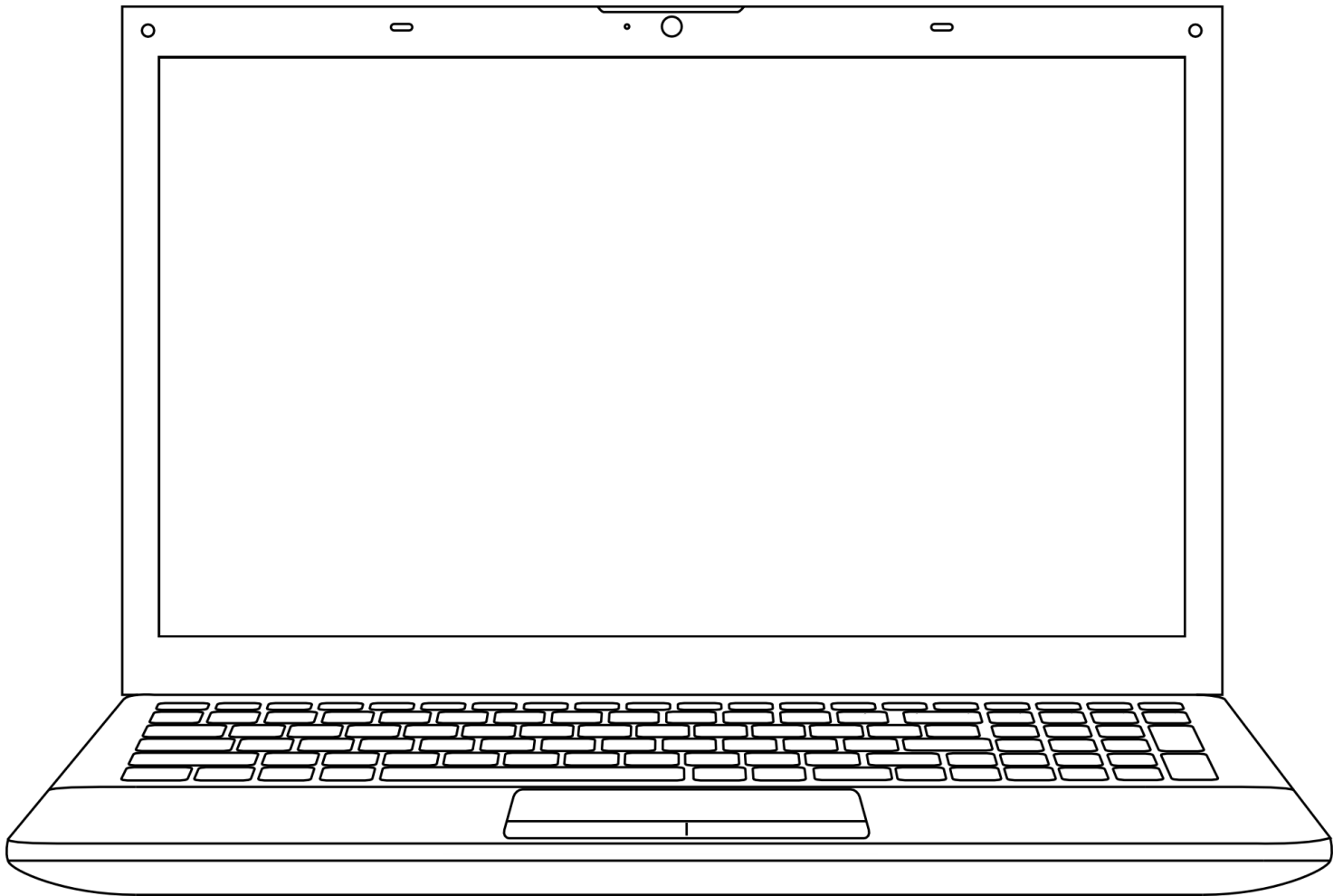
To avoid damage, you should always close your laptop screen when you are carrying your laptop and avoid holding your laptop by the hinge.

CPU

The Central Processing Unit (CPU) is a microchip which processes all the data and instructions in a computer system.
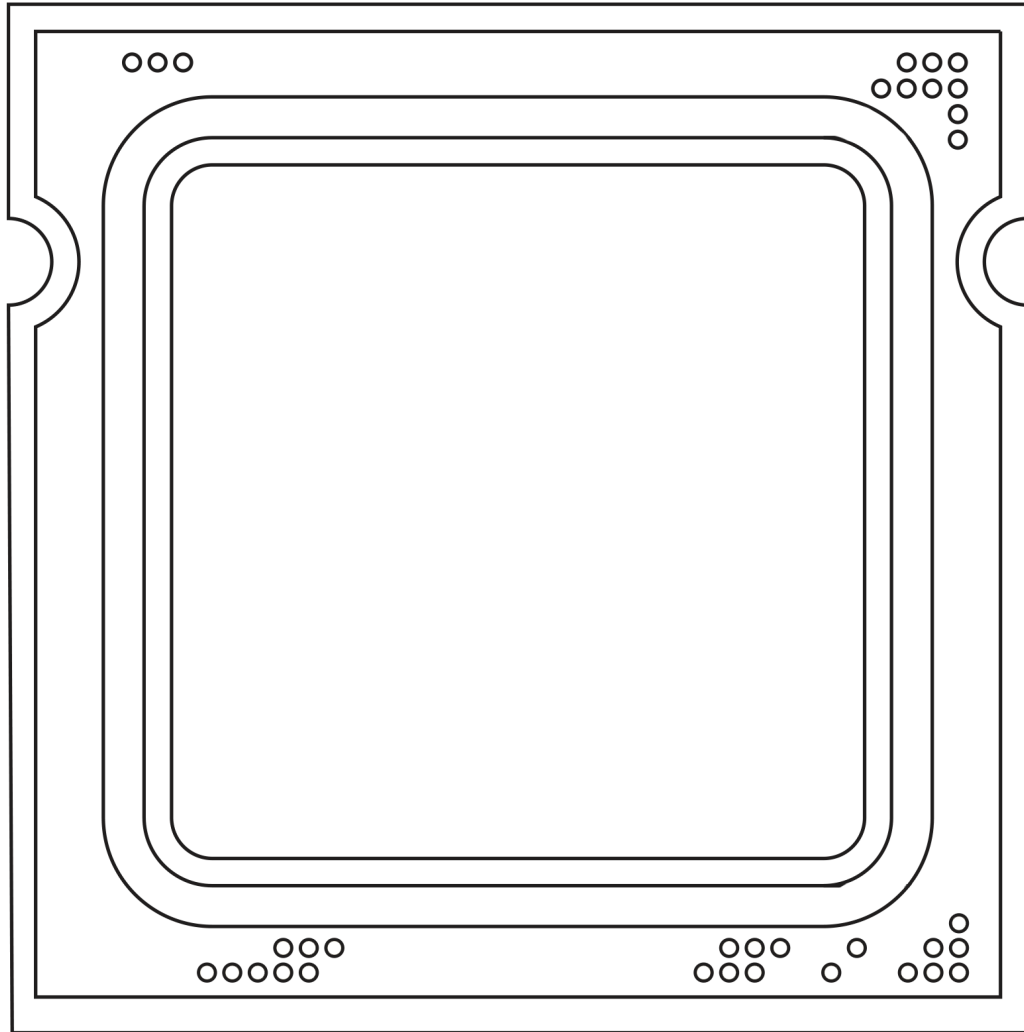
A CPU instruction cycle consists of three stages:

1. The CPU fetches data and instructions from memory. The instructions and data are in binary format which means they are made up of 0s and 1s.
2. The CPU decodes the instructions to make sense of all the 0s and 1s.
3. The instructions are executed.

The CPU can perform billions of these "fetch-decode and execute" cycles every second!

Main Memory

The CPU reads instructions from memory. The CPU has its own memory called cache, however this is very small and only stores frequently or recently used data. The computer's main memory is in the form of RAM and ROM.

RAM stands for Random Access Memory. This stores programs and data currently in use. When a computer is turned off, all data in RAM is lost. RAM is therefore described as volatile. Originally, all RAM modules had green circuit boards. However, RAM now comes in various colours.
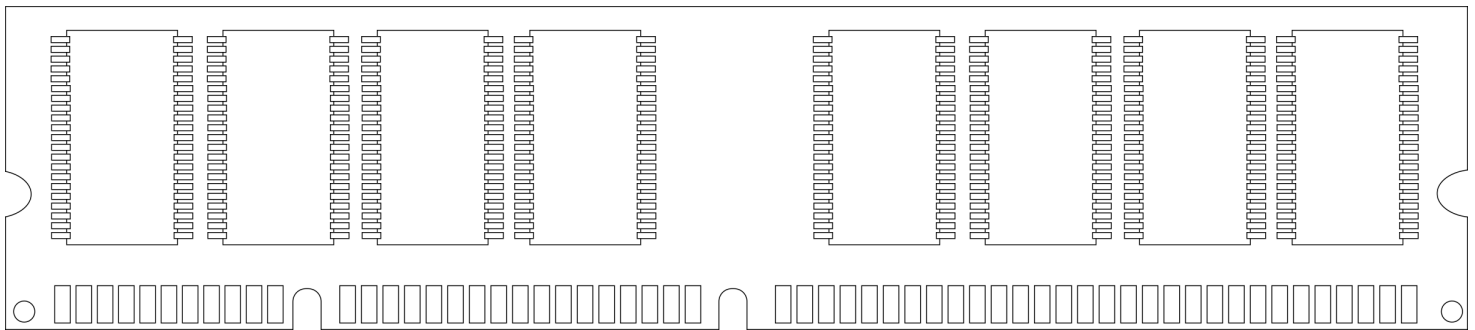
ROM stands for Read Only Memory. The main job of ROM is to boot up (start) your computer when it is turned on. ROM in an embedded system (such as washing machine) may contain the software for the device as this is unlikely to change.
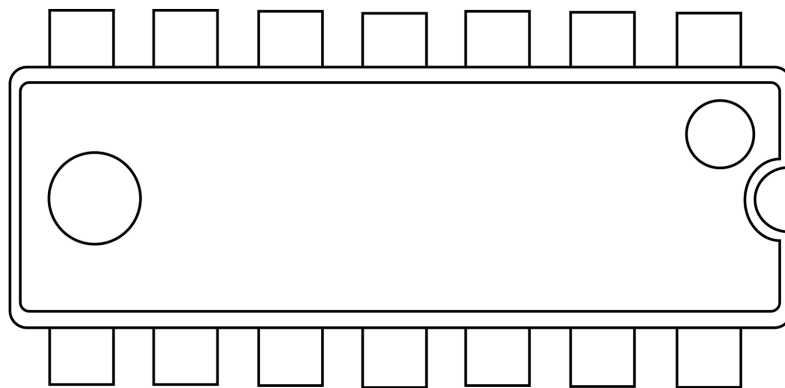
As ROM has such an important role in the boot up of a device, it is non-volatile which means data is not lost when the computer is turned off. The CPU, ROM and RAM chips are all directly connected to the motherboard.

Floppy Disk

If we want to save programs or files, we need a separate storage to main memory. This secondary storage is non-volatile which means data is not lost when the computer is turned off. The most reliable type of secondary storage is magnetic storage. Examples include the floppy disk, magnetic tape and hard disk drives.
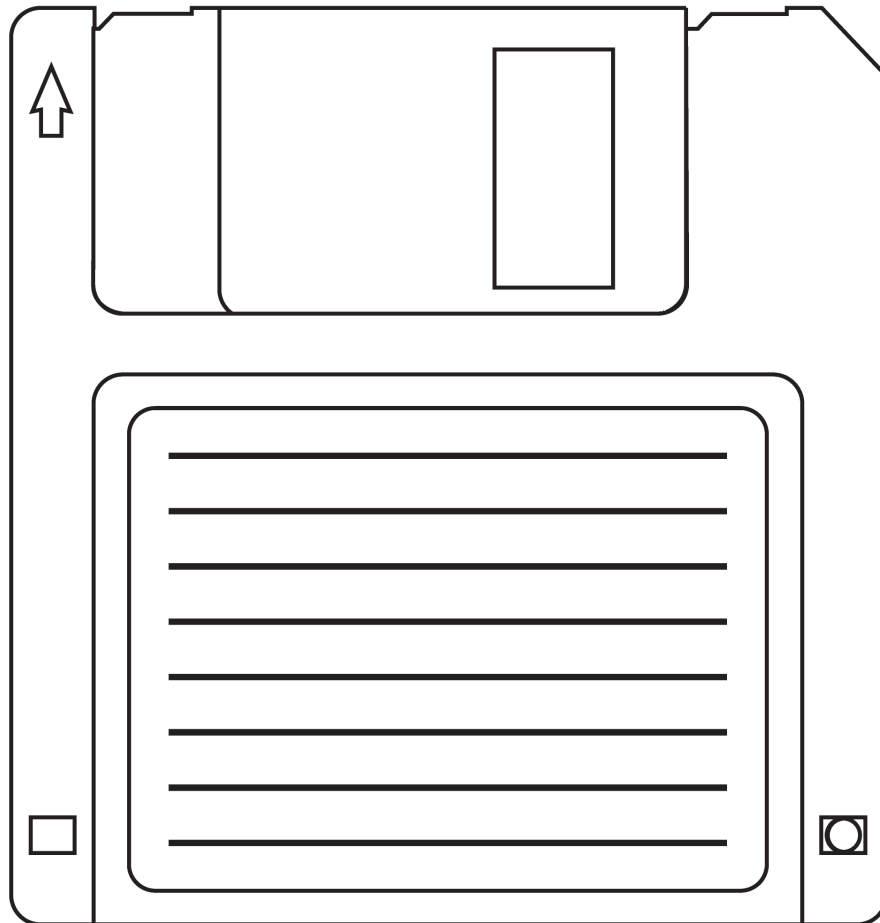
For younger readers, the image above may look like the icon that you click on to save your work. This icon is based on the floppy disk. Each floppy disk had a plastic case which protected a magnetic disk inside. Between 1980 and 2000, these disks were the dominant form of portable storage. Software was often distributed on floppy disks. You could also save files such as word-processed documents and images to a floppy disk. The files could then be carried from home to work or given to friends.

By the early 2000s, optical storage such as CDs and DVDs began to dominate.

Hard Disk Drive

Magnetic storage gets its name from the electromagnets which are used to magnetise and demagnetise sectors on a spinning disk or tape. A magnetised sector on the disk could represent a 1, whereas a demagnetised sector can represent a 0. Hard disk drives like the one below offer large storage capacity at a relatively low cost.
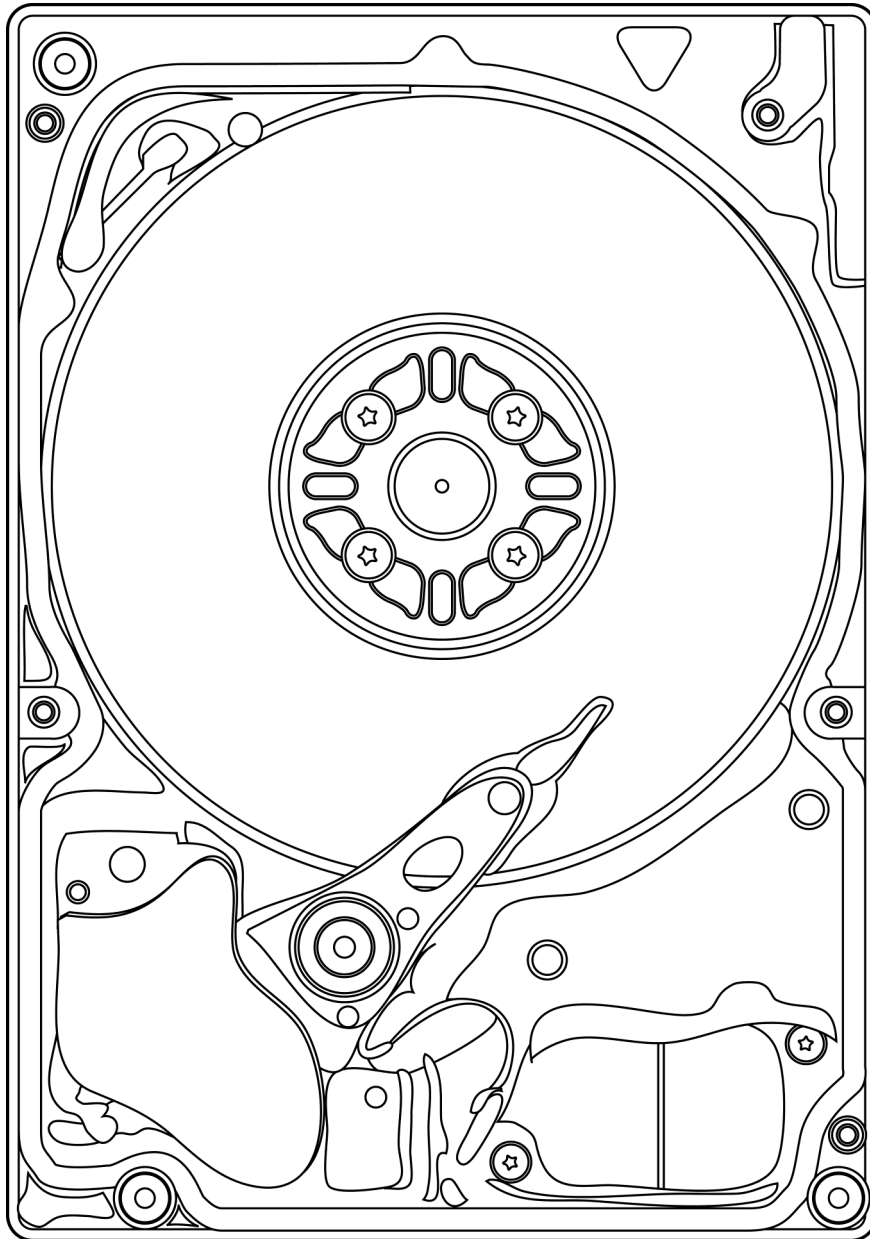
The electromagnet on a hard disk drive is attached to the end of a moving arm. The arm frequently has to move to different sectors and this takes time. By modern standards, hard disk drives are considered to have slow access speeds.

Optical Storage

Beneath the clear plastic surface of an optical disk is a track which varies between bumps and flat sections known as pits and lands. As the disk spins, a laser is shone onto the disk and a sensor is used to detect a reflection from the disk. The lands are reflective, so when the laser hits a land, the laser is reflected back to a sensor. If the laser hits a non-reflective pit, no light is sent back to the sensor. By varying the pits and the lands, 1s and 0s can be coded on a disk.
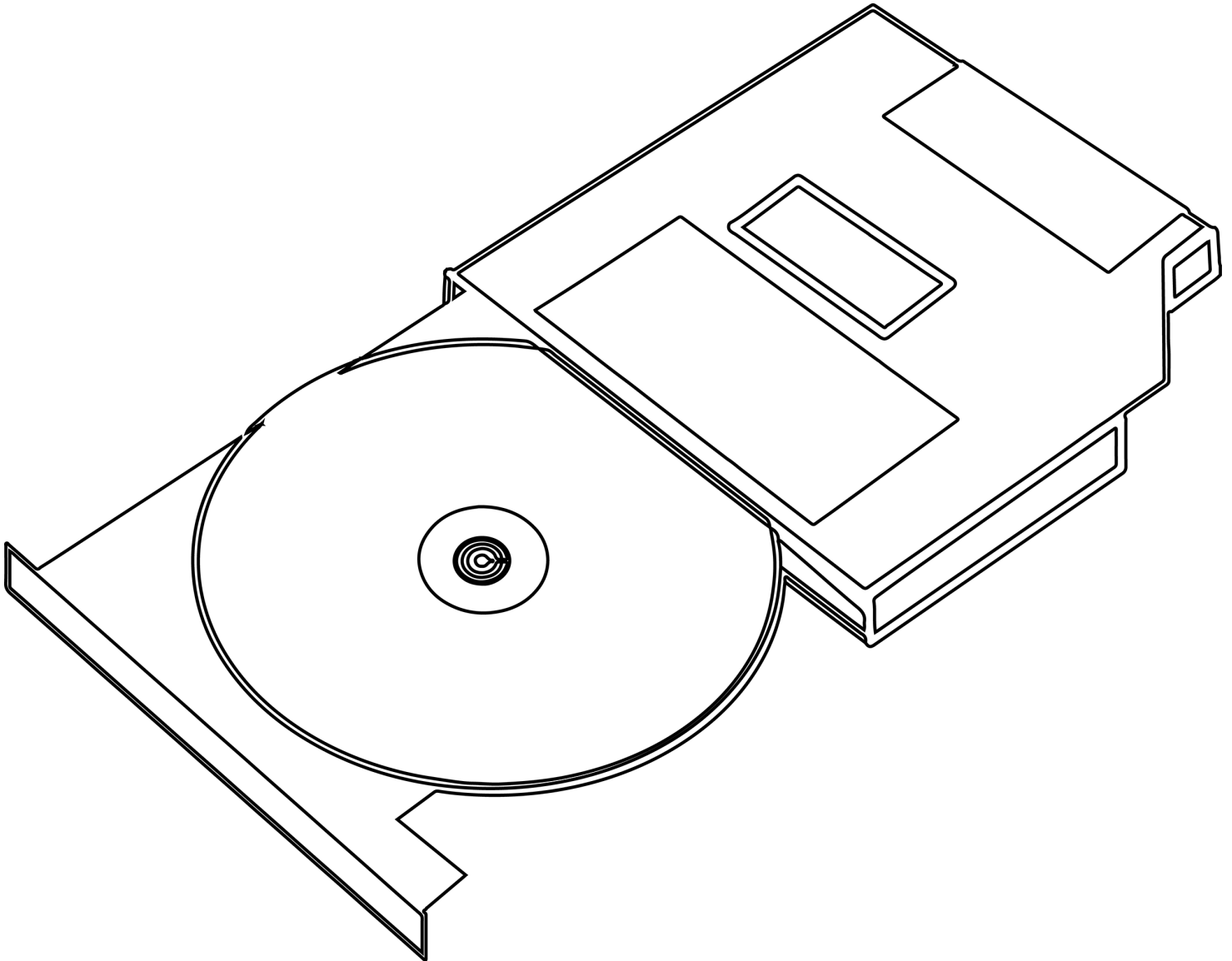
CDs, DVDs and Blu-ray disks are examples of optical storage. Optical storage is cheap and universal - most people have a device that can play CDs and DVDs at home. However, optical disks can get scratched and it is not possible to change the contents on the majority of disks.

Solid State Storage

The Flash memory used in USB sticks, SD cards and solid state drives (SSDs) have no moving parts making them fast and robust. This makes them ideal for storing data in mobile phones, tablets and cameras. Although SSDs are more expensive than hard disk drives, their fast access times are making them more popular in desktop computers too.

SD Card
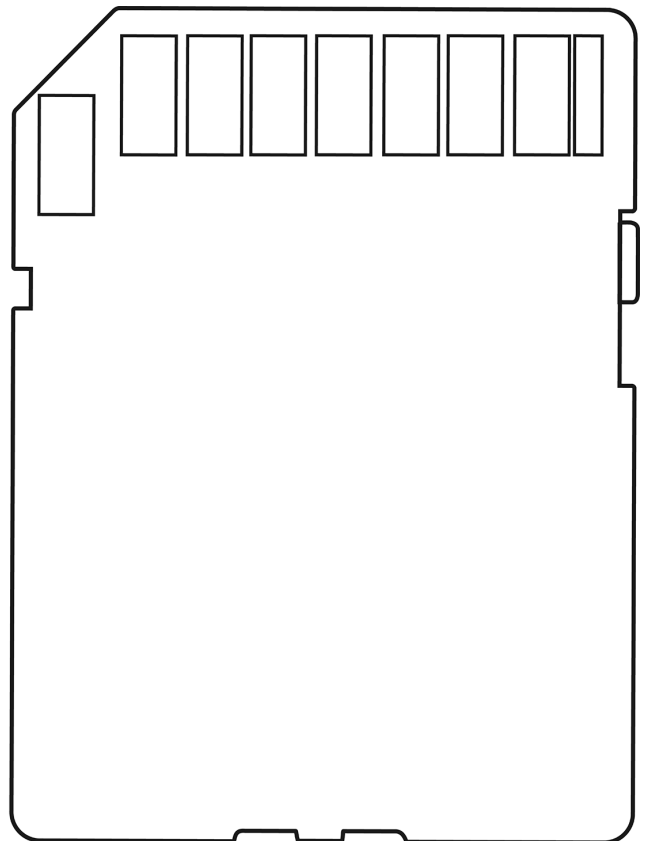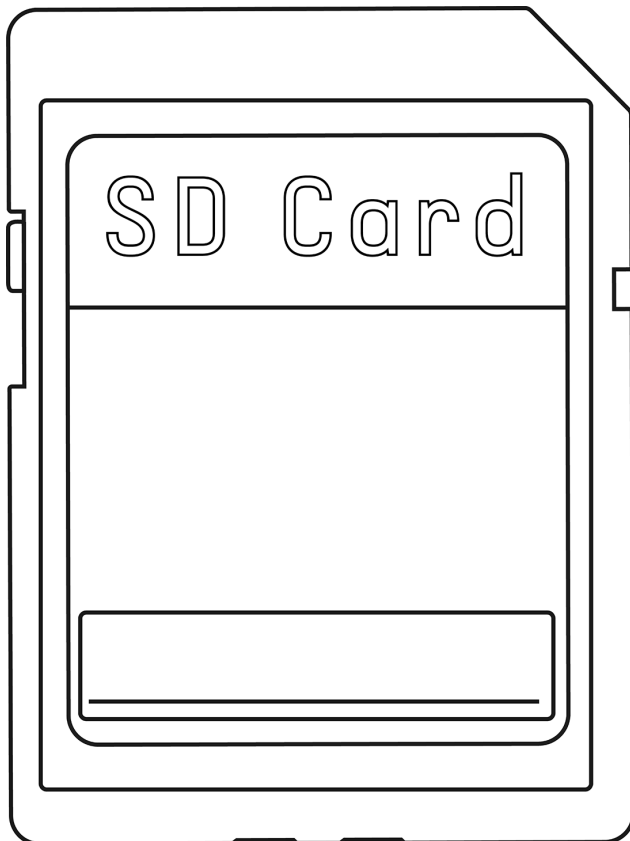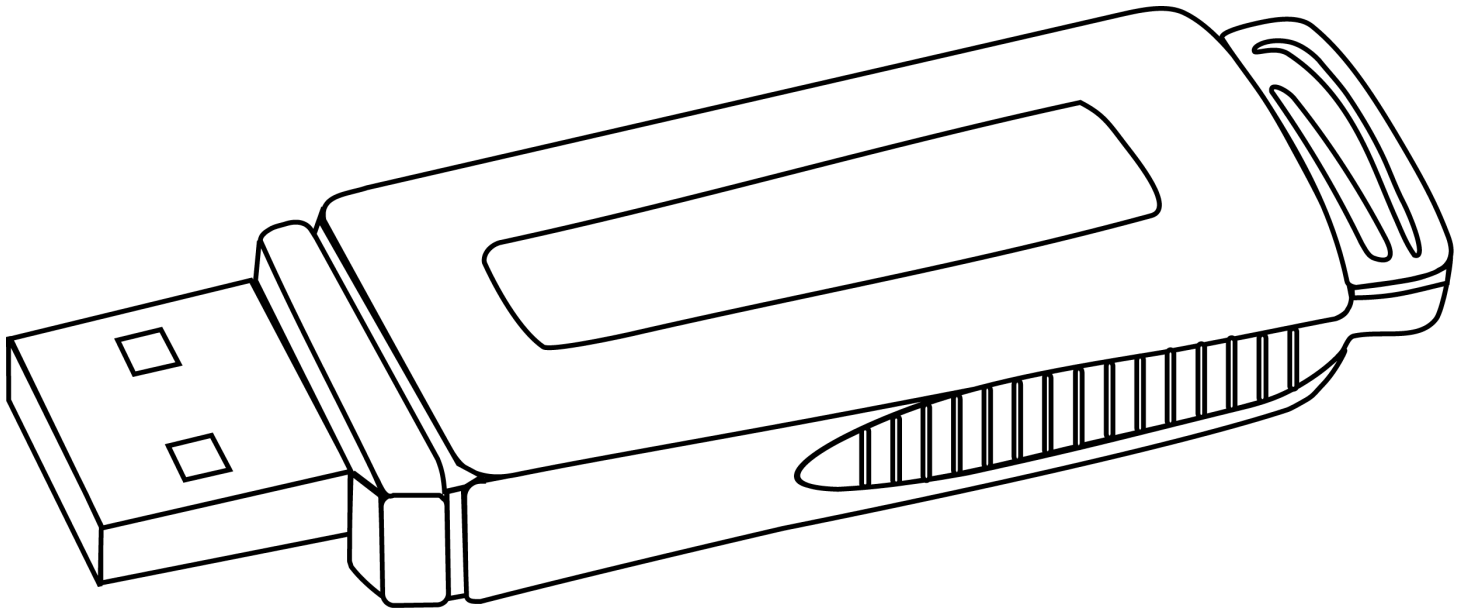
GPS Satellite Navigation

Computer systems can be built into everyday devices such as Satellite Navigation devices, washing machines and digital cameras. Embedded systems only perform a limited number of specific tasks.

GPS

11:58

1 mi left

Baker St.

SW

Satnav 2000
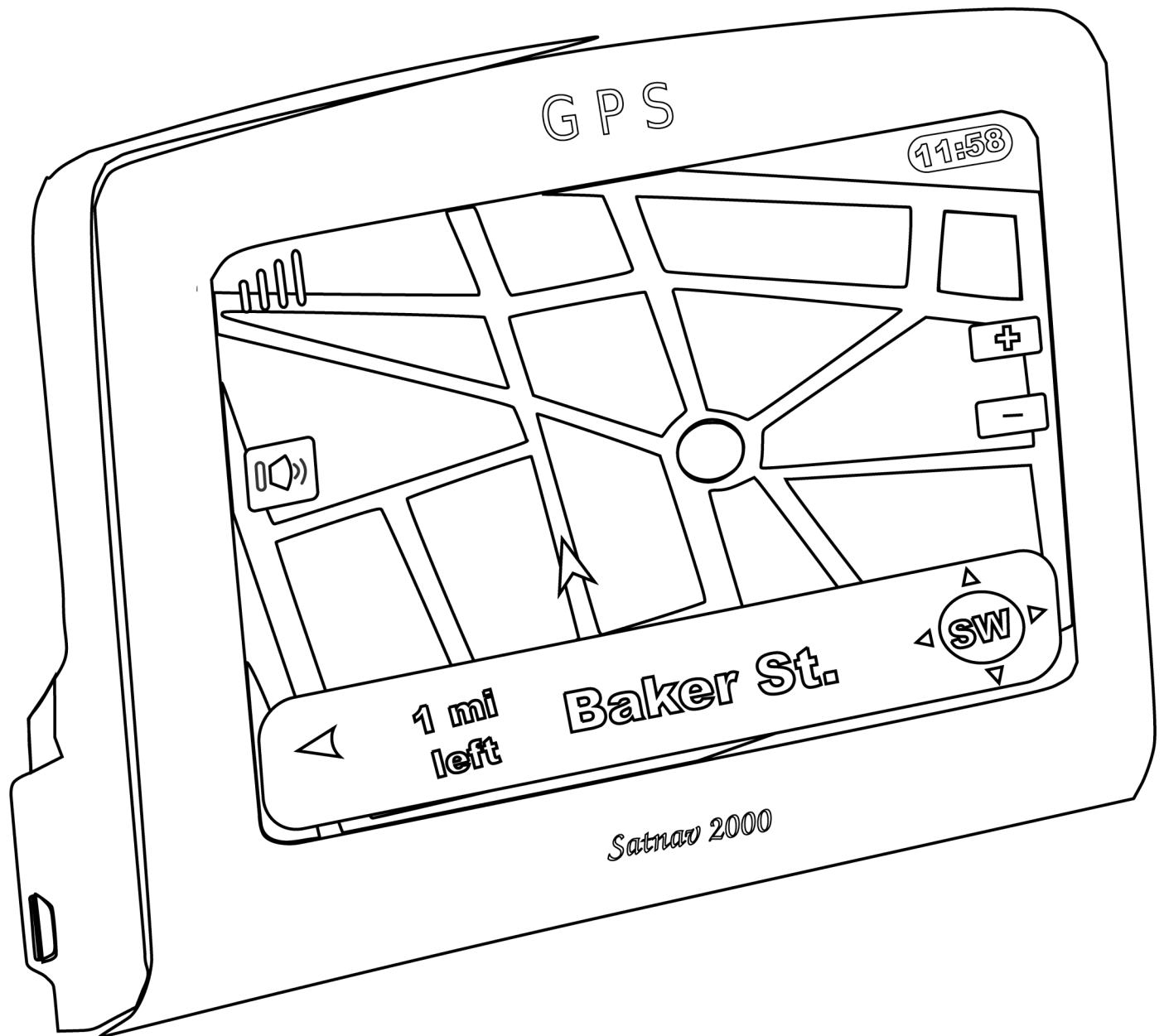
Embedded systems have a single circuit board and the chips such as RAM and the CPU are not designed to be modified or upgraded. The chips are often soldered to the circuit board.

Washing Machine

Unlike general-purpose computer systems, embedded systems are not designed to be modified. The ROM in an embedded system contains special software known as firmware - permanent software which only needs to be changed if a fault develops.

BEST WASH

Synthetics   Cottons
60°   60°
Duo 40°   40°
30°   30°
Shirts 40°   A Class 40°

02:43
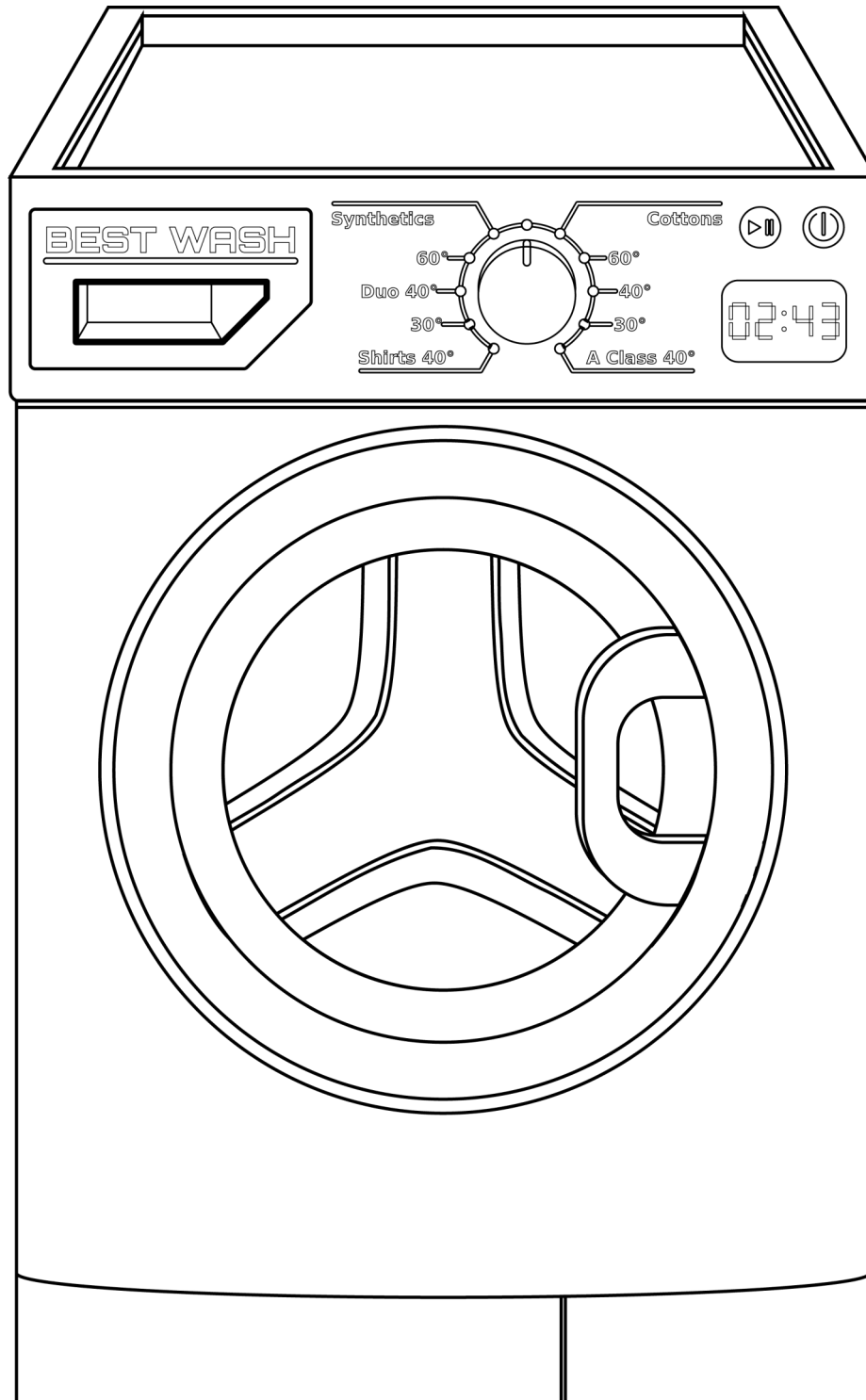
Digital Camera

A digital camera is an embedded system as it only performs a limited number of specific tasks.
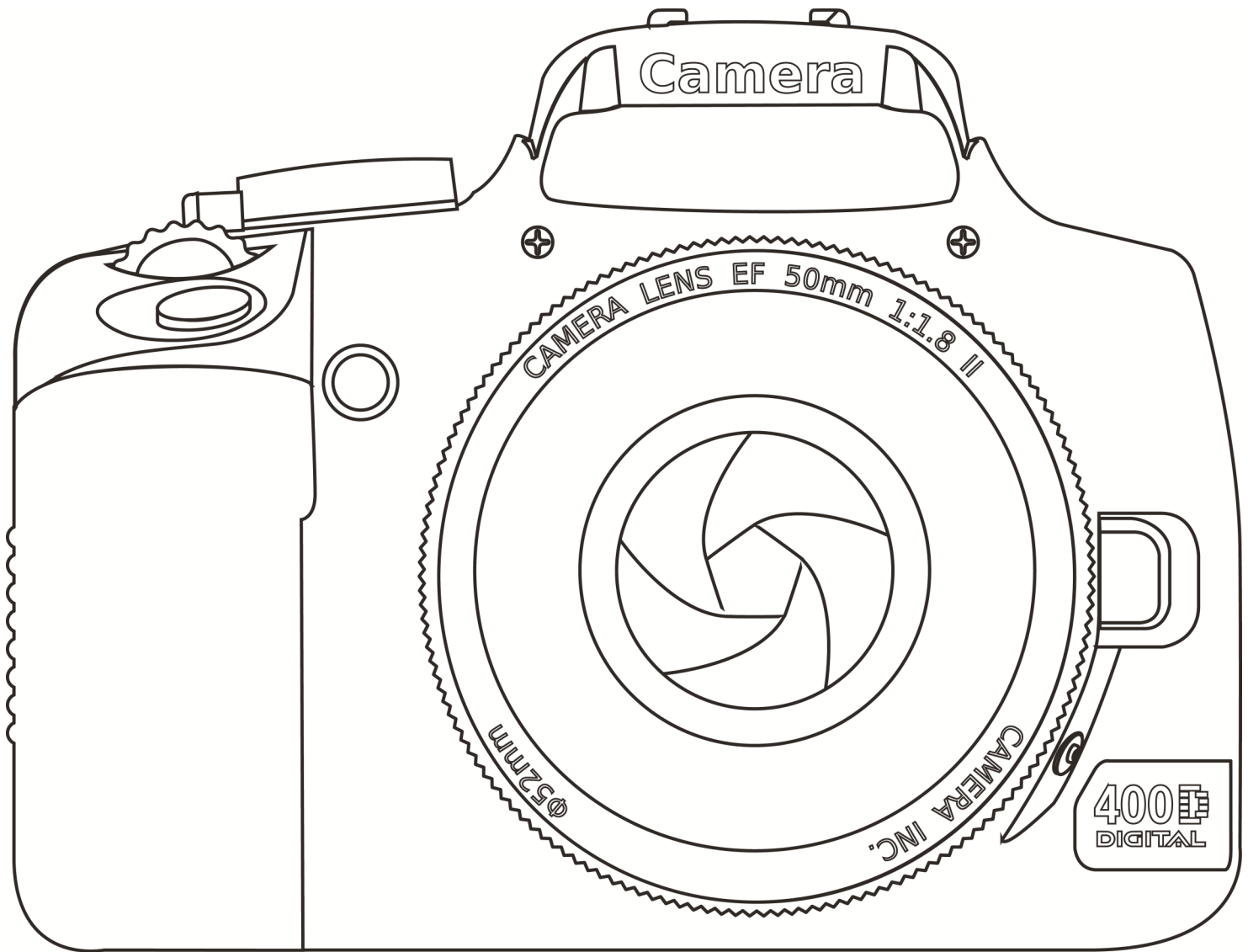
As cameras need to be portable and may need to save lots of video or photo data in a short amount of time, modern digital cameras use solid state storage such as SD cards.

Quiz 1

1) What is the name of the component that processes all the data and instructions stored in a computer's memory?

....

2) What are the two types of main memory in a computer system?

....

3) What is the fastest, most portable and durable type of secondary storage? Hint: It has no moving parts.

....

4) What type of light is used to read optical media such as a DVD or Blu-ray disk?

....

5)The camera on the previous page is an example of an embedded system, can you name another embedded system?

....

Networks

A group of computers connected together is called a network. Most schools and large companies use a network because networks offer many advantages - users can share files, an internet connection and resources such as printers.
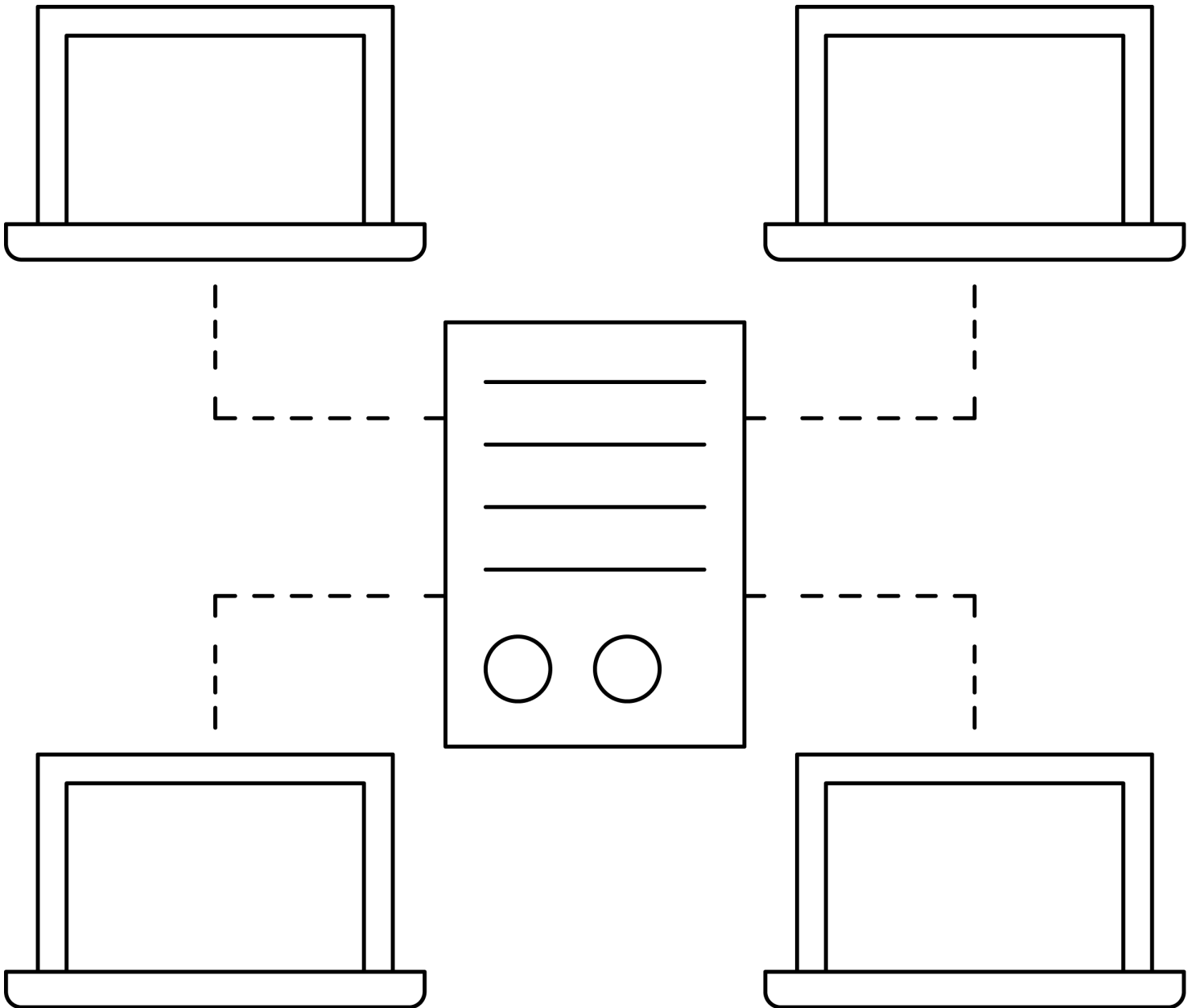
Computers can be connected using wires or wirelessly. Wired networks are faster and more stable. Wireless connections, also known as WIFI networks allow people to move around whilst connected to the network.

The Internet of Things

The Internet itself is a network - the largest network in the world. Sometimes the Internet is referred to as the "cloud". Any services or data storage provided over the Internet can be referred to as "cloud computing".

It is not just desktops, laptops and mobile phones that are connected to the Internet. There are many other devices which can be controlled by their owners through the Internet. Some people have their TV, lights, central heating and air conditioning connected to the Internet. They can then control their household devices through an app on their mobile phone. For example they can heat up their house before they get home. All these devices connected to the Internet are known as the Internet of Things or IOT.

Switch

We can connect several computers together in one building using a switch.
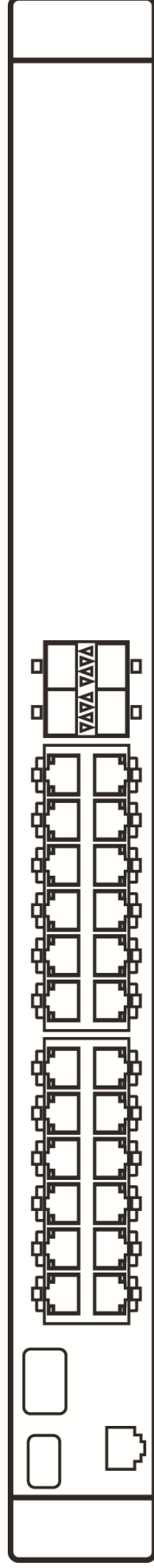
Each computer connects to one of the switch's sockets known as ports. Switches come in different sizes, some switches have 4 ports, others can have 48 ports. If you have more than 48 devices on a network, you can have several switches!

Router

If you want to connect two different networks together, for example your home network and the Internet, you need a router.
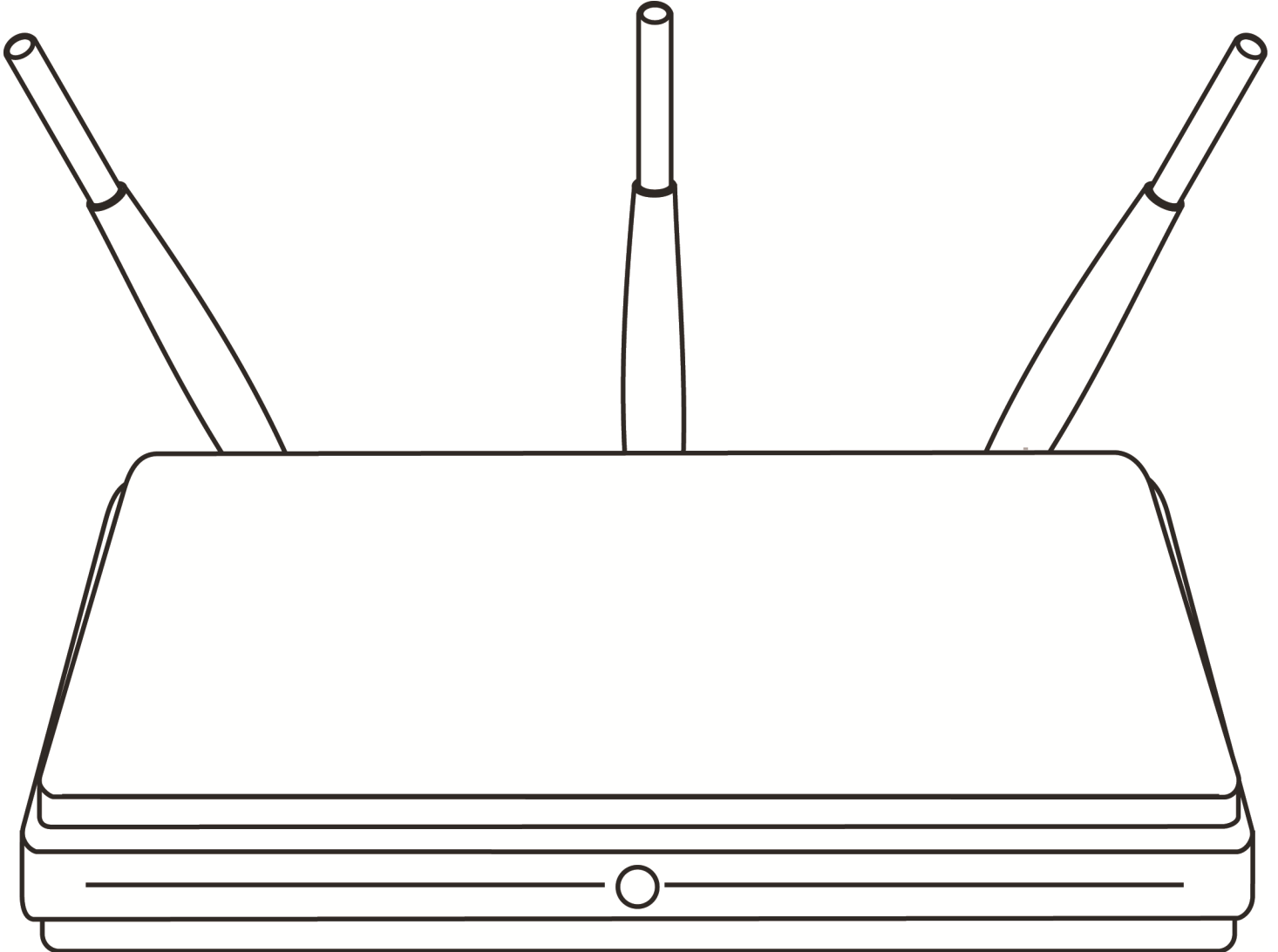
The router shown above is a wireless router. You will probably have one of these at home. The antennae help broadcast the signal in different directions so that you have a good signal throughout your house. Wireless signals can suffer from interference from other wireless devices as well as physical obstacles such as walls.

Server

A server is a dedicated network device which all other computers on a network connect to. The other computers on the network are known as clients and will request services from the server.

Some servers allow you to login to your network and access shared files. Other servers on the Internet store web pages that make up the World Wide Web.
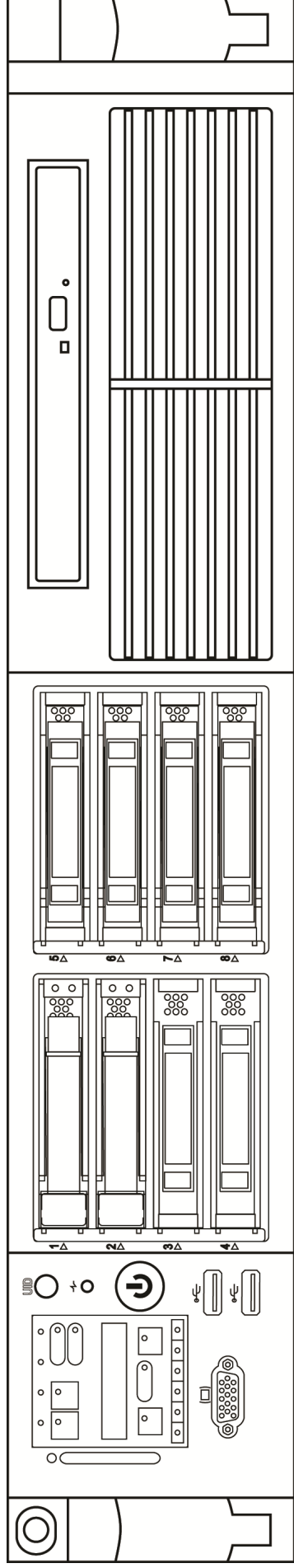
When you type a website address into a web browser on your computer, phone or tablet, it is a web server which eventually receives your request and sends you the web page that you requested.

Quiz 2

1) What is the name of the device used to connect computers together on small network?

....

2) What is the largest network in the world called?

....

3) What is the name of the device used to store web pages on the World Wide Web?

....

4) To connect two different networks, what device do you need to use?

....

5) Name an item connected to the Internet of Things?

....
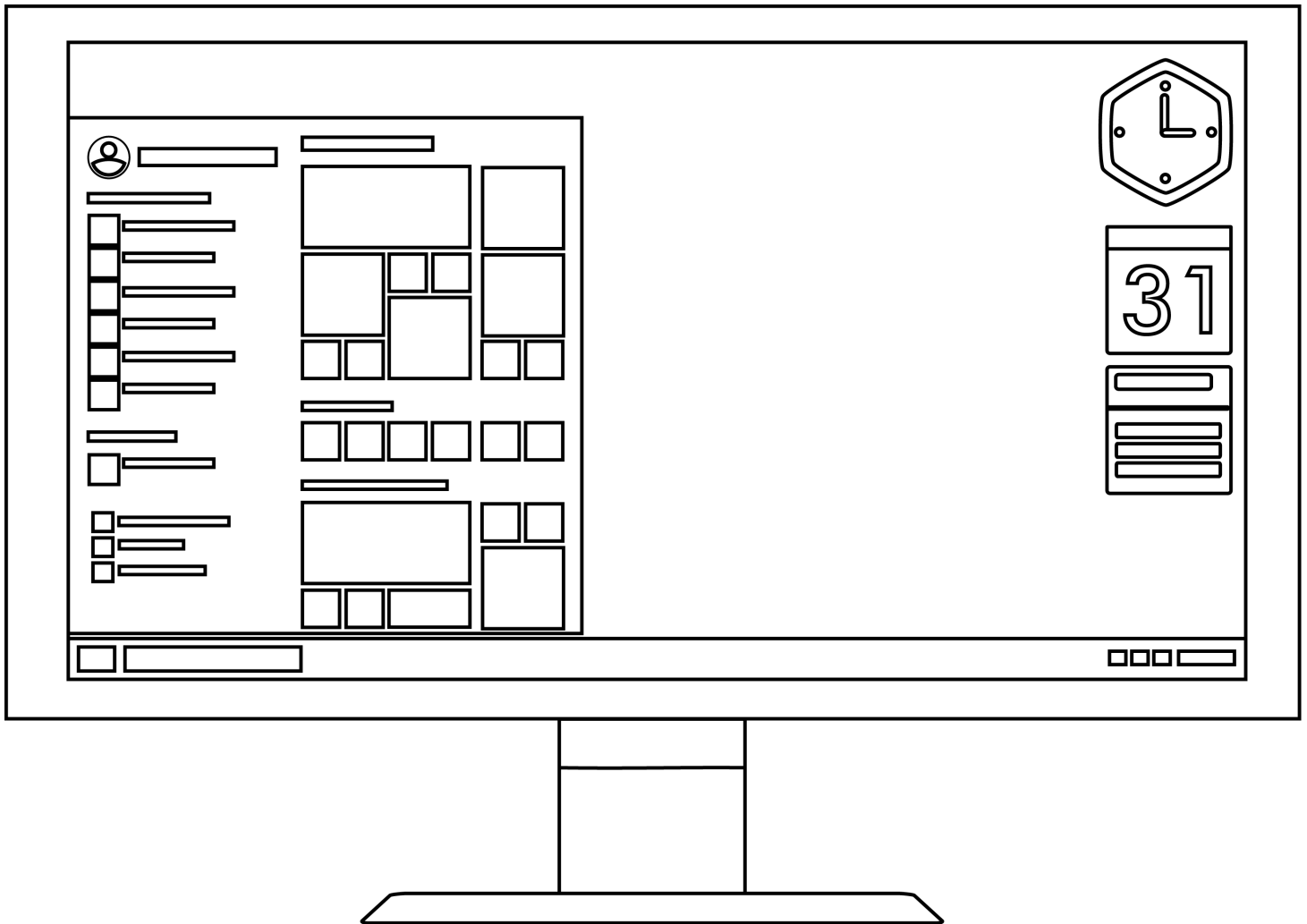
Operating System

Hardware is any component that we can touch and feel. All of the previous images have been hardware; the CPU, RAM and ROM are all examples of hardware.

Computers are incredible because humans can tell computers what to do. We do this through software. One of the most important pieces of software, which every computer system needs to run is called the operating system.


The operating system manages the memory and all the other hardware that is connected to your computer. Most modern computers allow a human to interact with the computer using a Graphical User Interface (GUI) which has windows, icons, menus and pointers. Desktop PCs run an operating system called Microsoft Windows or Linux. Apple also have their own operating system called MacOS.

Utilities

The operating system is one form of system software, another group of system software are known as utilities. These are used to maintain or improve the performance of a computer. An example of a utility is anti-virus software designed to scan for and then delete or quarantine computer viruses. Other examples include backup software, which can be used to make a copy of your computer system and your files.
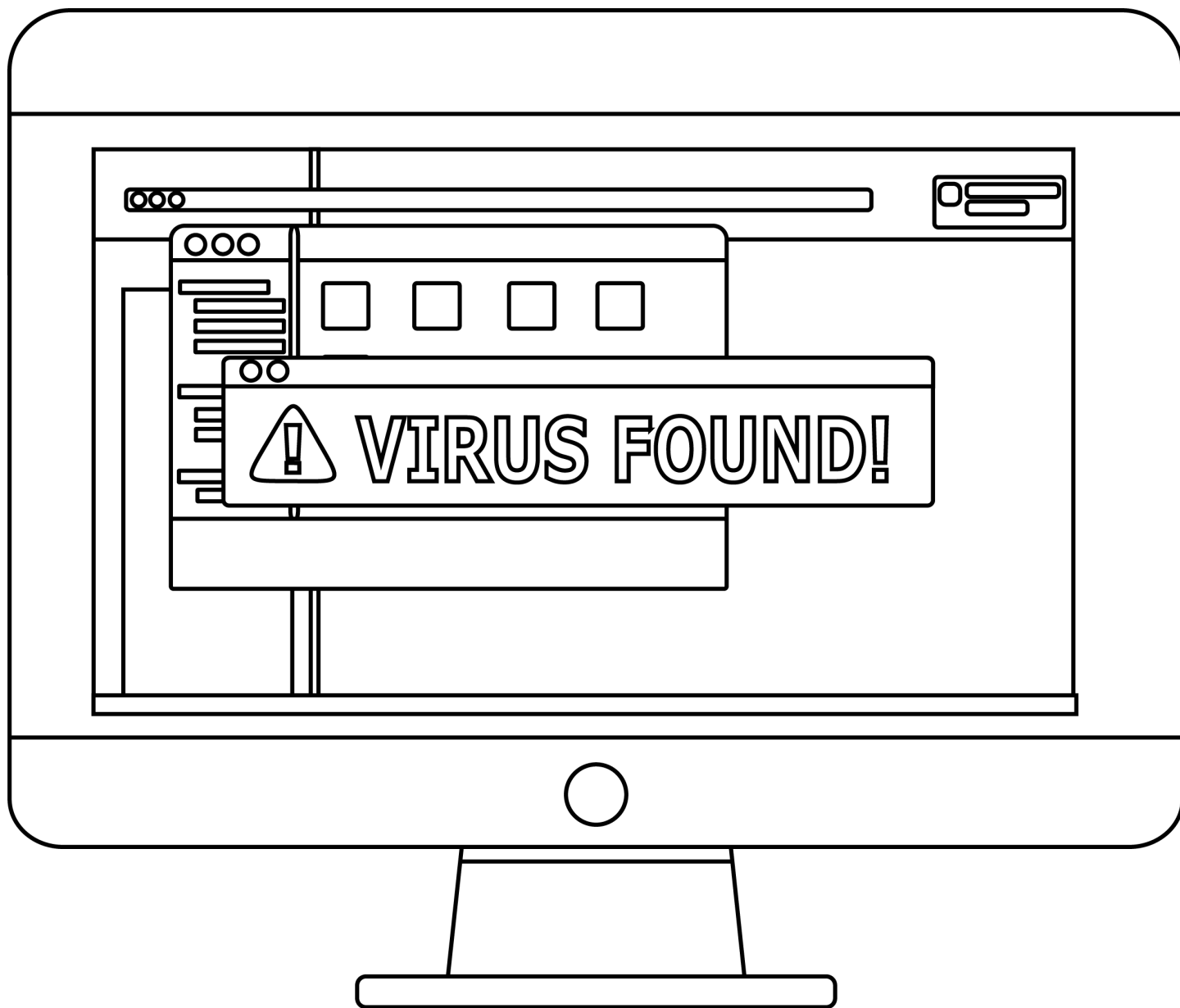
You can avoid downloading viruses by only going on trustworthy websites. Viruses can also come attached to emails so do not download files from unknown senders.

Application Software

Computers can perform many jobs. For common tasks, such as writing letters, sending email, browsing the web and doing calculations, computer scientists have made applications. These are also known as apps. Every app performs a different task.
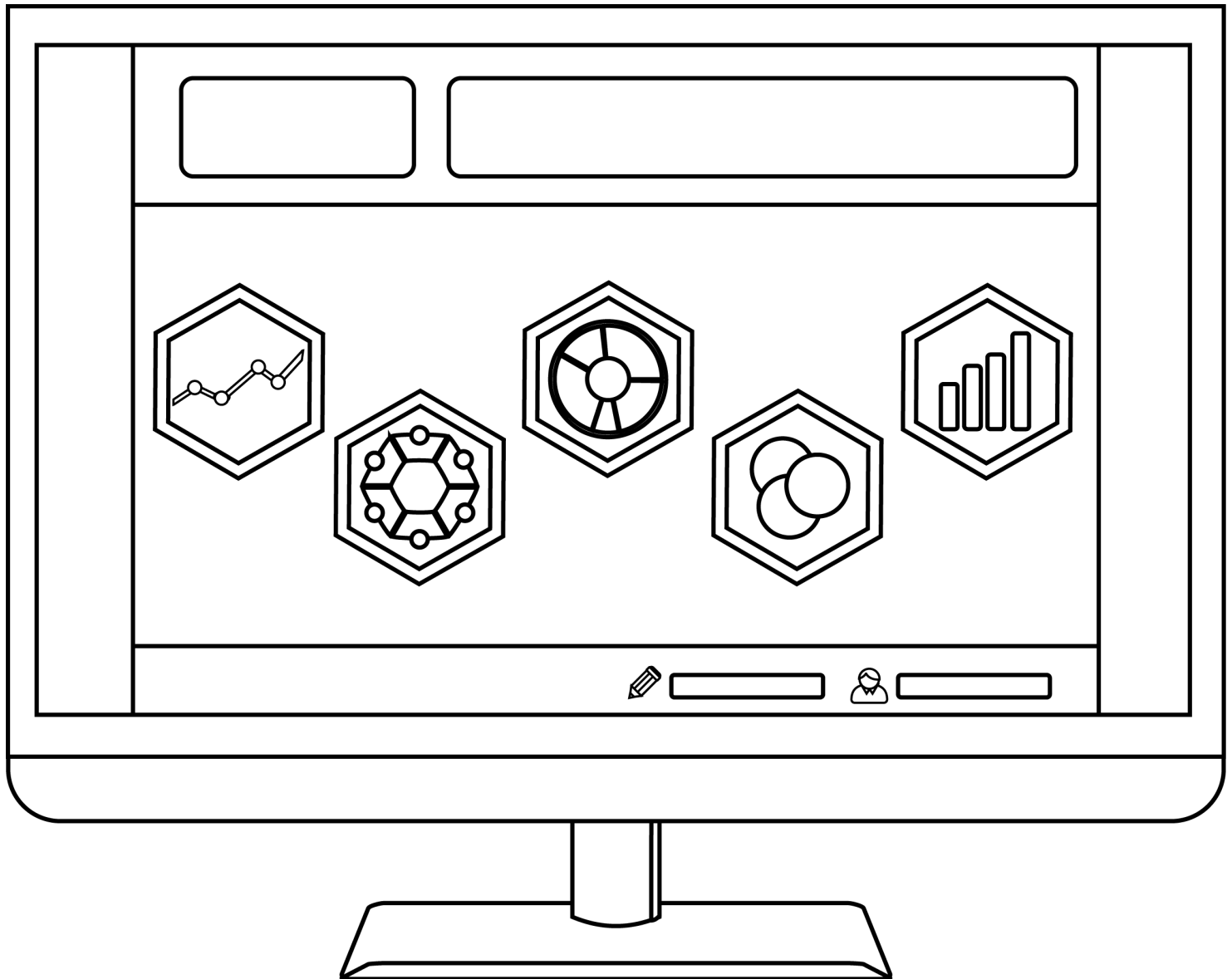
Application Software

This book was made using several different pieces of application software - illustration software, desktop publishing software and a web browser. The image below shows the illustration software that I used to outline most of the images in this book.
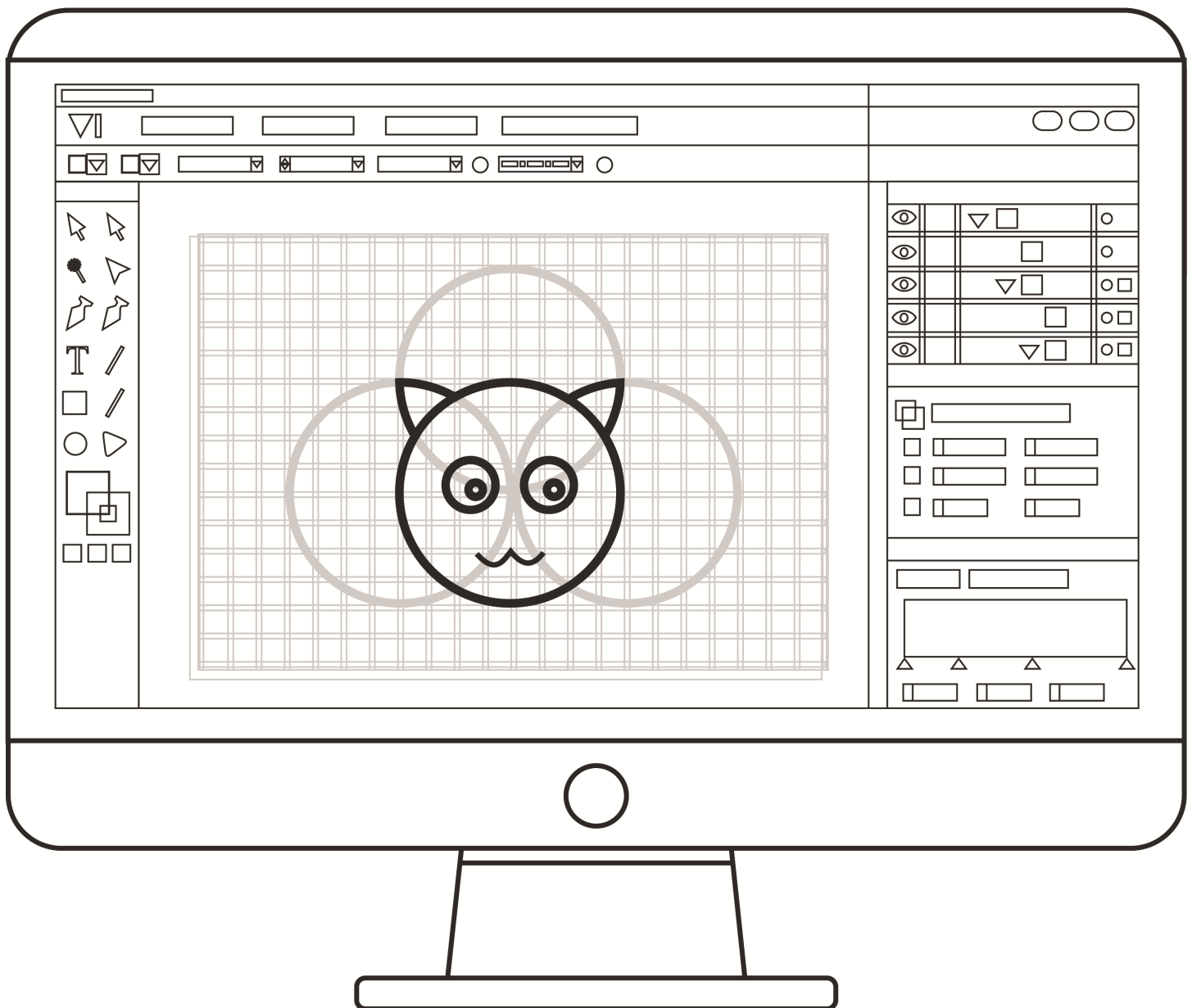
Many of the images in this book come from websites such as pixabay.com . Pixabay uses a Creative Commons (CCO) license which allows creative people to use the images from their website without having to pay a fee. To create this colouring book, I manually outlined and filled in all the shapes in the images.

Flowcharts

To write software, we need to have a clear idea of the problem we want to solve. Once we have an idea of what the problem is, we need to formulate a solution. For many problems, we can write an algorithm - a series of steps that are used to solve a specific problem.

Some people like to think of algorithms like the recipes you follow when you are baking a cake. There are a few ways that we can represent these algorithms, the simplest of these is using flowcharts. The flowchart has a series of boxes connected by arrows to show what happens next. Each shape has a different role:
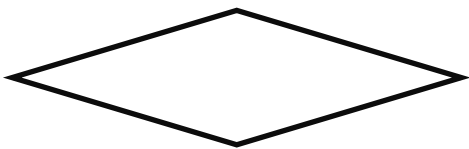
Rounded rectangles are used at the start and end of algorithms.

Parallelograms are used to input data into an algorithm or to output data. Most programs have inputs and outputs.

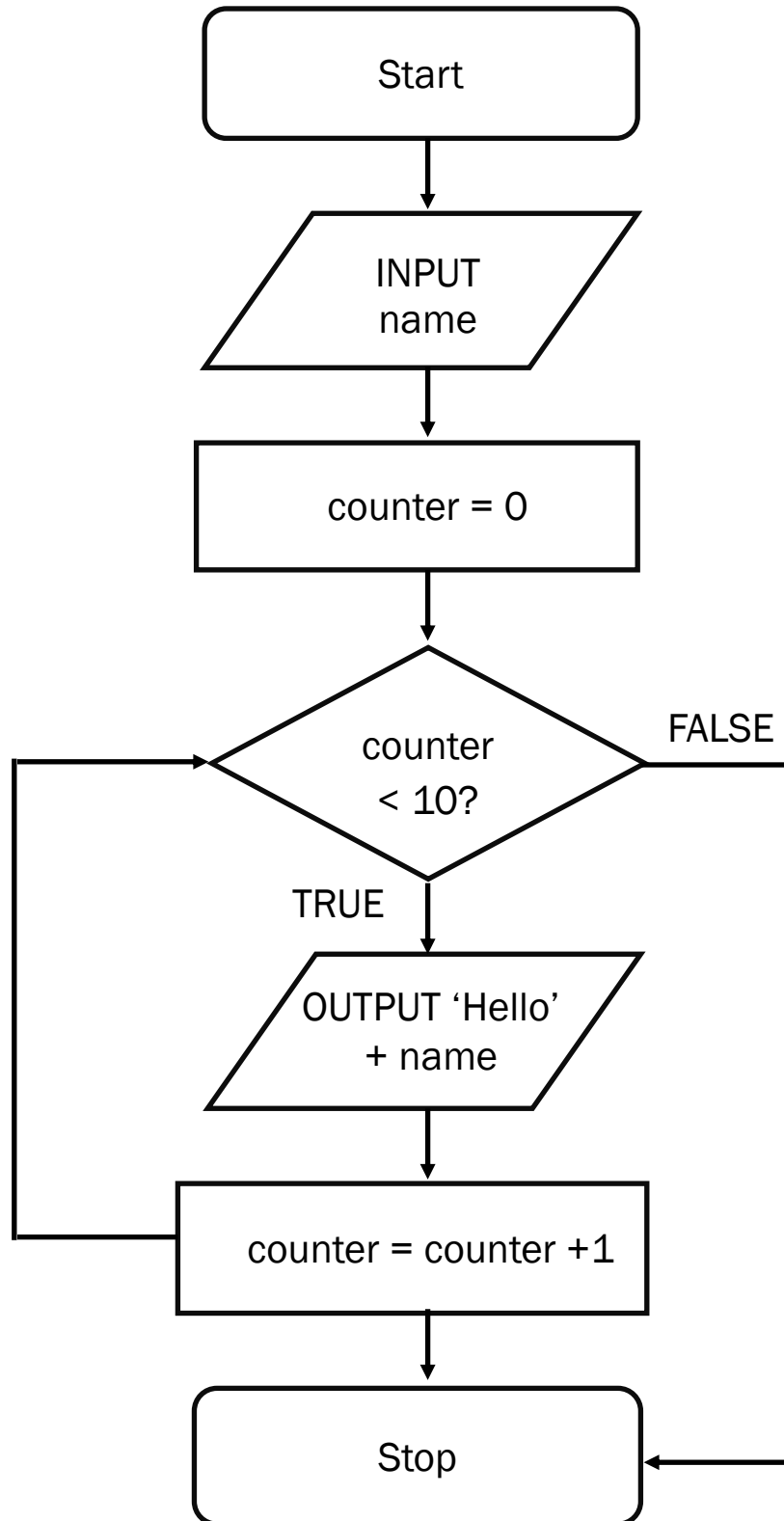Rectangles are used for processes such as calculations.

Diamonds are used for decisions. Most programs will have decisions. Someone travelling on a train might enter their age when buying a ticket and based on their age, the price will change. Here the computer has made a decision or a selection.
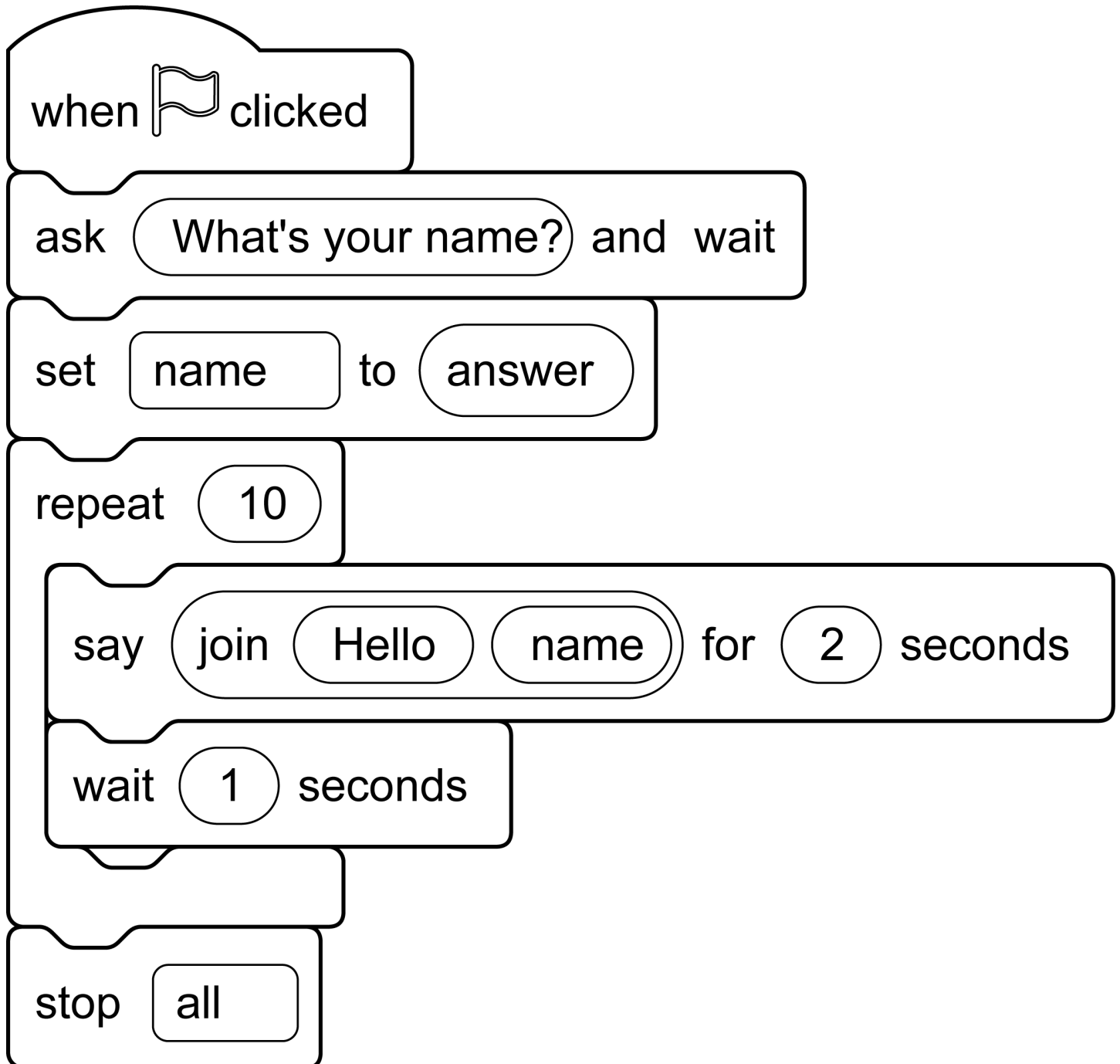
Flowcharts

Here is a simple flowchart. It asks for a person's name and then says Hello to them ten times.

```
                    ┌─────────────────┐
                    │      Start       │
                    └─────────────────┘
                             │
                             ▼
                      ╱─────────────╲
                     ╱   INPUT        ╲
                     ╲   name         ╱
                      ╲─────────────╱
                             │
                             ▼
                    ┌─────────────────┐
                    │   counter = 0    │
                    └─────────────────┘
                             │
                             ▼
                      ◇─────────────◇
                     ╱   counter      ╲        FALSE
                     ╲   < 10?        ╱
                      ◇─────────────◇
                        TRUE │
                             ▼
                      ╱─────────────╲
                     ╱ OUTPUT 'Hello' ╲
                     ╲   + name        ╱
                      ╲─────────────╱
                             │
                             ▼
                    ┌─────────────────┐
                    │ counter = counter +1 │
                    └─────────────────┘
                             │
                             ▼
                    ┌─────────────────┐
                    │      Stop        │
                    └─────────────────┘
```

Programming: Blocks

When you first learn to write their own programs, you are likely to encounter block-based languages. Examples include Scratch and Blockly. Here is the previous algorithm written out using blocks:

```
when 🏳 clicked
ask ( What's your name? ) and wait
set [ name ] to ( answer )
repeat ( 10 )
    say ( join ( Hello ) ( name ) ) for ( 2 ) seconds
    wait ( 1 ) seconds
stop [ all ]
```

Programming: Text

As you begin to understand how programs work and how a computer uses logic to make decisions and follow instructions, you will progress on to text-based programming.

Writing large programs using blocks can become cumbersome as there will be lots of blocks to drag and drop into place. Writing programs with text means you can write large programs much quicker. The previous program can be written in python using the three lines of code shown at the bottom of the page.

Programmers use special tools to write their programs called Integrated Development Environments (IDEs). IDEs have their own way of colouring in different words (syntax highlighting) so that the words stand out and are easier to read and understand. It is the same as using different shapes in a flowchart for different roles.

To mimic an IDE's syntax highlighting, you could choose four different colours and colour in the following words according to their grouping:

Group 1 functions: input, range, print.
Group 2 keywords: for, in.
Group 3 strings: The inverted commas ' ' and the text contained within them.
Group 4: All other text.

```python
name = input('What is your name?')
for count in range(10):
    print('hello', name)
```

This program is written using a language called Python. It is simple, yet powerful. You can learn Python at www.pythonschool.net . There are also further recommendations at the back of this book.

Quiz 3

1) What piece of software does every computer system need in order to run?

....

2) Give an example of a piece of utility software?

....

3) A word processor, internet browser and illustration software are all examples of what type of software?

....

4) In a flowchart, what is a parallelogram used for?

....

5) Programmers use a special piece of software to write their programs. What is this software called?

....

Binary Numbers

Throughout this book, we have emphasised that computers process all their instructions in binary i.e. 1s and 0s. The following pages will look at how we can represent any data in binary, including numbers, text and images.

Binary is quite easy to understand once we think more closely about the numbers that we use in everyday life. The number system we use is called denary or decimal. Starting on the right, each column increases by a factor of 10.

100	10	1
9	3	1

So the number 931 can be read from right to left as one 1, three 10s and nine 100s. If you add these together you get the number nine hundred and thirty one.

With binary, the columns increase by a factor of 2. The prefix "bi" means "two" and you will see this in words such as binoculars, bicycle, bicep-all involve two objects: two sets of lenses, two wheels and two muscles. Binary also only has two states 1 and 0.

8	4	2	1
1	0	1	1

So we can write the binary number 1011 and using the same method as we used previously, this means we have one 1, one 2, zero 4s and one 8. If we add these together, this gives us eleven. 1011 in binary is 11 in denary!

Binary Numbers

Here is a table of the first 16 numbers in binary from 0 to 15. A 1 can be seen as on and a 0 as off i.e. if a number is a 0, you do not count that column at all:

	8	4	2	1
0	0	0	0	0
1	0	0	0	1
2	0	0	1	0
3	0	0	1	1
4	0	1	0	0
5	0	1	0	1
6	0	1	1	0
7	0	1	1	1
8	1	0	0	0
9	1	0	0	1
10	1	0	1	0
11	1	0	1	1
12	1	1	0	0
13	1	1	0	1
14	1	1	1	0
15	1	1	1	1

Use the first column in the table on the left to write down what the values of these denary numbers are in binary:

6:_____0110_____

10:_____

13:_____

15:_____

What would these binary numbers be in denary? Try to remember the place values for each column, then check your answer on the left:

0011:_____3_____

0101:_____

1110:_____

0111:_____

Characters

Characters and therefore any text (string of characters) can also be represented using binary. One way of representing text is with the following "extended ASCII" binary codes for each character:

A	B	C	D	E	F	G
01000001	1000010	1000011	1000100	1000101	1000110	1000111
H	I	J	K	L	M	N
1001000	1001001	1001010	1001011	1001100	1001101	1001110
O	P	Q	R	S	T	U
1001111	1010000	1010001	1010010	1010011	1010100	1010101
V	W	X	Y	Z		
1010110	1010111	1011000	1011001	1011010		

Why not colour in the characters for your name or your favourite animal, then write the binary value here:

What is the binary for the word: HELLO

H	E	L	L	O

Images

Representing images using binary codes is one of the most beautiful ways of visualising how a computer stores its data. Images which are made using dots) (pixels) are also referred to as raster or bitmap images. All images taken with a camera use pixels.

Using only 1-bit and the values 1 and 0, we can colour in the grid below. I would suggest that you leave the 0s uncoloured. Then pick one colour to colour in all the squares (pixels) with 1s inside. There are three different images hidden in the grids below.

0	0	0	0	0	0	0	0	0	0	0	0	0
0	0	1	1	1	0	0	0	1	1	1	0	0
0	1	1	1	1	1	0	1	1	1	1	1	0
0	1	1	1	1	1	1	1	1	1	1	1	0
0	0	1	1	1	1	1	1	1	1	1	0	0
0	0	0	1	1	1	1	1	1	1	0	0	0
0	0	0	0	1	1	1	1	1	0	0	0	0
0	0	0	0	0	1	1	1	0	0	0	0	0
0	0	0	0	0	0	1	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0	0	0	0	0

0	0	0	1	0	0	0	0	0	0	1	0	0
0	0	0	0	1	0	0	0	0	1	0	0	0
0	0	0	1	1	1	1	1	1	1	1	0	0
0	0	1	1	0	1	1	1	1	0	1	1	0
0	1	1	1	1	1	1	1	1	1	1	1	1
0	1	0	1	1	1	1	1	1	1	1	0	1
0	1	0	1	0	0	0	0	0	0	1	0	1
0	0	0	0	1	1	0	0	1	1	0	0	0
0	0	0	0	0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0	0	0	0	0

0	0	0	0	0	0	0	0	0	0	0	0	0
0	0	0	1	0	0	0	0	0	1	0	0	0
0	0	0	0	1	0	0	0	1	0	0	0	0
0	0	0	1	1	1	1	1	1	1	0	0	0
0	0	1	1	1	0	1	0	1	1	1	0	0
0	1	1	1	1	1	1	1	1	1	1	1	0
0	1	0	1	1	1	1	1	1	1	0	1	0
0	1	0	1	1	1	1	1	1	1	0	1	0
0	0	0	0	0	1	0	1	0	0	0	0	0
0	0	0	0	1	1	0	1	1	0	0	0	0

You will realise by the end that there are so many possibilities if we could increase the number of colours that can be represented. This is covered in the following pages.

Images

When we could only have one number in each pixel, we could only have two possible colours throughout our entire image. If we want to increase the number of colours, we can increase the "colour depth" by using more digits. If we use two digits, this would give us four possible colours. You can pick two of your own colours for the codes below:

00	Black
01	
10	
11	White

Now colour in the grids below using the colours from the table above.

11	11	11	11	11	11	11	11	11	11	11	11
11	11	11	11	11	01	01	11	11	11	11	11
11	11	01	01	11	01	01	11	01	01	11	11
11	11	01	01	01	01	01	01	01	01	11	11
11	11	11	01	01	01	01	01	01	11	11	11
11	01	01	01	01	10	10	01	01	01	01	11
11	01	01	01	01	10	10	01	01	01	01	11
11	11	11	01	01	01	01	01	01	11	11	11
11	11	01	01	01	01	01	01	01	01	11	11
11	11	01	01	11	01	01	11	01	01	11	11
11	11	11	11	11	01	01	11	11	11	11	11
11	11	11	11	11	11	11	11	11	11	11	11

11	01	11	11	11	11	11	11	11	01	11
11	01	01	11	11	11	11	11	01	01	11
11	11	01	01	11	11	11	01	01	11	11
11	11	11	01	01	11	01	01	11	11	11
11	11	11	11	01	11	01	11	11	11	11
11	01	01	01	01	01	01	01	01	01	11
11	01	10	10	10	10	10	10	10	01	11
01	01	10	10	10	10	10	10	10	01	01
01	01	10	00	10	10	10	00	10	01	01
11	01	10	00	10	10	10	00	10	01	11
11	01	10	10	10	10	10	10	10	01	11
11	01	01	01	01	01	01	01	01	01	11
11	11	11	01	10	10	10	01	11	11	11
11	11	11	01	10	10	10	01	11	11	11
11	11	11	01	01	01	01	01	11	11	11
11	11	11	11	01	11	01	11	11	11	11
11	11	11	11	01	11	01	11	11	11	11

Images

To demonstrate what is possible with by increasing the colour depth to 3-bits, fill in the table below which has the potential to represent 8 different colours.

000	Black
001	
010	
011	

100	
101	
110	
111	White

111	111	111	111	111	111	111	111	111	000	111	111	111	111	111	111	111	111	111
111	111	111	111	111	111	111	111	000	001	000	111	111	111	111	111	111	111	111
111	111	111	111	111	111	111	000	001	001	010	000	111	111	111	111	111	111	111
111	111	111	111	111	111	111	000	001	010	010	000	111	111	111	111	111	111	111
111	111	111	111	111	111	000	001	010	010	011	011	000	111	111	111	111	111	111
111	111	111	111	111	111	000	010	010	010	011	011	000	111	111	111	111	111	111
000	000	000	000	000	000	010	010	010	011	011	011	100	000	000	000	000	000	000
000	001	001	001	001	010	010	000	011	011	011	000	100	100	100	101	101	110	000
111	000	001	001	010	010	010	000	011	011	011	000	100	100	101	101	110	000	111
111	111	000	010	010	010	011	000	011	100	100	000	100	101	101	110	000	111	111
111	111	111	000	010	011	011	011	100	100	100	101	101	101	110	000	111	111	111
111	111	111	111	000	011	011	100	100	100	101	101	110	110	000	111	111	111	111
111	111	111	111	000	011	100	100	100	101	101	110	110	110	000	111	111	111	111
111	111	111	000	011	100	100	100	000	000	000	110	110	110	111	000	111	111	111
111	111	000	000	100	100	000	000	111	111	111	000	000	111	111	000	000	111	111
111	111	000	100	100	000	111	111	111	111	111	111	111	000	111	111	000	111	111
111	111	000	000	000	111	111	111	111	111	111	111	111	111	000	000	000	111	111

Quiz 4

1) Computers generally process data in a series of 0s and 1s. What is this number system known as?

....

2) What would the binary number 0010 be in denary?

....

3) What would the denary number 13 be in binary?

....

4) How many colours can be represented with a 2-bit colour depth?

....

5) If you only want to represent two colours, how many bits would you need?

....

Graphics Tablet

Computer science is meant to make our lives easier and better. For example computer scientists have invented various tools to help us in the work place. One of these tools is the graphics tablet. A graphics tablet is an input device that enables animators, graphic designers and architects to create digital drawings.
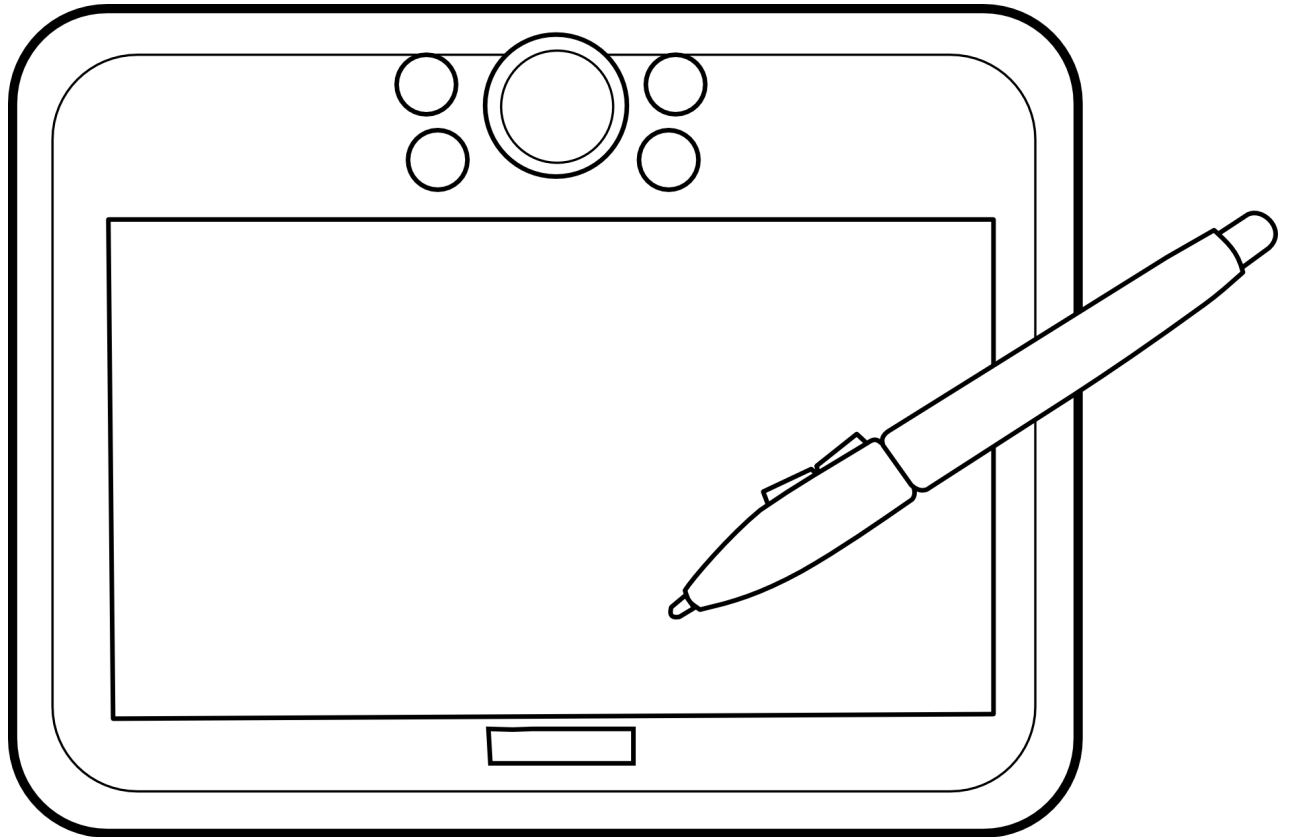
The drawings created with the stylus (pen) on a graphics tablet are far more accurate than those that could be drawn using a mouse.

VR Headset

VR Headsets are often seen as a device used by gamers. However engineers can also use these in augmented reality environments to help with training and solving problems in the real world.
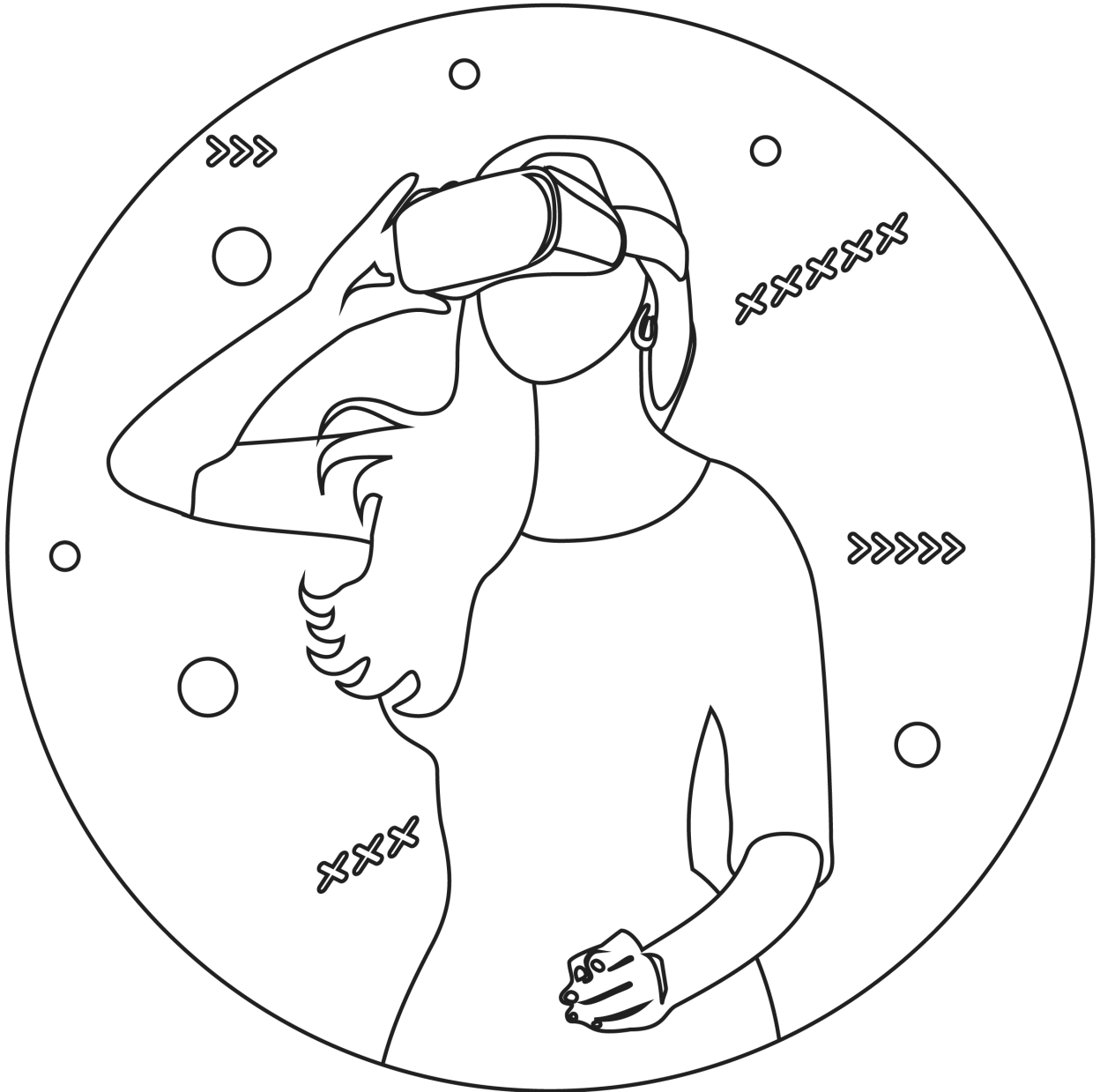
VR is also used in advertising and artist installations. An extreme and somewhat controversial use of VR was recently reported amongst cows. Researchers from The Netherlands and Scotland found that calm cows produce more milk. As a result, Moscow's Ministry of Agriculture and Food developed a VR headset for cows, so that in the winter, the cows see summer fields in their headsets instead of the bleak wintry ones that they are stood in!

3D Printer

Traditional printers let you print onto flat surfaces such as paper. 3D printers allow you to print almost any 3D shape by building up a 3D object in layers from bottom to top.

Imagine stacking different-sized rings on top of each other and the different shapes that you could create with this. Imagine if these shapes were not all round, but any shape. As these layers are stacked on top of each other, any 3D shape could be printed. You can print replacement parts for toys, jewellery, art and even clothing.
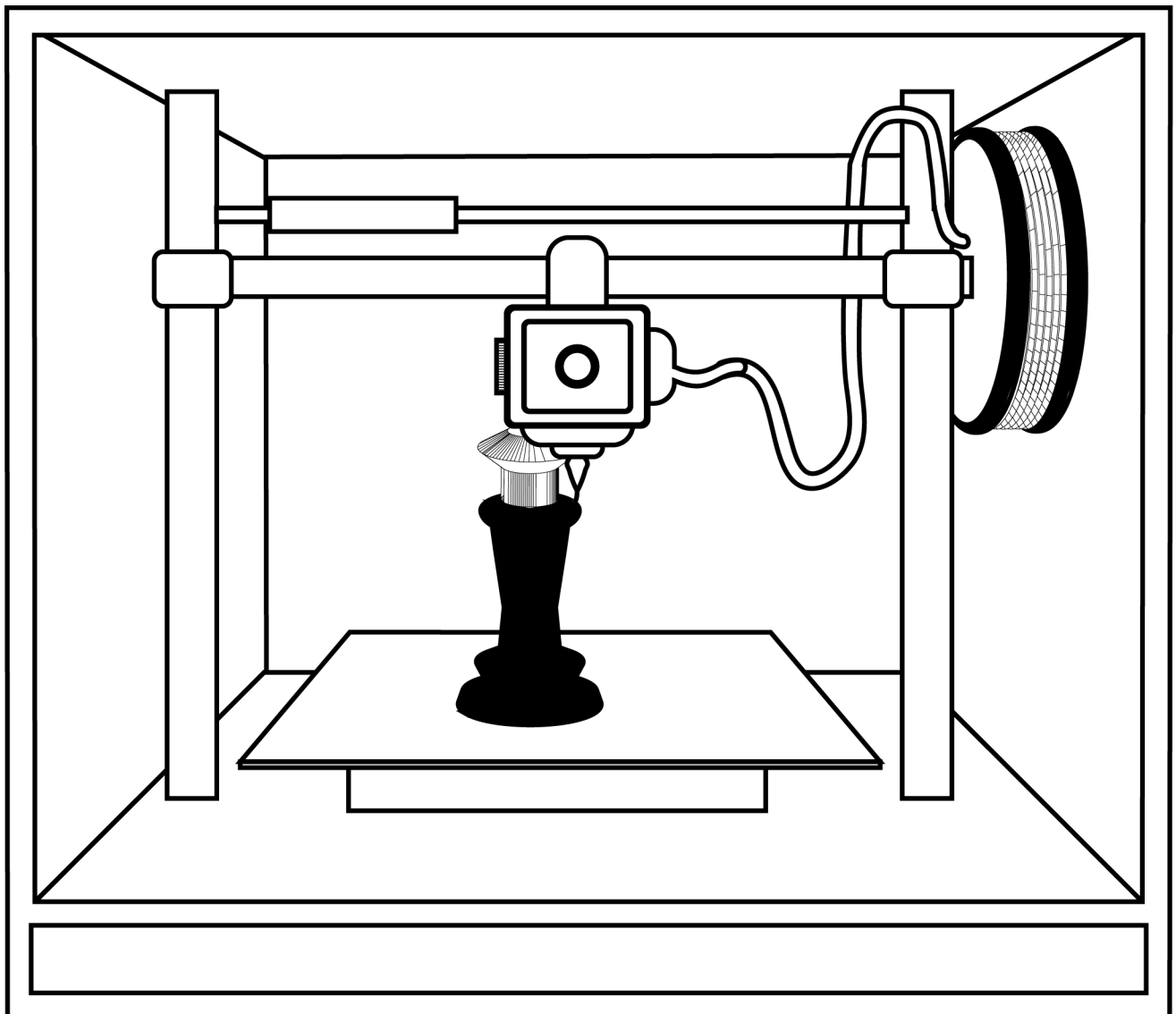
3D printing has been used in medicine (3D bioprinting) to produce prosthetic limbs and organs. The 3D bioprinted organs can be used to test new medicines.

Work and Play

It is hard to avoid the technology that computer scientists have brought into our homes. From voice assistants such as Amazon Alexa and Google Assistant to Smart Watches, Games Consoles and Smart TVs. There are so many ways to access information.
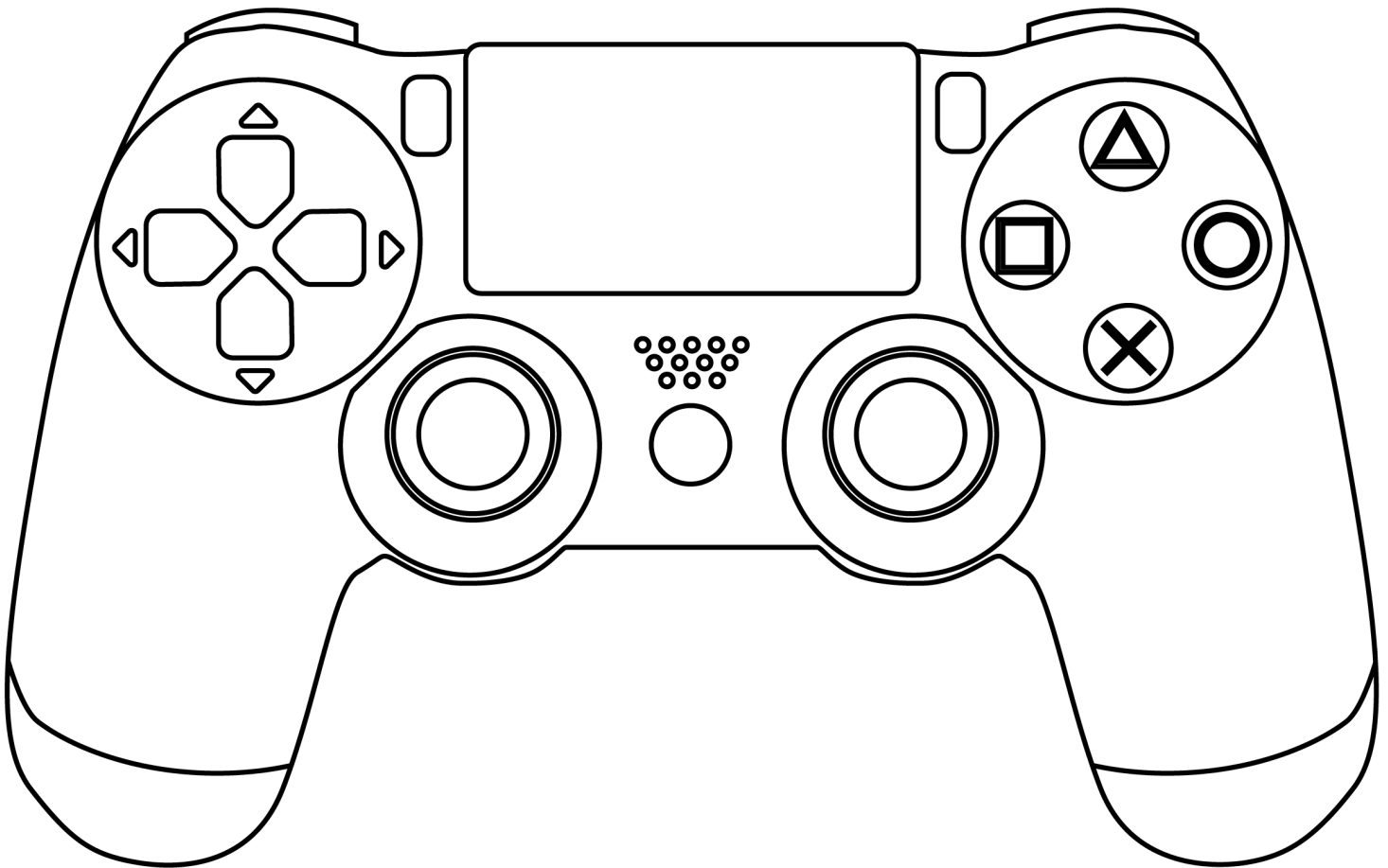
Some people argue that there are negatives to the amount of technology in our lives; we may become overly dependent on technology. Some people develop tech addiction, which is just as serious as any other addiction. We should use technology responsibly and remember that technology is there to help us when we need it and at other times it is good to switch off and enjoy reality without any technology.

Event Horizon Telescope

Katie Bouman is a computer scientist who works in the field of computer imagery. At the age of 23, she led the development of an algorithm which eventually captured the first images of a black hole 55m light years from Earth. The team of 200 researchers, working together for over six years, used algorithms to control a network of radio telescopes known collectively as The Event Horizon Telescope.

MPIfR

OAN NOEMA IRAM

SPT

GBT

VLBA

ARO SMT

LMT

APEX ALMA

JCMT SMA

N
E
S
W
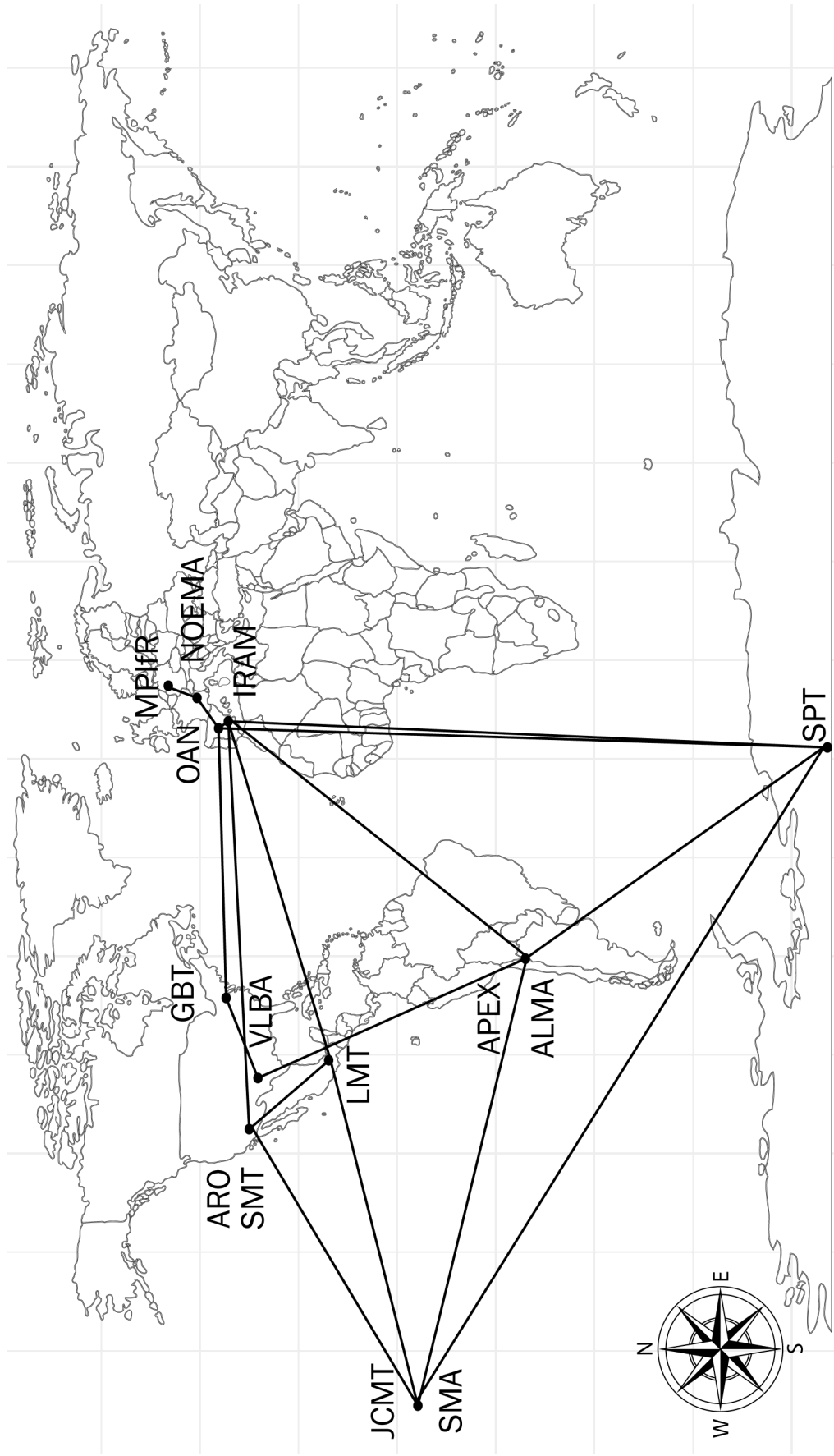
Artificial Intelligence

In the same way that humans can learn things and become intelligent, computers can be taught different things too. We can teach a computer how to recognise human speech or how to drive. We can teach a computer how to choose the correct medicine for an illness or how to play games such as Chess and Go. The way that we teach computers is also known as machine learning and with this, computers develop Artificial Intelligence (AI) and can make decisions based on what they have learnt. AI is one of the most exciting areas of computer science.
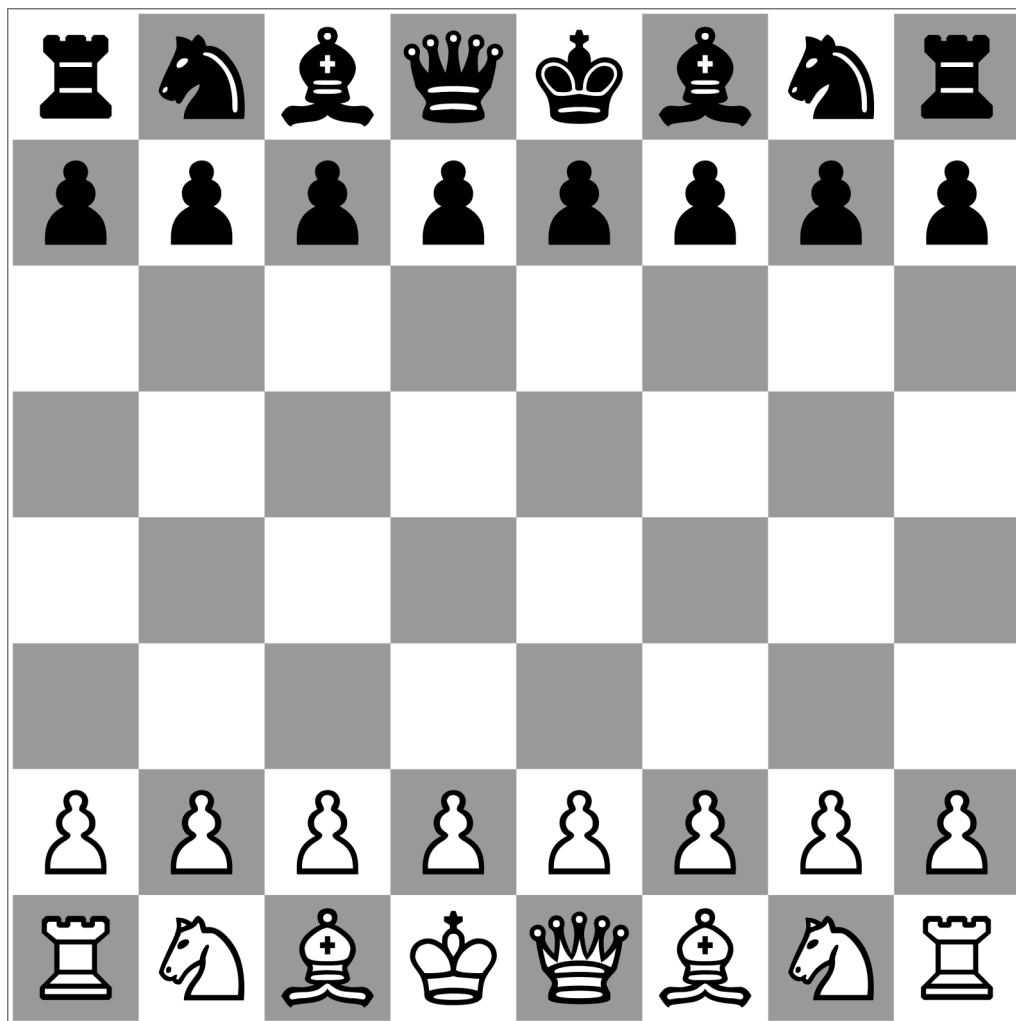
Teaching computers how to "think" and make decisions based on past experience does raise some ethical issues. What data do these computers have about us? Who has access to this data? What if these computers make a mistake in their decisions? In some cases, these mistakes could result in a loss of life. The following pages will show examples of artificial intelligence.

Robots

The word Robot was first used in a play written in 1920 by Karel Čapek called R.U.R, which stood for Rossumovi Univerzální Roboti (Rossum's Universal Robots). In the play, robots work for humans. It took over 40 years for this idea to become a reality. The first robots were used in factories to assemble cars. However, there are now a range of robots which are used as helpers around the house. There are also many robot toys and Sony even made a robot dog called Aibo.
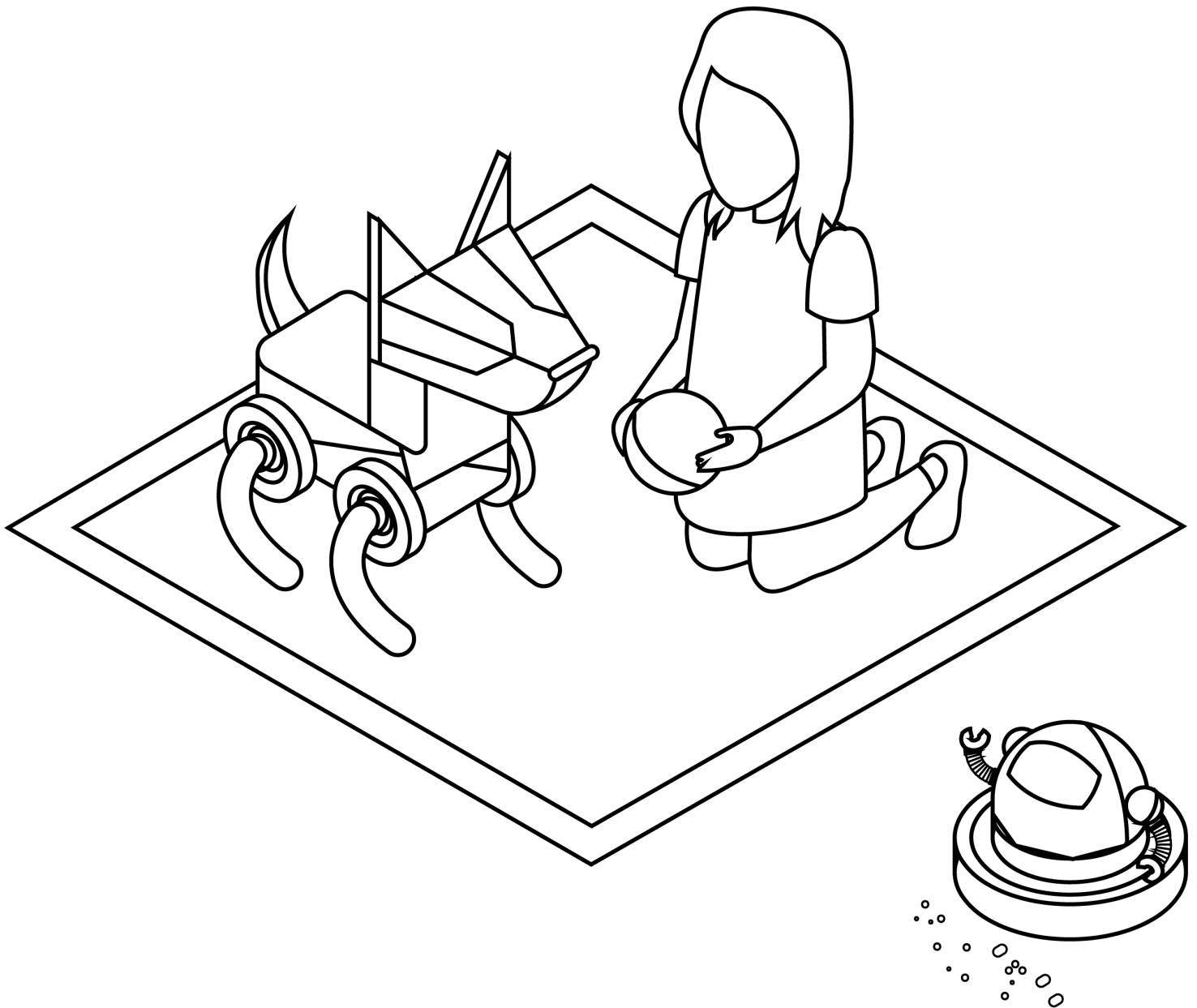
Robots

In his 1920's play, Karel Čapek raises many ethical issues: Is it right for humans to force machines to do work? What if artificial intelligence develops so much that robots can begin to think for themselves? What if a robot harms a human? Is it OK for robots or machines to replace humans in certain jobs? All of these ethical questions are still being dealt with by computer scientists and society as a whole today.
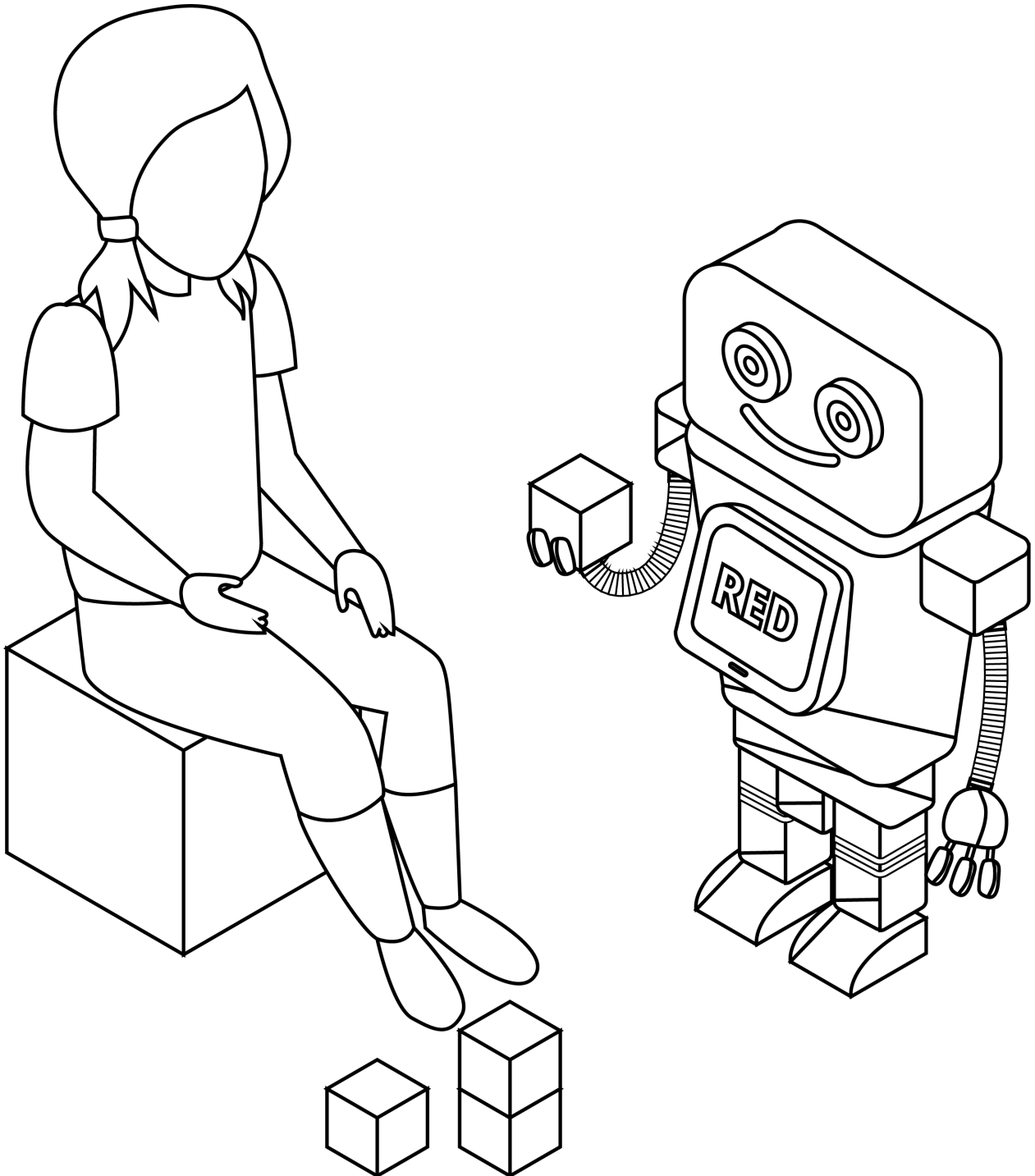
Autonomous Vehicles

Autonomous vehicles are vehicles which drive by themselves. Self-driving cars and trains are becoming quite common. Eventually, we may also have self-driving trucks which can deliver goods without a driver. These autonomous vehicles use different sensors and artificial intelligence to "see". This 'computer vision' and programmed artificial intelligence allows these autonomous vehicles to make decisions whilst driving. Based on thousands of hours of video footage, the vehicles are trained into how to drive safely and how to respond at red lights or if a person walks in front of the car.

Self-driving cars have very few accidents and some autonomous cars such as those made by Tesla have collision avoidance systems which detect and avoid crashes.

Colour Word Search

Find and colour in the words: Hardware, CPU, RAM, ROM, Desktop, Laptop, Volatile, Memory, Binary, WIFI, Router, Network

```
B R A N D O N Z R O M K D V
L E U N E T W O R K G E A O
J T A H S I N Z Q F I H N L
F B S E K P T P O H A N I A
Q L A P T O P S P R A R E T
Z M E M O R Y O D M K E L I
V S W R P X S W L G A Z I L
P H R A M Q A A I F I W E E
A S K B S R S R T H E O C U
R A M S E Y O B I N A R Y P
K M K M D F C A E Q A P X S
E U M A R L O N A N A V W U
R V Y S Y C C P U T J N Q K
G V V F R E T U O R W I Z I
```

Colour and match

Colour in the hardware on the left. Then draw lines to match them up to their correct names:
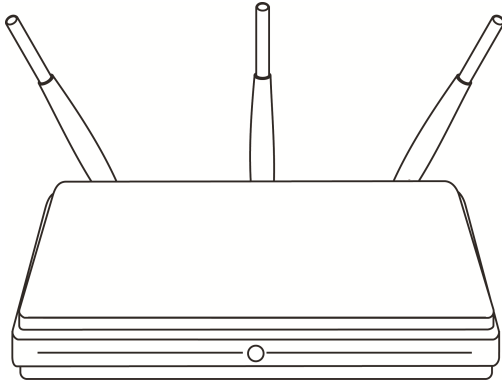
RAM
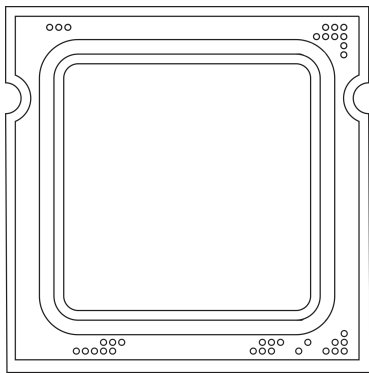
CPU
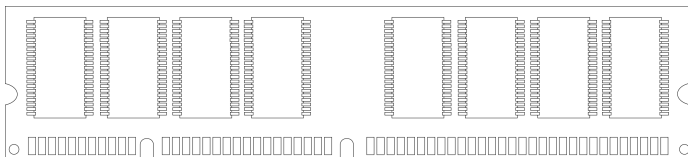
Graphics

Tablet
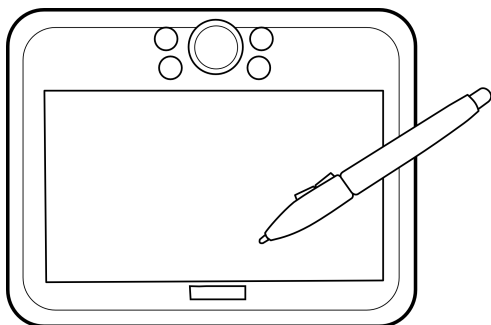
Router

Copy and colour

Use the grid to copy the drawing on the left, then colour them in.
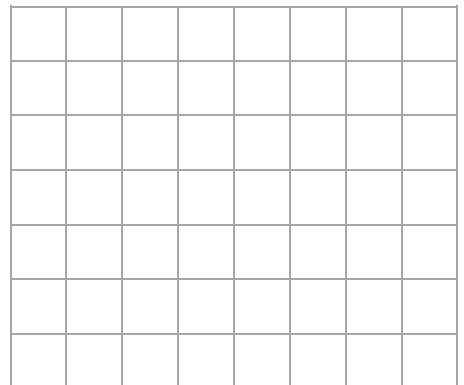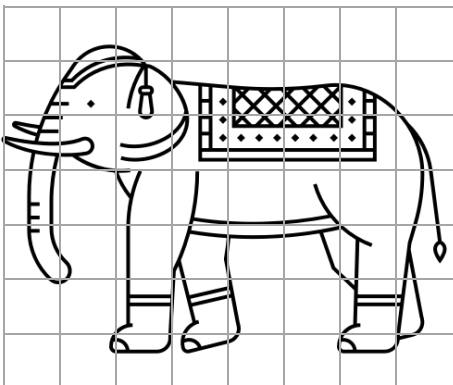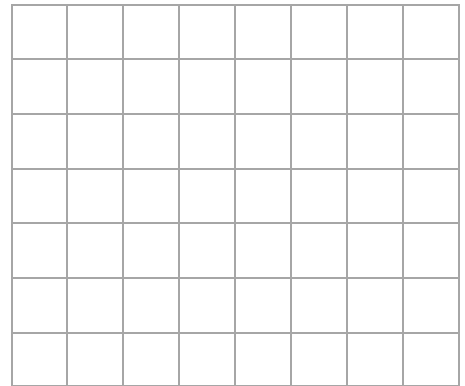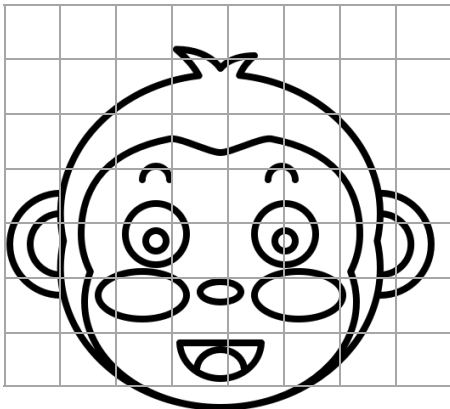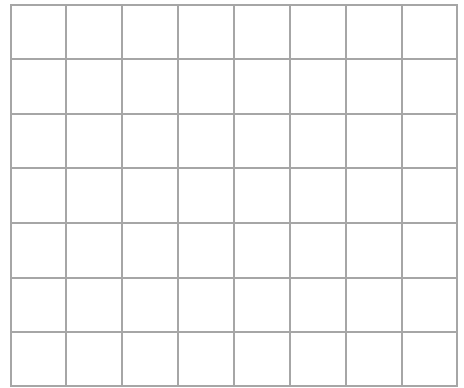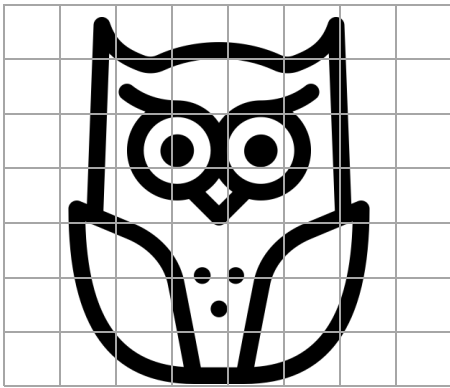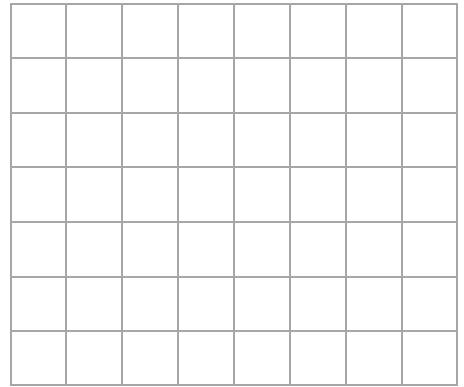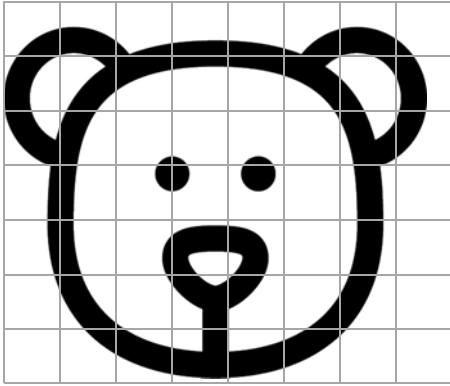
Answers

Quiz 1
1) CPU
2) RAM and ROM
3) Solid State Storage
4) A laser, either red or blue-violet
5)The camera on the previous page is an example of an embedded system, can you name another embedded system?

Quiz 2
1) Switch
2) The Internet
3) (Web) server
4) Router
5) Smart watch, central heating, air conditioning, TV, lighting and many more...

Quiz 3
1) The Operating System
2) Anti-virus, backup software, Firewall, compression software, disk defragmenter, auto-update
3) Application software
4) Inputs and Outputs
5) Integrated Development Environment (IDE)

Quiz 4
1) Binary
2) 2
3) 1101
4) 4 colours
5) 1 bit

Further Reading

You can never have too many books. These are some books that will help take you further on your journey to becoming a computer scientist:

Title	Author	Category
Computational Fairy Tales	Jeremy Kubica	Computational Thinking
Hello Ruby: Adventures in Coding	Linda Liukas	Computational Thinking
Brown Dogs and Barbers: What's Computer Science All About?	Karl Beecher	Computer Science Theory
Code: The Hidden Language of Computer Hardware and Software	Charles Petzold	Computer Science Theory
How Computers Work: The Evolution of Technology	Ron White	Computer Science Theory
GCSE Computer Science 9-1 Complete Revision Visual Notes	H A Billinghurst	GCSE Computer Science
Python Basics Level 1	Chris Roffey	Intro to Python Programming
Python by Example	Nichola Lacey	Intro to intermediate Python Programming
Little Book of Algorithms	William Lau	Intermediate Python Programming
Code This Game!	Meg Ray	Intro to intermediate Python Programming
Making Games with Python & Pygame E-book: inventwithpython.com	Al Sweigart	Python Programming
My Amazing Book of Broken Programs: JavaScript	Kiki Prottsman	Intro to intermediate JavaScript
Adventures in Raspberry Pi	Carrie Anne Philbin	Raspberry Pi and Programming
The Maker's Guide to the Zombie Apocalypse: Defend Your Base with Simple Circuits, Arduino, and Raspberry Pi	Simon Monk	Maker, Physical Computing and Electronics
The Vignelli Canon E-book: www.vignelli.com/canon.pdf	Massimo Vignelli	Graphic Design
Thinking With Type	Ellen Lupton	Typography

A few extra books and websites for good measure:

Title	Author	Category
www.pythonprogramming.net See also: Youtube channel- sentdex	Sentdex	Intermediate to advance Python programming
www.kidscancode.org See also: Youtube channel- KidsCanCode	Chris and Priya Bradfield	Making games using Python and Pygame
Youtube channel– MrLauLearning	William Lau	Computer Science tutorials
Youtube channel– Tech With Tim	Tech With Tim	Programming tutorials
Youtube channel- Corey Schafer	Corey Schafer	Python Programming tutorials
Youtube channel– Computerphile	Computerphile	A-Level and advanced Computer Science
Youtube channel– CraigNDave	Craig Sargent and David Hillyard	Computer Science tutorials
Youtube channel– Computer Science Tutor	Computer Science Tutor	GCSE and A-Level Computing tutorials
www.3dami.org	Peter Kemp	Digital Art
www.revisecomputerscience.com	Sam Wickins	GCSE and A-Level revision
www.geeksforgeeks.org	Geeks For Geeks	A-Level and University level
How We Learn	Benedict Carey	Learning
Why We Sleep	Matthew Walker	Wellbeing

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I'd like to thank Zi, Q and Suki for being my daily inspiration. You are the colour in my life– playful, fun and happy souls.
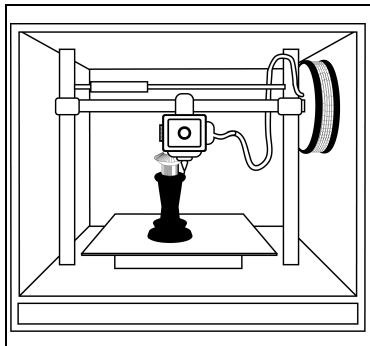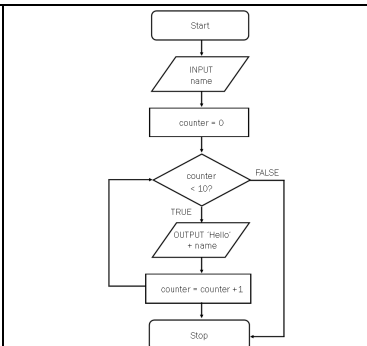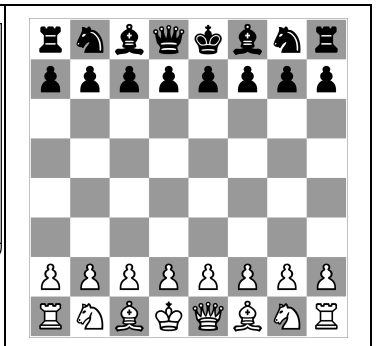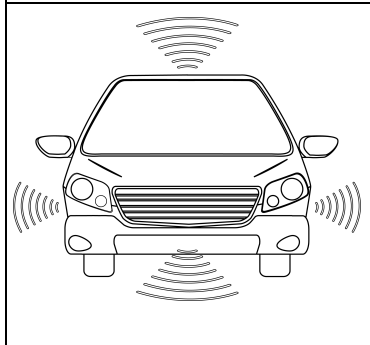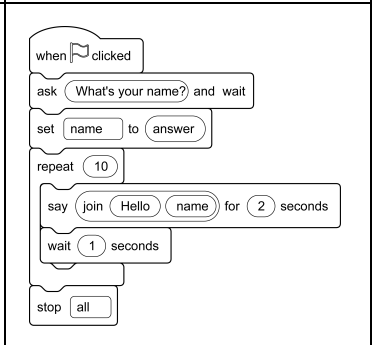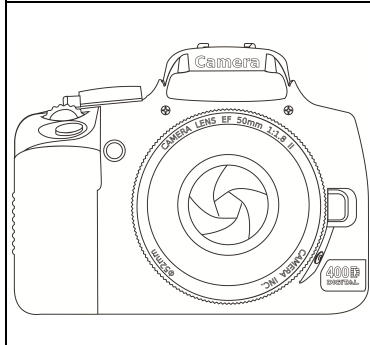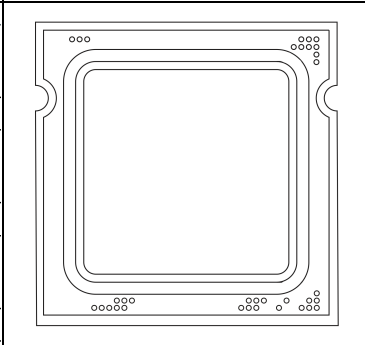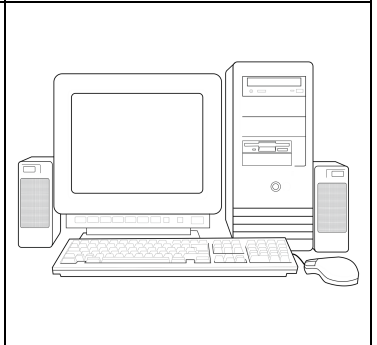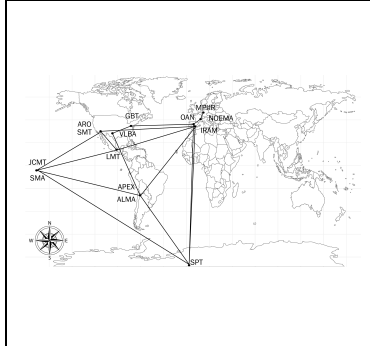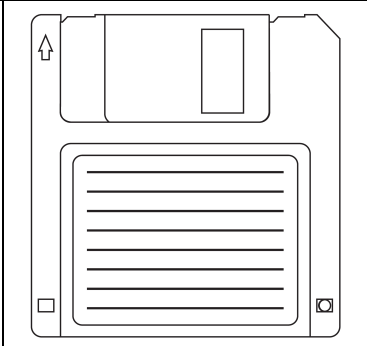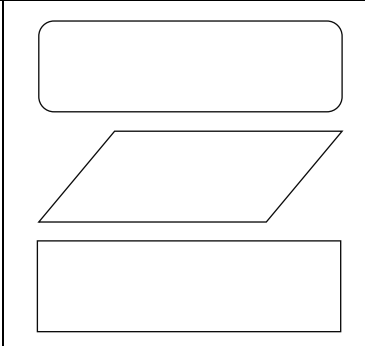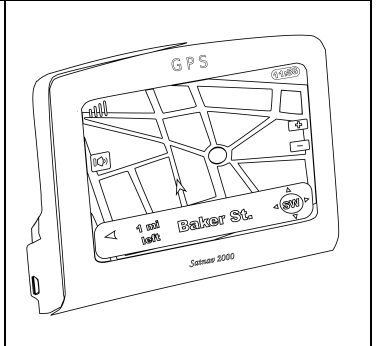
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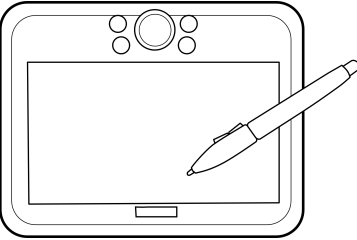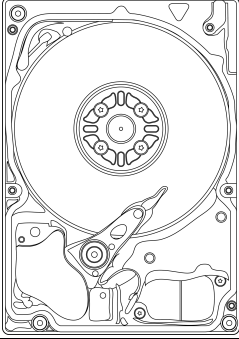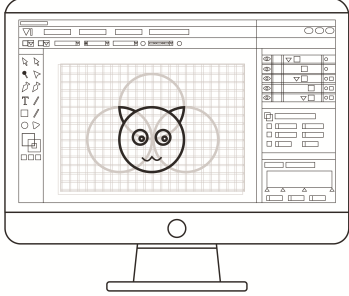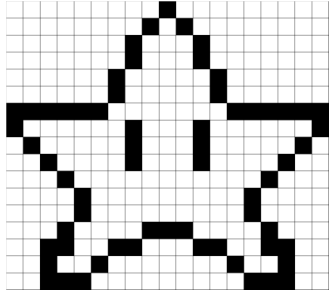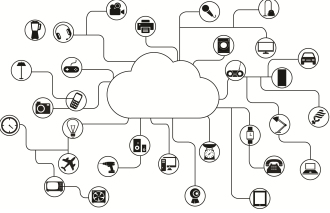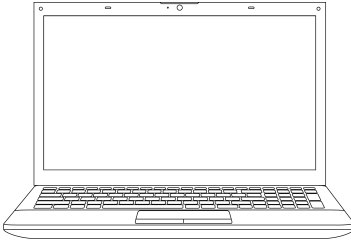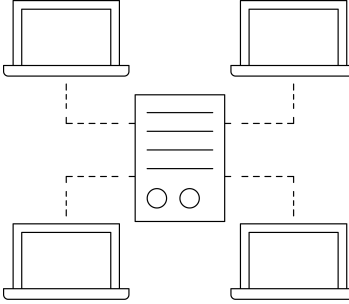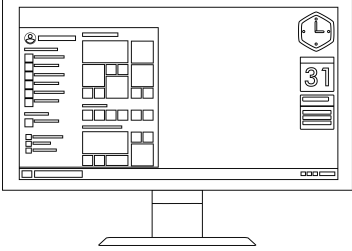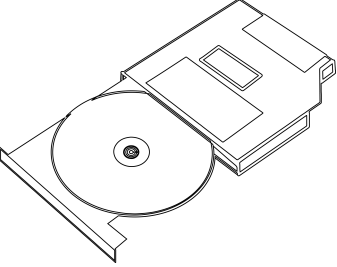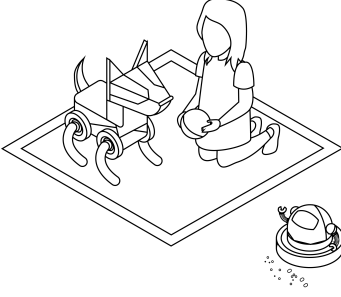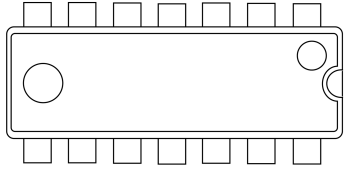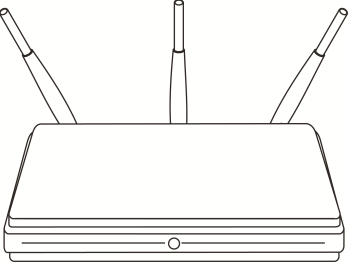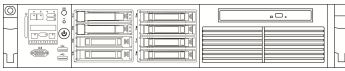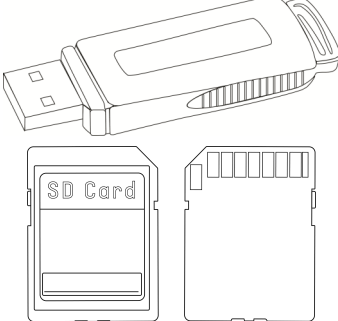
Thanks to Mum, Dad, Anita and Steve Marshall, Tung, Mary and Wendy Hau, Susan Nemcek, Jeremy and Jennifer Franklin, Ariane Gras, Richard Morgan, Nathan Coppard, Robert Lessels, Florent Gonthier, Nadia Lumley, Rian Perle, Charlie Marbles, Spencer Whatmore, Thomas Bird, Carl Stratton, Eric Liu, Karman Law, Angharad Jones Buxton, TJ Jones, Yasmin Coutinho and Andy Swann for your support over the years.
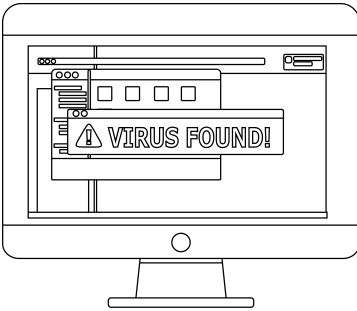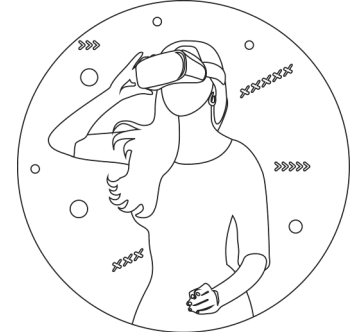
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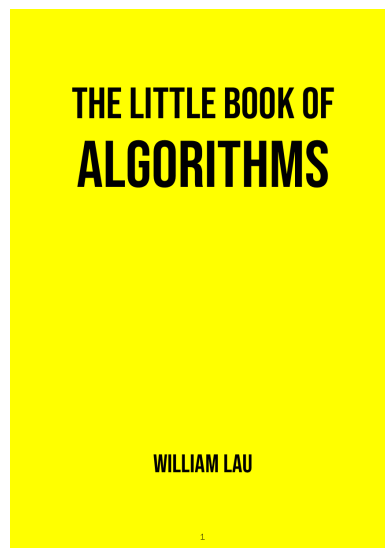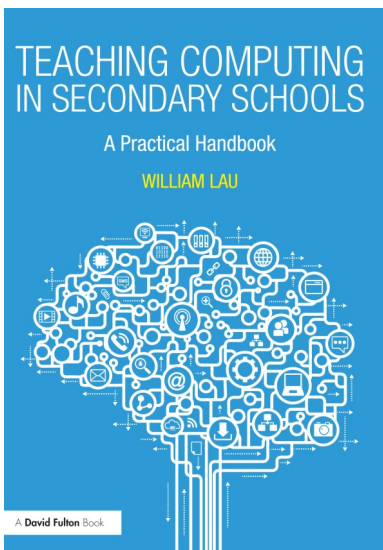
| ```
name = input('What is your name?')
for count in range(10):
    print('hello', name)
``` | VIRUS FOUND! | | |
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repeat 10

say join Hello name for 2 seconds

wait 1 seconds

stop all