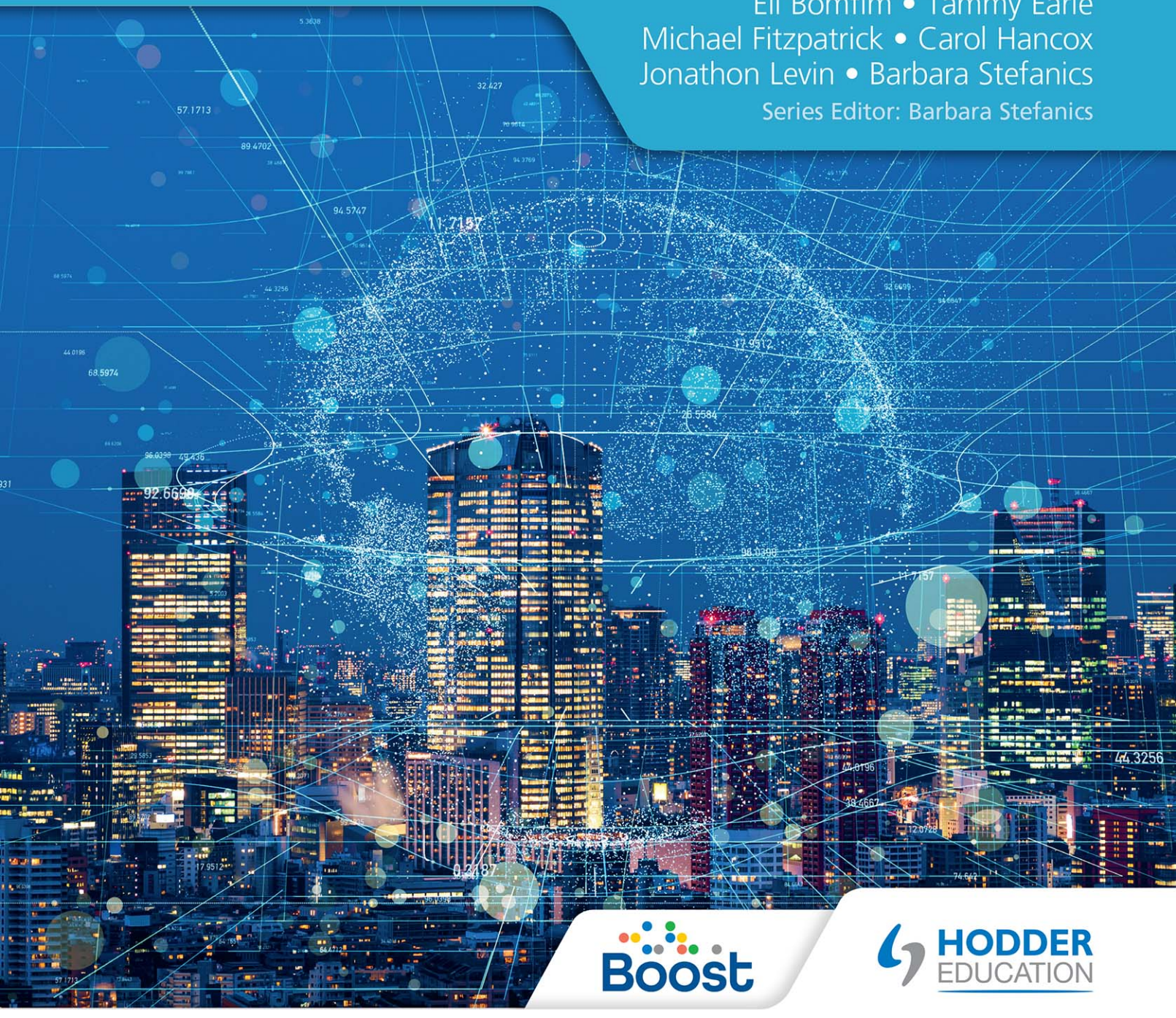
FOR THE
IB DIPLOMA
PROGRAMME

IN COOPERATION WITH ib

Digital Society

Eli Bomfim • Tammy Earle
Michael Fitzpatrick • Carol Hancox
Jonathon Levin • Barbara Stefanics
Series Editor: Barbara Stefanics



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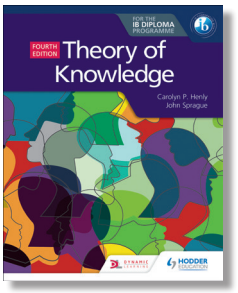

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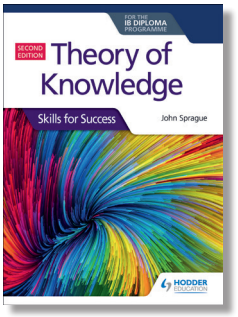

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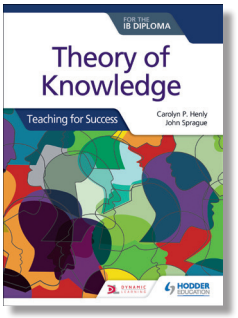

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ISBN: 978 1 3983 5841 6

First published in 2022 by

Hodder Education,
An Hachette UK Company
Carmelite House
50 Victoria Embankment
London EC4Y 0DZ

www.hoddereducation.com

Impression number 10 9 8 7 6 5 4 3 2 1

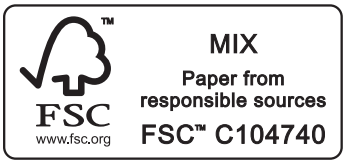
Year 2026 2025 2024 2023 2022

Illustrations by DC Graphic Design Limited

Typeset in ITC Berkeley Oldstyle BT 10/14pt by DC Graphic Design Limited, Hextable, Kent

Printed in

A catalogue record for this title is available from the British Library.



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Contents

The 'In cooperation with IB' logo signifies the content in this coursebook has been reviewed by the IB to ensure it fully aligns with current IB curriculum and offers high quality guidance and support for IB teaching and learning.

Dedication

It has been a most invigorating and rewarding pleasure to collaborate with top International Baccalaureate (IB) professionals in this field to produce what we hope is the ultimate guide for students. We wish to thank the many Information Technology in a Global Society (ITGS) colleagues and Diploma Programme (DP) educators who have contributed through online discussions, social media groups, virtual meetings, exchanges and workshops to this next significant step: the digital society.

About the authors

Hours of ongoing discussions, deliberation and collaboration between members of the authoring team has gone into producing what we believe will be a valuable resource for students. We hope that it will be the springboard for student inquiries into the impacts and implications that digital technologies are having for themselves, for other groups of individuals and for other communities in today's world.

Digital society is a constantly evolving subject, with new digital technologies and new real-life scenarios on an almost daily basis. This book takes on the challenge of providing the knowledge, understanding and skills needed to adapt to our changing digital world and the challenges that it presents.

As a team, the authors have an extensive range of experience and roles across the IB spectrum: as teachers, examiners, workshop leaders and developers, consultants, authors, bloggers, presenters and innovators in the DP. We have been involved in DP initiatives for over 40 years, and over 30 years in ITGS development, the precursor to digital society.

Eli Bomfim

Eli was born and grew up in Curitiba, Brazil, where he also had his formal education and graduated in civil engineering from the Universidade Federal do Paraná. He got his Master of Education from Framingham State University, Massachusetts. Over the years, Eli has taught English as a second language, mathematics, physics, theory of knowledge and ICT, and has been an IB coordinator, but his teaching passion is ITGS, the course predecessor of digital society, which he has been teaching for over 23 years. He taught ITGS at the International School of Curitiba between 1998 and 2010, and at the Sultan's School in Muscat, Oman, from 2010 onwards. Eli is also an online ITGS teacher for Pamoja Education, an IB examiner and an IB workshop leader.

Tammy Earle

Tammy lives in Rothesay, New Brunswick, Canada, and is the director of technology and learning initiatives at Rothesay Netherwood School. She graduated with her Bachelor of Science (mathematics) and Bachelor of Education from Dalhousie University, and a Master of Education (learning and technology) from Acadia University. Tammy continues to explore ways to redefine education through the effective use of digital technology and build new approaches to pedagogy through a culture of inquiry and design thinking. Over the last 25 years, Tammy has worked as a teacher (ITGS, mathematics, digital design and robotics), IB diploma coordinator, and has been involved with IB as an examiner, workshop leader and online curriculum developer. She also participated in DP curriculum reviews for ITGS and the digital society course.

Michael Fitzpatrick

Michael was born in Melbourne, Australia. He studied at a variety of universities in the city and has a Bachelor of Science (mathematics and information science), a Bachelor of Education, and a Master of Education (thesis: focus on constructivist learning). He has written a number of ICT textbooks for the Victorian Certificate of Education, and has presented at in-service events and conferences. When Carey Baptist Grammar School in Melbourne first began offering the IB programme in the late 1990s, he taught ITGS, the course predecessor of digital society. Over the years he has become involved with IB in various roles with ITGS, including IB examiner and IB workshop leader. He has also taught Theory of Knowledge for many years.

Carol Hancox

Carol was born and grew up in London, UK, graduated from the London School of Economics with a degree in management science, and complemented this with a Postgraduate Certificate in Education in business studies to become a teacher in 1995. Carol started as an ICT and business studies teacher, and has been working at the International School Brunei for the last 20 years, where she has been teaching computer science and ITGS. Carol has been involved with IB in various roles with ITGS since 2002, including examiner, and participated in the DP curriculum review for the new digital society course, which she is looking forward to teaching.

Jonathon Levin

Jonathon grew up in Northern California, USA. He graduated from UCLA with a degree in business economics before earning his Master of Education at LMU. Over the past decade, he has taught in a variety of contexts including public, private and charter schools in the USA, Spain, Indonesia and Israel. He has taught mathematics, computer science, graphic design, robotics, sustainable architecture, English as a foreign language and ITGS. He has worked to develop curriculums in mathematics, technology education, sustainability and robotics. Jonathon emphasizes a student-centred approach to education to ensure all students have access to engaging, meaningful and relevant learning experiences.

Barbara Stefanics (author and series editor)

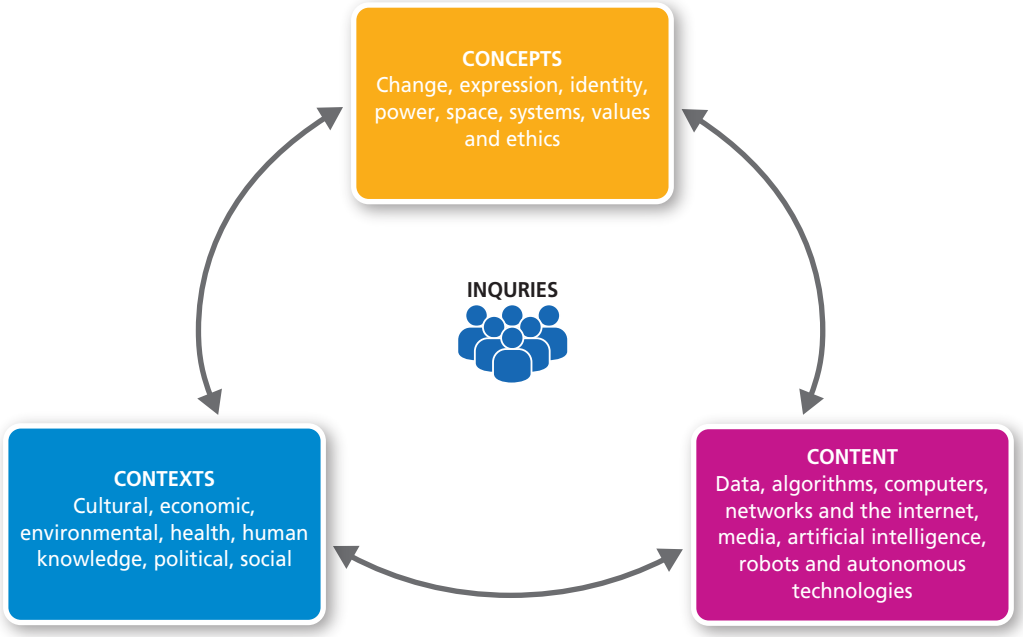
Barbara has been actively involved in IB education for over 40 years in a wide range of roles: teacher (mathematics, computer science, ITGS), head of ICT K-12 (Vienna International School), DP consultant and site visitor, workshop leader and online facilitator and developer, webinar developer (technology in the IB classroom), examiner and participant in DP curriculum reviews (computer science, ITGS, extended essay, learner profile and digital society). The next frontier, digital society, is an exciting opportunity for teachers and students to actively engage with contemporary topics and promote responsible and ethical use of digital technologies, as well as decision-making and taking action.

Welcome to digital society

We are living in a constantly evolving society where developments in digital technologies are having significant impacts. They are transforming how we think, communicate, collaborate, create and organize ourselves. It can be argued that we are living in a digital society.

This course provides a foundation for studying and understanding the impacts and implications of digital technologies for both individuals, and local and global communities. We want to gather experiences, knowledge and insights from diverse, real-world contexts in order to anticipate and prepare for future developments in digital technologies.

The Digital Society course is based on using concepts, content and contexts as a structure for approaching real-world examples, as shown in the diagram below. This digital society diagram will be referred to as the '3Cs' throughout the textbook. Take a close look. It actually consists of four important interrelated elements – the fourth being the impacts and implications for people and communities.



■ Digital society diagram – the 3Cs

The diagram captures all of the topics in the core standard level (SL) and higher level (HL) syllabus and answers the question '*what* will we learn?'.

A later chapter, 1.4 Your digital society toolbox, addresses *how* we will learn.

HL students will address three additional topics in Section 5 HL extension: challenges and interventions. These topics provide additional areas for study that extend the topics on the 3Cs diagram. The three topics and their subtopics are shown in the following diagram.

■ HL extension: challenges and interventions

The digital society textbook supports the International Baccalaureate Diploma Programme (DP) Digital Society course. You are expected to engage with the information presented both as an individual and also in collaboration with other students. You will explore digital society topics through the inquiry process. Higher level students will also be expected to use extended inquiry to investigate challenges and interventions in Sections 5 and 6. Both of these approaches – inquiry process and extended inquiry – are considered in more detail in Chapter 1.4 Your digital society toolbox.

Sections 1–4, 7, 8 and 10	Core topics for both SL and HL students
Sections 5–6	Topics for HL students only
Section 9	Guidance for the digital society extended essay

No specific prior learning or courses of study are expected in order to be successful in the Digital Society course. You are expected to engage in a high level of curiosity and engagement with the topics presented and take the initiative to explore further.

As a digital society student, you must have access to:

- the Diploma Programme *Digital Society Guide*
- a computer with internet access
- research materials available online as well as a range of media in the classroom, school library and local libraries
- research tools and online services that can be used to conduct secondary research, as well as primary research and investigations needed for some assessment components
- applications, both offline and online, for creating, storing, analysing and sharing information and for developing the required multimedia presentation.

Moreover, you are expected to take responsibility for your own learning and support the learning of other digital society students by:

- reading and completing the activities in this textbook
- developing your ATL skills and using the inquiry process throughout the course
- contributing to ongoing discussions and collaborations with other digital society students
- consulting the resources used in each chapter
- keeping abreast of emerging digital technologies and their impacts and implications for stakeholders.

You should take note of the digital technologies in your immediate environment, as well as those that have local and global implications. The first step in taking action is to share your findings and discoveries with others.

Throughout the Digital Society course we will refer to the 3Cs (concepts, content and contexts), which will be explained in the next section. However, the fourth 'C' – connections – is an important one to keep in mind throughout your studies. Digital society students are expected to take an active role in 'making connections' throughout the course. This involves analysing information and real-world examples, and linking them to:

- the 3Cs in the digital society diagram, and to various chapters and topics in the Diploma Programme *Digital Society Guide*
- other real-world examples and how they relate to each other
- the Diploma Programme core – theory of knowledge (TOK); creativity, activity, service (CAS) and extended essay (EE) – and other Diploma Programme subjects.

With this mindset, you are now ready to embark on studying the impacts and implications of digital systems on stakeholders in our digital society.

Additional resources to supplement the Digital Society textbook can be downloaded from www.hoddereducation.co.uk/ib-extras

Section 1

Understanding digital society

1.0 Overview of IB digital society

UNDERSTANDINGS

By the end of this section, you should understand:

- the key terminology relating to 'digital' in digital society
- the digital society diagram (the 3Cs)
- digital society in the IB context
- approaches to learning and studying digital society
- the digital society assessment model.

If we search the internet for the words 'digital society', what are the results? Links to businesses or organizations? Links to universities and university programmes? Articles about life in a digital society? In fact, all of these are likely to appear in the list of results.

For our purposes, digital society is the study of the impacts and implications of the use of digital systems and digital technologies for individuals, people and communities at a local, regional or global level. However, digital society is changing constantly due to the ubiquitous nature of digital technologies and their evolving connectivity.

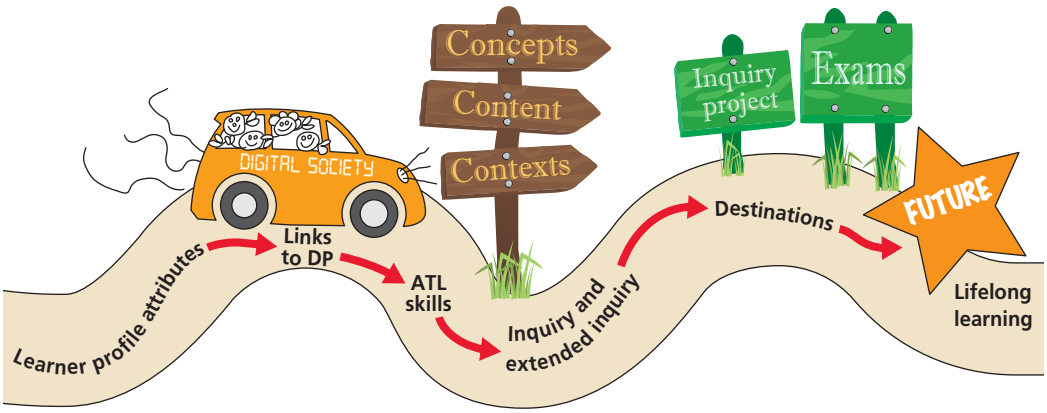
Through specific real-world examples you will develop knowledge, understanding, skills and concepts that you can apply to new situations that you encounter. The changing nature of digital technologies and their uses requires you to always look for connections to what has gone before, and apply your insights to new situations that you encounter in the future. Your first thoughts about digital society may be:

- What is the Diploma Programme Digital Society course all about?
- Why should you study digital society?

- What knowledge, understandings, skills, attributes and values will be developed in order to be successful in both assessments?
- How will studying digital society be beneficial in your future?

Path to success – making connections

When you embark on the course, you need to keep the immediate destinations (aims) in sight: success in the external assessment and Inquiry Project, and in the examinations.



Digital society path to success – making connections

Through the journey, you will be in the 'driver's seat' and taking responsibility for:

- *what you need to know* in the digital society subject (concepts, content, contexts, impacts and implications for stakeholders)
- *how you will learn* the subject, using your digital society toolbox (inquiry process – extended inquiry, developing ATL skills, learner profile attributes)
- establishing links to other Diploma Programme subjects and to the Diploma Programme core (TOK, CAS and EE)
- using digital technologies to support your learning and your inquiry project
- applying your learning critically and creatively to new scenarios in preparation for examinations
- keeping abreast of emerging digital technologies and their impacts and implications
- envisioning how digital technologies will play an important role in your future.

Due to the changing nature of any subject based on the use of digital technologies, the focus of this course is on developing knowledge, understandings and skills from the real-world examples provided, and the impacts and implications for a range of individual, local and global contexts.

1.1 What is digital society?

We are (in) a digital society. Digital systems are changing our world and transforming how we think, communicate, collaborate and create. This course invites young people to better understand this changing world and to imagine where we might go next. As partners in inquiry, students and teachers explore the impacts and implications of digital systems for people and communities in diverse real-world contexts.

Diploma Programme Digital society guide

We will use this statement as our focus into digital society.

1.1A Digital society has multiple names

There are many names associated with 'digital society' and the use of digital systems. For the purpose of this study, we will consider the following terms: information age, computer age, post-industrial society, network society and fourth industrial revolution. It is not important to compare features of each era, but to note ongoing developments that contribute to digital society.

The terminology used to describe how the developments in digital systems have taken place is sometimes confusing. For example, we often see references to the five generations in computing, however the 'fourth generation in computing' is completely different from what is meant by the 'fourth industrial revolution'. The more recent developments in the **digital revolution** from 1980 onwards are those that we will consider as contributing to the rise of digital society.

◆ **Digital revolution**: The advancement of technology from analogue electronic and mechanical devices to digital.

We have to keep in mind that dates on timelines are not distinct points in time. Dates often mark a point in time when a particular digital technology was actually used to a significant extent. Digital technologies undergo years of development before their use is actually acknowledged.

In taking a close look at the developments during the digital revolution (third industrial revolution) and the emergence of digital society (fourth industrial revolution), which digital technologies have had significant impacts and implications for individuals, people and communities?

1.1B Digital society has uneven access to digital systems

The ability to access digital technologies and the internet has become increasingly important in order to connect to the economic, political and social aspects of the world. The term **digital divide** highlights that not everyone has access to this technology. Digital divide refers to the significant gaps between members of society who have uneven access to computers or the internet, and the more privileged (wealthier, middle-class) living in urban and suburban areas who have access. Those with limited access to digital technologies may include:

◆ **Digital divide**: The gaps between members of society who have uneven access to computers or the internet, and those who do have access.

- people who are economically disadvantaged
- people living in rural areas where digital infrastructure and the internet are not easily accessible
- older people (intergenerational digital divide)

- non-native language speakers (linguistic and cultural digital divide)
- people with disabilities
- poorly educated individuals who are unable to properly use the existing IT tools.

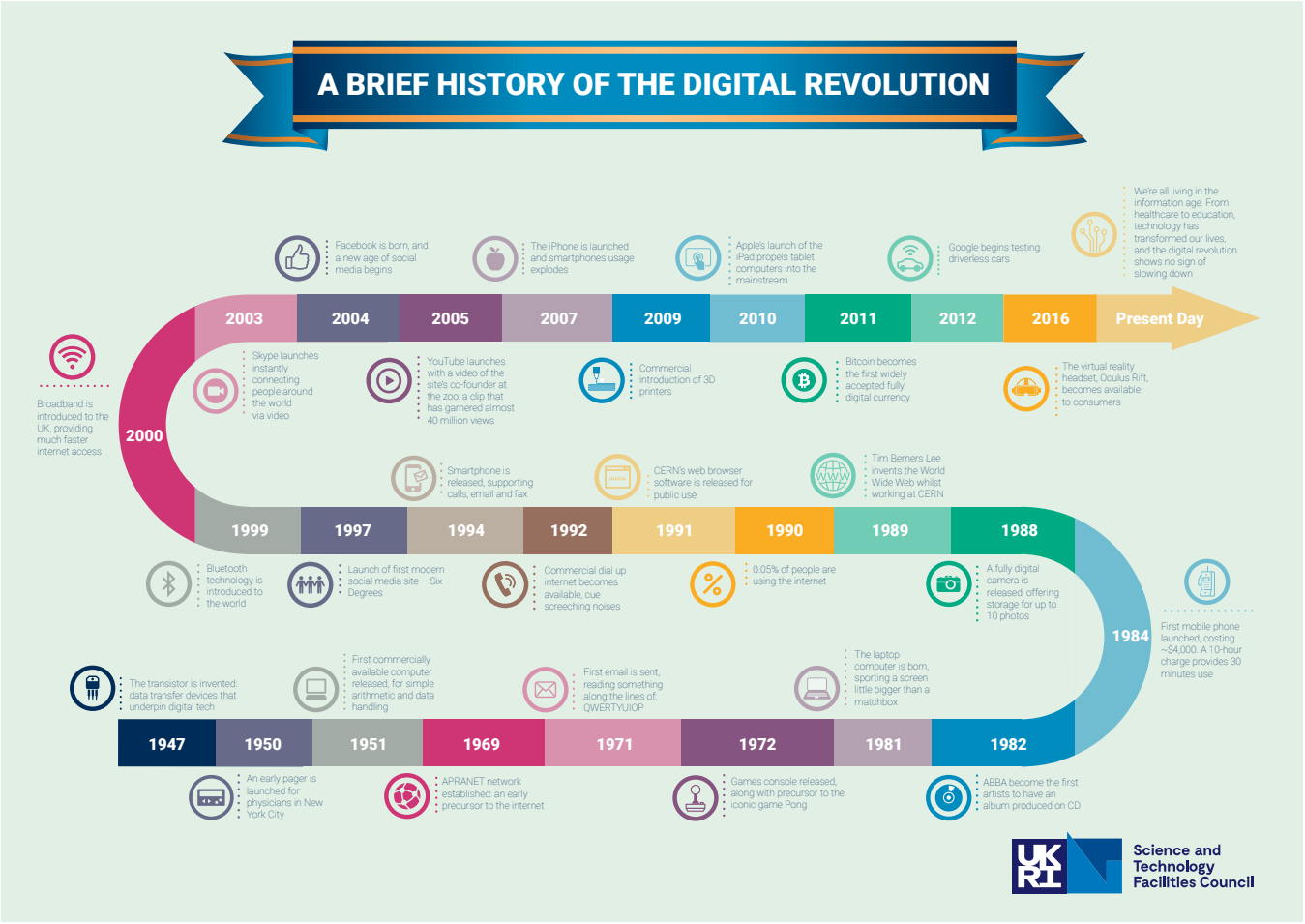
ACTIVITY

Smartphones narrow the digital divide in both a local and global context. Outline specific real-word examples of how smartphones have reduced the digital divide in rural Africa.

1.1C Milestones in the development of digital society

Milestones that have contributed to the developments in digital society span the period of time from 1947 to the present (third industrial revolution and fourth industrial revolution). There is considerable disagreement about when the digital revolution began, but 1980 is often cited because of the availability of the first personal computers.

Consider the milestones in this timeline. It includes a range of digital developments. Can you identify the following digital technologies on it: integrated circuit, microprocessor, personal computer, the internet, World Wide Web (WWW), online social networks, mobile computing and cloud computing?



ACTIVITY

Personal milestones

Add details of personal milestones for you and for one older family member in the table below, adding other milestones as needed.

First use of digital technologies	Details of this milestone for you	Date of first use	Details of this milestone for a family member	Date of first use
Accessed a personal computer at home				
Played a computer game on a computer				
Used a digital camera				
Played first online game				
Accessed the internet for the first time				
Used the WWW for the first time				
Registered for an email account				
Registered for a social media account				
Used your own cell phone or smartphone				
Uploaded a digital image to a website				
Use video conferencing				

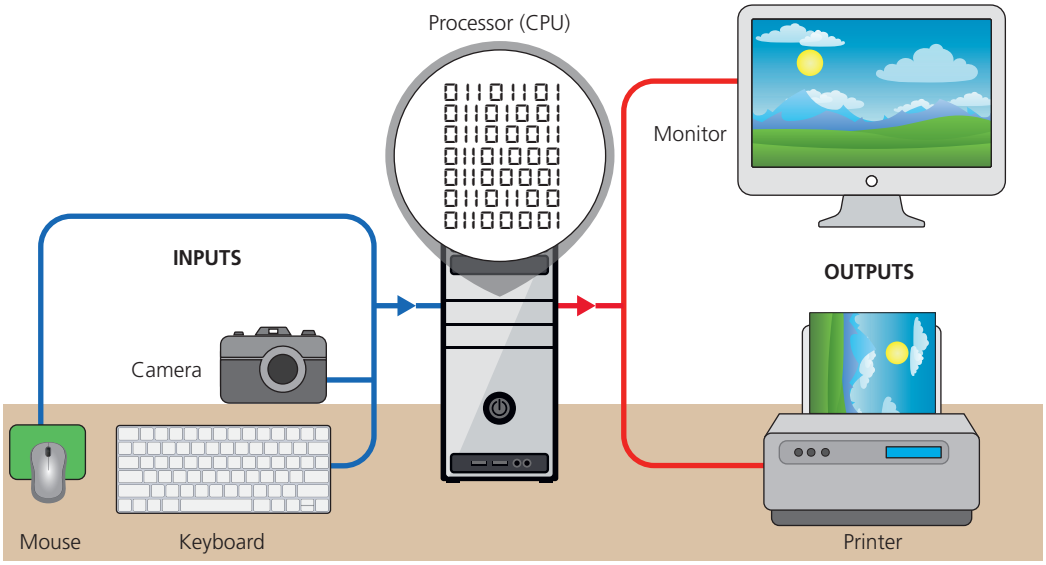
1.1D Digital systems use binary digits

The invention of the modern **binary** number system is attributed to Gottfried Leibniz, a well-known mathematician, through his article *Explication de l'Arithmétique Binaire* (Explanation of Binary Arithmetic), published in 1703, in which he used the binary number system to convert verbal logic statements into mathematical ones.

All data and information used by digital systems uses the binary digits (**bits**), 1 and 0. This includes all text, images, photos, video, audio, music, software – all data and information are represented by a sequence of 1s and 0s in all of the digital technologies we use.

◆ **Binary**: A system used to convert verbal logic statements into mathematical ones.

◆ **Bit**: A binary digit – either a 0 or a 1.



■ Data input is converted into binary for storage, manipulation and transfer

Inputs can come from a range of sources including the keyboard, mouse, cameras and scanners, including QR scanners on smartphones. For example, this QR code can be scanned by a mobile device to provide access to a website.

Can you think of other uses for QR codes?

Encoding

Strings of 1s and 0s can be encoded to represent various kinds of data and information.

Information can be stored in eight bits, called a '**byte**'. For example, a byte can represent 256 different characters of text represented from 00000000 to 11111111. ASCII (American Standard Code for Information Interchange) is the encoding standard for text. The letter 'D', for example, is represented by this byte: 01000100.

◆ **Byte**: A group of binary digits (usually eight).

Different encoding formats have been standardized to allow for compatibility between different digital systems and technologies. Examples include:

- text encoded in a text file format, e.g. TXT, CSV
- audio encoded as audio file formats, e.g. MP3, WAV, AAC
- video encoded as video file formats, e.g. MPEG-4, AVI
- images encoded as file formats, e.g. JPEG, PNG, GIF, RAW.

Data formats and file formats can only be created, saved and accessed by specific programs. Therefore, ensuring compatibility between digital technologies is often a challenge. Some formats are unique to the software used to create them, or use a file format that is no longer used by newer software.

Steganography

Information stored in binary is not legible to humans. Therefore, programs, freely available on the internet, can be used to embed text within an image file. This is called 'steganography' – the practice of hiding secret text in image files.

Steganography can be used to send messages as no particular security precautions need to be taken to send the file and no one is likely to suspect that the image contains hidden text. The photo used to hide the message can be accessed as normal, and the person receiving it can use software to read the hidden message.

The images below demonstrates the use of steganography. The cat on the right has a text message (approximately 1 KB) embedded within the binary code for the image, but it looks the same as the original image on the left.

There are legitimate purposes for using steganography, for example, watermarking images as a means for copyright protection. However, steganography can also be used to hide illegal activity and communication between members of criminal or terrorist groups.

1.1E Digital is different from analogue

Analogue and digital measurements

Most people are used to using **digital** devices to measure time and temperature. Digital watches and clocks have replaced telling the time from the placement of hands on the face of clock. Likewise, the temperature of a room can be read from a digital display on the wall rather than reading a thermometer. There are instances where **analogue** measurement is still used, for example, speedometers in many cars still use a pointer to show how fast the car is travelling.

◆ **Digital**: Discrete signals with a finite set of values.

◆ **Analogue**: Continuous physical quantities and signals.

What is the difference between analogue and digital? In measurement, analogue refers to continuous physical quantities and signals. So, a clock, thermometer and speedometer will measure a continuum of values.

Digital, on the other hand, only displays digits – that is, discrete signals with a finite set of values. So, for time, digits representing hours, minutes and seconds will be represented by digits on a display.

Analogue and digital signals

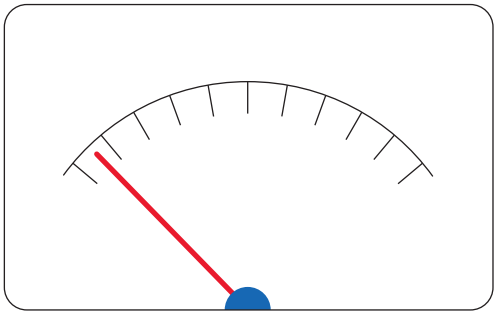
Analogue and digital can also refer to signals. Analogue signals are continuous and represented by waves. They are used for audio and video transmissions. Digital signals are discrete and are represented by 1s and 0s. They allow for the transmission of data between digital devices.

Before computers, all measurements and signals were analogue. However, digital signals have a more reliable transmission rate with less interference. They are also less expensive and more flexible.

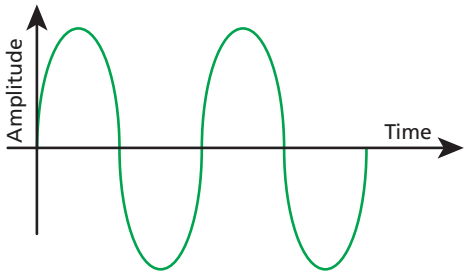
Analogue to digital, and digital to analogue

Some devices use both analogue and digital signals. Bluetooth earphones have a built-in digital-to-analogue converter (DAC) that converts the digital signal received to analogue so that it can be played and heard.

Likewise, whenever we speak into a digital microphone and save the file on our computer, an analogue-to-digital converter (ADC) makes the conversion.

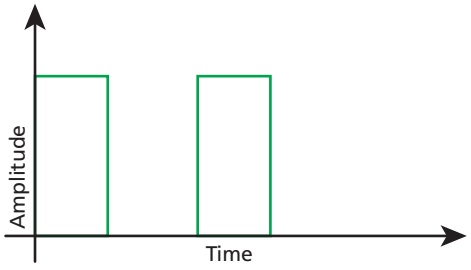


Analogue display



Analogue signal

Digital display



Digital signal

■ Analogue signals versus digital signals

1.1F Digitization

Analogue and digital information

Analogue forms such as printed photographs, printed documents and other artifacts can be converted into a digital (binary) format that can be saved on a digital device. The process of changing data and information from analogue to digital is called **digitization**. It allows us to store, process and share information between devices.

◆ **Digitization**: Changing analogue data and information to digital.

Digitization also refers to taking data that is filled in on paper forms and transferring it to a digital system or database. The data from the forms must then be stored according to the procedures and policies that have been established for the storage of personal data. Individuals may use digitization for personal purposes, to save and share personal source material on a digital device or on a cloud service.

In addition to the established procedures and policies for storing data, institutions such as museums, libraries, businesses, news agencies and governments also need to consider the actual process that will be used for the digitization of source material, such as copyright, accessibility to the digitized material and equitable digitization of cultural materials.

Digital preservation

Digitization is not the same as **digital preservation**. Digitization is only one of the steps that could be involved in the digital preservation process. Digital preservation is the process of ensuring that source material is stored and accessible in a digital format regardless of technological changes that may take place over time.

◆ **Digital preservation**: The process of ensuring that source material is stored and accessible in a digital format regardless of technological changes that may take place over time.

> *Data preservation means more than just making a backup copy of your data; it means protecting your data in a secure environment for long-term access and reuse.*
>
> *Stanford University*

Digital preservation may involve source material such as texts, documents, images, photographs, databases and spreadsheets, programs and applications, desktop files and operating systems, emails, tweets, social media, games, movies, music and sound, entire websites – indeed, anything digital accessed on a digital system.

Since digital technologies are constantly changing, the procedures and policies used for the digital preservation of source material must be able to address these changes and get around the problems caused by digital systems that are no longer available.

ACTIVITY

Obsolete digital systems

Identify five specific digital technologies, online or offline, that you or a family member used 10 years ago to create and access text, photos, music and other information that are no longer available.

To what extent is it possible to access the digital material using current digital technologies?

Digital reformatting

Digital reformatting is part of the process of preserving original materials for long term accessibility. It involves converting analogue materials into a digital format so the need to use of the original material is much less or totally eliminated. It is guided by policies and best practices to ensure that the materials being converted in the digital reformatting process are protected and that the digital version produced is of the highest quality.

Digital archives

A digital archive, also referred to as a data archive, is an information system used to store different digital resources and make them available to a specific group of users.

Digital archives can be structured in very different ways: by topic, by archive owner, by type/file format of the content (images, text, videos), by access (public or not public), by technical structure, by language, and by interaction possibility for the users (the type of navigation and search allowed).

ACTIVITY

Search for a digital archive

There are hundreds of public digital archives available from universities, libraries, museums, organizations, businesses and governments across the globe.

Use a search engine to find a public digital archive from:

- a university library
- a newspaper or magazine publisher
- a government archive
- a medical library
- a museum.

Use the words 'digital archive' along with other keywords in your topic of interest.

What are your observations about the impact and implications of making digital archives publicly accessible?

Links

This topic links to 3.1 Data and data analysis and 4.1A Arts, entertainment and popular culture.

1.1G Digitalization

The terms 'digitization', 'digitalization' and 'digital transformation' can be confused with one another, but they are all different.

Digitalization is the use of digital systems to change the structure and/or operation of a business, institution or organization. Examples include:

- a retail store introducing an online shop to sell their products
- a school deciding to use only electronic versions of textbooks
- a business deciding to store all of its data in a cloud service rather than invest in additional hardware and software to store its data on-site.

◆ **Digitalization**: The use of digital systems to change the structure and/or operation of a business, institution or organization.

Digitalization may be the result of the availability of new technologies that can be used and combined to replace the current processes that are being used. Examples of these technologies are further explored in Section 3.

Digital transformation

Digital transformation is a profound change in an entire institution, organization, business or other entity due to the need for change and the potential of digitalization to meet that need. Digital transformation can have implications for methods used, services offered, management, stakeholder involvement, ways of thinking and all other aspects of how the entity functions.

Digital transformation has been observed in education whenever natural disasters and other factors have disrupted the ability for students to attend school.

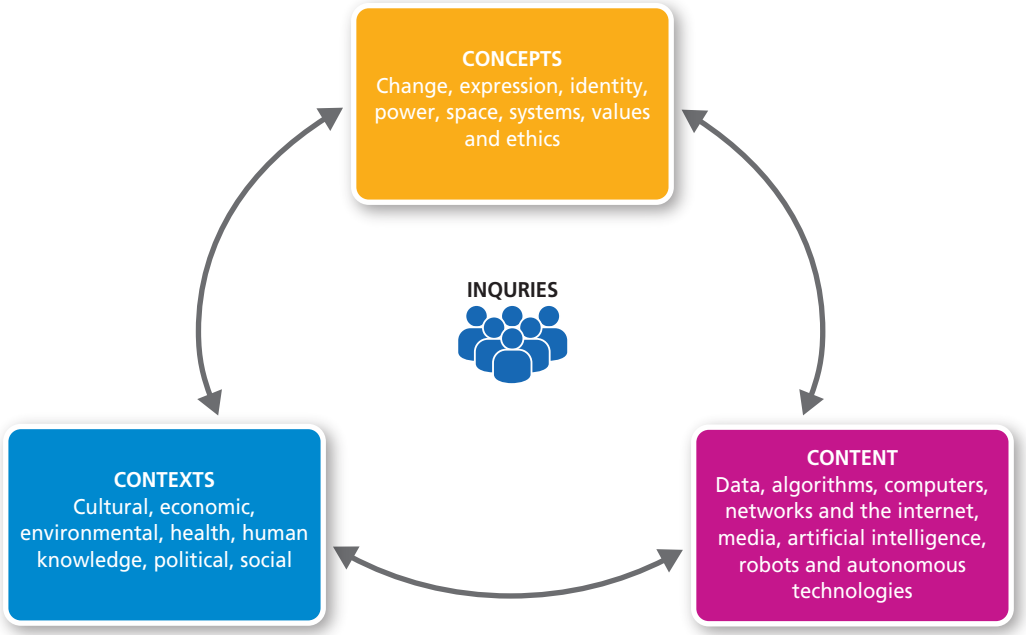
Reflection

Now that you have read this chapter, reflect on these questions:

- What is digital society, and what is the focus of our Digital Society course?
- How are all data and information stored in a digital device?
- What are the main purposes of digital preservation, digital reformatting and digital archiving?
- What are the differences between digitization, digitalization and digital transformation?

1.2 The foundations of digital society: Concepts, content and contexts

We will be applying the digital society diagram to a wide range of real-world examples throughout our study of digital society, and analysing the impacts and implications of digital systems on people and communities.



■ Digital society diagram – the 3Cs

The table below provides an overview of how real-world examples relating to digital society can be categorized under three headings: concepts, content and contexts.

■ Impacts and implications for stakeholders

Concepts	Content	Contexts
Large overarching themes that are powerful, pervasive and debatable. 2.1 Change 2.2 Expression 2.3 Identity 2.4 Power 2.5 Space 2.6 Systems 2.7 Values and ethics	Digital systems and digital technologies used in specific real-world examples. 3.1 Data and data analysis 3.2 Algorithms and code 3.3 Computing devices 3.4 Networks and the internet 3.5 Media 3.6 Artificial intelligence 3.7 Robots and autonomous technologies	Real-world examples in which the use of digital systems have impacts and implications for stakeholders. 4.1 Cultural 4.2 Economic 4.3 Environmental 4.4 Health 4.5 Human knowledge 4.6 Political 4.7 Social

If we simply consider the number of possible real-world examples that we can categorize using these three columns (concepts, content and contexts), there are 7 × 7 × 7, or 343, different possibilities. That is a significant number, and this is if we only consider one real-world example for each possibility.

In addition to considering the 3Cs when categorizing real-world examples, they can have impacts and implications for people and communities at various levels:

- individuals, groups and/or communities
- local, regional or national
- global.

This adds to the complexity of categorizing examples. It is not possible to study every possible combination of the 3Cs at all of the various levels. Therefore, it is necessary to look for similarities and make **connections** between the various real-world examples, so that the number is not overwhelming.

You will also need to have a well-organized way of saving your examples and findings, and for looking for connections to any new examples that you encounter.

Real-world examples involving the use of digital technologies can come from a wide range of sources, including:

- personal encounters and experiences
- family members, friends and acquaintances, and their experiences
- local businesses, institutions and organizations
- regional and national governments
- news items on television, radio, newspapers, magazines and other media sources
- books and published materials
- online courses, webinars, newscasts and podcasts
- anywhere.

One is never enough

One instance of a particular real-world example or news item is not enough to gain an overall perspective. We need to have a balanced overview through various sources of information from different geographical locations and different stakeholder perspectives. Every real-world example and news item will have more than one perspective.

Time changes perspective

The perspective about a particular news item or real-world example can change over time. A good example of this is illustrated by a well-known cartoon published in the *New Yorker* in 1993: 'On the internet, nobody knows you're a dog.' At that time, the cartoon suggested the internet provided anonymity.

Today, however, huge amounts of personal data are collected, stored and shared. There are alarming concerns about privacy and who has access to our data, how they acquire access, and how we can safeguard our data.

A more recent article from Digital Guardian, 6 August 2021, was titled 'On the internet, everyone knows you're a dog', which highlights how significantly the situation has changed from 1993 to 2021.

"On the Internet, nobody knows you're a dog."

ACTIVITY

What does your digital footprint look like?

Let's consider a personal real-world example. How does your involvement with digital technologies contribute – either actively or passively – to your digital footprint?

Footprints on the beach leave a trace that will wash away. The digital traces that are left intentionally or unintentionally by you, and through the actions of others, cannot be erased. They reside on servers where the information is stored, backed up, transferred, copied and shared. Even if the information is erased, we cannot be certain that it does not exist on another digital system somewhere else.

- Use a search engine to identify the key features of a 'digital footprint'.
- Use a search engine, such as Bing, Google or one of the many other internet search engines, and enter your own name. The result of the search will give you a first impression of what your digital footprint looks like. Follow this up by searching for your name on any social media account that you use frequently. What impression would your family, teachers, friends, future college admissions officer or future employer have about you from these search results? Do the results leave a positive or negative impression?

This part of your digital footprint is the result of your active posting of online, for example, social media posts, photos, videos or responses to others. Your digital footprint may also be the result of posts made by others, which can be positive, such as receiving an award, or negative, such as an embarrassing photo. These posts contribute to your passive digital footprint, which can be damaging in some instances.

Other passive contributions to your digital footprint occur when you are unaware that your actions are being collected and stored. These include data collected by browsing websites, by your internet service provider (ISP), through shopping online and similar activities.

- Conduct some initial searches and outline:
  - actions that you can take to create a positive digital footprint
  - steps that you can take to avoid having a negative digital footprint.

The concept of a digital footprint relates to the 3Cs in the digital society diagram and the table. It can be categorized as follows:

- Concepts: 2.3 Identity
- Content: 3.4 Networks and the internet
- Contexts: 4.4 Health and 4.7 Social.

We will consider the 3Cs and real-world examples in more detail in Sections 2 through 6.

Awareness of the world around us

Throughout the Digital Society course, you need to be aware of the impacts and implications of your own use of digital technologies as well as the use by others. This includes both digital technologies in our physical environments and in our virtual lives, and at all levels: individual, local and global.

As you collect real-world examples for your digital society studies, reflect on how the digital technologies that you use have an impact on you as an individual as well as the positive and negative impacts for others. Be proactive. Take whatever action is needed.

■ Keep a watchful eye on your own actions, and the actions of others

1.3 Digital society in an IB context

Digital society in the Diploma Programme

Digital society is one of the subjects in the 'individuals and societies' Diploma Programme (DP) subject group. You are encouraged to make connections between digital society and other subjects in the DP: language acquisition, studies in language and literature, mathematics, the arts, sciences and individuals and societies.

Digital society students are also expected to connect their learning to the core areas:

- **Theory of knowledge (TOK)**: Studying the nature of knowledge and knowing. How do we know that claims are true? Connections can be made in TOK classes or through learning activities in digital society.
- **Creativity, activity, service (CAS)**: Taking action in the areas of creativity, activity and service. Digital society offers many opportunities in all three areas.
- **Extended essay**: Developing a research paper based on a research question from one of your six DP subjects. We will look in depth at the digital society extended essay in Section 9. Your supervisor for an extended essay in digital society would most likely be your digital society teacher. Note the topic of the digital society research question for the extended essay (Section 9) cannot be the same as the topic for the inquiry focus for the inquiry project (Section 8).

Understandings, attributes and skills of an IB student

Through the activities in this digital society textbook, you will be seeking to develop:

- international-mindedness
- learner profile (LP) attributes
- approaches to learning (ATL) skills.

International-mindedness is how individuals view the world and see themselves connected to the global community. It also involves developing a sense of responsibility to other people. It is an awareness of the interrelationships that exist between nations, cultures and individuals, and a further recognition of the complexity of these relationships.

The relationships that exist between nations, cultures and people remind us of the 'butterfly effect', a theory associated with Edward Lorenz, a mathematician and meteorologist.

The butterfly effect theory claims:

> *… that an action as small as the flapping of a butterfly's wings can instigate a series of increasingly profound reactions that can cause something significant and meaningful to happen – sometimes on the other side of the world.*
>
> *Source:* **https://smagroupsolutions.com/blog/leading-with-intention-embracing-the-butterfly-effect**

In the context of digital society, we live in an interconnected world. This means everything you do and say is important because it has an effect on those around you, and can even have very rapid and far-reaching effects. What we say and do, no matter how insignificant it may seem, affects others whether we can see the impact or not. Dave Wright, chief innovation officer at ServiceNow claims that the 'digital butterfly effect' explains the unforeseen effects of new technologies.

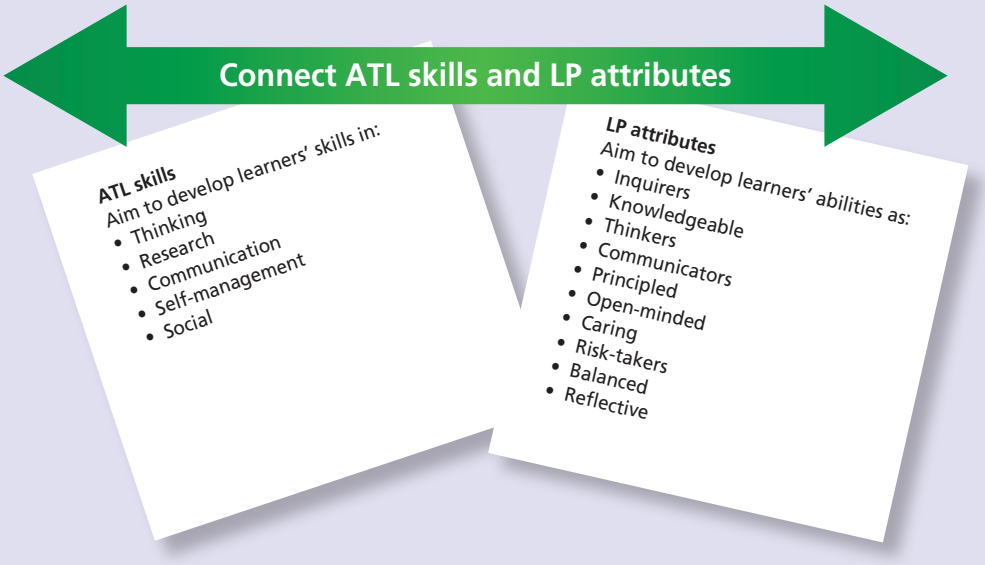
ACTIVITY

Digital butterfly effect

Identify one real-world example where someone has used a digital system in what seemed to be an insignificant way at the time, but the outcome had far-reaching impacts in another location or on other individuals.

ACTIVITY

The list of ATL skills and LP attributes overlap and complement one another in many ways. You will develop ATL skills through the activities in digital society, which will contribute to your overall learner profile attributes.



- Using a search engine, search for two diagrams and images that relate the two lists in the same diagram. Compare their effectiveness in relating ATL skills and learner profile attributes.
- Describe how each of the skills and attributes in the diagram relate to studying digital society in the IB Diploma Programme.

Connecting aims for digital society to aims for individuals and societies subjects

Individuals and societies aims

Individuals and societies subjects help young people develop a connection to our shared planet, exploring how to live sustainably and promoting the well-being of all people in our pursuit of a more peaceful world.

The aims of all the individuals and societies subjects are to equip young people to:

- explore and critically engage with multiple perspectives and ways of thinking
- investigate and evaluate the interactions between individuals and societies
- think and act as informed and principled individuals in societies
- understand and value the variety and diversity of the human experience across time and place.

Digital society aims

The Digital Society course invites SL and HL students to develop as ethical, empathetic and creative people who address the world with individual and shared understanding, imagination and action.

The course aims indicate important milestones on a student's learning journey as they:

- **focus** inquiry using course concepts, content and contexts, as well as real-world examples
- **explore** diverse sources relevant to digital society
- **investigate** impacts and implications of digital systems for people and communities
- **reflect** on emerging trends, future developments and further insights
- **share** discoveries about digital society with others.

Reflection

The aim of all IB programmes is to develop internationally-minded people who, recognizing their common humanity and shared guardianship of the planet, help to create a better and more peaceful world.

IB Learner Profile, IBO, 2017

How do the aims from the subject group, individuals and societies, and the aims from digital society align with the overall aim of all IB programmes?

1.4 Your digital society toolbox

Create your digital society toolbox

The skills and attributes that you develop through your studies contribute to your skill set as a lifelong learner. You are responsible for your own learning. Some of the approaches that you may take may be successful while others may need to be refined as you progress through your study.

The use of ATL skills and the LP attributes provides a solid foundation for learning about digital society. They provide the first tools in your digital toolbox.

The question is, what do they look like in practice?

Your success as a learner depends on your success as a:

- **thinker** who demonstrates both critical and creative thinking skills, and makes responsible and ethical decisions
- **researcher** who uses reliable sources and methods, and considers a range of perspectives and practical experiences that can be used to support investigations
- **collaborator** who interacts in exchanges with others to enhance your own learning and the learning of others
- **communicator** who shares findings through a range of means and media
- **self-manager** who can organize yourself and manage the successful completion of tasks.

Close-up on self-management in your toolbox

Self-management skills are involved in both organizing and managing information emerging from the course, as well as the real-world examples that you research and analyse.

It is not possible to re-read all of the information from a two-year course in the days before examinations. An on-going systematic approach for creating and storing notes needs to be decided early on in the course. This includes how the analysis of each real-world example will be summarized and where it will be saved. Some schools provide digital spaces for students where they can store their documents, or you may wish to use a combination of hand-created notes and digital notes.

You should also consider developing a one-page template that you can use for each real-world example that you analyse. Using a template helps you to have a consistent approach for summarizing your findings.

Self-management skills are also involved in the development of the inquiry project. This will be discussed at great length in Section 8.

Other ATL skills will be developed throughout the activities in the various sections of the textbook.

Terminology in your toolbox

You need to understand the terminology related to the *Digital Society Guide*, including:

- the command terms used on all examinations and internal assessment (pages 69–70 of the *Digital Society Guide*)
- Digital Society course keywords (page 8 of the *Digital Society Guide*)
- all terminology in the *Digital Society Guide* (pages 22–38 of the *Digital Society Guide*)
- for HL students only, terminology relating to the challenges and interventions (pages 39–43 of the *Digital Society Guide*).

You will need to expand your terminology as you encounter through real-world examples and news articles:

- record any new terminology or phrases that you encounter that relate to digital society
- record the sentence from the source that used the new terminology or phrase so that the meaning is clear when you review your list of terminology
- research the meaning of the terminology or phrase.

The inquiry process in your digital toolbox

The most important approach that will be used throughout the study of Digital Society by all students is the inquiry process. It is a step-by-step process for systematically progressing from what you want to find out through the process of research, analysis, evaluation, reflection, recommendation and communication (sharing). It will be used as the primary tool in our digital society toolbox.

Experience in using the stages will be gained in Sections 2 through 4, focused on the 3Cs, and in Section 8. Additionally, HL students will use the inquiry process and the extended inquiry in Sections 5 and 6.

The command term 'recommend' refers to recommending future courses of action. When 'recommend' is used in an extended inquiry for HL students, it will refer to making a specific kind of recommendation – an intervention for a challenge. More details on this are given in Sections 5 and 6.

ACTIVITY

Understanding the inquiry process

Consider the following steps in the inquiry process. Read the descriptions carefully.

■ The steps in the inquiry process

Starting point	**FOCUS** • Select a topic for the inquiry.
Determine inquiry focus	• Narrow the topic to a specific inquiry focus by using the digital society diagram and considering the 3Cs. • Find related real-world example(s).
Explore	**EXPLORE** • Find and evaluate sources. • Conduct research, collect data and record sources. • Check that there are adequate sources to address each aspect of the inquiry and the inquiry focus.
Analyse	**INVESTIGATE** • Analyse findings with respect to the 3Cs in the digital society diagram. • Analyse the impacts for people and communities. • Analyse the implications.
Evaluate	• Evaluate the impacts and implications. • Weigh up the positive and negative impacts and implications.
Reflect	**REFLECT** • Reflect on implications. • Reflect on discoveries, trends and future developments.
Recommend	• Recommend and suggest future courses of action.
Communicate	**SHARE** • Share outcomes from the inquiry through learning activities: essay, slideshow, discussion and other means (formative activity). • Digital society internal and external assessments (summative assessments).

Notice that 'explore' refers to finding real-world examples and conducting research.

Identify a list of possible secondary sources and primary sources for research.

Compare your list of secondary and primary sources with the following list

- news sources and media
- websites
- text-based sources: books, articles and other publications
- social media sources: posts, blogs
- media sources: images, videos, podcasts, webinars
- online databases
- live experiences: performances, workshops, lectures, interviews with experts
- original documents and documentation: policies, regulations, laws and other original material.

Guiding questions for the inquiry process

The following checklist provides a more detailed approach to using the inquiry process.

■ Inquiry process checklist: ATL and the 3Cs

Starting point	Select a topic that has inspired you and you would like to find out more • Was it something you read, an activity from the book or something else? • Did the topic link to a personal experience? • Has an external source, e.g. a news article or video, been an inspiration?
Determine inquiry focus	Narrow down the topic using the 3Cs • How will you narrow down the inquiry? Are you going to use the examples in the book? Work with your teacher? Choose for yourself? • Have you identified related concept(s) and/or content and/or context(s)? • Are you able to link your focus to a particular real-life example?
Explore	Find and evaluate sources • Where will you find your sources? Will they be secondary and/or primary? • Collect enough information until you have enough to appropriately address the inquiry focus with a balance of claims and perspectives. • Have you adequately evaluated the sources?
Analyse	Investigate impacts and implications on the stakeholders • Explain how the digital technology (content) is related to the inquiry focus? What perspective does the concept bring to the investigation? • Is the analysis based on relevant supporting real-world examples (context)? • What are the positive and negative impacts on stakeholders?
Evaluate	Investigate the extent of the impacts and implications • Evaluate the significance of the impacts and implications. • Have you weighed up the positive and negative impacts and implications? • Are the impacts and implications short or long term? • Do the negative implications have solutions (interventions)?
Reflect	Reflect on the implications and synthesize your findings • How is your understanding of the inquiry focus different now to what it was at the start? • How do your findings relate to future trends and developments?
Recommend	Recommend/suggest specific solutions (interventions) for the impacts and implications
Communicate	Select how to share the inquiry • What is the main purpose of your inquiry? Is it to educate, persuade or lobby? • Who is your audience? What medium will be used to present your findings? • How will you plan and structure your response?

At first glance, the inquiry process seems to progress from top to bottom. However, there are times in the process when you will have to go back to an earlier stage and explore, analyse, evaluate or reflect further before you can adequately address your original inquiry question. It is not always a straightforward process.

You will gain experience in using the inquiry process throughout the activities in this textbook, and also whenever you encounter a topic that you want to explore further. This is called 'open inquiry', where you take responsibility for the process and for your own learning.

1.5 Learning and assessment

The destination: Assessment

In order to be successful in the course, it is important to have an overview of how it is assessed and what knowledge, skills and understandings are required.

	What do you need to know? Knowledge, skills and understandings	How will you be assessed? Internal assessment and external assessments	Sections in this book
SL and HL core	• The SL and HL syllabus includes common topics for SL and HL based on the digital society diagram (3Cs diagram). • The approach for study is using selected steps in the inquiry process and ATL skills (thinking, communication, research, self-management and social).	• SL Paper 1 and HL Paper 1 Section A, common questions • SL/HL Paper 2, common paper	**0** Welcome to digital society **1** Understanding digital society **2** Concepts **3** Content **4** Contexts **7** How to approach external assessments **10** What's next?
Inquiry project	• The approach for study is the inquiry process. • ATL skills (thinking, communication, research, self-management). No collaboration.	• SL/HL inquiry project is the common internal assessment. It consists of three components: a multimedia presentation, the inquiry process document and a list of references. • It is assessed by the teacher using the assessment criteria for the inquiry project and externally moderated by an IB examiner. • Digital technology skills	**8** Inquiry project – internal assessment
HL-only extension	• An HL-only extension includes challenge topics and relevant interventions. • The approach for study: the inquiry process and the extended inquiry for evaluating interventions. • ATL skills (thinking, communication, research, self-management). Social skills are used in the collaboration in conducting research for the HL-only extension topics and HL pre-release.	• HL Paper 1, Section B, one question. • HL-only Paper 3 based on a HL pre-released extension topic.	**5** HL extension: Challenges and interventions **6** HL extended inquiry **7** How to approach external examinations

Optional destination: Digital society extended essay

Some digital society students may choose to develop their DP extended essay in the subject.

What do you need to know? Knowledge, skills and understandings	How will you be assessed?	Sections in this book
• SL/HL common topics based on the digital society diagram. • HL students may wish to use the HL extension topics. • The approach for study is the inquiry process and may also include extended inquiry for HL students, but this is not required. • ATL skills (thinking, communication, research and self-management). No collaboration.	• Submission of the extended essay and Reflections on Planning and Progress form (RPPF). • Extended essay assessment criteria with focus on the digital society subject guidelines for the extended essay.	**9** Digital society extended essay

Assessment objectives

The assessment objectives for external and internal assessments are summarized in the following table.

Assessment alignment in digital society	SL Paper 1	HL Paper 1	SL/HL Paper 2	HL Paper 3	Inquiry project
Understand, apply, analyse, evaluate and synthesize					
Course topics, enduring understandings and areas for inquiry	✔	✔	✔	✔	✔
Real-world examples	✔	✔	✔	✔	✔
Claims and perspectives			✔		✔
Impacts and implications	✔	✔	✔	✔	✔
Emerging trends and future developments	✔	✔	✔	✔	✔
Challenges and interventions (HL only)		✔		✔	
Develop and refine digital society skills					
Managing inquiry projects	✔	✔	✔	✔	✔
Researching	✔	✔	✔	✔	✔
Critical and creative thinking	✔	✔	✔	✔	✔
Communicating	✔	✔	✔	✔	✔

1.6 Conducting secondary research and primary research

As you proceed through the Digital Society course you will use both secondary research and primary research in your inquiries, using the same research skills and techniques that are used in other subjects in 'individuals and societies'.

In addition to the information in this chapter, consult the digital society toolkit in the *Digital Society Guide* (pages 18–20) for further details about research skills.

What are secondary research and primary research?

Both of these types of research should be used when carrying out inquiries:

- In **secondary research**, someone else has collected the data and presented the findings.
- In **primary research**, you are collecting the data.

◆ **Secondary research**: Research carried out by someone else.

◆ **Primary research**: First-hand research in which you collect original data.

Secondary research involves gathering information from printed and online sources, literature searches, newspapers, reports, encyclopaedias, journals, books, magazines, videos, podcasts and television broadcasts. This information can be easy to locate but may not always be appropriate for your inquiry. Considerable attention needs to be taken to ensure the reliability of the source(s) and the veracity of the information.

Primary research is when you gather data and information. This data collection needs to be planned carefully to ensure the data collected is appropriate and reliable. It may include interviews, surveys, working with focus groups and observations.

◆ **Quantitative**: Data that can be measured and converted into numbers.

◆ **Qualitative**: Descriptive, non-numerical data.

The data gathered may be **quantitative** or **qualitative**. You will need to determine what is the most appropriate data that needs to be collected for your inquiry.

When and where to use secondary research and primary research

Secondary research is normally done first. It will help you familiarize yourself with the topic being investigated. It will also allow you to determine whether the proposed investigation is feasible. If this is the case, possible primary research methods should be explored. This may require an iterative approach before a final decision is made about the balance between primary and secondary research methods and the balance between quantitative and qualitative data.

How to ensure your secondary research is appropriate

- Find out what you can about the author, their background and qualifications.
- Skim the source to determine if it is likely to contain sufficient relevant information for your inquiry.
- Determine whether the source helps to provide a balanced research base.

- Cross-check the information in your source with information in another source to verify the information.
- Check the timeliness of the source to ensure it is not out of date.
- Investigate sources provided within the source to determine whether they will be able to provide you with more information.

How to ensure your primary research is appropriate

- Clear links can be made from the need for primary research based on findings from the secondary research.
- Check if you can complete this research safely.
- Make sure the research is ethical.
- Make sure the proposed research is feasible, for example, whether you have the time and resources to carry it out.
- Use pilot studies before you commence the research.

Types of primary research

- **Interviews**: in-person or virtual meetings with one person or a small group with questions written in advance. The responses from the interviewee can be followed-up during the meeting for more information and to clarify responses.
- **Surveys and questionnaires**: information is systematically collected from a group of people. The information collected is limited to the responses to the questions. If a sample is used, the choice of sampling technique used (random, quota, stratified) is a key decision. The design of the survey is also critical to ensure you obtain reliable, usable information.
- **Observation**: Observations and measurements usually provide information with less bias and more clarity than interviews, surveys and questionnaires.
- **Investigation**: Investigative methods are appropriate when examining original sources such as policies, laws, video footage, photographs or similar material. They are also useful to experiment and demonstrate how digital technologies can result in specific outcomes.

Before you start …

Before starting, ask yourself:

- What information do I need for the inquiry?
- What will be the balance between primary and secondary research?
- What will be the balance between quantitative and qualitative information?
- What types of primary research will be used?
- Who will be involved in the primary research?
  - Are they appropriate?
  - Are they accessible?
- Is the research methodology balanced and appropriate for the inquiry?

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Section 2
Concepts

2.0 Overview of digital society concepts

UNDERSTANDINGS

By the end of the section, you should understand:

- how to use the seven concepts as a lens to focus on important aspects of the use of digital technologies
- the range of issues with impacts and implications associated with each concept.

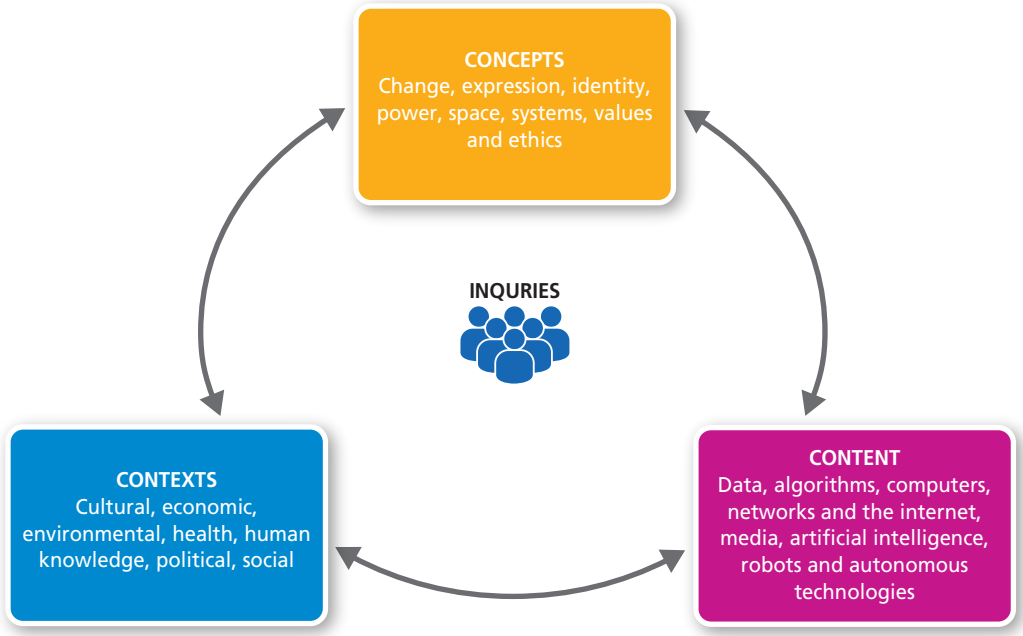
Chapter 1.2 introduced the foundations of a digital society. In this section, you will learn how to use the digital society concepts to probe and investigate our evolving digital society.

The study of the interaction of **concepts**, **content** and **contexts** will help you develop skills to transfer your learning and apply this to new situations through a series of investigations.

◆ **Concepts**: Powerful, widespread ideas that open up different perspectives and provide insight during inquiries into the real-world use of digital technologies.

◆ **Content**: The study of the digital technologies used.

◆ **Contexts**: The study of digital technologies in a variety of real-world examples.



■ Digital society: Concepts

The seven digital society concepts

The seven concepts provide different windows and perspectives that can be used to explore the digital society we are in, and the society we are evolving into. The concepts focus on elements that are applicable across our developing digital society.

It does not matter which of the concepts an inquiry may start with, as the exploration becomes deeper and broader, additional concepts will become relevant.

The starting concept is the one that is most applicable to the context and content of the inquiry. Also, when starting an inquiry with a content focus, such as databases or artificial intelligence, or a context focus, such as care for elderly people or education, the concepts will provide different ways to explore impacts and implications, and where to go next with future developments and interventions.

- **Change** is a fundamental concept as digital society is always evolving and there are many consequences that can be explored from a number of perspectives.
- **Expression** in a digital society examines how technological change has enabled different and expanded ways of thinking, communicating, collaborating and creating.
- **Identity** in a digital society considers how our personal and community identities are changing and becoming multifaceted.
- **Power** examines how digital technologies are extending and changing the way in which we influence others, control and are controlled by others, at personal, institutional and governmental levels.
- **Space** considers how our interactions with each other are changing, as well as our interactions with our physical environment.
- **Systems** thinking provides a way for understanding connections between human, natural and built environments, and the role of people and communities within them.
- **Values and ethics** looks at the consequences of change and explores their impacts and implications in the context of right and wrong, fair and unfair, just and unjust, legal and illegal, proper and improper.

ACTIVITY

Using the concepts: dashcams

Dashcams are being installed in many cars by their drivers for a variety of reasons. Some drivers record their trips to protect themselves with evidence if an accident or incident happens, some share the footage online to 'shame' offending drivers, while others post the footage on special police websites to help the police catch offenders.

Each of the concepts can be used to investigate the use of dashcams.

- **Change** – identify the type of change that has been happening, not just with technology but in other areas due to the use of the dashcam footage. Identify what is new and evolving about the use of dashcams.
- **Expression** – the footage is being published in a variety of ways and in different places that can have both positive and negative impacts and implications for people and communities.
- **Identity** – publishing the footage has affected the identities of many people, impacting their privacy and anonymity.
- **Power** – the footage has provided power to individuals and institutions in society through shaming and law enforcement, and the creation of a surveillance culture.
- **Space** – with the use of dashcams, spaces now have an additional surveillance component, beyond that of the police and road authority cameras. This should be considered when we use the roads.
- **Systems** – recording, using and publishing or posting the footage involves a set of connected systems: technology-based, legal systems, and others.
- **Values and ethics** – there are calls for the control of the use of the footage due to the mixture of benefits and issues that arise from its use.

How to use this section

The activities at the end of each concept do not require a comprehensive response. They are there to start you on the path of using concepts to explore, analyse and evaluate the issues, impacts and implications of the use of digital technologies in a society. As you progress through the other sections of this book, you will need to refer back to these concepts frequently.

Some examples of how to use the concepts are given, but you are expected to find more, especially from your own experiences.

The activities at the end of each concept can be attempted in two ways: directed (teacher-led) or guided (mixture of directed and open inquiry – your teacher and you together) depending on the time and resources available. You are also encouraged to engage in further self-initiated open inquiry as well.

Learning how to apply each concept is best explored through real-world examples involving content and context also.

2.1 Change

What are the different types of change in a digital society?

These are not exclusive, and often overlap, but provide a way of analysing change in a digital society. Digital technology innovation is the creation of something new that did not exist before, but it is often used interchangeably with change.

- **Change of form** – a change in the format, function or shape. For example, phones have morphed into different forms, from a single-purpose device into a multifunctional smartphone.
- **Change of state** – a change from one state to another, but still basically the same. For example, much of the old analogue information is now stored and used digitally. We have moved from analogue to digital watches; games have moved from the real world to the virtual world.
- **Change of values** – a change in what has been thought to be important. Privacy concerns, for example, have become more important to us and our families. Anonymity is now highly prized.
- **Incremental change:**
  - **Evolutionary** – something existing can evolve into something different but still basically be the same, for example, digital technology is always evolving to become faster and have more features.
  - **Adaptive** – something can basically be the same, but be adapted to new circumstances, for example businesses need to adapt to selling online as well as in physical shops.
- **Radical change:**
  - **Transformational** – something can change from one form to another, which can be disruptive, for example, office work can be transformed into working from home.
  - **Extends/combines** – change is enabled when digital technology and their uses are extended and/or combined to create something new, for example, people can now use all-pervasive networks and powerful devices to work anywhere and at any time, extending their office to the virtual world and combining it with other activities and places.

REAL-WORLD EXAMPLE

Online shopping

The growth of online shopping illustrates the different types of change. The impact and implications of the changes due to online shopping can be seen everywhere, for example in:

- the growth of huge online businesses such as Amazon and Netflix
- the creation of new businesses that did not exist in a bricks-and-mortar world
- the disappearance of businesses due to the impact of online shopping
- businesses changing how they operate and what they sell, often combining brick-and-mortar operations
- businesses changing locations, such as selling from home
- the scramble of many businesses to have an online presence.

When investigating change, we should be asking questions such as:

- Why does change take place? Is it due to needs or desires? Is it forced or optional? Is it due to something being new? Do people shop online just because it is possible? What are the reasons why people shop online? How many of these reasons are optional or compulsory?
- When change happens, is progress made? Change always brings a mixture of positive and negative impacts and implications. To what extent can online shopping be seen as progress, or does it have negative impacts as well?
- To what extent is change disruptive? To what extent has online shopping changed the way people shop? To what extent has online shopping changed the physical shopping environment? What is the impact of online shopping on businesses as a percentage of their, and our own, activities?
- Can change be predicted? Can we predict the outcomes of change? Can we force change? To what extent do announcements about the 'next big thing' in online shopping come true? How often do online businesses succeed? Online supermarket shopping has grown but it is not a large percentage of the way we shop, so how much has changed?
- To what extent can change be beneficial? It can be transformative for people who find going to a supermarket difficult, such as people who are time-poor or have mobility problems or are sick.

ATL ACTIVITY

Research

Research businesses in your local area and others that you know of that have been impacted by the growth of online shopping.

- Find examples of the different types of changes.
- Investigate the positives and negatives of food delivery services from restaurants.
- Explore the positives and negatives from the perspectives of the restaurants, the consumers of the food, the delivery companies, and the delivery riders/drivers.

The next three concepts focus on the use of digital technologies by people and communities and how they are being impacted by them. People and communities include the users, developers, stakeholders and others that are involved with the design, production and management of the digital systems explored in this course.

2.2 Expression

In a digital society technological change has enabled different and expanded means of thinking, communicating, collaborating and creating.

What is an expression?

An expression is the act, process or instance of representing ideas, emotions and/or experiences using different modes and media.

What is the purpose of expression?

Expression serves many functions, including storytelling, world-building, artistic innovation and political activism.

What are the benefits of expression?

Expression brings people and communities together but also introduces significant dilemmas, as expressions can have negative impacts.

How does expression change?

Forms of expression that are now possible using digital technologies have changed compared to past modes of expressing our thoughts and ideas.

- **Evolutionary** – something that exists can evolve into something different but still basically be the same, for example, email instead of 'snail' mail.
- **Adaptive** – something can basically be the same but be changed to new circumstances, for example, the development of audio combined with digital books allow persons to access books, not only through reading, but they can listen to the text spoken with human expression. Some digital books also allow hovering over specific words to learn the meaning of the words.

- **Transformational** – something can change from one form to another, for example, keeping up with friends and family using social media and video calls instead of letters and phone calls.
- **Radical** – the creation of new forms, states or values, for example, TikTok has enabled new forms of expression as communicating through short videos on popular topics to targeted audiences was not so easy on earlier online video hosting services.

Questions to consider

Issues arise from and about these changes of expression.

- In what ways do digital systems influence how people express themselves, for example, emojis? Are these an improvement or a step backwards in effective communication?
- What different kinds of stories are possible through digital media, such as the use of Instagram and TikTok? Should some of these be censored and controlled?
- Are there forms of digital expression that should be limited, such as certain types of negative posts on Facebook?
- This raises the question of *who* decides how digital expressions are controlled, such as the creation of new laws or the use of content monitoring or **censorship**.

◆ **Censorship**: The suppression or banning of certain content, speech or other information.

ATL ACTIVITY

Social

In class, discuss your favourite forms of expression in the digital world.

- Which apps are your favourite ways of communicating with others?
- Why do you choose to use these various forms?
- Describe how you use them for thinking, communicating, collaboration and creation.
- Explore how they are different from previous pre-digital forms of communication and expression, such as letters, books, passive TV, radio and movies.
- What are some of the negative and positive impacts and implications, for you and others?
- Do you operate in a 'media **echo chamber**'? How diverse are your news and information sources? What are the impacts and implications of being in a media echo chamber?

Links

The control of digital expression through content monitoring or censorship links to 2.4 Power and 2.7 Values and ethics.

◆ **Echo chamber**: An environment in which people only hear beliefs and opinions that echo their own.

2.3 Identity

When we express ourselves in the digital world, we are exposing facets of our identity. This has impacts and implications for our various personal, group, social and community identities.

What is identity?

Identity helps to define ourselves, as well as groups, social entities and communities we belong to or identify with. Identity is defined internally by our own thoughts and feelings, but is also externally defined by our relationships with others who interact with us and form opinions about us and the groups, social entities and communities we are associated with.

What are the features of identity?

Identities are multifaceted and include aspects related to age, nationality, religion, culture, gender, sexuality, race and ethnicity, as well as social and economic class.

Is identity static?

Identity is not static – it changes over time and according to our own contexts and the perspectives of others. Identities are linked to our behaviour, both in the real world where they are continually developing and changing, and in the online world where they can be permanently stored.

Questions to consider

The following questions arise about identities from the intersection of our digital world with our other worlds:

- How do digital systems and technologies influence or construct identity?
- How different are our identities in the real world from the virtual world? Why is there a difference?
- How do our online identities change over time? Since online identities remain in the online world for a long time and long after we have changed our real-world identities, how does this impact our identity?
- How can we hide or distort our identities online?

- To what extent do different aspects of our identity appear on digital platforms?
- What are the potential harms and benefits that arise from identities created online?

ATL ACTIVITY

Thinking

Reflect on the various identities you display and use in the digital world.

- What avatars, symbols user names and pictures do you use to identify yourself online?
- How do they intersect with your other worlds?
- Why do you create different identities online?
- How have your identities online changed overtime through evolution, adaptation, transformation, and/or radical creation?
- What are the benefits of having different identities online?
- What are the drawbacks of having different identities online?

◆ **Surveillance**: Is undertaken to collect information about people which can be used for a variety of purposes, both positive and negative, even though surveillance has mainly negative connotations. Surveillance can be conducted using technology, or through observations by people. The information collected can be used to control and influence those being observed and others.

Deeper thinking

Challenges to our identity: privacy and surveillance

Privacy means that an individual or group can isolate themselves and/or information about themselves from access by others. This enables them to operate and express themselves, their ideas and opinions, without worrying about the reaction of others. When something is private to a person or group, it usually means that something is special or sensitive about it. Most people agree that there is a right to privacy that should be protected by law. However, this right does not have priority over the law.

Our identities are mainly private and we may choose to keep many aspects hidden for a range of reasons. However, many digital technologies have allowed the invasion of our privacy. This includes technologies such as **surveillance** spyware on our phones; Google tracking our movements and locations as we move around using Google Maps; the use of CCTV and facial recognition; and hidden tracking of our mobile phones as we move from one mobile transmission tower to another, and the same in larger buildings such as shopping centres when we move from one shop to another.

The impacts of our loss of privacy are many. Among these are psychological damage, financial damage, damage to your reputation, and the physical invasion of your personal space. Often there is a mixture of these impacts.

There can be positives from the use of our 'private' information if we allow it to be collected. Companies often keep records of which sites we visit, and why. This data can be used to target advertising, which provides us with links to items that we are interested in. However, this data can be sold to others, which can lead to negative impacts as well.

ATL ACTIVITY

Research

Investigate how digital technologies can be used to impact our privacy.

- Search news items and other sources for examples of how digital technologies can be used to invade our privacy.
- Investigate both the negatives and positives of these technologies.

(You will study more about these technologies and their impacts in Section 3 and how and why they are used in Section 4).

◆ **Privacy**: The ability of individuals and groups to determine for themselves when, how and to what extent information about themselves is shared with others.

Links

This section links with 4.7A Social components of identity.

2.4 Power

In the future, the digital society we live in and see evolving around us will produce a range of positive and negative impacts and implications. We will need the power to control and influence these to advance the positive and lessen the negative impacts on ourselves. Other people may also want the power to control others through the use of digital technology. As soon as we interact with others, power becomes a factor to be considered.

Power is a feature of all social relations and it involves a person's or group's capacity and ability to influence or control the actions of others.

What are the types of power?

The use of power can include more than one of these at a time:

- **Coercive** – when someone forces us to do something against our will, for example, the power of bullies on social media, the power of a person who has invaded our privacy using digital technology (sometimes resulting in blackmail and other demands for money, or influencing others for their benefit).
- **Reward** – this is the opposite of coercive power; it involves giving benefits to someone if they do something, for example, the power to get you to spend money in computer games as it helps you to win.
- **Legitimate** – the power that arises from a formal relationship between people, for example, school rules about the use of digital devices.
- **Expert** – the power that comes from someone having a higher level of skill and experience, for example, students need digital devices to study so they consult an expert to keep them working; or people pay experts to do something for them.

- **Respect** – power that comes from liking and respecting others, for example, respect for social media influencers gives them the power to encourage their followers to buy certain products.
- **Information** – power that comes from the use and control of information, for example, posting information on the internet gives one power to influence others and what they think; power also comes from collecting information about others and their device use.

All of these types of power can be used for positive good as well as to manipulate others.

Where does power reside?

At the formal level, power is structural and embedded within groups, institutions, organizations and governments. At the lowest level we need to consider how the use of digital technologies influences each of us personally. This level it is called 'soft' power and is often cultural and goes largely unnoticed.

Can we all have power?

Yes. We all influence and, to some extent, can control others, but by definition power is unequal; people either have power over us or we have power over them.

Questions to consider

Questions about power and the use of digital technologies include:

- How is power embedded or exercised through specific digital systems, technologies and platforms?
- Do digital systems and technologies enable both the use and constraint of power?
- To what extent does the use of digital technologies impact the balance of power? Ranging from our personal lives to that at an international level.
- Where and how do digital technologies have too much power? How can this power be constrained? What form does this power have?

ATL ACTIVITY

Thinking and Research

Reflect on how much power digital technologies have over you:

- Think about the devices and apps that you use and how they influence what you think and do.
- Who influences you personally, and who do you influence? How do digital technologies facilitate this? Are these influences positive and/or negative?
- Investigate the positives and negatives of the power associated with
  - facial-recognition cameras
  - social media influencers
  - apps to track and monitor children.
- Which types of power do these technologies have over you and how are they being used?
- How can this power be lessened and controlled – through digital technologies and other ways?

2.5 Space

The previous three sections focused on concepts related to how people and communities use digital technology. The next two concepts focus on investigating the perspectives of space and systems thinking as ways of investigating the use of digital technologies.

What is space?

Humans organize, construct and represent space based on physical, geographic, cultural and/or social features (for example, locations, regions, borders, zones). But now virtual spaces are being created and used more often; and they are becoming more diverse and different from other spaces being used.

What is the purpose of space?

Different spaces often serve distinct functions for people and communities. People live and operate in spaces, and spaces are constructed and used for all the different functions and things in everyday living. We cannot operate without space.

Are there different types of spaces?

Space can be understood using multiple scales and dimensions, including local, regional, national and global and, increasingly, virtual. People are spending more and more time in virtual spaces due to the widespread use of digital technologies.

What happens in these spaces?

In both real and virtual spaces, people, information and objects interact. They interact through the use of the spaces, how they access their content, and how they move between them. The use of space is often a complicated flow of people, information and objects.

Questions to consider

Questions about spaces and the use of digital technologies include:

- How does online space differ from physical space? How are they similar?
- To what extent does physical space influence virtual space, and vice versa?
- How do information and digital objects circulate through digital society? How different is this from real spaces?
- Do physical or political borders still have meaning in a digital society?
- Real spaces usually have borders and laws connected to them – how is this changing in virtual spaces?
- Physical spaces usually have borders that restrict access and create divides – are digital divides the same or different to physical borders?
- How do digital systems and technologies affect how we experience specific spaces and locations?
- How do digital systems and technologies affect how we experience objects in virtual and real spaces and locations?
- What are the advantages and disadvantages of using virtual spaces to store virtual objects?

ATL ACTIVITY

Thinking

Reflect on your own experiences.

- Using your own experiences and other resources, provide answers to some of the questions above.

This inquiry will open up new considerations and ideas about the link between the real and virtual spaces you live in. Virtual spaces will often be encountered in your study of the various contexts later in this book.

ATL ACTIVITY

Thinking

Reflect on the virtual and real spaces you live in.

- What virtual spaces do you use and live in?
- How have digital technologies enhanced your use of real spaces, for example studying or working from home?
- How has the use of virtual spaces impacted different parts of your life – education, relationships, work, communications?
- How have virtual and real spaces clashed with national and political boundaries, and with your own life and relationships?
- What are the dangers and disadvantages of the virtual spaces you live in?
- What are the advantages of the virtual spaces you live in?

ATL ACTIVITY

Research

Investigate the positive and negative impacts of these virtual spaces:

- virtual reality technologies
- augmented reality technologies
- political boundaries in the online world
- the use of encryption technologies in online communications
- the legislation of data 'boundaries' to control the flow of data and information
- the political use of cyberspace
- the use of cryptocurrencies.

2.6 Systems

The concept of space introduced the idea of the interaction between real and virtual worlds. The systems concept focuses on **systems thinking**, which provides powerful tools for understanding, representing and exploring the links between the human, natural and built environments (both real and virtual), and the role of people and communities within them. The analysis of digital and real-world systems through systems thinking is needed due to their complexity.

◆ **Systems thinking**: A way to think about structure and order in human, natural and built environments.

What components of systems are studied in digital society?

We will learn about the hardware, software and networking technologies that take the data and media and process it into information. We will also learn about the people and communities involved in these processes, and those who supply the data and use the information produced.

How does systems thinking work?

Systems thinking involves investigating sets of interacting, interdependent and/or interconnected elements, usually through models, maps and visualizations that help us understand the connections within, and between, systems, and the components within systems. It also involves the people and communities in these systems, the impacts on them and the implications for them.

Why use systems thinking?

Changes within interconnected systems may generate both intended and unintended consequences. Analysis of a system, and connected systems, enables a deeper understanding to be developed that can be further investigated using the other concepts. Systems thinking can also support investigations based on the other concepts.

How do you represent systems thinking?

Many programs and apps are available to draw diagrams of the components of a system and their interconnection. Online diagram software, such as SmartDraw and Lucidchart, can represent people and communities as sources of data; as consumers of the information produced; and as their role in the generation and production of data and information.

The representation and exploration of systems through the use of models and simulations is often dynamic. These systems can be physical but, in digital society, they are usually logical and use software such as spreadsheets, databases and specialized simulation apps and programs that use algorithms.

What is the impact of digitally based systems?

Digital networks and devices are systems that can be small, such as those found in the home, or on a much larger scale, such as the global internet. These systems interact with each other faster and in many more ways than physical systems. Physical systems, such as roads, trains, planes, are also being greatly influenced and changed by the use of digital systems.

Questions to consider

Questions that arise from the application of systems thinking to the digital world include:

- How similar and how different are digital systems from real-world built and natural systems?
- How similar and how different are digital systems from our real-world social systems of interaction?
- In what ways have digital technologies changed human, built and natural systems and environments on both a large and small scale? Examples might consider:
  - evolutionary changes – something that exists can evolve into something different, but still basically be the same
  - adaptive changes – something can be basically the same but can be adapted to new circumstances
  - transformational changes – something can change from one form to another
  - extend/combine changes – extending and/or combining systems together.
- Change is often disruptive, both positively and negatively. What are some intended and unintended consequences of new and changed digital technologies or systems, especially on people and communities? How do these impact people and communities now, and what are the implications for them in the future?
- Is it possible to fully understand connections within and between systems using models, maps and visualizations?
- Digital models, maps and visualizations only represent the real world and are always a simplification of the real-world data, people and processes. What assumptions are made about the data being used? What are the limitations of representing this data? What assumptions are made about the way the processes operate, especially with regard to people and communities?
- Are digital and real-world systems too big and complex to understand? What are the implications and impacts of the simplification? Artificial intelligence is one area where these concerns are important.

Links

See Chapters 3.1 Data and data analysis, 3.2 Algorithms and code, 3.6 Artificial intelligence and 3.7 Robots and autonomous technologies for more details about the completeness, accuracy and reliability of digital systems, data and processes. In Section 4 you will investigate the link between real and virtual systems and explore the impacts and implications for people and communities.

ATL ACTIVITY

Research

To start the process of using systems thinking, use your own experiences and other resources to provide answers for the following digital systems:

- Investigate the various digital systems used by your school and how they interact and the issues with using the systems in your school.
- Investigate how digital systems are used in your local transport systems, for example roads, trains, buses and in the cars that you use.
- Represent these systems using models, maps and visualizations, or produce a systems diagram for each using your favourite diagram software.

ATL ACTIVITY

Research

Digitally based simulations and models are used in many areas to explore and understand real-world systems, such as weather, economics, traffic, ecosystems and more.

- Investigate and describe some of the models and simulations they use, and compare them.
- Investigate their positive use and their impact on people and communities.
- Investigate the negative impacts and implications due to their simplification of data, people and processes.

2.7 Values and ethics

Whenever people, actions and consequences are involved, the matter of values and ethics arise. The use of digital technologies is no different to any other human activity. The impacts and implications of the use of digital technologies on people and communities can be positive and negative; and the negatives can result in physical, emotional and psychological harm.

Digital societies need to have interventions built into digital technologies to ensure that these harms do not happen or are at least minimized. This means that some uses can be labelled as being wrong or right. But who decides, and what criteria is used to make this judgement?

It is important to analyse the use of digital technologies from an ethical and values-based perspective to ensure that the positive impacts and implications are maximized.

What are values and ethics?

Values and ethics are ways to determine distinctions between right and wrong, fair and unfair, just and unjust, legal and illegal, proper and improper.

What are the sources of values and ethics?

Our values and ethics are usually based on a combination of our personal experiences and the culture that we live in. Culture can broadly be defined as the ideas, laws, customs and social behaviour that people or society live by. There are family cultures, local and national cultures, religious cultures and business cultures. Everywhere there are groups of people, there is a culture.

What is the difference between values and ethics?

Values are the principles and ideas that we think are important. They form the basis for the development and formulation of ethical rules – the moral principles, both personal and group, that guide and govern our behaviour as individuals and communities.

What is the scope of values and ethics?

Values and ethics guide human action in the world, including individual and group conduct, and decision-making. Values and ethics may be personal, shared, collective and/or professional.

How are values and ethics manifested in society?

Values and ethics range from broad philosophical considerations to specific formulations. They are expressed through ethical/moral frameworks and principles, codes of conduct, rules, policies and laws.

What is the purpose and impact of values and ethics?

Values and ethics influence and shape ideas, practices, systems and spaces. They are manifested and used at every level and instance of human activity. Wherever there is a choice we can make, that choice is based on our values/preferences and often our ethical/moral expressions.

Why are many ethical issues difficult to settle?

Most ethical principles and frameworks originate from three main different perspectives, or a combination of them, which all need to be considered but often lead to contradictory results.

Deeper thinking

Ethical perspectives

A human action consists of three parts:

- the person performing the action
- the action itself
- the consequences.

All three need to be taken into account when making ethical decisions. Choices about which is the most important of these are based on our preferences and our values. There has been no conclusive argument found that has determined which perspective should take preference over the others, and this is true across all cultures, communities and individuals. The equal importance of the three perspectives is the source of ethical conflict.

The ethical framework is described in simple terms here. Many variations, explanations and justifications are discussed in ethical debates and used by individuals and communities in everyday life, however.

- A decision about right and wrong based on the **type of person** performing the action is called **virtue/character-based ethics**. For example, this person is a good person therefore what was done by them is right.
- A decision based on the **action itself** is called **deontological/rule-based ethics**. For example, killing is always wrong, so the person who did it deserves to be punished no matter what the circumstances are or who the person is.
- A decision based on the **overall consequences** of the action is called **utilitarian/consequential-based ethics**. For example, the result of the actions of this person is good so they do not deserve to be punished.

Here is a situation that shows how the use of each framework can lead to contradictory results and intense debates:

> *A shopkeeper saw a young man acting suspiciously in his shop with a gun in his hand who seemed to be under the influence of drugs. He took his shotgun from under the counter and told the man to stand still and put his hands up. The young man turned quickly, and the shopkeeper deliberately fired and killed him.*

- Following the virtue-based ethics argument, the man was protecting himself and his shop, so he should go free.
- Following the rule-based ethics argument, the shopkeeper must go to prison as he broke the law.
- The consequential-based ethics argument is based on the consequences of his actions, which were that a dangerous person was removed from society, therefore he should go free; or, alternatively, not go free as the consequences were that a popular member of the community was killed, and people said he went 'too far'.

In order to balance the different arguments, ethical, social and legal experts need to discuss them with the aim of finding a compromise. Hopefully the compromise is a win–win situation, but compromise means that not everyone will be fully satisfied with the result. This is usually done in a court or forum set up for the purpose.

Questions to consider

Questions that arise about the use of values and ethics in a digital society include:

- Do the designers of digital technologies have an ethical obligation to their users?
- What happens when different ethical frameworks are applied to the same issue in digital society?
- Can we program values and ethics into technologies that make decisions, such as artificial intelligence?
- Who decides which ethical framework robots and artificial intelligence programs should use?

Deeper thinking

Accountability and responsibility

When a decision is made, who is responsible, and who is accountable for the consequences? Does **responsibility** mean it carries **accountability** with it as well?

Someone has to be responsible for making a decision, and for implementing it. Once the decision has been implemented there are consequences, both good and bad, and someone needs to be accountable for them, either to take the credit, fix any resulting problems or to punished if necessary.

There is usually an overlap between the two, which is often determined in a court of law or other forum. There can be many people responsible for implementing a decision, but often only one person is ultimately accountable ('the buck stops here!').

Review Section 3.6 Artificial intelligence before working through these examples.

Example 1

Bugs in an expert medical advice program have harmed a patient because it was not designed and tested properly. Who is accountable for the harm done to a patient when doctors follow the system's advice? Is it the programmer, as they worked on the production and implementation of the program? Is it the expert doctors who contributed to the knowledge base of the expert system? Is the doctor who followed the advice accountable for the consequences? Are they all accountable and responsible to some degree?

Example 2

An artificial intelligence program has been trained by a programmer to diagnose cancer. Who is responsible and accountable if an unnecessary cancer operation is performed based on faulty advice from the program? Is it the surgeon who performs the operation that was not necessary? Is it the hospital administration that purchased the program? Is it the programmer? How is this different from the first example?

◆ **Responsibility**: a person is responsible for a decision that needs to be made and its implementation. Responsibility is a concept that is focused on future items that need to happen.

◆ **Accountability**: a person is accountable for the consequences arising from a decision that has been made. Accountability is a concept that is focused on what has happened. A person can be responsible for getting items done, and then can be accountable for the consequences.

Deeper thinking

Digital citizenship

The issue of ethics and digital technology is part of **digital citizenship**, which covers both the personal and business use of digital technologies. Digital citizenship is a practical topic and often can involve ethical considerations. In the Australian Curriculum technologies glossary it is defined as:

> *An acceptance and upholding of the norms of appropriate, responsible behaviour with regard to the use of digital technologies. This involves using digital technologies effectively and not misusing them to disadvantage others.*
>
> *Digital citizenship includes appropriate online etiquette, literacy in how digital technologies work and how to use them, an understanding of ethics and related law, knowing how to stay safe online, and advice on related health and safety issues such as predators and the permanence of data.*
>
> *Source: © Australian Curriculum, Assessment and Reporting Authority (ACARA) 2010 to present, unless otherwise indicated.*

◆ **Digital citizenship**: The responsible use of digital technology.

Deeper thinking

Digital and online etiquette – netiquette

Netiquette comes from the words *net*work and et*iquette*. Online etiquette is a set of rules that apply to your online behaviour. Similarly, digital etiquette focuses on the proper use of online data and apps/programs when you operate in an online social setting.

Netiquette is frequently interchangeable with, and is often extended to, the broader concept of a **netizen**, which comes from the words inter*net* and cit*izen*. A good netizen is a responsible person who uses the internet in a socially responsible way.

> *Almost two-thirds of children have had a negative experience online and 20 percent feel badly about something they have done online.*
>
> *Source: © State of Victoria (Department of Education and Training).*

◆ **Netiquette**: Rules that apply to your online behaviour to ensure the proper use of data, apps and programs.

◆ **Netizen**: A person who uses the internet in a socially responsible way.

Sample netiquette rules

Writing text online is very different from speaking to people in person, so be careful what you say. The internet and the online world are extensions of society, so be careful what you do and apply the same standards online as you do in public.

Positive rules	Negative rules
• Respect the opinions of others • Respect the privacy of others and what they communicate and share online (especially images) • Be polite in the same way that you are in person • Be accurate and factual • Be positive in your comments • Check and cite your sources of information • Be forgiving and understanding of others who do not follow the accepted rules, but discuss it with them • Read your text out loud to check it • Read your emails next day before sending them • Be kind and professional • Choose friends wisely on the internet • Keep your text short and to the point • Accept diversity of opinions and cultures • Call out online abuse and harassment where possible	• Don't abuse chat boxes for other purposes • Be careful with humour and sarcasm as it may be misunderstood and hurtful • Don't exclude others from conversations • If you would not say it, or would not do it, if your mother/father/grandparents/brother/sister were there, do not do it • Don't troll people in forums and elsewhere with negative comments – use good arguments instead • Do not post or share inappropriate material, as nothing is private on the internet • Be aware that strong language, all capitals, and exclamation marks can be misread or misunderstood • Don't post items that you do not want your family, friends, employers and others to see in years to come

Remember: the internet never forgets!

Deeper thinking

Codes of conduct

For industries and organizations that focus on the development, production, sale and use of hardware and software, a **code of conduct** is used to define principles, standards and values. The introduction to the Australian Computer Society Code of Professional Conduct says:

> *As an ACS member you must uphold and advance the honour, dignity and effectiveness of being a professional. This entails, in addition to being a good citizen and acting within the law, your conformance to the following ACS values.*
>
> *1 The Primacy of the Public Interest: You will place the interests of the public above those of personal, business or sectional interests.*
>
> *2 The Enhancement of Quality of Life: You will strive to enhance the quality of life of those affected by your work.*
>
> *3 Honesty: You will be honest in your representation of skills, knowledge, services and products.*
>
> *4 Competence: You will work competently and diligently for your stakeholders.*
>
> *5 Professional Development: You will enhance your own professional development, and that of your staff.*
>
> *6 Professionalism: You will enhance the integrity of the ACS and the respect of its members for each other.*
>
> *In a situation of conflict between the values, The Primacy of the Public Interest takes precedence over the other values.*
>
> *www.acs.org.au/governance/rules-and-regulations.html*

◆ **Code of conduct**: A set of rules outlining the standards that must be followed within an organization.

ATL ACTIVITY

Thinking

Find videos and internet sites that give you an opportunity to explore ethics and examine your own ethics, such as the Markkula Center for Applied Ethics app, https://www.scu.edu/ethics-app/

ATL ACTIVITY

Research

Examine your school's code of digital conduct for both students and staff members.

Deeper thinking

Analysing and resolving ethical issues and dilemmas

Values and ethical principles are used all the time by people to make decisions or to make claims that someone 'should' or 'should not' do something. So, it is no surprise when a dilemma arises. An ethical dilemma is a conflict between two ethically correct courses of action. The cause of the conflict is a clash between the values and principles that the different stakeholders have. A conflict can also arise when the same course of action is wanted by some stakeholders but their reasons, values and principles are different.

Ethical conflicts are best settled through discussions between the parties involved. In these discussions it often becomes clear that there will not be a resolution that pleases everyone.

Step-by-step guide for resolving ethical dilemmas associated with technology

The following step-by-step guide overlaps with the inquiry model used in this book, but it has a narrower focus on resolving a specific ethical conflict. The most appropriate place to use this ethical resolution guide is in the inquiry stage where recommendations and future steps are needed. It can also be used to help frame your extended responses to examination questions.

The ethical conflict	**1** What are the differing ethical claims about right and wrong of the various stakeholders? **2** What are the solutions that the various stakeholders want implemented? **3** Explain how these generate an ethical conflict?
Research stage	**4** What is the digital technology that is being used and how is it being used? **5** Why is the digital technology being used, developed or being changed? **6** Who are the people and communities involved, from the local to the global level? This includes stakeholders that use, develop, implement, are impacted by or control the digital technology.
Analysis stage	**7** How are people and communities **positively** impacted by digital technology? **8** How are people and communities **negatively** impacted by digital technology? **9** What are the **issues and concerns** with digital technology raised by people and communities? Issues are broader than direct negative impacts. Issues can be about positive impacts as well as negative impacts, for example 'we are not getting enough of the good impacts'. Negative impacts may be small and accepted, so are not a major issue. **10** What are the perspectives (and ethical frameworks) of the people and communities who raised the issues? What values and ethical principles are being used to justify their perspective on the issue? **11** What other principles (for example, human rights), laws, policies and rules apply or are being violated?
Evaluation stage	**12** Make a list of real and potential feasible solutions and interventions that could help to resolve the issues and dilemmas. Each stakeholder usually has one. **13** Which should be rejected? Which should be considered further as a basis for a compromise solution? **14** Which solution or intervention provides a win–win situation? Quite often it is a practical solution that each side of the issue can accept to some degree for a while.
Recommendation stage	**15** Who should be responsible and accountable for the solution when it is implemented and used? How should it be implemented? What is the timeline? What resources are needed?

Inquiry

Investigate and answer the following questions that have ethical and value dimensions. Can you think of examples of devices, programs and apps that apply to each question? Research news items that can provide examples.

1. Is it possible to program values and ethics into artificial intelligence programs and robots? For example, in self-driving cars, in medical decision-making advisory programs, in artificial intelligence that decides to allow a criminal parole, in robot soldiers, in programs that analyse behaviour using CCTV monitoring.
2. What values and ethics should be programmed into artificial intelligence programs and robots? How would they operate and work?
3. Multinational technology companies need to operate in many different countries and cultures, but the internet is fragmented and controlled by individual governments. Is it possible to have a universal system of digital ethics?
4. What is the difference between a 'black hat hacker' and a 'white hat hacker'? Can they be separated without violating ethical principles and creating ethical dilemmas?
5. What ethical obligations do the designers of digital technologies have? What are the perspectives that need to be considered?
6. Do program and app designers need to be held accountable for the use their programs and apps are used for? Do they have a duty to fix the issues that arise from the use of their programs and apps?

Section 2 summary

EXAM PRACTICE QUESTIONS

These types of evaluation and synthesis questions appear in all three digital society examination papers, especially for extended-response questions.

1. To what extent is it **ethical** for parents to monitor the activities of young people?
2. To what extent should the **power** of big-tech companies to use and share data about their users and clients be constrained?
3. Evaluate the impact of the **change** towards the increased use of online shopping on small businesses.
4. To what extent should the **expression** of freedom of speech be constrained by social media companies?
5. Using the results of your inquiries during the course, evaluate the potential impact of a stolen **identity** on a member of your family.
6. Compare the relevance of the physical borders of nations in the modern digital world filled with virtual **spaces**.
7. Data collected from the use of personal digital systems, such as your smartphone, is used in many digital **systems** that supply you with targeted information and advertising. Discuss whether this situation is beneficial to you.

TOK

Information is at the centre of all digital systems. The **completeness, reliability and accuracy** of this information is very important for us when we use the systems.

When you use information from digital systems, it needs to be assessed using TOK concepts. These concepts enable our understanding to be deepened and prevent us from being deceived.

ATL ACTIVITY

Thinking

Search for news items and articles about the impact of automation on employment and work. For each one of them, ask and answer these questions based on the TOK concepts. If this topic is not of interest to you, find articles and news items about an alternative topic or concern of yours and answer these TOK questions:

- **Evidence**: What evidence has been supplied?
- **Certainty**: To what extent does the evidence provide certainty of the conclusions?
- **Truth**: Is the complete, reliable and accurate truth presented?
- **Interpretation**: Is it possible to have a different interpretation of the evidence?
- **Power**: To what extent do the claims in the news item have the power to influence?
- **Justification**: How well were the conclusions justified? What methods were used?
- **Explanation**: Are the explanations of the reasons for and causes of the impacts and implications clear and easy to understand?
- **Objectivity**: Are objective facts presented or are they mixed with subjective ideas and opinions?
- **Perspective**: What perspective is the news item or article written from?
- **Culture**: Is the article or news item impacted in a positive or negative way by the culture of the context and author?
- **Values**: What values and ethical principles are used?
- **Responsibility**: To what extent are we responsible for checking all of the above?

Extended essay (EE)

The purpose of the extended essay is to give you an opportunity to research an area of interest from the topics in the Digital Society course. You may decide to write an extended essay that has one or more of the concepts as its focus. The research and essay will enable you to add knowledge to the existing body of research connected to the concepts. Your research into the broad concepts needs to be narrowed down to specific contexts and digital technologies in order to be manageable. A good way of doing this is to focus on your local area.

Concepts and possible research topics to explore include:

- **Change**: To what extent have the changes in digital technology been positive for education in your school?
- **Expression**: Many businesses, large and small, now use Facebook, Instagram and other social media to advertise and communicate with clients and customers in your local area in conjunction with, or as a replacement for, a dedicated website. To what extent has this been successful?
- **Identity**: Avatars are used by most people, young and old, when playing online games. Investigate the range of avatars and the reasons why they have been chosen?
- **Power**: To what extent has the impact of influencers in social media, such as Instagram, had a negative impact on boys and girls at your school?
- **Space**: To what extent have government authorities in your city/town/region successfully transitioned into the use of virtual spaces and communications with citizens?
- **Systems**: To what extent have your local authorities used digital technologies to improve the use and operation of your city?
- **Values and ethics**: Some families control the use of digital technologies strictly, and some do not. What are the range of ethical principles and moral values that are used by families in your local area?

Creativity, activity, service (CAS)

The creativity, activity, service (CAS) component of the IB Diploma core provides an excellent way to make links between the Digital Society course and practical real-world experiences. For your CAS project you could connect your digital society skills and knowledge, and your inquiries and activities, with meaningful and practical CAS experiences.

- **Change**: Investigate and instigate/facilitate a change that is needed in the way that digital technologies are used, or need to be used, in a sporting, musical, artistic or cultural activity.
- **Expression**: Create an internal school website that enables students to express themselves creatively.
- **Identity**: Create and run internal websites or private social media groups for various groups in your school that need an opportunity to make themselves known.
- **Power**: Use digital technologies to empower students about school issues through digital surveys.
- **Space**: Create a virtual reality or augmented reality game for a teacher to help in their teaching.
- **Systems**: Volunteer to run and maintain some digital technologies that are used by the school and students.
- **Values and ethics**: Organize and conduct sessions for students and parents about the dangers for students on social media and the impacts of their digital footprints.

Reflection

Now that you have read this section, reflect on these questions:

- How much change have you seen with the digital devices that you have used during your life?
- How dependent are you on using social media to express yourself, and to communicate?
- How many identities do you have on social media, and what is the difference between them?
- How much power and influence do you exercise through your use of social media?
- How much time do you spend in digital spaces compared to physical spaces?
- Are you aware of how far your digital footprint extends because of the interlinking of digital systems?
- Reflect on the times that your actions on social media have resulted in benefits and negative impacts?

Section 3
Content

3.0 Overview of digital systems

UNDERSTANDINGS

By the end of this section, you should be able to:

- investigate different digital systems through different perspectives using the concepts and apply these to examination-style questions in Papers 1 and 2
- understand the digital systems that will be used in context and apply these to examination-style questions in Papers 1 and 2
- investigate in more detail a digital system that will be a focus of the inquiry project
- discuss the digital systems that are creating challenges or providing interventions for real-life challenges for the higher-level topics
- investigate in more detail the digital system in the prescribed case study for Paper 3.

When studying digital society, it is important to have an understanding of the underlying technologies and terms associated with the digital systems being used in society today. Page 8 of the Diploma Programme *Digital Society Guide* states:

> *Digital systems include technologies, applications and platforms that create, store, process and distribute digital data and information. Smartphones, gaming platforms, AI-enabled personal assistants and robots are types of digital systems.*

It is important that you must gain a more precise understanding of the terms and technologies used by digital systems in this section, as you are now a digital society scholar. Very often people have a colloquial or common-sense understanding of the terms that you will come across in this course. They are not always correct, and you will be required to understand these in more detail.

This section consists of seven chapters:

- Data and data analysis
- Algorithms and code
- Computing devices
- Networks and the internet
- Media
- Artificial intelligence
- Robotics and autonomous technologies.

The importance of the content section

Chapter 3.1 starts with an in-depth study of data. Data is at the heart of all digital systems. In the same way that the heart pumps blood around the human body, digital systems are essential for processing and managing data. Without data there is nothing to process; without data we have no information; without data we cannot train artificial intelligence systems. So, as you can see, data is a vital component of any digital system. In this chapter, we will investigate the difference between data and information, look at the different types and uses of data, and the data life cycle. We will also consider the great responsibility that comes with handling data, and will have an opportunity to discuss and conduct inquiries into the issues surrounding the use of data.

Chapter 3.2, the study of algorithms and what they are, will provide an insight into how data is used by digital systems. Understanding algorithms will provide a greater understanding of the 'thinking' behind digital systems, because they govern how digital systems work and the outputs generated. Combining algorithms with the developments in artificial intelligence and how it is being used raises issues around bias and transparency.

Chapters 3.3 and 3.4 – Computing devices, and Networks and the internet – the 'nuts and bolts' of the underlying technologies used by all digital systems. It is interesting to see how these technologies have evolved over time and how technologies from the past are still influencing the technologies of today.

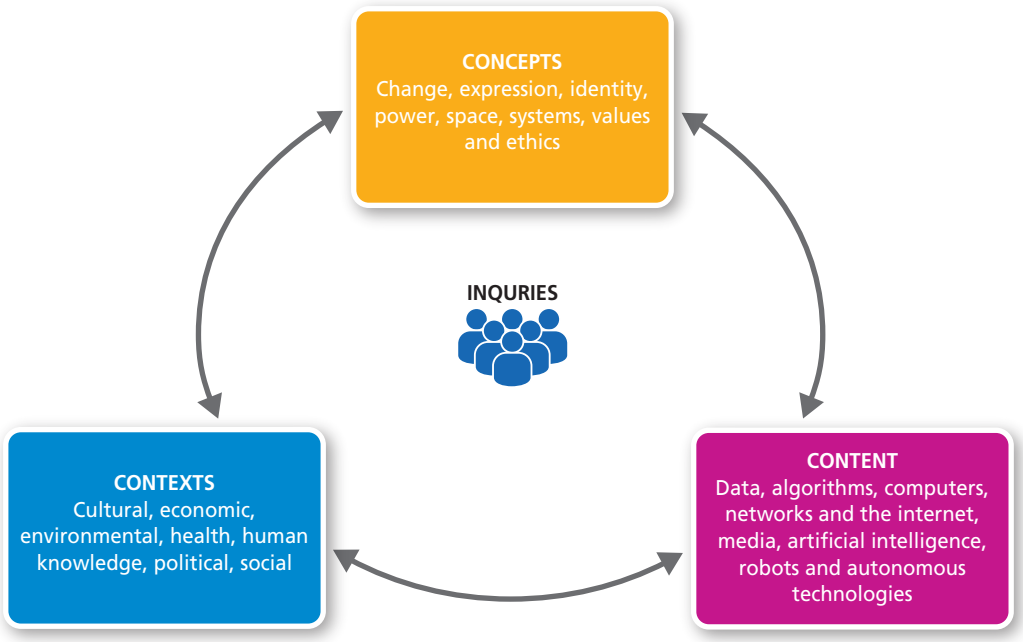
Chapter 3.5 looks at how the evolution of the internet and the World Wide Web have changed the digital media landscape. 'Traditional' media is now available in a wide range of formats, and can be interactive and shared easily. Digital media is creating new online and virtual spaces that were not possible before, creating a wide range of concerns along with it that need to be addressed by all those who are part of the digital society.

The final two chapters in this section, Chapters 3.6 and 3.7, go hand in hand: developments in artificial intelligence and parallel developments in robotics and autonomous technologies. As these technologies become ubiquitous in our lives, their influence is changing everything from what we watch and whose posts we see, to the scope of our jobs. Developments in artificial intelligence are creating a lot of buzz today, as well as uncertainty for the future, with legislation and regulations struggling to keep up. This makes it an interesting area for further investigation.

Each chapter will provide an in-depth study of the prescribed areas of inquiry, with supporting real-life examples, some engaging activities to try out and opportunities for inquiry and practice questions. In Section 1, you were introduced to the inquiry process. You will be given opportunities to develop your skills by completing activities which focus on some or all of the stages in the inquiry process. When attempting practice questions use the guidance given in Section 7 on how to approach the different command terms used. The topics will also include CAS and TOK ideas, as well tips for your extended essay (EE), which you can go back to once you start your EE journey. Although this section covers all of the supporting details for each prescribed area, the course does not require all to be covered.

Content and the 3Cs

By completing inquiries in the content chapters, you will be able to go back to the previous section on course concepts and have a deeper understanding of the technologies discussed. When you study the different contexts in Section 4, you will be more equipped to investigate the technologies being used in each area.



■ Digital society: Content

Remember, there is no right or wrong way to use this book – you can choose to visit each chapter in order or mix it up, jumping between the 3Cs as guided by your inquiries.

3.1 Data and data analysis

UNDERSTANDINGS

By the end of this chapter, you should understand:

- there are many types, uses and ways of representing data
- big data and data analytics involve extracting and processing useful information in ways that are often impossible for humans
- there are significant opportunities and dilemmas associated with data in digital society.

The focus of the first of the 'content' chapters is data. Data is at the heart of any digital society. It comes in many forms and has a wide range of uses. Data may be as small as one bit, represented by 1s and 0s in binary, or as large as 'big data' when used in data analysis. In this chapter we will thoroughly investigate the data life cycle and the dilemmas that arise.

3.1A Data as distinct from information, knowledge and wisdom

People talk about data and information interchangeably in everyday language but, as a student on the Digital Society course, it is important to distinguish between the two and also to understand that information can lead to knowledge and then wisdom.

Data refers to the collection of raw and unorganized facts and figures, which may be in the form of numbers, letters, characters or images. Data is often composed of facts and observations. It is an individual unit containing raw material that does not have any meaning and is measured in bits and bytes. For example, data collected by a heat sensor, 50, or a test score, 75.

Information, on the other hand, refers to the output after data has been processed, organized or structured to convert it into something that is more reliable, easier to measure, and ready to be visualized or analysed. Information may be based on questions such as 'who', 'what', 'where' and 'when'. Information provides context for the data and is measured in different units, for example, temperature 50°C or a test score of 75%.

◆ **Data**: Raw and unorganized facts and figures, which may be in the form of numbers, letters, characters or images.

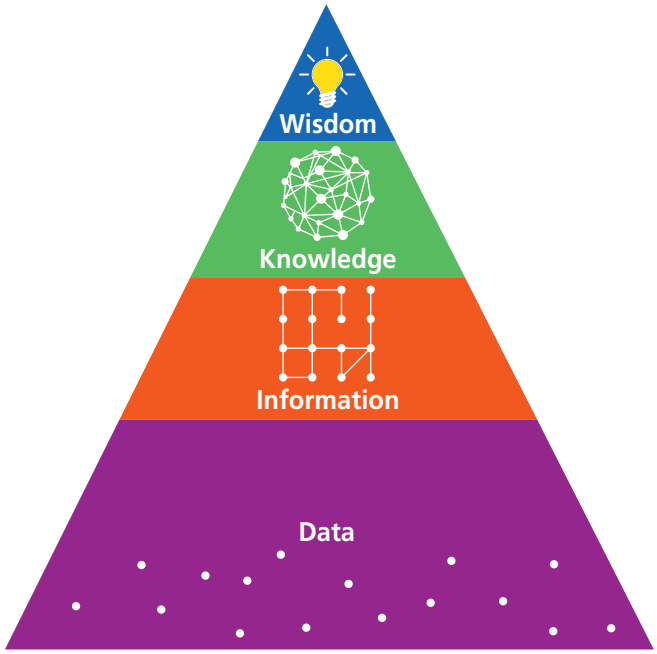
◆ **Information**: The output after data has been processed, organized or structured, to convert it into something that is ready to visualize or analyse; it provides context for the data.

Knowledge comes next and refers to when more meaning can be derived from information, which is then applied to achieve a set goal. Examples of 'how' information can be used include a meteorologist using rainfall information to determine if flooding is likely, or a teacher using test results to determine how successful a student is.

Wisdom follows on from knowledge and is when knowledge can be applied in action. One may ask questions such as 'why' and use knowledge and insight to make decisions, determine patterns and make predictions. For example, a meteorologist may predict if the country will have a heatwave, or a teacher could determine a student's predicted grade.

The data, information, knowledge, wisdom (DIKW) pyramid is a diagram that represents the relationship between data, information, knowledge and wisdom. Each block builds on the previous block, answering different questions about the initial data and how to add value to it.

- **Knowledge**: Meaning can be derived from information and applied to achieve a set goal.
- **Wisdom**: The application of knowledge.



Data, information, knowledge, wisdom (DIKW) pyramid

EXAM PRACTICE QUESTIONS

Paper 1 (core)

1 Outline the steps that need to be taken in order for humans to gain wisdom from knowledge. *[4 marks]*

2 Distinguish between knowledge and data. *[4 marks]*

ATL ACTIVITY

Social

Work in a small group to conduct a simple experiment using a digital fitness tracker/watch.

- Each student should perform a small fitness activity, for example, run a short circuit around the school.
- Review the sort of data collected by the fitness tracker/watch and what information is shown on the app.
- Review the data that is manually entered into the app.
- Discuss the results with each other.
- Create a DIKW pyramid to demonstrate how the data collected can be used to create information, knowledge and wisdom.

ATL ACTIVITY

Thinking

Discuss each of these questions in a small group:

- Will there ever be too much data?
- Is it possible for computers to have wisdom?
- How does our data define our identity?

You can have data without information, but you cannot have information without data.

Daniel Keys Moran

3.1B Types of data

Information technology (IT) systems operating in a range of contexts, for example, cultural, economic, environmental and health, and are used to create, collect and store different types of data. A financial system may store **quantitative** data about a company's sales with numbers that can be computed, for example, while a marketing department may conduct a survey to collect **qualitative** data about customer feedback, which is more descriptive. Now we will briefly introduce the different types of data that you will study in more detail under the different contexts.

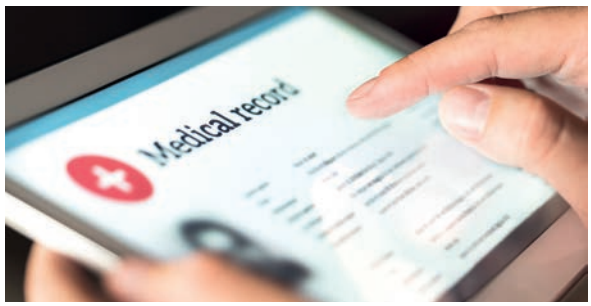
Financial data

Financial data consists of information that is related to the finances of a business, such as cash flow statements, balance sheets, and profit and loss accounts. Specialized software is often used for financial data management to analyse, report and provide data visualization tools. Good financial data management also ensures that businesses meet existing regulations and legal requirements.

Links

This section links to Chapter 4.2 Economic.

Medical data



Medical data is collected, analysed and stored during the ongoing care of a patient. For example, hospitals keep electronic health records that are updated after each visit. Patients' details may be entered on disease registries, which keep details of data for medical conditions such as Alzheimer's, cancer, diabetes and asthma. Additionally, patients may register for clinical trials to take part in the testing of new treatments.

ATL ACTIVITY

Research

Complete the following research activity and document the process used.

- Conduct research to find out about the different types of data that your Ministry of Health collects.
- Find details about the statistics that it publishes.
- Write a step-by-step guide on the research process used.

Links

This section links to Chapter 4.4 Health.

Meteorological data

Instruments are used to collect data about the weather and climate. Basic instruments include thermometers, rain gauges, barometers and anemometers. More sophisticated technologies include doppler radar, which can detect precipitation, rotation of thunderstorm clouds, wind strength and direction, and tornado debris; radiosondes, which are launched into the air using weather balloons can collect data about the upper atmosphere, and weather satellites that monitor the Earth from space can capture images that are then analysed.

ATL ACTIVITY

Research

Use effective research skills to download historical weather data.

- Ask the humanities or science teachers if your school has a weather station, or research weather data that is available for download (this data may be local or national weather, or weather from another country).
- Save the data in a suitable format (you will use this data later on in this chapter).

Meteorological data is used, for example, in weather forecasting and to predict extreme weather conditions, as well as climate modelling.

Geographical data

Location data, also known as geospatial data, refers to data related to the positioning of an object in a geographic space. It is usually collected using global positioning system (GPS) technologies, which may be used by a phone to provide location services or provide data for mapping applications. Location data has a wide range of uses.

REAL-WORLD EXAMPLE

Accessing location data without authorization: Australian Federal Police (AFP)

According to Australian Computer Society's *Information Age*, in 2021 the Australian Federal Police (AFP) were being investigated for accessing location data without gaining the correct authorization. The investigation covered a period of five years from 2015 to 2020 in which there were 1700 instances of police accessing location data, with compliance for only 100 of these.

https://ia.acs.org.au/article/2021/afp-misused-metadata-powers.html

Links

This section links to Chapter 4.3 Environmental.

Links

This section links to Chapter 4.3 Environmental.

ATL ACTIVITY

Communication

Explain in your own words how GPS technologies work.

- Conduct research into how GPS technologies work and their uses.
- Create a simple diagram to explain how GPS technologies provide location data.
- Describe what format the location data is presented in.
- Describe two real-life examples of when GPS data is used.
- Use your diagram to explain your understanding of GPS technologies to a friend.

Scientific data

Scientific data refers to the research carried out by scientists that has been published in peer-reviewed journals.

To support a hypothesis, a scientist must collect data either through an experiment or by observation. To automate the collection of data in an experiment a scientist may use sensors. Sensors are small devices used to measure a specific property of data and send this as a signal to a computer. Usually the signal is an analogue (continuous) signal that needs to be converted to a digital signal before it can be understood by the computer. This is done using an analogue-to-digital converter (ADC). Examples of sensors include temperature, light, pressure, moisture, chemical and gas.

ATL ACTIVITY

Thinking

Revisit an experiment that was conducted in one of your Group 4 subjects. Revisit your notes and data collected from the experiment, or re-run the experiment. Use this information to help answer these questions:

- What was the purpose of the experiment?
- Describe the tools used to collect the data, for example, sensors.
- What type of data was collected and what units were measured?
- What conclusions were drawn from the data?

REAL-WORLD EXAMPLE

Citizen scientists

During 2020–21, there was a marked increase in bird watching, which generated an increase in data. Many people were working from home during this time due to the COVID-19 pandemic, and large numbers joined projects to collect and share data about birds in the form of pictures, sound recordings and observations. One such citizen-science project, Project Safe Flight, asked users to record birds injured by flying into windows, while eBird allowed citizens to update sightings of the different species of birds.

In many cases, the number of people registered to these projects doubled, and so did the amount of data uploaded. From this data, scientists could see changes in bird behaviour, although it was not clear whether this could be attributed to the increase in observations, or whether the birds were actually changing their behaviour.

www.wired.com/story/pandemic-bird-watching-created-a-data-boom-and-a-conundrum

Links

This section links to Chapter 3.6, 3.7 – IoT and 4.5 Human knowledge.

Metadata

In addition to storing data, IT systems also store data about the data they are storing, which is known as **metadata**. Metadata is a set of data that describes and gives information about other data. For example, a document may store details such as the author, the size of the file and the date it was created.

◆ **Metadata**: A set of data that describes and gives information about other data.

ATL ACTIVITY

Research

Use research skills to investigate different examples of metadata. For each of the following, write up the metadata found for a

- website
- document
- image
- video.

Consider why this data might be useful?

Links

This section links to Chapter 3.5 Media.

3.1C Uses of data

With storage costs declining and advances in storage technologies and artificial intelligence, organizations are becoming more able to identify trends and patterns in their data, which they can use to inform their decision-making. What once would have taken individuals months to compute, can now be done at speed and with greater accuracy. **Data mining** is the term used to describe the process of finding patterns and correlations, as well as anomalies, within large sets of data.

◆ **Data mining**: The process of finding patterns and correlations, as well as anomalies, within large sets of data.

REAL-WORLD EXAMPLE

Data analysis in employment

Data is collected widely by both people and communities. In employment, for example, artificial intelligence can be used to analyse data generated by detailed questionnaires to identify which employees would be suitable for new job opportunities.

In the health industry, data analysis can be used to determine staffing levels. Too many staff can lead to overspending on labour costs, while understaffing can create a stressful working environment and lower the quality of medical care. Data can be used to solve this issue.

In addition to analysing data within one set of data, data can be gathered from multiple sources of data in order to create new connections, determine new relationships and discover new information. **Data matching** is when two different sets of data are compared with the aim of finding data about the same entity. For example, data matching can be used to compare the prices of the same product on different platforms, or used in fraud detection when identifying suspicious transactions. Another example is in the medical field, where medical researchers have been able to find connections between environmental factors and diseases, such as exposure to the sun and skin cancer.

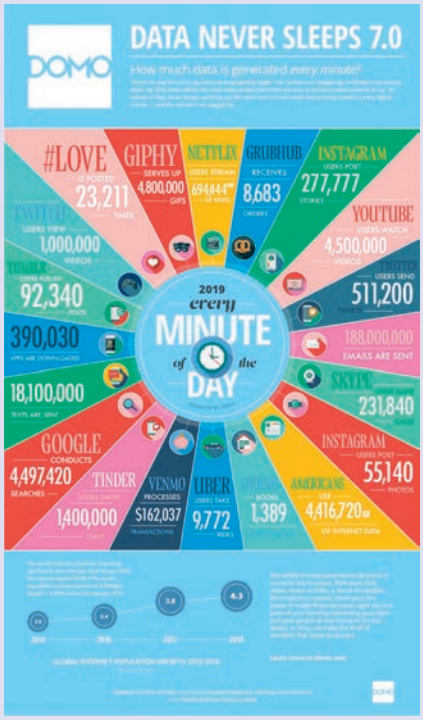
◆ **Data matching**: The process of comparing two different sets of data with the aim of finding data about the same entity.

ATL ACTIVITY

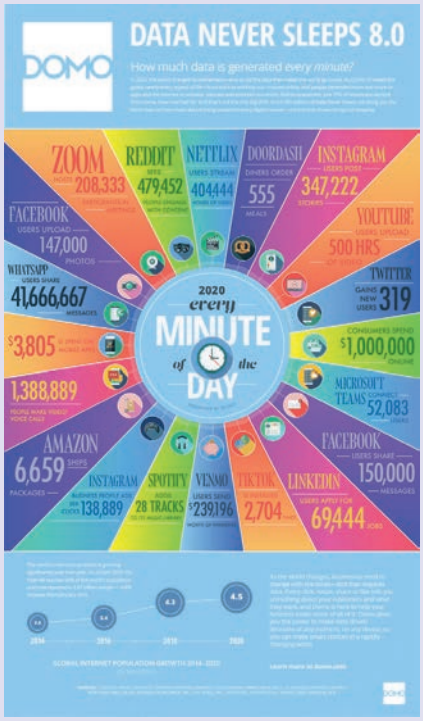
Communication

Domo is an organization that aims to bring people, data and systems into one place for a digitally connected business. The following infographics are from the resource centre on their website.

- Study the two infographics Data Never Sleeps 7.0 and Data Never Sleeps 8.0.
- List the data each of the infographics shown.
- Describe the similarities and differences that you notice.
- From your knowledge of the apps, websites and terms in the infographics, suggest possible reasons for any changes.



Data Never Sleeps 7.0



Data Never Sleeps 8.0

3.1D Data life cycle

The data life cycle has five stages. Organizations and data scientists use it to manage the flow of data, which can improve efficiency as well as help with adherence to data governance regulations.

Stages of the data life cycle

Stage 1: Data creation

The first stage of the data life cycle is the creation of data. New data may be created through manual data entry by a member of the organization, through the completion of an online form, or collected automatically through the use of sensors. As we discussed earlier, this data may be in many different formats.

Stage 2: Storage

Once the data has been created, it needs to be stored and protected with the appropriate level of security and access configured. Organizations will set what data can be accessed by who, as well as the different levels of access rights, so that users can either read, modify or have full control of the data.

Stage 3: Usage

Data is collected and stored for many reasons. At this stage of the data life cycle, the data can be viewed in its raw format, be processed so that it can be presented in a more visually appealing manner, or specific information can be extracted out. Once processed, the data can be analysed or shared with others. IT systems may be required to use data that has been previously collected by another organization or for a different purpose, or third parties may be given access to the data.

Stage 4: Preservation

Following the analysis of data, it is important that this data is preserved by the organization. One reason is to ensure that the data is maintained to support current analysis and decision-making. It also allows data to be reused in the future.

Stage 5: Destruction

Although organizations may wish to keep this data forever, as the volume of data grows so does the cost of storage. Compliance with data protection regulations may also mean that data must be destroyed once the agreed retention period is over.

ATL ACTIVITY

Thinking

Demonstrate a personal relevance to this activity by analysing a file in the recycle bin.

- Select one file from your computer's recycle bin.
- Analyse the file using the data life cycle by answering the questions in this table.

Name of file:		
Stage	**Question to be addressed**	**Answers**
1 Data creation	How was the file created? Was it manual or automatic? What file type?	
2 Storage	Where was the file being stored (location on the computer)? How was the file being kept secure? Who had access to the file? Was the file being shared?	
3 Usage	What was the purpose of the file? How did you use the file? Was the file used in its raw format or processed to create a different format?	
4 Preservation	How long did you intend to use the file? What was the intended future use of the file?	
5 Destruction	When did you add the file to the recycle bin?	

3.1E Ways to collect and organize data

Data creation | Storage | Usage | Preservation | Destruction

At the data creation stage there are two main categories of data: primary data and secondary data. **Primary data** is original data collected for the first time for a specific purpose. This may be an interview as part of your extended essay, or it may be data collected by cameras for facial recognition. **Secondary data** is data that has already been collected by someone else for a different purpose. For your extended essay this may be in the form of a website or online news article, or may include a set of training data for a facial-recognition system.

◆ **Primary data**: Original data collected for the first time for a specific purpose.

◆ **Secondary data**: Data that has already been collected by someone else for a different purpose.

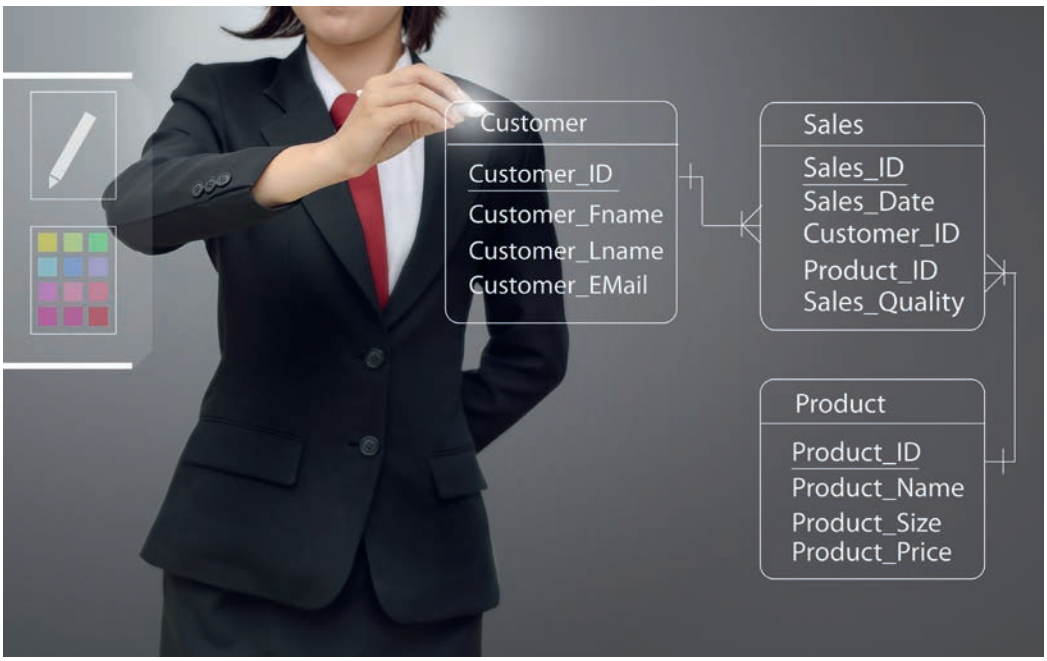
Data creation | **Storage** | Usage | Preservation | Destruction

Once data has been collected, it is important that organizations or users are able to store this data. **Databases** are often used to store large volumes of data in one place. Data is organized and structured using tables, which makes finding information quick and easy. A table consists of columns (**field names**) and rows (**records**). Databases organize data about **entities**. For example, an entity could be a book, movie, house or country.

When designing a database, one must think about what **attributes** needs to be stored (what specific data) about the entity. For example, a database about students (entity) may store data such as their name, date of birth, telephone number and address (attributes). The fields that store these attributes are predefined by size and **data type**. The most common types are integers, floating point numbers, characters, strings, Boolean values and dates. For example, name and address would be string, date of birth would be date.

A database that has more than one table is called a **relational database**, with tables linked by their primary key and corresponding foreign key. A field is assigned to be a primary key when it contains unique values. It is important for records in relational databases to have a unique identifier.

◆ **Relational database**: A database that has more than one table.



■ Example of an entity–relationship diagram (ERD) for a relational database

Links

This section links to Chapter 1.6 Conducting secondary research and primary research and Section 9 Digital society extended essay.

It is important during database design to reduce data entry errors and promote integrity, so that the data being input is valid, accurate and consistent.

Two methods to improve the accuracy of data in a database are validation and verification.

Validation in database design means that only valid (suitable) data can be entered. This can be done in various ways, such as setting the field length, assigning data types, using input masks, configuring range checks and designing lookup tables. Incorporating these into the database ensures that errors are minimized at the time of data entry. Should unsuitable data be entered, users will receive an error message.

On the other hand, **verification** checks that the data entered is the actual data that you want, or that the data entered matches the original source of data. Two common methods of data verification include double entry (for example, being asked to enter a password twice when registering a username for a new website) or having a second person check the data visually.

◆ **Validation**: In databases, this means that only valid (suitable) data can be entered.

◆ **Verification**: In databases, these are checks that the data entered is the actual data that you want, or that the data entered matches the original source of data.

Multiple users can access databases at any one time, and it is easy to add and modify data. Databases can be sorted so that information can be:

- presented in an organized manner
- searched in order to find specific information
- analysed to find trends or patterns.

In databases, searches are sometimes called **queries**. A query can be designed and saved, then executed whenever the user needs it. Queries are often presented in the form of a **report**, which can be designed to make the information extracted more visually appealing to the recipient.

As part of the process of organizing and structuring data, data needs to be classified into **categories**. Categorization may be done by defining fields in a database or through data tagging. Classification can make accessing information easier and more searchable, as well as for security purposes, such as classifying documents as confidential. Some standard categories of information include:

- public information, for example an organization's name, address and telephone number
- confidential information, for example bank details
- sensitive information, for example biometric data
- personal information, for example ethnic origin or political opinions.

When classifying data is it important to determine the relative risk associated with each set of data. Public data, which is easy to recover, is low-risk, whereas sensitive personal information or data that is necessary for an organization to function will be high risk.

Links

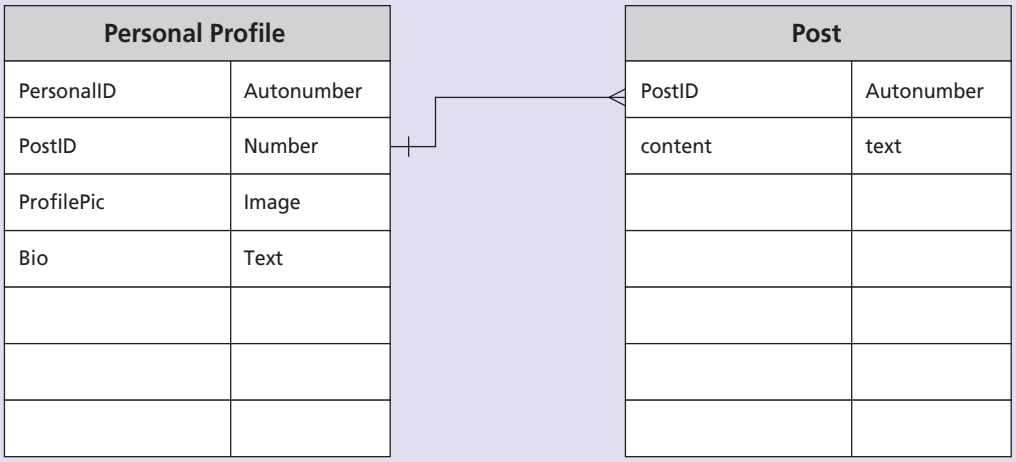
This content links to Section 4.7A Social components of identity.

ATL ACTIVITY

Thinking

Analyse the database behind a social media website.

- Select one of your social media accounts.
- Study the chosen account and make notes of the data that was entered to set up the profile.
- Next, study the sort of data that would be entered and automatically created every time a post is made.
- Describe the different formats of data that are used, for example images, date/time, text, integer, video, sound.
- Select a suitable drawing program to create an entity–relationship diagram (ERD) for your social media account. Use the example ERD below.



ERD template for social media

- Complete the following table to classify the data in your social media account.

Type of information	Summary of data found in the social media account
Public	
Personal	
Sensitive	
Confidential	

3.1F Ways of representing data

Data creation → Storage → Usage → Preservation → Destruction

Data collected can be presented in different ways to make it both easier to understand and more interesting to read.

Numerical data, such as financial, meteorological, scientific and statistical data, are often presented in a visual manner in the form of charts and tables. The type of chart will often depend on the type of data being represented. For example, rainfall is often presented as a bar chart, whereas temperature is presented as a line graph. These may also be combined with text to create a report. **Data visualization** is the process by which large sets of data are converted into charts, graphs or other visual presentations.

◆ **Data visualization**: The process of converting large sets of data into charts, graphs or other visual presentations.

ATL ACTIVITY

Communication

Earlier in this chapter, you downloaded a set of weather data. Use your spreadsheet skills to present this data.

- First, identify which spreadsheet software to use.
- Import the downloaded weather data into the software.
- Use formatting tools to present the data in an easier-to-read format – consider the use of fonts, colours, borders and shading.
- Use simple functions, such as average, minimum and maximum, to make calculations on the data.
- Use chart tools to create suitable charts for the weather data. Tools may include selecting the chart type, formatting the horizontal and vertical axes, labelling the axes, adding titles and a legend.

If your spreadsheet skills need refreshing, find suitable online tutorials to assist you in each of these activities.

Infographics are an alternative way to provide an easy-to-understand overview of a topic. They can contain images, charts and text.

ATL ACTIVITY

Research

Throughout the course, there will be numerous occasions when you will be required to present your findings in an easy-to-understand manner. Research and try out at least two online infographic creators.

- Research the most recommended online infographic creators.
- Select two and try them out.
- Create a table and compare their features.
- Make a decision on which one to use for this course.
- Write a short justification of your choice.

Infographic design template

3.1G Data security

Data creation → Storage → Usage → Preservation → Destruction

It is of paramount importance that data is secure at the time of storage but also in transmission. This may be when the data is collected or shared between systems or organizations. One method to ensure that data is kept secure is encryption.

Encryption

Encryption is the process of converting readable data into unreadable characters to prevent unauthorized access. Encryption is based on cryptography, where an algorithm transforms information into unreadable ciphertext. For the intended person or computer to be able to make sense of this encoded data, they must use a key to decrypt it back to its original form, called plaintext.

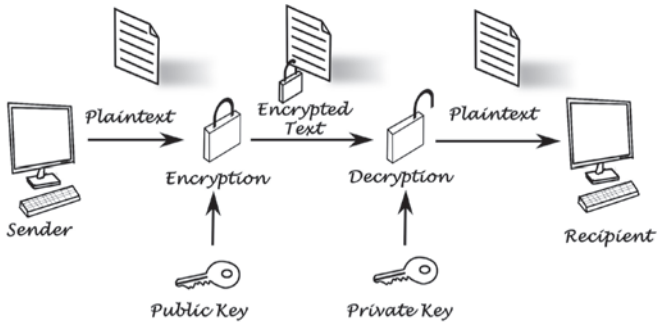
◆ **Encryption**: The process of converting readable data into unreadable characters to prevent unauthorized access.

There are two types of encryption:

- symmetric key
- public key.

Symmetric key encryption is where the key to encode and decode the data is the same. Both computers need to know the key to be able to communicate or share data. The advanced encryption standard (AES) uses 128-bit or 256-bit keys, which are currently considered sufficient to prevent a brute force attack (trying every possible combination to find the right key). For example, a 256-bit key can have 2^{256} possible combinations. This type of encryption is commonly used in wireless security, security of archived data and security of databases.

Public key (asymmetric) encryption uses two different keys to encode and decode the data. The private key is known by the computer sending the data, while the public key is given by the computer. It is shared with any computer that the original computer wishes to communicate with. When sending data, the public key of the destination computer is used. During transmission, this data cannot be understood without the private key. Once received by the destination computer the private key is used to decode the data.



Public key encryption

Public-key encryption is found in **Secure Socket Layer (SSL)** and **Transport Layer Security (TLS)** internet security protocols. The 'http' in the address line will be replaced with 'https' to provide secure transmission of data over the internet, especially when confidential and sensitive data is collected. It is commonly used in digital signatures, time stamping of electronic documents, electronic transfers of money, email, WhatsApp, Instagram, and sim card authentication.

◆ **Secure Socket Layer (SSL)**: is a protocol developed for sending information securely over the Internet by using an encrypted link between a web server and a browser.

◆ **Transport Layer Security (TLS)**: is an improved version of SSL and is a protocol that provides security between client and server applications communicating over the Internet.

ATL ACTIVITY

Social

Work in a small group to try out Caesar's cipher (Julius Caesar used a substitution technique, shifting three letters up, so C became F, D became G, and so on).

- Teach a friend how to use Caesar's cipher.
- Try coding and decoding messages with each other.

Data masking

Encryption is essential for the trusted delivery of sensitive information; however, cyber threats still exist and the implementation of more stringent data protection legislation means that organizations must ensure that sensitive data is kept private. One method of doing this is called **data masking**. Data masking is the process of replacing confidential data with functional fictitious data, ultimately anonymizing the data.

◆ **Data masking**: The process of replacing confidential data with functional fictitious data, ultimately anonymizing the data.

As we all know data is a valuable commodity and, once collected, it can be stored, used and shared. However, organizations face privacy problems should they do this without user consent. By anonymizing data an organization can both protect the privacy of their customers while using the data for application testing or business analytics, and/or sharing their data with third parties. Classifying data at stage 2 of the data life cycle makes this process much easier.

Data erasure

At the final stage of the data life cycle, data needs to be destroyed. **Data erasure** can be either physical or by a software-based method.

◆ **Data erasure**: The destruction of data at the end of the data life cycle.

Two physical methods are the use of degaussers, which use powerful electromagnetic fields to remove data (often used for magnetic media), and shredders, which break storage media down into tiny particles (an effective way of destroying solid-state storage devices and smartphones). Data-erasing software, on the other hand, permanently removes the original data on a storage device by overwriting it with zeros and ones.

Data erasure must not be confused with the term **data deletion**. As a computer user, you can delete files on your computer or cloud storage and send them to the recycle bin, or you can even reformat your storage device. However, with the right tools, deleted data can be recovered and is therefore not secure, especially if you are disposing of hardware.

◆ **Data deletion**: The sending of the file to the recycle bin, which removes the file icon and pathway of its location.

EXAM PRACTICE QUESTIONS

Paper 1 (core)

1 Outline two methods of data erasure. *[4 marks]*

2 Explain why an organization may wish to use data masking to anonymize data. *[6 marks]*

ATL ACTIVITY

Communication

Orally present to your peers a summary of a data breach.

- Using effective online searching skills, investigate a recent article about a data breach due to the improper disposal of computer hardware.
- Summarize your findings.
- Create prompt cards and practice presenting your findings using them.
- Orally present your findings to a group of friends.

REAL-WORLD EXAMPLE

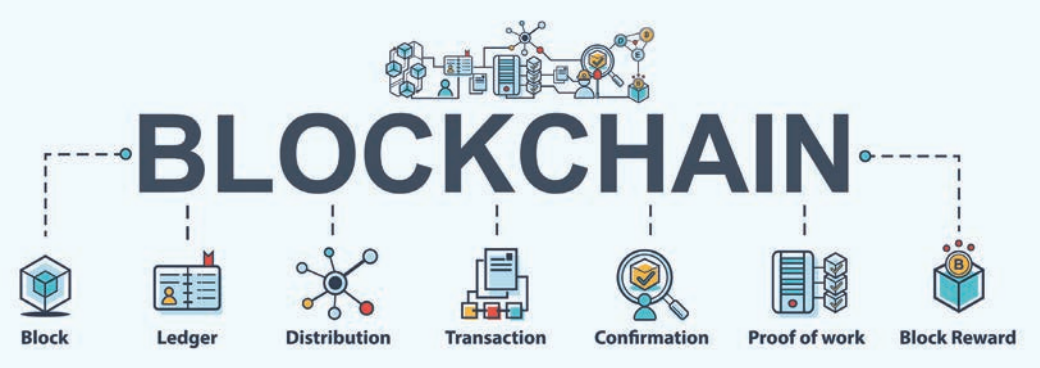
Data breaches from lack of data erasure

In 2010, some photocopiers that were used to copy sensitive medical information were sent to be resold without wiping the hard drives. Three hundred pages of individual medical records containing drug prescriptions and blood test results were still on the hard drive of the copiers. The US Department of Health and Human Services settled out of court with the original owner of the copiers for the violation of the Health Insurance Portability and Accountability Act (HIPAA) for US$1.2 million.

In 2015, a computer at Loyola University that contained names, social security numbers and financial information for 5800 students was disposed of before the hard drive was wiped.

https://njbmagazine.com/njb-news-now/the-challenge-of-recycling-office-electronics

Blockchain



With increasing numbers of reports of hacking in the news, many individuals, organizations and governments are looking for alternative systems that are more secure and transparent. **Blockchain** uses a shared ledger in the process of recording transactions, allowing the trading and tracking of anything of value, such as copyrights, property and loyalty card points. To participate in blockchain, users need to be part of the blockchain network, which will give them access to the distributed ledger. When a transaction occurs, it is recorded as a block of data. Each block forms a chain of data as the ownership of the asset changes hands, with details such as time and sequence of the transaction being recorded. Each additional block strengthens the verification of the previous block, which makes it very difficult to tamper with the transaction.

◆ **Blockchain**: a digital ledger of transactions that is duplicated and distributed across a network of computers.

There are many real-life examples of uses of blockchain; four are given here:

- Microsoft's Authenticator app for digital identity
- the health care industry is using blockchain technology for patient data
- blockchain technology can provide a single unchangeable vote per person in digital voting
- the US Government is using blockchain to track weapon and gun ownership.

EXAM PRACTICE QUESTIONS

Paper 1 (core)

IBM collaborated with Raw Seafoods in the USA to digitize the supply chain in 2019. Data would be uploaded to the IBM Food Trust platform at each stage of the supply chain. This included data on the time and location when the seafood was caught, when the boat docked at the port, when and where the seafood was packed, details about the shipping and delivery to supermarkets and restaurants. This included images and video. Blockchain technologies were used by the platform to reduce the level of fraud and increase confidence in the quality and freshness of the seafood.

1 a Identify two types of data recorded on the IBM Food Trust platform. *[2 marks]*

b Outline two benefits of using the IBM Food Trust platform for seafood customers such as restaurants. *[4 marks]*

2 Explain step-by-step how blockchain technology can be used to reduce the level of fraud. *[4 marks]*

Inquiry

In Section 1.4 you were introduced to the Inquiry Process. In this inquiry we will focus on only two of the stages. Use the guiding questions for each stage to help you complete the activity.

3.1G Data security (content) and 4.1B Home, leisure and tourism (context)

Research one use of blockchain in the home, leisure or tourism industry. Make sure that you have enough sources to be able to:

Starting point	**FOCUS** • Identify a real life example of blockchain.
Determine inquiry focus	• Identify which context this applies to from Section 4.1. • Suggest suitable concepts that could be applied. • Draft three suitable inquiry questions.

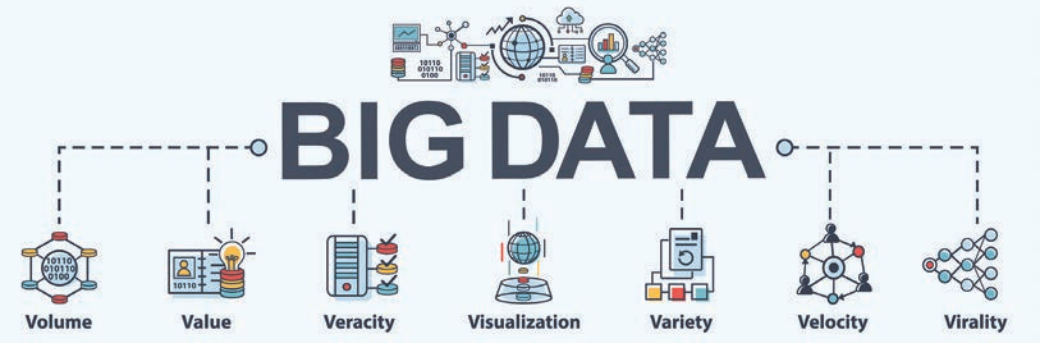
3.1H Characteristics and uses of big data and data analytics

Data creation → Storage → **Usage** → Preservation → Destruction

The term **big data** has been around since the 1990s and was made popular by John R Mashey, who worked for Silicon Graphics at the time. Big data is the term used to describe large volumes of data, which may be both structured or unstructured. Big data can be characterized by the 4Vs: volume, velocity, variety and veracity.

◆ **Big data**: Term used to describe large volumes of data, which may be both structured or unstructured.

Characteristics of big data



1. **Volume** – big data consists of very large volumes of data that is created every day from a wide range of sources, whether it is a human interaction with social media or the collection of data on an internet of things (IoT) network.
2. **Velocity** – the speed that data is being generated, collected and analysed.
3. **Variety** – data consists of a wide variety of data types and formats, such as social media posts, videos, photos and pdf files.
4. **Veracity** – refers to the accuracy and quality of the data being collected.

Uses of big data

Big data analytics is when large and varied data sets are processed to identify trends and patterns. This may be used to analyse past behaviour in order to improve customer service, streamline operations or identify new revenue streams.

REAL-WORLD EXAMPLE

Big data in banking and finance

Big data is allowing banks to see customer behaviour patterns and market trends. American Express is using big data to get to know its customers using predictive models to analyse customer transactions.

It is also being used to monitor the efficiency of internal processes to optimize performance and reduce costs. JP Morgan has used historical data from billions of transactions to automate trading.

A third use of big data has been to improve cybersecurity and detect fraudulent transactions. Citibank has developed a **real-time** machine learning and predictive modelling system that uses data analysis to detect potentially fraudulent transactions.

https://algorithmxlab.com/blog/big-data

◆ **Real-time**: Happening now or live.

Big data is at the foundation of all of the megatrends that are happening today, from social to mobile to the cloud to gaming.

Chris Lynch

REAL-WORLD EXAMPLE

Big data in the sports industry

Bundesliga, Germany's professional association football league, introduced Match Facts in 2021 to give match insights to its viewers. During a match, 24 cameras are positioned on the field to collect and stream data during the 90-minute game. This data is then converted into metadata and used with past data to provide insights for the fans, such as which player is being most closely defended or the likelihood of a goal being scored.

https://searchbusinessanalytics.techtarget.com/feature/Bundesliga-delivering-insight-to-fans-via-AWS

Inquiry

In this inquiry we will focus on only two of the stages. After your initial research, use the guiding questions for each stage to help you complete the activity.

3.1H Characteristics and uses of big data and data analytics (content) and 4.4 Health (contexts)

Research how big data is being used in medical diagnostics or medical care.

Determine inquiry focus

- Narrow the topic to a specific inquiry focus by using the digital society diagram and considering the 3Cs.
- Find related real-world example(s).

Explore

EXPLORE

- Find and evaluate sources.
- Conduct research, collect data and record sources.
- Check that there are adequate sources to address each aspect of the inquiry and the inquiry focus.

From your research:

- narrow down your focus to a particular application of big data used
- describe the use of big data for this real life example
- select three articles that you found to be useful and correctly list them in a bibliography.

Activity: HL Extended Inquiry

Once you have been guided through the extended inquiry process in Section 6 and learned the prescribed area of inquiry in Section 5.3A – make the connection with this topic and complete the extended inquiry.

3.1 Data and data analysis (content) and 5.3A Climate change and action

Research and evaluate one intervention for climate change that uses big data.

- Research and evaluate this intervention using the HL extended inquiry framework.
- Make a recommendation for steps for future action.

Present your work in the form of a written report.

3.1I Data dilemmas

Alongside the ownership of data comes a huge responsibility to ensure that data dilemmas are addressed at every stage of the data life cycle.

Stage 1: Collection of data

Organizations must consider whether the data was **collected ethically** and complies with data protection regulations. For example, there should be no excessive collection of data and consent should be obtained. Careful consideration should also be placed on what data is collected so as to avoid **biased data sets** that may ultimately skew outcomes in machine learning.

REAL-WORLD EXAMPLE

Bias in facial recognition

In 2019 the National Institute of Standards and Technology (NIST) published a report analysing the performance of facial-recognition algorithms. Many of these algorithms were less reliable in identifying the faces of black or East Asian people, with American Indian faces being the most frequently misidentified. The main factor was the non-diverse set of training images used.

https://jolt.law.harvard.edu/digest/why-racial-bias-is-prevalent-in-facial-recognition-technology

Stage 2: Storage of data

Where data is stored, who owns it, who is responsible for it, who has control of it and who has access to it, all impact **data privacy**. Organizations must comply with the local data protection regulations of the country that the data is stored in. Failure to do so can cost an organization a huge amount in legal fees and compensation should a data breach occur.

Security of data and levels of access can impact the **reliability** and **integrity** of the data. Unauthorized changing of data could deem data invalid and useless.

The problem with unreliable data is that it is often used to make decisions and can lead to faulty predictions and inaccurate forecasting. It is therefore important to identify the common problems that lead to unreliable data.

1. **Biased data**: We looked at data bias earlier in this chapter. This could be due to using biased data sets or bias by humans when selecting the data.
2. **Viruses and malware**: Stored data can be vulnerable to these external threats. Data can be changed, and therefore lose its integrity, or be corrupted and ultimately lost.
3. **Reliability and validity of sources**: Data can be generated from a number of online sources; if these sources have not been evaluated, this can lead to unreliable data being used by the IT systems.

◆ **Data privacy**: The ability for individuals to control their personal information.

◆ **Data reliability**: Refers to data that is complete and accurate.

◆ **Data integrity**: Refers to the trustworthiness of the data and whether it has been compromised.

4 **Outdated data**: Many IT systems collect and store data that is changing; if data is not updated it becomes unreliable data. Consider the telephone numbers of parents at school, for example – if a parent does not inform the school of a change in number, this data cannot be relied on to contact parents.

5 **Human error and lack of precision**: Any form of manual data entry is prone to human error. Automating data entry is crucial for reducing these types of errors. It is also easy for users to accidentally delete files, move them or even forget the name of the file and where it was saved. Effective file management procedures are essential to reduce these types of errors.

REAL-WORLD EXAMPLE

Reliability and validity of COVID-19 data

In June 2020, the *Guardian* reported on a study that was published online about the effect of the anti-parasite drug Ivermectin on COVID-19 patients. The data in the study was obtained from the Surgisphere website using the QuartzClinical database, which claimed to be monitoring real-time data from 1200 international hospitals. However, as doctors around the world started using this data, they soon became concerned regarding the amount of anomalies they found. This resulted in prestigious medical journals reviewing studies that were based on this unreliable data and the World Health Organization stopping their research into the potential COVID-19 treatment.

www.theguardian.com/world/2020/jun/04/unreliable-data-doubt-snowballed-covid-19-drug-research-surgisphere-coronavirus-hydroxychloroquine

EXAM PRACTICE QUESTIONS

Paper 1 (core)

1 Distinguish between data reliability and data integrity. *[4 marks]*

Top tips

There are many terms and keywords when discussing data. Make sure you know the difference between reliability and integrity, data matching and data mining, and validation and verification.

Stage 3: Use of data

The use of data should be ethical and comply with local data protection regulations. For example, data should only be used for the intended purpose and should not be shared without the user's consent. When investigating the uses of data, one must also question who the data is shared with and for what purpose, as well as whether data has been anonymized before sharing with third parties.

Individuals may choose to be anonymous for legitimate reasons, such as seeking personal advice or advice on embarrassing health conditions. However, too often, the use of privacy conceals the identity of criminals, terrorists or computer hackers from law enforcement agencies. It may also be used in **cyberbullying** or to conduct internet searches without being traced.

◆ **Cyberbullying**: Bullying carried out online, for example, on social media.

Stage 4 & 5: Archiving and storage of data

Again, organizations must comply with local data protection regulations when it comes to the retention and security of archived data.

Deeper thinking

Privacy

◆ **GDPR (General Data Protection Regulation)**: Legislation designed to harmonize data privacy laws across the EU.

Throughout the Digital Society course, there will be many times when the impact of a digital technology creates a breach of privacy. So, what does privacy actually mean? How can digital technology cause a privacy breach? How are citizens being protected by legislation?

Privacy is the ability of individuals and groups to determine for themselves when, how and to what extent information about themselves is shared with others.

There are three key aspects of privacy:

- **Freedom from intrusion** – an individual has the right to be left alone; for example, when at home, you have the right to not answer the door if someone calls, and you don't have the right to walk into someone else's house uninvited.
- **Control of information about oneself** – controlling information about yourself is a very important aspect of privacy. You are the one who decides what information is shared and where.
- **Freedom from surveillance** – if you have privacy, it means that you are not being watched.

What does it mean to have a breach of privacy?

Possible causes of data breaches include

- the unauthorized use of data by insiders – this could include the IT staff that maintain the data or the systems storing the data
- an accidental leak of data due to negligence or carelessness, which could result in access by hackers or third parties
- a series of errors that results in the exposure of information about an individual
- intentional use of data, such as used by marketing or for surveillance, that citizens may not approve of.

Data protection legislation

To protect individuals and groups of people from privacy breaches, different countries have their own set of data protection regulations and laws. In May 2018, the **General Data Protection Regulation (GDPR)** was introduced in Europe with the aim of harmonizing data privacy laws across Europe and providing greater rights and protection for European citizens. Designed to be more stringent and up to date than previous laws, many other countries are following suit and adapting their own laws accordingly.

There are seven key principles at the heart of GDPR:

- Lawfulness, fairness and transparency – outlines how the data being collected, used and stored may be treated.
- Purpose limitation – data collected should only be used for its original intended purpose.
- Data minimization – organizations should not collect more personal information than necessary.
- Accuracy – includes the responsibility of keeping data up to date and having processes to correct data.

- Storage limitation – covers the duration that data is kept; it should not be kept longer than necessary.
- Integrity and confidentiality – encourages organizations to adopt best practices for securing data.
- Accountability – a new principle to ensure that organizations can prove that they are working on compliance with the other principles.

The aims of data protection regulations are to provide individuals with more control over their data and to provide them with rights. For example, an individual has the right to be informed, they have the right to access their data, and they have the right to have it rectified. They also have the right to be forgotten.

ATL ACTIVITY

Thinking

Hold a discussion with a group of friends on the following questions:

- If someone says 'you are invading my privacy', what does this mean?
- What sorts of information do you think you should keep private?
- If you have been watching the news lately, how is social media being used to invade users' privacy?
- Should you expect privacy if you use social media?
- If someone says 'it was an anonymous post', what does that mean?
- How has digital technology helped people be anonymous on the internet?
- Distinguish between privacy and anonymity.

ATL ACTIVITY

Research

Research and apply the data protection regulations.

- Research the data protection regulations in one country of your choice.
- Apply these data protection principles/regulations to each stage of the data life cycle.
- Listen to the pizza order here **www.aclu.org/ordering-pizza** or here **www.youtube.com/watch?v=RNJl9EEcsoE**.
- Describe the breach of privacy of this scenario, including which data protection principles have been breached.
- Investigate one recent example of a data breach.
- Describe the cause of the data breach and the cost to the organization.

Inquiry

3.1 Data and data analysis (content) and 2.4 Power (concepts)

Starting point	Select a real-life example/news item with a digital society topic of interest • Does this source involve digital systems? • Does this digital system(s) clearly cause impacts and have implications for people and communities? • Is this a topic that provides opportunities for both secondary and primary research?
Determine inquiry focus	• Narrow the topic to a specific inquiry focus by using the digital society diagram and considering the 3Cs. • Find related real-world example(s).
Explore	**EXPLORE** • Find and evaluate sources. • Conduct research, collect data and record sources. • Check that there are adequate sources to address each aspect of the inquiry and the inquiry focus.

- Look back at the topics in this chapter. Select one that you would like to investigate further.
- Next, look at Chapter 2.4 Power and review the different prescribed areas. Conduct some initial research to help select a focus area.
- Can you link the inquiry to a personal experience?
- Find one or two examples of secondary research that will be the inspiration for this inquiry.
- Write a short summary to describe the topic of this inquiry, any link to a personal experience and the source that inspired you.

Creativity, activity, service (CAS)

Promote screen time awareness among the school community

Complete a short formal survey about screen time among a cross section of students in your school. Find out:

- what type of devices they use
- what activities students use their screens for
- how many hours they spend on-screen on school-related activities
- how many hours they spend on-screen on non-school-related activities.

Use a ready-made template online to create an infographic of your findings. Include suitable charts, images and text to describe student screen time habits.

Share this with the school community.

TOK

Knowledge and technology

In TOK lessons you may have discussed what is meant by the term 'knowledge'. How is the knowledge we have talked about in this chapter similar to your discussion in TOK? How is it different? Is there one 'right' definition of knowledge? One can also ask what is the difference between data, information and knowledge?

IT systems with artificial intelligence may be better at analysing patterns compared to humans but they rely on a vast amount of data. Many people are unaware that their digital footprint is allowing personal data to be collected, raising questions such as: What data is being collected? What methods are being used to get this data?

How has digital technology impacted how we filter data and information?

Does this data give a complete picture of what it is really like to be human?

It also raises ethical questions about information systems, how much data they should have about an individual, and how they are using the data.

Reflection

Now that you have read this chapter, reflect on these questions:

- How is data different from information, and what role does technology have in creating wisdom?
- Could you explain the different stages of the data life cycle?
- There are so many different types of data. Could you match up the types of data with the different contexts in the next section?
- Do you have the skills to present data in different ways? How might this be useful when working on the digital society internal assessment?
- Security is an important aspect of the data life cycle. What other chapters in this section might security be important for?
- What is the relationship between big data and artificial intelligence? How are these being used to improve the quality of life?
- Do the benefits of collecting, analysing and sharing data outweigh the ethical concerns that it raises?
- What is the relationship between data and power?
- How does your learning about data and knowledge in this chapter relate to your understanding of knowledge in TOK?

Extended essay (EE)

The data life cycle, big data and analytics, or the dilemmas of data may give you some initial ideas for an extended essay topic.

Learner profile

Thinker

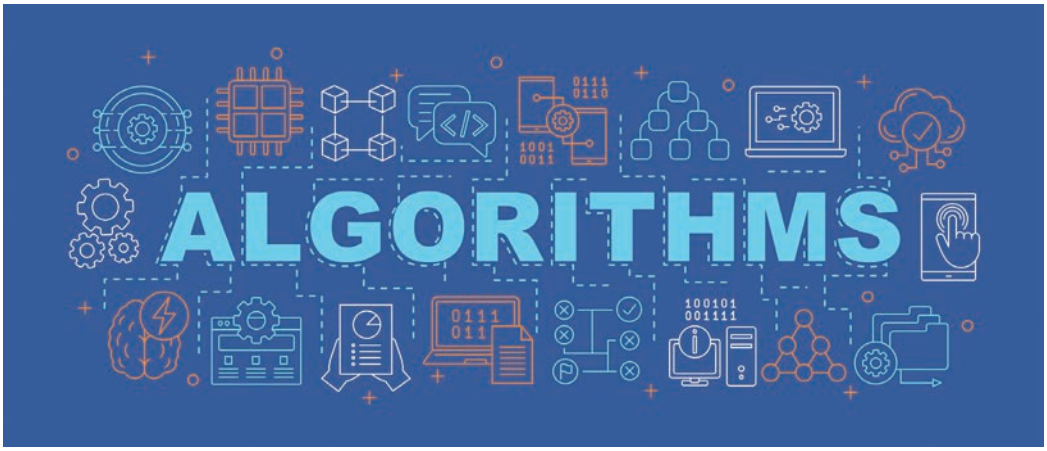
How has studying data made you think differently about your own personal data and how it is used?

3.2 Algorithms and code

UNDERSTANDINGS

By the end of this chapter, you should understand:

- algorithms are defined sequential steps or instructions to solve a specific problem or perform a task
- the effectiveness of an algorithm is often evaluated according to its efficiency
- the use of algorithms poses significant opportunities and dilemmas in digital society.



Algorithms have been around for thousands of years, but it's likely that you are hearing this term more frequently than ever before. Essentially, an algorithm is a step-by-step set of procedures used to solve a problem or perform a specific activity. The success of all computer systems is dependent on algorithms and how they are programmed.

◆ **Algorithm**: A procedure or formula for solving a problem that is based on a sequence of steps.

Whether we are conscious of it or not, algorithms are a ubiquitous part of today's society. For example, they are responsible for what we see on our social media feeds, and what movies are recommended on Netflix. The use of algorithms presents significant opportunities, but also poses new dilemmas for society.

3.2A Characteristics of an algorithm

Algorithms define a set of instructions that will be carried out in a specific order, to obtain an intended output. Consequently, algorithms should have the following characteristics:

- **Unambiguous**: Algorithms should be clear and concise; the inputs and outputs should be clear and all steps of the procedure explicit.
- **Finite**: Algorithms must have a finite number of steps that end once they have been completed. The algorithm must stop eventually with either the expected output or a response that indicates that there is no solution.
- **Well defined**: Each step of the procedure should be well defined, making very specific the steps to be taken and in what order. Details of each step must be explicit, including how to handle any errors.

- **Inputs**: The input is the data, which will be transformed by the procedure. An algorithm may have zero or more inputs.
- **Outputs**: The output is the data that has been transformed by the process; it should match the desired output. An algorithm should have one or more well-defined outputs.
- **Feasible**: For an algorithm to be effective, the procedure must be possible with the available resources and not contain any redundant unnecessary steps.
- **Independent**: The algorithm should have step-by-step instructions and be independent of any programming language.

ATL ACTIVITY

Social

Work in a small group to play this game. The purpose of the game is for one person to give instructions to their partner in sufficient detail to recreate a diagram. Each pair will need:

- copies of a printed diagram (this can be of anything as long as there is sufficient detail for person A to describe it)
- paper and pens
- chairs.

Setting up the game:

- Place the chairs back-to-back in a row.
- Get into pairs; each pair should sit down back-to-back.
- On one side (side A) give all the contestants a copy of the diagram (side B must not see it).
- On the other side (side B), each contestant should have paper and a pen.

Playing the game:

- Contestants on side A must give instructions to their partners (side B) on how to recreate the diagram.
- A time limit can be set to make this game harder.
- The winner of the game will be the team that has recreated the diagram most similar to the original diagram.

After playing the game, reflect on the characteristics of an algorithm. Which characteristics did the winning team display?

3.2B Components of an algorithm

The first computer algorithm was written in the 1840s by Ada Lovelace. It calculated a sequence of numbers called the Bernoulli numbers and was written for the 'Analytical Engine'. However, since the introduction of computers, algorithms have become more and more complex and sophisticated.

Despite the complexity of the more recent algorithms, many of the same components are commonly found. These include:

- **Instructions**: An algorithm consists of a series of sub-algorithms, each performing a small activity. Each set of steps for a small activity is called an instruction. One example would be digit addition.
- **Variables**: You may have come across variables in mathematical problem-solving or science experiments. They have the same function here in an algorithm, which is to temporarily store values while the steps of the algorithm are being executed. As the algorithm is being processed line by line, the variable will change value, hence its name. For example, an algorithm used to calculate profit will have the variable named 'profit' to store this data.

Ada Lovelace

- **Conditionals**: One of the steps in an algorithm could be to make a decision or choice. An example of this is when an algorithm is required to determine whether a profit has been made. This could be written as:

```
if Sales > Costs, then print 'We are profitable'
```

- **Loops**: Algorithms would be very limited if they could only run a sequence of steps once, which is why many algorithms contain loops. Loops allow a set of instructions to repeat when a certain condition is met. For example, an algorithm may repeat until there are no more customers.

3.2C Ways of representing algorithms

Algorithms are created independently of a programming language, which allows computer programmers to develop code in their preferred programming language. However, there are three main ways to represent an algorithm.

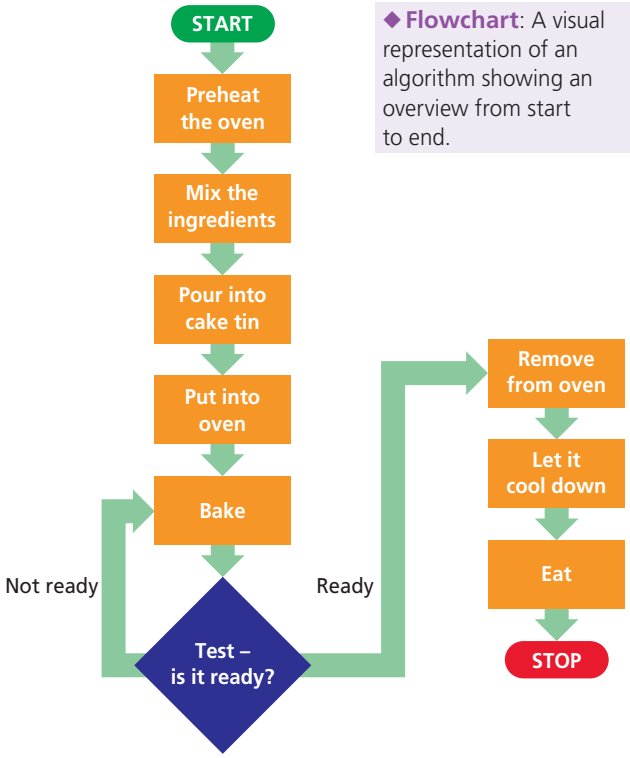
Natural language is a popular choice and may often be considered the first step of designing a computer program. Using everyday language allows developers to work with non-coders to write down the steps that the algorithm needs to follow, with the advantage that everyone involved is able to understand the process.

An example of a natural language algorithm would be a cooking recipe. To make a cake, you would follow the detailed steps of the recipe, such as get the ingredients from the cupboard through to take the cake out of the oven.

Although natural language is easy for everyone to understand, it has a tendency to be ambiguous and lack clarity. Consequently, an alternative method used to represent an algorithm is a **flowchart**.

Flowcharts use a standard set of symbols to represent the different components, and arrows are used to show the direction of the steps. For example, each rectangle represents an action, while diamonds represent a condition or a loop. Flowcharts help programmers visualize the steps of the algorithm and force them to think about sequence and selection. This makes them a useful planning tool.

Once an algorithm has been planned, it is time to start writing the **code** so that the program can be tested and implemented. There have been many **programming languages** created throughout history, with over one-third of these developed in a country that has English as the primary language. Despite the diversity of languages, many of the keywords, such as 'if' for conditions and 'while' for loops, are in English. It is not just the language used in the code that is important, however, but also the language of the community of programmers. According to the TIOBE Index 2022, Python is the most popular programming language, followed by C, Java and C++ https://www.tiobe.com/tiobe-index/



■ Flowchart to create a cake

◆ **Flowchart**: A visual representation of an algorithm showing an overview from start to end.

EXAM PRACTICE QUESTIONS

Paper 1 (core)

1 a Outline two characteristics of an algorithm. *[4 marks]*

b Outline two common components found in an algorithm. *[4 marks]*

2 Explain why programmers may prefer to plan out the algorithm using a flowchart compared to natural language. *[6 marks]*

3.2D Uses of algorithms

Whether they are processed by mathematicians, scientists or computer scientists, algorithms often perform the same common tasks. Take, for example, the **bubble sort algorithm** learned by computer science students. This is one of the most basic sorting algorithms, which runs in a loop and swaps adjacent elements until they are in the correct order. Alternatively, sorting may be found as a built-in function in a spreadsheet or database.

Algorithms may also be used for **searching** (which may be referred to as a 'query' in a database), **filtering** (with the selection of cells based on certain criteria) and **counting**. For example, a scientist may use a spreadsheet to analyse the results of an experiment. To do this they may sort the results to find the highest or lowest values, or filter the spreadsheet for a specific variable to narrow down their results, or count how many instances a given value appears in their results. Alternatively, the scientist may use an open-access research database to **search** for results of similar laboratory investigations.

ATL ACTIVITY

Thinking

In the last chapter, there was an activity to download weather data. Use this data to practice using functions in a spreadsheet program.

- Search for online tutorials on how to sort, filter and count in a spreadsheet.
- Using the weather spreadsheet from before
  - select a column to sort the data in order
  - try using the filter features to narrow down the data
  - decide on a certain criterion and use the 'count' function.

REAL-WORLD EXAMPLE

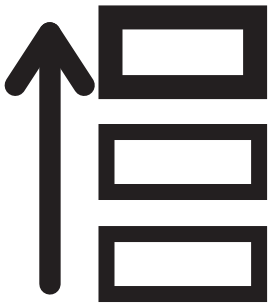
Search algorithms: PageRank

Google's search algorithm PageRank is one of the most frequently used search algorithms to find the most relevant web pages for a given search criteria. There are many sub-algorithms in this search algorithm that look at factors such as the words used in the query, expertise of sources, quality of content, location and useability of web pages.

An effective algorithm is one that makes an activity more efficient and solves the initial problem. So, naturally businesses are looking to algorithms to help them be more competitive. One such algorithm is the **prioritization algorithm**, which is a sorting algorithm used to prioritize customer orders, prioritize help desk requests or even decide which region to prioritize sales in. The first step in the algorithm is to count the frequency of requests from a customer, department or area. They are then sorted and classified into high, medium and low frequency, and then finally the customer, support, request or region would be ranked.

A second algorithm to improve efficiency is the **association rule**. Used in machine learning, association rules are algorithms being used in market basket analysis and medical diagnosis. Simply put, an association rule uncovers how items are associated with each other and reveals relationships between items in large databases. For example, analysing items in shopping baskets can determine how likely one item is to be bought with another. This information can then be used to determine product placement within a store, which will save customers time and remind them of things that they might be interested in buying.

Whether algorithms are in basic computer programs written by computer science students or by programmers from the top technology companies, the increase in the amount of data generated has steered companies towards artificial intelligence algorithms to help them make sense of the data.



■ Prioritization algorithms

◆ **Prioritization algorithm**: A sorting algorithm used to prioritize tasks.

◆ **Association rule**: Uncovers how items are associated with each other and reveals relationships between items in large databases.

■ Analysing items in shopping baskets can determine how likely one item is to be bought with another

ATL ACTIVITY

Research

Search for open-access databases using a search engine.

- Conduct a simple search to identify the most popular free, open-access databases.
- Search these databases to see if you can find out more information about prioritization and association algorithms.
- Read and make notes.

Links

We will learn more about machine learning and neural networks in Chapter 3.6 Artificial intelligence.

REAL-WORLD EXAMPLE

Machine learning algorithms and facial recognition

According to *American Scientist*, machine learning algorithms are being used to link physical appearance with other traits, many of which are reportedly making false claims. In one example, an algorithm was used to determine personality traits of job candidates based on their facial expressions. In another, machine learning was used to determine if a person was cheating in an online examination based on how their face changed as they answered the questions. One notorious misuse of facial recognition was an algorithm that claimed to identify a criminal based on the shape of their face with an accuracy of 89.5%!

www.americanscientist.org/article/the-dark-past-of-algorithms-that-associate-appearance-and-criminality

Inquiry

In this inquiry we will focus on only one of the stages of the inquiry process. If you need to refresh yourself on the Inquiry Process, revisit Section 1.4.

3.2 Algorithms and code (content) & 2.2 Expression (concepts)

Artificial intelligence models are being used to capture human expressions to make predictions. What impact is this having on people?

Determine inquiry focus

Formulate an inquiry question, find real-world example(s) and connect them to the 3Cs

- Is your question concise, thought-provoking and worth considering from different perspectives?
- Does your question support discoveries that move beyond recall, description and summary?
- Are the course concepts, content and contexts that you have identified connected to your inquiry question?

Use your research skills to narrow down this focus question to a particular context.

- Find one real-life example to support your choice of context.
- Rewrite your focus question to include the context and summarize the real-life example.

3.2E Algorithmic dilemmas

One goal of algorithms is to make people's lives easier, for organizations to operate with greater efficiency, and for governments to make better decisions. Algorithms are all around us, aiding us with online searching and shopping. Small businesses can gain new insights into trends when making sales forecasts without having to hire experts, which ultimately allows them to provide a better service for customers and employ the right staff. Governments can analyse health data to improve hospital services and use artificial intelligence in the courtroom.

However, algorithms created with good intentions in mind sometimes have negative consequences, albeit unintentional.

Algorithms replacing human judgements

Algorithms can be better decision-makers than humans: they don't get tired, and the decisions can be applied consistently and with precision as they are not emotional. On the other hand, however, even logical algorithms can give inappropriate results.