Section 1: Understanding Digital Society

1.0 Overview of IB Digital Society

Pathway of IB Digital Society

- 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.

1.1 What is Digital Society?

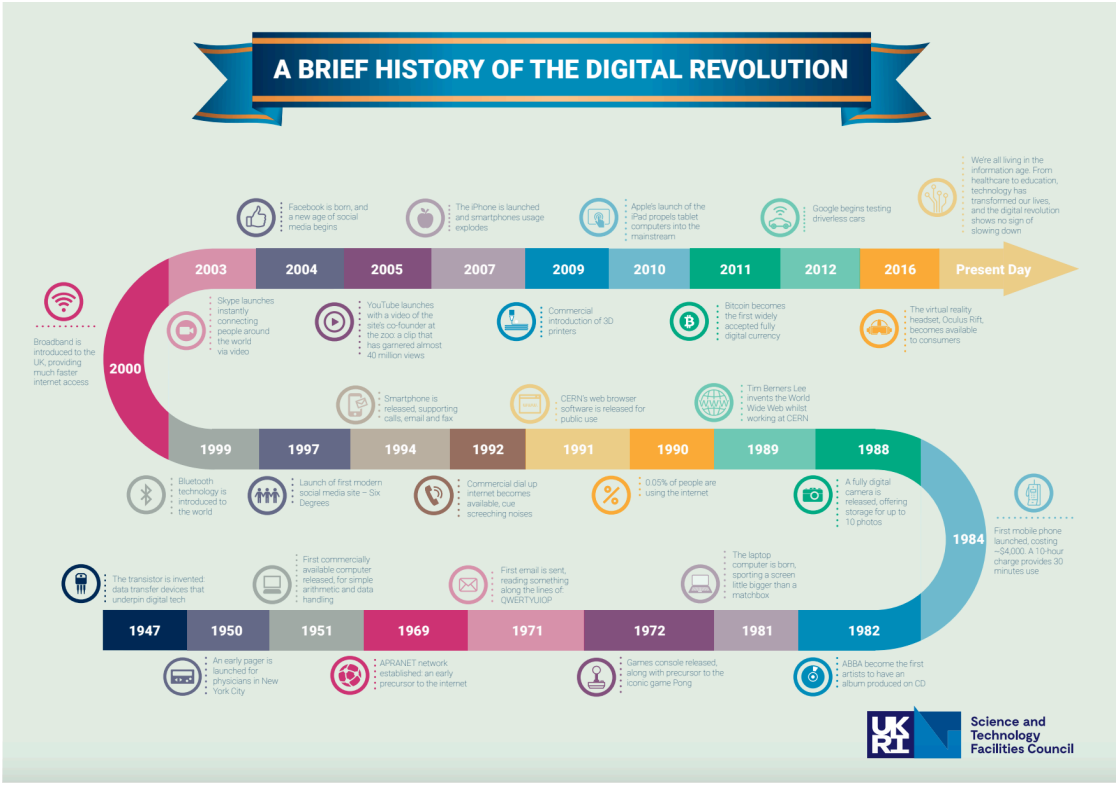
1.1A Digital Society has Multiple Names

- digital society is associated to: information age, computer age, post industrial society, network society and fourth industrial revolution
- **Digital Revolution**
    - the advancement of technology from analogue electronic and mechanical devices to digital
    - started from 1980 onwards, which is the rise of digital society

1.1B Digital Divide

- the gaps between members of society who have uneven access to computers or the internet, and those who do have access
- **Reasons of People who are Influenced by the Digital Divide**
    - 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

1.1C Milestone in the Development of Digital Society



1.1D Digital Systems Use Binary Digits

- **Binary**
  - a system used to convert verbal logic statements into mathematical ones
- **Bit**
  - a binary digit – either a 0 or a 1
  - all data and information are represented by a sequence of 1s and 0s in all of the digital technologies we use (all text, images, photos, video, audio, music, software)
- **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'
  - ASCII (American Standard Code for Information Interchange) is the encoding standard for text
  - different encoding formats have been standardised to allow for compatibility between different digital systems and technologies
    - 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
- **Steganography**
  - practice of hiding secret text in image files.
  - legitimate purposes for using steganography: watermarking images as a means for copyright protection.
  - can also be used to hide illegal activity and communication between members of criminal or terrorist groups.

1.1F Digitization

- **Digitization**
  - changing analogue data and information to digital.
- **Digital Preservation**
  - 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 Reformatting**
  - part of the process of preserving original materials for long term accessibility.
  - involves converting analogue materials into a digital format so the need to use of the original material is much less or totally eliminated.
  - 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 Archive**
  - an information system used to store different digital resources and make them available to a specific group of users.

1.1G Digitalization

- **Digitalization**
  - use of digital systems to change the structure and/or operation of a business, institution or organisation.
- **Digital Transformation**
  - profound change in an entire institution, organisation, business or other entity due to the need for change and the potential of digitalization to meet that need.
  - can have implications for methods used, services offered, management, stakeholder involvement, ways of thinking and all other aspects of how the entity functions.
  - observed in education whenever natural disasters and other factors have disrupted the ability for students to attend school.

1.2 The Foundations of Digital Society: Concepts, Content and Context

1.3 Digital Society in an IB Context

1.4 Your Digital Society Toolbox

1.5 Learning and Assessment

1.6 Conducting Secondary Research and Primary Research

Primary Research

- First-hand research in which you collect original data.

Secondary Research

- Research carried out by someone else.

Section 2: Concepts

2.0 Overview of Digital Society Concepts

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

Seven Digital Societies Concepts

- provide different windows and perspectives that can be used to explore digital societies

- starting concept is the one that is most applicable to the context and content of the inquiry and will provide different ways to explore impacts and implications and where to go with future developments and interventions
    1. **Change** - digital society is always evolving; many consequences can be explored from a number of perspectives.
    2. **Expression** - examines how technological change has enabled different and expanded ways of thinking, communicating, collaborating and creating.
    3. **Identity** - considers how our personal and community identities are changing and becoming multifaceted.
    4. **Power** - examines how digital technologies are extending; changing the way in which we influence others, control and are controlled by others, at personal, institutional and governmental levels.
    5. **Space** - considers how our interactions with each other are changing; our interactions with our physical environment.
    6. **Systems** - provides a way for understanding connections between human, natural and built environments; role of people and communities within them.
    7. **Values and ethics** - consequences of change; explores their impacts and implications in the context of right and wrong, fair and unfair, just and unjust, legal and illegal, proper and improper.

2.1 Change

What is Change?

- evolution, transformation, adaptation or movement from one form, state or value to another.
- involves understanding and evaluating people, ideas, objects and forces that shape the world: past, present and future.

Types of Change

1. **Change of Form**
    - change in the format, function or shape
    - eg: evolution of phones from single-purpose device to multifunctional smartphone
2. **Change of State**
    - change from one form to another but still basically the same
    - eg: analogue to digital watches, IRL games to online games
3. **Change of Values**
    - change in what has been thought to be important
    - eg: anonymity is now valuable due to privacy concerns
4. **Incremental Change**
    - **Evolutionary**
        i. existing thing evolves into something different but basically still the same
        ii. eg: digital technology is always getting faster and have more features
    - **Adaptive**
        i. same thing but adaptable to new conditions
        ii. eg: selling things online and simultaneously in the shop due to pandemic
5. **Radical Change**
    - **Transformational**
        i. change from one form to another but can be disruptive
        ii. eg: work from home
    - **Extension/Combination**
        i. when digital technology's uses are extended or combined to create something new

ii. eg: people using powerful devices and huge networks to work from anywhere at anytime to extend their workspace virtually and combining it with multiple activities and places

2.2 Expression

What is Expression?

- the act, process or instance of representing ideas, emotions and/or experiences using different modes and media.
- serves many functions, including storytelling, world-building, artistic innovation and political activism.
- brings people and communities together but also introduces significant dilemmas, as expressions can have negative impacts.

Change of Expression by Digital Technology

1. **Evolutionary**
    - existing thing evolves into something different but basically still the same
    - eg: snail mail to email
2. **Adaptive**
    - same thing but adaptable to new conditions
    - eg: development of audio combined with digital books allow persons to access books audibly
    - eg: digital books that allow hovering over specific words to learn the meaning of the words
3. **Transformational**
    - change from one form to another but can be disruptive
    - eg: keeping up with friends and family using social media and video calls instead of letters and phone calls
4. **Radical**
    - creation of new forms, states or values
    - eg: TikTok enabled new forms of expression through creating short videos on popular topics targeted to specific audience

2.3 Identity

What is Identity?

- helps to define ourselves, as well as groups, social entities and communities we belong to or identify with.
- 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.
- multifaceted and include aspects related to age, nationality, religion, culture, gender, sexuality, race and ethnicity, as well as social and economic class (features of identity)

Is Identity Static?

- No, it is NOT static.
- changes over time and according to our own contexts and the perspectives of others.
    - reason: identity is 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.

2.4 Power

What is Power?

- 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.
- structural and embedded within institutions, organisations and governments.
    - at the lowest level we need to consider how the use of digital technologies influences each of us personally
    - this level is called 'soft' power and is often cultural and goes largely unnoticed
- not equally distributed.

Types of Power

1. **Coercive**
    - someone forces us to do something against our will.
    - eg: power of bullies on social media
    - eg: power of a person who has invaded our privacy using digital technology (resulting in blackmail and other demands for money, or influencing others for their benefit)
2. **Reward**
    - opposite of coercive power.
    - giving benefits to someone if they do something.
    - eg: power to get you to spend money in computer games as it helps you to win
3. **Legitimate**
    - power that arises from a formal relationship between people.
    - eg: school rules about the use of digital devices
4. **Expert**
    - power that comes from someone having a higher level of skill and experience.
    - eg: students need digital devices to study so they consult an expert to keep them working
5. **Respect**
    - power that comes from liking and respecting others.
    - eg: respect for social media influencers gives them the power to encourage their followers to buy certain products
6. **Information**
    - power that comes from the use and control of information.
    - also comes from collecting information about others and their device use.
    - eg: posting information on the internet gives one power to influence others and what they think

2.5 Space

What is Space?

- organisation, construction and representation of space is done by humans based on physical, geographic, cultural and/or social features (for example, locations, regions, borders, zones).
- now virtual spaces are being created and used more often; becoming more diverse and different from other spaces being used.
- different spaces serve distinct functions for people and communities.
- we cannot operate without space.
    - we live and operate in spaces, and spaces are constructed and used for all the different functions and things in everyday living.
- understood using multiple scales and dimensions, including local, regional, national and global and, increasingly, virtual.
    - people spend more and more time in virtual spaces due to the widespread use of digital technologies.

- interaction of people is done through the use of the spaces (how they access their content, and how they move between them)
    - use of space is often a complicated flow of people, information and objects.

2.6 Systems

What are Systems?

- focuses on systems thinking (a way to think about structure and order in human, natural and built environments)
- involve sets of interacting, interdependent and/or interconnected elements.
    - done through models, maps and visualisations that help us understand the connections within, and between, systems, and the components within systems.
    - involves the people and communities in these systems, the impacts on them and the implications for them.
- analysis of a system, and connected systems, enables deeper understanding that can be further investigated using the other concepts.
    - systems thinking can also support investigations based on the other concepts.
- representation of systems in digital society is:
    - usually logical and use software such as spreadsheets, databases and specialised simulation apps and programs that use algorithms.
- impact of digitally-based systems:
    - systems interact with each other faster and in many more ways than physical systems, which are also being greatly influenced and changed by the use of digital systems (eg: roads, planes, trains)

2.7 Values and Ethics

What are Values and Ethics?

- ways to determine distinctions between right and wrong, fair and unfair, just and unjust, legal and illegal, proper and improper.
    - values - core principles and ideas that individuals or groups consider important, guiding their beliefs and decisions
    - ethics - moral principles that govern a person's behaviour or the conduct of an activity.
- guide human action in the world, including individual and group conduct, and decision-making.
- may be personal, shared, collective and/or professional.
- expressed through frameworks, codes, rules, policies and laws.
- influence and shape ideas, objects, practices, systems and spaces.

Section 3: Content

3.0 Overview of Digital Systems

Content: The study of the digital technologies used.

This section consists of seven chapters:

1. Data and data analysis
2. Algorithms and code
3. Computing devices
4. Networks and the internet
5. Media
6. Artificial intelligence
7. Robotics and autonomous technologies

3.1 Data and Data Analysis

3.1A Data as Distinct from Information, Knowledge and Wisdom

- **Data** - the collection of raw and unorganised facts and figures, which may be in the form of numbers, letters, characters or images.
    - composed of facts and observations
    - an individual unit containing raw material
    - does not have any meaning and is measured in bits and bytes
- **Information** - refers to the output after data has been processed, organised or structured to convert it into something that is more reliable, easier to measure, and ready to be visualised or analysed.
    - based on 'who', 'what', 'where', 'when'
    - provides context for the data
    - measured in different units
- **Knowledge** - when more meaning can be derived from information, which is then applied to achieve a set goal.
- **Wisdom** - 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

3.1B Types of Data

- **Financial Data**
    - consists of information that is related to the finances of a business
        - specialised software often used for financial data management to analyse, report and provide data visualisation tools
        - ensures that businesses meet existing regulations and legal requirements
        - eg: cash flow statements, balance sheets, and profit and loss accounts
- **Medical Data**
    - collected, analysed and stored during the ongoing care of a patient
        - register for clinical trials to take part in the testing of new treatments
        - eg: disease registries which contain details of data for medical conditions such as Alzheimer's, cancer, diabetes and asthma
- **Meteorological Data**
    - used to collect data about the weather and climate
        - basic instruments:
            - **thermometers, rain gauges, barometers and anemometers**
        - sophisticated instruments:
            - **doppler radar** *(detects precipitation, rotation of thunderstorm clouds, wind strength and direction, and tornado debris)*
            - **radiosondes** *(launched into the air using weather balloons can collect data about the upper atmosphere)*
            - **weather satellites** *(monitor the Earth from space can capture images that are then analysed)*
- **Geographical/Location/Geospatial Data**
    - related to the positioning of an object in a geographic space
        - usually collected using global positioning system (GPS) tech
        - eg: used by a phone to provide location services or provide data for mapping applications
- **Scientific Data**
    - 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 which then use Analogue to Digital Converter (ADC)
            - **sensors** - *small devices used to measure a specific property of data and send this as a signal to a computer*
- **Metadata**
    - a set of data that describes and gives information about other data
        - data about the data IT systems are storing
        - eg: document may store details such as the author, the size of the file and the date it was created

3.1C Uses of Data

- **data mining** - the process of finding patterns and correlations, as well as anomalies, within large sets of data.
- **data matching** - the process of comparing two different sets of data with the aim of finding data about the same entity

3.1D Data Life Cycle

- **Stage 1: Data Creation**
    - New data may be created through manual data entry by a member of the organisation, through the completion of an online form or collected automatically through the use of sensors
    - May come in different formats
- **Stage 2 : Storage**
    - Once data is created, it needs to be stored and protected with appropriate level of security and access configured
    - Organisations will set what data can be accessed by who by establishing a level of hierarchy for those who can only read, modify or have full access on the data
- **Stage 3 : Usage**
    - 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 organisation or for a different purpose or third parties may be given access to the data
- **Stage 4 : Preservation**
    - Following the analysis of data, it's important that the organisation preserves the data
    - It is to ensure data is maintained to support current analysis and decision-making
    - It allows data to be reused in the future
- **Stage 5 : Destruction**
    - As 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

3.1E Ways to Collect and Organise Data

- Two Main Categories of Data
    - **Primary data:** original data collected for the first time for a specific purpose
        - eg: interviews, surveys and questionnaires, observation
    - **Secondary data:** data that has been collected by someone else for a different purpose
        - eg: online news article, website, journals, podcasts
- **Databases**
    - Used to store large volumes of data in one place and organises data called entities

    - Consists of columns (field names) and rows (records)
    - Need to think about attributes which are predefined by size and data type
    - A database can be sorted out so that the information can be:
        - presented in an organised manner
        - searched in order to find specific information
        - analysed to find trends or patterns
    - **Relational Database:** database containing more than one table
        - tables are linked by their primary key and corresponding foreign key
        - fields that become primary keys need to be unique and become a unique identifier
- Two Methods to Improve Accuracy
    - **Validation**
        - Only valid or suitable data can be entered
        - Types:
            - length check
            - range check
            - type check
            - presence check
            - check digit
            - format check
    - **Verification**
        - Checks that the data entered is the actual data that you want or that the data entered matches the original source of data
        - Types:
            - double entry of data
            - proofreading/visual check
- **Queries and Reports**
    - In database, searches are called queries
    - Queries can be designed and saved and executed whenever the user needs it
    - They're often presented in the form of a report which can be designed to make the information extracted more visually appealing to the recipient
- **Categorization of Data**
    - Can 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 making documents classified as confidential
    - Some standard categories include:
        - public information (eg: organisation's name, address, telephone number, etc)
        - confidential information (eg: bank details, identification card details, etc)
        - sensitive information (eg: biometric data, family information, etc)
        - personal information (eg: ethnic origin, political opinions, racial background, etc)

3.1F Ways to Representing Data

- **Data Visualization**
    - The process of converting large sets of data into charts, graphs or other visual presentations

3.1G Data Security

Involves 3 stages of data life cycle: Storage, Preservation, Destruction.

- **Encryption** - The process of converting readable data into unreadable characters to prevent unauthorised access.
    - Cryptography algorithm transforms information into unreadable ciphertext

    - A key is used to decrypt the ciphertext back to its original form, plaintext
    - There are 2 types of encryption:
        - **Symmetric key encryption**
            - The key to encode and decode the data is the same
            - Both computers need to have the key to communicate
            - Commonly used in wireless security, security of archived data and security of databases
        - **Public key (asymmetric) encryption**
            - Two different keys used to encode and decode the data
            - Private key: known by the sender's computer (used to decrypt once file is received)
            - Public key: shared with any computer (used when sending data per destination)
            - Found in SSL and TLS:
                - *Secure Socket Layer (SSL)*
                  It 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)*
                  It is an *improved version of SSL* and is a protocol that provides *security between client and server applications* communicating over the Internet.
- **Data masking** - The process of replacing confidential data with functional fictitious data, ultimately anonymizing the data.
- **Data erasure** - The destruction of data at the end of the data life cycle.
    - Can be by a physical or software-based method:
        - Physical data removal
            - **Degaussers** - *powerful electromagnetic fields*
            - **Shredder** - *break storage media down into tiny particles*
        - Software-based method:
            - **Data erasing softwares** - *removes original data by overwriting it with zeros and ones*
    - Data erasure ≠ Data deletion
    - **Data deletion** - The sending of the file to the recycle bin, which removes the file icon and pathway of its location, data is recoverable.
- **Block chain** - a digital ledger of transactions that is duplicated and distributed across a network of computers.
    - Each transaction is recorded as a block of data
    - Each block forms a chain of data
    - eg: the healthcare industry is using blockchain technology for patient data

3.1H Characteristics and Uses of Big Data and Data Analytics
Involves 1 stage of data life cycle: Usage.

- Big Data: large volumes of data, which may be both structured or unstructured.
- **Characteristics of Big Data**
    a. 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.
    b. Velocity - the speed that data is being generated, collected and analysed.
    c. Variety - data consists of a wide variety of data types and formats, such as social media posts, videos, photos and pdf files.
    d. Veracity - refers to the accuracy and quality of the data being collected.

- **Uses of Big Data**
  - Big Data Analytics - when large and varied data sets are processed to identify trends and patterns.
    - Used to analyse past behaviour → *improve customer service, streamline operations or identify new revenue streams*.

3.1I Data Dilemmas

- **Stage 1: Collection of Data**
  - Check whether data is collected ethically and complies with data protection regulations
  - Example: data shouldn't be collected excessively and consent should be obtained
  - Careful consideration, to avoid biased data sets (may skew outcomes in machine learning)
- **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.
    - organisations must comply with data protection laws like GDPR (mandatory)
    - Level of security impacts the reliability and integrity of the data
    - Unauthorised data change could deem data invalid and useless
    - Unreliable data is used to make decisions → leads to faulty predictions and inaccurate forecasting
    - Unreliable data such as:
      - Biased data - *Data influenced by certain perspectives (data set/human bias)*
      - Viruses and malware - *Vulnerable to these external threats. Data can be changed (lose its integrity) or be corrupted and lost*
      - Reliability and validity of sources - *Data can be generated from a number of online sources (sources not evaluated/unreliable)*
      - Outdated data - *Data may not accurately reflect the present situation*
      - Human error and lack of precision - *Errors made during data collection, entry, or analysis leading to inaccuracies*
- **Stage 3: Use of Data**
  - Data should be used only for the purpose for which it was collected
  - Should be ethical and comply with local data protection regulations
  - Misuse or repurposing of data without consent can lead to ethical and legal violations
  - Users may use anonymity for legitimate reasons
  - Anonymity may also be used by criminals, terrorists or hackers
  - May aid in cyberbullying
- **Stage 4 & 5: Archiving and Storage of Data**
  - Archiving data presents long-term risks
    - the potential for outdated or irrelevant data to be used improperly
  - Ensuring that archived data remains secure and is eventually erased when no longer needed is crucial

3.2 Algorithms and Code

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
- **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.

3.2B Components of an Algorithm

- **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**
    - They 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.
- **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: *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.
    - They 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

- **Natural 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
    - has a tendency to be ambiguous and lack clarity
- **Flowcharts**

    - A visual representation of an algorithm showing an overview from start to end.
    - Use a standard set of symbols to represent the different components, and arrows are used to show the direction of the steps
- **Code/Programming Language**
    - Once an algorithm has been planned, it is time to start writing the code so that the program can be tested and implemented by using programming languages (Python, C, Java, C++, etc)

3.2D Uses of Algorithms

- Can be used for bubble sort, searching (query), filtering and counting.
- Two Algorithms that Make Activities Efficient:
    - **Prioritisation Algorithm**
        - A sorting algorithm used to prioritise tasks.
        - used to prioritise customer orders, prioritise help desk requests or even decide which region to prioritise 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.
        - Then finally the customer, support, request or region would be ranked.
    - **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.

3.2E Algorithmic Dilemmas

- **Algorithms Replacing Human Judgments**
    - 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.
    - But, even logical algorithms can give inappropriate results.
    - Since machine learning algorithms are learning from data sets using historical data, it is not surprising that these algorithms adopted the same level of bias that was present with previous human judgements.
- **Algorithmic Bias**
    - Two main reasons why AI systems have built-in bias:
        - Human algorithm developers unknowingly introduce bias into their models.
        - The training data set includes biased data or is incomplete, so it is not a true representation of the population.
- **Black Box Algorithms and the Lack of Transparency**
    - Black box algorithms - An algorithm that provides insight without clarity on how the conclusions were reached from the data input.
    - Transparency in algorithms - the ability to understand and be able to explain the inner workings of the algorithm.
    - People are held accountable for the decisions being made by AI systems. Transparency can be problematic, however, because:
        - it is often difficult to explain how the algorithm reached its conclusion
        - it is not always possible to know how the training data was selected
        - the evolving nature of machine learning makes it difficult to keep up

3.3 Computing Devices

3.3A Types of Computers

- **Computer** - A machine or device that processes data, performs calculations and conducts operations based on algorithms provided by software and hardware programs; it can input data, process it, store it and produce an output.
- **Embedded Computers -** A combination of hardware and software designed to perform a specific task and incorporated into an electronic or mechanical system.
- **Personal Computers** - A general purpose computer designed for individual use
    - Moore's Law - The number of transistors in a dense integrated circuit doubles every two years
        - *As Moore's Law has been applied to microprocessors, RAM and storage, laptops today are almost as powerful as desktop computers, and have the additional benefits of portability and convenience.*
- **Mainframe Computers** - A large computer used by businesses to host databases (servers used for transactions and business applications). Mainframe computers require high-level security measures.
- **Mainframe Servers** - A large computer dedicated to managing network resources. They can use specialised server hardware or can be a regular computer with a server specific operating system capable of managing network resources

3.3B Components of a Computer

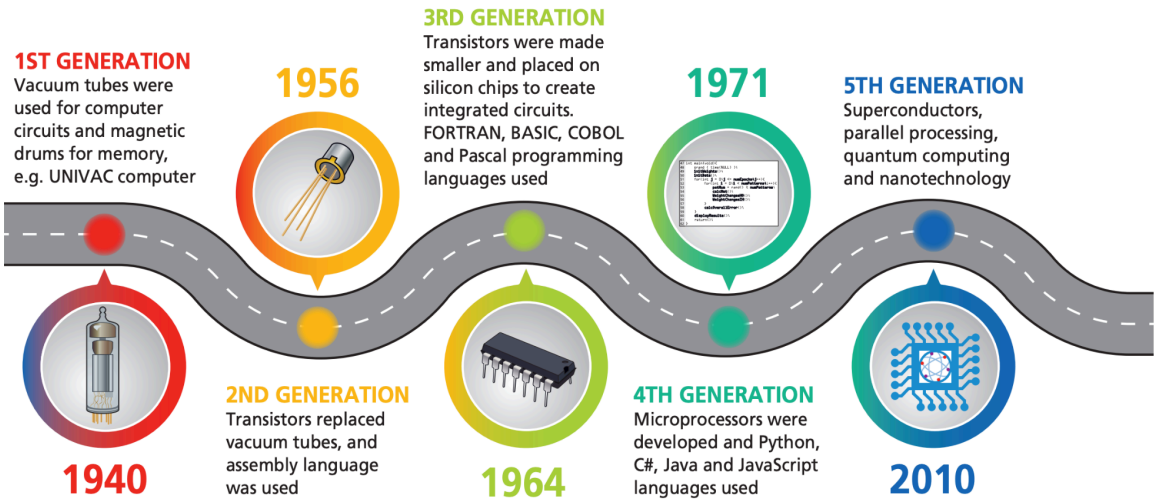
- **Input Devices**
- **Central Processing Unit (CPU)** - The part of a computer that carries out and controls the computer's instructions
- **Output Devices**
- **Hardware**
    - Motherboard - A circuit board that allows data to travel to the different components in a computer.
        - Their performance can be affected by:
            - **Clock speed**, *measured in hertz, which represents the number of pulses the CPU clock generates per second.*
            - **Cache**, *the small amount of memory built into the CPU that stores data while it is being processed.*
            - **Cores**, *the more cores there are, the faster the CPU can process data; many processors have quad (four) core processors*.
        - **Random Access Memory (RAM)** - *short-term memory where data is stored temporarily while it is being processed or viewed on screen*
        - **Secondary Storage** - *non-volatile, long-term memory, used to store programs and data until they are required*.
        - come with built-in sound and graphic cards.
            - *the graphics processing unit (GPU) contains a circuit that will speed up the rendering of images and video, and thus free up the CPU to perform other tasks.*
    - Lithium-Ion Batteries - small containers of chemical energy.
        - When a phone is plugged in to charge, the electricity is used to reset a chemical reaction within the battery.
        - They contain a lot of power in a small size, which has made them suitable for portable devices.
- **Software**
    - Operating System - Software that manages the hardware, software and memory of a computer as well as providing a user interface.

        - **User Interface** - *The means by which human users interact with a digital technology. The intent is to make the user's experience straight forward, intuitive, and requiring minimum effort to achieve the desired outcome.*
            - **Graphical User Interface (GUI)** - *uses WIMP*
            - **Haptic Interface** - *allows the user to interact with a device through bodily sensations and movements (such as VR)*
    - Utility Software - Software designed to perform specific useful tasks that either help to analyse, configure or maintain the computer
    - Application Software - Software that serves a specific purpose, such as a word processor or video editor.
        - **Open Source Software** - *free of charge and free of copyright, allowing the source code to be modified, often by an open-source community. However, there is no guarantee that the software will be /bug free or support readily available.*
        - **Proprietary Software** - *often downloaded after paying for a licence or subscription. In return for payment, users can expect updates and help from the company. Proprietary software is copyrighted which denies users access to the source code (so that it cannot be modified) and restricts the sharing of the software.*
    - Malicious Software - Software designed to steal data or damage computers/IT systems.

3.3C Uses and Forms of Computer Coding

- **Machine Code** - Sometimes called object code, machine code is written in binary (0s and 1s) or hexadecimal instructions that the computer can respond to directly. Each type of computer has its own machine language.
- **Assembly Language** - Used by programmers to write code for special hardware or so that a task can be performed very quickly.
- **Compiler** - translates the code in the source language, for example Java, into the object code in binary and stores this in a program file

3.3D Evolution of Computing



- **First Generation: Vacuum Tubes (1940-1946)**
    - used for computer circuits and magnetic drums for memory, which could only perform one activity at a time.
    - would take days to program in machine language.
    - would frequently malfunction due to the heat they emitted.

- **Second Generation: Transistors (1956-1963)**
    - replace vacuum tubes
    - allowed computers to become smaller and more reliable, with the benefit of being more energy efficient.
    - used punch cards and paper tapes, and produced printouts as output.
    - assembly language was introduced, making it easier for programmers.
    - high-level languages such as COBOL and FORTRAN were being developed.

- **Third Generation: Integrated Circuits (1964-1971)**
    - were made smaller and placed on silicon chips (called semiconductors).
    - even more efficient, reliable and faster than the previous generation, and were able to run multiple applications at the same time.
    - no longer used punch cards; instead, input devices such as a keyboard and mouse were installed with an operating system.
    - main programming languages of this generation were now high-level including FORTRAN, BASIC, COBOL and Pascal.
- **Fourth Generation: Microprocessors (1971-2010)**
    - saw thousands of the third-generation integrated circuits built on to a single silicon chip.
    - programming languages in this generation were all high-level, including Python, C#, Java and JavaScript.
- **Fifth Generation: Artificial Intelligence (2010-Present)**
    - from superconductors (with millions of transistors on a microchip) and parallel processing (using two or more microprocessors to run tasks at the same time) to quantum computing and nanotechnology, computing today is still changing radically.
    - use natural language as input, such as voice recognition, and for computers to learn for themselves.
- **Quantum Computing**
    - The technology that uses quantum mechanics to create powerful quantum hardware which can solve complex problems faster than existing supercomputers.
        - computers use **qubits**, which follow the law of quantum mechanics. Instead of being on or off, they can be both on and off, or somewhere in between – this is called superposition.
        - allows for uncertainty and the ability to analyse multiple options at the same time, making problem-solving much more efficient.
        - set to combat problems that would take current supercomputers hundreds of years to solve.
        - currently being researched to make further developments in: *battery technology, cybersecurity, drug development, financial modelling, weather forecasting, AI, traffic optimization and cleaner fertilisers*

3.4 Networks and the Internet

3.4A Types of Computing Networks

- **Network** - A series of interconnected nodes (connection points) that are able to transmit, receive and exchange data. The data may have various formats including text, sound, images and video. Examples of nodes include computers, servers and routers.
- **Personal Area Network (PAN)** - The smallest type of network, consisting of the connected devices that are in close proximity to an individual.
    - A typical PAN could be wirelessly connecting a phone and printer to one laptop.
    - Another example is a health watch wirelessly syncing data to a phone.

- **Local Area Network (LAN)** - A group of computers or devices that are connected on a single site.
    - This could be on a small scale, such as a home with two or three users, or on a larger scale, such as an office or school that may have hundreds of users.
    - It is usually set up to help the sharing of resources, whether it is giving access to a centralised store of data in an office, sharing a printer at home or sharing internet access in school.

- **Metropolitan Area Network (MAN)** - A network that covers a larger geographical area, such as a city.
    - It will include two or more computers connecting together when they are not in the same building or campus, but they are in the same city.
    - It can cover an area of between 5 and 50 km.
    - Examples of MANs include governments that provide free Wi-Fi access to residents in a city, or municipalities that connect traffic lights or parking meters to a single network.
    - A future use of MANs will be the road infrastructure used by autonomous vehicles.
- **Wide Area Network (WAN)** - A national or international network; the largest example is the internet.
    - WANs can be a collection of LANs connected by telecommunication technologies that are available to the public or may be limited to an organisation that operates nationally or internationally.
    - A company can have offices in different cities connected by public telecommunications networks in order to share applications and centrally held resources, which eliminates the need to have a server at each location, and all offices can access the same data.
    - To secure the public connection a virtual private network (VPN) is often used.
    - Alternatively, the organisation may lease a dedicated line from their internet service provider (ISP), which they do not have to share with any other organisation in the area.
- **Type of Connectivity**
    - Wired Networks - wired devices connected on the network with copper ethernet cables using an ethernet port (either integrated on to the motherboard or installed as a separate network interface card) and a router or switch
        - fiber-optic cables are now being used as they offer better connectivity over greater distances and a faster speed
        - still used by many businesses and governments because they are considered to be more reliable, operate at faster speeds and are able to transfer data more securely
    - Wireless Networks - use of wireless technologies to connect the different nodes to form a network
        - uses radio signals to send data across the network
        - widely used because it is easy to set up (there is no need for cables) and it offers flexibility because devices can connect anywhere within range
        - still uses cables to connect the access points to a wired backbone, however, but it allows the devices to connect wirelessly
    - Cloud Networks - incorporate some or all of the network capabilities on a public or private cloud platform
        - with a cloud-based wireless network, the organisation can still install access points on site, but the management of the network or the data can be hosted off-site

        - configurations to the network can be made by accessing the IP address of the hardware controlling the wireless network, so it's easier to deploy, saving costs and allowing for scalability

- **Sharing Data**
    - Client-server networks - a type of network where data is stored centrally on a server and access is given to each device (client) connected to the network. It can be hosted internally by the organisation or externally in the cloud.
        - Advantages:
            - organisations can prioritise IT resources that will secure and backup the data.
        - Disadvantages:
            - configuring and setting up a server can be costly and requires expert staff.
            - there must also be adequate bandwidth for all clients to request access to the server at the same time.
    - Peer-to-peer networks (P2P) - a decentralised network in which each computer is equally responsible for storing and sharing data. It is very popular to share large files over the internet.
        - Advantages:
            - network is not dependent on one server.
            - easy to set up.
        - Disadvantages:
            - much harder to manage and control security of data.
            - can be used to illegally share copyright content.
            - makes it very difficult for authorities to shut them down due to decentralised nature.

3.4B Components of Computing Networks

- **Network Interface Card (NIC)** - Device responsible for converting data into a digital signal and communicating this data to a network.
- **Media Access Control (MAC) Address** - A unique identifier assigned to every piece of hardware.
- **Router** - A networking technology that transfers data from one network to another by the most efficient route available.
- **Modem** - A device that converts digital data into analogue data so that it can be transmitted over a telephone line.
- **Wireless Access Point (WAP)** - A device that creates a wireless local area network to improve coverage throughout a building.
- **Hub** - A networking device that broadcasts data to all devices on the network.
    - uses up a lot of bandwidth and sends unnecessary data, but it is easier to set up and can be useful when connecting only a few devices
    - example: game consoles for a local multiplayer game
- **Switches** - A networking device that forwards data packets more efficiently than a hub.
    - give the network manager more control over how the data is shared across the network

3.4C Characteristics of Computing Networks

- **Interoperability** - Allows different digital technologies or systems to connect and exchange data with one another without restrictions.
- **Network Protocol** - a set of agreed rules that state how to format, send and receive data.

- To successfully transmit data, both sides of the communication must accept and follow these protocols
- Four Layers of Network Protocol:
  - Application Layer
    - *includes the set of protocols that are used by applications, for example the web browser*
    - *eg: HTTP, FTP, DNS*
  - Transport Layer
    - *sets up the communication between hosts using protocols such as UDP and TCP*
    - ***Transmission Control Protocol (TCP)/Internet Protocol (IP)** - Protocol that defines where data is to be sent to and from (IP), and how the data is to be broken down into packets before sending (TCP).*
    - *states how data is exchanged by providing end-to-end communication that identifies how the data is to be broken into packets*
  - Internet Layer
    - *layer adds the sender and recipients' IP addresses and routes the packets across a network.*
    - ***Internet Protocol (IP) Address** - A logical numeric address that is assigned to every node on a network*
    - *assigned by the dynamic host configuration protocol (DHCP).*
    - *web servers typically have a fixed IP address.*
  - Physical Network Layer
    - *includes the protocols that allow the different networking technologies to work together, for example, ethernet.*
- **Domain name server (DNS):** A server that translates domain names into IP addresses

- **Network Capacity**
  - Bandwidth - The maximum rate of data transfer at any one time, measured in hertz (Hz).
  - Speed - The length of time it takes for data to be transferred, measured in megabits per second (Mbps).
  - File Compression - a process that reduces the size of a file by reencoding it to use fewer bits of storage than the original file.
    - **Lossy** - reduces the file size by permanently removing unimportant, less noticeable data from the file (JPG, MP4, MP3)
    - **Lossless** - which reduces the file size without losing data; this means that the data can be returned back to its original size after transmission (PNG, BMP, TIFF)
  - Net Neutrality - The concept that all data requests on the internet should be treated equally by the internet service providers (ISPs).
- **Security**
  - Controlling Access from Within
    - **Multi-factor authentication** - *The use of multiple methods of authentication to verify a user's identity*
  - Controlling Access from Outside Threats
    - **Firewall** - *Hardware or software designed to block unauthorised access to a network by inspecting incoming and outgoing network traffic*

        - **Proxy Servers** - *Computer system that acts as an intermediary between the client on the network and the internet; providing an additional layer of security.*

3.4D Computing Network Providers and Services

- **Mobile Service Provider (MSP)** - A company that offers cellular connection to mobile phone subscribers.
    - purchases a license to transmit radio signals over a specific range within a particular frequency band, such as 1800 to 2100 MHz, which is used to provide high data speeds.
    - referred to as 4G or 5G networks.
- **VoIP (Voice over Internet Protocol)** - Allows users to make voice calls using a broadband Internet connection instead of an analogue phone line.
    - With a regular mobile phone call, a user can call a landline or another mobile phone and audio data is transferred wirelessly from cell tower to cell tower.
    - With VoIP, audio data is transformed into digital packets that are sent via the internet between any two devices
- **Internet Service Provider (ISP)** - A company that provides internet access and other related services to its customers.
    - making it possible for subscribers to use online services such as browsing the 'web', online shopping, file sharing and video conferencing
    - also provide other services such as email, domain registrations and web hosting

3.4E The World Wide Web

- **Internet** - The global collection of networks and networking technologies that link billions of users worldwide.
- **World Wide Web (WWW)** - The websites and web services that are hosted on web servers and identified by their URL (uniform resource locator).
- **URL** - unique address of each resource on the web, which could be the address of a web page or the file hosted by a web server.
- **HTTP (hypertext transfer protocol) or HTTPS (secure hypertext transfer protocol)** - determines how web resources are transmitted between the web browser and the web server; HTTPS is now a requirement of many web browsers; has forced web-hosting companies to add security certificates to their web servers so that when users transfer sensitive data it is encrypted.
- **HTML (hyper text markup language)** - the format of web pages that allows documents to be displayed as web pages as well as web pages to be linked together.

3.4F Evolution of the Internet and the Web

- **The Early Days of the Internet (1969-2000)**
    - Internet started earlier than WWW.
    - First computer network was in 1965 when a computer at the University of California, Los Angeles, sent a message to a computer at Stanford University (made a system crash)
    - Second attempt was more successful and led to the creation of the ARPANET (Advanced Research Projects Agency Network) in 1969
        - expanded to include up to 30 academic, military and research institutions, connecting them from different locations including Hawaii, Norway and the UK.
        - Introduced TCP/IP protocol and was operational until 1990
    - As the internet grew from 2000 nodes to 30000, it became very apparent that it needed to be easier to use.

    - Sir Tim Berners-Lee invented WWW in 1989.
        - His proposal was for the information being shared to be structured and linked in a new way that made it quicker and easier to access.
        - the web browser was introduced, which made WWW more accessible.
        - In 1993 there were only 130 websites, became 100,000 by 1996.
        - the World Wide Web Consortium (W3C) was formed in 1994 to promote its evolution and ensure interoperability.
        - At the time of writing, Sir Tim Berners-Lee is the director of W3C.
        - main aim is to coordinate the developments of both web technology and standards.
        - uses processes that promote the development of these standards based on the agreement of a wide range of members who work for organisations all over the world
- **The Expansion of the Web (2000-2020)**
    - Initially, only few that knew how to program in HTML.
    - Websites were considered static and did not change frequently, because every change of content or formatting required a programmer.
    - This version of the web was called Web 1.0.
    - By the year 2000, new technologies and protocols were developed so Web 2.0 was born.
        - also known as the 'social web', enabled users to generate their own content without needing to be coding experts.
        - mainly about innovating the user experience
        - web developers would use XML and RSS to format and structure websites, allowing users to add their own content.
        - allowed for more dynamic content as it was separated from the formatting.
        - saw the introduction of social media platforms, blogging, podcasting, social bookmarking and tagging, many of which are still popular today.
- **Web 3.0: The Semantic Web (2020–Present)**
    - In Web 3.0 the focus shifted to the back end, with the promise of being more intelligent.
    - One development is the focus on generating a greater understanding of the meaning of the words being used when creating, sharing and searching content.
    - second feature: utilisation of AI and natural language processing.
        - can now display interactive 3D graphics and the market for the internet of things (IoT) is growing.
- **The Internet of Things (IoT)** - Internet-connected devices that collect and share data.
    - use sensors to collect data and communicate with each other over a network, often with the aim of providing assistance or increasing efficiency.
    - individuals are investing in smart home technologies to increase efficiency, become more energy efficient or to control household appliances for greater convenience.
        - for example, smart light bulbs can be controlled with a phone, and smart door locks can let delivery drivers drop off packages.
    - While the IoT promises to make our homes and environment smarter, privacy and security remain real concerns that need to be addressed.

3.4G Internet Dilemmas

- **Understanding the Risk to Data**
    - Spamming - Sending unsolicited emails, mainly for the purpose of advertising.
    - Hacking - Unauthorised access to a computer or network.
        - **Social Engineering**

        - in internet security, this means to manipulate a user into sharing confidential or personal information with a fraudster
    - **Hacking Website/Penetrating a Network**
        - gaining access to the back-end database of user information, or redirecting users to a different website
    - **Exploiting a Security Flaw**
        - if a network does not have adequate malware and virus protection, or a firewall, hackers can take advantage of this to gain access to company servers
    - **Viruses**
        - a type of malicious software comprised of small pieces of code, often attached to legitimate programs or emails
    - **Ransomware**
        - malware that infects a computer and effectively locks the user out of their own device and demands a payment to unlock it.
    - **Distributed Denial of Service (DDOS) Attacks**
        - Overwhelming a site or service so that it is not available to its intended users.
- **Consequences to the Risks of Data**
    - Anonymity - use of digital technology to conceal a person's true identity.
        - increased the confidence of those with malicious intent, such as cyberbullies and internet trolls.
        - two types of trolls:
            - *people that **target influencers** with a large social media following – their aim is for their hateful messages to reach as wide an audience as possible*
            - *people that **just enjoy causing harm to others** – the more one responds, the more hateful messages they send*
        - trolling can cause significant harm and stress to those being affected, including disrupted sleep, low self-esteem and self-harm
    - Identity Theft - when someone steals your personal information with the intention of committing fraud; may use your information to apply for a credit card or gain access to medical services.
    - GDPR governs how data is being protected in Europe and states that citizens have the right to request to have their data erased from an organisation should the right circumstances apply; includes:
        - the personal data is no longer needed by the organisation
        - the individual's consent has been withdrawn
        - there is no longer a legitimate reason to keep the data, or data was obtained unlawfully
        - the individual objects to having their data used for direct marketing purposes

3.5 Media

3.5A Types of Digital Media

- **Media** - referred to as any communication channel that serves as a medium to enable information to reach a large group of people
- **Digital Media** - Video, audio, images and other content that is created, encoded and stored before sharing to the user(s); Encoding is the process of converting the media into a computer readable format.
- **Media and Web 1.0**
    - Digital technology may have changed the speed and volume of media but digital media still fulfils the same basic roles in society that it has always done:

        - to entertain, educate and be a channel for public discussion.
    - As bandwidth increased, it allowed the ability of WWW to host video, animations and audio recordings.
- **Media and Web 2.0**
    - introduction of blogs, podcasts, wikis and social media were instrumental in increasing the volume of user-generated content, which has changed the way that the public receives both local and global news
        - Trending: A topic that experiences a sudden surge in popularity on social media platforms for a limited period of time.
        - Hashtag: A word or phrase preceded by the symbol # to classify or categorise the accompanying text.
        - Meme: An image, video, piece of text – typically humorous in nature – that is copied and spread rapidly by internet users, often with slight variations.
- **Media and Web 3.0**
    - Content Creation
        - **Deepfake** - Synthetic media created with the use of deep learning/ AI.
            - readily available online and are being used to manipulate media, through face-swapping or lip-syncing.
            - contributed to fake news (false or misleading information presented as news)
    - Artificial Intelligence and the Consumer's Media Experience
        - AI is used by media companies to predict demand and adjust their media production (such as Netflix recommendations),
        - challenge for the media industry: how to effectively manage the data needed to train the AI algorithm so that it can be more reliable.
            - needs to collect data about the audience, like their choice of device, when they watch and the routines they have, as well as what they are watching (content data).
    - Electronic Games
        - development of internet-enabled gaming consoles and personal computers enabled more social aspects to video gaming and opened up gaming to new audiences.
            - example: senior citizens can now play bowling games in their retirement homes, and busy parents can play games on their phone while waiting for their children to finish after-school activities.
        - Platforms such as YouTube and Twitch have allowed gaming influencers to grow their fanbase and tournaments now offer large cash prizes.
        - E-sports (electronic sports) have been gathering momentum since 2000, with a variety of types of tournaments, from first person shooter events (for example, Call of Duty), to multiplayer games (Dota 2) and fighter events (Mortal Kombat).
            - in 2019, US$100 million was made available for the Fortnite World Cup.
            - a player must select a game, develop their skills, find a community to practice with and climb the ladder.
            - window of opportunity for professional gamers is a small one, with the average age being 24 to 27.
            - now many professional teams are turning to data analytics and machine learning to optimise their chances of success.

3.5B Characteristics of Digital Media

- **Rapid Sharing**
  - easy to share any kind of content
- **Efficient Storage**
  - huge amounts of data can be stored in one place
  - cloud computing can store all data
- **Interactivity**
  - has potential to be more engaging for consumers and to motivate them to revisit web pages, post comments and make recommendations to friends
- **Non-Linear Content or Hypertextual**
  - hyperlinks on web pages allow people to click and visit pages in any order
  - allows them to navigate media according to their own preferences and not how a media company has decided they should
- **Global Networks**
  - allowed people to interact more globally
  - can pool resources together more easily and have access to a wider range of sources of information than before
- **Virtual**
  - allows people to communicate virtually through a wide range of technologies
  - can now communicate very differently (individuals can choose how they present themselves)
- **Convergence of Digital Media**
  - communication using more than one form of digital media at a time

3.5C Immersive Digital Media

- **Virtual Reality (VR)** - A simulation that provides a completely immersive environment for the user.
  - involves programming 3D objects to perform actions depending on how the user interacts with them
  - variety of uses for businesses:
    - **employee safety training:** *allows employees to make mistakes in a controlled environment without causing themselves any harm*
    - **sales and marketing presentations:** *let potential customers experience products by interacting with them in an immersive environment*
    - **design decisions:** *see the effects of various design decisions, allowing decision-makers to visualise different options before making their final choice*
    - **virtual workspaces:** *provide a space for more casual work discussions, which may promote problem-solving and creative solutions*
- **Augmented Reality (AR)** - Digital content overlaid on to a real world experience.
  - variety of uses for industries:
    - **inspection process of machinery:** *manufacturing, mining and maritime industries are using AR for this in machinery for remote support to minimise interruptions to operations.*
    - **education:** *augmented reality is being used to allow teachers to present real situations through 3D modelling and providing a fun and engaging way to learn.*
- **Mixed Reality (MR)** - Blending the real world and digital world to create new experiences.
  - simulation of a real-world system is called a digital twin.
    - used by industries that are looking for ways to **visualise, analyse, maintain and control their valuable assets**.
    - its **dynamic nature** offers professionals **more tools and information than static 3D data models**

3.5D Digital Media Dilemmas

- **Advantages**
  - has made news, information and entertainment more readily available and almost instant.
  - much of the online content is free or of minimal cost.
  - now widely more accessible around the world.
- **Dilemmas**
  - Media Addiction and Psychological Concerns
    - example of behavioural addiction
    - an uncontrollable urge to use social media for extended periods of time.
    - influence the way the brain functions.
    - individuals experience dopamine hits, which makes them feel rewarded temporarily
    - brain 'encourages' individuals to stay on social media in order to get more dopamine which leads to addiction.
    - overuse of social media can lead to:
      - *low self esteem*
      - *anxiety and depression*
      - *disrupted sleep patterns*
      - *FOMO*
      - *decreased physical activity/engagement in real-life activities*
  - Impact on Journalism
    - breaking down of cultural barriers
    - shifted to online, real-time reporting, multimedia content, access to global information and the personalization of news, which has challenged the monopoly previously held by the mass media
    - journalists are expected to complete their articles with shorter deadlines and for more than one type of media
    - a higher chance that the information has not been checked adequately to stop the flow of misinformation
      - **Misinformation** - *false or inaccurate information that is mistakenly or inadvertently created or spread; the intent is not to deceive*
    - journalists can allow readers to get to know them on a personal level through their profile and online conversations
      - *create their own 'brand' can bring about loyalty in their followers*
    - solution to prevent misinformation: formation of a peer-review network, whereby journalists review and fact check each other's work
  - Media Authenticity
    - technological developments in the creation and distribution of media are making it increasingly more difficult to check the authenticity of the media
    - people pay less attention to the source of the content, making it more difficult for them to evaluate sources and therefore are more vulnerable to fake news
    - intent to disinform and is usually political or criminal in nature.
      - to go **viral** so that creators can **make money** or **promote a political agenda**.
      - **Disinformation** - *false information that is deliberately created and spread with the intent of influencing public opinion or obscuring the truth*
    - deepfakes can negatively impact journalism
  - Ownership of Media
    - **Intellectual Property** - The outcome of thought or intellectual effort, for example a new invention or an original design. It also refers to the legal protection of that work.

- **Copyright** - Legal protection for the creators of literary and artistic works including books, music, paintings, films and computer programs, which may also be digital.
    - outline the **rights of users to be able to use, modify or distribute the work** included in this category.
    - to use copyrighted work, one must first **identify the owner** of the work and then **obtain permission** to use it.
    - can be **a time-consuming process and ultimately restricts creativity.**
    - two circumstances in which work can be used **without gaining permission**:
        - *work in the public domain (work that is available to the public and not subject to copyright)*
        - *fair use (which can include using the work for study or research, commentary or criticism).*
    - **questions to consider** if copyrighted work comes under **fair use**:
        - *Is it being used to create something new, or is it just straight-forward copying?*
        - *Will it impact the market value of the original work?*
        - *How much of the original work is being used?*
- **Copyleft** - When owners of original work allow others to use their copyrighted property freely under specific conditions.
    - *help build communities so that they can collaborate to improve the creative works.*
    - *creative commons licensing - can be used by anyone and helps to standardise the way that copyright permissions are granted to others who wish to use their work*
    - **CC BY** - *least restrictive and allows others to distribute, remix, adapt and build on work as long as they credit the original creator.*
    - **CC BY NC ND (non-commercial and no derivatives)** - *most restrictive and only allows others to download and share the work as long as the owner is credited; cannot be changed or used commercially.*

- Censorship and Control of Media
    - Political Content
        - *of a political nature may be blocked by governments when the opinions of minority groups conflict with that of the government.*
    - Social Content
        - *socially sensitive or perceived to be offensive is often blocked by governments to protect their citizens from exposure to undesirable media.*
        - *can include content related to sexuality, gambling, alcohol and illegal drugs.*
    - Conflict and Security
        - *related to conflicts, militant groups and border conflicts may be blocked so that local citizens do not contribute to the conflict in question.*

    - Internet Tools
        - *may monitor communications within a country, looking for keywords in conversations in emails or messages, or internet searches.*

- Digital Media Preservation
  - essential for modern history and includes practices to ensure that information is safe from media failure and hardware/software obsolescence in the future.
  - must be transferred onto fresh media.
  - in the case of obsolete software, emulators are used to simulate the old software so that the data can be retrieved.
    - *For example, when computers simulate an older operating system, they can then run the older software, open the file and save it in a new format.*

3.6 Artificial Intelligence

3.6A Types of AI

- **CAPTCHA**
  - **CAPTCHA (Completely Automated Public Turing test to tell Computers and Humans Apart)** is a form of the modern-day Turing Test, which is used to prove at the time of registration on a website that they are human and not a bot.
- **The Types of Artificial Intelligence**
  - **Weak/narrow AI**: AI that has a limited function or can only perform a specific task.
  - **Domain-specific AI**: AI that performs tasks better than humans in certain domains.
  - **Strong AI**: AI that can develop consciousness and make decisions better than humans.
    - also known as full AI or artificial general intelligence (AGI);
    - demonstrates self-awareness and emotions, and also has full human cognitive abilities.
  - **Super AI**: AI that surpasses human intelligence.
    - When AI gets to this point, there will be concerns that machines will overthrow the human race. This concept is also known as **singularity**, which is the hypothetical future where AI is superior to human intelligence.
- **Expert System**
  - It is a computer system that acts like a human expert in a specific subject area.
  - Falls under domain-specific AI
  - It is made of three main components:
    - **knowledge base**: facts and rules in an expert system
    - **inference engine**: the component of an expert system in which programmed rules are used to interpret and evaluate the facts in the knowledge base.
    - **user interface**: component of the expert system that allows a non-expert to ask questions regarding the expert system and receive advice or information.
  - Used frequently in:
    - medical or car diagnosis;
    - petroleum engineering;
    - financial advising;
    - identifying unknown items; etc.

3.6B Types and Uses of Machine Learning

- **Key Elements of Machine Learning**
  - requires a good set of data;
  - uses algorithms to look at the data and understand it;
  - data is input into the algorithm to make a prediction; and
  - the prediction is then evaluated and, if inaccurate, the data is fed back to the system to update and reevaluate the algorithm.
- **Types of Machine Learning**
  - Supervised Learning

        - it is the simplest form of machine learning, with algorithms learning based on examples.
        - training process
            - data consists of a set of inputs, each paired with a set of correct outputs.
            - algorithm will search for patterns in the data that correlate to the desired output.
            - once completed, it will be fed new, unseen inputs and determine which label to give the new input.
        - it can have different algorithms for different purposes.
            - **classification algorithm**: *takes input data and assigns it to a category that is based on the training data.*
            - **regression algorithm**: *used for predictions and looks at the relationships between variables; commonly used to make predictions based on the analysis of a data set.*
        - apps that use this include spam filters, fraud detection, handwriting character recognition.
    - Unsupervised Learning
        - used to find underlying patterns in data;
        - uses data sets that do not have any labels but instead uses data's features;
        - uses cluster analysis (looks for ways to group data);
        - its goal is to find hidden patterns that cannot be noticed by human observers.
        - apps that use this include social networking analysis and market segmentation.
    - Reinforced Learning
        - based on rewarding positive behaviour;
        - if the system performs correctly, it is rewarded, else it is given a penalty;
        - this form of learning requires a lot of data.
        - apps that use this include autonomous vehicles, predictive maintenance, games and robotics.
    - Deep Learning
        - it is used for more complex problems and does not require structured data, instead using artificial neural networks.
        - a neural network is considered to be a deep learning algorithm if it consists of more than three layers.
        - apps that use this include facial recognition, image recognition, natural language processing and speech recognition.
- **How are Machine Learning Algorithms Used?**
    - Pattern Recognition - to observe physical or mathematical patterns
    - Data Analytics - used in stock market forecasting and audience research, used to analyse changing values in the stock exchange in order to make predictions.
    - Natural Language Processing - teaches a computer to understand human language.
        - **text analysis** - *used to convert unstructured data into structured data ready for analysis.*
        - **plagiarism detection** - *used to analyse text and compare to sources on the internet.*
        - **text generation for chatbots**
        - **text translation** - *uses text analysis, word substitution and sentiment analysis to recreate messages in different languages.*
        - **text correction** - *used in grammar correcting apps*
    - Image Recognition - used to understand what is in a picture in order to describe the picture and the image can be more searchable

        - **image search** - *uses pattern recognition and metadata in its search algorithms*
        - **facial recognition** - *recognizing someone from utilising their faceprint*
    - Voice and Sound Recognition - analyses patterns of sound that can be converted into text and applied to natural language processing
        - **AI assistants** - *allows users to interact using voice commands*
        - **speech-to-text and text-to-speech translation** - *allows users to convert spoken words into text on screen and vice versa*
    - Sentiment Analysis - interpret someone's mood or intent using pattern recognition
        - commonly used in audience research or customer relationship platforms to gain insight on a customer's response to a product or service.

3.6C Uses of Artificial Neural Networks

- **Neural Networks**
    - neural networks are made of interconnected nodes, which activate when there is sufficient input, in turn providing inputs for the next series of nodes until it produces an output; the signals are transmitted from one node to another, move from one hidden layer to the next and are processed as they travel from the first input to the final output layer
    - neural networks and deep learning are used in image processing and forecasting.
    - **Steps:**
        - data enters the neural network through the input layer and is processed in the hidden layers.
        - within these hidden layers, the input data is combined with assigned appropriate weights and coefficients.
        - the weighted inputs are then summed and passed through an activation function, which determines how signals proceed through the network.
        - the final result is then retrieved from the output layer.
    - **Advantages:**
        - can learn and model non-linear and complex relationships;
        - can generalise and infer relationships from unseen data; and
        - do not impose restrictions on the input variable.

3.6D Evolution of AI

- AI concepts dated back to the 1940s to 1960s, with a strong desire to bring together the functionality of machines and organic beings.
- Research into AI started at the Dartmouth Conference in 1956, aiming to unify cybernetics, automation and complex processing, allowing machines to 'think'
    - **cybernetics:** *the study of communication and control in both living things and machines, especially automatic control systems and mechanical-electrical communication systems.*
- **AI Winter** - *a period in which funding and interest in research and development of AI is reduced*
    - first AI Winter occurred in 1974-1980;
    - second AI Winter occurred near the 1990s due to the market for expert systems collapsing.
- **Expert systems** were the next peak in AI, considered as a move in the right direction and focused on very specific problems, becoming very popular in the 1980s.
- The prediction of a future where technology growth would be out of control and be irreversible, with the boundary between humanity and computers being removed, is known as a **singularity**, popularised in 1993.

- Between the 2000s and 2010s, another AI boom happened with the advances in machine learning and deep learning. Factors include:
    - availability and access to massive amounts of big data
    - developments in computer graphic cards and processors

  An AI summer was then triggered, which led to an increase in AI development.
- Ken Goldberg, a roboticist at UC Berkeley, believed in a future that AI and robots would instead be developed to work alongside people, rather than replacing them, calling this **multiplicity.**

3.6E AI Dilemmas

- Importance of the Development of Artificial Intelligence
    - allows for the automation of the discovery of data;
    - can automate certain computerised tasks more reliably and without getting tired;
        - an example is AI can operate 24/7 and send alerts for human intervention
    - can add intelligence to existing products, such as home appliances or security intelligence;
    - as AI adapts through learning and can analyse data more deeply, it can be more reliable in classifying and making predictions;
    - AI systems are more accurate and are consequently being widely used in medical systems.
- Global Dilemmas of the Design and Use of AI
    - **Fairness and Bias**
        - AI is limited to learning data sets that are fed to the system, meaning that any inaccuracies in the data will be reflected directly back to the results
        - AI designers and developers are given the role to minimise algorithmic bias through research and data collection.
    - **Accountability in Design and Use**
        - developers are responsible for the designs, developments, outcomes and impact that the system has on the world.
        - becomes increasingly difficult when considering the range of uses and different types of AI being developed
        - when discussing accountability, these are questions that can be asked:
            - how does accountability change if the end-user has more influence over an AI system
            - how does accountability change if the AI is being used to support decision-making or decisions of its own
    - **Transparency in Design and Use**
        - the solution to designing AI in a way that humans can understand its decision-making process easily is known as transparency
        - there are four main problems to why a program may not be working as expected:
            - **unexplainable algorithms** - *When AI is drawing a conclusion, whether during classification or regression, there is no visible understanding of how it was reached.*
            - **lack of visibility in training data sets** - *It is not always clear where the training data has come from, whether it has been cleaned, or even if it is accessible.*
            - **lack of visibility in methods of data selection** - *Even if developers were given access to training data, this could be petabytes of data. However, they may not know which aspects of the data was actually used. For transparency, one would want to know how the training data was used.*

        - **poor management of model versioning** - *As models are continuously developed, it is sometimes difficult to keep track of which version is being used.*
- **AI's Carbon Footprint**
    - the carbon emissions when training a neural network are the same as that of a car.
    - factors that influence the carbon footprint include:
        - the algorithm and its training time
        - the processing unit
        - the energy efficiency of the data centre
        - the type of energy used in the data centres
    - **CodeCarbon**, an open-source project, is being developed to estimate the carbon footprint of computing
        - aim: help data scientists make more environmentally friendly decisions.
- **Uneven and Underdeveloped Laws, Regulations and Governance**
    - rapid pace of AI adoption -> created a strain on existing regulations -> laws struggling to keep up.
    - early 2020s, Cognilytica concluded that many countries were not rushing into developing laws and regulations on AI
        - instead they were waiting to see how the technology was being used before they came up with a meaningful law
        - another research -> level of discussion regarding the restrictions of **lethal autonomous weapons systems (LAWS)**.
            - *only one country, Belgium, had passed legislation on this, with 13 countries engaged in discussions.*
        - leaves the technology companies in a dilemma, because without the laws, their technology may not be legal to operate.
            - *eg: for AVs to be allowed on the roads, laws must be written to permit them (only 24 countries had laws allowing for them)*
        - gaining regulatory attention is user data rights
            - *data sets may include data from people, collected by the IT systems they have signed up for.*
            - *organisations must comply with data protection laws*
- **Automation and Displacement of Humans in Multiple Contexts and Roles**
    - **automation** - increased use of technology in a process, which reduces the need for human involvement
    - AI is only capable of narrow tasks or intelligence; humans possess a more generalised intelligence that will continue to be important.
    - World Economic Forum concluded that advances in AI could potentially replace a large proportion of jobs.
        - AI is predicted to replace 75 million jobs by 2025.
        - In 2020, 2.7 million industrial robots were found in manufacturing, completing heavy-duty work or completing tasks with high precision.
            - *food preparation was another area where jobs have been lost to automation, as well as construction and driving jobs.*

        - *the most vulnerable group of people likely to lose jobs to AI are those with lower level qualifications*
    - more-educated employees will be required to adapt to the technological changes or will be in senior management roles that still require human judgement
    - AI is predicted to also create 133 million new jobs (employment opportunities will be based on what AI and robots are not capable of)
        - *sectors like health, education, scientific and technical services will be least affected*
        - *jobs that require care and understanding (eg: caring for elderly people) will still be in demand, especially in countries with an ageing population*

3.7 Robotics and Autonomous Technologies

3.7A Types of Robots and Autonomous Technologies

- **Robot** - A programmable machine that can complete a set task with little or no human intervention.
- **Industrial Robots**
    - different from professional service robots based on their purpose
        - they complete tasks in manufacturing which have replaced many human workers on the production line, while service robots often perform tasks by assisting workers or customers
    - organisations always looking for greater efficiency and accuracy on their production lines
- **Service Robots**
    - robots developed to assist humans in completing tasks that are less desirable, such as dull, dirty or dangerous jobs.
    - may be for domestic or professional use and is growing in demand because it frees up humans to do other things, which could include more challenging tasks or allowing individuals to have more leisure time
    - **Personal service robots** used in the home include robots that can vacuum, clean the pool, mow the lawn and even robotized wheelchairs for elderly people.
        - can be programmed to complete the task and work autonomously
    - **Professional service robots** are semi-autonomous or fully autonomous robots developed to assist humans in commercial settings
        - may clean public places (windows and floors), make deliveries, complete inspections for maintenance and even assist in surgery
        - can work efficiently, accurately and with very little downtime
- **Virtual Personal Assistant**
    - voice-controlled helpers mainly found in smart speakers or mobile phones.
    - such as Google Home, Amazon Echo or Apple HomePod
    - a user can use voice commands to prompt different activities, such as providing a weather update, setting a timer or reading out the latest news
- **Social Robots**
    - designed to interact and communicate with humans in a socially acceptable manner
    - increasing in demand in the workplace, for example, customer service robots or home companion robots for elderly people.
    - can be programmed to perform many routine tasks, but they may lack empathy or emotion and do not always respond appropriately to unknown situations
- **Internet of Things (IoT)**
    - earlier forms of IoT used by businesses included RFID (radio-frequency identification) tags to track the location of assets or deliveries

    - now businesses can add sensors to their components to collect even more data that can be analysed to increase efficiency of their production lines or services
    - Top Industrial Uses for IoT
        - **Predictive Maintenance** - *Organisations use wireless IoT sensors to collect data that will alert employees when a machine needs maintenance.*
        - **Location Tracking** - *GPS, RFID and other wireless technologies allow organisations to track stock, components or equipment; real-time data allows employees to find what they need faster.*
        - **Workplace Analytics** - *Data analytics software provides information that can be used to optimise operations and increase efficiency.*
        - **Remote Quality Monitoring** - *IoT devices can monitor the quality of resources and products, such as water or air quality, remotely. In industry this can lead to a faster response to pollution.*
        - **Energy Optimisation** - *IoT devices can measure energy consumption in manufacturing and adjust equipment to use less electricity.*
- **Autonomous Vehicles (AV)**
    - A vehicle with the ability to drive itself and operate without human intervention.
    - Different Levels of Autonomy
        - **Level 0** - *traditional car with 0 automation; may include cruise control (can be turned on for long distances); warning signs (eg: when reversing or warnings for blind spots)*
        - **Level 1** - *driver assistance (provides features such as adaptive cruise control, which keeps the vehicle a safe distance from the vehicle in front); lane keep assistance (prevent the vehicle from veering out of its lane); many newer models of cars include these features*
        - **Level 2** - *partial automation (assists drivers by controlling steering and speed); similar to autopilot but requires the driver to have their hands on the wheel, ready to take back control should they be needed*
        - **Level 3** - *conditional automation (vehicles that can drive themselves but only under certain conditions); drivers do not need to have their hands on the wheel but must be seated in the driver's seat (eg: the car could drive automatically in a traffic jam)*
        - **Level 4** - *high automation (vehicles that can drive themselves without human interaction and are available on public roads subject to a country's regulation); do not require a steering wheel or pedals, as there is no human driver; trialled uses include driverless taxis and public transport services, where vehicles can be programmed to travel between two geographical points; will only operate if certain conditions are met (eg: they may only function under certain weather conditions)*
        - **Level 5** - *full automation (has no restrictions and, to date, has yet to be achieved); intended to be fully responsive to the road conditions and other vehicles on the road; will not be restricted by the weather and can travel to any geographical location*
    - Obstacles to Overcome
        - **Sensors** - *bad weather, heavy traffic and road signs with graffiti provide a challenge for AVs as they use sensors to obtain data from environment*
        - **Machine Learning** - *being used by AVs to detect and classify objects within the path of the car; decide how to act (eg: brake or swerve to avoid the obstacle); industry agreement on standards for training and testing the AI is a challenge*
        - **Deep Learning** - *industry must determine how to ensure that the vehicle continues to be safe as it continuously learns from the environment*

        - **Regulations & Standards** - *governments need to work with manufacturers to develop the regulations and standards required to allow AVs to operate on public roads; need to consider international standards so that AVs can operate across borders*
        - **Social Acceptability** - *several high-profile accidents involving AVs in the news; trust needs to be built up in the community*
- **Drone**
    - a remote controlled or autonomous flying robot.
    - aka unmanned aerial vehicle (UAV)
    - fully automated drones have a wide range of sensors to function, and hosting sensors for data collection
    - Two Main Uses
        - **flight** - *needs to be lightweight, include propellers and have enough power to last the duration of the journey*
        - **navigation** - *built-in systems such as GPS are used so that they can communicate their exact location to the user*
    - Uses in Military
        - **anti-aircraft practice**
        - **gather data from the sensors attached**
        - **used with weapons to make military attacks**
    - Commercial Uses
        - **delivery**
        - **surveillance**
        - **search and rescue operations**
    - Private Uses
        - **capture video footage.**

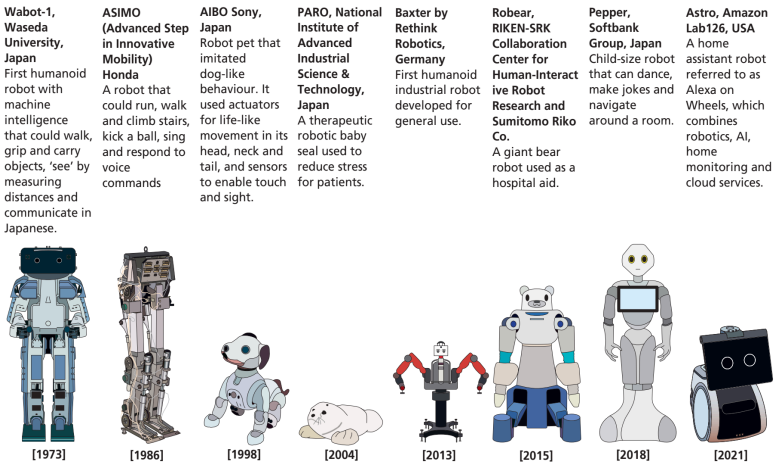
3.7B Characteristics of Robots and Autonomous Technologies

- Sensory Input for Spatial, Environmental and Operational Awareness
    - **Vision**
        - **digital cameras** - capture images within range
        - **light sensors** - used to detect changes in light levels and inform the robot if it is night or day so that it can perform different functions accordingly
        - **infrared or ultrasound sensors** - to 'see' objects; emit beams of infrared light or sound signals to determine how far away an object is based on how long it takes for the signal to bounce back
        - **GPS satellite navigation** - inform a robot of its exact geographical location in a physical space
        - **lidar (light detection and ranging)** - measure the shape and contour of the ground; measure the time it takes for the light waves bounce off an object
        - **sonar (sound navigation and ranging)** - measure the depth of water; measure the time it takes for the sound waves bounce off an object
        - **radar (radio detection and ranging)** - detect moving objects and map the shape of the environment; measure the time it takes for the radio waves to bounce off an object
    - **Hearing**
        - **microphone** - collect sounds, which are then converted into electrical signals used for processing.
        - **voice recognition** - can 'understand' what is being said.
    - **Smell & Taste**
        - **chemical sensor** - collects data, converts into an electrical signal and uses pattern recognition to identify the origin of the smell.

        - **pH sensor** - same thing but for taste
    - **Touch**
        - **pressure sensors/resistive touch sensors** - determine how strong a hold a robot has on an object so that it does not drop it or break it.
        - **capacitive touch sensor** - used where the robot detects an object, including the human touch, that conducts electricity.
        - **temperature sensors** - a robot may be required to perform a certain function when a particular temperature is reached
- Ability to Logically Reason with Inputs (Machine Learning and/or Machine Vision)
    - the robot's computerised control system processes sensor data for decision-making, sending commands to actuators and end effectors
    - robots exhibit varying levels of AI
        - **basic AI** - *solves problems within limited domains; uses data comparison to make optimal decisions*
        - eg - a production line robot inspects products to verify compliance with quality standards
    - **machine learning** - allows robots to learn and improve within certain limits.
        - eg - robots like ASIMO demonstrate learned skills such as walking
        - **supervised learning** - *industrial robots trained to select specific parts, enhancing their utility in production lines*
        - **reinforcement learning** - *robots learn and adapt through interaction with their environment, as seen in autonomous vehicles*
    - **machine vision** - advanced through deep learning, enabling improved depth and image recognition, increasing robots' accuracy and utility in manufacturing
- Ability to Interact and Move in Physical Environment
    - most robots have parts that can move
        - may be moving parts in a robotic arm on a production line, or motorised wheels that allow a service robot to roam around
    - use an **actuator** (a device that moves or controls some form of mechanism and needs power to operate); may include the following:
        - **electric motor**
        - **a hydraulic system** (*driven by incompressible fluid*)
        - **a pneumatic system** (*driven by compressed gas*)
    - a peripheral device is usually attached to make actuators useful and are called **end effectors** (a mechanical or electromechanical peripheral device that can be used to grip objects and attach tools or sensors)
        - **grippers** - *most common of end effectors allow robots to pick up and manipulate objects; particularly useful on an assembly line*
        - **process tools** - *tools for completing a specific task, for example tools for welding, spray painting and drilling*
        - **sensors** - *useful for applications such as robot inspections*
- Demonstration of Some Degree of Autonomy
    - **Semi-Autonomous Robots**
        - have some level of intelligence
        - will be able to react to certain conditions without needing to be directed all the time.
        - *eg: a basic robotic vacuum can work autonomously with sensors that will stop the vacuum from hitting objects in its path and sensors to detect the level of debris but if you want to change its settings, it requires human interaction*
    - **Fully Autonomous Robots**
        - operate independently, can accomplish more complex tasks and are generally more mobile

        - currently they may be restricted to one working environment
        - *eg: a factory floor or shopping mall but, as digital technology advances, they will become more adaptable and more autonomous*

3.7C Evolution of Robots and Autonomous Technologies

- Early Forms of Robots and Autonomous Technology
    - numerous developments in robots and autonomous technologies over time
    - idea of robots goes as far back as 1500 B.C. with Egyptian water clocks using human figurines to strike the bell, or the period of around 400 B.C. when Greek mathematician Archytas built a steam powered mechanical bird
    - in 1948, William Grey Walter created two autonomous robots, Elmer and Elsie (shaped like tortoises and used three wheels for mobility; could navigate themselves to a recharging station when needed)
    - in 1958, Charles Rosen led a research team at the Stanford Research Institute in developing a robot called ‘Shakey’ (could wheel around the room, observe the scene with its television ‘eyes’; move across unfamiliar surroundings and make simple responses to its environment)
- Robots in Science Fiction and Philosophy
    - Czech writer Karel Capek introduced the term ‘robot’ in his 1921 play Rossum’s Universal Robots
    - In 1941, science fiction writer Isaac Asimov, wrote the three laws of robotics:
        - 1) A robot must not injure a human being
        - 2) A robot must obey orders given by human beings, except if it conflicts with Law
        - 3) A robot must protect its own existence as long as it does not conflict with Laws 1 and 2
    - then a zeroth law was added
        - 0) A robot may not injure a human being or, through inaction, allow a human being to come to harm, unless this would violate a higher order law
- Robots Designed for Industry and Manufacturing
    - they were able to perform repetitive tasks and were capable of lifting heavy objects, making them ideal on a production line
    - they have been able to move faster, carry heavier loads, ‘see’ better, and handle more decisions
    - commonplace to see a robot assembly line in manufacturing today
- Robots Designed to Interact with Humans
    - 

- Machine Consciousness, Cognitive Robotics and Robot Rights
    - assumed that these robots did not have consciousness and could only simulate intelligence

    - for a robot to have machine consciousness, it requires the development of strong artificial intelligence
    - cognitive robotics is an emerging field aimed at designing robots with human-like intelligence
        - goal is to create robots that can perceive their environment, plan what they will do and deal with the uncertainty of the real world by continuous learning
        - an important aspect of cognitive robotics is the development of predictive capabilities and the ability to view the world from different perspectives

3.7D Robots and Autonomous Technology Dilemmas

- Anthropomorphism and the Uncanny Valley
    - **anthropomorphism** - attributing human characteristics to nonhuman entities
    - **uncanny valley** - describes the phenomenon of the eerie, unsettling feeling that people get when they interact with lifelike humanoid robots or lifelike computer-generated characters
        - observed that robots become more appealing as they become more human-like, but only up to a certain point
        - the point is called the uncanny valley
        - after this, there is a sense of unease and a negative reaction
        - creates a dilemma for robot designers that design machines to operate in the human world that push the boundaries of biology, cognitive science and engineering
            - *on one hand, the more lifelike a robot is, the more they are accepted in certain situations (eg: autistic children respond better to more lifelike robots, and they are more effective in training situations)*
            - *on the other hand, if they are too lifelike, they will be less accepted by society*
- Complexity of Human and Environmental Interactions
    - **cobots** - robots designed to work alongside humans and augment their capabilities
        - developing robots that can respond to human emotions may be considered a more desirable end goal, as these cobots will end up in the workplace or shop floor and will ultimately be more accepted if they can make eye contact, smile or behave in a more human-like way
        - aim may not be to develop an emotional robot, however, but one that can develop an emotional attachment from the human to the robot
        - developments in machine learning and robot vision technologies are being used to overcome the challenge of navigating along a path with obstacles
- Uneven and Underdeveloped Laws, Regulations and Governance
    - minimizing privacy and security risks is a challenge not only for robot developers but for governments too
        - eg: the data used to train robots could be misused, ultimately causing the robot to malfunction, or the robot could be hacked for malicious purposes, putting not only personal data at risk but also the human lives interacting with the robot
    - discussions about the ownership of data, for example who owns the data – the end-user, the robot manufacturer or the robot developer?
        - with significant developments in technology, should new laws be considered?
        - should there be a level of complexity before the rules apply?
        - is there an agreed definition of what a robot is before the law can be applied?
        - laws may need to be adapted according to the context they are being used in
    - governments with advanced developments in robotics are prioritizing developments in legislation

        - for robots to operate legally in the real world, robot designers need to comply with each country's regulations
        - if something should go wrong while being used, existing legislation would be applied in a court of law, with judges using the laws to make the final decision in a trial
        - while product liability rules are there to promote high quality and safety in products, when it comes to more complex robots, legislation could ultimately deter developments in robotics, so a fine balance is needed
- Displacement of Humans in Multiple Contexts and Roles
    - there is no doubt that these robots will impact the workplace (replacing jobs on a production line, or working alongside humans in the service industry)
    - industries susceptible to automation:
        - food
        - medical/health
        - law enforcement
        - security
    - new jobs to be created:
        - eg: robot engineers, robotic technicians, robotic sales people, software developers, robotic operators, etc

Section 4: Contexts

4.0 Overview of Real-World Contexts

Context: The specific real-world example as it relates to individuals or people and communities at a local or global level.

This section consists of seven chapters:

1. cultural
2. economic
3. environmental
4. health
5. human knowledge
6. political
7. social

4.1 Cultural

4.1A Arts, Entertainment and Popular Culture

- **Popular Culture** - music, dances, movies, performances, art and other forms of expressive media enjoyed by a society
- **Genre** - a category of art
- **Form** - physical natures of a work of art, for example painting, graphic design, sculpture, literature, film, music, theatre, fashion and architecture
- **Technique** - the way an artist uses their technical skills to create their art
- **Streaming** - multimedia (especially video and audio) that is delivered digitally with little or no intermediate storage
- **Online Exhibition** - an exhibition in a virtual venue (cyberspace)
- **Online Forum** - any platform where people can post and discuss messages
- **Influencer** - social media celebrity with large numbers of followers

4.1B Home, Leisure and Tourism

- **Smart Homes** - homes equipped with internet connected lighting, heating and other electronic devices
- IoT Security Tips

    - Using more complex passwords and checking the administration settings can allow users to limit unwanted access to their devices.
    - Check the data permissions when installing a device or app and only share data that is essential to device functionality.
    - Routine software updates will help address any known bugs or security risks that the company has identified and addressed.
    - Setting up a separate network for your IoT devices will ensure that any security breaches do not give hackers access to your computers, phones and other sensitive data.
- **Gig Economy** - labour market in which individuals and organizations exchange short-term/task-based services using digital platforms
- **Virtual Conferencing Platforms** - digital platform that allows multiple users to video chat at the same time, for example Zoom or Google Meet
- **Ranking Systems** - the assignment of a number or short description to data to indicate first to the last in a data set
- **Customer Review** - is the evaluation of particular items posted by previous customers or users
- **Translation Apps** - an app that translates one language into another allowing communication in real time

4.1C Heritage, Customs and Celebrations

- **Heritage** - objects and qualities that are passed down from generation to generation
- **Customs** - traditional ways of behaving or doing things
- **Celebrations** - important events and milestones that are honoured and observed within a culture
- **Rite of Passage** - a ceremony or tradition that marks when an individual leaves one group and enters another, for example a birth, marriage or death

4.1D Subcultures

- **Subculture** - smaller cultural groups that exist within a larger culture
- **Youth Culture** - the culture and social norms of teenagers and young adults
    - youth subcultures can also divert young people away from their own cultures, locally and nationally
    - known as **soft power** (*where the cultural values of one society are spread through the use of digital technology to the detriment of the native culture*)
- **Online Community** - a group of people united by a shared interest or purpose who use digital tools to communicate with each other
- **Guidelines** - norms and rules for membership and participation
- **Forum** - online discussion sites that allow users to post and reply to messages
- **Moderation** - a system designed to ensure messages posted online comply with the rules set by the online community
- **Fluidity** - the ease with which people can join/ leave digital subcultures
- **Radicalisation** - the use of the internet to share ideas and resources that are radically different from those in mainstream society
- **Cancel Culture** - public backlash on social media when a person or organization says or does something that is considered objectionable or offensive

4.2 Economic

4.2A Business

- **Transaction Processing System** - a system designed to incorporate all of the resources, software and hardware needed to manage sales, purchases and other transactions
- **Office Automation System** - a system designed to centralize and organize data, improve communication between workers and departments, manage calendars and facilitate collaboration in businesses

- **Diversification** - when a business enters into a new market or industry
    - **Horizontal Diversification** - when a business adds on products/services that are complementary to their core business *(eg: a social media platform building a direct messaging platform or a marketplace for buying and selling)*
    - **Conglomerate Diversification** - when a business adds new products that are completely separate from their existing operations *(eg: a search engine investing in self-driving car technology)*
    - **Vertical Diversification** - when a business takes over a new part of their supply or production chain *(eg: online stores purchasing their own delivery fleet to ship purchases to the consumer, or when a computer company begins producing its own microprocessors instead of purchasing them)*
    - **Concentric Diversification** - when a business adjusts their existing product lines to meet a wider customer audience *(eg: a social media platform could adapt its content for younger users, or for business/corporate accounts)*
- **Diversity** - in business, this refers to the inclusion of people with a range of demographic indicators
- **Inclusive** - in business, this refers to an environment in which people of all backgrounds feel valued, safe and respected
- **Discriminate** - unjust treatment of people based on gender, social identity, race or disability
- **Psychometric Survey** - survey designed to measure an individual's mental capabilities and behavioural style

4.2B Employment and Labour

- **Office Design** - functional and decorative components of the working environment
- **Remote Working** - conducting business and completing tasks from anywhere that employees are able to connect to the essential networks, for example, working from home
- **Digital Nomad** - a person who works remotely and is not tied down to any particular location
- **Crowdsourcing** - collecting information/ ideas/work from a large group of people, usually over the internet
- **Microwork** - short-term projects completed quickly for payment
- **Sharing Economy** - assets or services that are shared between individuals, often using an online booking system
    - Examples of Gig/Sharing Economies

Sector	Description	Examples
Transportation	enable freelance drivers to provide transport services, for example taxis, ride sharing and restaurant food delivery	Uber, Gojek, Grab, DoorDash, Lyft, Careem, Bla Bla Car, Grubhub
Asset Sharing	enable person-to-person sharing of property, such as holiday homes, parking spaces and equipment	Airbnb, Traveloka, VRBO, Turo, Zipcar, Red Doors
Professional Services	connect freelancers with businesses for microwork, administrative assistance, writing/translation	Upwork, Fiverr, PeoplePerHour, Catalant, Guru
Handmade Goods and Individual Services	enable people to sell homemade goods and services such as dog walking and tutoring	Etsy, Airtasker, Rover, GoPeer

- **Gamification** - applying elements of game playing to other activities to encourage participation or efficiency

4.2C Goods, Services and Currencies

- **E-Commerce** - buying and selling of goods and services online; can be business-business, business-consumer or consumer-consumer
- **Brick and Mortar Store** - retail outlet with a physical building
- **Online Marketplace** - digital platform that allows individual sellers and buyers to trade
- **E-Trading** - trading of financial products, such as stocks, bonds or other assets, online; subsection of e-commerce
- **Microtargeting** - strategy of using consumer data and information to create personalized content and advertisements
- **Cryptocurrency** - digital currency that use blockchain technology to create a decentralized encrypted ledger
- **Non-Fungible Token (NFT)** - a unique digital artifact (usually drawings, music or art) combined with blockchain technology to allow a unique identification and authentication of the artifact
- **Cashless Society** - society in which all transactions are carried out electronically
- **Micro-Transactions (mtx)** - purchase of virtual goods for small sums of money in games/apps
- **Loot Box** - a virtual consumable that contains a random/mystery item; can be purchased or won in games/apps
- **Additive Manufacturing** - adds raw materials layer by layer to build an object or product, as in 3D printing
- **Subtractive Manufacturing** - creating an object by cutting or carving a larger material into the desired shape

4.2D Globalization

- **Borderless Selling** - process of selling goods across national borders
- **Global Sourcing** - buying materials, goods and services from all over the world; the supply-side equivalent of borderless selling
- **Offshoring** - practice of moving corporate operations overseas
- **Outsourcing** - practice of moving corporate operations to another company, usually overseas
- **Reshoring/Inshoring** - practice of bringing previously outsourced jobs back from overseas
- **Nearsourcing** - practice of establishing operations as close to where the end-products are sold as possible
- **Insourcing** - practice of finding existing employees to complete a task rather than outsourcing it

4.3 Environmental

4.3A Natural Resources and Ecosystems

- **E-Waste** - discarded electronic and electrical devices
- **Recycle** - process of converting waste into reusable materials
- **Smart City** - a city that integrates sensors, voice recognition and other new technologies to better manage transportation, energy distribution and other services
- **Biodiversity** - the variety in animal and plant life in a particular community or ecosystem
- **Ecosystem** - a community of living organisms and the physical environment that they live in
    - digital tools and systems are produced and operated using resources (eg: cobalt is a nonrenewable magnetic metal that is mined and processed to develop batteries)
    - scratch-resistant glass used to make many smartphone touch screens contains a range of materials such as silicon dioxide, aluminium, magnesium and sodium
    - these resources must be processed and manufactured from their natural state into the parts, components and end products you are able to purchase in stores
- **Supercomputers** - refers to high performance computers capable of high-speed calculations that are required in scientific and engineering fields (used in climate models for weather forecasting)

4.3B Pollution and Waste

- **E-Waste Service** - a business that collects obsolete electronic devices and sorts them into recyclable and nonrecyclable elements
- **Pollution** - the introduction of substances or energy into the natural environment that cause a negative impact
    - **Solid Pollution** - solid waste material *(packaging and plastics used in consumer electronics contribute to solid waste, which can lead to overcrowded landfills or end up in waterways)*
    - **Air Pollution** - pollution released into the air either through exposure to heat or burning *(e-waste is exposed to heat, either in landfill or when burned, chemicals, gases and particles are released into the air; contribute to global warming, acid rain, respiratory illness, heart disease, cancer risks and wildlife degradation)*
    - **Water Pollution** - pollution released into water *(same chemicals that produce air pollution are connected with water through rain or contact with a stream, river or ocean; increase the risk of waterborne illness as well as damage the ecosystems that rely on that water)*
    - **Noise Pollution** - excessive noise in the environment *(cars, loudspeakers, floodlights, screens and dense populations; disrupts sleep cycles and can also be linked to higher blood pressure and communication problems)*
    - **Light Pollution** - excessive light in the environment *(hard to see the stars and disrupts nocturnal wildlife, migratory patterns and human sleep cycles)*
- **Planned Obsolescence** - the development of products with intentionally short lifespans so that companies can get repeat sales as devices are replaced or upgraded (can lead to circular economy where existing resources are reused and repurposed to minimise waste and reduce demand for new materials)
- **Green Computing** - the study and adaptation of computer design, engineering, manufacturing, use and disposal to reduce their negative environmental impact
- **Carbon Footprint** - total greenhouse gas emissions caused by a person, place or product

4.3C Cities, Infrastructures and Built Environments

- **Infrastructure** - structures and facilities, such as roads, buildings or power supply, that allow a place to operate effectively
- **Wayfinding** - technologies and systems that give directions to people as they navigate a physical space
- **Global Positioning System (GPS)** - a satellite-based navigation system
- **Trilateration** - technology that uses three satellites to pinpoint our device's location
- **Geographic Information System (GIS)** - system that connects data to a map

4.3D Agriculture

- **Distribution** - movement of products from farmers and growers to customers
    - while some farmers host their own websites and online stores to distribute directly to customers, many start-ups are building platforms and services to partner with farms and connect them with local customers

4.4 Health

4.4A Medicine and Health

- **Medical Diagnostics** - equipment, tools and processes that professional medical personnel use to make a diagnosis
- **False Positive** - test result that incorrectly suggests a condition is present
- **Wearable Medical Devices** - device that can be worn to provide continuous, real-time data to improve the treatment, diagnosis and monitoring of patients
- **Telemedicine** - remote treatment of patients
- **Robotic Surgery** - surgery carried out using robotic systems, for example mechanical arms controlled by a surgeon

- **Research and Development** - work on innovating, improving and introducing new services or products
- **Digital Healthcare Records** - online databases that store patient information
- **Digital Medication** - prescription medicine that contain an ingestible sensor; also known as 'smart pills'
- **Internet Connectivity** - ability to connect to the internet
- **Digital Literacy** - ability to use various digital platforms

4.4B The Human Body

- **Transhumanism** - a movement that aims to use technology to evolve and augment the human experience
- **Bio-hacking** - any activity that helps you gain control over your own biology
- **RFID** - radio-frequency identification
- **Microchip Implant** - implanting an RFID transponder under the skin
- **Exoskeleton** - a wearable robotic tool that supports/strengthens the human body
- **Organ Printing** - 3D printing of organs using a combination of cells, proteins or biocompatible plastic that simulates the skeleton
- **Bioprinting** - 3D printing of tissues using a combination of cells, proteins or biocompatible plastic that simulates the skeleton
- **Assistive Technology** - any item, equipment, programme or product that enhances the life for people living with disabilities
- **Ergonomic Design** - designing workplaces, products and systems so that they meet the physical and emotional needs of the user

4.4C Mental Health

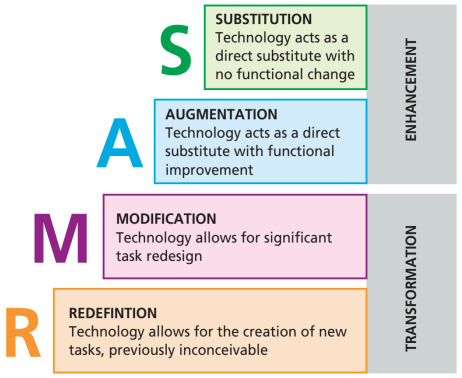
- **Social Media Addiction** - psychological or behavioural dependence on social media to the detriment of other important parts of life
- **Video Game Addiction** - psychological or behavioural dependence on playing video games to the detriment of other important parts of life
- **Virtual Reality Exposure Therapy** - therapy designed to reduce a person's fear and anxiety by confronting the experiences in a computer-generated virtual environment

4.5 Human Knowledge

4.5A Learning and Education

- **Design and Delivery of Formal Education**
    - educational systems changing due to introduction of new digital technologies based **pedagogies** (teaching approaches) -> evolving to better equip learners with the knowledge, tools and skills they need for jobs that do not yet exist
    - being taught to use and explore digital technologies, to develop:
        - mastery of content
        - skills and comfort with various tools
    - **social-emotional learning** (*skills that help students to understand their emotions and build empathy and understanding towards themselves and others*) and **critical-thinking skills** (*process of conceptualising, applying, analysing, synthesising, and/or evaluating information*)
        - utilises web-based tools to help deliver information, check students' understanding and encourage collaboration.
        - **creative computing** - *interdisciplinary area at the cross-over of the arts and computing*
    - **remote learning** - *education that occurs over a network connection, for example, using video-conferencing software*)
        - hosting and sharing pre-recorded video lessons, broadcasting television and radio content, or a variety of other forms that allow students to access materials without being in the same room as their teacher and peers

        - gives learners access to more courses and content without the need to travel or physically relocate
        - developed decades ago as a solution for students:
            - *who live in very remote areas with only radio contact*
            - *who could not attend formal schooling due to illness or disability*
            - *who had other duties, such as work, and could not find time to participate in education during the day*
        - were called '**correspondence courses**' as all communication was done by physical mail, with the student receiving the work and resources by mail and sending the assignments back by mail
        - **synchronous learning** - *remote learning that happens in real time with a live teacher*
        - **asynchronous learning** - *remote learning that can happen at any time, for example, using pre-recorded content*
- **Approaches to Non-Formal and Post-Formal Education (eg: Skill Training, Competency Development and Self-Directed Learning**
    - **self-guided learning** - *strategy that allows students to direct their own learning*
    - **massive open online course (MOOC)** - *an online course that is available for a nearly unlimited number of students to participate in*
        - many universities publish and share course recordings, and their online platforms offer this course
    - online learning can help in **competency development** (*practice of developing competencies in particular skills*)
        - **behavioural competencies** - *interpersonal skills required to do a job well*
        - **functional competencies** - *knowledge required to do a job well*
- **Digital Pedagogies**
    - **digital pedagogies** - *approaches to teaching that integrate digital tools into the learning environment*
    - how to analyse educational technology - **SAMR model** (*a framework for analysing educational technology*)



    - Is it **substituting** for a low-tech alternative (*such as replacing a poster project with a presentation slide*)?
    - Is it **augmenting** the experience with a similar but increased functionality (*such as incorporating multimedia in the presentation that would not be possible in a poster alternative*)?
    - Does it offer a significant redesign or **modification** (*such as using a cloud-based platform to allow students to share their work and synthesise their work with their peers*)?
    - Does it **redefine** the learning experience in a way that would not be possible without the technology (*such as students could share their work with learners from a different*

country and ask questions to see how their findings would be different if they lived in a different location)?

4.5B Science and Technology Innovation

- **Approaches to Scientific and Technology Research and Development**
  - **open innovation** - *organisations incorporate external sources into their research and development strategy*
    - growing trend
    - rather than relying only on their own internal knowledge and resources
  - **citizen scientists** - *ordinary people who want to become involved in scientific research with the aim of increasing scientific knowledge*
    - people in the community with the skills and passion to find answers to questions about the world and how it works
    - many apps that have been set up by research institutions, such as the Smithsonian Institution, that make it easy to participate in research
    - facilitated by the internet
    - people can now volunteer, and even be paid to complete surveys and provide other information as part of market research, take part in online focus groups, and in medical and psychological scientific research

4.6 Political

4.6A Political Processes

- **Electronic Voting System** - a digital system designed to count votes the moment they are cast
- **Online Voting** - a systems that allows voters to cast their ballot online
- **Propaganda** - biased or one-sided information
- **Psychographic Analysis** - analysis of people based on their activities, interests and opinions
- **Confirmation Bias** - tendency to accept news and facts that confirm our existing beliefs

4.6B Governing Bodies

- **Organisation and Role of Local, Regional, National and Global Governing Institutions**

Level of Government	Definition	Examples
Global	Operates internationally, trans-nationally or regionally across national borders	UN, EU, Organisation for Economic Co-operation and Development (OECD), etc.
National (Central)	A country's political authority	US government, Australian government, etc
Regional	Governs a particular region and enforces the laws that central government passes	California State Assembly (within the USA), Bali Provincial Government (within Indonesia), local council, etc.
Local	Focuses on a specific community or group	School district, parks and recreation department, etc.

- **Non-Governmental Organisation (NGO)** - transnational organization that operates independently of government agencies (also non-profit organisations where any money earned cannot be used for personal gain of its employee or supporters)
- **Non-State Political Actors** - societal, technological, war-fighting and/or individual actors
- **Biometric Passport** - passport that contains an electronic microprocessor chip biometric information about the passport holder
- **Biometric Information** - physiological details about a person that cannot change, such as their fingerprints
- **Counterfeit** - to imitate fraudulently

4.6C Conflicts and War

- **Digital Warfare** - the use of digital technology to disrupt or impact vital computer and warfare systems
- **Sabotage** - disruption of computers and systems that operate military, economic infrastructure or other vulnerable networks
- **Terrorism** - unauthorized use of violence/force to create fear and coerce a government or its people toward a political or social cause

4.6D Laws, Regulations and Policies

- **Digital Surveillance** - collection of data about a person's online communications, connections, finances and other available information
- **Data Broker** - a company that collects and stores information about users and sells it on to companies or advertisers

4.7 Social

4.7A Social Components of Identity

- **Dominant Culture** - a culture that has established its own norms and values as the standard for the entire group
- **Intersectionality** - the overlap and interconnection that a specific and unique set of identity markers may create
- **International Mindedness** - a mindset in which one sees their connection to the global community and has a sense of responsibility to its members
- **Demographic Contents** - statistical data points that are used to characterize or label groups of people
- **Race** - a social construct based on people's physical traits and characteristics
- **Ethnicity** - the cultural expression and identity shared by people with a common racial, national, religious, or any other identity marker
- **Disability** - conditions that limits a person's movement or senses
- **Accessibility** - the quality of being easy to use
- **Doxing** - the publication of personal and/or private information such as addresses, phone numbers and photos
- **Filter Bubble** - when information only comes from a narrow range of sources dues to algorithms designed to personalize your online experience

4.7B Social Class

- **Social Class** - method of classifying people and communities according to their social status
- **Digital Redlining** - the systemic denial of digital services to specific communities
- **Proxy Discrimination** - discrimination that occurs due to correlations to indicators such as race, disabilities or socioeconomic status
- **Predictive Policing** - use of algorithms in an attempt to forecast criminal activities
- **Recidivism** - the tendency to reoffend

4.7C Families and Relationships

- evolution of family connection through location tracking, video calls, DNA analysis and social media
- digital tools helping to provide social and emotional support to foster friendship, companionship, personal relationships, online relationships and group memberships

Section 5: Challenges and Interventions (HL extension)

5.0 Overview of the HL Extension

5.1 Global Well-Being

5.1A Local and Global Inequalities

5.1B Changing Populations