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An introduction to data and information

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Introduction

Computers are used to find, store, process and share data and information. The World Wide Web is an example of a vast store of information, which can be searched. This material will introduce you to what a web browser is and how to use one. The use of search engines to find information more effectively on the web will also be demonstrated. This course looks at how data is transformed into information and relates the topics of data and information to the computer. These are fundamental issues in an understanding of the way in which the computer has shaped and changed contemporary life.

This OpenLearn course provides a sample of Level 1 study in Computing & ICT

Learning outcomes

After studying this course, you should be able to:

- identify some of the instances in daily life where a computer is, or is likely to be, involved
- describe, in simple terms, the difference between data and information.
- give a simple explanation of why computers are important to people in terms of data and information
- explain in simple terms what a computer program is, and why one is necessary
- explain the role of the computer with respect to the data given to it.

1 An introduction to data and information

1.1 What this course is about

> Each venture
>
> Is a new beginning, a raid on the inarticulate …
>
> T. S. Eliot, 'East Coker'

Some years ago I was playing with my nephew. 'Guess what', he said. 'My gran remembers before there was television!' He was clearly thinking about the past in terms of 'before there was television'.

At that time, I was working in computing, and most people couldn't really understand what I did. Computers were mysterious boxes that were hidden away in large, secure buildings in major companies and government organisations. The average person came in contact with them only in the form of stories in the press or printed statements they received from their bank or gas supplier.

All that has changed, as dramatically and as completely as from 'before television' to the present day. Today, most people experience computers not as remote machines producing bills or directing space flight (though they still do these things), but in two ways:

1. as a medium that combines graphics, video, sound and text to impart information and a means of enabling us to shop on the internet, and so on;
2. as a ubiquitous but hardly noticeable means of controlling everything from toasters to air traffic.

Whether or not you realise it, you are not only surrounded by computers but you have a *persona* created by the data associated with you. Some of this data you create yourself, consciously. Some is created when you open a bank account, enrol on a course, shop using a loyalty card, and so on. How much of this persona of yours is public, whether the data it contains is correct, and whether it should be held in the public domain are all things you need to be aware of.

Exercise 1

Take a moment to look in your wallet or purse. What kind of persona do you think you present through the cards and documents it holds? Each of these is likely to mean that some organisation holds electronic records about you.

This is what I found in my wallet:

- driving licence;
- two credit cards;
- a store card;
- three library cards for different libraries;

- membership cards for the National Trust and RSPB;
- loyalty cards for an airline and a car hire firm;
- my National Health Service medical card.

Your wallet or purse is likely to contain similar items. The point is that various organisations (the DVLC in Swansea, the credit card companies, a department store, several libraries, as well as the NHS) *all* hold data about me. Probably they hold my name, age, date of birth, and address in common, but each will also hold data that is different from the others. For example, I have three bank accounts, two with the same bank, and one with another. The two different banks may have very different views of my finances!

My persona consists of all of this data, whether I am aware of it or not. That is what I mean by a persona: a 'picture' of you created by various collections of data about you, such as your finances, shopping habits, interests.

You might like to ask yourself at this point how aware you were, before doing the above Exercise, that so much information about you existed in the public domain.

1.2 Aims of the course

This course will:

- use case studies (real-life examples of interesting aspects of the course which illustrate particular points) that relate the use of computers to finding, storing, processing and disseminating data and information;
- describe various instances of computer use to see how computers can work with data to produce information;
- introduce you to what a browswer is, and how to use one;
- demonstrate how to use a search engine to find information more effectively.

1.3 Summary

This section briefly discussed the public awareness of computers and how quickly this has developed from a situation where computers hardly impacted on most people to one where they are involved in virtually every facet of modern life. As an illustration, you examined the contents of your wallet to determine how much data about you (your persona) might be kept by a variety of organisations. This sets the scene for developing an understanding of how this affects you as an individual in modern society.

The aims of the course were then described.

2 Daily life and computers

2.1 The individual: an average day

If I take an average day in my life, I find myself surrounded by computers, most of which are invisible to me. This section looks at where computers are found in the course of everyday life. It aims to:

- place computers in the context of the activities we do and the things we handle in our day-to-day lives.

But it does this from two points of view: the individual and the commercial organisation.

2.1.1 A day in my life

I wake to a radio-alarm. It's controlled by a small computer that lets me set the time I want to wake up and the radio programme that will wake me.

I prepare breakfast on a cooker which has a small computer that controls the clock, timer, and other functions such as oven temperature.

I take my dog for a walk. She has a 'microchip' (i.e. a very small simple computer) implanted under her skin that will enable her to be traced if she is lost or stolen.

I take my son to his nursery in the car. It has a number of small computers that control the steering, manage the engine, and control the braking system.

My son's nursery has a computer that children as young as two can use. The nursery keeps its records on a computer and it has a website.

At work, I write material such as this course using a computer, and find information both from the library catalogues and from the World Wide Web (the web) using my computer. I send and receive emails from colleagues down the corridor or across the world.

During my lunch break I stop at the bank. My computer-produced statement has a confusing entry that I want clarified. On the way out I draw cash from another computer (an automated teller machine or ATM).

I phone a friend using my mobile telephone. It's controlled by a small computer, and my network is able to locate my phone and connect my calls through computer-controlled switching systems.

After picking up my son, I drive to the supermarket. Supermarkets are just one form of business that depends on computers to check stock, order items that are running out and add up sales, among other things. These computers also use my loyalty card to record my preferences, and issue me with vouchers that might entice me to exercise these preferences.

On the way home I pass a police speed camera. If I were exceeding the speed limit, its computer-controlled system would recognise my number plates, identify me as the owner using the DVLC licensing records, and automatically send me a ticket. (Of course, it's not triggered into action as I pass by!)

Later in the evening my partner and I go to visit a friend who's in hospital. Because we aren't too sure where the hospital is, we use an in-car navigation system to help us get there using the best route.

At the very end of the day, I take a shower which uses a small computer to control the temperature and pressure to ensure I'm neither frozen nor scalded if someone else in the house turns a tap on or off.

The one thing I'm fairly certain of is that my bed doesn't (yet) contain a computer.

Exercise 2

Think about your day as I have thought about mine. Note down the places you visit and things you do in the course of the day, and tick those items you think involve a computer of some kind. As you study this course, you may want to return to this list to check whether you were right about computers being involved.

Chances are, if you've chosen an ordinary day, you'll do many of the same things I described above. Many, if not most, of these will involve a computer in some form or other. Most modern mechanical devices are now controlled entirely or partially by computers, including buses, trains and aircraft. Even bicycles are sometimes fitted with a computerised speedometer and odometer.

Most activities these days involve exchanging data or finding and using information – tasks that increasingly are being done by computer.

Exercise 3

Imagine wandering around your local supermarket. Mentally observe the behaviour of other shoppers and the staff at the supermarket. Write down the information that these two groups need.

There is no single answer to this Exercise. I can only give you some examples.

Shoppers want information about a particular product, where it is, what it costs and perhaps nutritional information associated with the product.

The *store manager* wants different information, such as:

- which items are being sold quickly so that shelves can be replenished and stock reordered;
- what the daily turnover of the supermarket is so that new staff can be hired when business increases.

The *staff who stack the shelves* need to know what products to put on shelves, and where the products can be found.

Staff at the check-outs need to know what some products are (e.g. different fruits, or how to distinguish pastry items) in order to enter the correct codes.

Exercise 4

What sort of information would a doctor need in the course of his or her working day?

Here is my list of the things I believe a doctor needs to know:

- personal information about a patient which enables the doctor to visit that patient;

- the patient's medical records which show previous treatments, any adverse reactions to treatments, and so on;
- information about the external bodies that deal with patients, such as the location of the nearest pathology laboratory, and the name of the consultants at the local hospital who treat particular disorders;
- information about the latest policies and procedures of the NHS;
- recent research findings relevant to a patient's condition.

The above list shows how daunting information requirements can be. A doctor needs everything from the simple and obvious (the patient's name and address) to the complex and possibly obscure (the latest research findings on a rare disease).

2.1.2 Data and information

So far, I have used two words in connection with computers: data and information. Did you see any differences in the way the two terms have been used? Let me point out one.

Data refers to discrete items, such as the price of an item on the shelf of a supermarket, or the type of product listed on a sign over a supermarket aisle. The word ‘data’ is a plural Latin word but it is generally used as a singular word in English.

In contrast, **information** involves linking together two or more items of data to provide an item of knowledge. If someone suddenly said to you, ‘50p’, you'd be a bit puzzled. However, being told, ‘The price of a litre of milk is 50p’, would convey *information*. In other words, information can be thought of as the answer to a question such as: ‘What is the price of this product?’ So the words ‘50p’ said in connection with nothing would mean little, but stated in answer to the above question would convey information or knowledge.

It's true that the distinction I've made here between data and information may seem fuzzy. One person's data could be another's information (as you will see later in this course). But for now, please work with the simple definitions given above.

2.2 The organisation: loyalty cards

Many supermarkets and other firms (such as petrol companies and airlines) use loyalty cards: cards that offer a customer some form of incentive, such as a future discount or gift, to continue buying from that firm. For example, the British supermarket chain Tesco issues such cards. The holder of a loyalty card is regularly sent vouchers which give the holder discounts from their shopping bills and also vouchers which enable them to gain a discount on items that the supermarket wishes to promote.

When applying for a loyalty card you are required to fill in a form which asks for your name and address, and possibly details about your lifestyle, such as what sort of car you drive, your annual salary range, and so on.

Once you have your loyalty card, it will be swiped through a reader whenever you take your purchases to the check-out.

This subsection is concerned with how a supermarket, or any other organisation, uses the data:

- taken from the loyalty card application form;

- generated when the loyalty card is swiped through the reader at the check-out.

Exercise 5

Can you think of a use for the postcode data that is written on the loyalty card application form of a supermarket chain?

You might have said that it is used to send special offers to card holders, and that's correct. However, the senior management of the supermarket chain might use postcode data in a much more subtle way. They often open new branches, and your postcode is a valuable piece of data which helps them to anticipate what the effect might be of opening a new branch in a particular area.

When a loyalty card is swiped at the check-out, the data associated with the holder is linked to the set of products which the holder has just bought. This provides further information for the senior management of the supermarket chain. For example, it could be used to detect whether there is any pattern in the buying habits of customers. If, for example, one product is consistently bought with another (e.g. bottled beer with snacks) this could lead the supermarket chain to display the linked items together in the aisles or near to the check-out in the hope of increasing sales.

2.3 Summary

This section showed that computers pervade our daily lives, but that many of them are invisible to us.

It investigated the information requirements of certain individuals, such as shoppers and doctors. You learned that their requirements can range from the simple and obvious to the complex and not so obvious.

You also learned that it is not just individuals who require information: it is also essential to the operation of *organisations*. The example of loyalty cards was used to demonstrate how the data associated with such cards could be used to derive information that could be put to subtle use.

The section also provided simple definitions of *data* and *information*, and noted that these will be developed further in this course.

3 Sensing data and turning it into something usable

3.1 Making sensation make sense

In the previous section you learned something about what data is, where it can be found, and how it can be used. But have you ever thought about how we get data in the first place? As human beings, we are so used to reading, writing, speaking and observing that we rarely think about the true origins of the data we commonly use with such ease. I don't intend taking you back to these origins – that would take too long. Rather, I want to describe how human beings ‘get’ data and put it into a useful form.

This section aims to:

- provide a more detailed definition of *data;*
- show in simple terms how human beings can turn sensory data into something that can be communicated and reasoned about.

Before computers, it was mainly philosophers who thought about how human **sensation** (such as sight or hearing) could be turned into an abstract thing like *thought* (i.e. ideas or reasoning). To do this, most agreed, sensation had somehow to be transformed into an appropriate form. Once it had such a form, it could become the subject of thought, and human beings could reason about it.

Example 1

If you touch a surface, one of the things you will *sense* is its temperature, i.e. whether it is hot, cold or neither. This is a survival mechanism: if a surface is so hot, or so cold, that it will damage your hand, you need to remove it immediately. But between the extremes of damagingly hot or cold there are all sorts of other sensory experiences: uncomfortably hot, comfortably hot, comfortably warm, neutral, comfortably cool, and uncomfortably cold. Even these categories can be further divided.

If we were only able to react *instinctively* to our sensations of hot and cold, we wouldn't be able to convey anything about that surface to another person – for instance to warn them that the surface was damagingly hot or cold. So in the course of our evolution, we have developed the means of transforming sensation into a form that can be thought about and communicated. We have developed words like ‘hot’, ‘cold’, ‘warm’, and ‘cool’. Such words allow us to link one sensation (touch) to another (vision) (e.g. ‘as hot as burning coals’) and use them to convey our thoughts to other human beings who share our language.

But humans have also gone further. Languages have been given *written* form, which enables us to transmit our sensations and thoughts across time and space, so that someone over four centuries ago could write:

> as, the icy fang
>
> And churlish chiding of the winter's wind,
>
> Which, when it bites and blows upon my body,
>
> Even till I shrink with cold, I smile …
>
> (Shakespeare, As You Like It)

and convey to us now the feeling of coldness.

Also, because science doesn't deal in words (such as ‘cold’) which are open to different interpretations, we have developed more *objective* measures of hot and cold, such as the length of a column of mercury in a thermometer. Thermometers can then be used to compare temperatures by dividing the column of mercury into gradations, called *degrees Celsius* (written °?C). (I n some countries temperature is measured in degrees Fahrenheit.) So everyone will agree that a particular surface with a temperature of 112°?C is hotter than one of 91°?C, even though both may feel unbearably hot.

The remainder of this section looks at the concept of sensation, and how perceptions of sensation (such as *feeling* something is warm or *seeing* colour or *hearing* sounds) can be represented so that a computer can do something with them.

3.2 Human beings, data, signs and symbols

We live in a sea of sensation: sight, sound, touch, taste, smell and balance (really a sense of our bodies in three-dimensional space). These sensations, and our ability mentally to process, and then react to and communicate them, are vital to our survival. What we perceive with our senses we call the most primitive form of *data:* **perceptual data.**

However, as Example 1 showed, human beings don't just react *instinctively;* they respond *reflectively*, using thought. In other words, we seek to name, to classify and finally to understand what we perceive. A reaction like withdrawing your hand from something that is painful to touch is instinctive. Physiologically, such a reaction protects us from harm.

Language, one of the defining characteristics of human beings, is a hugely complex system of meaningful sounds which can be combined and repeated. It enables us not only to name and classify our sensations, but also to communicate them and our thoughts about them to others.

About 30,000 years ago human beings began making ‘useless’ objects: items not strictly necessary for survival. They couldn't be used as tools, eaten or used to keep warm. They were the beginnings of art. These ‘art’ objects were often marked with regular scratches, rhythmic lines or dots. No one now knows what these marks meant to the people who made them. Yet we believe that they were signs conveying specific meanings to those who made and used them (anything from counts of days between full moons to reminders of important events in the stories told around the communal fire at night).

A **sign** (or **symbol**: we consider these terms to have the same meaning in this course) can be defined as something that conveys some information by means other than direct representation. *Signs* represent something other than themselves: they *symbolise* something. Signs vary: a beeping sound at a light-controlled pedestrian crossing *symbolises* that it's safe to cross while the beeping continues, an arrow on a traffic sign *symbolises* the way to go when it's not obvious (In this course the terms ‘sign’ and ‘symbol’ are considered to have the same meaning). In the well-known painting, the *Arnolfini Double Portrait* by Jan van Eyck (shown in Figure 1), the inclusion of the dog in the foreground *symbolises* domestic fidelity, and the convex mirror in the background symbolises the observing eye of God, keeping watch over the couple.

Figure 1 The Arnolfini Double Portrait by Jan van Eyck (1434) portrays the marriage of Giovanni Arnolfini and Giovanna Cenami, and is rich in Christian symbolism (National Gallery)

The painting includes many other objects which are symbolic as well as representational, such as the shoes, the single candle in the candelabra, and the positions of the couple's hands.

Generally, we distinguish signs and symbols from representations by saying that:

- they have a meaning apart from their direct representation;
- this meaning is understood by a group of people who agree broadly on what that meaning is.

A flag symbolises a nation or other group, and what is pictured on the flag usually symbolises things important to that group: homeland, language, history or myth. The hands of the couple in Figure 1 symbolise a very ancient custom that the groom 'asks for the hand' of his future wife, and the bride 'gives her hand in marriage'.

Coming back to language, *words* are also *signs*. The word 'cow' symbolises a particular type of ruminant animal from which we get milk, meat, and sometimes muscle power. The word itself is not a cow; neither is it a particular cow ('Daisy'); it symbolises the animal we think of as a cow.

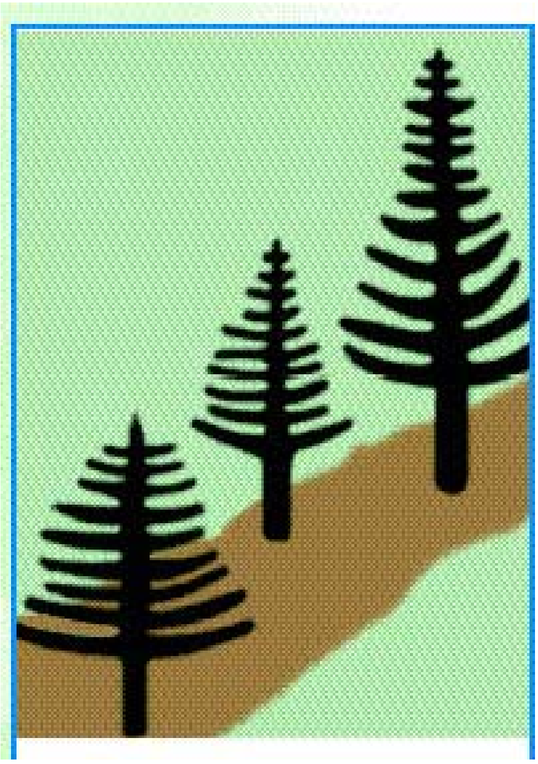

Figure 2 From a map by Olaus Magnus, Swedish cartographer, 1539

Exercise 6

Would you call the item shown in Figure 2, and which appears on antique maps, a *sign* in the sense used above? If so, what does it symbolise?

It is intended to be a sign that symbolises a coniferous forest on the map (you may have said woods, trees or something similar). Note that most maps have a *legend* which explains the exact meaning of such signs, although they are intended to be easy to interpret.

Signs can be of many types. There are *visual signs* (such as road signs), *audible signs* (beeps and tones used as attention-getters or warnings) and *tactile signs* (such as textured paving stones near a road crossing).

Exercise 7

Can you think of any other examples of tactile signs? What might their uses be?

You might have thought of *braille*, which is intended to be read by those with a visual impairment using the tips of the fingers.

Even for sighted users, tactile signs can be useful. Where the user must use sight or hearing for other things (operating complex machinery), or where vision or hearing is not possible (in very dark or very noisy environments), the position, shape, size or texture of a tactile sign can ensure that the user knows what it is without having to look at it. Most cars, for example, use position to differentiate between two otherwise similar controls such as the indicator lever and the windscreen wiper lever.

An alphabet of touch

Louis Braille, the inventor of the braille system, was only a precocious 10-year-old when he entered Valentin Haüy's pioneering school for children with a visual impairment in 1819. Haüy – a specialist in decoding manuscripts before he founded the school – had already invented a form of writing for people with a visual impairment using an embossed alphabet. Though a great step forward, Haüy's system had its drawbacks: it was prone to errors and confusion.

When Braille was 12, Charles Barbier de la Serre, a French army captain, visited the school and described his system of 12 raised dots representing sounds which could be combined to form words. Braille experimented with Barbier's system and, by the time he was 20, he had simplified it so that each letter of the alphabet could be represented by six raised dots arranged in three rows.

The dots are precisely placed in relation to each other for each character and precisely aligned (sloppily written braille is even harder to read than messy handwriting), and the 63 combinations of dots and positions comprise an alphabet, numerals, the main mathematical signs and a music notation.

Braille is interesting because the basic unit of the sign is, simply, the raised dot, whereas most alphabets compose letters using straight lines, dots, curves and compound marks. Thus braille is very simple and purely abstract (that is, it has no remnants of an iconic system, such as representing the quantity zero by an empty circle). An average braille reader can read about 150 words a minute.

The braille system also freed those with a visual impairment to write for themselves (using a variety of hand- and machine-operated tools). Nowadays computers can produce braille text directly.

In summary, a *sign* or *symbol* is a way of representing *data*. For example, the word ‘blue’ is a sign of a particular colour sensation; a seemingly-simple word like ‘cow’ is a sign of a complex thought or idea derived from many sensations; a road sign can represent some condition of the road (e.g. that it narrows ahead) and warn the driver to take care.

SAQ 1

Describe in your own words what is meant by a sign or symbol, and explain how your personal name is an example.

Answer

You might have said something like this: a *sign* is a representation of something, where the representation could be a *sound* (such as a word) or a *drawing* or some other more abstract representation. To be a meaningful sign, there must be a group of people who agree on what the sign represents.

My name is a sign in that it is not *me*, but represents *me* to myself and to others (e.g. my family, my employers, my community).

3.3 Data and information

This course is also about *information*, which in Subsection 2.1 was distinguished from data. Whereas data is a discrete item like a price or the name of a product such as milk, information links two or more items of data to give knowledge: e.g. the price of milk is 50p.

To give a simple example, if I said to you that I was standing at approximately 1 degree 40 minutes and 20 seconds *longitude* west (written 1°40′20″W), 55 degrees, 4 minutes and 57 seconds *latitude* north (55°4′57″N), you probably wouldn't know exactly where it was. You would need to know the meaning of the words 'latitude' and 'longitude' to understand that I was referring to a location.

Assume that latitude and longitude and the signs symbolising roads, towns, and so on are *data*. Longitude measures distance east and west of the Greenwich meridian in (angular) degrees, while latitude measures distance north and south of the Equator in degrees. When they are combined together in a map they become *information*, because they answer questions about location. You'd find, for example, that the latitude and longitude I mentioned above refer to a place called Ewe Hill in Northumbria, England. On the map, the printed words 'Ewe Hill' are the sign of what the place is called.

Human beings turn data into information through a process of:

- creating signs to represent the data;
- agreeing on what the signs symbolise;
- linking these signs in a variety of ways to create information;
- communicating that information to other people.

The distinction between data and information isn't always very clear. Is a bus timetable data or is it information?

In my view, it's a lot of data from which I can extract (if I know how to read it) information about when I need to be at a particular bus stop to catch an appropriate bus.

However, to the person who created the timetable from lots of data about when certain buses arrive at various points along a route, the timetable is information about the system of bus travel in a particular geographical area.

So whether something is data or information depends partly on the perspective of the user. Data *becomes* information in users' minds when it informs them (answers a question, such as how to use a bus to get from A to B at a particular time).

Here is another example.

Example 2

You and I meet on a street corner. You move your right hand towards me with your hand extended but relaxed and open with your palm held perpendicular to the ground. I perceive the movement. That's the data.

I now need to interpret that data. Are you going to hit me? Do I need to dodge or duck? Because you and I may share at least some common culture, I'd interpret this movement as a gesture to shake my hand, and *not* as a blow about to be struck. I'd be combining my perception of the movement of your right hand towards me in a particular way with other knowledge I have about cultural signs and their symbolism in order to *interpret* my perceptual data in a way that tells me I need not fear your arm movements. This knowledge (that the gesture is not hostile) is *information*. Alternatively I could say that I have used *information* about cultural norms and gestures in our shared cultural experience to *decode* the sign you have made with your gesture. Either interpretation is valid; indeed, both are valid.

You might consider the implications of you and me not sharing some cultural norm. Many cultures have a gesture that is intended to convey to strangers that one party has no hostile intent toward the other. However, what happens if one party (X) to the exchange doesn't understand the sign intended by the gesture of the other party (Y)? What if there is some additional data or information available (e.g. Y is carrying a weapon)? How then might X react?

You can see from this that information is very important to us as social beings. It is also possible for information to be false, or for a person to have the wrong information, or for information to be ambiguous (subject to multiple interpretations), or for a person to *misinterpret* information even when it is not ambiguous. One of the themes running through this course concerns whether or not you can always trust data and information to be true and whether or not data and information which were once true will remain so.

SAQ 2

Consider a recipe for making a cake. It consists of a list of ingredients and instructions for handling those ingredients.

1. Is a recipe information or data according to the definitions given above?
2. In what ways might a novice cook find difficulties in interpreting a recipe?

Answer

1. I consider the recipe to be *information*, because it answers the question: how do I make a cake? For me the list of individual ingredients and the separate instructions are all *data*.
2. There might be many difficulties in interpreting the recipe. The cook might assume that the measurements were in grams when they were in ounces. The recipe could list the instructions in an incorrect order. Also, most recipes in cookery books make *assumptions* about a cook's prior knowledge; e.g. they may assume that the cook knows what the terms ‘sauté’ and ‘rolling boil’ mean.

3.4 What has any of this to do with computers?

Human beings invented **computers** because we have a compelling interest in *data*. We seek to turn our perceptions of sensations into symbols, and then to store, analyse, process, and turn these symbols into something else: *information*. Modern computers, with their enormous storage capacity and incredible processing power, are an ideal tool for doing this. They allow us to acquire data, code it in terms of signs, store, retrieve, or combine it with other data. Sophisticated output devices allow us to present the results of all this processing (i.e. information) in ways that were hitherto impossible, too time consuming, or too expensive.

Long before we developed computers, human beings began developing tools to enhance and extend our perceptions, to help us know better what sort of world we lived in. Telescopes extended our sense of vision by compressing distance for us. We can make temperature sensors to determine the temperature of things so hot or so cold (e.g. the temperature of a kiln or liquid nitrogen, respectively) that we cannot possibly sense these directly without severe harm to ourselves.

Likewise, humans have invented many devices to amplify their muscle power. For example, a hydraulic lift can perform hundreds of times the amount of work that a human or an animal can. Automobiles and jet aircraft enable us to move at speeds and cover distances that would be impossible if we had to depend on our own legs, or even those of an animal like a horse.

Example 3

Remote sensing satellites have been examining the earth from space since the 1970s. They do so using not only the spectrum of light visible to our eyes but also infrared and ultraviolet radiation. The pictures built up through their sensing processes are decomposed into symbols which a digital computer can process. These symbols are stored, and then transmitted to an earth station where another computer converts the symbols back into pictures.

If temperature is sensed instead of light, a picture is built up using a technique called *false colour*, where colours are assigned to values of (in this case) temperature. Commonly, a so-called ‘cold’ dark colour, like black or deep blue, is assigned to areas of relatively low temperature, and a so-called ‘hot’ colour, like orange, to areas of higher temperature, with intermediate temperatures being represented by other colours.

In other examples, remote sensing is sensitive enough to detect disease or pests in crops before they are noticeable from the ground. It has also located upwellings of colder water in the seas and has resulted in the discovery of two hitherto unknown islands in the Arctic.

Figure 3 shows a false-colour image of a huge ice-storm system over eastern Canada.

Figure 3 This false-colour image of the great ice-storm over eastern Canada on 12 January 1998 was recorded by a remote sensing satellite orbiting at 800 km altitude. Vegetation is represented in green. Open water is depicted in black. The yellow lines represent political borders between Canada and the USA, and between the provinces of Quebec and Ontario. Clouds, ice and frost all appear in various tones of white to blue-white. It is therefore possible to obtain an impression of the extent of the area covered by heavy freezing rain concentrated in southern Quebec and eastern Ontario

Computers started as calculating instruments that took as input numbers symbolising things such as distance to a target and the velocity of a missile, and calculated ballistic trajectories to enable artillery troops to fire shells accurately. However, it quickly became obvious that computers could be used for far more than merely ‘number crunching’, because anything that can be symbolised in an appropriate code can be captured in a computer, stored, processed, and then fed back as information.

Using simple devices, computers can mimic our senses and gather data we have no way of dealing with directly. For example, photographs from space probes cannot come back to earth as rolls of film to be developed: they are transmitted back as radio signals which computers can reassemble into pictures. These pictures can be derived from things we cannot see, such as ultraviolet radiation.

The information that computers produce can be used to control devices like mechanical or hydraulic machinery. For example, computers can be ‘put in charge’ of machinery that might be dangerous for humans to operate, or which might move too fast for our nervous systems to control.

Furthermore, computers have vast memories, and they don't object to storing huge collections of data (e.g. all the tax records of individuals and firms in the UK) that are far beyond the capacity (or, indeed, interest) of a single human being. Once such data is stored, we do not need to remember it: rather we can concentrate on remembering what it describes and where it can be found.

SAQ 3

List at least four ways in which computers are important to human activities. You should think of one or two that are not mentioned above.

Answer

You should have listed at least four items similar to the following.

- Computers can store large amounts of data.
- They are not bored by what people might consider to be trivia.
- They can be used to control machinery in remote or dangerous situations or where things happen too quickly for human responses.
- They are useful for data analysis.
- They facilitate the transmission of data across vast distances by, for example, putting a picture into a form that can be transmitted, and then reassembling it into a picture at the receiving end.

The remainder of this course will provide some further discussion of the points raised so far and provide examples (called case studies) of how people have used *computer systems* as tools to process data and produce information.

3.4.1 A **computer system** is the combination of:

- the *computer* (with its processor and storage);
- other equipment such as a *scanner* or *printer*,
- the software programs that make it all work (software programs that are designed to help with some human task are often referred to as *applications*).

3.5 Summary

This section examined how human beings obtain data in the first place, by turning sensory data into something that can be communicated and reasoned about.

We ‘code’ this data using *signs and symbols* that are agreed within a community.

The section explored, again, the distinction between *data* and *information*, and noted that one person's data could be another's information.

It went on to describe how humans invented computers because we have a compelling interest in data, and the information we can derive from it. Modern computer systems with their incredible capabilities enable us to sense, store, process, transmit and display data in ways that were previously unimaginable.

4 Computers as tools for finding

4.1 Where am I and how do I get to … ?

Computers can be used to find things and the obvious thing they can find is information. The **World Wide Web** (**WWW** or just the web) is just one example of a vast store of information which can be searched to find what you want using computers (The web consists of linked data which is accessed via the internet using a browser). But computers can also ‘find’ things in the sense of locating them geographically, either by generating maps that can be used for navigation or by locating something or someone with reference to a map.

This section aims to:

- describe how computers can be used in geographical applications (and, in doing so, it discusses maps and shows that maps can have uses beyond mere navigation);
- describe and help you learn how to find information.

As you read on, you should try to determine for yourself:

- what data is involved;
- how it might be acquired;
- what the computer is doing to this data;
- what information is being presented, and for what purpose.

You may find it useful to take notes as you go along.

In Section 3, I used an example that gave a location (Ewe Hill in Northumbria) in terms of latitude and longitude, which are **parameters** for indicating specific locations on the face of the earth. (The word *parameter* comes from mathematics, and in this course means a property or characteristic – often measurable or quantifiable – of something.) Any point on the earth can be described in terms of latitude and longitude. Indeed, map-makers have used them ever since reasonably accurate means of determining them were developed in the eighteenth century.

Exercise 8

Can you think of four or five quantifiable and measurable parameters that describe you? If you're not certain about this, try looking in your wallet or purse at things like your driving licence or other documents.

You might have listed things as: your age in years, your height in centimetres, your weight in kilograms, and your birth date. All of these are measurable or quantifiable characteristics of you.

4.1.1 Maps

Many people are fascinated by maps, and most find them useful, though not in all situations. A lone driver, without a map-reading navigator, will find it difficult to use a map. New in-car navigation systems are designed to help such a driver, or one who is without map-reading skills but is able to follow directions.

The remainder of this subsection uses maps to introduce some important terms and concepts. It also examines a navigation system, used both in cars and in hand-held devices, as an example of the application of computer systems to problem solving.

Maps use latitude and longitude to form a two-dimensional grid that covers the curved surface of the earth.

Altitude or depth (based on a notional sea level) can be superimposed on the latitude and longitude grid using lines connecting adjacent points of the same altitude or depth called *contour lines*. Contour lines give a map-reader (using a two-dimensional map) an idea of the *topography* of the area covered by the map.

A map showing only latitude, longitude and contour lines might be of great interest to a geographer. But such a map would be almost useless for, say, a rambler or a driver unless other features, such as roads and villages, were also shown on the map. Examples of two types of map are shown in Figure 4.