Grammar Schools

ICT

Information and Communication Technology

GRADE 10

Express Publishing

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Contents

Introduction

For the student

Welcome to your new ICT textbook, *Grade 10 ICT*. Your textbook comes with a **Grade 10 ICT Student's Portfolio** and a range of *digital resources*. As well as deepening your understanding of key areas of ICT, this book aims to develop your learning skills in science. You will develop these skills in working with others to solve problems. An emphasis will be placed throughout this computer course on your ability to present core concepts, research and data effectively to others.

For the teacher

Written for the new Grade 10 ICT subject programme in Kazakhstan, *Grade 10 ICT* aims to meet the broad range of learning objectives set out in the Grade 10-11 ICT subject programme document. It focuses on developing learners' knowledge of and about ICT through the main content and skill strands outlined in the subject programme:

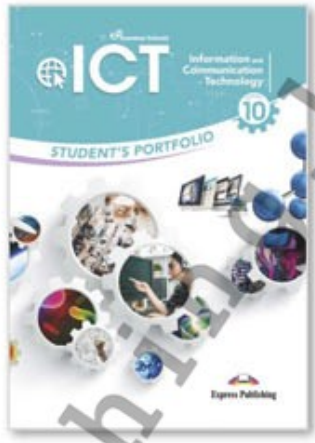
- understanding of the role of information processes in society
- development of skills to use information technologies effectively in everyday life, studies and future work
- development of abilities to solve tasks through analysis, abstraction, modelling and programming
- development of logical, algorithmic, and computational thinking
- developing a strong sense of responsibility in learners in their use of modern information technology culture

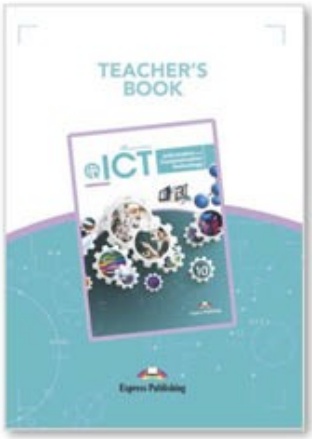
Key features of the textbook

- **Learning objectives** are clearly stated at the beginning of each module in student-friendly language.
- **Activities** and practical demonstrations allow students to build on their knowledge through guided observation, programming and design tasks and research.
- **Diagrams** have been fully labelled and are drawn in a simple style.
- **Questions** are interspersed within sections of the text to offer teachers the opportunity to use a range of teaching strategies. There are regular opportunities for learners to engage in group work and pair work, discussion, giving of presentations and online research.

Student's Portfolio

The Student's Portfolio provides additional revision material and further tasks. The Student's Portfolio enables learners to maintain a detailed record of answers and workings, giving them space to reflect on the processes and results of their work.





Teacher's Book

A Teacher's Book contains **full answers** to all questions in both the Textbook and Student's Portfolio.

Digital resources

Grade 10 ICT **digital resources** for teachers will further enhance classroom learning. These resources work in conjunction with the Textbook and Student's Portfolio. The resources have been designed to fully integrate with the Textbook to complement lesson content. Following the principles of the new national ICT subject programme, material is provided to suit a range of learner types and to encourage participation and engagement on the part of the learner.

A series of **videos** allow students to observe ICT science in action across all modules. These videos will reinforce the topic at hand, promote discussion about ICT issues in society and enable teachers to bring a range of perspectives on ICT topics into the classroom.

Further classroom discussion and participation is opened up through **PowerPoint presentations**, including a thematic presentation of information from the Textbook.

Module 1 Hardware peripherals and software

Learning objectives

- To connect and configure peripheral devices 10.1.1.1
- To classify application software by type and by distribution method 10.1.2.1
- To list the advantages and disadvantages of different operating systems 10.1.2.2

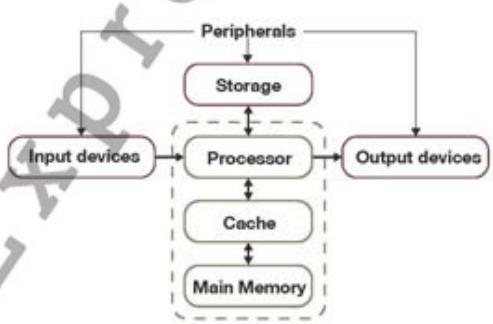
Hardware and Software

There is a very clear and simple distinction between computer hardware and software. **Hardware** is the term used to describe the physical parts of a computer and its input, output and storage devices.

Software comprises all the programs that are written to make computers function. Software can be broadly classified into **system software** and **application software**.

Peripherals

Peripherals are any computer hardware components that are not part of the CPU. This includes input, output and storage devices. For some of these, the term peripheral makes sense; the keyboard and monitor, for example, are outside the main computer casing, but storage is not so obvious. Although a hard disk is usually inside the computer casing, it is still considered a peripheral as it is outside the CPU (processor and main memory). Storage devices such as portable hard disks, memory sticks and CDs are also peripherals.



1.1 *Peripherals*

A function of the operating system is to manage these devices. When a user gives an instruction to print, the peripheral management function takes over and controls the sending of the data to be printed from memory to the device driver. (Each input or output device has its own driver – a small program that acts as an interface between the computer and the device. An HP printer, for example, will have different device drivers for a PC and a Mac, and the correct driver has to be installed so that the computer can communicate with the printer.) Meanwhile, the user can carry on editing their document in Word or whatever they were doing.

Q1: You can click a mouse to position the cursor at a chosen spot on the screen. Describe **three** other tasks you can perform with a mouse.

Q2: Name each item of hardware. Which ones are peripherals?

1.2 *Computer hardware*

Q3: Complete the table below using High, Medium or Low as appropriate for each storage medium.

Field	Capacity	Speed	Portability	Durability	Reliability
Hard Disk					
CD					
DVD					
Blu-Ray					
USB Flash Memory					

Configuration

Configuring a piece of computer equipment, involves setting it up so that it is ready to use. To use certain types of software may require that a computer has a certain minimum configuration. For example, it may have to have a particular type of microprocessor, a minimum amount of main memory or a certain type of graphics display monitor in order to provide minimum performance.

In cases where the hardware or software does not meet the minimum configuration, the addition of hardware or software accessories (upgrades) will be necessary.

When installing a new device or program, it is sometimes necessary to configure it. The device or program may, for example, need to know the type of printer or video adapter you are using. This can be a methodical manual process where the user has to select from a range of options provided but new technologies such as plug-and-play [PnP] mean that a lot of configuration in connecting devices is done automatically, enabling a computer system to recognise and adapt to a change in hardware configuration with no or minimal intervention of the user.

Task

1. Discuss with another student which of the following types of configuration involving peripheral devices you have experience of:
   - connecting a wireless speaker to your phone
   - installing a new printer
   - connecting a laptop to a projector
   - connecting two monitors to a computer
   - connecting a laptop to a touch screen whiteboard
   - setting up a network for a number of computers

   Try out one of the above which you are less familiar with. Report to another group any problems you had to overcome in configuration.

System software

System software is the software needed to run the computer's hardware and application programs. This includes the operating system, utility programs, libraries and programming language translators. In this module we will focus on modern operating systems and utility software.

Operating system

An operating system is a program or set of programs that manage the operations of the computer for the user. It acts as a bridge between the user and the computer's hardware, since a user cannot communicate with hardware directly.

The operating system is held in permanent storage, for example on a hard disk. A small program called the loader is held in ROM. When a computer is switched on, the loader in ROM sends instructions to load the operating system by copying it from storage into RAM.

1.3 *The operating system acts as a bridge between user and computer hardware*

Functions of the operating system

The operating system has many functions such as:

- resource management – managing all the computer hardware including the CPU, memory, disk drives, keyboard, monitor, printer and other peripheral devices
- memory management
- processor scheduling
- backing store management
- management of all input and output
- provision of a user interface

We will look in more detail at what these functions involve below.

Memory management

A PC allows a user to be working on several tasks at the same time. You may be listening to music via a streaming site such as Spotify, entering a Python program, checking your emails every so often and running Word so that you can document your program design. Meanwhile, a virus checker may be running in the background.

Each program, open file or copied clipboard item, for example, must be allocated a specific area of memory whilst the computer is running. Should a user wish to switch from one application to another in a separate window, each application must be stored in memory simultaneously. The allocation and management of space is controlled by the operating system.

In practice, the computer's RAM is not large enough to store all these programs simultaneously, so the hard disk is used as an extension of memory – called **virtual memory**. MS Word may be open on your desktop but if you are not actually using it at a particular moment, the operating system will copy the Word software and data to hard disk to free up RAM for the browser software, the Pascal compiler or whatever you as the user have requested. When you switch back to that program, the operating system will reload it into memory.

Q4: Do you notice that response time slows down on your PC when you have a lot of programs running? What would be the effect of installing more RAM on your computer? Why?

Processor scheduling

With computers able to run multiple applications simultaneously, the operating system is responsible for allocating processor time to each one as they compete for the CPU. While one application is busy using the CPU for processing, the operating system can queue up the next process required by another application to make the most efficient use of the processor.

A computer with a single processor can only process one instruction at a time, but by carrying out small parts of multiple larger tasks in turn, the processor can appear to be carrying out several tasks simultaneously. This is what is meant by **multi-tasking**.

The **scheduler** is the operating system module responsible for making sure that processor time is used as efficiently as possible. Of course, this is a much more complex task on a large multi-user network where many users may, for example, be accessing the same database or running different applications.

The objectives of the scheduler are to:

- maximise throughput
- be fair to all users on a multi-user system
- provide acceptable response time to all users
- ensure hardware resources are kept as busy as possible

Backing store management

When files and applications are loaded, they are transferred from backing storage into memory. The operating system is required to keep a directory of where files are stored so that they can be quickly accessed. Similarly, it needs to know which areas of storage are free so that new files or applications can be saved. The file management system that comes with your desktop operating system enables a user to move files and folders, delete files and protect others from unauthorised access.

Q5: What happens to file access times as the disk becomes very full? Why? What action needs to be taken?

Peripheral management

Different applications will require different input or output devices throughout their operation. If you send a file to print, the operating system will need to communicate with the printer to check that it is switched on and online, check that it is a printer and not, say, the keyboard and begin communication to send it the correct data to print.

Interrupt handling

An interrupt is a signal from a peripheral or software program that causes the operating system to stop processing its current list of instructions and decide what to do next. Should an error occur, such as a software crash or 'out of paper' message from a printer, the OS is responsible for detecting the interrupt signal and displaying an error message for the user if appropriate. It is because a processor can be interrupted that multi-tasking can take place.

Q6: What other events could cause an interrupt?

Provision of a user interface

To enable a user to interact with a computer at all, some kind of interface is required. There are many different forms of interface:

- text based, i.e. a command line interface
- speech/natural language
- Graphical User Interface (GUI) /WIMP (Windows, icons, menus, pointer)
- Sensors (including fingerprint sensor, touch screen, swiping or pinching fingers together)
- menu/forms

Command line interface

Command line interfaces involve knowing specific commands to operate the computer in response to a text-based visual prompt. This type of interface uses much less memory than a Graphical User Interface. For an experienced system programmer, it can be much faster to use than a GUI. However, commands have to be typed precisely. If there is a spelling error, or the command is not absolutely correct, it will fail.

1.4 *A command line interface*

Graphical user interface

A GUI uses clickable icons and menus for navigation and allows for multiple applications to be open at the same time, each in different windows. Windows is an example of a GUI. This is a much more suitable interface for people who mainly use their computer for word-processing, email, Skype and other common applications.

1.5 *A graphical user interface*

Range of uses

The interface depends to a large extent on the device in which the operating system is installed. Devices include:

- computers
- handheld devices
- entertainment systems
- domestic appliances
- controlling devices
- embedded systems

Factors affecting the choice of user interface

Software developers try to make sure that the user interface supplied with the operating system is the best possible in terms of:

- performance/response time
- ease of use
- user requirements
- user experience
- accessibility for users with special needs or disabilities
- storage space (amount of memory required)

The hardware and software that is controlled by the operating system also has an influence on the user interface. The size of the screen is one important factor. The manner in which the user inputs commands is another: is user input via the keyboard, mouse, voice or gesture?

The hardware resources, such as the processing power and the amount of memory available will impact on the design of the user interface. The rapid pace of development of new technologies means that the user interface on the latest smartphones or other device is almost always even smarter than it was just a year previously.

Q7: How do you log in, turn the torch on or off, activate the camera, and perform other tasks on your mobile phone? How does your phone communicate with you?

Task

2. Five different interface types are:
   - text based, i.e. a command line interface
   - speech/natural language
   - Graphical User Interface (GUI) /WIMP (Windows, icons, menus, pointer)
   - Sensors
   - menu/forms

   Work with a partner to research, discuss and write descriptions of situations and or devices in which each of these interfaces is used.
   What are the advantages of the chosen interface in each of the devices or situations you have described?

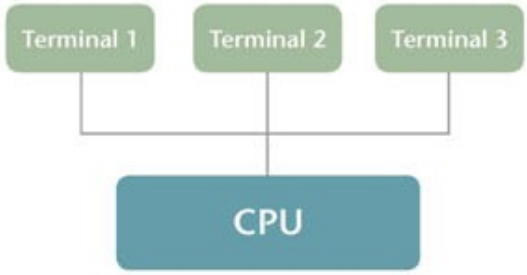
Types of operating system

Multi-tasking system

A multi-tasking operating system may run on a standalone computer such as a PC or laptop. The Windows operating system, for example, can run many jobs simultaneously, switching between them so that each one appears to be the only one running. You may be playing music, entering a Python or VB program, and checking your emails occasionally. At any one time if you look at the Task Manager (press Ctrl-Shift-Esc) you will probably find it has several programs in memory, most of which are not currently executing.

Multi-user, multi-tasking system

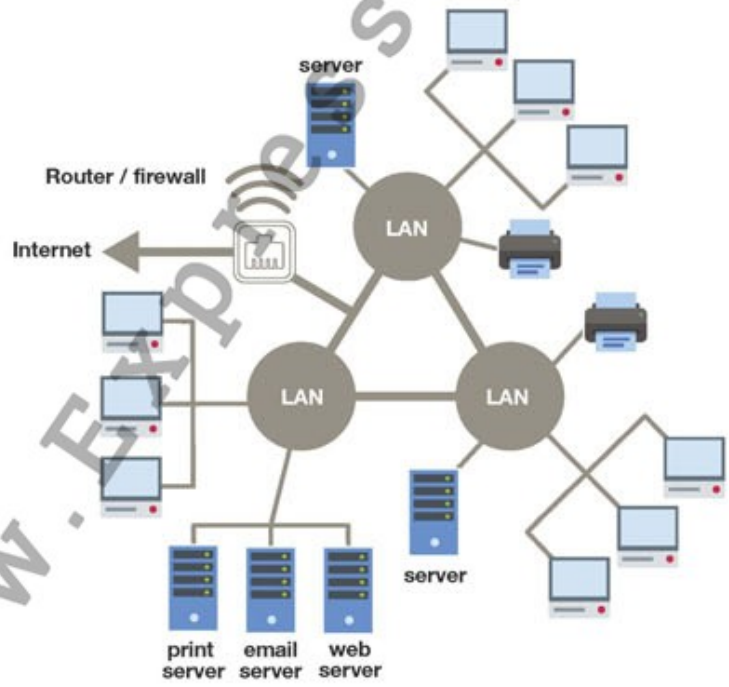
Time-sharing systems are multi-user, multi-tasking systems. A single powerful mainframe or supercomputer is connected to dozens or hundreds of terminals all using the mainframe CPU. Each user gets a slice of processor time according to a scheduling algorithm.



1.6 *Time-sharing systems*

Distributed operating systems

A distributed operating system is a form of parallel processing system which spreads the load over multiple computer servers. A single job is split up into several tasks and each of these is run on a separate computer, coordinated by the operating system, in such a way that it appears to a user to be a single system. Intranets, for example, may use a distributed system, in which the system is configured as a cluster of servers that share memory and tasks, providing more power than a single large server and resulting in better performance.



1.7 *Distributed operating systems*

Operating systems used by mobile phones

A mobile phone is a multi-tasking computer that has its own operating system. Operating systems used on smartphones, tablets, PDAs and other mobile devices are termed **mobile operating systems**.

These combine the features of a personal computer operating system with their own special features useful for mobile use such as managing cellular and wireless connectivity, as well as phone access.

Typically, for example, smartphones respond to the user's touch – the user can tap on the screen to open a program, pinch their fingers together to minimise or enlarge a screen, or swipe across the screen to change pages.

1.8 *Smartphones*

Most mobile operating systems are tied to specific hardware. Smartphones have two operating systems – the main system operating the user interface and running the application software and a second, low-level proprietary **real-time operating system** which operates the radio and other hardware. These low-level systems have a range of security vulnerabilities permitting others to gain control over a mobile device.

Embedded systems

Embedded systems are found in all kinds of hardware from a washing machine or microwave oven, to the control system of a passenger aircraft or a space shuttle. Clearly the requirements of the operating system will vary accordingly.

First, let's look at the simple case of a basic household appliance in which the application program is held in ROM. The main features of the operating system are:

- it will have a minimal user interface, probably consisting of a few buttons or a dial and maybe a small screen
- it will accept input from sensors, and send output to control devices
- there is a limited amount of RAM so a complex memory management system is not required
- there will not be any permanent data storage devices to be managed

Q8: Below are three devices that use embedded systems. Explain how embedded systems are used in each of these devices.



Real-time operating system

What about the operating system in the flight-control system of a "fly-by-wire" airliner such as the Airbus 320? This is a real-time, embedded system.

1.9 *Flight control system*

The operating system on the aircraft or similar safety-critical system must have the following features:

- it must respond very quickly to any inputs or sensors
- it must be able to deal with many inputs simultaneously
- it must have "failsafe" mechanisms designed to detect and take appropriate action if a hardware component fails
- it must incorporate redundancy – that is, if one component fails, it must automatically switch to backup hardware

Tasks

3. List four features of the user interface which you would expect to find on a smartphone but not on a PC.
4. Compare and contrast the functions of operating systems designed for a personal computer and a satellite-navigation system in a car.
5. What functions of an operating system used on a PC, would not be required in an embedded system such as the one in a digital camera?

Application software

Application software can be categorised as general-purpose, special-purpose or custom-written (bespoke) software.

General-purpose software such as a word-processor, spreadsheet or graphics package, can be used for many different purposes. For example, a graphics package may be used to produce advertisements or animations, manipulate photographs, draw vector or bitmapped images.

Special-purpose software performs a single specific task or set of tasks. Examples include payroll and accounts packages, hotel booking systems, fingerprint scanning systems, browser software and hundreds of other applications. Software may be bought **"off-the-shelf"**, ready to use, or it may be specially written by a team of programmers for a particular organisation. If, say, a hotel wants to buy some visitor booking software, they may be able to find a ready-made package that is quite suitable, or they may want a **bespoke** software package that will satisfy their particular requirements.

Software development over the past 40 years

Computing technology has moved forward at an almost incredible pace over the past few decades.

- In the 1980s, a few people began using PCs on their desks, mostly using a command line interface. (Windows was first introduced in 1985.)
- In 1989, the Word Wide Web was invented by Tim Berners-Lee and during the 1990s, people began surfing the web.
- In 2004, Google was introduced, and finding information on almost any subject via the Internet became massively quicker and easier. Facebook was introduced in the same year, and Twitter followed in 2006.
- In 2017, an artificial intelligence program beat the best human player at the ancient board game of Go.
- By 2018, robotic surgery had become a common option for many types of surgery. A robot-assisted procedure uses tiny surgical instruments inserted through small incisions to perform precise movements. A surgeon controls these movements from a console. The technology gives people more treatment options for complex problems like surgery for head and neck cancer.

Trends in software development

These are some of the trends in software development.

The rise of artificial intelligence

From voice-activated home assistants and smartphones to driverless cars, artificial intelligence solutions to perform specific tasks are likely to become more and more common, providing a better service to customers and helping companies that use the technology stay ahead of the competition.

The Internet of Things (IoT)

Android Wear, Apple Watch and Fitbit were just the start. Soon, everything from driverless cars, home appliances, communication devices, and business processes will always be connected, meaning enormous amounts of data will be created. Fitness and healthcare, manufacturing and retail are all areas that will potentially benefit from this technology. From cars to roads, deep sea

oil rigs to living rooms, nearly everything is turning into a data-collecting device. These devices collect enormous amounts of data, and IT companies are exploring cheaper and faster methods of processing it all.

Web apps and Mobile apps

Google has started focusing on features in its browser to allow web apps to work like mobile apps, giving the same level of user experience. Progressive web apps offer the best features of the web and mobile app combined. Companies involved in e-commerce, entertainment, healthcare, banking and more are having web apps developed to provide better accessibility to their customers and users.

Virtual reality

Virtual reality is being used in many situations where customer's interactions with products or services are an important aspect for a successful business. For example, e-commerce stores can allow their customers to view apparel on virtual models, or those involved in home improvements can design their houses virtually with furniture, colour, and floor, and see how they will look before making a purchase. 3D mapping and Mixed Reality is also used in educational programs and AR games.

Tasks

6. Software can be classified as either system or application software.

(a) Define:

(i) system software

(ii) application software

(b) Give an example of each type of software.

7. A company sells widgets via an online web store. The process of updating the website and processing sales involves many different types of software.

Below is a list of software:

- Operating system
- Utility software
- Special-purpose software
- General purpose application software
- Bespoke software

Complete the table below by writing one software category beside each use. You should not use a category more than once.

Software	Category
Firewall software installed on the web server	
Store's own online ordering system designed for their products and systems	
Graphics software to crop product images suitable for uploading to the site	
Online payment verification software	

8. State which four of the tasks listed below are carried out by the operating system.

(a) Carrying out a spellcheck

(b) Managing emails

(c) Creating new folders on a storage device

(d) Setting tab spaces

(e) Multi-tasking

(f) Organising hardware resources

(g) Managing virtual storage

(h) Sorting a database

9. Work with a partner to research a specific example of recent software development. Prepare a presentation to give to the rest of the class.

Module 2 Information security

Learning objectives

- To explain the meaning of the terms 'information security', 'confidentiality' and 'integrity' of data 10.1.3.1
- To describe security measures, including areas such as data backup, encryption, mirroring 10.1.3.2
- To make the case for the use of different methods of identification 10.1.3.3

Cyber security

Cyber security consists of the processes, practices and technologies designed to protect networks, computers, programs and data from attack, damage or unauthorised access. It is defined as the protection of computer systems, networks and data from criminal activity. Cybercrime can take many forms, including planting viruses, acquiring and using personal or confidential data and disrupting a website or service.

Vulnerability of a computer network is often due to a flawed system which is open to attack. An attacker or hacker can then exploit this weakness.Security on a network is important to prevent unauthorised access to data, misuse or modification of data including installing viruses and other malware.

Removable media

Removable media such as memory sticks and removable hard drives can pose two major threats to an organisation: data theft and virus infection.

Suppose you copy your latest school project on to a memory stick and take it home to use in your own computer. If your computer does not have adequate virus protection, then the memory stick could become infected and infect the whole school network when you insert it into a school computer.

Many IT rules do not take into account the frailty of human nature. System users often do not believe that security rules refer to them in their everyday use of computer systems.

Q1: In one study carried out, researchers scattered several memory sticks in the car parks of a number of companies. Nearly 60% of workers who found these devices used them in their office computers without giving any consideration to potential security risks. The percentage of workers who used these devices actually rose to 90% when they saw an official logo printed on the device.
What are the risks of using an unidentified memory stick in your computer?

Weak and Default passwords

Even the use of passwords is no guarantee of security. On average, Internet users have about 25 applications or devices (e.g. phones and tablets) that they have to manage; research has shown that these users often only have five or six unique passwords covering all devices and applications.

When a device needs a username and password to log on, a **default password** is usually provided that allows the device to be accessed during setup. Some users are careless and do not change the default password that the designer of a system may have used for testing purposes, such as 'password' or 'admin'. The default password is usually found in the instruction manual or on the device (e.g. a router) itself.

2.1 *Password security*

Leaving a default password is one of the major factors in compromising the security of a system.

A weak password is one that is easily guessed, such as a word from a dictionary or a piece of personal data that can easily be found out about the user. Lists of the most commonly used passwords are readily available on the Internet for any hacker trying to guess a password. They include: 12345, abc123, password, p@ssw0rd, admin, football, secret and monday.

Case study

In 2016 an heiress used the name of her dog as the password for her email account. She talked about the dog on several social media posts, and the account was hacked. When she went on holiday, they sent fake invoices to the family business for private jets, luxury villas and shopping sprees, which paid out around $900,000 before the crime was detected. It was only when her father got annoyed at how much money she was spending that it was discovered.

Task

1. 90% of people use a password that sits in the top 1000 most common passwords. 5% of people even use password, as their password. 10% use 123456. Also in the top 10 of the most common passwords are dragon and football. How secure is your password?
   Use the following website to check the security of some common passwords above and then try your own passwords. What happens if you add a number, an uppercase character and/or a symbol?
   https://howsecureismypassword.net/

Other forms of identification

Biometric methods

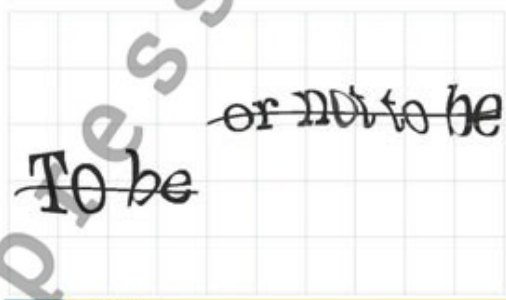
Employees of an organisation or members of the public passing through airport security, for example, may be asked to identify themselves by using a **biometric method** to prove to the system that they are who they claim to be. Biometric methods include a fingerprint scan, voice pattern sample or retinal scan. The probability of two people having identical biological characteristics is infinitesimally small, and so these methods can be used to positively identify a person.

2.2 *Retinal scan*

Biometric methods are often used on mobile devices. The advantage of these methods over password entry are that it is not possible to steal or forget a biometric characteristic.

CAPTCHA

CAPTCHA is an acronym for 'Completely Automated Public Turing test to tell Computers and Humans Apart', and is a type of test to determine whether or not the user is human.



2.3 *CAPTCHA text*

A piece of text is displayed on screen in a format indecipherable by text recognition software. Context is critical; a t might look like an l or i, and it is only in context that a human can identify it as a t.

Q2: Even perfectly sighted individuals sometimes find CAPTCHA text very difficult or impossible to read. Does the use of CAPTCHA images discriminate against any computer users?

Using email to confirm a user's identity

When you sign up to a new web service, you sometimes have to wait for a confirmation email. You will not be a registered user until you click on the link to finish the registration process and activate the account. Using email confirmations does provide some more certainty about the identity of the user.

If email confirmation is not used, and users are instead asked to enter their email address, they may give a false address as they do not wish to receive advertising emails. However, there is a problem with this – if they forget their password, there is no way to send them a new one.

From the web service's point of view, having a valid email address for everyone who registers on their site is valuable for marketing purposes. Email confirmation also prevents someone who has not registered on the site, but whose email address was given by another user, from receiving unwanted marketing emails.

To prevent this from happening, some sites will include a message with their marketing emails such as: "If you did not create an account with us and have received this email in error, please click this link."

Q3: Have you ever been required to wait for email confirmation and click on a link to complete a registration process? Do you always complete the registration?

Q4: **(a)** Explain why removable media can be a threat to the security of a network.

(b) Suggest two ways that computer users can leave themselves open to hackers.

Q5: Describe two biometric methods of identification, and for each one, give an example of where it might be used. (Give different examples for each method.)

Malicious code

Security is about keeping your computer and the files, programs and data stored on it safe from a number of hazards which are described below.

Malware

Malware is the term used to refer to a variety of forms of hostile or intrusive software, some of which are described below.

Computer virus

A virus is a program that is installed on a computer without your knowledge or permission with the purpose of doing harm. It includes instructions to replicate (copy itself) automatically on a computer and between computers.

Some viruses are just annoying and do not really do any damage but others will delete and/or change system files so that work files are corrupted or the computer becomes unusable. Some viruses fill up the hard drive/SSD so that your computer runs very slowly or becomes unresponsive.

2.4

How are viruses spread?

- Viruses are often spread though attachment to emails or instant messaging services. You may be invited to open a funny image, greetings card, audio or video file.
- They may also be spread through files, programs or games that you download from a web page or by loading an infected file from a memory stick or a CD/DVD.

Q6: Can a CD or DVD containing games software, bought new from a reputable manufacturer, contain a virus? Why is this unlikely?

Spyware

Spyware is software that gathers information about a person or organisation without their knowledge. It is often used to track and store users' movements on the Internet. Some spyware may change computer settings, making unauthorised changes in browser settings or changes to software settings. It can also be used to collect personal information such as user logins or bank details.

The use of the term 'spyware' has declined since the practice of tracking users' visits to different websites is used by many major websites and data mining companies and is not illegal. The information gathered is commonly used in adware (see below).

Adware

Adware analyses which Internet sites a user visits and then presents adverts for products which the user is likely to be interested in.

Adware is sometimes integrated into free software, so that the developer can recover development costs. Advertisement-funded software is often used with open-source software, and a large number of companies will pay to have their products advertised to selected customers in this way.

Adware is also sometimes described as malware and anti-adware software is available. However, most adware operates legally and some adware manufacturers have even sued antivirus companies for blocking adware.

Trojan

A Trojan, named after the famous Ancient Greek story of the Trojan Horse, is a program which masquerades as having one legitimate purpose but actually has another. It is normally spread by email. The user is invited to click on a link for some routine or interesting purpose, which then executes a program which may, for example, give the controller unauthorised access to that computer. The motives vary – the Trojan may crash the computer, spread malware across the network, corrupt data or reformat disks or access sensitive information. Often these emails will purport to be from legitimate companies but contain errors and incorrect company branding as shown below.

2.5 *Trojan email*

Network security

Networks are more vulnerable to hackers than standalone devices since a hacker may access a network through one device in order to gain access to other devices on the same network. This could have serious implications for an organisation, resulting in data theft, corruption of data, denial of service, and other damage caused by malware being installed on network servers.

Security on a network is important to prevent unauthorised access to data, misuse or modification of data including installing viruses and other malware.

Methods of keeping a network secure

Anti-malware software

Anti-malware software will protect a computer in three ways:

- It prevents harmful programs from being installed on the computer
- It prevents important files, such as the operating system, from being changed or deleted
- If a virus does manage to install itself, the software will detect it when it performs regular scans. Any virus detected will be removed.

New viruses are created regularly so it is important that any antivirus software gets regular updates from the Internet.

Firewall

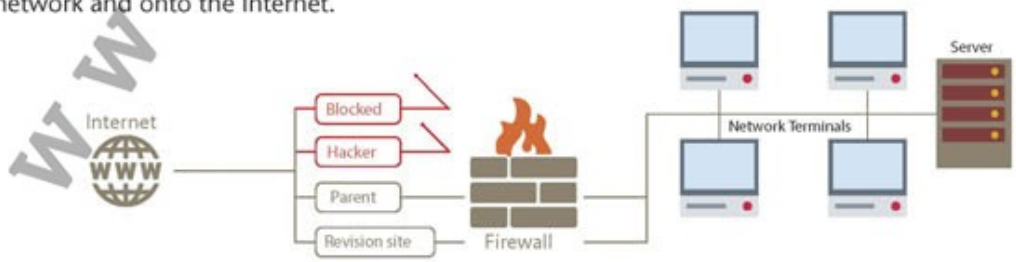
A computer connected to the Internet is potentially accessible to anyone else on the Internet. If a local area network, such as a school network, is connected to the Internet then all the file servers, the email server, the web server and all computers on the network are potentially accessible. Some people hack 'just because they can' but often it is for identity theft or, for example, to get your bank account details so they can empty your account. Occasionally people hack with malicious intent to disrupt or destroy files or entire computer systems but this is less common.

A firewall is designed to prevent unauthorised access to or from a private network or intranet. All messages entering or leaving the intranet pass through the firewall, which examines each message and blocks those which do not meet specified security criteria.

Criteria may include for example:

- Where the access is from (the computer's address)
- The type of traffic (e.g. `.exe` files which may carry viruses)
- Specific web site addresses

A firewall does not just stop unwanted access from the outside world via the Internet; it can also stop computers on a network from accessing specific sites or categories of site on the network. This feature is used to stop staff in companies watching the cricket while they should be working, or from using social networking sites during working hours. In school you will find that many sites have been blocked. Try going to a games website or getting to Facebook on a school computer and you will probably get a message saying that the site has been blocked. It is the firewall software acting as a proxy server that stops this traffic getting out of the local area network and onto the Internet.



2.6 *Firewalls*

Operating systems like MS Windows have firewall utilities included but you can also buy firewall software separately. Free firewall software can also be downloaded from the Internet and many banks provide free firewall software to customers using their Internet banking services.

Password protection

In a networked environment such as a school or a company, many of the computers are used by more than one person. Even if employees have their own computer it may be in an open plan office. The easiest way to stop unauthorised access to your computer or your files is to use a combination of a username and password.

The password should never be shared with friends or stuck on a Post-it® note under the keyboard. Also, the password should be "strong". This means that it is not easy to guess, it probably contains random letters, numbers and symbols and is at least six characters long. Some companies make employees change their password every month but this does not really work because people can just add the month number on the end because it is easy to remember.

For additional security against people trying lots of different passwords to get into someone else's account, the account can be locked after a certain number of failed attempts.

- Using **validation techniques** as well as verification; when the user inputs a Username and a Password, for example, checking format and field length
- Setting **access levels** to minimise the risk just in case the database security has been compromised

User access levels

User access levels should be set for disks, folders and files so users can only access what they need to. At school you can probably read files on a shared area but not edit them; this is Read-Only access. The teacher will have Read-Write access to these folders. Some folders you may not even be able to see.

In a work environment, the Accounts staff will have access to payroll details but other departments will not. The Data Protection Act says that employers must keep personal data secure so setting appropriate access rights is a legal responsibility as well as a good idea.

2.7 *User access levels*

Q7: Data entry errors can mean that data becomes accidentally corrupted. Describe briefly two methods which can help prevent this from happening.

Encryption

There are devices that can read network transmissions from the cables just by scanning the emissions; they do not even have to be plugged into the network. Also anything transmitted over a network can be intercepted and read. This takes place without leaving any trace so nobody would know that it had happened.

One way of stopping this unauthorised access to data is to encrypt anything sent on a network. Encryption changes the data before it is transmitted so it can only be deciphered by someone with the appropriate key. To anyone intercepting the message it would be unintelligible.

When you buy something on the Internet or use Internet banking you may have noticed that instead of HTTP in front of the domain name it changes to HTTPS. It works in the same way as HTTP but is encrypted so your payment details are kept secure.

2.8 *HTTPS*

Network policies

As well as configuration and software precautions, there are procedural precautions a company can take to protect its data. Without proper procedures and policies in place, company staff may ignore or be unaware of potential threats.

2.9 *Acceptable Use Policy*

An Acceptable Use Policy makes it clear to all network users what is acceptable and what is not.

When you started at your school you may have had to sign an Acceptable Use Policy before you were given a username and password. This policy probably said you must not use other people's accounts, access social media, play games or do anything else that is not related to your school work.

Employees will all sign a similar agreement. This is a contract between you and the school/company saying you agree to use the network only for certain things. In school you probably get away with playing games now and then but at work a company can dismiss you for going against the agreement you signed.

Tasks

2. A school has all of its computers in a local area network (LAN).
   (a) State two benefits of a LAN.
   (b) Explain two measures which the school will need to take to ensure the security of the network.
3. What means of preventing security breaches would you expect to find in a network which has attempted to provide protection from hackers and other external security threats?
4. When you load a web page which requires you to pay for a product by credit or debit card, the address of the page will normally start with the letters https.
   (a) What does the "s" stand for?
   (b) Explain why it is unlikely that a hacker will be able to steal your personal details when they are transmitted over an "https" site.

Information confidentiality, integrity and availability

Sometimes referred to as CIA, confidentiality, integrity and availability are the three basic principles for ensuring the effective functioning of modern network systems:

Confidentiality: Confidentiality is similar to the concept of privacy that we have discussed. It refers to precautions taken to ensure that sensitive information only gets to the people that it is intended for and not into the wrong hands.

Access rights and permissions: Access rights can be granted to users based on their user credentials. Files and folders can be given read-only or write access to certain users. Based on user group permissions, some folders may not be visible at all to users without permitted access. Senior management may have access to everything, whereas junior sales staff may only require access to the sales area of the network.

Physical access control: Some forms of access control may apply to physical access to specific rooms or buildings. Through the use of digital ID cards or biometric access devices, access may also be controlled for specific people, on specific days and at specific times of day.

The site used by an organisation may also be secured by a perimeter fence and manned security.

Integrity: Integrity involves thinking about what happens to data over its life cycle so that data remains accurate, reliable and consistent. Precautions taken to protect integrity aim to stop people without authorisation from accessing data.

Verification: Verification is the process of entering data twice into a system. Both entries are compared and if they match, the data is deemed correct and is accepted. This technique is commonly used with setting a new password, but can also be applied to entering large datasets between multiple operators to ensure that the data is as accurate as possible.

Availability: Availability concerns people's need to feel confident that they will be able to access information, services and data in a speedy and effective manner even in the event of a malicious attack or damage to computing devices. Precautions include upgrading computer hardware and software and safeguards against loss of data or malicious attacks.

Some organisations such as banks cannot afford to lose a single transaction. All transactions need to be written to two separate systems simultaneously. If one system fails, the other system will automatically carry on seamlessly.

A disaster recovery plan needs to be in place to minimise delay in recovering systems and data. This will include where to find replacement hardware, who to contact, what procedures should be followed and who will be responsible for implementing the plan.

Backup and recovery procedures:

The role and methods of backup

The staff that manage a network will back up the servers regularly. A backup is a copy of all the users' files, which can be restored in the event of files getting corrupted or deleted. Backup copies must be made regularly; how often will depend on the nature of the system.

In some organisations, a daily backup may be sufficient but in others, such as in the banking or retail industries, every transaction must be duplicated to a second and even a third storage device in a remote location.

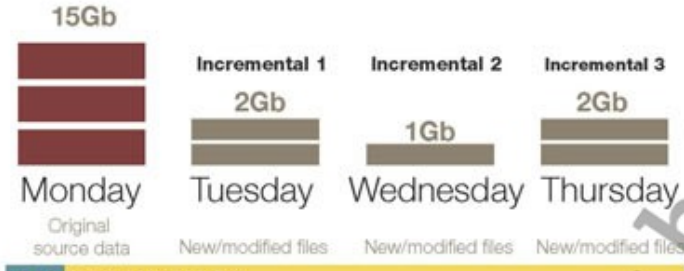
In the case of a daily backup, copies are normally made to a removable hard disk or cassette tape. The medium has to be high capacity and portable so it can be stored in a fire-proof safe or off site.

When you work on a project at school and save it in your user area on the school network, you are probably completely confident that it will still be available even if there is a catastrophic event like a hard disk crash. One method of ensuring that backups are safe is to save them in Cloud storage. The provider will have several huge data warehouses and will have copies of all data stored held at multiple sites.

Larger organisations also use a procedure known as mirroring. A mirror site is a website or set of files on a computer server that has been copied to another computer server so that the site or files are available from more than one source.

Full backup and incremental backup

It is not always necessary to make up a full backup of all files on a system. A more efficient method is to do an incremental backup, in which only new files or files which have changed since the last backup, are copied to the backup file. Software files, for example, are unlikely to change very often. Many data files will only be changed occasionally.



2.10 *Incremental backup*

Restoring form a backup

If a disaster occurs and the system has to be restored from the backup, it is much quicker to restore from a full backup. The entire contents can simply be copied onto a new hard drive.

When restoring from incremental backup, it is necessary to have the most recent full backup files as well as every incremental backup that has been made since the last full backup.

For example, a full backup was made on Monday and incremental backups were made on Tuesday, Wednesday and Thursday. If it is necessary to restore the backup on Friday morning, it would require all four backup files: Monday's full backup plus the incremental backup for Tuesday, Wednesday and Thursday.

Archiving

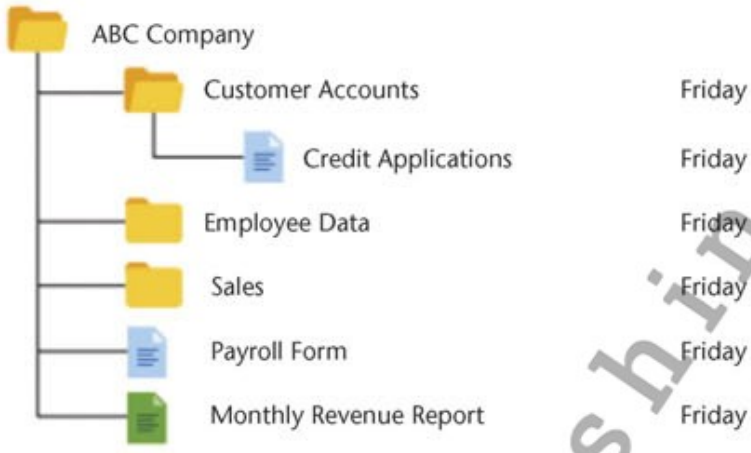
Often there is a large amount of data stored on a computer system that is no longer needed on a regular basis. However, you cannot delete it, in case it is needed again or because a company is legally required to keep some records for a number of years (for example tax returns). The data can be taken off the main system and archived, stored usually on magnetic tape as it is cheap. It can be loaded back onto the system if it is needed again. The purpose is to free up space on the main computer system.

Q8: **(a)** Explain the difference between backup and archiving.
(b) Explain what is meant by an incremental backup and how this would be carried out.

Tasks

5. Backup strategies often involve a combination of full backups and incremental backups. Start with the Full Backup and work through the incremental changes, noting the day last updated at each stage.

Day 1: Full backup:



Day 2: Incremental backup - Monday:

Update: ABC Company > Payroll Form.docx

Day 3: Incremental backup - Tuesday:

Update: ABC Company > Customer Accounts > Credit Applications.docx
Update: ABC Company > Monthly Revenue Report.xlsx
Create: ABC Company > Sales > Sales Presentation.pptx

Day 4: Incremental backup - Wednesday:

Update: ABC Company > Sales > Sales Presentation.pptx

Day 5: Incremental backup - Thursday:

Delete: ABC Company > Sales > Sales Presentation.pptx
Update: ABC Company > Monthly Revenue Report.xlsx
Move: ABC Company > Payroll Form.docx to ABC Company > Employee Dat

6. Fill in the name of the utility program being described in each row below:

	Prevents harmful programs being installed and important files being changed.
	Prevents unauthorised access to computers or a LAN.
	Secretly records the user's actions on the computer.
	Uses methods such as a fingerprint or retinal scan to identify a person.
	Notes sites a user visits and then presents adverts for products to the user.
	Controls what sites computers on the LAN can access.
	Procedure to copy all files which have changed since the last time the procedure was executed, to another storage device.

7. A company becomes aware that some of the customer data which was recorded in its database is no longer there.
   (a) Which of the following measures will help to discover why this is so?
   (b) Which of the measures will help to prevent a further occurrence of the problem? Write **D** (Discover), **P** (Prevent) or both in the appropriate box of the table below.

Measure	D (discover), P (Prevent)
Add access rights to the database	
Carry out tests on the database software	
Ensure that all PCs automatically log out after 10 minutes of inactivity	
Look at the audit trail created automatically by the computer system	
Have all employees sign an Acceptable Use policy when they join the company	

8. Look at the different types of information security measures we have seen in this module. Discuss what their main purpose is and label them `(C)` `(I)` or `(A)` depending on whether they aim to guarantee confidentiality, secure integrity or ensure availability. You may decide they serve more than one of these purposes.

```
Firewalls
Encryption
Password protection
Backup copies
Anti-malware software
User Access levels
Improving communication bandwidth
Upgrades
Acceptable Use Policies
Maintaining hardware
```

Module 3 Design: principles and processes

Learning objectives

- Explain the notions of "design" and "applicability" 10.2.1.1
- Explain how the principles of information perception can be implemented in a project 10.2.1.2
- Implement the principles of "good design" (convenience, simplicity, etc.) 10.2.1.3

What is design?

Design is a process that involves envisioning and planning the creation of objects, buildings or – in the case of computers – websites and interactive systems. The key to effective design is defining the **audience** for your product (website) very clearly. All good design is user-centred and in planning you must target who the website is for. It could, for example, be parents who enjoy travel with young children, teenage boys who are interested in racing cars or elderly people with difficulty walking.

At the start of the design process, you will also have to determine what the **purpose** of your website is. Are you seeking to inform, persuade – perhaps to buy – or purely to entertain? Design is about addressing needs and creating solutions for problems. The core purpose of the design should shape every decision you make. As Steve Jobs, the co-founder of Apple, put it: "Design is not just what it looks like and feels like. Design is how it works."

Design is a creative process but the goal of the process is to produce a practical, working tool/solution for the end-user. For this reason, research and information gathering are critically important to the designer. Collecting information about end-users – preferences they have or problems they face – through surveys or interviews and researching how other web pages have presented solutions are important stages in the process of design.

Design is a lot more than making things look nice. A web page designer, for example, should not think of the colours, shapes and contrasts he/she uses as a way of decorating the page but rather how these features will help the user to navigate the interface. The aim in creating a web page should be that a user when opening it will be able to understand almost immediately its processes of navigation and the meaning of its different elements.

Design principles

Information perception

Our understanding of how we perceive information visually is based largely on a set of principles which are known as Gestalt theory. We shall illustrate some of the basic principles in this theory here for you to consider later in the module when putting your web page designs together.

Simplicity

The most basic principle of information perception is that people prefer things that are simple and ordered. Things presented simply take less time to process and make the user feel safe.

3.1

Closure

When presented with more complex images people naturally look for a single, recognizable pattern. It is important when designing images or icons to provide enough information for the eye to be able to complete [fill in] the missing elements.

3.2

Q1: What do you see when you look at this image? How may of the individual shapes could you take away and still be able to recognise the whole image?

Symmetry

People naturally seek order and balance in images, tending to perceive them as symmetrical shapes built around a centre. Our eyes move quickly to find symmetry and order and designers can use this principle to communicate important information quickly.

3.3

Figure/ground

To understand an image the eye separates whole figures from their background. The smaller of two overlapping objects is seen as the figure and the larger as the ground.

3.4

Similarity

Elements in images that share similar characteristics are perceived as more related than elements that do not. Colour, shape, size and texture are all characteristics that can suggest similarity. In the image here, for example, the triangles of the same colour are perceived as similar.

3.5

Uniform connectedness

Elements in an image that are connected visually are perceived as more related than elements with no connection. The line between the figures on the right of the image leads to the perception that they are related. We do not have the same perception about the figures on the left.

3.6

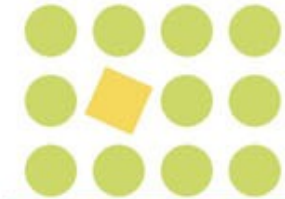
Common regions

Elements that are located in a closed region are perceived to be related. Designers can do this simply by placing a box around them or placing elements on a different coloured background

3.7

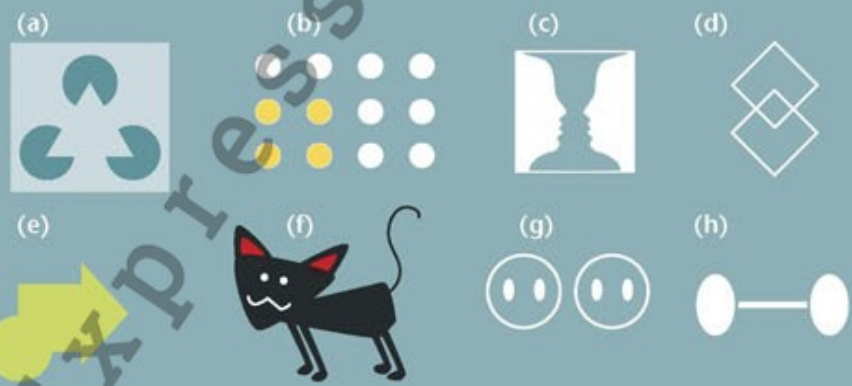
Point of focus

The attention of the user will be drawn towards an element that contrasts with the others in some way. The emphasis or difference of this element amongst others can be used by designers to convey messages such as important next steps or warnings.



3.8

Q2: Match one of the design principles above to the image that illustrates it below.



Task

1. Compare the design of the icons on the Android interface to those on Apple's platform. Which ones seem more unified in terms of design principles? Which ones are more appealing?
2. Use the Template in your Student Portfolio to sketch the outline of a web page design.

Accessibility

Accessibility refers to the potential of a service, product, device or environment to serve and meet the needs of as many individuals as possible. A system characterized by high accessibility can meet the needs of many people, while a system with low accessibility presents barriers to specific groups of people. Frequently, accessibility is studied in parallel with disabled people (people with special needs and the use of various assistive technologies.)

Usability

Usability refers to the potential of a product, application or website to accomplish user goals. The term is not limited to computer science but extends to other products and services of all kinds. Factors that influence usability are described below. Usability relates to effectiveness, efficiency and satisfaction in a specified context of use.

If a website is difficult to use, or if a website fails to clearly state what a company offers and what users can do, users will leave. If users get lost on various pages of the site then the website will not serve its original purpose. If a site's information is hard to read, does not answer users' key questions or contains irrelevant information, then the site has low or no usability. If an interface is not appealing then it will not attract users. For websites that serve e-commerce it is important for the users to quickly locate a product. Successful intranets increase employee productivity and decrease time wasted.

Features of usability

1. Complexity/Simplicity: Amount of effort to find a solution or get a result.
2. Effectiveness: Comparison of user performance against a predefined level.
3. Efficiency: Task completion time after the initial adjusting period.
4. Error: Number of errors, type of errors and time needed to recover from errors.
5. Learnability: Time used to accomplish tasks on the first use.
6. Memorability: Time, number or button clicks, pages, and steps used by users when they return to the device after a period of not using it.
7. Readability/Comprehensibility: Reading speed.
8. Satisfaction: Attitude of users toward applications after using them.

3.9 *Usability problems with different devices*

Visibility

Visibility is another key principle in design that can relate to a number of features in web page design. This can include features like signposts to show users where they are headed, keeping options they have visible rather than making users remember them and giving users warnings before they commit to actions.

Q3: Label these problems with design of a web page as **(a)** accessibility problems **(b)** usability problems **(c)** visibility problems.

1. On a ticketing website a user has to complete four separate forms before making a booking.
2. On most pages users have to scroll down very long menus.
3. An option menu is not available on a subsequent page.
4. It is difficult to re-enter information after a wrong input.
5. A website uses long written instructions rather than icons for navigation.
6. A website does not give warning signs about what clicking buttons means.
7. No subtitles are given with embedded videos on a web page.
8. It takes first-time users quite a long time to find what they want on the website.

Design Processes

Stakeholders are individuals, teams, groups or organizations that have an interest in the realization of a project or might be affected by the outcome of a project. So, any person who has interests in an existing or proposed information system can be described as a stakeholder of the system. The end-user is the person who is going to use the product. A relevant stakeholder can also be a frequent user of the current system. He/she will be able to identify flaws and errors of the current system or inconveniences that he/she has spotted. He/she will be able to propose some improvements that will be crucial to the update of the system. The manager or supervisor of the procedure that the system performs may also have some comments. Specialists who have dealt with a similar situation in the past can be asked for their advice.

- **Interviewing stakeholders.** An **interview** is a direct face-to-face procedure that focuses on obtaining reliable and valid data in the form of verbal responses from a person or a group (group of stakeholders).
  - **Structured interviews** are strictly standardized and prescribed. A set of prepared questions is presented in the same manner and order to each stakeholder.
  - **Unstructured interviews** are flexible. Stakeholders are encouraged to express their thoughts and personal beliefs freely.

An interview is a time-consuming conversational process that allows the interviewer to clarify questions and to observe verbal and non-verbal behaviors of the stakeholders. A disadvantage is that unstructured interviews often yield data too difficult to summarize, evaluate or perform any form of statistical analysis on.

3.10 *Interview*

- The use of **questionnaires** is effective when the questions are carefully constructed so as to elicit unambiguous responses. **Survey methodology** refers to a domain of applied statistics that focuses on taking samples from a population, as well as improving on the various data collection techniques (e.g. questionnaires).

  Closed or restricted questionnaires involve "yes" or "no" answers, short response questions and box checking. Such a questionnaire facilitates statistical analysis, tabular presentation of data, and summarizing processes.

Open or unrestricted questionnaires involve free response questions but allow for greater depth of responses from the stakeholder. Such a questionnaire is difficult to interpret or summarize and makes statistical analysis impossible.

Questionnaires guarantee uniformity of questions and therefore yield data that is easier to compare than information obtained through an interview. It is a time-saving, cost-efficient method to obtain data and reach a lot of stakeholders quickly. However, respondents' motivation is difficult to assess and stakeholders may not respond at all, answer only some questions, or misinterpret the question.

3.11 *Questionnaire*

- **Direct observation of current procedures** involves spending time in different departments. It is considered as a time-and-motion study that can show where procedures and processes could be made more efficient, or where possible bottlenecks may be present. Direct observation makes possible the collection of different types of data and information. Being on-site over a period of time familiarizes the analyst with the case study, thereby facilitating involvement in all activities and processes. Observation is independent of user bias but is a time-consuming method.

Q4: Customer support for a supermarket wants to develop a new system for online ordering with free delivery. Who are the stakeholders?

Q5: Compare unstructured interviews and restricted questionnaires as methods of data collection.

Q6: A company decides to build a web-site for marketing purposes. An analyst is asked to help. Explain what information the analyst must collect before the design process.

Developing a prototype

There are many advantages to creating a **prototype**. A prototype is either a working or non-working preliminary version of the final product or a simple version of the final system that is used as part of the design phase to demonstrate how the final product will work.

A prototype:

- Attracts the attention of the client, since it encourages them to use it and "get a feel for it"
- Provides just enough of the concept for the investors to decide if they want to fund the full production or not
- Encourages active participation between users and developers
- Gives an idea of the final product
- Helps in the identification of problems with the efficiency or the design
- Increases system development speed

3.12 *Prototype creation*

Iteration

Iteration refers to the repetition of a set of instructions for a specific number of times or until the operations yield a desired result. It is impossible to design a system, an interface or software that has no initial functional or usability problems. During the design process, the designers of the product may have to step back several times and reconsider choices they have made. Even the best designers cannot design perfect products in a single attempt, so an iterative design methodology should be adopted. As they proceed to decide how the product will finally look and function, they may stumble on several difficulties or inconsistencies that will force them to return to previous steps or versions and modify them, or even start the process from the very beginning. Iterative development of software involves steady improvement of the design based on various evaluation and testing methods (e.g. user testing). Hence, to make sure that everything works as it should, the producer may have to run through the process again and again.

For a system to be successful, the analysis and the design must involve all key stakeholders including the **client** (the person or organization paying for the project) and the end-users (people who will use the system). Involvement, collaboration and active participation are critical because a project with poorly-defined stakeholder goals is unlikely to be successful. The developed system may either solve a different problem, or deal with issues that are outside of the project's scope.

Q7: Give three advantages of using a prototype in the design process
Q8: Explain how 'user testing' is connected to the idea of 'iteration' in the design process.

Module 4 Animation

Learning objectives

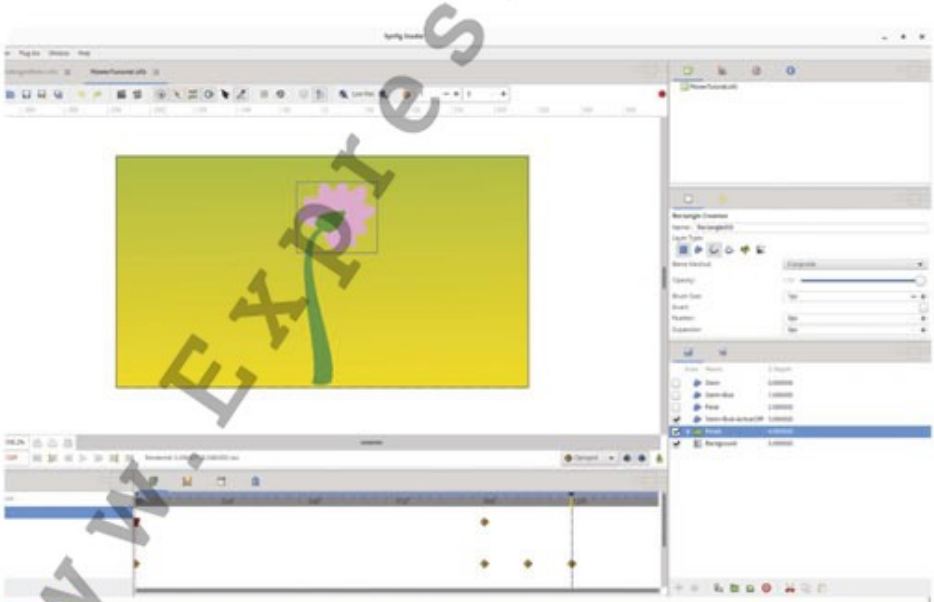
- To create a graphic object with the specified parameters (logo, banner, button for a web page) 10.2.2.1
- To create an animation for keyframes for a web page 10.2.2.2

Animations

When we show a series of images, each slightly different from the previous one, the brain is fooled into thinking the image is moving. Animation is created by a series of pictures that are shown very quickly in sequence similar to a children's flick-book. Very small changes between images create this illusion. Different programs can be used to create animations which can be anything from simple web banners to cartoons. These can then be used for interactive products such as presentations, information screens or websites. You can refer to this website www.bannerspiration.com to familiarise yourself with the kind of web banners that can be created using such software.

The Stage

The Stage is where the animation is created. Anything outside the Canvas window will not be seen in the final animation.



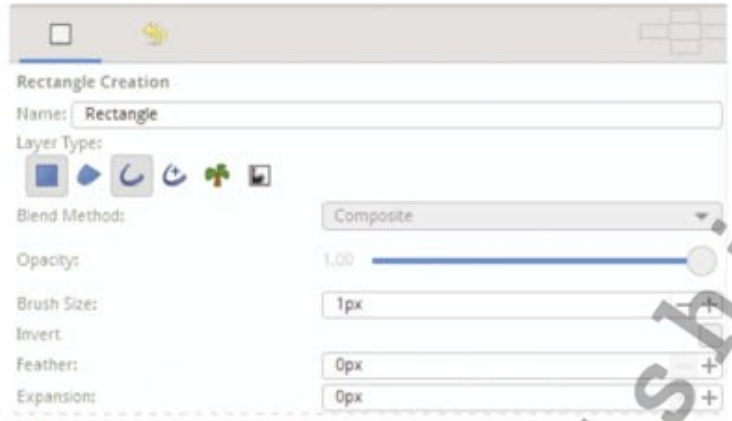
4.1 Canvas window

The main components in the user interface (workspace) of Synfig Studio are:

- Toolbox – This is the main Synfig Studio window. It contains tools and more to create and edit your artwork.
- Canvas – This window displays your artwork and animation.
- Panels – There are various panels which contain tools and information about certain elements of your project. Some panels will allow you to modify those elements.

Drawing tools

The toolbar is used to create shapes, set the Stroke line and Fill the colour.



4.2 *Toolbar*

Deselect the following icon to remove the outline from the shape:

When you draw in Synfig Studio, you create vector art. You can use these tools to add, subtract, join and distort shapes. Working with another learner, try out these techniques in Task 1.

Task 1

Joining shapes

- Click the Rectangle tool and select a black stroke or outline.
- Use the Rectangle tool to draw a rectangle (rectangle creation options will appear on the right-hand panel of the program).
- After you draw a rectangle, you can use the Transform tool to change its dimensions. Hold down the Shift key while you transform the shape to make a square.

- In the Layers panel, click on the rectangle and then Ctrl-click on the rectangle outline to select both layers.
- A selected shape appears to have dots over it. Be careful – if you only click the rectangle layer, the fill is selected but not the stroke around it.
- In the Parameters panel (at the bottom-left), make the stroke thicker so you can see it clearly. You can change the colours for the shape here too.

- Use the Circle tool to draw a circle. Drag the circle on top of the rectangle.
- Select all the shapes and outlines in the Layers panel, right click and select Group Layers. Rename the layer *MyShape*.
- With the Circle Outline selected in the Layers panel, change the Blend Method in the Parameters panel to Behind. Now the two shapes are joined together into one shape.

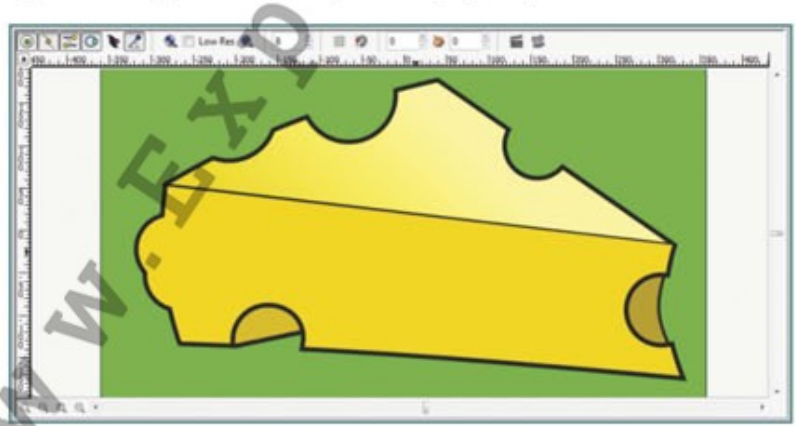
Subtracting shapes

- Draw a big circle. Next to it draw a big square. Group each shape layer to its outline layer.
- Use the Rotate tool to rotate the square group – moving your mouse to the blue vertex to rotate the square without changing its scale.
- Drag the square on top of the circle.
- Now use the Parameters panel, change the Blend Method of the Square layer to Alpha Over. Do the same to the Blend Method of the Square outline. This takes away the square including its stroke.
- Use Ctrl + Z to undo, putting the square outline back.
- This time change its Blend Method to Onto. This removes the black lines left outside the main shape.

Distorting shapes

- Draw a rectangle. Select all the layers of the rectangle in the Layers panel. Then in the Canvas window, you can drag the orange or yellow vertices to change the shape. Right click on the orange vertices to select the option Split Tangents. This gives much more flexibility to changing your shape.

Below we can see an image of a piece of cheese that is almost entirely constructed by subtracting and adding circles to a basic underlying shape.



These three techniques help you create all sorts of shapes.

Drawing splines

The Spline tool allows you to create more complex geometric shapes such as circles or rectangles.

Select the Spline tool and choose outline and fill colours. Also set the line width to a thick value, such as 10pt, so you can really see the power of this tool.

In the Tool Options panel, make sure that only Create Region, Create Outline and Link Origins are checked.

Left clicking with your mouse in the canvas will place a vertex. You can add as many vertices as you wish and adjust the tangents as you go to alter the shape.

You can right click and Delete Vertex if you do not like where you placed any of the vertices. You can also right click on a vertex and Split Tangents or Loop Spline.

To create the Spline layer, you must exit the construction mode. You can do this by selecting a different tool or you can click the Create button (which looks like a gear) at the bottom of the Tool Options panel.

Give some different shapes a try to get used to the tool.

Frame-by-frame animation

Frame-by-frame animations are created in the Timeline through the use of keyframes. Each keyframe defines a change on the stage and when the movie is played, the content seems to move.

4.3 *Frame-by-frame animations*

Using the Timeline

Familiarise yourself with the following features of the time line:

- A box with a mark means a Keyframe
- If there are no marks, then there are no keyframes.
- You can add keyframes using the plus icon in the Keyframe panel (at the button that looks like a key).
- A keyframe signifies a point of change
- A regular frame helps to alter the speed between keyframes

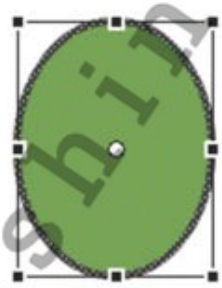
4.4 *Timeline*

Task 2

- Open a new Synfig Studio file.

The current frame is seen with a dotted line in the Timeline or in the Current Time box underneath the canvas. A red rectangle in the Timeline shows you which is the current frame. By default, you start in frame 0, which is a keyframe.

- Use the Circle tool to draw a circle.
- Navigate to frame 2 and select Add New Keyframe.
- Double-click the circle and use the Transform tool to drag the left and right sides in to keep the centre point in the same place.
- Navigate to frame 3 and select Add New Keyframe.
- Double-click the circle and narrow it again. Repeat the process in frames 4 and 5.
- In frames 6 to 8, add key frames and stretch the oval until it is a circle again.
- Below the canvas, select Play to see your animation.



- To make your animation repeat, select Show the Previews Settings Dialog from the Canvas toolbar (it looks like a video camera). Then select Preview and click the Loop button before playing the animation.
- Test your animation again. To stop the animation, press Pause or close the Preview window.

Task 3

Create a simple shape animation of your own. You should create your own shape and use Keyframes to make the shape change and/or move.

Frame rate

The secret to smooth animation is to have a reasonable frame rate - too slow and any animation would look jerky; over a certain speed the human eye would not notice any difference anyway, as it requires more processing power. Moving the drawing very slightly between frames rather than changing in big jumps makes the motion seem smoother. Adding frames between keyframes to pad them out helps slow the animation without noticeably affecting the smoothness. When keyframes are used for alternate frames this is known as shooting on twos, as each image appears for two frames before changing.

To alter the frame rate, you need to change the fps number by going to the Canvas menu, selecting Properties and in the Time tab, you can make changes by using the plus and minus buttons. You can also add an extra frame to your Timeline by increasing the value in the End Time by one.

In a movie that you view in a cinema or on DVD, the frame rate is 24fps. Television plays at 30fps. Synfig's default setting is 24fps.

Task 4

Experiment with altering frame rate and inserting extra frames. Can you work out how to:

(a) make your animation faster/slower?
(b) smoother?

Tweening or [inbetweening]

We can make animation easier by tweening. This involves creating the keyframes at the start and end of the sequence and then letting the program work out all the bits in between. There are two main ways of tweening:

- Shape tweening
- Motion tweening

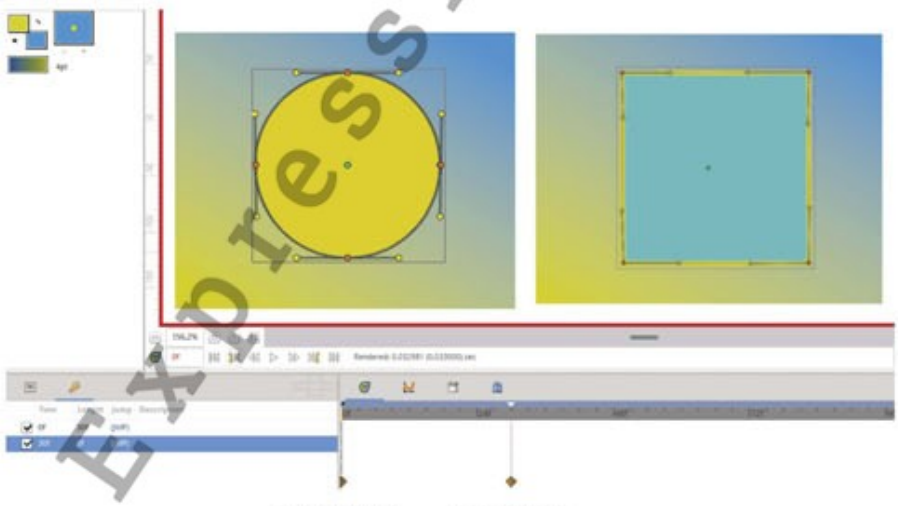
Shape Tweening

Shape tweening can be used to gradually alter the form of any editable shape. This gives the effect of one shape appearing to 'morph' into another. You can change the shape, colour and position of the shape and it works best on simple vector shapes such as lines, rectangles and circles.

Task 5

If we give the computer the start and end points, it can do the hard work for us.

- Draw a circle on the canvas using the Spline tool.
- Move further down the timeline to frame 30. Turn on animate editing mode by clicking the little green man under the Canvas window – he will turn red when it is activated. In the Keyframe panel, click the Add New Keyframe (+) button (If you are still working at 24 fps, that will give just over one second of animation.) We want a blank keyframe to draw the shape we wish the circle to turn into.
- Turn the circle into a square in a different colour. In the Parameter panel, you can edit the colour of the region and outline and it will Keyframe automatically.



Start point End point

- The shape is now automatically tweened between frames 0 and 30.
- If you scrub the timeline by dragging the yellow bar along it, or click on any of the intermediate frames, you will see the change happen.

Save your animation with a suitable filename.

Reversing the animation

You can reverse the animation by highlighting scrolling to frame 60 in the timeline and then, in the Keyframe panel, right-click on 0f and select Duplicate Keyframe. Frames 0 to 30 will now be reversed from frames 31 to 60.

To create a pause in the middle of the animation, you need to duplicate frame 30. Go to frame 40 in the timeline and Duplicate Keyframe 30 in the panel. Then drag the keyframe at frame 60 to frame 70.

Task 6

Create the reverse animation of the motion tween you created in Task 5.
Insert a pause before the reverse animation.
Can you work out how to

(a) play the animation on loop
(b) insert a pause between each loop?

Motion tweening

Tweening means giving Synfig the design of the keyframes and asking it to create the frames in between. Originally the job of animation was done by hand drawing, and the Keyframer would draw the keyframes, while the Inbetweener would draw the intermediate frames. These days we can ask the computer to work out the middle stages.

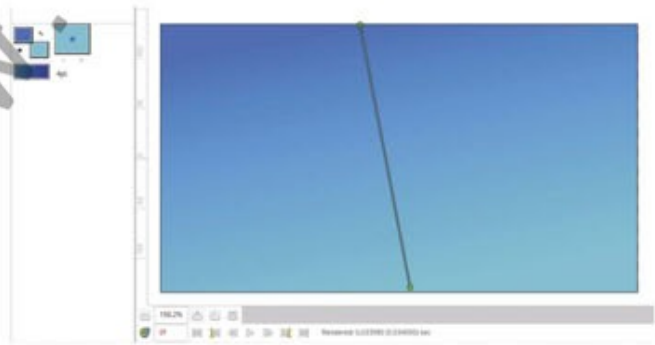
We saw in the previous section that a Shape tween is a transformation tween that morphs one shape into another. Another type of tween is a Motion tween that moves and rotates a graphic object or symbol.

You can create artwork and then save the artwork as a group that contains layers of images in sub-groups. The parent group links all the images, but each layer can also be animated individually. One typical use of groups is in a Motion tween, in which each layer requires a different type of motion such as forward movement and rotation in the case of a wheel.

Task 7

Creating an image and a motion tween

- Open a new Synfig file. The fps should be set to the default 24.
  Start by changing the colour of the stage.
- Select two similar sky blue colours in the outline and fill colour tabs. Right-click on the canvas, select Layer, New Layer, Gradients, Linear Gradient. Adjust the vertices until you get a result you are happy with.



- Now draw a small circle on the canvas. This might be the sun, for example.

Creating the motion tween

Now that we have created our circle, we can animate it!

- Select the circle with the **Selection** tool. Change the default interpolation under the canvas from **Clamped** to **TCB**. Drag the circle off the canvas to the left while in animate editing mode. This will be where the animation starts.
- Scroll to frame 120 on the timeline and drag the circle off the canvas to the right.

- Scrub the timeline. You will notice that the motion of the sun is straight. You can view the motion of the animation if you switch from **Timetrack** to **Graphs** in the **Timeline** panel.
- Press the **Play** button to view your animation.

Task 8

Changing the motion path

You can change the path of the animation by positioning it at different points along the timeline.

- Move the playhead to frame 60, and drag the sun to a different higher position on the canvas.

- Switch to Graphs on the timeline and you will see that the TCB interpolation automatically curved the motion of the circle. Try scrubbing the timeline again.
- Now try out some animations of your own using these techniques.

Task 9

Adding a background layer

Each layer can contain its own images, and you can draw and edit images on one layer without affecting objects on another layer. If, for example, you wanted to animate a face which smiled or winked, the face itself could be on one layer, and each of the features, e.g. eyes and mouth, on separate layers, where they can be separately animated.

In this task, you will give the moving circle or sun a background.

- Right-click in the **Layers** panel and select **New Layer**. Select the type of layer you want. You can also choose tools from the Toolbox to create new layers.
- Double-click the layer names to rename them with meaningful names.
- Drag the layers above or below each other to adjust the order of the layers 'stacked' on the stage. This will create the effect of one layer being behind another. In this example, the Sun layer is below the Hills layer so that the sun appears from behind the hills.

- Turn off animate editing mode and draw some hills at the bottom of the canvas. You could also do this using the Spline tool.

Task 10

Easing In or Easing Out

The Easing property of a Motion tween lets the symbol gradually speed up or slow down as it progresses through the tween. This can give the effect of a more gradual setting as the sun goes down behind the hills.

- Right-click on the first waypoint in the timeline (the green circle at frame 0). Select In, then Ease In.
- On the last waypoint at frame 120, right-click and select Out, then Ease Out.
- Test your animation.

Task 11

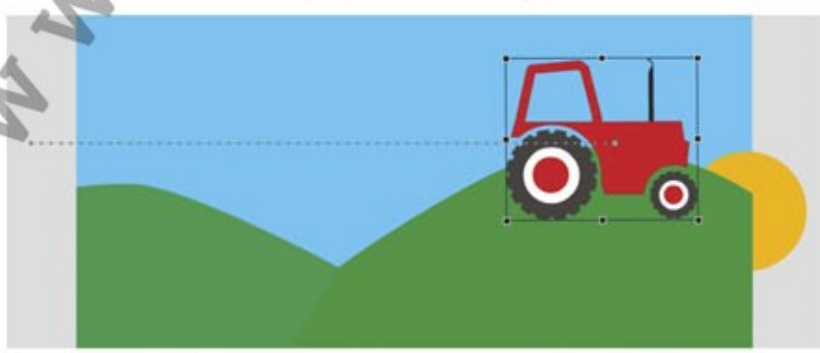
Importing graphics

Instead of creating your own image within Synfig, using the Drawing tools, you can import a graphic. If the image has been saved to your computer, you can use File, Import ... . The image will appear as a layer in the Layers panel and can be animated in the same way as the shapes you have learned how to make.

Removing a white background

It is best to remove the white background (or any other background) of an image you want to import in a graphics program such as Photoshop or GIMP and save it as a PNG file that supports transparency.

- If you do not have an image to use, select File, Import... and select the tractor-body.png files. You will have to import the front-wheel.png and back-wheel.png files, too.
- Group the image layers into a new group and rename the group Tractor.
- Create a motion tween for the image from left to right. Make sure the whole group is selected in order for the three image layers to move together.



- Adjust the motion path to follow the contours of your land.
- Test your animation.

Task 12

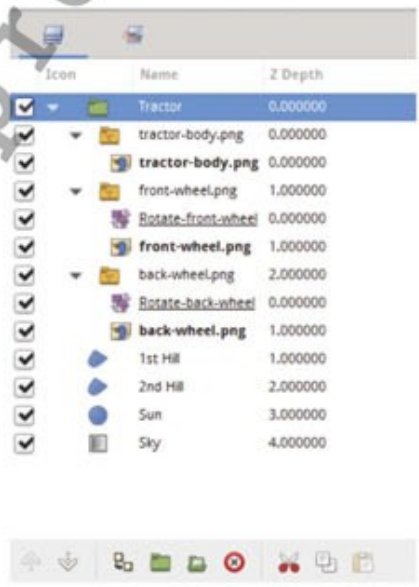
Orienting an object to a path

You will notice that as the tractor moves over the hills along a path, it does not follow the contours of the hills. You can change this by moving the blue vertex on the Tractor group at various frames along the timeline. When the tractor is going downhill, rotate the tractor downwards and when it is going uphill, rotate the tractor upwards.

Extension: Animating inside a group

If you have created your own group from shapes within Synfig, you can animate them and their sub-parts in the same way as you can animate anything on the canvas using layers and more groups. Once you are editing a group, you can zoom in to animate only that element. This is shown at the top of the Layers panel and by the vertices being displayed around the selected layers. Here, the Tractor is being edited, within the canvas.

- Open Farm.sifz. Double-click the tractor group to edit it.
- In the front-wheel.png layer, right click on the image and select New Layer, Transform, Rotate. Do the same for the rear wheel.



- With the Tyre symbol selected, apply a **Motion Tween**. You should not use a path in this instance.
- Go to the first frame of the timeline and record a keyframe (in animate editing mode). Go to the last frame and with the front wheel selected on the canvas, move the blue vertex in a clockwise motion so it almost completes a full rotation.
- Scrub along the timeline to see your rotation effect. (Sometimes an optical illusion called the wagon-wheel or stroboscopic effect will occur causing the tyre to appear to be spinning in the wrong direction.) You can reverse the rotation if this happens.
- Repeat this same process for the back wheel.
- Scrub along the timeline and see how your tractor moves much more realistically.
- Save and test your animation.

Module 5 HTML and Web page development

Learning objectives

- To get to know the main HTML tags 10.2.3.1
- To develop a web page in a web editor 10.2.3.2
- To place graphic objects and animations on a web page (logo, banner, etc.) 10.2.3.3

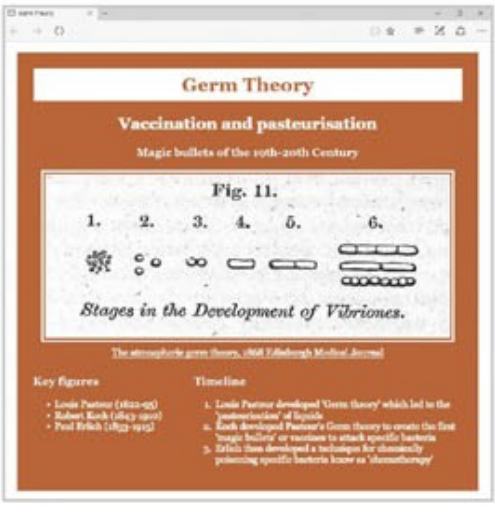
HyperText Markup Language (HTML)

HTML is the language or script that web pages are written in. It describes the content and structure of a web page so that a browser is able to interpret and render the page for the viewer. HTML is usually used in conjunction with Cascade Style Sheets (CSS) which dictate the style and formatting of a web page rather than its content.

HTML and CSS

The effects of HTML and CSS on a web page can be seen left, without CSS styles, and with styles on the right:

5.1 *HTML only, without CSS*



5.2 *HTML with CSS formatting*

HTML Tags

HTML is made up of tags written in angle brackets, often in opening and closing pairs, e.g. `<html>` and `</html>`.

A standard web page comprises two sections – a head and a body. The head contains the title of the web page that may appear in a window header or browser tab, and any script that may enrich your page content. The body contains the main content of the page, defining text,

images and hyperlinks. An HTML file can be created using a text editor such as Notepad, or using software such as Adobe Dreamweaver.

5.3 *Standard web page*

Q1: Create a simple HTML file in Notepad as shown above. Change the `<title>` text and add text to the `<body>` section. What effect does this have when viewed in a browser?

A table of common tags and their function is given below:

HTML Tag	Definition
`<html>`	All code enclosed within these tags is interpreted as HTML
`<body>`	Defines the content in the main browser content area
`<head>`	Defines the browser tab or window heading area
`<title>`	Defines the text that appears with the tab or window heading area
`<h1>, <h2>, <h3>`	Heading styles in decreasing sizes
`<p>`	A paragraph separated with a line space above and below
`<img>`	Self closing image tag with parameters: `<img src = location, height=x, width=y>`
`<a>`	Anchor tag defining a hyperlink with location parameter: `<a href="location"> Link text </a>`
`<ol>, <ul>`	Defines an ordered (numbered) or unordered (bulleted) list
`<li>`	Defines an individual list item within either a numbered or bulleted list

`<audio> </audio>`	Audio tag supporting MP3, WAV, and OGG:
	`<audio controls>`
	`  <source src="ping.mp3" type="audio/mpeg">`
	`</audio>`

`<video> </video>`	`<video width="160" height="120" controls>`
	`  <source src="skate.mp4" type="video/mp4">`
	`</video>`

Adding HTML tags to insert multimedia objects on a web page

Multimedia objects such as images, sounds and video can be embedded into a web page using the `<img>`, `<audio>` and `<video>` tags shown in the table above. The most common of those being the `<img>` tag. A complete list of the tags and their various attributes can be found at www.w3schools.com/tags.

The HTML tag

The `<div>` tag facilitates the division of a page into separate areas, each of which may be referred to uniquely by name, and styled differently using CSS.

CSS Script

CSS is a scripting language similar to HTML that is used to describe the layout and styles of a web page. Styles can be applied to existing HTML elements such as `<h1>`, `<p>` or `<div>`.

Embedded, inline and external CSS

CSS script can be inserted directly into the HTML document `<head>` as internal or embedded CSS between its own `<style></style>` tags. It can also be entered directly within the HTML body, known as **inline** CSS, as shown in lines 15 and 19 of the example HTML script overleaf. Either of these methods enable styles to be kept within the HTML document, and inline CSS can help make one-off style adjustments that are unlikely to affect any other part of the website. By far the most common technique, however, is to make style declarations in an **external style sheet**. A link to the external sheet can be placed in the HTML file using the `<link>` tag, for example see line 4 of the HTML script on the following page. Linking to an external style sheet has the advantage that multiple HTML or web page files within the same site can each link to the same style sheet so that formatting can be applied consistently without the need to duplicate CSS styles.

Identifiers and Classes

Identifier and class **selectors** are named 'hooks' onto which you can hang styles. You can then apply these grouped styles to an HTML element such as a `<div>` element by adding the class or id name as a parameter, e.g.

```
<div id="page">.
```

The styles for the id selector called page are listed within curly brackets within the CSS document:

```
#page{max-width:800px; margin: 20px auto; padding: 30px;
                          background-color: #cc6633;}
```

(Refer to line 8 of the HTML script on the next page, and lines 13-19 of the CSS script on page 54.) Any HTML content within the page divider will be styled accordingly.

Identifiers

Identifiers are defined with a hash tag (#) preceding the id name, e.g. `#header` (CSS lines 21-26). Identifiers must be unique to every web page. In this 'Germ theory' example, #header is a good example of a unique element since a web page is likely only to contain one header.

Classes

Classes work in a similar way to an identifier but use a full stop as a prefix to the class name e.g. `.list` (CSS Script lines 35-38). Classes can be used multiple times on a web page. In the example within this module, there are two lists which share common formatting unique to the list element such as the font colour. This can be defined in the CSS and applied to all list `<div>` regions on the page. See HTML Script lines 22 and 32.

5.4 *Web page formatting*

HTML Script

```
<html>
<head>
    <title>Germ Theory</title>
    <link href="styles.css" rel="stylesheet" type="text/css">
</head>

<body>
    <div id="page"><!--Opening page-->
        <div id="header">
            <h1>Germ Theory</h1>
        </div>
        <h2>Vaccination and pasteurisation</h2>
        <h3>Magic bullets of the 19th-20th Century</h3>
        <img src="germ_theory.jpg" width="750" height="300" alt="The atmospheric
germ theory">
        <p style="margin: 10px 0px;">
            <a href="https://archive.org/details/b21488308">The atmospheric germ
theory, 1868 Edinburgh Medical Journal</a>
        </p>

        <div id="left-column" style="float:left; text-align: left;
        width:300px;">
            <h3>Key figures</h3>
            <div class="list">
            <ul>
                <li>Louis Pasteur (1822-1895)</li>
                <li>Robert Koch (1843-1910)</li>
                <li>Paul Erlich (1853-1915)</li>
            </ul>
            </div>
        </div><!--Closing left-column div-->
        <div id="right-column">
            <h3>Timeline</h3>
            <div class="list">
            <ol>
                <li>Louis Pasteur developed 'Germ theory' which led to the
'pasteurisation' of liquids</li>
                <li>Koch developed Pasteur's Germ theory to create the first
'magic bullets' or vaccines to attack specific bacteria</li>
                <li>Erlich then developed a technique for chemically poisoning
specific bacteria know as 'chemotherapy'</li>
            </ol>
            </div>
        </div><!--Closing right-column div-->
        <div style="clear:both;"></div>
    </div> <!--Closing page div-->
</body>
</html>
```

Q2: Explain the function of the HTML code on lines 14 and 16.
Q3: The web page owners would like to change the font colour of the numbered and bulleted text to white. Explain what change needs to be made in order to achieve this.

CSS script

```
1  @charset "utf-8";
2
3  body
4  {
5      margin: 0px;
6      padding: 0px;
7      background-color:white;
8      font-family: Georgia, Times New Roman, "serif";
9      font-size: 18px;
10     text-align: center;
11 }
12
13 #page /* Styles for Page */
14 {
15     max-width:800px;
16     margin: 20px auto;
17     padding: 30px;
18     background-color: #cc6633;
19 }
20
21 #header /* Styles for Heading */
22 {
23     padding: 5px;
24     background-color: white;
25     text-align: center;
26 }
27
28 #right-column
29 {
30     float: right; /* Moves the container to the right */
31     width: 500px; /* Adjust width to fit content */
32     text-align: left;
33 }
34
35 .list
36 {
37     color: #ffcc66;
38 }
39
40 img
41 {   border: double 10px white;}
42
43 h1
44 {   font-size:36px; color: #cc6633; margin: 0px; padding: 5px;}
45
46 h2
47 {   font-size:30px; color: #ffcc66;}
48
49 h3
50 {   color:white;}
```

Tasks

1. A website has the following HTML code.

```
<html>
    <head>
        <title>Garden Roses</title>
    </head>

    <body>
        <h1 style="font-family:Arial; color:red">Species</h1>
        <p>There are over 100 species of rose.</p>

        <!-Part b -->

        <ul>
            <li>Climbing roses</li>
            <li>Shrub roses</li>
            <li>Rambling roses</li>
        </ul>
    </body>
</html>
```

   (a) Sketch and annotate the website as it would appear in a browser.

   (b) The site owner would like to add a hyperlinked image rose.jpg in place of the comment `<!-- Part b -->`. The image would link to the website http://www.roses.com. Write the code to enable this.

   (c) Heading 1 `<h1>` has had some styles applied using inline CSS.

   (i) Give one advantage of using CSS styles within the HTML document.

   (ii) Give two advantages of using an external CSS style sheet.

   (d) An external CSS style sheet is added to the web page. This contains three rules. Describe what effect if any these rules will have on the appearance of the web page. Where there is no effect, this should be stated.

   (i) `body {background-color: lightGreen}`

   (ii) `p.bold {font-weight: bold}`

   (iii) `h1 {text-align: center}`

   (e) The text within the `<ul>` tags needs to be styled in green with the intention that any other lists added to the page share the same style. Explain how this can be achieved.

2. Cascade Style Sheets (CSS) make use of .classes and #identifiers.

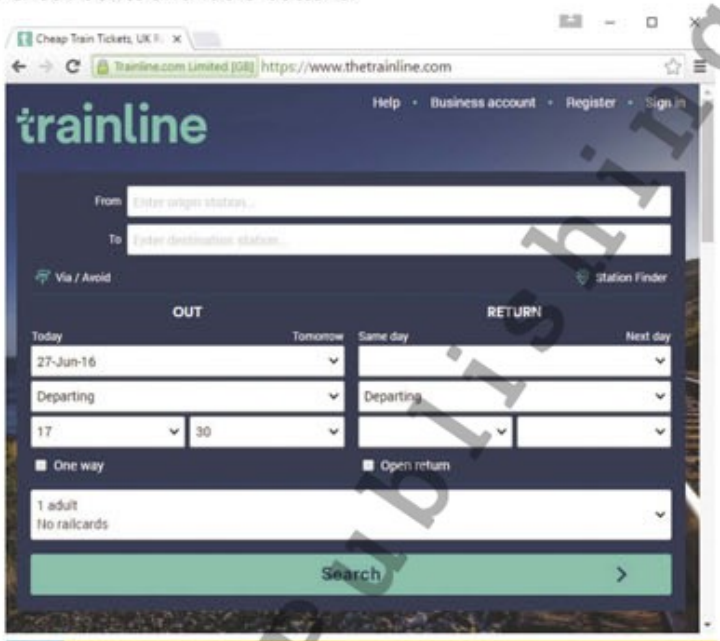
   (a) Explain the difference between them giving an example of when each might be used.

   (b) Explain how a CSS style defined as a class or identifier may be applied to a specific section of HTML content.

Web forms and JavaScript

Web forms

Web forms enable websites to collect user input data and selections. Input types include, for example textboxes, check boxes and radio buttons.



5.5 *Web form*

Input can be validated and submitted to the website owner's database or processed as part of a search query to find, for example, train times or your nearest shop branch when you enter a postcode.

Creating a web form using basic HTML form controls

A simple, unformatted web form that uses basic text boxes for input and a pair of buttons to **submit** and **reset** the page can be created very quickly. It will remain functionless, however, until actions are applied to it. JavaScript can be used to add **behaviours** to a web page, and included in that, active web forms.

The HTML script below should be compared with the screenshot of the page below.

```
<h1>Register</h1>
<form action="process.php" method="post">
    <label>Enter your email to register:</label>
    <input type="text" id="email" value="" size="40" />
    <button type="submit">Submit</button>
    <button type="reset">Reset</button>
</form>
```

5.6 *Page screenshot*

Q4: The buttons are created in the browser window using built-in formatting. How might customised styling be applied?

Form handling with submit and reset actions

The button type is specified as an attribute of the button, e.g. `type="reset"`. This will provide some basic functionality in the case of the **reset** button which clears the form data. A **submit** button type will send data to a **form handler** specified in the **action** attribute of the `<form>` tag. The form handler on the server will then process the form data – in this case, an email address.

Q5: What is the form handler called in the example above?

JavaScript

JavaScript is a **script** language that uses all of the same programming constructs that are familiar in languages such as Python and VB. It should not be confused with the language Java. JavaScript is commonly used to add interactivity to websites, including the manipulation of page objects, animations, navigation tools and form validation. JavaScript is **interpreted** rather than compiled. **Compilers** produce **object code** which is specific to a particular type of processor. JavaScript needs to be translated into the object code for whichever computer the browser is running on, and will be translated by the interpreter when the web page is displayed. An interpreter in the browser reads the JavaScript code, interprets each line and runs it. Some of the latest browsers, however, use 'Just-In-Time' compilation which compiles JavaScript into executable **bytecode** just before execution.

Input

JavaScript can be used to process input data on the client's computer. This may change the local page interactively or post data to a server. The advantages of processing input data before it is posted to a server are that:

- the local computer can validate erroneous data before submission to a database
- a busy server is relieved from having to process everything itself.

Output

JavaScript can reference and interact with HTML elements to edit, style or move them. For example, a **validation** script may change a 'postcode' input label to become red if a user has entered invalid data:

```
document.getElementById("postcode").style.color="red";
```

Using JavaScript to control web page functions

Building on the example of a basic web form above, JavaScript can be used to create a simulated Captcha form shown in figure 5.7.

The HTML form elements are given ids in order for the JavaScript to reference them. (See lines 16-19 of the HTML form script below.) Buttons are given onClick **attributes** in order to execute JavaScript functions when they are pressed. Their type has also been changed to become `"button"` rather than `submit` or `reset` actions. (See lines 20-21.)

5.7 *Captcha form*

HTML form script

```
<!DOCTYPE html>
<html>
<head>
    <title>Register with Captcha</title>
    <style>
        body, input { font-family: Arial, Helvetica, "sans-serif"; font-size: 15px; }
    </style>
</head>

<body>

<h1>Register with Captcha</h1>

<form>
    <div id="captchaImage"> </div> <!-- Empty div to contain random Captcha image -->
    <label id="captchaPrompt">Enter the word shown above:</label><br />
    <input type="text" id="captchaResponse" value="" size="40" /><br /><br />
    <label id="emailPrompt">Enter your email to register:</label><br />
    <input type="text" id="email" value="" size="40" /><br /><br />
    <button type="button" onClick="validateForm();">Submit</button>
    <button type="button" onClick="setupForm();">Reset</button>
    <input type="hidden" id="captchaAnswer" value="" />
</form>

```

JavaScript code

JavaScript functions and commands are added to HTML documents within <script> tags.

```
<script type="text/javascript">
// needs to run when page loads or refreshes
function setupForm() {
    document.getElementById("captchaPrompt").innerHTML='Enter the word shown above:';
    document.getElementById("captchaPrompt").style.color="black";
    document.getElementById("captchaResponse").value="";
    document.getElementById("emailPrompt").innerHTML='Enter your email to register:';
    document.getElementById("emailPrompt").style.color="black";
    var captcha=["captcha1.jpg","captcha2.jpg","captcha3.jpg"];
    var captchaAnswer=["weasel","moose","polecat"];
    var j=Math.ceil(Math.random() * captcha.length);
    j--; // Javascript indexes start at 0 - the count is 3 items, so subtract 1 to get item in
range 0-2
    document.getElementById("captchaImage").innerHTML="<img src='"+captcha[j]+"' width='305'
height='100' />";
    document.getElementById("captchaAnswer").value=captchaAnswer[j];
}

function validateForm() {
    // validates the captcha
    if (document.getElementById("captchaResponse").value != document.getElementById(
"captchaAnswer").value) {
        document.getElementById("captchaPrompt").style.color="red";
    } else {
        // validates the email for an @ character within the string
        var valid=false;
        var email=document.getElementById("email").value;
        //var emailLength=email.length;
        if(email.indexOf("@") >= 1) {
            valid=true;
        }
        if(valid==true){
            alert('Thank you for registering with address: \n' + email);
            document.getElementById("emailPrompt").style.color="black";
        } else {
            document.getElementById("emailPrompt").innerHTML='Enter a valid email to register:';
            document.getElementById("emailPrompt").style.color="red";
        }

    }
}
setupForm();
</script>

</body>
</html>
```

JavaScript output

JavaScript commands can access and edit HTML elements outside of the `<script>` tags, and write directly to the web page document using the command `document.write("Hello World");` for example. The attribute `.innerHTML` of an HTML element can be edited directly. (See line 28 above.)

Q6: What is the effect of line 57 of the JavaScript code?

Another method is to cause the browser to display a pop-up alert box with a custom message requiring the user's attention. Line 54 displays an alert box once the user has submitted valid details.

5.8 *JavaScript Alert box*

Functions and Variables

JavaScript functions are declared within curly brackets `{}` and called using the function name e.g. `setupForm();`. Function parameters may be included inside the round brackets, but if there are none, empty brackets must be used.

Q7: What are the identifiers of two variables used in the JavaScript code?
Q8: The function setupForm is called and executed using the command setupForm(); on line 63.
(a) What is the purpose of the function?
(b) Looking at the HTML form script, when else is this function used?

Validation

Validation routines are commonly built into web pages using JavaScript since the script is executed locally on the client's machine. The function `validateForm()` checks the user input and either changes form labels and styling in response to an invalid entry, or displays the alert box above.

5.9 *Validation routines*

Arrays in JavaScript

JavaScript arrays can hold any type of data. In this example there are two arrays – one to hold a set of three captcha images and the other to hold the answers to each of them.

```
var captcha=["captcha1.jpg","captcha2.jpg","captcha3.jpg"];
var captchaAnswer=["weasel","moose","polecat"];
```

On line 35, a math function generates an average number between 1 and the length of the array (i.e. 3 in this case), and assigns it to variable `j`. JavaScript array indexes begin at 0, so 1 is subtracted from `j` using the simplified command `j--` to decrement `j` by 1 in order to reference array indices 0-2.

Tasks

3. A website contains Javascript code.

(a) Describe what is meant by the term JavaScript.

(b) Explain why *JavaScript* is usually interpreted rather than compiled.

4. The website www.postrates.com offers a rate check service for sending letters and parcels. The homepage contains a button hyperlinked to the following web page:

```
1  <!doctype html>
2  <html>
3  <head>
4      <title>Shipping rates</title>
5  </head>
6
7  <body>
8  Calculate shipping rates
9  <script Language = "JavaScript">
10 var weight = prompt("Enter the parcel weight in kg", "");
11 var length = prompt("Enter the largest dimension in cm", "");
12
13 if (weight < 1 && length <= 20)
14 {
15     alert("Letter rate: £0.65");
16 }
17
18 if (weight < 1 && length > 20)
19 {
20     alert("Small parcel rate: £1.85");
21 }
22
23 if (weight >= 1)
24 {
25     alert("Large parcel rate: £3.50");
26 }
27 </script>
28
29 </body>
30 </html>
```

(a) Which lines of code contain JavaScript code?

(b) Give the identifiers of two variables used in the code.

(c) Looking at the web page code, what is the purpose of the JavaScript function called `prompt` on line 10?

(d) When the web page is requested, what would happen if a parcel weight of 1 kg and a maximum length of 10 cm is entered?

Module 6 Databases

Learning objectives

- To create a single-table database 10.2.4.1
- To sort and filter databases 10.2.4.2
- To create a form for data entry 10.2.4.3
- To generate queries for selecting data using the constructor 10.2.4.4
- To create formatted reports using the extracted data 10.2.4.5
- To explain why primary keys are used in databases 10.2.4.6

Data

From the day you are born, someone holds data about you. When you start school, go to the doctor or dentist or join a sports club or some other organisation data will be kept about you. We use the term **entity** to talk about a category of person, physical object or event about which data is held in a database table. A farmer, for example, might appear as a supplier in the database of a supermarket chain, and as a customer in the database of a business called **FarmCo** that sells tractors. Data about the farmer is recorded in a **Supplier** table in the supermarket database, and in a **Customer** table in the FarmCo database. **Supplier** and **Customer** are examples of entities.

6.1 *The same farmer or tractor may be an object in several different databases*

Q1: Suppose someone in your family buys a book, shirt, food or other items online. What data might be kept? By whom? For what purposes?

Databases

A database contains one or more **tables**. Each table generally contains data about a single entity; in the table named **tblFilm** shown below, the entity is **Film**. A table has many rows, and each row contains a record about an object in the database.

Columns in the table each contain one **field** of a record. Look at Figure 6.2. It is a screenshot from a database about films.

tblFilm

Film ID	Title	Studio	Release date	Production cost($m)	Box Office($m)
1	Avatar	Fox	01 July 2009	254	2787.97
2	Spider-Man 3	Sony	16 April 2007	286	890.87
3	The Dark Knight Rises	WB	12 July 2012	230	1084.43
4	The Hobbit: The desolation of Smaug	WB	13 December 2013	225	960.37
5	Harry Potter and the half-blood Prince	WB	15 July 2009	268	934.42
6	Pirates of the Caribbean:Dead Man's Chest	BV	24 June 2006	256	1066.18
7	Shrek 2	DW	19 May 2004	100	919.83
8	Pirates of the Caribbean: At world's end	BV	19 May 2007	300	963.42
9	Skyfall	WB	23 October 2012	205	1108.56
10	Titanic	Fox	19 December 1997	260	2186.77

6.2 *A screenshot from a database about films*

It has a single table with **rows** (records) and **columns (fields)**. The table **tblFilm** was created using MS Access, a Database Management System (DBMS) that enables users to create customised applications for their particular purposes. The software allows users to create new tables, input and validate data, query the database, create forms for data entry and produce reports.

Q2: **(a)** Look at Figure 6.2. Identify the **entity** about which data is held.
(b) How many **records** are shown?
(c) How many **fields** are there in each record?

Structure of a database table

Each field (or **attribute**) in the table has to be given a name and a data type.

tblFilm

Field Name	Data Type
Film ID	AutoNumber
Title	Short Text
Studio	Short Text
Release date	Date/Time
Production cost($m)	Number
Box Office($m)	Number

6.3 *Structure of the database table tblFilm*

When you create a new database table, you need to specify what type of data is to be stored in each field. These data types include:

- text
- integer
- real numbers with a decimal point
- date
- currency
- Yes/No or True/False (Boolean)

Q3: Complete the columns, which show some of the fields and data types that may appear in a database table about products

Field	Example	Data type
Product code	BR356681	Text
Description	Hamburger rolls	
Quantity in pack	12	
Price	2500.00	
Quantity in stock		
Gluten-free?		

Primary key field

One field in the table is designated as the **primary key**. Each record in a table must have a different value in the primary key field, so that it uniquely identifies the record. The primary key field is automatically indexed. The **index** will specify the address or position of the record in the table, so that it can be directly accessed.

You can specify that other fields are to be indexed. For example, in a table about books, you could specify that the field Title is to be indexed. This index is called a **secondary index**. In a very large database, a secondary index will speed up searches on that field, just like having an index at the back of a book.

Q4: Which field is the primary key field in the **TblFilm** table shown in **Figure 6.3**?

Validation checks

In order to minimise errors when data is entered into the database, as many fields as possible should be validated. This means specifying a rule that the data must obey. There are several types of validation checks, shown in Table 6.1.

Table 6.1

Type of check	Example
Range check	Price must be between 1000T and 14000T
Type check	A field must be a number data type
Presence check	Data must be entered in the field
Format check	A date must be in the format dd-mm-yy, or a product code must have 2 characters followed by 6 digits
List check	Data must be one of the items on a predefined list

You can use these **comparison operators** on numeric fields to specify a valid range.

> < <> = <= = <>

Q5: Suggest two different validation rules that could be applied to fields in the Films database table shown in **Figure 6.2**?

	Field name	Validation type
Validation 1:		
Validation rule		

	Field name	Validation type
Validation 2:		
Validation rule		

Activity 6.1

This activity can be found in the Portfolio. It shows how to perform the following tasks in MS Access.

- Add records to an existing Access database **Films.accdb**.
- Change the structure of the database by adding a new **"Yes/No"** field specifying whether a film has been seen (or shown in a particular cinema).
- Insert a second new field **Classification** with type "Drop-down list".
- Add validation rules to the **Release date** and **Production cost** fields.
- Save the database and test the changes by entering some more data.

Creating and answering queries

Once a database table has been created, it is easy to add, delete, change and view records. There is, however, a lot more that we can do. One of the main purposes of holding data in a database is to be able to answer **queries**.

Using the film database as an example we may have queries such as:

- Which films have grossed over a billion dollars worldwide?
- Which films have been produced by Warner Brothers (WB) since 1st January 2013?
- Which films have a "U" classification?

In Access, you can create a query to find records in a database table which satisfy specific criteria. Once a query has been created, it can be saved and run whenever it is needed.

With only a few records, it would be easy to find information manually in response to queries like:

- How many films had production costs of more than $250 million?

But when there are thousands of records, the power of databases really shows.

Q6: Complete the table of comparison operators used in queries.

Operator	Meaning	Example
<	Less than	
<=	Less than or equal	
>	Greater than	Production cost($m)>250
>=		
=		
<>		

Q7: Write the condition for a query which will list all the films from Fox that were released before 2006.

Q8: Write the condition for a query which will list all the films released by Fox since the beginning of year 2000.

The two logical operators **AND** and **OR** let you combine different criteria.

Q9: State the IDs of the films that would be found in **tblFilm** using this query:

```
(Release date > 01 January 2012) AND (BoxOffice($m) > 1000)
```

In MS Access, a query grid can be filled in to specify the table and criteria to be used. The grid for this query would appear as shown below:

Field:	Film ID	Title	Release date	Box Office($m)
Table:	tblFilm	tblFilm	tblFilm	tblFilm
Sort:				
Show:	☑	☑	☑	☑
Criteria:			>#01/01/2012#	>1000
or:				

6.4 *A query grid*

Activity 6.2

This activity can be found in the Portfolio. It shows how to create queries in a database, including those using **AND** and **OR** operators.

Parameterised queries

A **parameterised query** is the term used to describe a query for which the user specifies the search criteria to be used each time a query is run. For example, when searching a table about cars, the user will probably want to enter a different make of car each time they run the query.

Typical examples might include:

```
[Enter the make of car]
< [Please enter the maximum price]
Between [Enter start date] and [Enter end date]
```

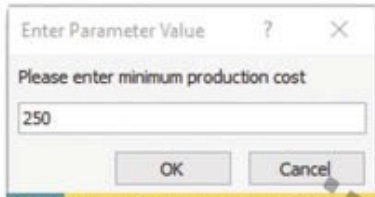
In these examples, the values entered by the user when the query is run, e.g. make of car, maximum price, start date and end date are the **parameters**.

The screenshot below shows a parameterised query.

Field:	Title	Studio	Release date	Production cost($m)
Table:	tblFilm	tblFilm	tblFilm	tblFilm
Sort:				
Show:	☑	☑	☑	☑
Criteria:				>[Please enter minimum production cost]
or:				

6.5 *Creating a parameterised query*

When the query is run, a window pops up for the user to enter the data they wish to use:



6.6 *Entering the query parameter*

Q10: Consider the following scenario.
A database has been used to record the responses from pupils at a school that is considering building a new sports facility. Students are asked to choose the facility they would most like to have – a football pitch and pavilion, a cricket pitch and pavilion, a swimming pool or an indoor sports hall.
Some of the responses are shown below.

tblSports

ID	Gender	Age	PreferredFacility
1	F	14	Swimming
2	F	13	Indoor
3	M	14	Football
4	F	11	Indoor
5	M	15	Cricket
6	F	14	Cricket
7	F	12	Indoor
8	F	14	Swimming
9	F	16	Swimming
10	M	13	Swimming
11	M	13	Football
12	M	14	Swimming
13	M	16	Cricket
14	F	12	Indoor
15	F	13	Swimming
(New)		0	

6.7 *Sports facility database*

Use comparison operators to create the following queries. List the IDs of the records that will be found by each query.

(a) All females who would prefer a swimming pool
(b) All males aged 12 and over who participated in the survey
(c) All students who voted for either football or cricket
(d) All students under 13 who voted for an indoor facility

Reports

Report creation functions are included in database programs such as Access. They allow users to analyse data in different ways. Businesses, for example, often generate quarterly sales reports which are then broken down further into monthly figures. These reports help managers to analyse factors affecting performance and make appropriate decisions.

Access makes it easy to create a report using a **wizard**, a feature of the software which allows you to specify the table(s) or query which the data for the report will come from, which fields are needed, what sequence they should appear in and what totals are required. The user can then select their preferred report layout from several options.

Using a wizard is much quicker and easier than creating a report from scratch.


Students' Preferred Sports Facility

PreferredFacility	Age	Gender
Cricket		
	14	F
	15	M
	16	M

6.8 *A sample report*

A report may use a query as the source of information. You can create a basic report using a **Report Wizard**. You can then improve the appearance of your report in **Design view**.

Some of the ways that the look of the report can be enhanced in Design view include:

- Adding a title
- Changing colours
- Adjusting field widths
- Setting orientation
- Adding a name and address or graphics such as a logo

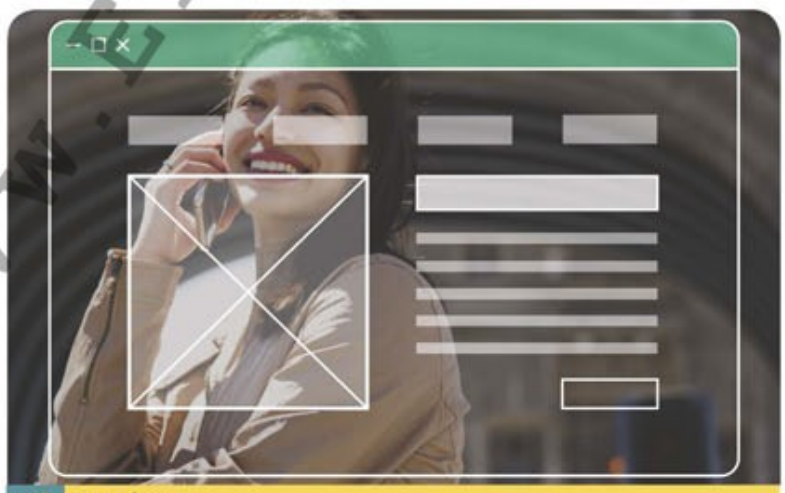
Activity 6.3

This activity can be found in the Portfolio. It shows how to create a report in MS Access.

Input forms

A database form, often displayed on websites selling anything from beans to airline tickets, connects to a database on a company's server. This allows customers to enter data themselves rather than place their order by phone and have the sales staff enter the data. Customers are less likely to make mistakes when they enter their own details, and this provides the company with more accurate data.

As you will be aware from using such forms, messages are often used to guide users entering data. A typical example of this is when users need to use a drop-down menu for a particular field; a pop-up message may appear guiding a user to select an option from the drop-down menu.



6.9 *Input form*

It is possible to create an input form in Access using the Forms Wizard, which may include fields from one or more tables, a query, or both. Using a query as the source of an input form allows you to add calculated fields, sort the records in a different order, and combine fields from two or more tables.

Creating a form for data entry

In Access, instead of having the user enter data directly into the table, you can create a Data Entry form using the table as the source of the form. This is quick and easy using the Form Wizard.

6.10 *A data entry form*

Activity 6.4

This activity can be found in the Portfolio. It shows how to create a data entry form in MS Access.

Activity 6.5

This activity can be found in the Portfolio. It shows how to create and use a relational database.

Learning objectives

- To determine the information volume of a bitmap graphic image 10.3.1.1
- To explain the difference between graphic file formats 10.3.1.2
- To explain the need to convert graphic files 10.3.1.3

Graphics

Images can be stored in different ways on a computer. A drawing that you create in PowerPoint is a **vector** graphic. It is made up of lines and shapes with specific properties such as line style, line colour, fill colour, start point and end point. The computer stores all of this data about each shape in binary.

When you take a photograph on a digital camera, the image is not made up of individual shapes. The picture somehow has to capture the continuously changing set of colours and shades that make up the real-life view. To store this type of image on a computer the image is broken down into very small elements called **pixels**. A pixel (short for picture element) is one specific colour. The whole image may be set to, for example, 600 pixels wide by 400 pixels high.

The **size** or **resolution** of an image is expressed directly as the width in pixels by height in pixels, e.g. 600 x 400.

If the size of a picture is increased, then more pixels will need to be stored. This increases the size of the image file. This is a **bitmap** image.

Colour depth

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

7.1 *Colour depth*

This image of a flower uses four colours. Therefore two bits are needed to record the colour of each pixel:

11	10	01	00

The number of bits used to store each pixel dictates how many colours an image can contain. 8 bits per pixel will give 256 possible colours. The number of bits per pixel is referred to as the **colour depth**. To work out the minimum required colour depth from the number of colours in the image, convert the number of colours to a power of 2.

For up to:

```
2 = 2¹ colours          1 bit is required per pixel
4 = 2² colours          2 bits are required
8 = 2³ colours          3 bits are required
...
256 = 2⁸ colours        8 bits are required
65,536 = 2¹⁶ colours    16 bits are required
```

If the **colour depth** is increased so more bits are used to represent each pixel, then the overall size of the file will increase.

If we record the value of each pixel in this image, starting from the top left-hand corner and going left to right across each row, we end up with the following data file:

```
10  10  10  10  10  10  10  10
10  00  10  00  10  00  10  10
10  10  00  00  00  10  10  10
10  00  00  01  00  00  10  10  etc.
```

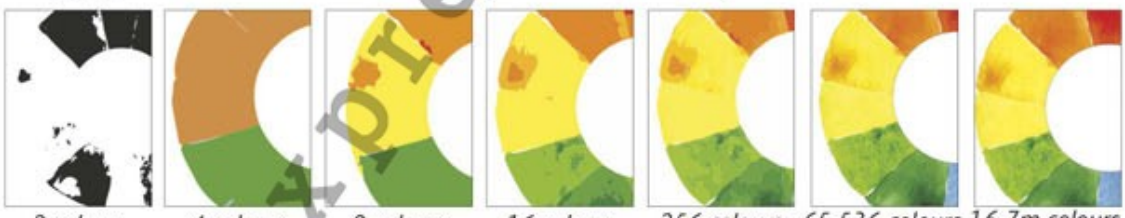
Q1: Convert the following binary data into a 5 x 5 pixel image, where 1 represents black and 0 represents white:

```
11111  00100  00100  00100  00100
```

The effect of colour depth and resolution

Colour depth is used to describe the maximum number of colours that can be used to represent an image. The higher the number of colours, the more faithful will be the image. This will clearly also affect the file size of the image.

We can have, for example, monochrome (black and white), grey scale (usually 256 shades of grey), 16-bit colour and 32-bit colour (known as true colour).



7.2 *Colour depth and resolution*

The **resolution** of an image is the number of pixels (picture elements) or dots that make up an image. The greater the number of pixels, the sharper the image will be, and the larger the file size of the image. Pixel density, measured in pixels per inch (`PPI`), is used to describe the resolution of a computer screen, camera or scanner.

An image from the Internet is typically `72PPI`, which is a low resolution. If you try to enlarge the image on the screen, the software makes up for the pixels which do not exist and you get a blurred image. The higher the resolution, the larger the image you can display on a screen without it looking blurred.

7.3 *Pixel density*

Example 1: Calculating the file size

An image captured in 256 colours, with a size of 2,100 pixels by 1,500 pixels, is saved on a memory stick. What is the size in bytes of the file?

```
Size in bytes   = (image width x image height x colour depth) / 8
                = (2,100 x 1,500 x 8) / 8 (256 colours = colour
                   depth of 8 bits)
                = 3,150,000 bytes (3.15MB)
```

Q2: Calculate the size in bytes of a black and white image that is 96 pixels wide and 1,024 pixels high.

Q3: Using a computer, try changing the resolution of an image to see how the sharpness and the size of the file change as the resolution is reduced.

Metadata

Metadata means "data about data". When a file is saved, information about the file is saved with it. This could include:

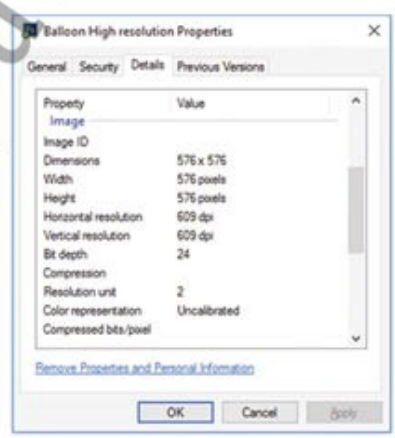
- Type of file
- Time and date of creation
- Creator or author of the data
- File size

This type of metadata can make it easier to find a particular file if you have forgotten the name you gave it, but can remember approximately when you created it.

Metadata about a digital image will also include:

- The dimensions of the image
- The image resolution
- The colour depth

From this information, the computer can interpret the binary digits to recreate the image on screen or paper.



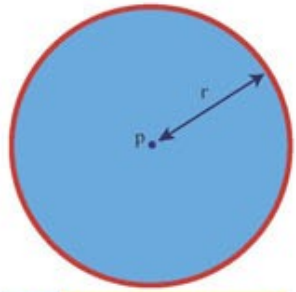
7.4 *Metadata*

Vector graphics

Vector graphics are represented quite differently. Rather than storing information on each individual pixel and building an image from them, vector images are made up of geometric shapes or objects such as lines, curves, arcs and polygons. A vector file stores only the necessary details about each shape in order to redraw the object when the file loads.

Q4: In order to draw a square exactly as someone else intended, what information would you need to know?

To recreate an image of a circle, a computer must store its properties, including the position of its centre within the image, its radius, fill colour, line colour and line weight.



7.5 *Creating a circle*

Vector drawing lists

These properties are stored in a drawing list which specifies how to redraw the image. If the image is resized on screen, the computer will adjust the position and dimensions of the image properties and redraw the image perfectly every time. A bitmapped image will pixelate.

The drawing list item for the circle above might appear in a drawing list like this:

Vector drawing list
Circle (centre = x,y, radius = r, fill = blue, stroke = red, weight = 3px)
Rectangle (position = x,y, width = 20, height = 60, fill = yellow, stroke = none)
Line (start = x,y, end = x,y, stroke = green, weight = 1px)

Regardless of how large these shapes are drawn, the image will always be sharp, and the amount of data required to store the image will not change.

Vector graphics versus bitmapped graphics

A vector image usually has a much smaller file size and will scale perfectly, regardless of how large or small you make it. A logo is often best created as a vector graphic since the company is then able to print it crisply on anything from a business card to a billboard.

7.6 *A vector image*

Since they are often smaller files, vectors use less memory and storage space, transmit faster and often load more quickly. Why then, are bitmap images used at all? A vector image cannot easily replicate an image with continuous areas of changing colour such as a photograph, taken with a digital camera. Take this image below, with a vectorised equivalent. Theoretically, if you created a vector image with squares of solid colour, each 1 pixel in size, you would be able to replicate a bitmap exactly; but your file would need to store a single list item for each pixel – far more than a short binary value.

Note the difference in file size and quality here:

84KB – Original bitmap

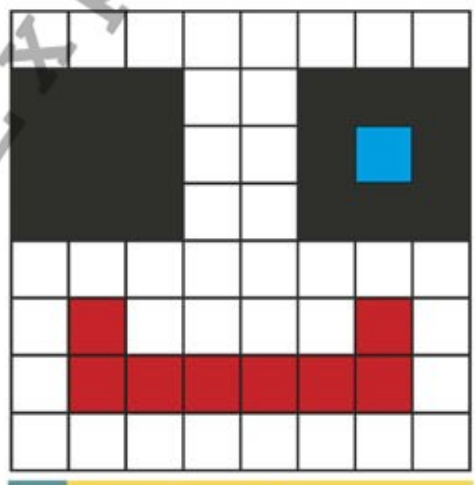
1.2MB – Vectorised version

7.7 *Comparing file size and quality*

Individual pixels can be manipulated within a bitmap image – useful in the case of photo retouching, for example. With a vector image, individual objects are easily manipulated, but individual pixels cannot be changed.

Tasks

1. Images are often represented in a computer's main memory using bitmapped graphics. Bitmapped images consist of **pixels**. A pixel is the smallest addressable part of an image.
   - **(a)** What is meant by the **resolution** of a bitmapped graphic image?
   - **(b)** What is meant by the **colour depth** of a bitmapped graphic image?
     An image has 10 x 10 pixels. It is stored in an image format that is limited to 16 colours.
   - **(c)** Calculate the image size in bytes.
     Instead of using bitmapped graphics, images may be represented in a computer's main memory using vector graphics.
   - **(d)** State **one** advantage of vector graphics compared with bitmapped graphics.
2. A bitmapped image consists of pixels. The figure below shows a bitmapped representation of an image of a winking, happy face consisting of red, blue, black and white pixels only.



7.8 *Bitmapped representation*

(a) Why must at least two bits be used to represent each pixel?
The second line of pixels (from the top) has been represented in a computer's memory as the bit pattern `1111 1100 0011 1111`. A black pixel is coded as `11`.

(b) Suggest a suitable 16-bit bit pattern that could be used to represent the third row of pixels.

(c) What, in bytes, is the minimum file size for the bitmapped image?
Instead of representing the face as a bitmapped image, vector graphics could have been used.

(d) State three items of data that would need to be stored about an eye object, similar to those shown in the image in the above figure, if it is to be represented using vector graphics.

(e) Describe two advantages of using vector graphics instead of bitmaps to represent an image.

Use of image processing software

Understanding layers

Most image processing software packages use a system of layers. You can think of layers within a graphics package as a series of images printed on clear acetate and piled up on top of each other.

Cutting out a selection within an image

A Lasso tool is a common method of cutting out an element from within a larger image. Selecting the Lasso tool and carefully drawing around the image will enable you to 'cut it out'. The cut-out can then be saved as its own layer.

7.9 *Lasso tool*

Adjustment layers

Adjustment layers enable you to apply special effects or adjustments to an image on another layer. A common adjustment is contrast which can be done using either the Levels or Curves tools in various graphics packages. This can either be used to correct poor contrast from a photograph or to add a high contrast effect to an image for dramatic effect.

Opacity and feathering

7.10 *Use of brush tool*

Opacity refers to the level of transparency in an image. This is usually set on a percentage scale. 100% opacity would be a solid colour or image. 0% would be completely transparent. You can set the brush tool to adopt a level of transparency. Similarly, you can do the same with the eraser tools. Using an eraser tool with 20% opacity, you can feather the edge of a smoke cloud for example, to provide a more realistic transparency against the layer behind.

7.11 *Use of eraser tool*

Adding depth through the use of layers

Building up an image using layers with foreground interest on top of those with background images will help to add depth.

7.12 *Using layers*

Building a complete image from multiple layers

Once you have assembled various components of a layered image, you can begin to put them all together.

7.13 *Assembling components*

Compression

When data is transmitted across the Internet it will go through many different physical links between routers. The connection from a computer or a LAN into the Internet is likely to be the slowest part of this route, as you probably know from experience. At home you may have quite a slow network connection and it may take a while for web pages to load.

One way of speeding up the rate at which files can be transmitted across the Internet is to compress them to make them smaller. Smaller files take less time to transmit over a network. Understanding how compression affects files is important as the type of compression selected will affect how the image looks or the audio track sounds. The final use of the file will dictate how much you can compress it and still have a file that is usable.

To summarise, compression is used in order to:

- reduce the amount of storage needed on a computer to save files
- allow large files to be transmitted as an email attachment; many email servers limit the size of a file that can be sent and compression can reduce the file size to allow users to send the file
- allow a file to be transmitted in less time, owing to the smaller file size.

Lossy compression

Lossy compression is a data encoding method where files are compressed by removing some of the detail. For example, photographs can be stored using fewer colours so fewer bits are needed per pixel. This type of compression is used to compress images, audio files and video files, where it is easy to recognise an image or sound clip even if some data is missing.

A bitmap image (.bmp) or .png file is a lossless version of an image. If you save the same photograph as a JPEG file then it is still a high quality image with a colour depth of 24 bits but some of the data is lost where it is unlikely to be noticed.

If you save the same picture as a GIF file, then you make the file size much smaller as you only use 8 bits instead of 24 bits per pixel. The human eye can tell the difference at this stage. You will see solid blocks of colour instead of gradual transitions in the photograph. However, for small pictures on websites that will only be viewed as a thumbnail, GIF files are fine and take less time to load on a webpage.

Here is a section of a photograph blown up so you can see the difference:

7.14 *JPEG version*

7.15 *GIF version*

Lossy compression formats are show below:

Type	File suffix	Compression Type	Explanation
Bitmap	.bmp	–	Uncompressed still image file
JPEG	.jpg	Lossy	Good for photographs. Colour depth = 24 bits, RGB, 16.7 million different colours

Lossless compression

This is a data encoding method where files are compressed but no data is lost – an essential factor for text and data files. For example, bank records must keep all of the data; you cannot transmit a bank statement and miss out a few zeros because they do not matter too much.

It could be used to compress data files, for example by 'zipping' them using a utility program such as WinZip, before attaching them to an email.

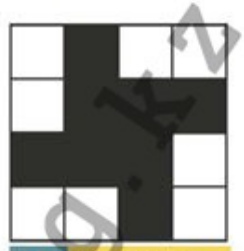
The following table shows different file types and file extensions used for lossless compression formats:

Type	File suffix	Compression Type	Explanation
Portable Network Graphic	.png	Lossless	Colour depth = 24 bits, RGB, 16.7 million different colours
Graphic Interchange Format	.gif	Lossless	Colour depth = 8 bits (only 256 colours) Good for images with large areas of solid colour. Ideal for web graphics Although this is a lossless compression, images with higher colour depths are often converted into GIFs to make them smaller (This process is called 'quantisation' but is not in the GCSE specification.)
Portable Document Format	.pdf	–	A (usually uncompressed) document format that is universally accessible.

Tasks

3. Explain why compression is considered necessary for images on the web.
4. Explain the difference between lossy and lossless data compression.
5. Which one of the following would never be stored as a vector graphic.
   - **(a)** Logo
   - **(b)** Photograph
   - **(c)** Maps
   - **(d)** 3D wireframe model

6. Look at the icon opposite. In binary, `black = 0` and `white = 1`.
   (a) State the binary values of the first row of pixels.
   (b) Work out the file size of the icon image in bytes.
   (c) How many colours could be represented if each pixel was represented by 4 bits?



7.16 *Binary icon*

7. Files are often compressed before they are sent over the internet.
   (a) State what is meant by compression.
   State **one** advantage of compressing files before sending them over the internet.
   (b) Two types of compression are lossy and lossless.
   State which type of compression is most appropriate for each of the following and explain why it is appropriate:
   (i) Downloading the source code of a large program.
   (ii) Streaming a large video file.

Image project

You will complete **graphics project** using software indicated by your teacher. You will use resources in your digital folder and send the completed project in a suitable format to your teacher.

As an introduction to the type of tasks and decisions your project will involve, work in groups to complete the project starter tasks below.

Project starter

Layout, integrating text and consistency

1. Which **one** of the following is good advice for a graphics presentation:
   - Use a selection of at least 10 appropriate font styles
   - Limit your selection of font styles to roughly 3
   - Place text over busy parts of a background image
   - Place dark text on dark areas of a background image
2. Look at the font styles below. Match each font style with an appropriate film genre.

Horror
Action
Period drama
Sci-Fi

Example text
Example text
Example text
Example text

3. Look at the consistency between each edition of the magazine covers below.

September	October	November	December

In the space below, design or sketch the cover for the December issue.

Task

8. In this project you will practise skills in design, photo-editing and image manipulation using a suitable graphics package.
Your project is to design two movie posters: one for the original film and one for the sequel. You need to maintain consistency of design throughout each poster, using similar fonts, effects and design techniques but make each poster noticeably different.
Work in a group and now go to your Graphics Project folder.

Module 8 Expert and Control systems

Learning objectives

- To talk about artificial intelligence and expert systems (definition, scope) 10.3.2.1
- To use expert systems 10.3.2.2

Expert systems

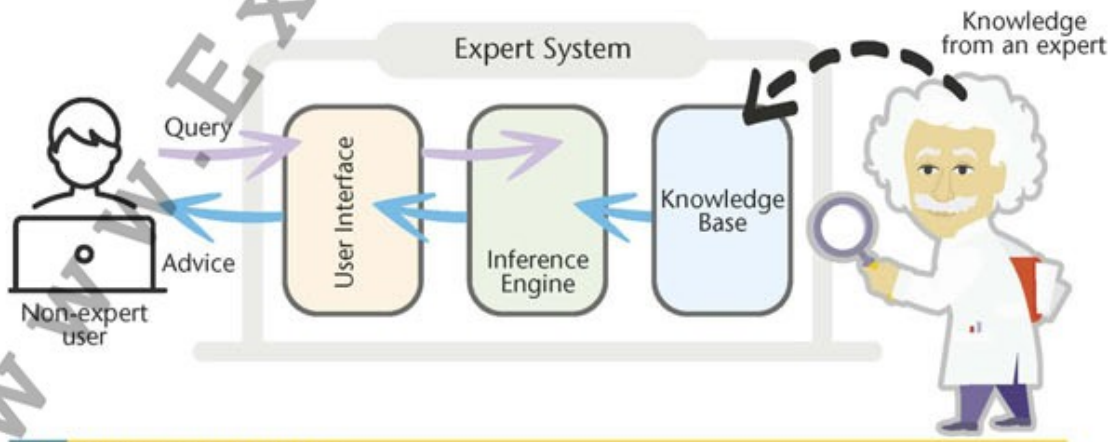
Artificial intelligence (AI) can be defined as the ability of a computer or computer-controlled system to perform tasks commonly associated with intelligent beings. Machines can simulate human **intelligence** processes such as:

- **learning** which involves acquiring information and rules for using that information
- **reasoning** where rules are used to reach approximate or definite conclusions
- **self-correction**

Expert systems are tools used to apply Artificial Intelligence techniques to real-world problems. Expert systems simulate the problem-solving process of human experts. The knowledge base of experts is captured and stored in a program that can then process a range of different types of data against this. Based on algorithms within the program it then makes decisions.

Artificial intelligence is used in all kinds of fields as diverse as control systems in buildings and homes, scientific exploration and testing, public transport monitoring and control, medical diagnosis and programs used to give financial advice. Such systems act as either assistants to human experts who may use such input in making decisions or in the case of control systems largely replace the human expert in determining the current status of systems and dynamically enacting changes.

Expert systems and **expert control systems** work using different models. An expert system in which a non-expert user uses an interface to get advice works as in Figure 8.1.



8.1 *Using an interface for advice*

Such systems include:

- a simple user interface through which queries can be input and advice received.
- a knowledge base relating to facts, rules and procedures understood by experts
- an inference engine which matches the user's query to the knowledge base.

Examples of systems such as these are expert systems used for diagnosis e.g. human health and car engine diagnosis; systems used for identification where the non-expert could seek help in identifying things such as animals, plants or type or model of product; and gaming where a player will enter into a game with the expert system.

Q1: What is the role of an inference engine in an expert system?

Tasks

1. Use these 3 different types of expert system.

   https://slagzet.com/en/play-computer
   http://www.vethelpdirect.com/dashboard/selfhelpguide/pdsa/
   https://play.google.com/store/apps/details?id=cn.danatech.xingseus&hl=en_GB

   What are advantages and limitations of each one?

Q2: Expert systems are only as good as the rules programmed by the programmer. In using which of the above programs are you most likely to seek further advice from a human expert?

Expert control systems

An expert control system is one or more devices that guide other devices or systems. This allows for the completion of various tasks in an automatic manner, without any human intervention. Control systems are set up once and can then perform the actions that they have been programmed to do in an automatic manner, relieving humans from repetitive and mundane tasks, as well as increasing productivity and efficiency. Control systems may include sensors to gain feedback from the environment and motors to control any actuators in an appropriate manner.

Control systems are mostly input, process, output systems. That means that an input is provided to the system, which is processed by some algorithm and an action is performed. The results of the action can then be measured by the control system (through the use of sensors) and feedback can be provided as input. The control system can then act upon the new input and the cycle continues as seen in Figure 8.2.

8.2 *Expert Control Systems*

Device drivers

Device drivers are computer programs used to control a computer device of any kind, from keyboards and printers to graphics and sound cards. These computer programs allow operating systems (OS) and other programs to access the devices with a layer of abstraction (i.e. without needing to know how the actual devices are used). The computer bus usually connects the drivers with the devices, allowing the drivers to send commands and receive data. Since drivers are developed specifically for each device, they are hardware-dependent, as well as operating-system specific, so that they are as efficient as possible.

Domestic robots

Domestic robots using computer guided control systems are already appearing in households. Vacuum, pool and gutter cleaning robots are examples of autonomous domestic robots that one might come in contact with in everyday houses. A number of sensors are packed within these robots to provide "intelligent" behaviour. For example, vacuum cleaning robots use a suite of sensors to map and find their way around rooms that may include clutter and furniture. Using various cameras they can create house maps, using landmarks, and know their current position as well as previous locations. Furthermore, they can return to their charging base whenever necessary, and complete the cleaning afterwards. Sensors can also detect the material on which the vacuum is currently on and perform appropriate kinds of cleaning. All these possibilities would not be available without closed-loop computer-controlled systems.

8.3 *Cleaning robot*

Tasks

2. A number of control systems may be used around the house such as:

- smart heating systems that turn on/off automatically as needed
- automatic doors/windows that open/close or even lock as needed
- lighting that turns on/off/dim or even changes colours as needed
- air conditioning that turns on/off as needed
- automatic cleaning that turns on/off as needed

(a) Discuss how a user may access these systems.

(b) Discuss two advantages of incorporating such technology inside the house.

GPS systems

Every day millions of people use GPS systems to find their way around cities, mountains or even the sea. Whether used to find a new café or guide a missile, GPS systems are required to work efficiently, precisely and with near 100% availability (no down time). The GPS system is a large, complex, computer-controlled system that includes both hardware and software elements and needs constant maintenance and support to work in

8.4 *GPS satellite system*

such an effective manner as it does. It uses around 30 satellites in orbit around the Earth, as well as a number of extra satellites that are 'fail-safes' (if one of the satellites fails, one of the extra satellites will take its place until the first one is fixed). These solar-powered satellites circle the Earth twice per day. A GPS receiver allows a user to know exactly where he/she is on Earth. It includes a sensor that locates four or more of the GPS satellites, figures out its distance to each one, calculates the time difference between the satellites and uses a mathematical principle called trilateration to deduce its location. Furthermore, modern GPS systems also receive input from their users, pinpointing their desired destinations, as well as map data that may be updated through software updates.

Open and Closed loop systems

Traffic lights play a key role in road safety. They manage traffic, prevent accidents and allow pedestrians to cross the roads without jeopardizing their lives. Traffic lights are usually control systems operated by computer systems and can be either 'fixed time' or 'dynamic control'.

- **Fixed time:** As the name suggests, fixed time traffic lights are open loop control systems, in that they do not receive any feedback from the environment in order to alter their performance. They are configured to change colour after a given period of time and they do so repeatedly. Fixed time traffic lights can be implemented with an electro-mechanical signal controller and as such does not necessarily need a computer system.
- **Dynamic control:** Using a closed loop control system to provide feedback on the amount of traffic passing by, dynamic control traffic lights can adapt their settings appropriately, following some algorithm. These kinds of traffic lights are operated through computer systems and would not be available otherwise.

8.5 *Traffic light with sensor*

They can use one of the two different types of sensors to detect traffic conditions: either embedded into the surface of the road or mounted on the traffic light itself (or some other high position). The sensors that are embedded into the surface of the road have the ability to sense when a car passes over it. Mounted sensors are less expensive and can provide the same feedback, including real-time photos or video.

Q3: What makes device drivers efficient communicators between a computer operating system and an expert control system?
Q4: What is the difference between open loop and closed loop control systems?
Q5: What type of sensors does a dynamic control traffic light system use?

Microprocessors and Sensors

A microprocessor, as its name suggests, is a small processor within a control system that contains all or most of the functions of a CPU on a single chip or integrated circuit. Like a CPU, a microprocessor performs arithmetic and logic operations, as well as many other data operations through the use of sensors.

In order for microprocessors to perform any processing, they need to receive input. For that to be accomplished sensor input is needed. A sensor converts continuous physical (analogue) quantities (such as speed, temperature, humidity, pressure, etc.) into discrete digital signals using an analogue-to-digital converter (ADC). These signals can then be read as input by microprocessors. The input is processed, according to some algorithm(s), and output is returned.

8.6 *Sensors*

A growing list of available sensors exists that can measure anything from density to heat and motion to magnetic fluctuations. Sensors sense a physical property and then transform it into an electrical signal.

Most common types of sensor are:

- **Sound:** Sound sensors, as the name suggests, detect sound waves and are widely used in microphones.
- **Motion:** Motion sensors detect moving objects. They are widely used in security/alarm systems, as well as automated lighting control, so that the lights are only on when necessary to conserve energy.
- **Vibration:** Vibration sensors detect vibrations and are placed on surfaces that can vibrate. They are widely used in security/alarm systems (placed on windows), as well as acoustic musical instruments (instead of microphones).
- **Optical/Image:** A wide variety of optical sensors exist, depending on the physical quantity measured. Two widely-used optical sensors are the following:
  - **Active pixel sensor (APS):** Used in almost all digital cameras, they contain an array of pixel sensors that can imprint light.
  - **Infrared (IR):** Used to sense invisible radiant energy with longer wavelengths than those of visible light. Widely used in security/alarm systems to detect motion at night, where visibility is low or non-existent.
- **Pressure:** Pressure sensors detect pressure. They are used in a variety of settings, including touch-screen devices, as well as the automotive industry (they regulate the engine power according to the pressure on the pedals) and others.
- **Temperature:** Temperature sensors detect temperature. They are widely used within thermostats to control the temperature of a given setting.
- **Proximity:** Proximity sensors can detect the presence of nearby objects without any physical contact. They are widely used in cars to help drivers reverse or park.

Tasks

3. A control system is used to control an elevator car to allow people to go to their desired floor in a building.
   - **(a)** Identify various types of sensors in this system.
   - **(b)** Identify other pieces of hardware, other than sensors, that are part of the control system.
   - **(c)** Outline the sequence of steps that will take place within the computer control system, when a person presses the button to call the elevator.
   - **(d)** Define the term interrupt, as well as a situation in which it may occur in this system.

Role of feedback

Feedback refers to the process where information about the result of an output, from a control system, is used as part of the new input to the control system in order to determine the best course of action for the next output. Feedback is a loop as shown in Figure 8.2.

Feedback is essential to control systems that need to react to their environment and its changes. For example, as discussed above, there can be two kinds of traffic lights, fixed time and dynamic control. Fixed time traffic lights do not take the environment into account and just change colour after a pre-programmed amount of time. On the other hand, dynamic control traffic lights use sensors to take the environment into account every time the lights change colour. Imagine the following scenario: A dynamic control traffic light uses a sensor to identify when no cars are near and changes the car lights from green to red, so that the pedestrians can pass. This action is the output. The traffic light then receives feedback from this action (a line of cars starts forming) and uses that feedback as input in order to turn the car lights green again when a long line has been formed. The input first affected the output (no cars, so the car lights turned red), the output affected the input (a line formed), and the new input affected the output (the car lights turned green). After a while, the output would affect the input again. The feedback keeps the system in a stable, working state avoiding long queues on the road and helping pedestrians cross safely.

Autonomous agents in larger systems

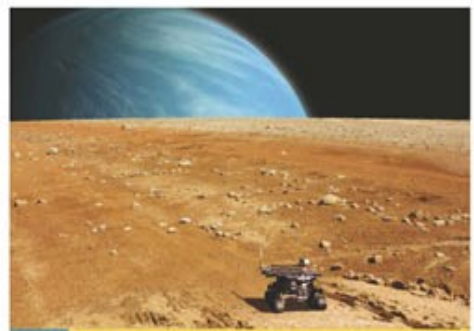
Agents can be anything that can perceive its environment, through sensors, and act upon it, through **effectors**. Examples of agents may be humans (that have eyes, ears and other sensors) to robotic agents (that have cameras, sonars and other sensors) and software agents (that have sensors in the form of bits and can sense their digital environment through those sensors).

Autonomous agents are entities operating on behalf of an owner (usually a user or another program) with a degree of autonomy and with minimal to no interference from the owner. These agents follow algorithms supplied by the owner to achieve some desired goal(s). Autonomous agents perform actions that depend on their own 'experiences' through their sensors. They can apply different sets of pre-programmed actions in different situations and even build their own set of actions through learning algorithms. Autonomous agents display artificial intelligence in that they need to 'reason' according to their acquired knowledge. The representation of knowledge is a key-concept for those agents.

8.7 *Autonomous agent (car)*

Autonomous agents in space missions

Autonomous agents may be of help in both unmanned and manned missions. One type of unmanned mission that needs to take place every day, all day (24/7) is the control and coordination of satellites orbiting Earth. Before the use of autonomous agents, 2-3 persons were needed per satellite. With the increase in the number of satellites this led to a large number of staff responsible for their control, which resulted (amongst other things) in a large financial burden.



8.8 *Autonomous space agent*

Another type of unmanned mission with difficult and/or restricted time frame communication with the device(s) launched in space, are the deep space missions. Sending a message from Earth to a planet far away, such as Mars or Jupiter, takes minutes or even hours, and may only be available for only a few hours per day. The bandwidth of the connection is also limited. As such, these devices cannot be controlled in a real-time manner. However, they need to be able to act in a real-time manner, as well as be able to face any situations when communication with Earth is unavailable.

Autonomous agents allow deep space mission devices to perform real-time tasks when connection to Earth is limited or non-existent, preventing pitfalls and unwanted situations.

In manned missions, the crew spends a long period of time each day in monitoring and maintaining. Monitoring is a repetitive and mundane task. Furthermore, most mistakes in manned missions are made by humans that may let something go unnoticed due to negligence or tiredness. Autonomous agents can be responsible for monitoring both everyday tasks, as well as human actions while performing some maintenance tasks.

Of course, it is impossible to take into account all the possible events that could occur. As such, autonomous agents that do not request human intervention in unfamiliar circumstances could lead to errors and to the detriment of a mission.

8.9 *Probable future autonomous agent picker robot*

Q6: Give four advantages of using autonomous agents over human agents in performing different tasks.

Q7: What might some of the ethical and social concerns be of the ever-wider use of autonomous agents in the future?

Module 9 Developing a mobile app

Learning objectives

- To create a mobile application interface using application designer components 10.4.3.1
- To edit component properties in the properties window and in the program code 10.4.3.2
- To create applications for mobile devices using conditional and loop structures 10.4.3.3
- To explain how to install the developed mobile application 10.4.3.4

Getting started

This Module, like Module 7, will involve you working in groups to design and create a digital product that you will present to the class. In this case you will be working through each stage of building a working web app which can be used on any HTML5 compatible device. You will be guided through the different steps of the process here but your success in producing a successful app will depend on:

- collaborating within your group and assigning different tasks to group members
- using the resources in your digital resources pack
- applying and building on the programming skills that you have developed.

Throughout this module you will review demo apps and be asked to consider features of different apps. For this, someone in the groups will need access to iTunes for Windows or Mac OS X to view the App Store.

Evaluating an app

Using the task sheet in your Portfolio choose review an app in Appshed, iTunes or Google Play.

Setting up your app

Use the set-up screen to give a name and description to your app. Make an attractive home screen and use the mock-up screen plan in your portfolio to get an initial idea of what you would like the different screens in your app to do.

The navigation tool bar allows the user to move around the app to view the different screens. Think about user-friendly titles you could give your tabs.

9.1 *Set-up screen*

9.2 *Navigation tool bar*

The Action tab lets you decide what happens when you press a button. It automatically generates a new screen and you can decide what sort of screen. This works for any clickable object in the app. Referring to your mock-up plan, add some tabs and try out different Actions to see what you can do.

Tasks

1. A web app resides on the Internet and is downloaded to a mobile phone when it is opened. A 'native' app is directly installed on a mobile phone and is opened from files in its own storage area.
   Give one advantage of using a web app and one advantage of using a native app.
2. Describe what is meant by the 'Home screen'.
3. Suggest three possible 'actions' or features that could be applied to an app.

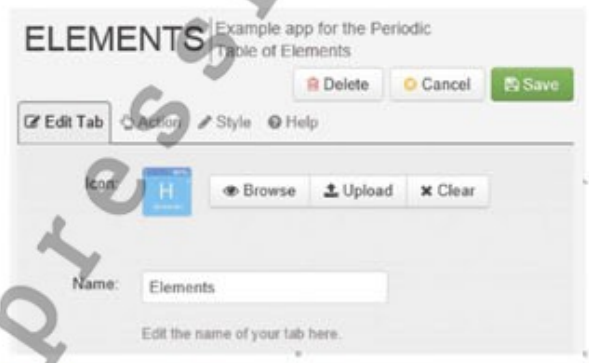
Adding links, icons, text and images

There are two different types of link screen: a Standard screen or an Icons screen.

9.3

Creating a tab icon

- The Home Tab is automatically selected for you to begin with. Click the Home Tab and select Edit from the pop-up menu.
- Give the tab a new name. Try to keep it under 12 characters long, otherwise it will not fit under the App icon.

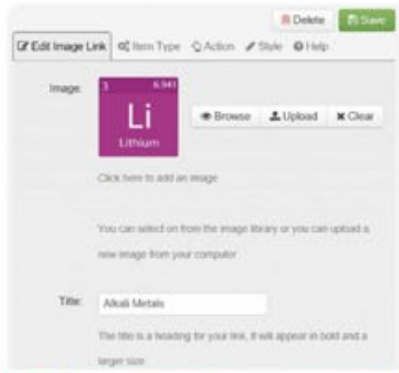


9.4

- Click Save.

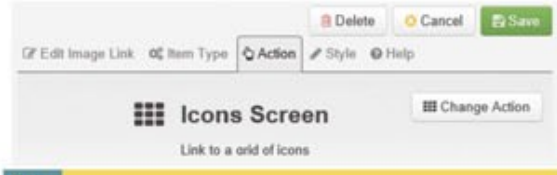
Adding a new Image Link to the Standard Screen

- Click on the Add new item link on the Home Screen.
- Using the Properties panel, select a suitable Image, give the link a Title and some descriptive Text if appropriate.



9.5

- Set the Item Type to Image Link and the Action to Icons Screen. This will attach a clickable link to the image in the Standard Screen and point it to a new Icons Screen.



9.6

- Click Save and add any other links that you have planned for the Home Screen.

9.7

Creating an Icons Screen

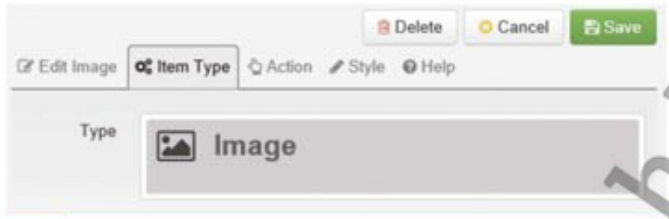
The Icons Screen works in exactly the same way as the Standard Screen but arranges the text links as a collection of images in a grid pattern rather than as a vertical list.

- Navigate to the Icons Screen that you have set up using the Action tab on the first Image Link. Click on the Add new item link on the screen.
- Add a Title and an Icon as appropriate.
- Click on the Action tab and click the Change Action button.
- Select Standard Screen to be able to add text and images to the new screen that your new icon will link to.
- Click Save.
- Add more icons according to your designs.

9.8

Adding an image to a screen

- Click on A new text item and select Delete to remove it.
- Click on the Add new item link and select an image to display. If you are uploading an image that you want to fill the width of the screen when the phone is vertical, you should aim for at least 350 pixles in width.
- Click the Item Type and change this to Image to fill the screen.



9.9

- Click the Action tab and Change Action to None.

9.10

- Click Save.

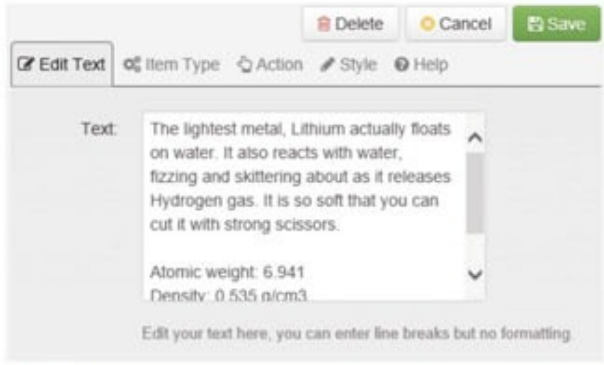
9.11

Adding text

Text can be added just like any other element, simply by selecting Text from the Item Type options.

- Click on Add new item and change the Item Type to Text.
- Click Save.
- Click on the new text link and select Edit from the pop-up menu.

- Under the Edit Text tab, enter the text you would like to display.



9.12

- Click Save.

Further developing the app

Go to the folders in your digital resources:

- Adding files, links and image galleries
- Using the Blockly visual programming editor to explore how you can further customise your app.

9.13

Tasks

4. Blockly instructions are based on which programming language?
   (a) Java **(b)** JavaScript **(c)** Python **(d)** Kodu
5. Variables are commonly used in programming.
   (a) What is meant by a variable?
   (b) Suggest one suitable use of a variable in a mobile phone pin access system.
   (c) Look at the code below.

9.14

   (i) Identify the variable used.
   (ii) A Repeat while loop will repeat a section of code until a condition is met. What is this condition?
   (iii) Explain what the code will do.

Finishing and publishing your app

As you move towards finishing your app, make sure that:

- you have completed your app title and description
- all buttons and links take you to the correct screens
- you are happy with all icons, backgrounds, media and fonts
- a splash screen has been added.

9.15 *Finished app*

Once you click the publish button, you have various options for sharing your app so that other groups in the class can access and use it. Test your app on a mobile device in a real-life situation and then share it on different devices using the QR code or the URL address.

Tasks

6. Navigate your app completely and test every link and button.
7. Does everything work as planned?
8. Is the app easy and intuitive to use?
9. Do you need to make any changes?
10. Once other groups have tested your app, ask for their views.

Module 10 Game programming

Learning objectives

- To create a background image (scene) in two-dimensional space 10.4.2.1
- To create images of objects (sprites) for use in developing the game 10.4.2.2
- To write simple scripts to manage sprites 10.4.2.3
- To include audio in the application 10.4.2.4.
- To create a 2D mini training application 10.4.2.5

In this module you will use the games program Scratch to develop a game around themes and characters that you choose. It is possible for you to sign up to Scratch and download it at home. This will allow you to upload your game so that it can be played and commented on by others. It will also give you the opportunity to look at games that others have created to get ideas and you will also be able to reverse-engineer these games so as to make improvements and modifications if you wish.

Sequencing instructions

A simple analogy for making a workable game in a program like Scratch is that of the recipe. A recipe is typically written in two sections: ingredients and instructions. The ingredients are analogous to the variables in your game: the background setting, story context and characters you choose for your game, and the instructions are analogous to the code blocks you need to make the game work.

As in a recipe, the sequence of instructions is crucial in making the game work effectively.

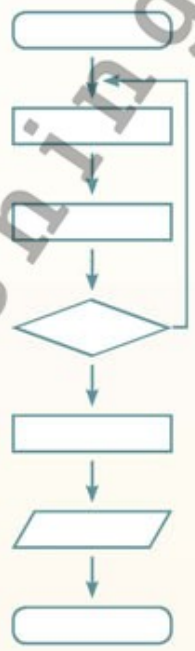
Consider a set of instructions needed, for example, to successfully make a smoothie in a blender.

10.1

Activity 10.1

Look at the flowchart and decide in what order the instructions below should go in order for them to make sense:

Add strawberries and bananas
Turn on blender for 30 seconds
Add milk and ice cream
End
Start
Is blender full?
Put on lid



10.2 *Instructions given in wrong order!*

Does it matter what order the instructions are in?

Would it still 'work' if some statements were in a different position?

Sprites

A Sprite is the term for an animated character or object that is separate from the background in a game. There are a number of ways that you can create a sprite in your game:

- using the Sprite Library
- creating a sprite using the Sprite Editor
- importing a sprite from a file

10.3 *Creating a sprite*

Activity 10.2

Create a new sprite and place in a game background.

Think about the instructions you would use if you wanted a sprite to move on the screen when you press a button on the keyboard.

Q1: How would you implement this in Scratch?

Activity 10.3

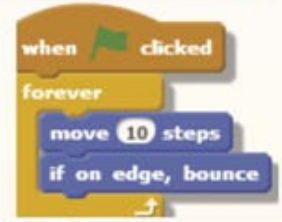
Write the blocks of code necessary to make the sprite move in any given direction using the arrow keys.

10.4

Q2: How would you make the sprite move faster or slower?

Add a new sprite and make it move continuously by itself when the green arrow is clicked. Write the block of code to make it bounce if it hits the edge of the screen.

You should now have a simple game where you can control a character to try and avoid another character or object. To explore how you might develop this idea, look at some other games in the Scratch Community. By using the 'See inside' facility, you can get ideas from other games and see how they work.



10.5

10.6

Activity 10.4

You will now complete a plan for the design of your own original game using the template Activity 10.4 in your Student Portfolio. You will need to think of:

- A scenario for your game
- A character to control
- A character to avoid
- Something to collect

When you have completed your plan and decided that it is a good one, collect some appropriate sprite images in preparation for making your game.

Lives and scoring

In a game what typically happens when one sprite touches another? Look at, for example, the code block in the *Fish Game* that has been added to stop all if the Fish touches the Shark and note the use of the loop (Forever) and the selection statement (if).

Activity 10.5

Use the Forever loop and the If block to modify the simple game you made in Activity 10.3.

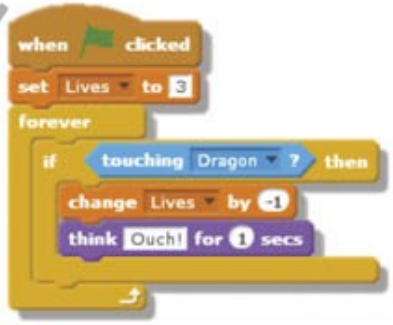
Variables

A variable represents a location in memory. This location is used to hold a value which you assign to it and you can change the value in the program. You give a variable a name, which you use to refer to it when doing things like setting an initial value or changing, using or outputting the value.

A variable Lives, for example, will store an initial value such as 3 to represent the starting value in a game.

Tasks

1. What are the steps required to set the starting value of lives and reduce that by one when one sprite touches another? Write a simple algorithm.
   (1)
   (2)
   (3)
   (4)
   (5)
   (6)
   Do your steps include something like the Forever loop and the If block in the code block below?



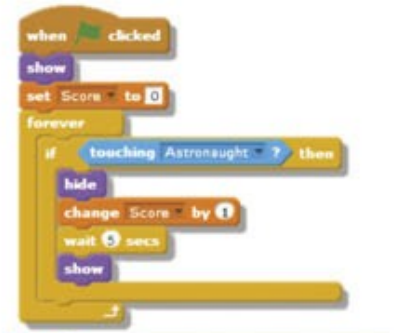
10.7

In a game like the Fish Game, the think, say or wait commands can be used after the lives are reduced in order to allow time for the fish to escape the shark. Without this, a single encounter can reduce lives repeatedly as the fish slowly passes the shark.

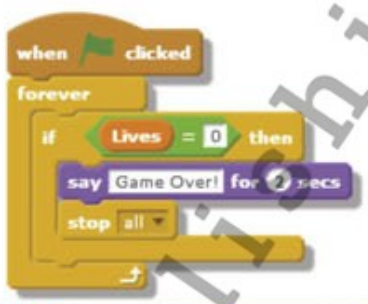
Scoring

Collecting something, beating a timer and solving a problem are typical ways of earning points in a game. A Score variable can be added which will change when you 'collect' something in a game. You might, for example, in your game create an additional sprite and use the Show/Hide commands to make it disappear on contact with your character.

A game is ended using a Stop block with a message added for the user.



10.8



10.9

Activity 10.6

Work out how you can use the same techniques with variables to add scoring and ending the game elements to your game.

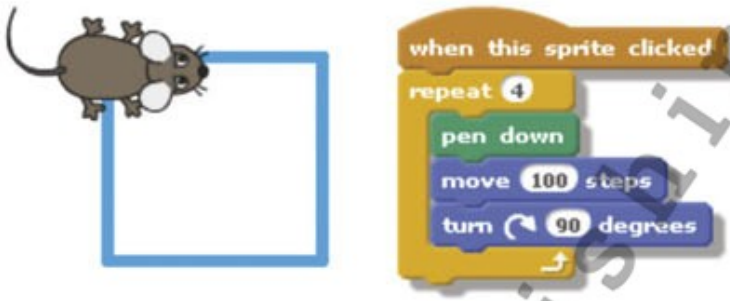
Adding comment boxes

It is possible to add Comment boxes in Scratch to help you, and others, understand your code at a later date. By right-clicking a block you can add a comment which attaches itself to the block. This is proper practice in the programming world and is a good habit to get into for future projects.

10.10 *Adding comment boxes*

Repeat loops and procedures

Using a **repeat** loop wraps up code into a block that can be repeated. Repeat statements are used to repeat sets of commands automatically. The loop can specify how many times to repeat, or it can happen forever until another condition is reached.

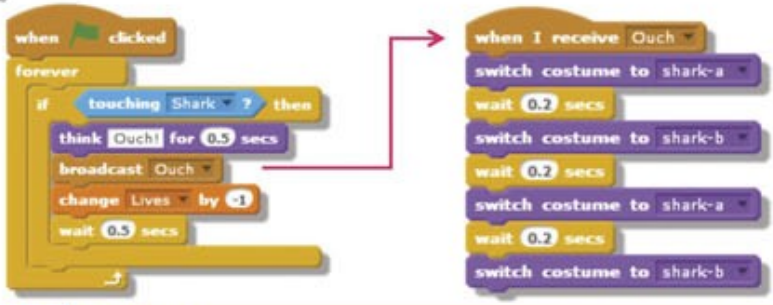


10.11 *Repeat loop*

A **procedure** takes advantage of similar efficiencies by wrapping up a section of code and giving it a name. A procedure like 'Dance', for example, contains a whole sequence of minor instructions (left leg forward, left leg back and so on) that we do not need to iterate explicitly for most people.

A procedure in programming uses a similar concept. Programmers can write a sequence of code that they wish to use several times and give that block of code a name (the procedure name). The procedure can then be 'called' at a specific time. By using this name in your code, you ask the program to run the sequence of instructions wrapped up inside the procedure.

Procedures in Scratch are called **broadcasts**. This is like shouting out a command,and waiting for others to respond. The advantage of a broadcast in Scratch is that other scripts will continue to execute concurrently. In this way you can get several things to happen at once, for example, getting a shark to open and close its mouth whilst moving or the actions in the code block below from the same *Fish Game*.



10.12 *Broadcasts*

Q3: When does the code block on the right run?
Q4: What is the effect of this code block in the game?

The broadcast function can also be used to change the background of the Stage to create a new level when a certain condition is satisfied e.g. the number of points collected reaches a target value.

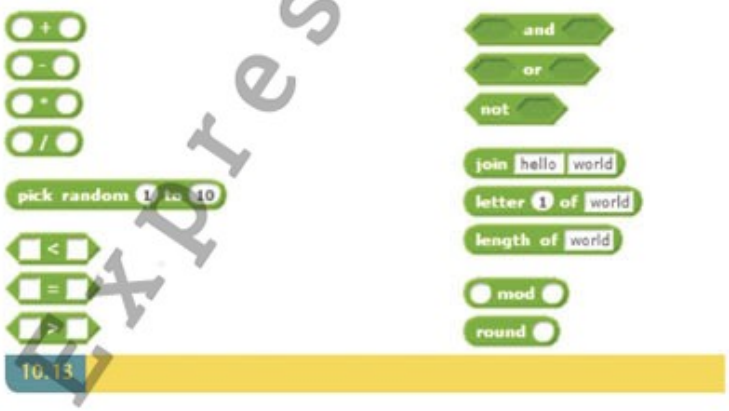
Activity 10.7

Add broadcasts to your game. Remember to look at other games in the Scratch community to get ideas about how broadcasts are used and add comments to your new code blocks when they are ready.

Working with operators

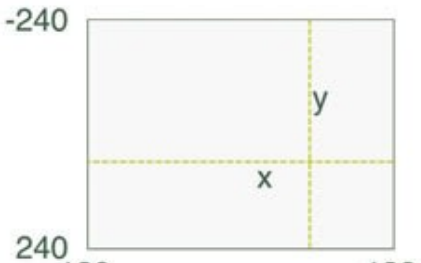
The operators featured in the Green block menu in Scratch can be used in conjunction with the x and y coordinates of sprite locations to position them on the game screen or can be used for more mathematical problems – for example, making a sprite get smaller so it appears to move further away, or calculating a score.

Combining the use of operators, sprites, and coordinates is necessary to make objects appear at various points on the screen randomly. This might be useful in game scenarios such as when enemies that have been killed return or collectable treasures appear on the screen randomly.



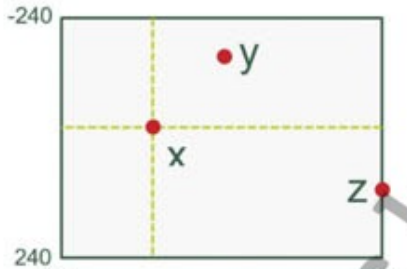
10.13

The Scratch window has coordinates to define a single point on the screen. A particular point on the screen is indicated below the bottom right of the Scratch window as x, y coordinates.



10.14

Q5: Where is 0,0?
Q6: The point marked **x** is at coordinate -100, 30
(a) What are the coordinates of point **y**?
(b) What are the coordinates of point **z**?



10.15

The following code block could be added to the *Fish Game* when adding a new Crab sprite and randomising its appearance and movement.

10.16

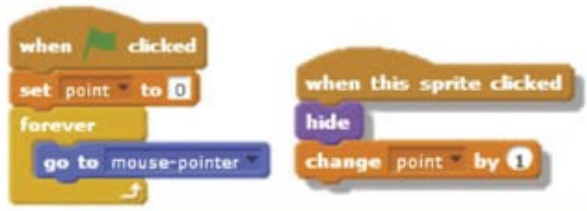
Tasks

2. Use built-in help or the Internet to learn how to use operators to make objects appear randomly on the screen. Apply the code block above to a new Crab sprite in the *Fish Game* and then create new sprites in your game that appear randomly.
   Add comments to your code so that you can later explain to other members of the class what you have done.

Shooting and jumping

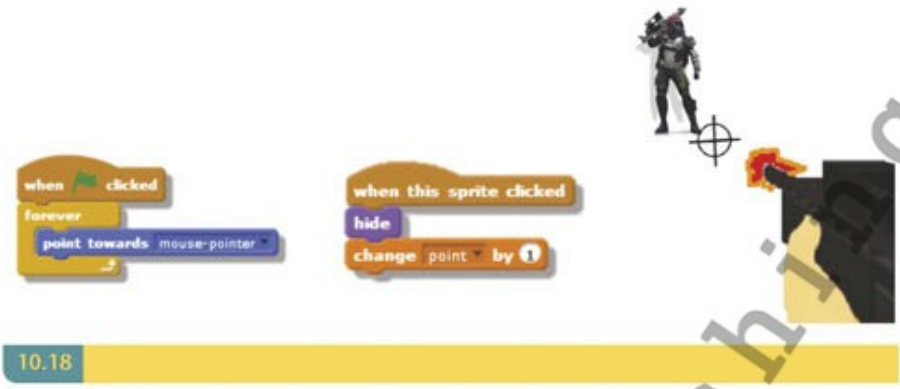
There are a variety of relatively straightforward ways in which you might like to implement shooting in your game. Three of these are described here in order of complexity.

1. Create a cross-hair sprite, make it go to the mouse pointer and make another sprite disappear when it is clicked. Add one point to the score when this happens.



10.17

2. A First Person Shooter is where you make your weapon follow the direction of the mouse and hide sprites that get shot or clicked on.

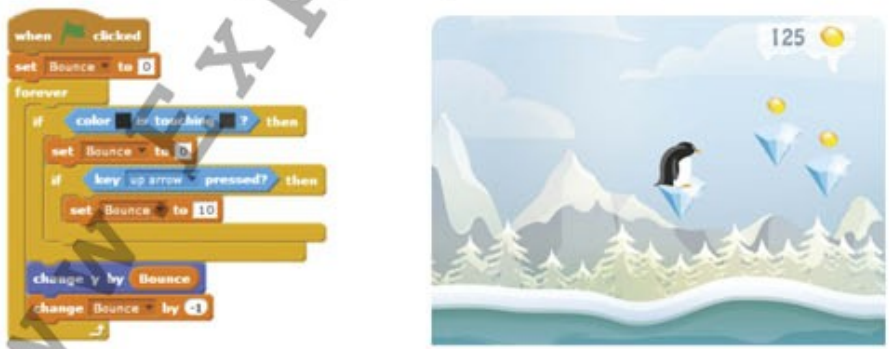


10.18

3. To create a sprite that can shoot while moving, create a variable to store the direction of the bullet and then create a bullet sprite to come from your character when a key is pressed.

10.19

To implement jumping in your game you can create a jump variable to control the jump. Set the variable to 0 and if you are on the ground and press the jump key, change the jump variable. Your character's position on the 'y' axis will change by the jump value and you can gently bring the character back down by reducing the co-ordinate by -1.



10.20

Tasks

3. Add either a shooting or jumping feature to your game.

Adding Sound

Sounds can be added to Scratch in several different ways as indicated on the Sounds tab of a Sprite. You can:

- Use a pre-recorded sound from the Scratch library
- Record a sound yourself and import it
- Upload a sound you have saved on your computer

If the Scratch library does not have the particular sound effect you are looking for, you may find that a website like www.findsounds.com may have what you need.

Once you have selected a sound to use, the pink Sound blocks can be inserted into the code where you want the sound to be played.

10.21

Tasks

4. Add a range of sound features to your game and add comment boxes to help you explain what you have done to other members of the class.

   For your final task in Scratch in this Module, you will put your game to one side and develop a mini-training application to be used at an airport. The idea is to develop a screen or series of screens that show people arriving at an airport which passport queue to stand in. You should use a background and sprites appropriate for the target audience of international travellers and the skills you have learnt in this Module.

10.22

5. Design a training application to show passengers arriving at an international airport which passport queue to stand in. You can come up with as many options you wish based on things such as:
   - citizen or foreign national
   - foreign national with visa or without visa
   - ordinary passenger or fast-track

Glossary

A

Acceptable Use Policy (AUP) is a document stipulating constraints and practices that a user must agree to for access to a corporate network or the Internet.

access levels The set of permissions or restrictions provided to a data type. The user receives an access denied or error message if access is not obtained.

accumulator A register for short-term, intermediate storage of arithmetic and logic data in a computer's CPU (central processing unit).

address book A collection of electronic contacts used in an electronic mail or mobile phone system.

address bus This transfers data between devices that are identified by the hardware address of the physical memory, stored in the form of binary numbers to enable the data bus to access memory storage.

adware Often refers to a form of malware (malicious software) which presents unwanted advertisements to the user of a computer. Advertisements produced by adware are sometimes in the form of a pop-up or sometimes in an "unclosable window".

algorithm A list of instructions that describe how to do a particular task.

alignment Arrangement in a straight line e.g. cells in a spreadsheet.

ALU (Arithmetic Logic Unit) The part of the central processing unit (CPU) which performs all calculations and logic operations such as comparing two operands.

AM (Amplitude Modulation) A technique used in electronic communication, mainly for transmitting information via a radio carrier wave. The amplitude (signal strength) of the carrier wave varies according to the message signal being transmitted.

analog A smoothly changing signal, for example, from a sensor. In the context of equipment used for recording and playing back sound, analog refers to the way in which the sound is recorded and reproduced. All analog recordings suffer from background noise and the quality of reproduction gradually degrades as the record or tape wears out.

anonymous This refers to keeping a user's name and identity hidden through various applications.

application (software) A computer program or a suite of computer programs that performs a particular function for the user, for example, a word-processor.

array A collection of identically typed data items distinguished by their indices (subscripts).

artificial intelligence (AI) Modelling aspects of human thought on computers.

ascending Arranged from smallest to largest.

ASCII (American Standard Code for Information Interchange) The most common character encoding format for the transfer of data from one computer to another. There are 128 standard ASCII codes representing each alphabetic, numeric or special character in English with a 7 bit binary number.

attribute The characteristics of an object, such as fields in a database, i.e. surname is an attribute of a person. Attributes can only exist within tags.

B

backup A copy of data that is made in case the original data is lost or damaged. The backup can be used to restore the original data.

bespoke software Custom software specially developed for some specific organization or other user rather than being produced for the mass market.

bias Prejudice towards one viewpoint or against another.

binary (or base-2) A number system that only uses two digits 0 and 1. Computers operate in binary because they can only recognise two values,1 or 0.

binary search A search algorithm which repeatedly divides an ordered search space in half. The search compares the required element with the middle element.

biometric test In computer security, biometrics refers to authentication techniques that rely on measurable physical characteristics that can be automatically checked. Unique identifiers include fingerprints, retina and iris patterns, voice waves, DNA, and signatures.

bit The smallest measurement unit of computer memory or data transmission speed.

bitmap A computer graphic or image composed of thousands of individual dots or pixels, each pixel being stored as a number. The image is displayed by specifying the colour of each pixel.

browser A software application for retrieving, presenting and navigating information resources on the World Wide Web.

Boolean A data type that is used to express the two truth values of logic – 'true' and 'false' – and a function with Boolean arguments or result, the most common being AND, OR and NOT.

bus typology A set of parallel wires for connecting the CPU of a computer to all other input-output devices. Data can be transmitted in two directions, from and to the CPU.

byte A measurement of computer memory or disc capacity. A byte comprises 8 bits.

C

cache memory A small, fast memory holding recently accessed data, designed to speed up subsequent access to the same data.

cache size The size of the data store where the memory elements are actually stored.

CAPTCHA "Completely Automated Public Turing test to tell Computers and Humans Apart". It is a type of challenge-response test used in computing to determine whether or not the user is human.

cell reference Name of a particular cell in a spreadsheet e.g. C8 refers to the third cell across in the eighth row.

character A character is any letter, number, space, punctuation mark, or symbol that can be typed on a computer.

character sets A defined list of characters, each represented by a number and recognized by the computer hardware and software.

chart Information presented graphically in a graph or diagram e.g. a pie chart.

CIA Confidentiality, integrity and availability is a model designed to guide policies for information security within an organization.

CIR (Committed Information Rate) In a frame relay network, the average transmission rate in bits per second (typically Kbps) for a virtual circuit. It defines the maximum rate that the network can handle under normal conditions.

circuit diagram A circuit is a model of computation in which input values proceed through a sequence of gates, each of which computes a function.

circuit switching This involves communication via a single dedicated path between the sender and receiver. The telephone system is an example of a circuit switched network.

clock speed The rate in cycles per second at which a computer performs its most basic operations.

cloud storage Data that is stored on a central server owned by a company (e.g. Google). Users access data virtually.

collaborate Work together to achieve common goals.

colour depth Also referred to as pixel depth or bit depth. Colour depth refers to the number of bits per pixel on a computer monitor to represent a specific colour. The more bits per pixel, the higher colour variety and quality of the monitor.

column A column (e.g. in a spreadsheet or database) holds the data for a single field in each record in the database.

compatible Term to describe the ability of a device to communicate and share information with another device.

composite A data type composed of multiple elements.

compression A technique to make a file or a data stream smaller for faster transmission or to take up less storage space.

concatenating strings The operation of joining two strings together in programming.

conditional formatting A feature that is used to highlight values automatically e.g in spreadsheets.

constant A parameter or quantity for which the value does not change.

control bus A computer bus used by the CPU to communicate with devices that are contained within the computer. This occurs through physical connections such as cables or printed circuits.

control systems A set of mechanical or electronic devices that regulates other devices or systems through an open-loop or closed-loop model.

convert To change the format or function of something.

cookie A packet of data sent by an internet server to a browser. It is used to identify the user.

core A core is the processing unit that receives instructions and performs calculations or actions based on those instructions, enabling a software program to perform a specific function. Processors can have a single core or multiple cores.

CPU (Central Processing Unit) The electronic circuitry within a computer which controls all other parts and performs basic arithmetic, logical, control and input/output operations.

CSS (Cascading Style Sheets) They can be used to format the layout of Web pages by defining text styles, table sizes, and so on.

current instruction register The part of a CPU's control unit that holds the instruction currently being executed or decoded.

cyber security The protection of internet-connected systems.

D

data Computers process data to produce information. Symbols, characters, images and numbers are all types of data.

data bus A system within a computer or device, consisting of a connector or set of wires, used to carry data.

data theft The illegal transfer or storage of any information that is confidential, personal, or financial in nature, such as passwords, software code, algorithms, or technologies.

data type A specific form of data item which is defined by the values it can take.

decryption The conversion of encrypted data into its original form is called Decryption. It is generally a reverse process of encryption.

descending order Arranged from largest to smallest.

desktop computer A computer designed to sit on a desk, usually consisting of a tower and separate monitor.

digital A description of data which is stored or transmitted as a sequence of discrete symbols from a finite set. This usually means binary data represented using electronic or electromagnetic signals.

digital footprint Information held about a particular person as a result of their online activity.

digital product A product produced using ICT tools and viewed on-screen. It does not need to be printed out.

disc defragmentation Defragmentation is the process of consolidating fragmented files on the user's hard drive, increasing the efficiency of data retrieval and thereby improving the overall performance of the computer.

domain name system A naming system for computers, services, or other resources connected to the Internet or a private network. DNS servers are located at many strategic places on the nets to resolve the routing of e-mail and Internet connections.

download Transfer of a file from a central computer to another computer.

drop-down list A graphical control list that allows a value from a list to be selected.

E

e-commerce The sale of goods electronically, usually over the Internet.

embedded systems Hardware and software which forms a component of some larger system and which is expected to function without human intervention.

encryption Encryption is the most effective way to achieve data security. Readers need access to a secret key or password that enables encrypted data (cipher text) to be read as unencrypted data (plain text).

entity In a database, anything about which information can be stored, such as a person, physical object or event.

ethical Relating to someone's principles about what is right and wrong.

expert systems Computer software that uses artificial intelligence methods to solve problems; it acts like a human expert on a particular subject area. Expert systems are often used to advise non-experts.

F

fetch-execute cycle The sequence of actions that a central processing unit performs to execute each machine code instruction in a program.

field An attribute or property such as surname, description, cost price, held in the column of a database.

file format The particular code that a file is stored in.

firewall A system to prevent unauthorised access to your computer when connected to a network such as the Internet.

flat file database A database held as a single table. It is structured with a row for every record.

flowchart A diagram which shows the breakdown of an algorithm into all of the necessary steps.

font A set of type or characters in a particular style and size.

forecast A prediction or calculation made about future events.

forged link A link in an email that leads to a phishing site.

format A defined structure for the processing, storage, or display of data.

formula A statement or equation that automatically calculates a result based on values entered in the formula or in other cells.

fraud Tricking someone for personal gain or to damage them.

FTP (File Transfer Protocol) A standard network protocol used for the transfer of computer files between a client and server on a computer network.

full backup This allows the computer system to be restored as it was at a given point in time, including the operating system, all applications and all data.

function A formula used in a calculation, such as IF or SUM.

functionality The different things that you can do with a website or other product, e.g. click on a link to go to another page, select check boxes, submit an online form.

G

generic A term to describe the basic or typical form of something e.g. generic software is non-specialised software.

global positioning system (GPS) A navigational system used in many devices which gives current location, directions.

GUI (Graphical User Interface) The use of pictures rather than just words to represent the input and output of a program.

H

hacker A person seeking to gain unauthorised access to a computer to obtain data stored on it.

hardware The physical parts of a computer system, including input, output and storage devices.

home page This is the first screen of an interactive digital product.

HTML (Hypertext Markup Language) The coding system used for creating pages on the World Wide Web. It allows the author to control how the page appears and to insert Hypertext links within one Web page or to other pages anywhere on the Web.

HTTP (Hypertext Transfer Protocol) The transfer method used by the World Wide Web to transmit and receive Web pages.

I

identifier A sequence of characters used to refer to a specific variable or set of data.

incremental backup A type of backup that only copies files that have changed since the previous backup.

index A set of items each of which specifies information about a record in a file and its address.

information overload Having so much information available that the user feels overwhelmed and is unable to take any of it in, possibly leading to stress.

input Information which is put into a computer.

integer An integer is a whole number (not a fraction) that can be positive, negative, or zero. A commonly used data type in computing.

interrupt A signal from a device attached to a computer or from a program within the computer that requires the operating system to stop and figure out what to do next.

IP address A unique address which identifies every piece of computer equipment connected to the Internet.

J

javaScript A programming language primarily used on the Web to enhance HTML pages and is commonly found embedded in HTML code. JavaScript is an interpreted language so does not need to be compiled.

K

keyframe A drawing that defines the starting and ending points of any smooth transition in animation or film-making. A sequence of keyframes defines which movement the viewer will see, whereas the position of the keyframes on the film, video, or animation defines the timing of the movement.

kilobyte A unit of measurement of computer memory or disc capacity = 1,024 bytes.

L

LAN (Local Area Network) A network of computers at one site that provides services to other computers connected to it. The most important part of a LAN is the server that delivers software to the computers (also known as workstations or clients) that are connected to it.

layers In graphics software, a layer is the term used to describe the different levels at which you can place an object or image file. In the program you can stack, merge or define layers when creating a digital image.

linear search A search where items stored in a file are searched sequentially.

link The code or instruction which links one element in a program to another e.g. an audio link.

loader In computer systems a loader is the part of an operating system that is responsible for loading programs and libraries.

logic gate Logic gates perform basic logical functions and are the fundamental building blocks of digital integrated circuits. Most logic gates take an input of two binary values and output a single value of a 1 or 0.

login details The username and password used when logging into a system.

loop A sequence of instructions in a program that the processor repeats, either until some condition is met, or indefinitely (an infinite loop).

lossless audio compression Lossless compression reduces a file's size with no loss of quality. Lossless compression basically rewrites the data of the original file in a more efficient way. In any audio compression, the quality remains the same as the original signal and decoded signal are bitwise identical.

lossy compression Lossy is a data encoding and compression technique that deliberately discards some data in the compression process.

M

MAC address The hardware address of a device connected to a shared network medium.

macro A set of instructions used to automate a particular task, typically activated by pressing a button or combination of keys on the keyboard.

mail server A program that distributes files or information in response to requests sent via electronic mail.

maintain To keep something in good condition.

malware Software that is designed to cause problems for users.

MAR (Memory Address Register) This holds the memory location of data that needs to be accessed.

merge To combine into a single entity.

mesh networking A type of network topology in which a device (node) transmits its own data as well as serves as a relay for other nodes. Routers are used to provide the best and most efficient data path for effective communication.

metadata Information about the content of a digital item. Some governments keep metadata on electronic communications.

microchip A miniature electronic circuit used to control computers and most other electronic devices.

minimise To reduce to the smallest size possible.

mirroring A mirror is a server that provides an exact copy of data from another server. This may be one or more files, a database, a website, or an entire server. Another type of mirroring – FTP mirroring – simply provides one or more files from multiple servers.

mobile app A software application developed specifically for use on small, wireless computing devices, such as smartphones and tablets, rather than desktop or laptop computers.

motherboard The main electronic circuit board of a microcomputer, to which other circuit boards (also known as cards) can be connected in order to fulfil special functions.

multi-tasking The execution of more than one program at the same time on a computer.

N

navigation bar Usually found along the top or side of the screen, it provides a series of links to other screens.

network Devices connected together to allow communication and exchange of data.

O

off-the-shelf software Software or hardware products that are ready-made and available for sale to the general public.

opcode The part or parts of a machine language instruction which determines what kind of action the computer should take, e.g. add, jump, load, store.

operand The part of a computer instruction which specifies what data is to be manipulated or operated on, while at the same time representing the data itself.

operator In computer programming an operator is a character that represents an action; (the Boolean operators are used to work with true/false values).

output The production or delivery of data out of a system.

P

packet switching A communications network in which relatively small units of data called packets are routed based on the destination address contained within each packet. Breaking communication down into packets allows the same data path to be shared among many users in the network.

parameter A special kind of variable in computer programming language that is used to pass information between functions or procedures. The actual information passed is called an argument.

parameterised query A type of SQL query that requires at least one parameter to be inserted into a statement for it to be executed.

PC (Program Counter) A register in the central processing unit that contains the addresses of the next instruction to be executed. After each instruction is fetched, the PC is automatically incremented to point to the following instruction.

peripheral A computer peripheral is any external device that provides input and output for the computer; a keyboard and mouse are input peripherals, while a monitor and printer are output peripherals. External hard drives provide both input and output for the computer.

pharming The practice of directing Internet users to a bogus website.

phishing A type of Internet fraud involving the stealing of valuable information such as credit card details, usernames and passwords.

PIN (Personal Identification Number) A type of password applied to a credit or debit card.

pixel This is the basic unit of programmable colour on a computer display or in a computer image which can be set according to the user's choice to produce either low-resolution output, medium-resolution output or high-resolution output.

pixel density Also referred to as Pixels per inch (PPI). A measurement used to define the resolution of a computer display.

pop-up A small, often 'unwanted' window, that appears within a program or over the top of a Web page to deliver additional information.

port A connection point or interface between a computer and an external or internal device.

presence The existence of something in a place or program.

primary key A unique identifier, often an integer, that labels a certain row in a table of a relational database.

primary source Information or data that you have collected yourself.

protocol Rules used by computers to communicate with each other across a network.

pseudocode A detailed readable description of an algorithm.

Q

query Computer programming language used to retrieve information from a database.

R

RAM (Random Access Memory) Computer memory where any byte of memory can be accessed without touching the preceding bytes. RAM is found in servers, PCs, tablets, smartphones and other devices.

rating Ranking or scoring of someone or something based on assessment of their performance.

real-time The actual time during which something happens.

record Set of fields pertaining to a single entity (person or thing).

register A processor register may hold an instruction, a storage address, or any kind of data. It is one of a small number of high speed memory locations in a computer's CPU.

relational database A database that uses more than one table. Tables are linked together by common data items, such as ID number, known as keys.

remote From a different location.

removable media Any type of storage device that can be removed from a computer while the system is running, such as CDs, DVDs and Blu-Ray disks.

reset Set a program or display back to its original or default setting.

resolution The maximum number of pixels that can be displayed on a monitor, expressed in terms of the number of pixels on the horizontal axis and the number on the vertical axis.

ROM (Read-Only Memory) Computer memory on which data has been pre-recorded. ROM keeps its contents whether the computer is turned on or off.

router A device which forwards packets between networks. The forwarding decision is based on network layer information and routing tables, often constructed by routing protocols.

row A single record in a database table.

RTOS (Real-time Operating System) A class of operating system designed to handle events as they occur, thereby making it suitable for control of hardware in embedded systems and other time-critical applications.

S

sample resolution The representation (or size of the numbers) used to write samples in digital sound recording.

sample rate The number of times an analog signal is measured (sampled) per second, often expressed in kiloHertz (kHz).

scenario Imagined sequence or development of events.

scheduling The method by which work specified by some means is assigned to resources that complete the work. The work may be virtual computation elements such as threads, processes or data flows, which are in turn scheduled onto hardware resources such as processors, network links or expansion cards.

scope This refers to the visibility of variables and methods in one part of a program to another part of that program. The two general scope concepts many languages have in common are 'local' and 'global' scope.

secondary storage A storage device such as hard disk or USB pen, which is separate from the main memory (RAM) of the computer.

selection statement Keywords such as if. and else. are used in selection statements. A selection statement causes the program control to be transferred to a specific flow based upon whether a certain condition is true or not.

sensor An electronic device that measures or detects a physical quantity such as heat, motion, light or loudness and converts it into an analog or digital representation.

server A program which provides some service to other (client) programs. The connection between client and server is normally by means of message passing, usually over a network and uses some protocol to encode the client's requests and the server's responses.

smart phone A phone offering advanced features, e.g. Internet connection and email capacity.

social networking site An online community where people can communicate and share information.

software Programs that give instructions to a computer and which allow the user to carry out different tasks.

spam Unwanted or junk email sent to lots of recipients at the same time.

specification The technical details of a device or system.

splines In computer graphics, a spline is a curve that connects two or more specific points, or that is defined by two or more points.

spreadsheet modelling A simulation of a real-life situation.

spyware Software that is installed on a computing device without the end-user's knowledge. In the workplace, such software may be installed on corporate laptops to monitor employees' browsing activities.

SQL (Structured Query Language) A standard computer language for relational database management and data manipulation. SQL is used to query, insert, update and modify data.

star typology A network configuration for a Local Area Network (LAN) in which all nodes are individually connected to a central connection point, like a hub or a switch. A star typology requires a lot of cable but the benefit is that if a cable fails, only one node will be brought down.

storage device Any computing hardware that is used for storing, porting and extracting data files and objects.

stored program concept Data and instructions are both logically the same and can both be stored in memory.

string Any finite sequence of characters including letters, numerals, symbols and punctuation marks. The length of each string is determined by the number of characters in it.

subroutine A sequence of instructions for performing a particular task. Most programming languages, including most machine languages, allow the programmer to define subroutines.

suspicious Having doubts about the integrity of something.

system software Any software required to support the production or execution of application programs but which is not specific to any particular application. System software typically includes an operating system to control the execution of other programs.

T

tab An icon that can be clicked to open a further page in a spreadsheet or browser.

table A set of data elements in a database in columns and rows.

tag A keyword or term assigned to a piece of information, for example, a computer file or Internet bookmark. This kind of metadata helps describe an item and allows it to be found again by browsing or searching.

tailor-made Made for a very specific purpose e.g. software for a city transport system.

trojan A type of malicious code or software that looks legitimate but can take control of your computer and is designed to damage, disrupt, steal, or in general inflict some other harmful action on your data or network.

truth table A table listing all possible combinations of inputs and the corresponding output of a Boolean function such AND, OR, NOT, IMPLIES, XOR, NAND, NOR. Truth tables can be used as a means of representing a function or as an aid in designing a circuit to implement it.

tweening A key process in all types of animation, including computer animation. Sophisticated animation software enables you to identify specific objects in an image and define how they should move and change during the tweening process.

U

unicode The Unicode Worldwide Character Standard is a character coding system designed to support the interchange, processing and display of written texts of the diverse languages of the modern world.

unidirectional The transfer or transmission of data in a channel in one direction only ensuring information is secure.

upgrade Improve the quality or performance of a piece of equipment or software.

URL (Uniform Resource Locator) URLs specify the location of a resource in the Internet. You can type or paste a URL into the location window in your browser and then connect to it. The URL shows the type of item and its basic address and path.

user interface The way a user interacts with a computer system e.g. keypad, screens, menu and icons.

user-friendly Easy to engage with or understand.

V

validation The process of checking that the data entered is reasonable or one of the given options.

value The integer, real number or character string held in a location in a computer's memory during the execution of a program.

variable A value that can change.

vector graphic The representation of separate shapes such as lines, polygons and text, and groups of such objects, as opposed to bitmaps.

verification The process of checking that data is accurate by entering it twice.

virtual memory A system which enables a computer program to behave as though the computer's memory was bigger than the actual physical RAM.

virtual reality Computer simulations that use 3D graphics and devices, such as the data glove, to enable the user to interact with the simulation.

virus A program designed to cause other programs on a computer to malfunction or stop working altogether.

W

WAN (Wide-Area Network) A computer network that spans a relatively large geographical area, usually consisting of two or more local-area networks (LANs).

warning sign A sign that indicates potential danger.

WAP (Wireless Application Protocol) A communications protocol that is used for wireless data access through most mobile wireless networks. WAP enhances wireless specification interoperability and facilitates instant connectivity between interactive wireless devices and the Internet.

wireless networking Networks that operate without the need for cables to connect them.

wizard Part of a program that helps the user to create a new document, chart, etc. A sequence of dialogue boxes guides the user through the steps needed to create the item required.

wizard Software that guides the user step-by-step through a complex task, such as setting up software on a network or configuring a printer to output data in a special format, such as printing labels from a database program.

Z

zipped file The process of compacting files or programs in order to cut down the amount of storage space they require by compressing them into one tightly-packed file.

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