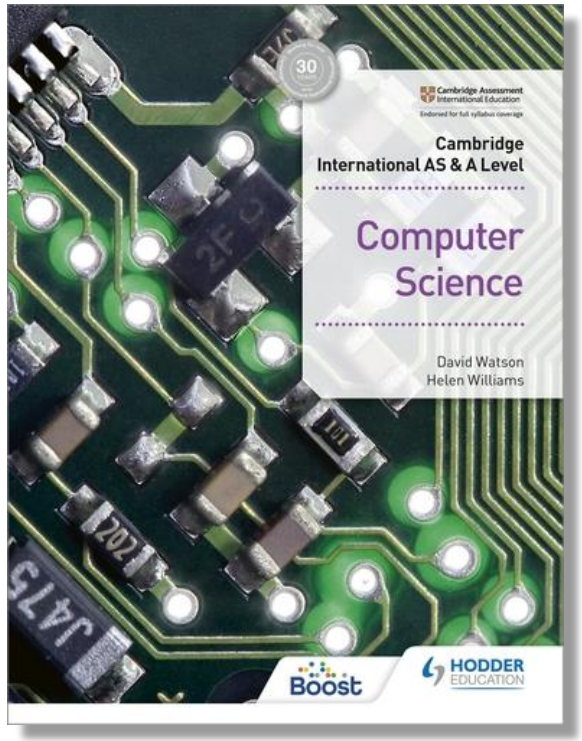
GCE AS LEVEL
In the context of CIE 9618 syllabus

CAMBRIDGE International Examinations

Chapter 7
Ethics and Ownership

7.1 Legal, moral, ethical and cultural implications
7.2 Copyright issues
7.3 Artificial intelligence (AI)



7. Ethics and Ownership

LEARNING OBJECTIVES:

1. The need for and purpose of ethics as a computer science professional
2. The need to act ethically at all times
3. The impact of acting ethically or unethically in a given situation
4. The need for copyright legislation
5. The different types of software licensing, including free software, open source software, shareware and commercial software
6. The impact of artificial intelligence (AI) on social, economic and environmental issues.

7.1 Legal, Moral, Ethical and Cultural Implications

KEY TERMS:

- Legal – relating to, or permissible by, law.
- Morality – an understanding of the difference between right and wrong, often founded in personal beliefs.
- Ethics – moral principles governing an individual's or organisation's behaviour, such as a code of conduct.
- Culture – the attitudes, values and practices shared by a group of people/society.
- Intellectual property rights – rules governing an individual's ownership of their own creations or ideas, prohibiting the copying of, for example, software without the owner's permission.
- Privacy – the right to keep personal information and data secret and for it to not be unwillingly accessed or shared through, for example, hacking.
- Plagiarism – the act of taking another person's work and claiming it as one's own.
- BCS – British Computer Society.
- IEEE – Institute of Electrical and Electronics Engineers.
- ACM – Association for Computing Machinery.

7.1 Legal, Moral, Ethical and Cultural Implications

Important Definitions:

- Legal: Deals with the law and whether actions can be punished.
- Morality: About right and wrong, personal choices.
- Ethics: Focuses on right and wrong in a professional context.
- Culture: Involves society's attitudes, values, practices.
- Illegal: Breaks the law; copying software without permission.
- Morality: Varies among people and cultures; what's right for one may not be for another.
- Immoral: Not always illegal, like creating distressing fake news.
- Hacking: Generally immoral, but can be illegal if affecting security, financial gain, personal info.
- Unethical: Breaks a code of conduct; sharing company secrets.
- Importance of Culture: Need to avoid offensive or obscene content in computer games.
- Boundaries can be crossed: Some actions, like mocking religion, may be illegal in certain countries.

7.1.1 Computer ethics

- Computer ethics: Rules for computer use.
- Factors considered:
  - Intellectual property: Like copying software without permission.
  - Privacy: Such as hacking into personal data.
  - Society's impact: Like job losses or social effects.
- Internet use can lead to plagiarism (copying others' work).
- Quoting is okay, but credit to the original creator is needed.
- Software checks for plagiarism on the internet.

7.1.2 Professional ethical bodies

- Professional bodies: Groups for people in computing and IT.
- They create codes of conduct for members to follow.
- Being a member shows professional integrity and commitment to their standards.

The British Computer Society (BCS)

- British Computer Society (BCS): A group for IT professionals in the UK.
- Started for ethics and rights in IT and computing.
- Now global, partners with others to guide worldwide IT practices.
- The BCS Code of Conduct covers four main areas:
    1. The Public Interest
    2. Professional Competence and Integrity
    3. Duty to Relevant Authority
    4. Duty to the Profession

7.1.2 Professional ethical bodies

The Institute of Electrical and Electronics Engineers (IEEE)

- The Institute of Electrical and Electronics Engineers (IEEE) was set up in the USA with the aims of
  - raising awareness of ethical issues
  - promoting ethical behaviour among professionals working in the electronics industry
  - ensuring engineers and scientists respect the need for ethical behaviour

7.1.2 Professional ethical bodies

The Institute of Electrical and Electronics Engineers (IEEE)

- To help in this aim, the IEEE has also set out a code of ethics:

IEEE Code of Ethics

We, the members of the IEEE, in recognition of the importance of our technologies in affecting the quality of life throughout the world, and in accepting a personal obligation to our profession, its members, and the communities we serve, do hereby commit ourselves to the highest ethical and professional conduct and agree:

1 to hold paramount the safety, health, and welfare of the public, to strive to comply with ethical design and sustainable development practices, and to disclose promptly factors that might endanger the public or the environment;

2 to avoid real or perceived conflicts of interest whenever possible, and to disclose them to affected parties when they do exist;

3 to be honest and realistic in stating claims or estimates based on available data;

4 to reject bribery in all its forms;

5 to improve the understanding by individuals and society of the capabilities and societal implications of conventional and emerging technologies, including intelligent systems;

6 to maintain and improve our technical competence and to undertake technological tasks for others only if qualified by training or experience, or after full disclosure of pertinent limitations;

7 to seek, accept, and offer honest criticism of technical work, to acknowledge and correct errors, and to credit properly the contributions of others;

8 to treat fairly all persons and to not engage in acts of discrimination based on race, religion, gender, disability, age, national origin, sexual orientation, gender identity, or gender expression;

9 to avoid injuring others, their property, reputation, or employment by false or malicious action;

10 to assist colleagues and co-workers in their professional development and to support them in following this code of ethics.

7.1.2 Professional ethical bodies

The Institute of Electrical and Electronics Engineers (IEEE)

- To help in this aim, the IEEE has also set out a code of ethics: *(simplified version)*
  1. Safety & Welfare: Protect public safety, health, and environment.
  2. Avoid Conflicts: Prevent conflicts of interest, inform when they arise.
  3. Honesty & Realism: Be truthful, realistic in claims, expose risks.
  4. No Bribery: Reject all forms of bribery.
  5. Tech Understanding: Educate about tech's impact on society.
  6. Maintain Competence: Keep skills updated, work within expertise.
  7. Honest Criticism: Give and take honest, fair feedback.
  8. Fair Treatment: Treat all fairly, no discrimination.
  9. No Harm: Don't harm others, their property, or reputation.
  10. Support Colleagues: Help others develop, uphold this code.

7.1.2 Professional ethical bodies

- IEEE and ACM together made 8 principles for software engineers.
- Principles make sure engineers follow a consistent code of ethics.
- Public and peers have expectations from scientists and engineers.
- 8 principles were published in 1999 for ethics and professional practice.

Software Engineering Code of Ethics

1 PUBLIC – Software engineers shall act consistently with the public interest (contains 8 sub-clauses).
2 CLIENT AND EMPLOYER – Software engineers shall act in a manner that is in the best interests of their client and employer consistent with the public interest (contains 9 sub-clauses).
3 PRODUCT – Software engineers shall ensure that their products and related modifications meet the highest professional standards possible (contains 15 sub-clauses).
4 JUDGEMENT – Software engineers shall maintain integrity and independence in their professional judgement (contains 6 sub-clauses).
5 MANAGEMENT – Software engineering managers and leaders shall subscribe to and promote an ethical approach to the management of software development and maintenance (contains 12 sub-clauses).
6 PROFESSION – Software engineers shall advance the integrity and reputation of the profession consistent with the public interest (contains 13 sub-clauses).
7 COLLEAGUES – Software engineers shall be fair to and supportive of their colleagues (contains 8 sub-clauses).
8 SELF – Software engineers shall participate in life-long learning regarding the practice of their profession and shall promote an ethical approach to the practice of the profession (contains 9 sub-clauses).

7.1.2 Professional ethical bodies

- IEEE and ACM together made 8 principles for software engineers.
- Principles make sure engineers follow a consistent code of ethics.
- Public and peers have expectations from scientists and engineers.
- 8 principles were published in 1999 for ethics and professional practice. *(simplified version)*

1. Public Interest: Work for the greater good.
2. Clients & Employers: Prioritize client and employer interests while considering the greater good.
3. Product Excellence: Ensure top-quality products.
4. Integrity & Judgment: Be truthful, make unbiased judgments.
5. Ethical Management: Ethical software management.
6. Professional Integrity: Boost the profession's integrity.
7. Supporting Colleagues: Treat colleagues fairly, provide support.
8. Personal Growth: Keep learning, practice ethically.

7.1.2 Professional ethical bodies

- There are 80 clauses and sub-clauses in total.
- We shall consider one scenario and see how it fits into a selection of the clauses.

Mikhail works during the day for a software company called *EthicalGamz* developing new software in a number of applications. Mikhail is part of a large team of software engineers writing and testing new code. The team also do market research to help in their development of new software for the future. Much of the work is commercially sensitive and multiple layers of access exist to protect the company from unauthorised sharing of data.

In the evenings and at the weekend, Mikhail works for his own company, *MikhailSoft*, which produces software available to buy on the internet only. To save costs, Mikhail uses coding he helped develop for *EthicalGamz* in his own software. He also outsources some of the work to software engineers in other countries where the wages are much lower and ethics policies are more lax. This saves him a lot of time and money when producing his own software. Mikhail does not pay any licensing fees to *EthicalGamz* and makes no reference to any code used from that company in his own products.

7.1.2 Professional ethical bodies

- There are 80 clauses and sub-clauses in total.
- We shall consider one scenario and see how it fits into a selection of the clauses. *(simplified version)*

Mikhail's Work:

1. Day Job: Software engineer at EthicalGamz, making new software with a team.
   - Commercially sensitive work.
   - Protecting data with layers of access.

2. Free Time: Own company, MikhailSoft.
   - Makes software to sell online.
   - Uses code from day job to save costs.
   - Hires cheaper foreign engineers.
   - Doesn't pay EthicalGamz or credit them.

7.1.2 Professional ethical bodies

- We will now consider the ethical implications of the above scenario using the following subclauses from the Software Engineering Code of Ethics.

> 1.03 approve software only if they have a well-founded belief that it is safe, meets the specification and passes the appropriate tests and does not diminish the quality of life, diminish privacy or harm the environment;

- Ethical issue: Software from other countries might not meet requirements or tests.
- This could break the three factors, like having spyware that Mikhail doesn't know about.

> 2.02 not knowingly use software that is obtained or retained either illegally or unethically;

- Mikhail has no control over the coding being developed by his overseas team, furthermore, using the coding from EthicalGamz is illegal use.

> 3.05 ensure an appropriate method is used for any project on which they work or propose to work;

- Using external companies (in his own country or overseas) may be used at various steps in the production of Mikhail's own software. Unless he applies good managerial control, he will be unable to ensure methods used in projects are appropriate or fully ethical in their implementation.

> 4.02 only endorse documents either prepared under their supervision or within their areas of competence and with which they are in agreement;

7.1.2 Professional ethical bodies

- Documentation produced by third party developers is not produced under Mikhail's direct supervision, indeed some of the work done overseas may be outside Mikhail's sphere of knowledge which probably removes his ability to objectively endorse the external work being done.

5.03 ensure that software engineers know the employer's policies and procedures for protecting passwords, files and information that is confidential to the employer or to others;

- By using software developed by EthicalGamz for his own use, Mikhail may need to give passwords and access to other files to engineers working for his own company, MikhailSoft. This would allow non-authorised personnel access to files and information stored on EthicalGamz computer systems leading to a potential security breach.

6.05 not protect their own interest at the expense of the profession, client or employer;

- By using coding from EthicalGamz, Mikhail is enhancing his own interests at the expense of the company and his colleagues at that company.

7.03 credit fully the work of others and refrain from taking undue credit;

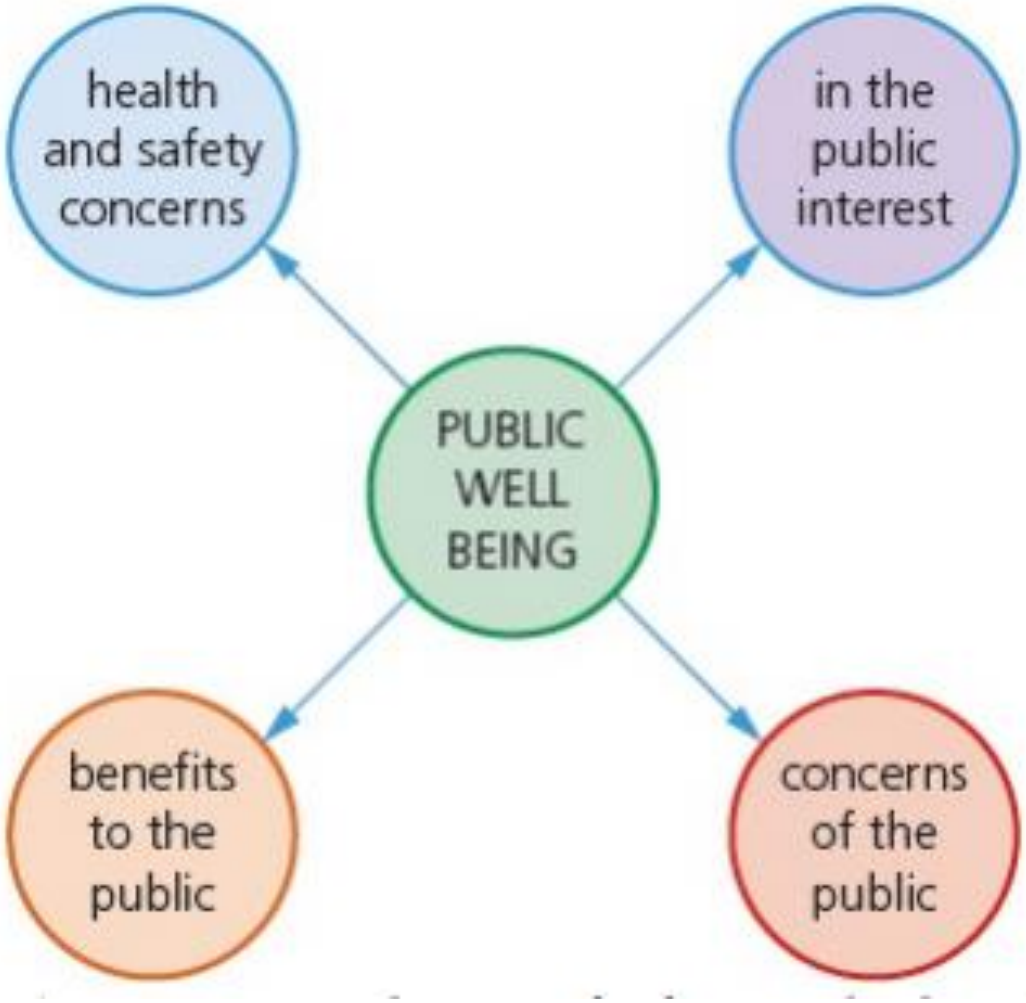
- By using coding from EthicalGamz illegally and unethically, and by making no reference to the source of his 'illegal' code, Mikhail is effectively taking full credit for all the work done by his colleagues.

8.07 do not give unfair treatment to anyone because of any irrelevant prejudices

- Mikhail may dismiss overseas workers who do not agree with his own political or religious beliefs and such dismissals would be deemed unfair and break this code of practice.

7.1.3 Impact on the public

- Potential Impact on the General Public:
  - Software and Hardware Development: Considering the Software Engineering Code of Ethics.
  - Importance of General Public Impact.
- Examples of Expensive Errors:
  - Instances of computer hardware or software causing costly mistakes.
  - Impact on the General Public highlighted.



7.1.3 Impact on the public

LA airport shutdown in 2007

In this example, aeroplanes at LA airport (in the USA) were grounded due to a simple software issue: a faulty network card in a device continued to send incorrect data over the airport's network. Eventually, the whole of the USA Customs and Borders Agency came to an abrupt standstill at LA airport. This resulted in all flights leaving and landing at the airport being cancelled for about eight hours until the fault was cleared. It cost several million US dollars in lost revenue to the aeroplane operators. The impact on the general public was cancellation of holidays, loss of business and general frustration.

Exploding laptop computers in 2008

Japan holds an annual trade show displaying the latest in computer technology. In 2008, during the trade show, a number of Dell laptop computers burst into flames under the full view of the visiting public and television cameras. The problem was traced back to faulty batteries in the laptops which had been overheating and eventually exploded and burst into flames. As if this was not enough, the problem escalated when Apple reported similar problems with some of its tablets, laptops and desktop computers. Some 100 million computer devices had to be recalled at an estimated cost of over 300 million US dollars to the manufacturers. The impact on the general public would have been devastating if this problem had not been discovered before the devices were generally available to buy.

Airbus A380 incompatible software issue in 2006

In Europe, Airbus Industries uses a number of factories throughout Europe where the design, development and construction of aeroplanes takes place. During 2006, while the new A380 was being developed, a surprising issue came to life: the software in two factories would not 'talk to each other'. The factory in Hamburg (Germany) was using an old version of CATIA design software while another plant in Toulouse (France) was using the latest version of CATIA software. When a part of the A380 from Hamburg and a part of the A380 from Toulouse were brought together for assembly, the wiring in the two parts did not match up (the cables could not be linked together). This was all due to the fact that the two versions of the software produced different design specifications for the wiring. It cost the company millions of Euros to redo the design and remanufacturing of parts where old software was still in use. Fortunately, this was not a safety issue, but if some other design incompatibility had occurred after assembly of an A380, the effect could have been catastrophic leading to possible loss of life.

7.1.3 Impact on the public

- LA Airport Shutdown in 2007:
  - Aeroplanes Grounded: LA airport grounded planes due to a software issue.
  - Faulty Network Card: Incorrect data sent by a faulty network card caused the issue.
  - USA Customs Impact: USA Customs and Borders Agency shut down at LA airport.
  - Flight Cancellations: All flights cancelled for about eight hours, costing millions in lost revenue.
  - General Public Impact: Cancelled holidays, business losses, and frustration.
- Exploding Laptop Computers in 2008:
  - Japan Trade Show Incident: Dell laptops burst into flames at a trade show.
  - Faulty Batteries: Overheating and exploding faulty batteries caused the issue.
  - Recall and Costs: About 100 million devices recalled, costing over $300 million.
  - Apple's Similar Issue: Apple reported similar problems in tablets, laptops, and desktops.
  - Public Impact Averted: Issue discovered before widespread availability.
- Airbus A380 Incompatible Software Issue in 2006:
  - Airbus Industries: Uses factories across Europe for airplane development.
  - Software Compatibility Problem: Different versions of CATIA software in different factories.
  - Wiring Mismatch: Assembly issues due to software-generated different design specs.
  - Costly Redesign: Millions of Euros spent on redoing design and remanufacturing.
  - Safety Concerns: Though not safety-related, potential for catastrophic effects in other cases.

7.1.3 Impact on the public

- Examples of Impact:
  - Cost and Public Impact: The given examples had cost-related impacts on the general public.
  - Other Examples Exist: Many other examples also exist with potential public impacts.
- Issues Affecting Public and Businesses:
  - Insecure Software Systems: Companies selling software systems without proper security measures.
  - Covering Up Security Issues: Instances of hiding security threats, like the XEN security threat.
  - Private Data Release: Leaks of private data, like the celebrity photo leaks, due to hacking.
  - Social Media Concerns: Lack of policing for hate mail and cyberbullying on social media.
  - Search Engine Manipulation: Search engines giving priority based on donations to operators.

7.2 Copyright Issues

KEY TERMS:

- Piracy – the practice of using or making illegal copies of, for example, software.
- Product key – security method used in software to protect against illegal copies or use.
- Digital rights management (DRM) – used to control the access to copyrighted material.
- Free Software Foundation – organisation promoting the free distribution of software, giving users the freedom to run, copy, change or adapt the coding as needed.
- Open Source Initiative – organisation offering the same freedoms as the Free Software Foundation, but with more of a focus on the practical consequences of the four shared rules, such as more collaborative software development.
- Freeware – software that can be downloaded free of charge; however, it is covered by the usual copyright laws and cannot be modified; nor can the code be used for another purpose.
- Shareware – software that is free of charge initially (free trial period). The full version of the software can only be downloaded once the full fee for the software has been paid.

7.2.1 Software copyright and privacy

- Software Copyright Protection:
  - Software is protected under copyright laws like music, videos, articles, and books.
- Rules When Purchasing Software:
  - No Unauthorized Copies: Making and distributing unauthorized copies of software is illegal.
  - Multi-Use License: Software can't be used on networks or multiple computers without a proper multi-use license.
  - No Unauthorized Code Use: It's illegal to use code from copyrighted software in your own software without permission.
  - No Unauthorized Rental: Renting out software without permission is illegal.
  - No Unauthorized Use of Names: Using the name of copyrighted software on other software without agreement is illegal.
- Fighting Software Piracy:
  - Steps to prevent piracy:
    - Entering a unique reference number or product key during installation.
    - Agreeing to a license agreement before installation.
    - Labels on packaging indicating copying is illegal.
    - Some software requiring physical media or a dongle for use.
- FAST and Anti-Piracy Laws:
  - Federation Against Software Theft (FAST) in the UK prosecutes copyright infringements.
  - Similar organizations exist in other countries to enforce anti-piracy laws

7.2.2 The internet and the World Wide Web (WWW)

- Digital Rights Management (DRM):
  - Originally for CDs, controlling playback on specific devices to prevent illegal copying.
  - Evolved to cover more content types: music tracks, videos, ebooks, etc.
  - Uses protection software to prevent copying and enforce restrictions.
- DRM Restrictions:
  - Controls user actions with data:
    - Streaming music but not copying.
    - Reading an ebook on a specific device only.
    - Games requiring internet connection to work.
- DRM Goal:
  - Defend copyright by making copied content defective and unusable.
- DRM Protected Products:
  - Products with DRM may come with a key for single user/device.
  - Apple Music uses DRM to prevent bulk downloads during a subscription.

7.2.3 Software licensing

- Commercial Software:
  - Available for a fee, includes single device or multi-use licences.
  - May be free if previous version purchased.
  - Fully copyright-protected, code use needs consent.
- Free Software & Open Source Initiative:
  - Promoted by non-profit organizations.
  - Emphasizes user freedom to run, copy, change, adapt software.
  - Examples: F-spot, Scribus, LibreOffice.
- Four Freedoms for Users:
  - Run software for any legal purpose.
  - Study and modify source code to meet needs.
  - Redistribute software copies to friends/family.
  - Distribute user-modified code to friends/family.
- No Need for Permission:
  - Users can follow four freedoms without seeking permission.
- Rules for Free Software Users:
  - Cannot add source code from non-free software.
  - Cannot copy software under copyright laws.
  - Cannot adapt source code to infringe on others' copyright.
  - Cannot produce offensive software using source code.

7.2.3 Software licensing

- Free Software Foundation vs. Open Source Initiative:
  - Both emphasize four freedoms, but with different philosophies.
  - Free Software Foundation focuses on what users are permitted to do.
  - Open Source Initiative emphasizes practical consequences for collaboration.
- Open Source Initiative's Ten Principles:
  1. Free Redistribution: No restriction on selling/giving software as part of aggregate distribution without royalty.
  2. Source Code: Program must include source code, accessible with reasonable cost, preferred for modifications.
  3. Derived Works: License must allow modifications and distribution under same terms.
  4. Integrity of Author's Source Code: Modified source code can be distributed, must allow software built from it.
  5. No Discrimination Against Persons or Groups: No discrimination against anyone.
  6. No Discrimination Against Fields of Endeavor: No restriction on program use in specific fields.
  7. Distribution of License: Rights apply without need for additional licenses.
  8. License Not Specific to a Product: Rights aren't tied to specific software distribution.
  9. No Restrictions on Other Software: License can't restrict other software on the same medium.
  10. Technology-Neutral License: License provisions can't depend on specific technology or interface style.

7.2.3 Software licensing

- Freeware:
  - Users can download from the internet free of charge.
  - No fees for using software (e.g., Adobe Reader, Skype, media players).
  - Subject to copyright laws, terms and conditions apply.
  - Users can't study or modify the source code.
- Shareware:
  - Trial period to try software for free.
  - Pay a fee after trial to continue use.
  - Paying gets registered with software's author, gets updates and help.
  - Copyright laws apply, can't use source code without permission.

7.3.1 Artificial intelligence (AI)

- Artificial Intelligence (AI):
  - Performs tasks requiring intelligence like humans.
  - Tasks include:
    - Using a language
    - Math calculations
    - Recognizing faces
    - Operating machinery (cars, planes, trains)
    - Analyzing data for predictions.
  - Duplicates human tasks with decision-making and problem-solving skills.

7.3.2 The impact of AI

- People often link AI with science fiction and robots due to movies and books.
- Author Isaac Asimov created his three laws of robotics:
  1. A robot may not harm a human through action or inaction.
  2. A robot must obey human orders without question.
  3. A robot must protect itself, unless it conflicts with the above laws.
- AI is not just about robots; it covers various areas like:
  - Autonomous (driverless) vehicles
  - Artificial limb technology
  - Drones for dangerous tasks (bomb disposal, welding)
  - Climate change predictions
  - Medical procedures, like precise eye operations.

7.3.3 The impacts of AI on society, the economy and the environment

- AI's Impact on Society, Economy, and Environment: As automation grows, we need to think about the effects of AI on society, the economy, and the environment.
- Exploring AI Technologies: We'll examine various AI technologies, including future predictions, to spark discussions.
- Diverse AI Fields: AI goes beyond robots, covering areas like:
  - Autonomous vehicles
  - Artificial limbs
  - Drones for tasks like bomb disposal
  - Climate change predictions
  - Medical procedures needing precision.
- Job Losses and Changes: Predictions indicate around 600 million job losses by 2030 due to AI advancements. High- and low-skilled jobs might be affected, potentially leading to unrest.

7.3.3 The impacts of AI on society, the economy and the environment

- History and New Jobs: Past technological shifts created more jobs. As automation takes over routine tasks, new roles arise in quality control and more engaging fields.
- Potential Job Elimination: Some forecasts suggest 99% of jobs could vanish due to AI growth. Robots building and maintaining each other could become reality.
- More Leisure Time: With increased AI, people might enjoy more leisure and a better lifestyle.
- Economic and Environmental Considerations: Embracing AI ensures economic growth, but we must weigh its environmental impact.
- Positive Environmental Effects: AI can enhance environmental understanding and action, such as:
  - Conserving natural resources
  - Precise pollution detection
  - Combining weather and renewable energy forecasting
  - Learning from nature's ecosystems for better environmental management.
- Upcoming Focus Areas: We'll delve into three significant areas where AI's impact could be substantial.

7.3.3 The impacts of AI on society, the economy and the environment

Transport:

- Driverless Taxis: Taxi companies are thinking about using driverless cars. Customers can call a taxi using their phone and it will arrive at the right spot with AI control.
- Autonomous Vehicles: Car makers might soon provide driverless cars, buses, and trucks, which could be more efficient but affect jobs.

Criminal Justice:

- Facial Recognition: AI is replacing fingerprinting in crime investigations.
- AI in Courts: AI is used to help with legal work and even decide sentences. Questions arise:
  - Online Searches: Does the government need permission to use AI for online data searches?
  - Privacy Concerns: Can AI listen to calls and read emails? Could criminals misuse it?
  - Challenging AI: How can people challenge AI legal decisions?
  - Avoiding Bias: How do we prevent biases in AI decisions? Some AI systems show prejudice.

Advertising and Data:

- Cambridge Analytica Case: AI could prevent misuse of data like the Cambridge Analytica scandal.
- Tailored Advertising: AI learns about people's interests for personalized ads. Data from searches, social media, and websites is analyzed by AI algorithms.