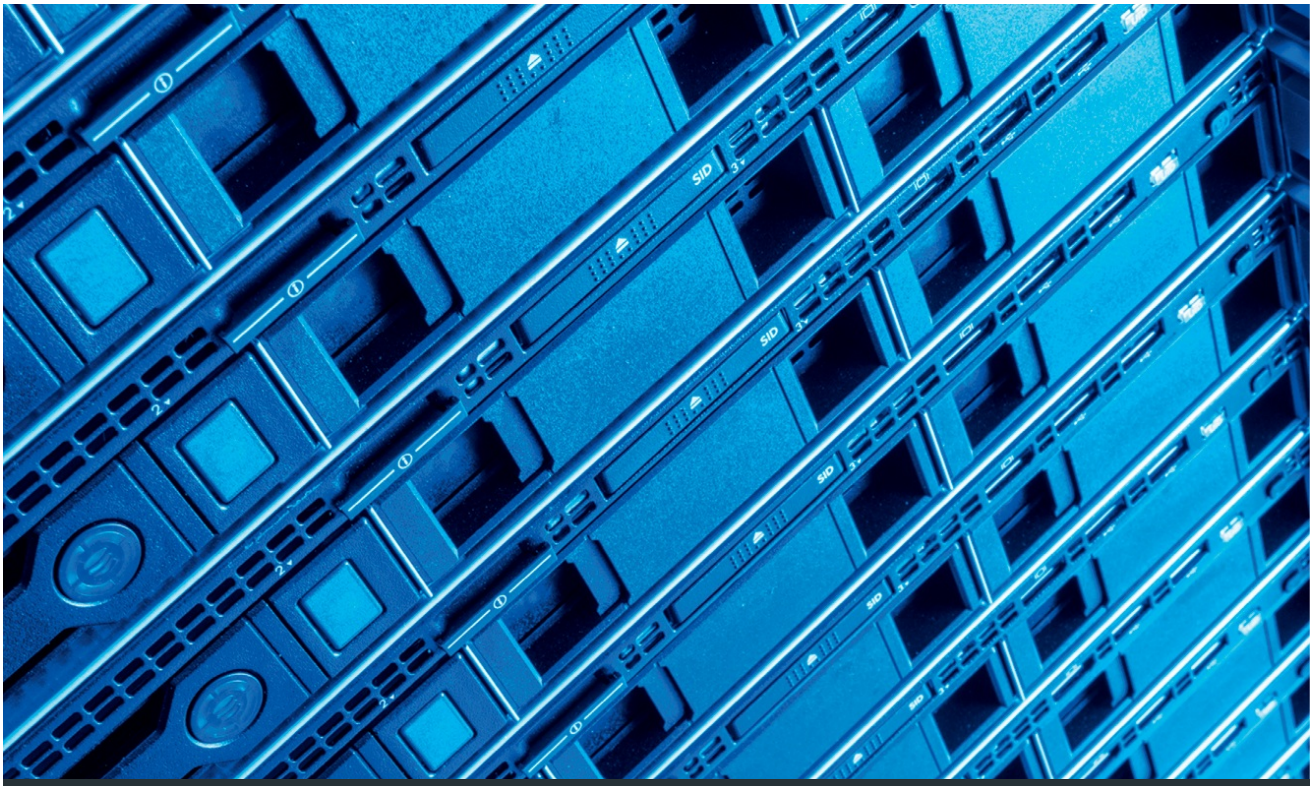

# Chapter 10:
# Ethics and ownership

## Learning objectives

***By the end of this chapter you should be able to:***

- show understanding of the need for and purpose of ethics as a computing professional
- show understanding of the need to act ethically and the impact of acting ethically or unethically for a given situation
- show understanding of the need for copyright legislation
- show understanding of the different types of software licencing and justify the use of a licence for a given situation
- show understanding of Artificial Intelligence (AI).

## 10.01 Ethics

You can find a number of definitions of ‘ethics’. The following three sentences are examples.

- Ethics is the field of moral science.
- Ethics are the moral principles by which any person is guided.
- Ethics are the rules of conduct recognised in a particular profession or area of human life.

In this book, we will not use the first definition. The third definition is the focus of this chapter. However, the rules of conduct of computer scientists and developers must reflect the moral principles of the second definition. Here are some observations that come to mind when considering moral principles.

Moral principles concern right or wrong. The concept of virtue is often linked to what is considered to be right. What is right and wrong can be considered from one of the following viewpoints: philosophical, religious, legal or pragmatic.

Philosophical debate has been going on for well over 2000 years. Early thinkers frequently quoted in this context are Aristotle and Confucius but there are many more. Religions have sometimes incorporated philosophies already existing or have introduced their own. Laws should reflect what is right and wrong. Pragmatism could be defined as applying common sense.

This chapter is not an appropriate place to discuss religious beliefs, but we should remember that religious beliefs do have to be considered in the working environment. Legal issues clearly impact on working practices but they are rarely the primary focus in rules of conduct. What remains as the foundation for rules of conduct are the philosophical views of right and wrong and the pragmatic views of what is common sense. These will constitute a frame of reference for what follows in this chapter.

## 10.02 The computing professional

No matter what their particular specialism is, any professional person is expected to act ethically. A professional can receive guidance on ethical behaviour by joining an appropriate professional organisation. Such an organisation will have a code of conduct that will include reference to ethical practice.

For example, the British Computer Society (BCS) has a code of conduct that gives guidance under four headings:

1. Public Interest
2. Professional Competence and Integrity
3. Duty to Relevant Authority
4. Duty to the Profession

The Association for Computing Machinery (ACM) and the Institute of Electrical and Electronics Engineers (IEEE) are both based in the USA but have a global perspective and global influence. The IEEE-CS/ACM Joint Task Force Software Engineering Code of Ethics defines eight principles defined as follows.

1. PUBLIC – Software engineers shall act consistently with the public interest.
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.
3. PRODUCT – Software engineers shall ensure that their products and related modifications meet the highest professional standards possible.
4. JUDGEMENT – Software engineers shall maintain integrity and independence in their professional judgement.
5. MANAGEMENT – Software engineering managers and leaders shall subscribe to and promote an ethical approach to the management of software development and maintenance.
6. PROFESSION – Software engineers shall advance the integrity and reputation of the profession consistent with the public interest.
7. COLLEAGUES – Software engineers shall be fair to and supportive of their colleagues.
8. SELF – Software engineers shall participate in lifelong learning regarding the practice of their profession and shall promote an ethical approach to the practice of the profession.

Despite the differences in the detail the codes are consistent with regard to the following:

- the public interest or public good is a key concern
- the codes present fundamental principles
- the professional is expected to exercise their own judgement
- the professional should seek advice if unsure.

**WORKED EXAMPLE 10.01**

### Applying ethics to a software engineering scenario

In a real-life scenario there might be many individual clauses that should be considered when a judgement is to be made. For example, let's consider the following scenario.

You are employed by a company that develops software. You are working on a software engineering project to be delivered to a client. One day the project manager states that the project is running behind schedule. As a result, the time allocated for testing of the software will be limited to one week rather than the one month that was stated in the project plan.

As a professional you could be guided in your thinking by referring to the eight principles listed above from the IEEE-CS/ACM Joint Task Force Software Engineering Code of Ethics.

Considering them in turn your thinking might be as follows:

1. You could probably rule out any immediate need to consider public interest.
2. You would recognise that the end result might be the client being delivered a sub-standard product that would reflect badly on the reputation of your employer.
3. You would identify the primary cause of concern as being the likely poor quality product likely to be delivered.
4. You would realise that you needed to make a judgement as to what action, if any, you should take.
5. You might identify the secondary cause of concern as being one of poor management.
6. You would have some concern concerning how delivering a product with many errors would cause your profession to be judged badly but this would not be a primary concern.
7. You would be concerned about your colleagues being put under pressure to deliver in an unrealistically short timescale.
8. You would recognise that this was not an issue relating to your professional development.

You would now consider what action to take. This is where you would need to make a judgement. You might consider four possible scenarios:

1. You decide that this unprofessional behaviour by the project manager must be challenged. Following this challenge the decision is reversed.
2. You decide that this unprofessional behaviour by the project manager must be challenged. However, your protests are ignored.
3. You decide that no challenge is needed because although the testing will not be properly completed there will always be the opportunity to remedy the remaining errors in the code through routine maintenance following product installation.
4. You decide that an immediate protest would be useless but you intend to raise the matter at a later time when the errors in the product have become evident.

The first scenario is the ideal one where the appropriate ethical action leads to a fully-tested product. In the second scenario the professional has acted ethically but this has had no effect. The question is now whether anything else ought to be done. The remaining two scenarios are where unethical behaviour leaves the outcome of an unsatisfactory product being provided for the client.

**Discussion Point:**

Search the clauses for all eight principles of the IEEE-CS/ACM Joint Task Force Software Engineering Code of Ethics code and identify the ones that mention documentation.

Why is documentation mentioned so many times?

## 10.03 The public good

In different parts of the IEEE-CS/ACM Joint Task Force Software Engineering Code of Ethics code there is reference to:

- the health, safety and welfare of the public
- the public interest
- the public good
- public concern.

The BCS code has the statement that the professional should:

'have due regard for public health, privacy, security and wellbeing of others and the environment'.

There is no further indication of how these should be interpreted. We can look at some individual cases to illustrate what might be considered.

Fortunately, there are very few examples which have involved loss of life and certainly none where large numbers of deaths were caused. However, there have been a number of incidents where extremely large sums of money were wasted because of rather simplistic errors.

The first example is the Ariane 5 rocket which exploded 40 seconds after blast-off in 1996. Approximately 500 million dollars' worth of investment in development, scientific equipment and launch costs were wasted. The problem was caused by a line of code that tried to convert a 64-bit floating point number into a 16-bit integer. The resulting overflow crashed the program and as a result also the rocket.

The second example also relates to space exploration. The NASA Mars Climate Orbiter project centred on a space probe that was due to orbit Mars to study the climate. The probe reached Mars but unfortunately failed to get into orbit. The cause of the problem was that all of the software was supposed to use the SI system of units for all calculations. One group of software engineers used the Imperial system of units. This mismatch only caused a problem at the stage when the calculations concerned with achieving orbit around Mars were executed. This time the loss to the public purse was 125 million dollars.

These examples illustrate the public interest in successful software engineering. There is a strong argument that the correct application of the code of ethics with respect to specification, development and testing of software could have saved a lot of money.

A different type of disaster is the system that never gets built. In 2011 the UK government scrapped the National Programme for IT in the NHS (National Health Service), which had been commissioned in 2002. The project failed to produce a workable system. The estimated amount spent on the program was 12 billion pounds. The initial estimated cost was less than three billion pounds. In examples like this the software engineers are not to blame, but if correctly applied, the part of the code of ethics specifically targeted at project management would not have allowed this type of failure to occur.

In the three examples outlined above, the public concern was solely related to the costs associated with a failed project. There was no public concern relating to the ethics of the endeavour itself. In contrast there are many areas associated with computer-based systems where there is public concern about the nature of the endeavour or at least about what it has led to. Here are some examples:

- powerful commercial companies being able to exert pressure on less powerful companies to ensure that the powerful company's products are used when alternatives might be more suitable or less costly
- companies providing systems that do not guarantee security against unauthorised access
- organisations that try to conceal information about a security breach that has occurred in their systems

- private data transmitted by individuals to other individuals being stored and made available to security services
- social media sites allowing abusive or illegal content to be transmitted
- search engines providing search results with no concern about the quality of the content.

There is by no means a consistent public attitude to concerns like this. This makes it difficult for an individual software engineer to make a judgement with respect to public good. Even if the judgement is that a company is not acting in the public good, it will always be difficult for an individual to exert any influence. There are recent examples where individuals have taken action which has resulted in their life being severely affected.

**Discussion Point:**

This section has deliberately been presented in generalisations. You should carry out a search for some individual examples and then consider actions that could have been taken and justified as being for the public good.

## 10.04 Ownership and copyright

**Copyright** is a formal recognition of ownership. If an individual creates and publishes some work that has an element of originality, the individual becomes the owner and can therefore claim copyright. An exception is if the individual is working for an organisation. An organisation can claim copyright for a published work if it is created by one or more individuals that work for the organisation. Copyright cannot apply to an idea and it cannot be claimed on any part of a published work that was previously published by a different individual or organisation.

Copyright can apply to any of:

- a literary (written) work
- a musical composition
- a film
- a music recording
- a radio or TV broadcast
- a work of art
- a computer program.

The justification for the existence of copyright has two components. The first is that the creation takes time and effort and requires original thinking, so the copyright holder should have the opportunity to earn money for it. The second is that it is unfair for some other individual or organisation to reproduce the work and to make money from it without any payment to the original creator.

As with the case of data protection discussed in Chapter 9 (Section 9.01), laws are needed to protect copyright. Different countries have different details in their laws but there is an international agreement that copyright laws cannot be avoided, for example by someone publishing the work in another country without the original copyright holder's permission.

Typical copyright laws will include:

- a requirement for registration recording the date of creation of the work
- a defined period when copyright will apply
- a policy to be applied if an individual holding copyright dies
- an agreed method for indicating the copyright, for example the use of the © symbol.

When copyright is in place there will be implications for how the work can be used. The copyright owner can include a statement concerning how the work might be used. For instance, the ACM has the following statement relating to the code of ethics discussed in Section 10.02:

This Code may be published without permission as long as it is not changed in any way and it carries the copyright notice. Copyright © 1999 by the Association for Computing Machinery, Inc. and the Institute for Electrical and Electronics Engineers, Inc.

This is one of several possible variations referring to permissions that are granted when the work has not been sold. If someone has bought a copy of a copyrighted product there is no restriction on copies being made provided that these are solely for the use of the individual. A general regulation relates to books in a library, where a library user can photocopy part of a book.

# 10.05 Software licensing

## Commercial software

In one respect commercial software is no different to any other commercial product. It is created and made available for sale by a company that is aiming to make a profit. There is, however, a significant difference. If you buy a computer you become the owner but if you buy software you do not become the owner. The ownership remains with the vendor. As a buyer you have paid for an end-user licence that allows you to use the software. It is normal that the software license has to be paid for but there are a number of different options that might be available:

- A fee is paid for each individual copy of the software.
- A company might have the option of buying a site licence which allows a defined number of copies to be running at any one time.
- Special rates might be available for educational use.

A company that normally sells the software licence may sometimes provide a license free of charge. There are two possibilities. **Shareware** is commercial software which is made available on a trial basis for a limited time. It might be the full package available at the time or a limited version of it. A beta test version of new software might be considered to come in the shareware category. **Freeware** might be a limited version of a full package or possibly an earlier version. The difference is that there is no time limit for the licence.

Whatever license is obtained by the user of the software the source code will not be provided and the license will define limitations on the use of the software.

Examples of when using commercial software can be justified include:

- The software is available for immediate use and provides the functionality required
- The software has been created to be used in conjunction with already installed software
- There will be continuous maintenance and support provided
- Taking advantage of a shareware offer might allow suggestions to be made as to how the software could be improved
- Freeware can often offer sufficient functionality to serve a user’s limited needs.

## Open or free licensing

For open licensing there are two major operations under way. Both are global non-profit organisations. They are very similar in what they provide but there is a difference in their underlying philosophies.

The Open Source Initiative makes **open source software** available. The philosophy here is that the use of open source software will allow collaborative development of software to take place. The software is normally made available free of charge. The source code is provided. The user of the software is free to use it, modify it, copy it or distribute it in accordance with the terms defined by the license.

The Free Software Foundation is so-named because the philosophy is that users should be free to use software in any way they wish. The software is not provided entirely free of charge; there is a small fee to cover distribution costs. The **free software** is still open source. However, there is a special feature of the license which is called ‘copyleft’. This is the condition that if the software is modified the source code for the modified version must be made available to other users under the same conditions of usage.

Examples of when using open source software can be justified include:

- The full functionality needed can be provided for at most a nominal cost
- The software could provide the required functionality with just a few modifications to the source

code

- A consortium of developers are collaborating in producing a new software suite
- The future development of the software or the continuous provision of the existing software is controlled by the user.

**Discussion Point:**

How often do you think that open licence software is being used? Should it be used more often?

**TASK 10.01**

Carry out a search to investigate some of the software available under an open licence.

# 10.06 Artificial intelligence (AI)

Artificial intelligence (AI) depends on and draws from many other disciplines including: philosophy, psychology, neuroscience, mathematics, linguistics and control engineering. The only definitions of AI that are acceptable are at the same time so generalised that they are not very practical. The following is a typical example:

AI concerns the use of a computer or computer-controlled device to perform tasks normally associated with intelligent behaviour by humans.

We will consider five aspects of intelligent human behaviour and discuss some applications of AI that mimic this human behaviour.

## Problem solving

One example is the development of a system that can play chess. This can be considered as displaying artificial intelligence but this is only demonstrated because the rules of chess are limited. A computer with sufficient storage capacity and processing power can investigate so many options for a possible sequence of moves that a human cannot compete.

A second example is the traditional form of expert system that, for example, has been developed to aid medical diagnosis. This is supplied with data and rules from living medical experts. The expert system contains more knowledge than is possible for an individual doctor to have. However, if the expert system is given a new situation that is not covered by the data and rules it has been given, it cannot attempt a new or creative approach – unlike a human.

## Linguistics

Voice recognition and voice synthesis techniques are already developed and in use. One example is if you phone a help line where you might be answered by a computer. Provided that you answer questions clearly the computer might be able to identify your needs and pass you on to an appropriate human who can help. However, this is a long way away from the computer itself creating new questions based on your answers and providing the help you need.

## Perception

Traditionally robots have been used in manufacturing processes. Here the robot is programmed to perform repetitive tasks. The action of the robot each time is triggered by some mechanism. However, if anything unexpected happens the robot continues to operate as normal, regardless of any damage being caused.

There is now much research focussed on the development of autonomous robots. These have to be fitted with sensors to enable the robot to take appropriate action depending on the information received from the sensors. This is an example of perception in AI.

A development of this concept is the driverless car. There are several examples available or in development but so far they have only been able to perform limited tasks. An example is the capability for a car to park itself in a vacant parking space.

## Reasoning

There are examples of the application of AI where a program has been able to draw inferences (reach conclusions based on evidence) which is a requirement for reasoning. The best examples concern the proving of mathematical theorems. Attempts have also been made to develop techniques that can verify that software that has been created does indeed correctly and fully match the documented specification.

## Learning

This is currently a very active area for the application of AI techniques. Machine learning is said to take place if a system that has a task to perform is seen to improve its performance as it gains experience.

The AI system has access to ‘experience’ in the form of a massive set of data. By the use of appropriate statistical algorithms the system learns from this data.

One example is when the actions of users visiting websites to buy products are stored. The AI system then attempts to identify appropriate products to be advertised when a user returns to the website. If sales progressively increase there is evidence that learning is taking place.

Another example is the program that investigates incoming emails and makes decisions as to whether these can be classified as spam and therefore should be refused entry to the user inbox.

### The impact of AI

The use of the Internet dominates the lives of a large proportion of the world’s population. Global organisations that provide the systems underpinning this user activity are collecting and storing massive amounts of data concerning how the Internet is being used. If this data is only being used to enable the organisation to increase its profits, this could be seen as normal business practice. However, if the data is not being securely stored it could get into the wrong hands and be used for criminal or subversive activity.

There are different concerns with respect to the introduction of autonomous mechanical products such as robots, robotic devices and driverless vehicles into our daily lives. There are arguments that technological developments lead to employment of more people to manufacture, service and install the new products. There is a further argument that more technology leads to less manual labour and therefore to increased leisure time. One counter argument is that more technology leads to fewer jobs because machines are doing the work. Another is that such developments simply make the rich richer and the poor poorer.

Some people are excited by the introduction of driverless vehicles, but other people believe that the potential for accidents will be increased and that there are not enough measures to prevent accidents.

Robots can be used in environments that would be dangerous for humans to enter. Giving the robot the capability to act autonomously would make it more useful in such environments.

The environmental impact of robot manufacture and disposal is probably the most significant issue. Robots are manufactured and require materials for their construction. There is only a limited supply of the raw materials needed. Also, all mechanical and electronic devices eventually end up on the scrap heap contributing to the already serious problem of waste products harming the environment and creatures living in this environment.

The use of improved expert systems to aid practising doctors and nurses is clearly a benefit. However, if these systems came to replace doctors and nurses the social consequences are difficult to predict.

**Discussion Point:**

Have you seen any recent information about new developments in AI?

**Reflection Point:**

Is there an organisation in your country for professional computer scientists? If so, does it encourage young people to join?

## Summary

- There are different definitions of ethics.
- Professional organisations provide rules of conduct that include guidance on ethical behaviour.
- There is a history of software disasters that might have been prevented if good software engineering practice had been employed.
- Copyright is formal recognition of ownership.
- The use of software is controlled by a license
- Only open source software is provided with the source code which allows freedom of usage
- Artificial Intelligence is currently mainly focused on the development of autonomous mechanical products and machine learning based on access to massive data sets.

## Exam-style Questions

**1** **a** Complete the following sentences:

**i** As a computer professional your primary concern when faced with an issue should be

.....

**ii** If an issue arises you should exercise your ..... and possibly seek

.....

**iii** You have a responsibility to act in accordance with the welfare of

.....

**iv** You are expected to act in the interests of your ..... and of your

.....

**v** You should not accept ..... for which you lack

..... [8]

**b** Explain **two** reasons why documentation is mentioned so often in the ACM/IEEE code of conduct. [4]

**2** **a** Copyright is an important consideration when something is created.

**i** State what copyright primarily defines. [1]

**ii** When copyright is registered, some data will be recorded. Identify **two** examples of the type of data that would be recorded. [2]

**iii** Copyright legislation defines two conditions that will apply to the copyrighted work. Identify **one** of these. [1]

**iv** When copyright has been established there are options for how usage will be controlled. Give **two** alternatives for the instructions that could be included in the copyright statement for the created item. [2]

**b** When software is obtained there will be an associated licence defining how it can be used.

**i** For commercial software, describe **two** different ways in which the licence might be applied and explain the benefits to the customer of one of these. [4]

**ii** Define the difference between freeware and shareware. [2]

**3** Identify **two** applications of artificial intelligence. For each one identify an aspect of human intelligence that the application mimics. Either explain how the application will be a benefit or explain why there would be concern about its use. [8]

**4** Bobby is a senior programmer at a software house which produces intruder detection software.

He also runs his own software company which develops and sells various computer applications.

The following table shows seven activities which Bobby carries out.

Put a tick (✓) in the appropriate column to identify if the activity is ethical or unethical.

| **Activity** | **Ethical** | **Unethical** |
|---|---|---|
| Gives away passwords used in the intruder detection software | | |
| Uses source code developed at the software house for the software he develops for his own company | | |
| Insists that staff work to deadlines | | |
| Turns down training opportunities offered by his employer | | |
| | | |

| | | |
|---|---|---|
| Writes and sells software that reads confidential data from client computers | | |
| Fakes test results of safety-critical software | | |
| Has the software applications developed overseas for sale in his own country | | |

[7]

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**5** A team of software engineers is developing a new e-commerce program for a client.

State **three** of the principles of the ACM/IEEE Software Engineering Code of Ethics. Illustrate each one, with an example, describing how it will influence their working practices. [6]

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