STADIO

Fundamentals of Information Technology
FIT152

Note

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This Study Guide should be read in conjunction with prescribed eBook readings that are downloadable for free from the STADIO Online library. You can find the list with specific instructions in the References section of this Study Guide. We suggest that you download these prescribed resources before you start reading this Study Guide. To access some of the eBooks you must also download and install the latest version of the Adobe Digital Editions eBook reader. This is a once-off process and will enable you to read all subsequent books requiring this reader without downloading it again. You will get clear instructions on how to download this software when this is necessary.

Links to websites and videos were active and functioning at the time of publication. We apologise in advance if there are instances where the owners of the sites or videos have terminated them. Please contact us in such cases.

A Glossary of terms is provided at the end of this study guide to clarify some important terms.

Any reference to the masculine gender may also imply the feminine. Similarly, singular may also refer to plural and vice versa.

Throughout all Topics of this Study Guide, reference will be made inside a lined box marked “Prescribed Reading” to any one of several books, which are all downloadable from the STADIO library for free. It is suggested that you download them once (as described in the “Reference” section of this study guide), name them as done in the “Reference” section and refer to them later when necessary. Note that you should be logged in to your STADIO account before trying to download most books from the library.

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Module purpose and outcomes

The focus of this module is to provide you with a wide introduction to concepts like Information Technology (IT), Computer Science (CS), Software Engineering (SE), Information Systems (IS), Cognitive Science (CS) and Computer engineering (CE). Basic mathematics and statistics are also covered (whole numbers, fractions, decimals, graphs and measures of central tendency). Not only basic theory is included, but many practical examples are provided.

This module covers the following topics:

1. Information Technology
2. History of Information Technology
3. Characteristics of IT systems
4. Development and deployment of IT systems
5. Application domains

Module purpose

The increased importance and global reach of computing technology today was the basis for the emergence of the IT discipline. IT is the study of systemic approaches to select, develop, apply, integrate, and administer secure computing technologies to enable users to accomplish their personal, organizational, and societal goals.

This module provides an overview of the discipline of IT, and how it relates to other computing disciplines. The goal is to help you understand the diverse contexts in which IT is used and the challenges inherent in the diffusion of innovative technology.

Module outcomes

Upon successful completion of this course, you should be able to:

1. Demonstrate an understanding of the relationship between IT and related and informing disciplines.
2. Demonstrate insight in the history of computing technology, and an understanding of the Internet, and the World-Wide Web, as well as the

components of an IT system and how they interrelate.

3. Demonstrate an understanding of complexity in an information technology environment and how and why it occurs.
4. Demonstrate an understanding of why life-long learning and continued professional development are critical for an IT professional.
5. Illustrate the use of Information and Communication Technologies (ICT) to solve problems.
6. Demonstrate an understanding of how and to what extent IT has changed various application domains.

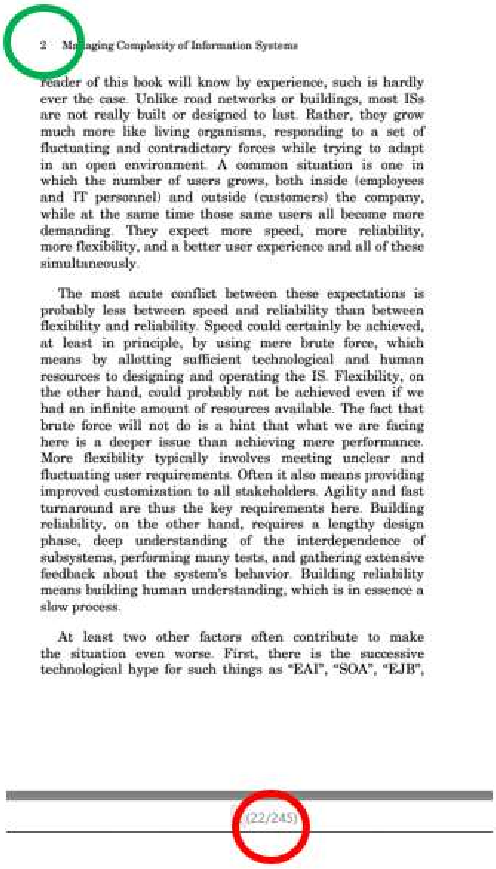
Prescribed reading

Prescribed reading sources are listed in the References section of this Study Guide. These readings are downloadable for free from the STADIO Online Library.

NOTES on page numbers:

a. Whenever reference is made in the text of this Study Guide to any page number in a book, it always refers to the actual page number printed on the top/bottom of the page on your screen (see the green circle in Figure 15), and not to the page number displayed by your eBook or PDF reader program (see the red circle in Figure 15). These two sets of page numbers might differ – hence this arrangement, to prevent confusion.

b. If you want to print out sections of a book, you might have to use the page numbers supplied by, for example, Adobe Digital Editions (see the red circle in Figure 15).



2 Managing Complexity of Information Systems

reader of this book will know by experience, such is hardly ever the case. Unlike road networks or buildings, most ISs are not really built or designed to last. Rather, they grow much more like living organisms, responding to a set of fluctuating and contradictory forces while trying to adapt in an open environment. A common situation is one in which the number of users grows, both inside (employees and IT personnel) and outside (customers) the company, while at the same time those same users all become more demanding. They expect more speed, more reliability, more flexibility, and a better user experience and all of these simultaneously.

The most acute conflict between these expectations is probably less between speed and reliability than between flexibility and reliability. Speed could certainly be achieved, at least in principle, by using mere brute force, which means by allotting sufficient technological and human resources to designing and operating the IS. Flexibility, on the other hand, could probably not be achieved even if we had an infinite amount of resources available. The fact that brute force will not do is a hint that what we are facing here is a deeper issue than achieving mere performance. More flexibility typically involves meeting unclear and fluctuating user requirements. Often it also means providing improved customization to all stakeholders. Agility and fast turnaround are thus the key requirements here. Building reliability, on the other hand, requires a lengthy design phase, deep understanding of the interdependence of subsystems, performing many tests, and gathering extensive feedback about the system's behavior. Building reliability means building human understanding, which is in essence a slow process.

At least two other factors often contribute to make the situation even worse. First, there is the successive technological hype for such things as "EAI", "SOA", "EJB",

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Figure 15: Page numbering (Source: Printz et *al,* 2020).

Topic 1: Information Technology (IT)

1.1 INTRODUCTION

This topic relates to the following module outcomes:

Demonstrate an understanding of the relationship between IT and related and informing disciplines

In this topic, you will gain knowledge in the following areas:

1. Definition of IT
2. Computer Science
3. Software Engineering
4. Information Systems
5. Cognitive Science
6. Computer Engineering
7. Mathematics and Statistics

1.2 DEFINITION OF IT

Information Technology (IT) is arguably one of the widest and most misunderstood subdivisions of study and work in our modern world. Every second person claims to be an "IT expert", and while many of them are in fact experts, some are just using the IT nickname to add value to a title.

Searching for a definition of IT you can start with a "Google search", but at this stage let us suffice to say that IT can be viewed as the use of computers to make humans more productive in their daily and working lives, by allowing them to create information, store it, process it and retrieve it again at a later stage. See Figure 1 for an overview of what IT involves.

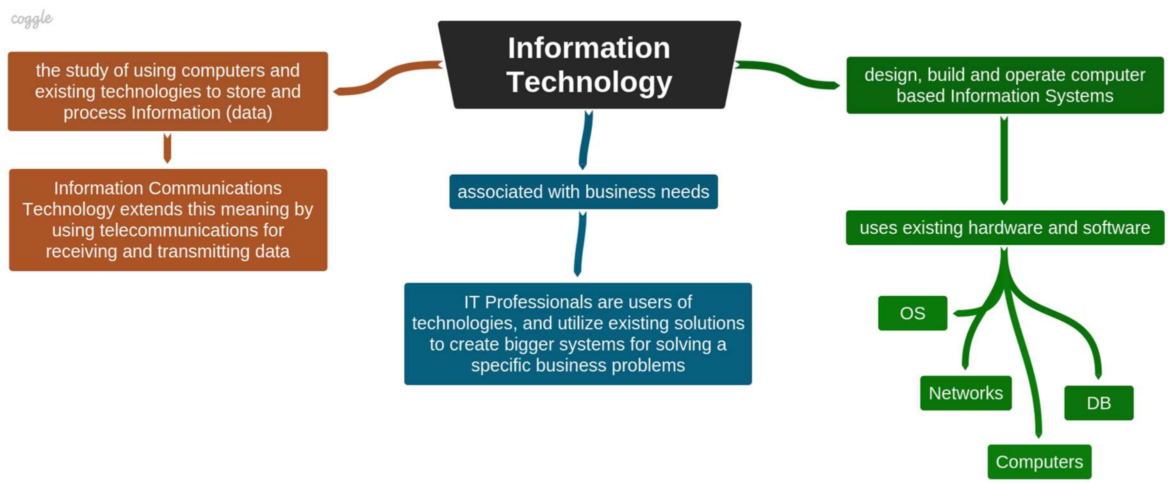

Figure 1: What IT looks like (Source: https://dev.to/vorakl/computer-science-vs-information-technology-1idn, October 2022).

Note

IT is not something for professional users only – it is meant to make life easier and more productive for every human being on earth. It is something you have probably come across somewhere in your normal daily life.

To enable you to get a better picture of the IT industry, please complete the following activities:

Activity

Watch this video (4m30s), which explains Information Technology: https://www.youtube.com/watch?v=XZrckLYqdys. While watching the video, compare the content of the video with Figure 1.

Watch this video (9m30s), which considers various positives and negatives of working in the IT industry: https://youtu.be/2WB6RcY0MPc. While watching the video, ensure that you make a list of the positives and negatives.

1.3 COMPUTER SCIENCE (CS)

Whereas IT is a general term referring to the use of computers, CS is more specific, as it refers to using a computer to amongst other things, design programs in a given programming language, to execute on a computer to perform a certain function. CS includes the study of algorithms and data structures and various other topics like artificial intelligence and machine learning.

In a broad sense, CS can also include the study of computer hardware and how the components function together to form a working computer.

CS can be viewed as part of a group of five different but related disciplines: information systems (IS), software engineering, computer engineering, CS and IT. See Figure 2 for an indication of what CS involves.

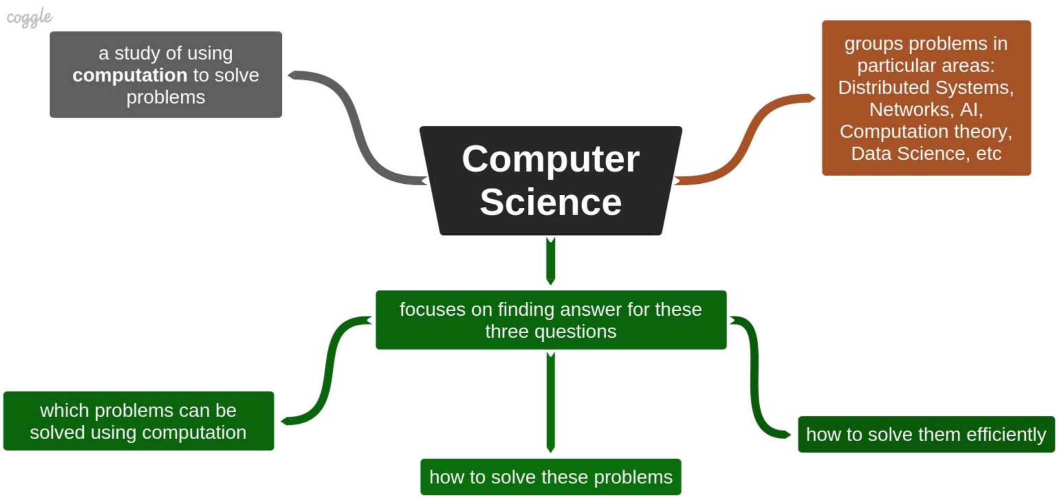

Figure 2: What CS looks like (Source: https://dev.to/vorakl/computer-science-vs-information-technology-1idn, September 2022).

Activity

Let us look at typical jobs you can consider in the CS world and the job opportunities available today. Watch this video (4m14s), which looks at work in the CS world: Is Computer Science Worth It? Retrieved from: https://youtu.be/srUFc7Tg50I. Make a list of all the CS jobs mentioned in the video.

Note

CS is a very specific field of study, and it is unlikely that you have stumbled across it during your everyday life, except if you have studied it specifically.

At this point you may ask: what is the difference between IT and CS? The answer is simple: where IT focuses on working with computers to find solutions to problems, CS focuses on the theory and design of computers and algorithms. See Figure 3 for a comparison between the two.

	INFORMATION TECHNOLOGY	COMPUTER SCIENCE
WHO THEY ARE	Technology Implementers & Practitioners	Technology Designers & Developers
CAREER FOCUS	IT professionals use computer systems, software, and networks to process and distribute data. They find technological solutions for business needs by adapting, deploying, and maintaining the operating systems and programs designed by computer scientists. IT has become a crucial element of everyday operations and business growth—for small and large businesses alike.	Computer Science professionals study the design and purpose of computers, especially the mechanics of computation, data processing, and systems control. They understand the intricacies of computer theory and master the mathematical algorithms necessary to write code and develop innovative computer hardware, software programs, and operating systems.

Figure 3: The difference between IT and CS (Source: https://www.easyuni.com/computer-science-and-information-technology/, September 2022).

1.4 SOFTWARE ENGINEERING

Software Engineering is another new term which sounds like IT and CS, which we have just covered. Some people consider software engineering (SE) to be part of CS, since it involves the development of new software, using an engineering approach. Again, some people consider the terms software engineer and "programmer" to be synonyms. However, the term "programmer" might not explain that an engineering education and skills are typically also required for this job. The best way to describe SE is by interpreting Figure 4, which lists the typical components of SE.

Note

The terms "software engineer" and "programmer" are sometimes used interchangeably.

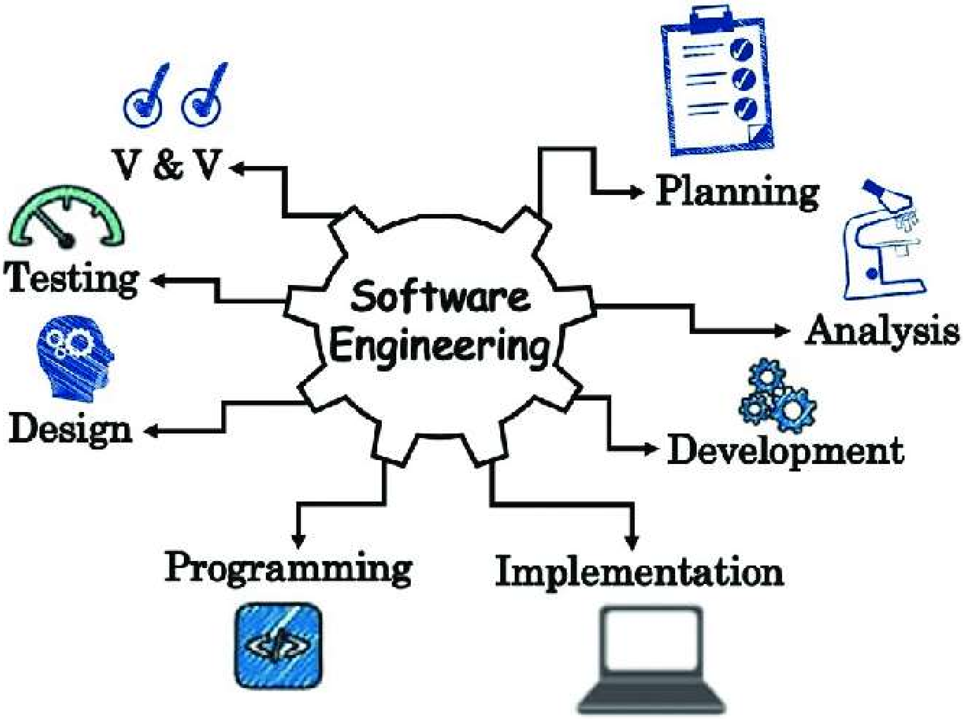

Figure 4: The components of software engineering (Source: https://www.researchgate.net/publication/342457338_Artificial_intelligence_in_software_engineering_and_inverse_review, September 2022).

If you have to provide a full definition of a software engineer, this adapted definition can be used: A software engineer is a person who designs, develops, tests, and maintains software applications. Software engineers apply engineering principles and knowledge of programming languages to build software solutions for end users. (Adapted from: https://www.coursera.org/articles/software-engineer)

It is clear from what we have seen so far that SE involves the writing of computer programs. By breaking the term SE up, we get two components:

- software and

- engineering.

Software is simply a collection of computer coding which, when executed, performs a certain very specific function, while engineering refers to the development of specific products using the best practice of design (in this case, best practice of programming). Software engineers need to be oriented towards problem solving and approaching problems strategically.

Activity

Watch this video (9m48s), which gives a realistic picture of what software engineers do: What do I do in my job (as a software engineering). Retrieved from: https://www.youtube.com/watch?v=YAWuyx8k6fw. Summarise what a day in the job of a software engineer looks like.

Activity

Terms often found in the SE industry are "front-end" and "back-end" development. There are three sides to this coin: front-end, back-end and DevOps. For a discussion on what the first two are, read this article (estimated time: 15m.): https://www.geeksforgeeks.org/frontend-vs-backend/

For more on DevOps: download and read the white paper on DevOps here (estimated time: 20m.):

https://www.dynatrace.com/monitoring/solutions/devops-wp/

Also see this website for more on the difference between the three, and for a look at the famous yellow/orange roadmaps you often see on the walls in many IT Departments (estimated time: 10m.):

https://dev.to/mahmoudessam/roadmap-for-frontend-backend-devops-python-1cd3

At this point we should compare CS to SE for better understanding about the differences between the two. See Figure 5 for such a comparison.

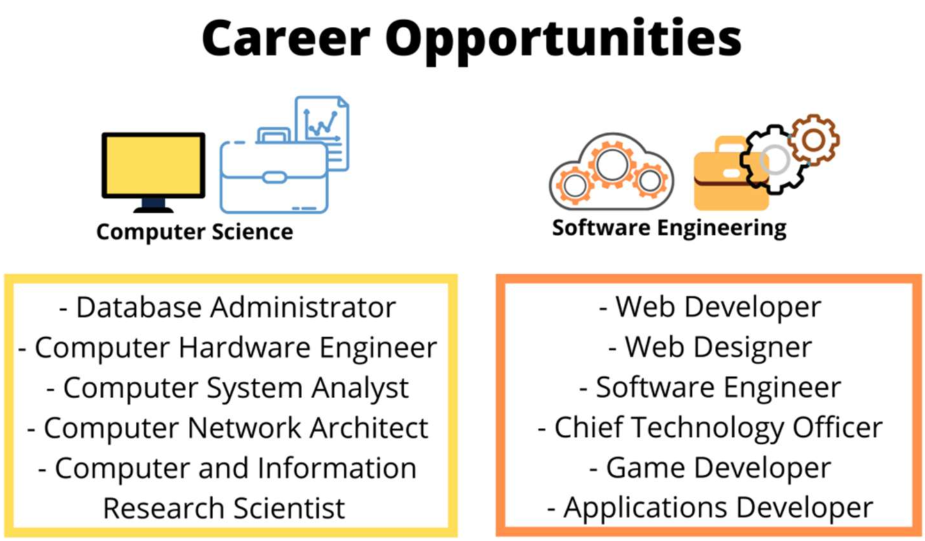

Figure 5: CS versus SE (Source: https://www.e2studysolution.com/news/computer-science-vs-software-engineering-what-are-the-differences/, September 2022).

1.5 INFORMATION SYSTEMS

Another new term! And again, it sounds very similar to the previous three (IT, CS and SE). And yet again, it is another similar but different concept.

Definitions of an information system (IS) are many and varied. In its simplest form, an IS is simply a collection of hardware, software, people, networks, and data (see Figure 6).

Note

IS's are everywhere, and you have probably worked on one without knowing it. See Figure 7 for some examples you might recognise.

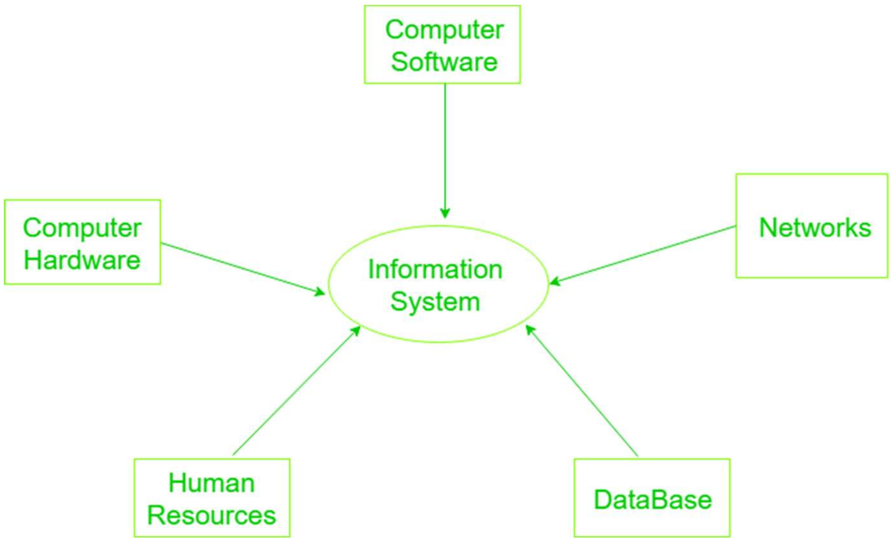

Figure 6: What an IS looks like (Source: https://www.geeksforgeeks.org/components-of-information-system/, October 2022).

There are many kinds of information systems, normally categorized based on what their purpose is – see Figure 7.

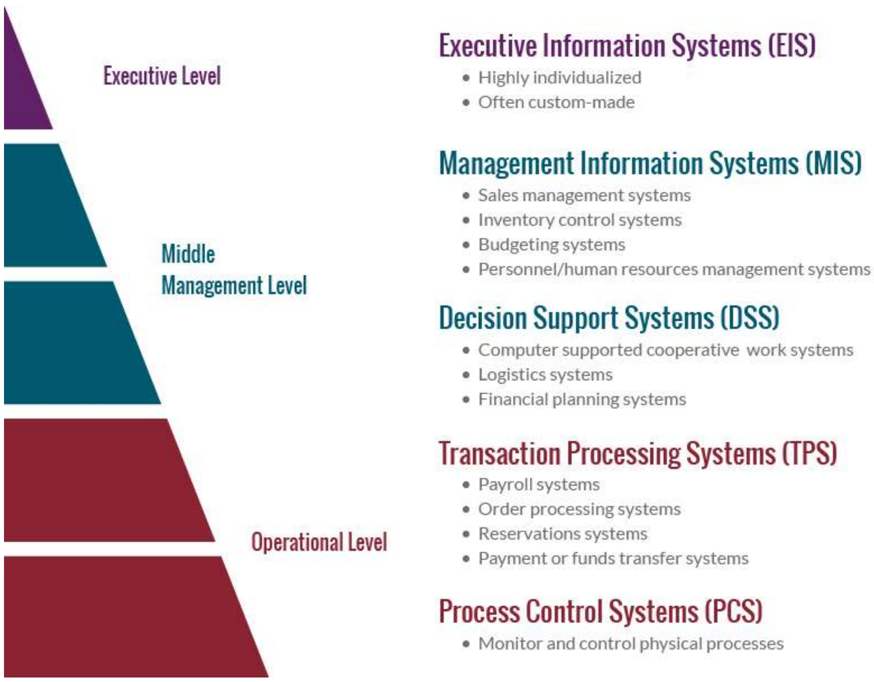

Figure 7: Types of IS's (Source: https://www.floridatechonline.com/blog/information-technology/5-types-of-information-systems/, October 2022).

Note

ISs come in many shapes and sizes, depending on what their purpose is. Any one organisation often has more than one IS, accessible from their website (normally through a login).

ISs are quite common, and if you work in a large organisation, you have probably used one or more of its IS's, like an HR or a budgeting or a payroll system.

To enable you to get a better picture of what an IS is, please complete the following activity:

Activity

Watch this video (2m58s), showing us what an IS is, and how they are used in our everyday lives: What is an Information System? Retrieved from: https://youtu.be/Qujsd4vkqFI

Prescribed Reading

Read Chapter 1, specifically 1.1 to 1.6 (pages 1.1.1 to 1.5.1), of this book: Pham2021.

1.6 COGNITIVE SCIENCE

As the name suggests, cognitive science has to do with the human brain, how it functions, and how we use it to learn more and store information about something. Cognitive science is a highly interdisciplinary field of study, drawing on other areas like linguistics, neuroscience, philosophy, artificial intelligence and psychology. See Figure 7 for a presentation of how cognitive science uses other areas to inform it.

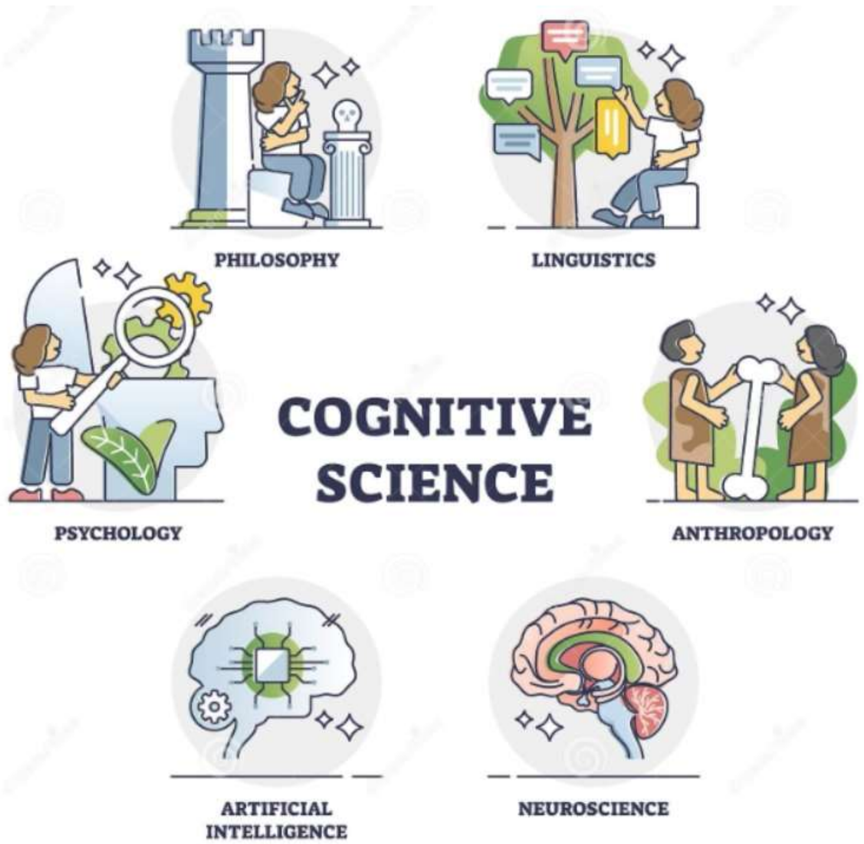

Figure 8: Some of the inputs from other fields into cognitive science (Source: https://www.dreamstime.com/cognitive-science-as-interdisciplinary-study-mind-outline-collection-set-cognitive-science-as-interdisciplinary-study-mind-image229491006, October 2022).

The word "recognition" is based on the word "cognition", and refers to the way we look at something, understand what it is, and learn more in the process.

You might come across some descriptions which refer to the fact that cognitive science is also about the way we perceive and think about things.

Activity

You should know more about cognitive science, since it will help you understand more about how we all learn. Watch this video (7m28s) to assist you in this process: Cognitive Science: What Is It and Why Is It Important? Retrieved from: https://www.youtube.com/watch?v=OtU9yJNF5QY

Activity

At this point you should use any big search engine (like Google {www.google.com}, Bing {www.bing.com} or Duckduckgo {www.duckduckgo.com}) to find and study more definitions of cognitive science. Try using search queries like: *definition of cognitive science* OR *what is cognitive science?* (Estimated time: 15m.)

1.7 COMPUTER ENGINEERING

Computer engineering is a combination of electrical engineering and computer science, which considers the design and implementation of logic devices and software, to form a fully functional computer. A computer engineer works on an entire computer system, including hardware and software.

Note

A computer engineer's working life often starts by completing at least a relevant bachelor's degree.

As in most other fields of work, computer engineers often specialise in one or more directions. These could include:

- Embedded systems (computer hardware and software designed for use in a specific device, like a digital alarm system, a cell phone, or a video recorder).
- VLSI (very large-scale integration). This involves the inclusion of many functions on a single chip used in some device.
- Multimedia (this could include the retrieval of multimedia information from a database, and the processing of multimedia information).
- Networking (this could include wide area and local area networks, mobile and wireless technology, and other telephony services.

See Figure 9 for more details about the work of a computer engineer.

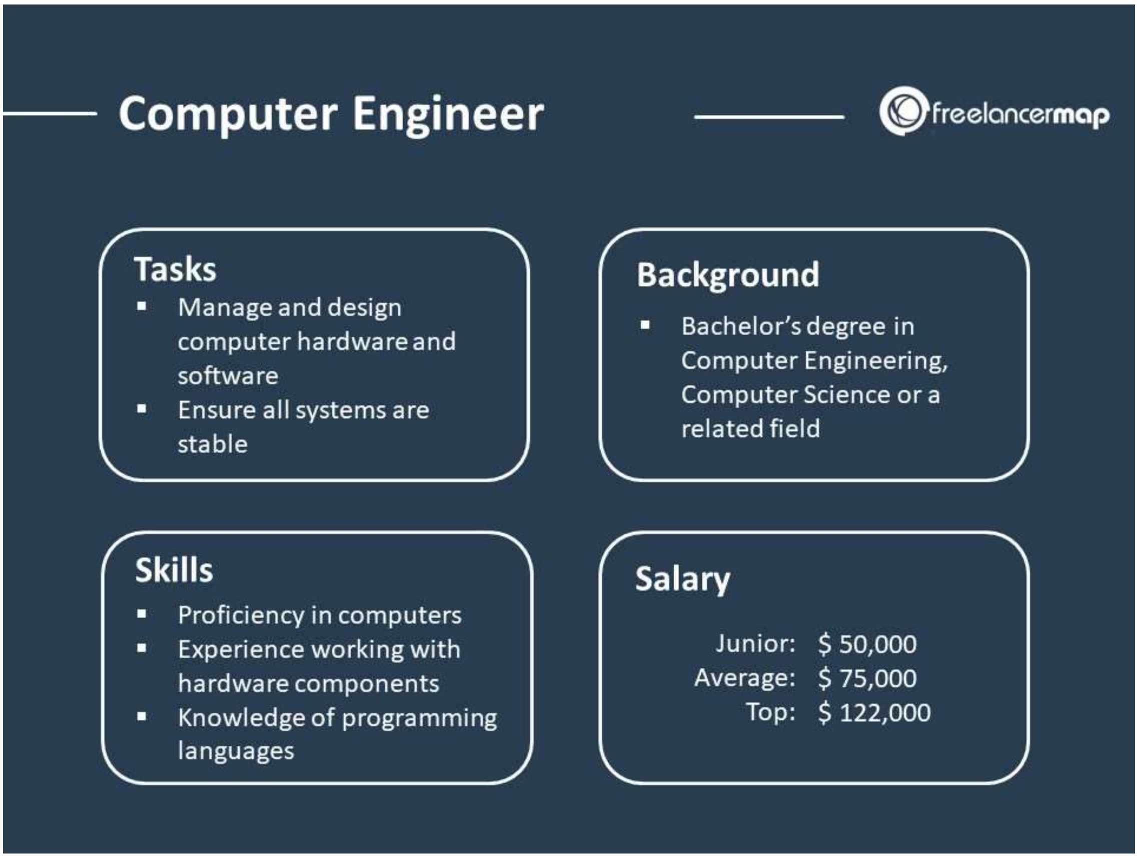

Figure 9: More details about a typical Computer Engineer's job (Source: https://www.freelancermap.com/blog/what-does-computer-engineer-do/, November 2022).

1.8 MATHEMATICS AND STATISTICS

MATHEMATICS

It is assumed that you are familiar with the basics of mathematics (things like whole numbers, fractions, decimals, percentages, equations, formulas, and the use of graphs). However, if you feel that you are a bit rusty, go through these basics again, as indicated in the "Prescribed Reading" blocks below.

Activity

Watch this video (10m40s), which explains some basic mathematical concepts you must be familiar with: Math Foundations – Basic Math Skills every Adult should know. Retrieved from https://youtu.be/F0X5xY_2c-c

Prescribed Reading

First read Truchon1997, p1 to p6.

A **whole number** is simply any (positive) number which does not have a fraction or a decimal point or comma. The following are all whole numbers: 0, 1, 2, 3, 4, 5, 6, 7, etc. Numbers like -5, 3.1, or 5 ¼ are therefore not whole numbers.

Prescribed Reading

Now read the section on whole numbers of this book: Truchon1997 (pages 7 to 21, both included). Initially you may skip the exercise sections (marked Exercise 1.1, 1.2, etc). You will be doing these Exercises in the Self-Assessment questions at the end of this section.

A **fraction** is any number which is not a whole number and is expressed as a proportion of a whole number. Numbers like 3.1, 2 ¼ and 0.7 are therefore fractions.

Prescribed Reading

Now read the section on fractions of this book: Truchon1997 (pages 22 to 38, both included). Initially you may skip the exercise sections (marked Exercise 1.1, 1.2, etc). You will be doing these Exercises in the Self-Assessment questions at the end of this section.

A **decimal** is part of a number which is expressed as a component of a whole number based on the number ten, or powers of ten. The moment we start working with decimals, we have to use some symbol to show where the decimal number starts. Often a full-stop or a comma (in South Africa) is used for this purpose, as in these decimal numbers: 0.5 and 1.9 and 20.15 or 0,5 and 1,9 and 20,15. In these examples, the section to the left of the decimal point (comma) are whole numbers, and the section to the right of the decimal point (comma) are the decimal parts. Since decimal numbers are also fractions, it follows that 0,5 is the same as ½, 0.75 is the same as ¾, etc.

Prescribed Reading

Now read the section on decimals of this book: Truchon1997 (pages 39 to 53, both included). Initially you may skip the exercise sections (marked Exercise 1.1, 1.2, etc). You will be doing these Exercises in the Self-Assessment questions at the end of this section.

You are expected to be able to draw basic bar, line, and circle graphs, given the raw data.

A bar graph is a graph where the different graph points to be plotted are shown as bars of differing heights. Most graphs have a horizontal axis (called the x-axis) and a vertical axis (called the y-axis) – refer to Figure 9. All graphs should have a descriptive title, and both the x-and y-axis should be clearly named and marked off with values, as done in Figure 10. The relative heights of the bars give one an indication of how the values compare, for example from Figure 10 the most common birthday month for the students is June, and the least common month is August.

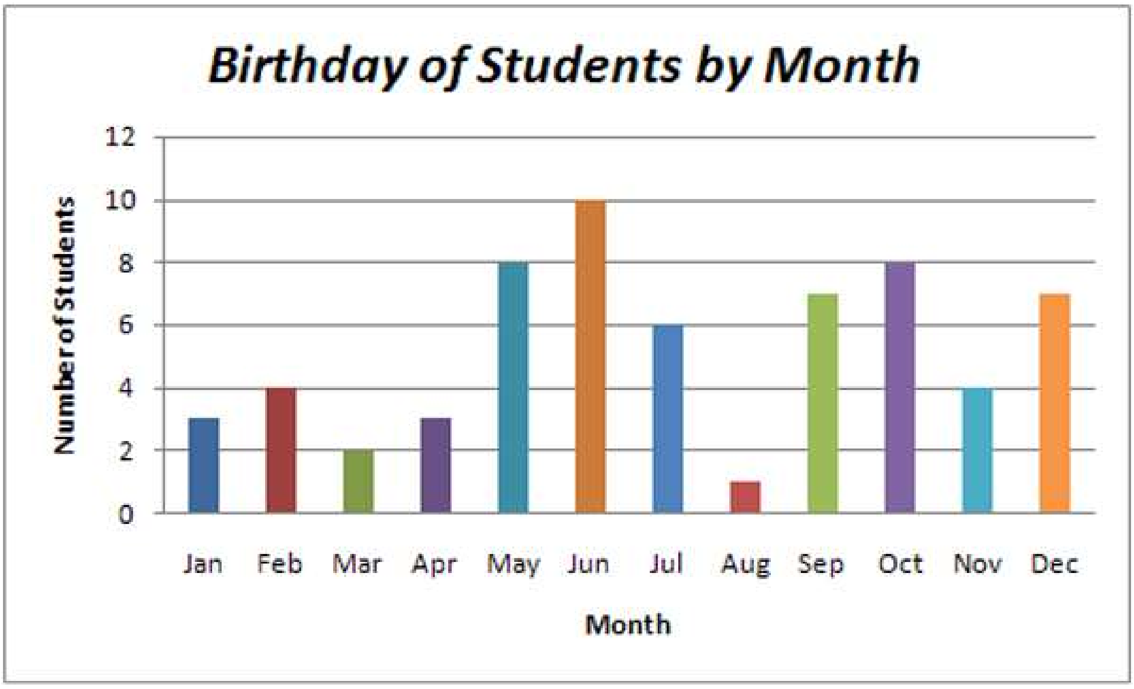

Figure 10: An example bar graph (Source: https://wikieducator.org/MathGloss/B/Bar_Graph, November 2022).

Prescribed Reading

Now read the section on bar graphs of this book: Truchon1997 (pages 104 to 106, both included). Initially you may skip the exercise sections (marked Exercise 8, 9, etc). You will be doing these Exercises in the Self-Assessment questions at the end of this section.

In a line graph, the different graph points are connected by lines instead of bars. As the lines go up and down, one can see patterns appearing. More than one set of values can be plotted on one line graph, as done in Figure 11.

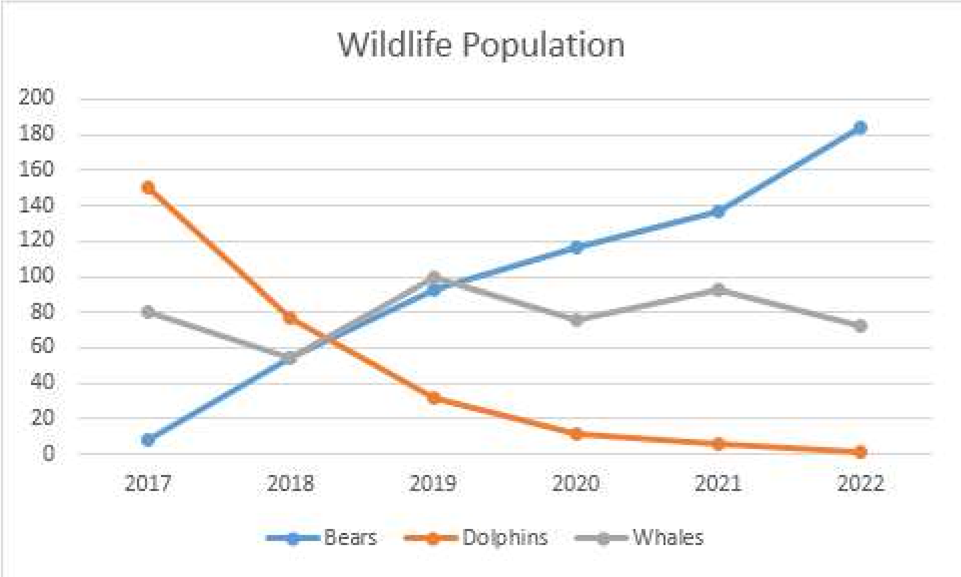

Figure 11: An example multiple line graph (Source: https://medium.com/@patrickbfuller/line-plot-7b4068a3a9fc, November 2022).

Again, the graph helps us spot patterns. In the case of Figure 11, the bear population is growing the fastest of the three animal types, while the dolphin population seems to be decreasing.

Note

We all know the saying: "A picture is worth a thousand words". This is especially true with graphs – they help us spot patterns which we probably would have missed without the graph.

Prescribed Reading

Now read the section on line graphs of this book: Truchon1997 (pages 107 to 108, both included). Initially you may skip the exercise sections (marked Exercise 8, 9, etc). You will be doing these Exercises in the Self-Assessment questions at the end of this section.

A circle graph, or a pie chart shows the relative fractions of the whole as wide and narrow slices of a pie, as in Figure 12.

Sometimes, pie charts are drawn as three-dimensional "exploded" graphs, to enhance their effectiveness (see Figure 13).

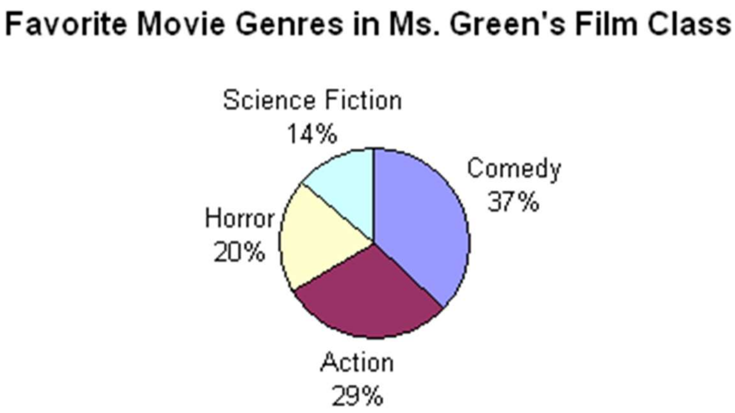

Figure 12: An example circle graph (Source: https://www.mathgoodies.com/lessons/graphs/construct_circle, November 2022).

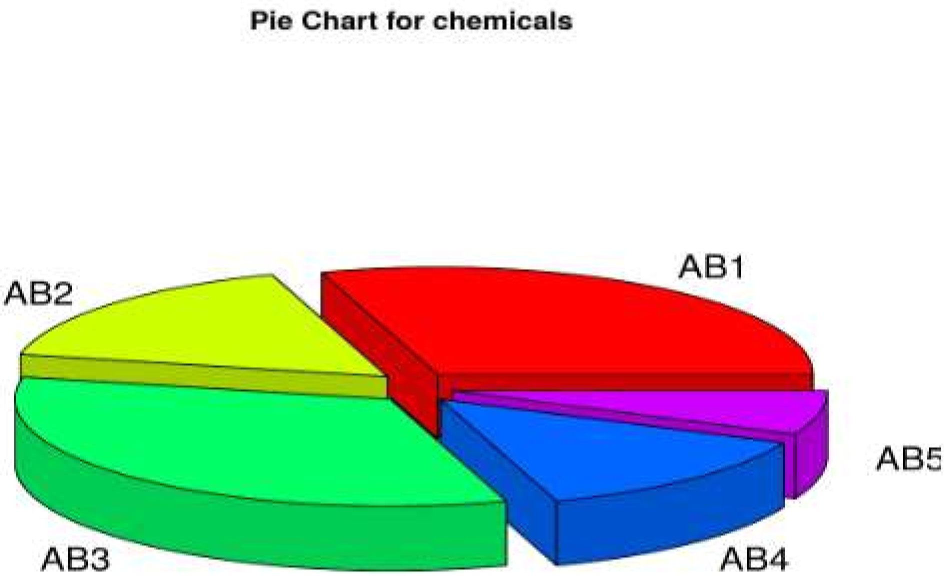

Figure 13: An example of an exploded 3D pie chart (Source: https://www.educba.com/pie-chart-in-r/, November 2022).

Again, graphs help us spot patterns in the data which would otherwise have been difficult to see. In the case of Figure 13 it is clear that chemicals AB2, and AB4 and AB5 combined contribute roughly the same fraction to the whole.

Prescribed Reading

Now read the section on circle graphs of this book: Truchon1997 (pages 109 to 111, both included). Initially you may skip the exercise sections (marked Exercise 8, 9, etc). You will be doing these Exercises in the Self-Assessment questions at the end of this section.

Since it is rather counter-productive to draw graphs by hand, you should learn how to draw basic graphs using a spreadsheet program.

Activity

Watch this video (9m18s), which explains how to use the Excel spreadsheet program to draw some simple graphs. Excel Quick and Simple Charts Tutorial. Retrieved from https://youtu.be/TfkNkrKMF5c

STATISTICS

It is assumed that you are familiar with the basics of statistics (including the measures of central tendency). However, if you feel that you are a bit rusty, go through these basics again, as indicated in the "Prescribed Reading" section below.

We often use the so-called measures of central tendency in statistics, to indicate the variety of ways that a set of values group themselves around one central value. The three most used measures of central tendency are the **average**, the **median** and the **mode**.

Prescribed Reading

Now read the section on "Statistical Math" of this book: Truchon1997 (pages 112 to 113, both included). Initially you may skip the exercise sections (marked Exercise 11, etc), since you will be doing these Exercises in the Self-Assessment questions at the end of this section.

Summary

In this topic, we discussed… IT is a field of study and work where people use and apply their knowledge of using and managing computers to solve problems. Job opportunities in the IT field include project managers, network managers and security experts. CS is a field of study and work where people use their computer skills to design systems and computers. Job opportunities in the CS field include operating system designers, programmers, and software engineers. IT and CS appear to be similar, but their focus differs: IT looks at the use and management of computers and related systems, where CS focuses more on the design and development of computer programs and other related elements. SE is a field of study which focuses on the design of computer programs, and as such it is a sub-section of CS. An IS is a collection of hardware, software and people designed to perform a specific function. Cognitive science informs us on how we learn about something new. Computer engineering involves a study of electrical engineering and computer science. For our study of mathematics, you must be familiar with whole numbers, fractions, decimals, percentages, equations, formulas, and the use of graphs. For our study of statistics, you must be familiar with the three measures of central tendency: average, median and mode.

Self-Assessment Questions

Topic 1.1

Q1 How would you define an IT expert?

Q2 Write your own definition of IT, as you see it.

Q3 Describe how you would be able to use IT in your everyday life to make things easier for you.

Topic 1.2

Q4 Name some jobs one could apply for in the computer science field.

Q5 How would you describe the difference between IT and CS?

Topic 1.3

Q6 Make a list of some job opportunities in SE, by listing some job titles typically advertised in this field.

Q7 What is the relationship between CS and SE?

Q8 Make a list of some of the typical job names associated with jobs in the SE industry.

Q9 Match the programming languages listed under a. below with the jobs listed under b.

a. HTML, Ruby, Python, CSS, PHP, JavaScript.
b. Front-end development, Back-end development.

Topic 1.4

Q10 Exercises 1 to 5 in the prescribed reading.

Topic 1.5

Q11 What are the informing fields to cognitive science?

Topic 1.6

Q12 Name a few typical jobs advertised for a computer engineer.

Topic 1.7

MATHEMATICS

Q13 At this point you should return to the Exercises on whole numbers (Truchon1997 p 10, p12, p15, p17, p21) supplied, complete all of them and check your answers against the supplied answers (starting on Truchon1997 p120 and onwards). Estimated time: 15m.

Q14 At this point you should return to the Exercises on fractions (Truchon1997 p 26, p28, p30, p32, p33, p35 and p38) supplied in Truchon1997, complete all of them and check your answers against the supplied answers (starting on p120 and onwards). Estimated time: 15m.

Q15 At this point you should return to the Exercises on decimals (Truchon1997 p40, p41, p42, p44, p46, p47 and p49), complete all of them and check your answers against the supplied answers (starting on p120 and onwards). Estimated time: 15m.

Q16 At this point you should return to the Exercises on bar graphs (Truchon1997 p104), complete all of them and check your answers against the supplied answers (starting on p120 and onwards). Estimated time: 15m.

Q17 At this point you should return to the Exercises on line graphs (Truchon1997 p108), complete all of them and check your answers against the supplied answers (starting on p120 and onwards). Estimated time: 15m.

Q18 At this point you should return to the Exercises on circle graphs (Truchon1997 p111), complete all of them and check your answers against the supplied answers (starting on p120 and onwards). Estimated time: 15m.

STATISTICS

Q19 At this point you should return to the Exercise on Statistical Math (Truchon1997 p113), complete it and check your answers against the supplied answers (starting on p120 and onwards). Estimated time: 15m.

Topic 2: History of IT

2.1 INTRODUCTION

This topic relates to the following module outcome:

Demonstrate insight in the history of computing technology, and an understanding of the Internet, and the World-Wide Web, as well as the components of an IT system and how they interrelate.

On completion of this topic, you will come to understand that IT has, as is the case for many other fields of study, a rich, interesting, and chequered history. In this topic, we will work through this history by first considering the history of computing technology, then working through the history of social impacts of computing. Next, we will look at the development of user-computer interaction, and we will conclude with the history of the development of the internet.

In this topic, you will gain knowledge in the following areas:

1. History of Computing Technology
2. Social history of Computing impacts
3. Development of user interaction
4. History of the internet

Prescribed reading

For Topic 2, the following prescribed books will be needed: Pham (2021) and Vermaat (2018).

2.2 HISTORY OF COMPUTING TECHNOLOGY

It will be wise to start the study of history of computing by considering the wide variety of computing hardware we have access to, since this development, to a large extent, has driven the development of computing.

Hardware development

Prescribed Reading

Read module 1, (pages 1-1 to 1-31), of this book (up to just before "Technology Uses"): Vermaat2018.

Read Section 1.3 (pages 1.3.1 to 1.3.6) of this book: Pham2021.

You should now have a fairly good idea of how technology has developed over the past few decades to bring us to where we are today, with access to a wide variety of computing devices (from desktops and laptops through using the internet, browsers and search engines to tablets, smartphones and networks). The development of hardware is discussed, firstly by using vacuum tubes, and later the omnipresent transistor. The many different computers which saw the light also tells a story of its own (the "Difference Engine", the Hollerith card reader, the ENIAC, the UNIVAC, and finally, the one computer which changed the flow of history for ever – the IBM PC (1982)). Another view on the development of technology is to look at how computing developed from the large and cumbersome mainframe to the much smaller and more powerful desktop, laptop, and tablet computers we use today.

2.3 SOCIAL HISTORY OF COMPUTING IMPACTS

Equally important than the hardware development of computing, is the way these developments have affected our daily lives, i.e., the social aspects of computing. The mere fact that we use the term "social media" so often lately, is confirmation of the fact that computing is closely linked to our social development and interaction with each other. Furthermore, the economic implications of the "haves" and the "have-nots" is strongly echoed in the possession and use of computing devices: if you have more economic resources, you are likely to possess more and better computing devices, and the other way around.

The use of computers affects the way we relate to other human beings we meet.

One of the social side-effects of the use of computers, is the appearance of a new type of crime – cybercrime. We now must be aware of how others can steal our identity, computer viruses and much else while we are using computers.

2.4 DEVELOPMENT OF USER INTERACTION

Part of the social aspect of using computers, is how we interact with a computer while using it. This is such an important aspect of computing, that yet another abbreviation has been created to describe it: HCI (Human Computer Interaction.)

Note

Working on a computer is more than just using the keyboard to type – it involves how we read the screen, how we respond to error messages, etc.

Prescribed Reading

Read this book: Norman2018, pages 1 to 5, up to just before "References".

This reading will take you on a whirlwind tour through the generations of HCI, touching on Boole, Hollerith, FORTRAN, BASIC and WIMP.

2.4 HISTORY OF THE INTERNET

Before starting this section, let us first clarify the difference between two terms which have often been used interchangeably, causing some confusion: the internet and the www (world wide web).

The **internet** is simply a globally connected network which enables us to communicate easily. In a way one can see the internet as all the computers in the world connected to the internet viewed together. Think of it as all the roads in the world which connect all the cities and towns to each other.

The **www**, on the other hand is the information retrieval section of the internet – this is all the many billions of web pages, spread across more than a billion websites, which is the stuff we look for when we are trying to find some very specific information. So, while travelling on the roads of the internet, the www is the houses and shops you see on the side of the road.

Taking this analogy further, the data (your emails and documents) which is constantly moving around, are the cars on the roads.

All of this leads to one very obvious question: how big is the internet? It is very much like asking different people on the street what the time of day is – the answers you get will change all the time.

Back to the question. The answer, late in 2022, is given in Figure 14.

Figure 14: How big is the internet (Source: https://siteefy.com/how-many-websites-are-there/, November 2022).

Considering that, at the same time, there were around 8 billion people in the world, that means that there is about 1 website per 7 people in the world. By the time you read this, the figures are likely to be quite different (most likely even higher).

Let us find out how the internet and the www have developed over time.

Prescribed Reading

Read this book: Vermaat2018, pages TT-1 to TT-13 (directly following on p5-44). This will provide a snapshot of not only the development of the www and the internet, but also an overall view of the development of computing in general from 1937 to 2018.

Summary

The history of the development of IT is closely linked to the history of the development of hardware, software, and associated devices. The design of the transistor, a tiny and very basic device, heralded the decrease in size of modern computers. A variety of computers have seen the light over the decades, normally shrinking in size but growing in processing power and storage capacity. During this time, IBM and its predecessors were born, and the computer has finally arrived to stay until this day. The IC (integrated circuit) was designed, cramming thousands of transistors and other components onto a small area, encapsulated in plastic – this further reduced the size and heat generated by computers. A turning point in this history was the release of the IBM PC in the early 1980s. This event has given rise to the development of a large number of "clones" – initially called IBM PC compatible computers, lately simply called PCs. One should always consider the social impact of computing on us as humans. One such positive effect is the ability we now have to view, order and pay for products online, to be delivered to our doorstep. Another more negative effect is the start and rise of cyber-crime – criminal activity executed with the aid of a computer and/or the internet. In parallel with the development of hardware, software has been designed to run on the hardware, empowering humans to become ever more productive. All these developments had a major impact on the human race and our interaction with each other. This interaction as further enhanced by the development of the internet.

Just as the first computers saw the light because of a need of business users, the internet saw the light because of the efforts of a defence organisation in the US.

Self-Assessment Questions

Topic 2

Q20 Create a timeline to show the development of computers over time, as well as the development of software. Your timeline should start with Charles Babbage in 1792, and end with Tim Berners-Lee in 1989.

Q21 Write your own notes on how computers have changed the way you interact with other humans.

Topic 2.1

Q22 Use a table to illustrate the basic differences between a laptop and a desktop computer, and a mobile phone.

Topic 2.2

Q23 What is considered to be the most important computing development of the twentieth century?

Q24 Make a drawing of and discuss the CIA triangle.

Q25 Make a list of any ten threats to an information system.

Topic 2.3

Q26 Identify and discuss the development of the three generations of human-computer interfaces.

Topic 2.4

Q27 What is the difference between the world wide web and the internet?

Q28 How big is the internet today, at the time of your reading this question?

Topic 3: Characteristics of IT Systems

Module outcomes

Topic 3 relates to the following module outcome/s:

Demonstrate an understanding of complexity in an information technology environment and how and why it occurs.

Module references

Throughout this topic, use will be made of prescribed books. Details about where to get hold of them and how to use them can be found in the "References" section at the end of this Study Guide. Inside Topic 3, the following prescribed books will be needed: Gupta2020, Pham 2021 and Printz2020.

3.1 THE COMPONENTS OF AN IT SYSTEM AND HOW THEY INTER-RELATE

Needless to say, IT systems (also called Information Systems, or simply ISs) consist out of many computers, normally linked together in some form of a network.

Let us find out more about the components making up an IS.

Prescribed Reading

Read this book: Gupta2020, pages 1 to 7, for a clear introduction to a typical IT system and related concepts.

Read this book: Pham2021, Chapter 2, for a clear introduction to a typical IT system and related concepts.

3.2 COMPLEXITY IN IT AND WHY IT OCCURS

IT systems can be quite complex, as they grow over years, often after joining one IT system to another. Before we dive into the complexity of IT systems, we must first look a bit more closely at systems and their interdependency.

Prescribed Reading

Read this book: Printz2020, the Foreword, pages ix and x, for an introduction to systems, their complexities and their integration.

Read this book: Printz2020, Introduction to Part 1, pages 3 and 4, for an introduction to systemic analysis, leading to the formation of the internet and the WWW, finishing off with a look at the pervasiveness of errors in systems.

Before understanding IT system complexity, we must look at Cybernetics. The term "cybernetics" has been derived from the Greek word *kybernetikos*, which means "to be good at steering"

Cybernetics is the science of automatic control systems (such as the human brain, driving a motorcar and our central nervous system) and communications in both living things and in machines. In machines, one can consider the complex system of railway signals and electronics/mechanics controlling it, including the ever-important feedback needed to make this system work (feedback is when system output is used to control input to other systems or parts of the same system). An example of a control system and feedback is as follows: while a human drives a motorcar, he/she has to use continuous feedback obtained through eyesight, using the ears, road signs, other traffic and weather conditions to take safe and sensible actions in controlling the motor vehicle. In this example the human brain acts as a controller which has to take decisions on future actions such as increasing or decreasing the speed, navigation around obstacles, changing gears, etc. Another aspect to be considered here is the sampling of outside elements. In our driver example, the driver has to continuously sample all the inputs to be able to take good decisions. At low speeds, sampling can be done say every one second, but at high speeds, it might be necessary to sample quite a few times per second.

The father of Cybernetics was Robert Wiener who described it in an early book ("Cybernetics", 1948). In this book, the act of governing a country or group of people is likened to cybernetics.

Of course, the birth of the computer has given rise to many comparisons between cybernetics and the use of a computer, since in both cases the element of feedback and control are present.

> **Prescribed Reading**
>
> Read this book: Printz2020, Part 1, pages 5 to 31, for more about cybernetics, and how it is linked to, for example, computer science.

3.3 MANAGING COMPLEXITY IN AN IT ENVIRONMENT

This background in systems, cybernetics and errors will help us understand the complexities of managing IT in general.

Managing complexity in software development can be likened to orchestrating a symphony. Just as a symphony conductor coordinates multiple instruments to create harmonious music, software developers orchestrate various components and functionalities to create a cohesive and efficient system. Each instrument in a symphony represents a different aspect of the software, such as user interface, database management, and algorithmic logic. The conductor's role mirrors that of a project manager or lead developer, ensuring that each part of the software works together seamlessly to achieve the desired outcome. Like a symphony, successful software development requires careful planning, precise coordination, and continuous refinement to produce a masterpiece of functionality and usability.

Example of a complex software system

Modern e-commerce platform consists of three primary components:

- the front-end:

    - what users interact with directly
    - user interface (UI) components such as web pages, mobile apps, and other graphical elements
    - using technologies like HTML, CSS, JavaScript, and various front-end frameworks such as React.js or Angular.
    - communicates with the back-end through APIs (Application Programming Interfaces) to fetch data and perform various actions like searching for products, adding items to the cart, and placing orders.
- the back-end
    - serves as the engine of the e-commerce platform, handling all the business logic and data processing.
    - managing user authentication, product catalogue management, inventory management, order processing, payment gateway integration, and more.
    - built using server-side technologies such as Node.js, Python (with Django or Flask), Ruby (with Ruby on Rails), or Java (with Spring Boot).
    - interacts with the database to retrieve and store data and exposes APIs that the front-end and other external services can consume.
- the database
    - where all the essential data of the e-commerce platform is stored, including user profiles, product details, inventory information, orders, and transaction records.
    - include relational databases like MySQL, PostgreSQL, or SQL Server, as well as NoSQL databases like MongoDB or Cassandra, depending on the specific requirements and data models.

Modern e-commerce platform

- Integration with Third-party Services: Modern e-commerce platforms often integrate with various third-party services to enhance functionality and provide a better user experience. These integrations may include payment gateways (such as PayPal, Stripe, or Square), shipping carriers (like UPS, FedEx, or DHL), analytics tools (such as Google Analytics), customer support systems, and marketing platforms. Integration with these services typically involves utilizing their APIs and SDKs to exchange data and trigger actions seamlessly.

- Scalability and Performance: A critical aspect of any e-commerce platform is its ability to handle increasing user traffic and transaction volumes without compromising performance. This often involves employing techniques like load balancing, caching (using tools like Redis or Memcached), horizontal scaling (adding more servers), and optimizing database queries. Additionally, leveraging cloud services such as AWS, Google Cloud Platform, or Microsoft Azure can provide scalability benefits by allowing resources to be dynamically allocated based on demand.
- Security: Security is paramount in an e-commerce platform to protect user data, financial transactions, and prevent unauthorized access. This entails implementing measures such as HTTPS encryption, secure authentication mechanisms (like OAuth or JWT), input validation, parameterized queries to prevent SQL injection attacks, role-based access control (RBAC), regular security audits, and compliance with industry standards such as PCI DSS (Payment Card Industry Data Security Standard).
- Monitoring and Analytics: To ensure the smooth operation of the e-commerce platform and gain insights into user behaviour and system performance, comprehensive monitoring and analytics are essential. This involves logging and tracking various metrics such as response times, error rates, conversion rates, user interactions, and sales performance. Tools like Prometheus, Grafana, ELK stack (Elasticsearch, Logstash, Kibana), and Google Analytics are commonly used for monitoring, logging, and analytics purposes.

Managing complexity in an IT environment

1. Understanding Complexity:

- Imagine you're building a Lego structure. When the structure gets bigger and more intricate, it becomes harder to manage all the pieces and make changes without messing up other parts.
- Similarly, in software development, complexity refers to how difficult it is to understand, change, and maintain a software system as it grows in

size and functionality. (Reference: Sommerville, I. (2016). Software Engineering (10th ed.). Pearson.)

2. Why Complexity Matters:
   - As software projects become more complex, they become harder to manage, leading to delays, errors, and frustration for developers.
   - Complex software is like a tangled knot: it's tough to unravel, fix, or add new features without causing more problems. (Reference: McConnell, S. (2004). Code Complete: A Practical Handbook of Software Construction (2nd ed.). Microsoft Press.)
3. Managing Complexity:
   - Just as you'd organize your Legos into different piles based on colour or shape to make building easier, software developers use strategies to manage complexity.
   - One strategy is to **break down big tasks into smaller, more manageable pieces**. This is like dividing a big project into smaller, bite-sized tasks that are easier to handle. (Reference: Larman, C., & Vodde, B. (2008). Scaling Lean & Agile Development: Thinking and Organizational Tools for Large-Scale Scrum. Addison-Wesley Professional.)
4. Agile Methodology:
   - Agile is like working on a puzzle one piece at a time instead of trying to solve the whole thing at once.
   - With Agile, developers work in **short bursts called sprints**, focusing on completing small, achievable goals and getting feedback from users along the way. (Reference: Martin, R. C. (2003). Agile Software Development: Principles, Patterns, and Practices. Prentice Hall.)
5. Good Communication:
   - Imagine building a Lego castle with a friend. If you don't talk about your plan and work together, you might end up with mismatched pieces or parts that don't fit.
   - Similarly, in software development, good communication between team members is crucial for managing complexity. Developers need to **share ideas, coordinate tasks, and solve problems together**. (Reference: Cockburn, A. (2002). Agile Software Development. Addison-Wesley Professional.)
6. Continuous Improvement:

- Building complex software is like building a skyscraper—it requires careful planning, constant adjustments, and teamwork.
- By continuously **learning from their mistakes, adapting to changes, and refining their processes**, developers can better manage complexity and build software that meets users' needs. (Reference: Beck, K. (1999). Extreme Programming Explained: Embrace Change (2nd ed.). Addison-Wesley Professional.)

Summary

An IS (Information System) is a computer system which performs some specific function, involving the collection, storage and processing of data and information, often in a business context. IS's are built up from IT components, and often involve quite complex constructs. Errors in IT systems sometimes involve complex solutions to complex situations. Cybernetics is the study of automatic control systems involving feedback.

Self-Assessment Questions

Topic 3.1

Q29 Make a drawing to show the typical components of an Information System. Use arrows to show their inter-dependency.

Topic 3.2

Q30 Give a one-paragraph description of cybernetics.

Topic 3.3

Q31 Briefly describe complexity in an IT environment.

Topic 4: The Development and Deployment of IT systems

Module Outcomes

Topic 4 relates to the following module outcome/s:

Illustrate the use of Information and Communication Technologies (ICT) to solve problems.

Module references

Throughout this topic, use will be made of prescribed books. Details about where to get hold of them and how to use them can be found in the "References" section at the end of this Study Guide. Inside Topic 4, the following prescribed books will be needed: Cadle2014, Gupta2020 and Pham2021.

4.1 THE DEVELOPMENT AND DEPLOYMENT OF IT SYSTEMS

Designing an IT system to perform a certain function is a major undertaking, not to be underestimated in its scope, costs and time taken. There are a number of phases to go through, and many tools and techniques to be used during this process. The process is generally referred to as the SDLC (the Systems {or Software} Development Life Cycle).

Activity

Watch this video (22m09s), which explains the basics of the SDLC: System Development Life Cycle. Retrieved from https://youtu.be/mH-Nc5kvyQQ

4.2 AN OVERVIEW OF PHASES, METHODS, TOOLS AND TECHNIQUES

For an overall description of the SDLC, follow these instructions.

Prescribed Reading

Read this book: Pham2021, Chapter 10 (pages 10.1.1 to 10.7.1, both included) for an introduction to the SDLC process.

Read this book: Gupta2020, Chapter 1 (pages 1 to 32, both included) for details about Information Systems.

Read this book: Cadle2014, Chapters 1 to 3 (pages 1 to 46, both included) for details on the complexities of the SDLC process.

4.3 HOW THE PROCESS IS MANAGED

Like any other complex process, the development and deployment of an IT system must be carefully managed and monitored.

Prescribed Reading

Read this book: Pham2021, Chapter 10 (page 10.4.1) for a description of the management of this type of process.

4.4 THE ROLE OF THE IT PROFESSIONAL

One of the most important roles in the SDLC process, is that of the Business Analyst.

Activity

Watch this video (16m49s), which explains the role of the business analyst in the SDLC process: What is the Business Analyst's Role in SDLC – Software Development Life Cycle. Retrieved from: https://youtu.be/018hXxd_8zs

Summary

The SDLC (Systems or Software Development Life Cycle) outlines each stage of software development, breaking down the process into separate phases that have individual:

Goals,
Tasks,
Expectations,
Process instructions,
Documentation,
Deliverables, and
Go-to personnel (specified either by name or position).

The exact number and nature of steps depend on the business and its product goals. On average, most companies define SDLCs with five to seven phases, although more complex projects reach ten or more stages.

Each step in an SDLC results in an output (document, diagram, working software, etc.) that acts as the necessary input for the next step. Despite this funnel-like approach, modern SDLC strategies are not strictly linear. The team often goes back a step or two in the SDLC to perform fixes or make improvements.

Adapted from: https://phoenixnap.com/blog/software-development-life-cycle [16 December 2022].

Self-Assessment Questions

Topic 4.1

Q32 List the seven basic steps in the SDLC

.

Topic 5: Application domains

Module Outcomes

Topic 5 relates to the following module outcome/s:

Demonstrate an understanding of how and to what extent IT has changed various application domains.

5.1 APPLICATION DOMAINS

As noted elsewhere, information technology is for everyone, and is no longer the domain of a small selection of technically astute wizards who seem to know everything about computers and how they work. It is a safe bet that everyone reading this study guide has had to make use of a computer somewhere during the last few weeks – maybe even right now, while reading this study guide.

While IT is truly ubiquitous – everywhere, all the time, there are certain areas we need to consider where IT has had a profound effect. These areas include the worlds of business, e-commerce, manufacturing, education, software development, medical, government, science and even human relationships. Let us consider these areas of IT involvement in more detail.

5.2 BUSINESS APPLICATIONS

As we remember that the first computers were made to assist humans in business, it comes as no surprise that today still computers find a strong area of application in the world of business.

Activity

Watch this video (5m57s), where the importance of IT in business is discussed: Why Is Technology Important in A Business? Retrieved from https://youtu.be/UIjSINmNV00

Prescribed Reading

Read this book: Pham2021, Section 1.4 (p 1.4.1) for details on the role of technology in business.

Read this book: Williams2010, Section 1.2 (p8-p9) for more details on this topic.

5.3 E-COMMERCE

Linked very closely to business is the use of IT in e-commerce, where e-commerce is simply the conclusion of a commercial transaction through the internet.

This is in stark contrast to the concept of "bricks-and-mortar" – which is where a paying customer visits a traditional store, looks around at the wares on display, and possibly pays for products, walking out with these products in his/her possession.

Linked computers lend themselves very well to the electronic equivalent of this process: the customer can view the products on his/her own computing device. They can then place an order and pay for it using the server computer(s) of the retailer, which will also process to order from start to finish. Afterwards, the order can easily be tracked through all the stages until it is finally delivered.

Activity

Watch this video (3m10s), where the importance of e-commerce discussed: What is Ecommerce and How Does it Work in 2022? Retrieved from https://youtu.be/mUNchZeLDBc

Prescribed Reading

Read this book: Pham2021, Section 1.4 (p 1.4.1) for details on the role of technology in business.

Read this book: Williams2010, Section 12.5 (p97-p98) for more details on this topic.

Read this book: Williams2010, Section 8.5 (p421-p) for more details on this topic.

5.4 MANUFACTURING

Most manufacturing processes can easily be automated, and often are.

Activity

Watch this video (12m38s), where the manufacturing process is discussed: Intro to Manufacturing Operations, Technology, and Processes. Retrieved from https://youtu.be/zR36urTYC4k

Prescribed Reading

Read this book: Pham2021, Section 1.4 (p 1.4.1) for details on the role of technology in manufacturing.

Read this book: Vermaat2018 (p1 – p38) for details on the role of technology in the manufacturing business.

5.5 EDUCATION

After the Covid pandemic, most people know about online or at least blended learning, where instead of face-to-face teaching with a lecturer addressing a group of students, teaching takes place on an online platform like Moodle, Blackboard or Canvas.

Activity

Watch this video (10m24s), where the education process is discussed from the viewpoint of a digital immigrant – someone who did not grow up with the internet, Google and social media: Technology and Teaching. Retrieved from: https://youtu.be/kix_OF9n4tk

Prescribed Reading

Read this book: Vermaat2018 (p1 – p31) for details on the role of technology in education.

Read this book: Williams2010, Section 1.2 (p5-p6) for details on the role of technology in education.

5.6 ENTERTAINMENT

The entertainment world lends itself very well to the world of computers. Not only playing games on computers, which has become a multi-billion-dollar industry, but also the more mundane tasks like booking tickets for an event have become so much more "do-able" through the use of computers.

Activity

Watch this video (24m20s): Director of IT in Entertainment Informational Interview, for a peek behind the scenes of what we often see on TV and accept it as being normal. Retrieved from: https://youtu.be/DheIiHqywnE

Prescribed Reading

Read this book: Vermaat2018 (p1 – p34) for details on the role of technology in entertainment.

Read this book: Williams2010, Section 1.2 (p9-p10) for details on the role of technology in entertainment.

5.7 SOFTWARE DEVELOPMENT

The development and testing of complex sets of software coding can also be done through the use of computers.

Prescribed Reading

Read this book: Pham2021, Section 1.4 (p1.4.1) for details on the use of computers in software testing.

Read this book: Williams2010, (p150 and p499-p527) for details on the use of computers in software testing.

Activity

Watch this video (3m12s): The roles of a software development team. Retrieved from: https://youtu.be/hvDTweQJWRg

5.8 BIO-INFORMATICS AND MEDICAL APPLICATIONS

As humankind grows continuously, the health and welfare of our bodies and possibly a longer lifespan becomes more and more important to many of us. Computing has found numerous applications in the Bio-informatics and general medical fields.

Prescribed Reading

Read this book: Vermaat2018 (p1-35) for details on the use of computers in healthcare.

Read this book: Williams2010, Section 1.2 (p6-p7) for details on the use of computers in the medical world.

Read this book: Williams2010, Section 9.4 (p476-p482) for more details on the use of computers in the medical world.

Activity

Watch this video (8m58s): Bio-informatic sciences. Retrieved from: https://youtu.be/uSNc44V6GZQ

5.9 OTHERS

Of course, the application of computing is not limited to the fields discussed above only. IT also finds a home in the fields of Governance, Science, Travel, Careers and even human relationships in the form of online dating, as explained in various references below.

Prescribed Reading

Read this book: Vermaat2018, (p1-p36).

Read this book: Williams2010, section 1.2 (p10-p11).

Read this book: Williams2010, section 2.5 (p98-p101).

Read this book: Williams2010, section 9.5 (p484-p486).

Note

Is there are area of application where you know computers can and are used, which has not been covered here? There are likely to be a few of them.

Summary

IT finds an application in almost every sphere of everyday life we can think of. In this section we have "only" considered the application of IT in the fields of business, e-Commerce, manufacturing, education, entertainment, software development, bioinformatics and medical applications, governance, science, travel, careers and online dating. But one can mention just about any sphere of life, and one will be able to find an application of IT there as well.

Self-Assessment Questions

Topic 5

Q33 A large number of applications of IT has been discussed before. Identify any field with which you are familiar, and which has not been included in this discussion, and discuss the application of IT in that field.

References

Prescribed resources:

These books will be referred to in the text of this Study Guide by their first author and year of publication respectively, like this: Cadle2014, Gupta2020, Landauer2022, Norman2018, Pham2021, Printz2020, Truchon1997, Vermaat2018 and Williams2010.

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Self-Assessment Answers

Topic 1.1

A1 Someone who probably works in the IT industry, and who has in-depth knowledge and understanding of one specific area inside IT.

A2 This could be any sensible definition, for example: It is an area of expertise which has to do with computers and how to use them in a way that benefits either yourself, or other people, or an organisation.

A3 a. Use a computer to keep track of daily personal income and expenses.
b. Use a computer to make useful drawings of something you can use at work.
c. Use a computer to edit and sort digital pictures taken with your cell phone.

Topic 1.2

A4 Systems analyst, computer programmer, hardware designer, operating system designer.

A5 IT is about the use of computers, where CS focuses more on the design and development of computer programs and other related elements.

Topic 1.3

A6 SE is a part of CS.

A7 Web developer, web designer, UX designer, app developer, front-end developer, back-end developer, software developer, DevOps developer

A8 Front-end developer, back-end developer, programmer, software engineer.

A9 Front-end development: HTML, CSS, JavaScript. Back-end development: Ruby, Python, PHP.

Topic 1.4 (see Pham2021 Chapter 1, 1.1 to 1.6)

Exercise 1.

Exercise 2.

Exercise 3.

Exercise 4.

Exercise 5.

Topic 1.5

A11 Philosophy, linguistics, psychology, anthropology, artificial intelligence, neuroscience.

Topic 1.6

A12 embedded systems engineer, VLSI engineer, multimedia designer, network engineer.

A13 to A19 – see Truchon1997.

Topic 2

A20

- 1792-1871 Charles Babbage Difference engine
- 1815 - 1852 Ada Byron, first programmer
- 1888 Herman Hollerith Card reader for census > became IBM (typewriters, calculators)
- 1939 ENIAC - tubes
- 1939-1944 - digital electronic computers started appearing
- 1947 Transistor invented
- 1950 First PC was built Apple 1 (Steve Wosniak)
- 1951 UNIVAC commercially available, tubes
- Grace Hopper codes on the UNIVAC
- 1952 IBM mainframes
- 1958 CDC builds the first large transistor-based computer.
- Early 1960s - transistors start replacing tubes
- ICs were designed
- 1969 DoD ARPAnet started
- 1971 email started being used
- 1972 HP builds first small desktop

- 1975 Altair 8800 becomes first PC to be sold
- 1976 Bill Gates starts Microsoft
- 1977 Apple was started
- 1981 IBM PC came on the market, followed by many clones - this started the computer revolution
- 1989 Tim Berners-Lee wrote the code which started the www.

A21

This could be any description that fits the bill, eg:

a. How computers are used for everyday tasks, and how family members communicate about these tasks. This could include things like household budgeting, planning or organizing things, arranging photographs, etc.

b. How social media has changed the way people communicate with each other, etc.

c. How emails and instant messaging has replaced traditional letter-writing, Christmas cards, etc.

A22

Feature	Laptop	Desktop Computer	Mobile Phone
Portability	Portable, easy to carry	Not portable, fixed location	Highly portable, fits in pocket
Power Source	Battery and AC power	AC power only	Battery powered
Performance	Moderate to high	High	Moderate
Upgradeability	Limited (RAM, storage)	High (RAM, storage, GPU, CPU)	Very limited
Input Devices	Built-in keyboard and touchpad	External keyboard and mouse	Touchscreen
Connectivity	Wi-Fi, Bluetooth, USB ports	Ethernet, Wi-Fi, Bluetooth, multiple USB	Wi-Fi, Bluetooth, cellular
Storage	SSD/HDD, typically 128GB to 2TB	SSD/HDD, typically 256GB to multiple TBs	Flash storage, typically 32GB to 512GB

A23

The most important computing development of the twentieth century is widely considered to be the invention of the microprocessor.

Key Points about the Microprocessor:

1. Introduction and Impact:

- Introduced in the early 1970s, the microprocessor is essentially the brain of a computer, integrating the functions of a computer's central processing unit (CPU) onto a single or a few integrated circuits.
- It enabled the creation of personal computers, which revolutionized both personal and professional computing.

2. Significance:

- Miniaturization: Allowed for the miniaturization of computing devices, leading to the development of laptops, tablets, and smartphones.
- Accessibility: Made computing power more accessible to the general public and small businesses, not just large corporations and governments.
- Innovation: Spurred innovations in various fields including software development, gaming, and internet technologies.

3. Key Milestones:

- Intel 4004 (1971): The first commercially available microprocessor, developed by Intel, marked the beginning of the microprocessor era.
- Intel 8080 and 8088: Subsequent microprocessors that led to the development of early personal computers like the Altair 8800 and IBM PC.

4. Long-term Effects:

- Digital Revolution: Catalyzed the digital revolution, transforming industries and everyday life through the proliferation of digital technologies.
- Moore's Law: The microprocessor industry followed Moore's Law, leading to exponential growth in processing power and efficiency over the decades.

The invention of the microprocessor fundamentally transformed computing from large, expensive machines used by few, to compact, affordable devices accessible to many, shaping the modern digital world.

A24

The CIA Triad is a fundamental concept in information security, representing the three core principles that ensure the protection of data and systems. Here's a discussion of each component:

1. Confidentiality (C):
   - Description: Ensures that sensitive information is accessed only by authorized individuals and remains protected from unauthorized access.
   - Examples: Encryption, access controls, and authentication mechanisms.

2. Integrity (I):
   - Description: Ensures the accuracy and completeness of data, protecting it from unauthorized alteration or tampering.
   - Examples: Checksums, hash functions, and version control.

3. Availability (A):
   - Description: Ensures that information and resources are accessible to authorized users when needed.
   - Examples: Redundant systems, regular backups, and network traffic management.

The CIA Triad serves as a guiding framework for developing and implementing security policies, procedures, and technologies to protect information systems from various threats. By focusing on these three principles, organizations can build robust security measures to safeguard their data and maintain operational continuity.

A25

Here are ten threats to an information system:

1. Malware:
   - Includes viruses, worms, trojans, and ransomware designed to damage or disrupt systems, steal data, or gain unauthorized access.
2. Phishing:
   - Fraudulent attempts to obtain sensitive information such as usernames, passwords, and credit card details by disguising as a trustworthy entity.
3. Insider Threats:

- Security risks that originate from within the organization, such as employees, former employees, contractors, or business associates who have access to sensitive data.

4. Denial of Service (DoS) Attacks:
   - Attempts to make a machine or network resource unavailable to its intended users by overwhelming it with a flood of internet traffic.
5. SQL Injection:
   - A code injection technique that might destroy a database by injecting malicious SQL statements into an entry field for execution.
6. Man-in-the-Middle (MitM) Attacks:
   - Eavesdropping attacks where the attacker secretly intercepts and possibly alters the communication between two parties.
7. Zero-Day Exploits:
   - Attacks that target vulnerabilities in software that are unknown to the software maker and have no available patches.
8. Password Attacks:
   - Techniques such as brute force, dictionary attacks, or credential stuffing used to gain unauthorized access to systems by cracking user passwords.
9. Social Engineering:
   - Manipulating people into performing actions or divulging confidential information, often through deception and psychological tactics.
10. Advanced Persistent Threats (APTs):
    - Prolonged and targeted cyber attacks in which an intruder gains access to a network and remains undetected for an extended period.

These threats can lead to data breaches, financial loss, reputational damage, and other serious consequences for individuals and organizations.

A26

Human-Computer Interfaces (HCI) have evolved significantly over time, marked by three distinct generations. Each generation brought about a new way for humans to interact with computers, enhancing usability and expanding the possibilities of computing.

First Generation: Command-Line Interfaces (CLI)

Development:
- Era: 1950s-1970s
- Interaction: Text-based, requiring users to type commands using a keyboard.
- Systems: Early computers and mainframes, Unix systems.

Discussion:
- Complexity: High, requiring knowledge of specific command syntax and computer language.
- Flexibility: High, allowing detailed and specific instructions to be given to the computer.
- User Base: Primarily used by computer scientists and professionals due to the technical knowledge required.
- Examples: DOS, early Unix.

Second Generation: Graphical User Interfaces (GUI)

Development:
- Era: 1980s-1990s
- Interaction: Visual-based, using icons, windows, and menus navigated by a mouse and keyboard.
- Systems: Personal computers, early Mac OS, Windows.

Discussion:
- Ease of Use: Increased dramatically, allowing non-technical users to interact with computers.
- Accessibility: Made computers accessible to a broader audience, including home users and businesses.
- Productivity: Enhanced productivity with intuitive drag-and-drop, copy-paste, and multitasking features.
- Examples: Microsoft Windows, Apple Macintosh, various Linux distributions with GUI.

Third Generation: Natural User Interfaces (NUI)

Development:
- Era: 2000s-present
- Interaction: Natural and intuitive methods such as touch, voice, gesture, and even brain-computer interfaces.

- Systems: Smartphones, tablets, smart devices, virtual and augmented reality.
Discussion:
- Intuitiveness: Maximizes ease of use by mimicking natural human actions and behaviours.
- Innovation: Introduced new interaction paradigms such as multi-touch gestures, voice commands (e.g., Siri, Alexa), and motion sensing (e.g., Kinect).
- Ubiquity: Extended beyond traditional computers to everyday devices, enhancing interactivity and engagement.
- Examples: iOS and Android devices, Microsoft Kinect, VR headsets, smart home devices.

Summary

- Command-Line Interfaces provided powerful but complex interaction, suitable for expert users.
- Graphical User Interfaces revolutionized computing by making it accessible and user-friendly, leading to widespread adoption.
- Natural User Interfaces have further simplified and enriched interactions, integrating computing seamlessly into daily life through intuitive and innovative methods.

These advancements in HCI have continuously improved the way humans interact with technology, making it more accessible, efficient, and integrated into various aspects of life.

Topic 3

A27

The terms "World Wide Web" (WWW) and "Internet" are often used interchangeably, but they refer to different aspects of the digital world. Here are the key differences between the two:

The Internet

1. Definition:
   - The Internet is a global network of interconnected computers and servers that communicate using standard protocols.

2. Components:

- Consists of hardware (servers, routers, computers) and infrastructure (cables, satellites) that form the backbone of global communication.

3. Functions:

- Supports a wide range of services and applications, including email, file transfer, remote access, and the World Wide Web.

4. Protocols:

- Uses protocols such as TCP/IP (Transmission Control Protocol/Internet Protocol) for communication between devices.

5. Scope:

- Encompasses all types of digital communication and data exchange.

The World Wide Web

1. Definition:

- The World Wide Web is a system of interlinked hypertext documents and multimedia content accessible via the Internet using web browsers.

2. Components:

- Consists of web pages, websites, and web servers that store and serve content to users.

3. Functions:

- Allows users to navigate and access information using hyperlinks, enabling activities such as browsing, searching, and interacting with web applications.

4. Protocols:

- Primarily uses HTTP (Hypertext Transfer Protocol) and HTTPS (HTTP Secure) for transmitting web pages over the Internet.

5. Scope:

- Represents just one of the many services available on the Internet, specifically focused on hypertext and multimedia content.

Summary of Differences

- Nature:
  - Internet: The global network infrastructure.
  - World Wide Web: A service that runs on the Internet, providing access to hypertext and multimedia content.

- Scope:
  - Internet: Includes all types of online communication and services.
  - World Wide Web: Specifically refers to web pages and websites accessed through browsers.

- Protocols:
  - Internet: Utilizes a variety of protocols for different services (TCP/IP).
  - World Wide Web: Primarily uses HTTP/HTTPS protocols.

- Function:
  - Internet: Facilitates global communication and data exchange.
  - World Wide Web: Provides a way to access and navigate hypertext documents and multimedia content.

In essence, the Internet is the underlying network that supports various services, including the World Wide Web, which is a collection of interconnected documents and resources accessible via web browsers.

A28

As of 2024, the Internet has reached impressive scales in terms of users, websites, and data. Here are some key statistics to illustrate its size:

1. Internet Users: There are approximately 5.44 billion internet users globally, which accounts for 67.1% of the world's population.

2. Websites: The number of websites is nearly 2 billion, with only about 20% being active at any given time.

3. Data: The total amount of data created and consumed globally continues to grow exponentially. In 2020, the global datasphere was estimated at 64 zettabytes, and it has been expanding rapidly ever since.

4. Daily Data Generation: Every day, the world generates about 2.5 quintillion bytes of data. This includes data from social media, IoT devices, and various other digital sources.

These figures highlight the vast and continually expanding nature of the Internet, encompassing a significant portion of the global population and generating enormous amounts of data daily.

A29

Components of an Information System:

1. Hardware: The physical devices and equipment used in the information system, such as computers, servers, and networking equipment.
2. Software: The applications and programs that run on the hardware and perform various tasks.
3. Data: The information that is processed and managed by the system.
4. Processes: The procedures and rules that govern the operation of the system and the flow of data.
5. People: The users who interact with the system and use its outputs.

Inter-dependency:

- Hardware ↔ Software: Hardware runs the software, and software controls and makes use of hardware resources.
- Software ↔ Data: Software processes and manages data.
- Data ↔ Processes: Processes define how data is collected, processed, and stored.
- Processes ↔ People: People follow processes to use the system effectively.
- People ↔ Hardware: People interact with hardware to input and retrieve data.

These components and their inter-dependencies illustrate the integrated nature of an information system, where each element relies on the others to function effectively.

A30

Cybernetics is an interdisciplinary field that studies the structure, function, and behaviour of complex systems, focusing on the regulatory and feedback mechanisms that enable systems to self-regulate and adapt. Originating in the 1940s, the field was significantly influenced by Norbert Wiener, who defined it as the science of "control and communication in the animal and the machine." Cybernetics integrates principles from various disciplines including engineering, biology, computer science, and social sciences to understand how systems—be they mechanical, biological, or social—process information, react to feedback, and achieve desired outcomes. It has applications ranging from robotics and artificial intelligence to organizational management and ecological sustainability.

A31

Complexity in an IT environment refers to the intricate and multifaceted nature of managing, integrating, and securing various technological components and systems within an organization. This complexity arises from several factors, including the diverse range of hardware and software platforms, the interdependencies between different systems and applications, the rapid pace of technological change, and the need to meet various compliance and security requirements. It involves challenges related to system interoperability, data integration, network management, and the coordination of IT operations across different departments and geographies. Additionally, complexity is exacerbated by the need to ensure seamless user experiences, maintain system uptime, and protect against cyber threats, all while managing limited resources and budgets.

Topic 4

A32

The Systems Development Life Cycle (SDLC) consists of several distinct phases that guide the development and maintenance of information systems. The seven basic steps in the SDLC are:

1. Planning:

- Identify the scope, objectives, and feasibility of the project. This phase involves resource allocation, risk assessment, and defining the project goals.

2. Requirements Analysis:

- Gather and analyze the needs of users and stakeholders to define the system requirements. This includes functional requirements, performance requirements, and user interface requirements.

3. Design:

- Create detailed specifications and design documents for the system architecture, including data models, process flows, and interface designs. This phase also involves selecting the technologies and tools to be used.

4. Implementation (or Development):

- Translate the design documents into actual code. This involves coding, integrating different modules, and creating the database structures.

5. Testing:

- Validate the system against the requirements to ensure it is working as intended. This includes unit testing, integration testing, system testing, and user acceptance testing (UAT).

6. Deployment:

- Install and configure the system in the production environment. This phase may involve data migration, user training, and the implementation of any necessary support structures.

7. Maintenance:

- Provide ongoing support and enhancements after the system is operational. This includes fixing bugs, updating the system for changes in requirements, and ensuring the system continues to meet user needs.

These steps provide a structured approach to developing information systems, ensuring that each phase is completed systematically and thoroughly to deliver a functional and reliable system.

Topic 5

A33

One field where Information Technology (IT) has had a profound impact, but which might not have been discussed in detail previously, is agriculture. The application of IT in agriculture, often referred to as "AgriTech" or "smart farming," involves the use of various technologies to improve the efficiency, productivity, and sustainability of farming practices.

Applications of IT in Agriculture:

1. Precision Farming:
   - Description: Precision farming involves using GPS, remote sensing, and IoT devices to monitor and manage crops at a micro level.
   - Benefits: Enhances crop yields, reduces waste, and optimizes the use of inputs like water, fertilizers, and pesticides.

2. Data Analytics:
   - Description: Big data analytics helps in processing vast amounts of data from various sources such as weather forecasts, soil sensors, and crop health monitors.
   - Benefits: Provides actionable insights for better decision-making, predicting crop diseases, and optimizing planting schedules.

3. Drones and Satellite Imagery:
   - Description: Drones and satellites capture high-resolution images of fields to monitor crop health, soil conditions, and irrigation needs.
   - Benefits: Allows for early detection of issues, efficient land management, and precise application of inputs.

4. Automated Machinery:
   - Description: Use of automated tractors, harvesters, and other machinery equipped with sensors and GPS.
   - Benefits: Increases efficiency, reduces labor costs, and ensures precise operations like planting and harvesting.

5. Farm Management Software:

- Description: Integrated software solutions for managing all aspects of farm operations including inventory, finances, and crop management.
- Benefits: Streamlines operations, improves record-keeping, and enhances overall farm management.

6. Smart Irrigation Systems:

- Description: IoT-based irrigation systems that use real-time data to manage water usage.
- Benefits: Reduces water waste, ensures crops receive the right amount of water, and saves energy.

7. Blockchain for Supply Chain Management:

- Description: Blockchain technology is used to track and record the journey of agricultural products from farm to table.
- Benefits: Enhances transparency, ensures traceability, and reduces fraud in the supply chain.

Impact on Agriculture:

- Increased Productivity: By using IT, farmers can achieve higher crop yields and more efficient resource use.
- Sustainability: Smart farming practices reduce the environmental impact of agriculture by optimizing input usage and minimizing waste.
- Risk Management: Data-driven insights help farmers manage risks related to weather, pests, and market fluctuations.
- Economic Benefits: Improved efficiency and productivity translate into higher profits for farmers and lower costs for consumers.

Overall, the integration of IT in agriculture is transforming the way farming is done, making it more efficient, sustainable, and profitable. This technological evolution is crucial for meeting the growing food demands of a rising global population.